UNIVERSITY FOR DEVELOPMENT STUDIES

CLIMATE-RESILIENT HEALTH SYSTEMS IN LOW-RESOURCED SETTINGS OF GHANA: AN ASSESSMENT OF POLICY, PRACTICE AND OPPORTUNITIES IN THE UPPER EAST REGION.

RUDOLF ABUGNABA-ABANGA

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BY

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THESIS SUBMITTED TO THE DEPARTMENT OF ENVIRONMENT AND SUSTAINABILITY SCIENCES, FACULTY OF NATURAL RESOURCES AND ENVIRONMENT, UNIVERSITY FOR DEVELOPMENT STUDIES IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF PHD ENVIRONMENTAL MANAGEMENT AND SUSTAINABILITY

JULY 2024

DECLARATION

Student

I hereby declare that this thesis is the result of my original work and that no part of it has been presented for another degree in this University or elsewhere:

Candidate Signature:  Date: 10th July, 2024

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Supervisors

I hereby declare that the preparation and presentation of the thesis was supervised following the guidelines on supervision of thesis laid down by the University for Development Studies.

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ABSTRACT

Ghana's national climate change masterplan 2015-2020 underscores the need to mainstream climate change adaptation into health systems. Ghana's Ministry of Health mainstreamed climate change and health into its Medium-term Development Plans in 2010-2013 and 2014-2017. The study assessed how Ghana's climate change agenda has translated into climate action within the Primary Healthcare System (PHC). The study was conducted in the Upper East Region of Ghana. Multi-stage sampling was applied to select the Binduri, Builsa North, and Talensi Districts. In this mixed method study, thematic Analysis was applied to understand how the Community-Based Health Planning and Services (CHPS) policy supports climate action because they comprise 63% of health facilities in Ghana. The study assessed the health system's resilience to climate change via checklists based on World Health Organisation indicators. The study also assessed the vulnerability and environmental sustainability of healthcare facilities (HCF) in three low-resourced Primary Health Care (PHC) settings/Districts between September 2021 to September 2022. The preparedness (risk levels) of PHCs and HCFs were categorized by calculating the average score. Key informant interviews with PHC and HCF managers were held to understand context-specific facilitators and barriers to mainstreaming climate change adaptation and mitigation into PHC operations and thematically analysed. Twenty-seven of 33 District Health Management Team members of PHCs (82%), 65 of 67 PHC facility managers (97%) participated in vulnerability assessments, and 18 managers were interviewed. The CHPS policy minimally mainstreams climate change adaptation and mitigation. Also, PHC systems show incomplete preparation due to a lack of formal plans and budgets for mainstreaming climate change adaptation and mitigation into PHC operations. Between September 2021 and September 2022, 80% of Health Care Facilities (HCFs) observed multiple climate hazards, and 80% of HCFs were found to be

unprepared (higher risk) for the impacts of climate hazards. The results suggest that most PHC facilities are at high risk or are unprepared for the negative impacts of climate change. Mainstreaming climate action into PHC policy protocols and standards is an essential facilitator for climate change adaptation and mitigation by PHC, while the cost of mainstreaming is a significant barrier. The study recommends Ghana's health system policy makers (Ministry of Health) to take steps and build capacity to mainstream Ghana's national climate agenda into health systems and PHC policies, protocols and standards to enhance sustainable climate action.

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DEDICATION

I dedicate this work to my mum, Elizabeth Apibil. Thank you for always believing in me.

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CHAPTER ONE

INTRODUCTION

1.1 The Background of the Study

Climate change significantly threatens global health and wellbeing (Costello et al., 2009). Negative impacts of climate change on human populations can be directly due to extreme weather events or indirectly arising from the modifying effects of contamination pathways and transmission dynamics of vectors. The modifying effects of contamination pathways and vector dynamics amplifies health effects on human populations such as increase in temperature-related illnesses, death, extreme weather-related health effects, air pollution-related health effects, water and food borne diseases, vector-borne, rodent-borne diseases, mental, nutritional, infectious and other health effects (Smith et al.,2014). Heatwaves (Watts et al.,2022), mental health (Saltzman et al., 2023; WHO,2022a; Carlos et al., 2022), and changing disease patterns (Ross et al.,2023) due to climate change put global populations at higher risk. The World Bank estimates climate change could drag more than 100 million people back into extreme poverty by 2030, with much of this reversal attributable to negative impacts on health (World Bank, 2017).

Climate change will disproportionately impact the global south (Carlson et al., 2023). For example, extreme weather events caused global devastation worth US$253 billion in 2021, particularly in countries with low Human Development Index (Romanello et al.,2020). Specifically in Africa, climate change is worsening public health systems (Opoku et al., 2021) due to increased pressure on health systems (Zakari et al.,2023). Health service disruptions due to climate change can undermine the Sustainable Development Goal target of Universal Health Coverage (Salas & Jha, 2019). The negative impacts of climate change on human populations require active adaptation of health systems to cope with the increased frequency of extreme weather events and mitigation efforts to contribute to reducing the impacts of climate change, especially in poorer countries.

Ghana invested in restructuring and strengthening its health systems to improve efficiency and access to health services in 1996. The Ghana Health Service and Teaching Hospitals Act 525 (Act 525, 1996) introduced reforms in the Ghanaian health system, leading to the separation of roles between the Ministry of Health (MOH) and Ghana Health Service (GHS), with the MOH responsible for policy formulation and the GHS being an implementing agency. The reforms deepened decentralization in the provision of health services by creating regional health directorates and district health systems or Primary Health Care (PHC) systems in Ghana. As shown in Figure 1, PHCs are subnational health systems modelled around three-tier management and healthcare facility levels comprising Community-Based Health Planning and Services (CHPS), health centres, district hospitals, and a District Health Management Team (DHMT) as supervisors with Community- Based Health Planning and Services (CHPS) designated as the gatekeeper or first point of contact with the health system by the population.

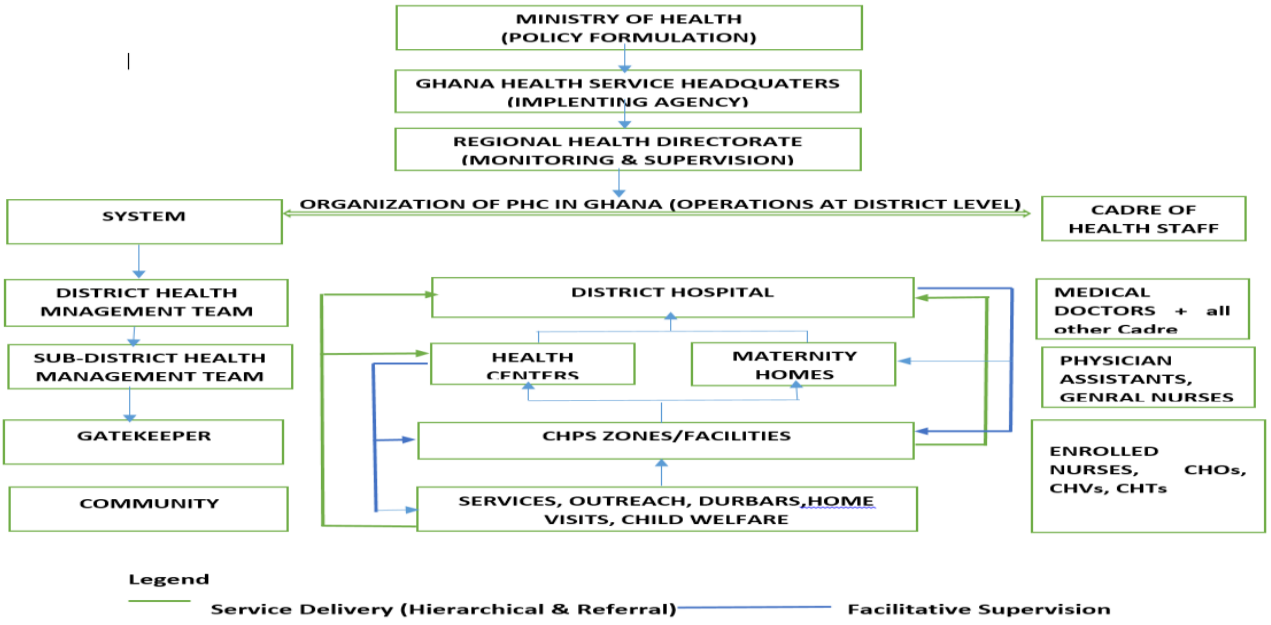

Figure 1: Organization of Primary Healthcare in Ghana
Source: (GoG/MOH, 2020 ; GHS, 2023)

The Navrongo Health Research Centre piloted CHPS as a community health and family planning project in 1994 (Awoonor-Williams et al., 2013; Binka et al., 2007). In 2009, key stakeholders in health adopted and scaled up the CHPS initiative as a national strategy to improve access, efficiency, and quality of health care because of its successful contribution to improving geographical access (Elsey et al., 2023) and to critical health services, especially in rural areas after a decade of implementation (Johnson FA et al., 2015). The Ministry of Health developed a formal policy (GoG/MOH, 2016) and implementation guidelines (GHS, 2016) to standardize the concept of CHPS across the country. The CHPS concept comprises a demarcated geographical zone with a population of 5000 people or 750 households. It has an approved structure, a service delivery point, and resident health staff, known as Community Health Officers (CHOs), with a mandate to provide health services for the population in the zone. CHPS has duty care and a minimum package of services, information and surveillance, tracking, and prompt reporting of important events as part of the policy arrangement. CHPS is Ghana's key strategy for improving access to health services and deepening community participation through outreach and community engagement. In two decades, CHPS has become the most widespread health facility in Ghana, accounting for 65% of health facilities in the country, both private and public (GHS, 2017). CHPS is an integral part of Ghana's strategy to achieve Universal Health Coverage by 2030 (GoG/MOH, 2020), making climate resilience (Adaptation) and environmental sustainability (Mitigation) of CHPS critical if Ghana must achieve Universal Health Coverage.

After successful structural reforms, Ghana pursued a trajectory of climate resilience in the health systems. Through the Ministry of Health, the Government of Ghana (GoG) piloted a climate change and health project between 2010 and 2015 (UNDP, 2010). This pilot experience resulted in the mainstreaming of adaptation actions into Health Sector Medium-term Strategic

Development Plans in 2010 and 2014 (GoG, 2010,2014) and the development of relevant climate change and health tools and information (Tye & Waslander, 2019) to enhance health systems adaptation and mitigation to climate change.

Subsequently, Ghana developed a National Climate Change Policy led by an inter-ministerial national climate change committee (GoG/MESTI, 2013) and the Ghana Climate Change Master Plan Action Programmes for Implementation 2015-2020 to guide climate change action across all sectors with an estimated cost of adaptation (GoG/MESTI, 2015). This plan recommended that the Ministry of Health spend 10% of its annual budget (USD 94 Million) on Climate change and Health (Asante et al., 2015). By 2015, Ghana had built some institutional and technical capacities to work on climate change and health, leading to the development of a national health adaptation strategy approved by relevant government institutions, an Integrated Disease Surveillance and Response (IDSR) system, including an early warning and response system for climate-sensitive health risks and estimated implementation cost for building health system resilience to climate change including planned allocations from domestic funds (WHO & UNFCCC, 2015).

Decentralizing climate action through mainstreaming and broad intersectoral collaborative action into sector-wide systems, policies, laws, and programmes has remained core to Ghana's climate change agenda (UNEP & UNDP, n/d; GoG/EPA,2018). Specific to health, the National Climate Change Master Action Programmes for Implementation 2015-2020 also underscores the need to mainstream climate change adaptation into health sector policies, standards, programmes, projects, technologies, capacity needs, funding, plans, and budgets to ensure that health systems normalize climate change considerations in their development planning process with detailed implementation plans, communication materials and multi-sectoral collaboration building on Ghana's goal to

achieve Universal Health Coverage using Primary Health Care(PHC) strategies (GoG/MESTI, 2015).

Despite the recognition of climate change impacts on health systems, the availability of policies to strengthen health systems' adaptation and mitigation (GoG/MOH, 2020a, 2020b) to climate change using decentralised and sectorial approaches, progress in implementing health systems adaptation is slow within the health systems (Tye & Waslander, 2019; World Bank, 2021). Climate change adaptation and mitigation assessment of Ghana by the World Bank recommended that Ghana should increase investments to build resilience to climate shocks in Ghana's healthcare infrastructure, build capacity in the health sector to support adaptation and response, improve monitoring and surveillance systems, and prioritize health adaptation research agenda. Furthermore, the World Bank report recommended conducting a comprehensive national assessment of climate change impacts and existing vulnerabilities, evaluating health sectors' capability to respond and adapt to climate change impacts, and integrating climate change concerns into relevant policies and plan processes.

In particular, the Upper East Region of Ghana is highly vulnerable to climate change, facing extreme weather events and rising climate-sensitive diseases that disrupt health services for poor, remote communities (GoG/MESTI, 2013). Poor infrastructure and an inadequate workforce slow progress in maternal mortality reduction (GHS, 2017; GoG/MOH, 2020). Over 50% of the population has a travel time of 30-60 minutes to the nearest health facility, exceeding the national average (GSS, 2019).The region also faces high poverty rates (US & UNICEF et al., 2016), intermittent outbreaks of climate-sensitive diseases, such as Cerebral Spinal Meningitis (Akanwake et al., 2022) , zoonotic diseases (Aminu, 2023), and endemic malaria.

1.2 Research Problem

Climate change is projected under high emission scenario to cause 38,000 air pollution-related deaths, put 58 million at risk of malaria, increase dengue vector transmission capacity between 1990 and 2100 (WHO &UNFCCC, 2015), increase the incidence of other climate-sensitive diseases (Asante, 2015) in Ghana. An increase in the frequency of climate hazards will disrupt health services, thereby intensifying pressure on Ghana's health budget and widening healthcare disparities, resulting in poor households estimated to spend 30% of their income on malaria alone (GoG/MESTI, 2013).

Over 12 million of the most vulnerable Ghanaian population reside in the savannah dry lands and coastal belts (GoG/EPA, 2024). The Northern regions are already experiencing aggravated climate change impacts due to perennial exposure to extreme weather events that disrupt access to healthcare services (GoG/MESTI, 2013). The Upper East region of Ghana is highly vulnerable due to increased exposure to floods (Atanga & Tampa, 2021), storms droughts, heat, and wildfire (World Bank, 2021), coupled with high poverty rates (University of Sussex & UNICEF et al, 2016), poor health infrastructure, intermittent outbreaks of climate-sensitive diseases like Cerebral Spinal Meningitis (Akanwake, et, al., 2022) and zoonotic diseases (Aminu, 2023) with endemic malaria.

In pursuit of health system adaptation to climate change, the government of Ghana piloted a climate change and health project (UNDP, 2010) from 2010 to 2015, mainstreamed climate change and health into health sector medium-term strategic development plans in 2010 and 2014 (GoG/MOH, 2010,2014), and prioritized of the health sector in its national climate change agenda in the last decade (GoG/MESTI, 2013 ; GoG/MESTI, 2015) with emphasis on decentralization and mainstreaming across all sectors (UNEP/UNDP, n/d; GoG/EPA, 2018).

Amidst the increasing threats of climate change to human health in northern Ghana, with limited knowledge of the nexus between climate change and health systems among health system mangers(Hussey & Arku, 2020), the lack of data on health system vulnerabilities nationally (World Bank, 2021), this study examines how Ghana's national-level climate change and health systems agenda, the availability of relevant policies, information, tools, and improved capacities in the last decade have translated into building climate-resilient (adaptation) and environmentally sustainable (mitigation) primary health care systems in the low resource subnational level of the Upper East Region of Ghana. Furthermore, the study investigates context-specific facilitators and barriers to mainstreaming climate -resilience (adaptation) and environmental sustainability (mitigation) to support relevant stakeholders' strategies for effective mainstreaming amidst scarce resources. Finally, the study identifies opportunities informed by local knowledge and community engagement to promote sustainability (Marín-Puig et al., 2021).

1.3 Main Research Question

What are the context-specific challenges and opportunities for mainstreaming climate change adaptation and mitigation into operations of low-resourced PHCs in the Upper East Region of Ghana?

1.3.1Specific Research Questions

1. To what extent does Ghana’s CHPS policy (2016) support climate change adaptation and mitigation actions?
2. What are the context-specific vulnerabilities of PHC facilities to climate change in Upper East Region of Ghana?
3. What are the context-specific facilitators and barriers to mainstreaming climate change adaptation and mitigation into PHC in Upper East Region of Ghana?

4. What opportunities can be leveraged to enhance health systems adaptation and mitigation in Ghana's low-resource settings?

1.4 Main Research Objectives

To assess the context-specific challenges and opportunities for mainstreaming climate change adaptation and mitigation into the operations of low-resourced PHCs in the Upper East Region of Ghana?

1.4.1 Specific Research Objectives

1. To assess how Ghana's CHPS policy (2016) supports climate change adaptation and mitigation actions.
2. To assess context-specific vulnerabilities of PHC facilities to climate change in Upper East Region of Ghana.
3. To assess the context-specific facilitators and barriers to mainstreaming climate change adaptation and mitigation into PHC in Upper East Region of Ghana.
4. To identify context-specific opportunities and co-create with PHC managers a collaborative framework for mainstreaming climate change adaptation and mitigation into PHC operations in low-resourced settings of Ghana.

1.5 Significance of the study

This study directly supports the global development goals of SDG 3 (Good Health and Well-being) and SDG 13 (Climate Action). By advancing climate change adaptation and mitigation in the operations of primary healthcare (PHC) systems in Ghana's Upper East Region, it contributes specifically to SDG 3 target 3.8 (achieving universal health coverage) and SDG 13 target 13.1 which underscores the need to strengthen resilience and adaptive capacity to climate-related hazards and natural disasters Pacheco(2021). Furthermore, the study promotes equitable health outcomes by building climate-resilient health systems in low-resource settings in Ghana.

The study aligns with the Ghana's National Adaptation Plan Framework (2018) which identifies health as a priority sector. It provides essential data for health systems policymakers, researchers, and local government authorities to improve the adaptation and mitigation of PHC systems and enhances Ghana's national agenda for health systems adaptation to climate change and Universal Health Coverage (UHC). The expansion of the Guinea and Sudan savannah zones and the shrinking forest and transition zones in Ghana due to climate change (Yamba et al., 2023) underscores the relevance of this study to health systems policymakers in Ghana and neighbouring countries in West Africa, which share similar ecological characteristics with northern Ghana.

This study provides relevant ministries and health system policymakers with context-specific facilitators and barriers to mainstreaming adaptation and mitigation into the PHC system. It also contributes to deepening participatory and bottom-up approaches to mainstreaming efforts of the government of Ghana by highlighting the voices of PHC managers, who are at the forefront of any health systems adaptation and mitigation efforts.

As shown in Figure 1, PHCs are the operating units of Ghana's health systems, accounting for over half of essential public health services, and are at the forefront of managing public health emergencies related to natural disasters (GoG/MOH, 2020); hence, the need for PHCs to be resilient to climate hazards to enable them to provide services during disasters, and to enhance their readiness to manage the changing climate-induced disease patterns.

Knowledge generated by this study provides an opportunity to develop a flexible, practical, low-resource-input prototype that allows for easy adoption and replicability in similar settings to support PHC systems mainstream climate change adaptation and mitigation into PHC operations. The use of participatory processes builds the capacity of local healthcare providers, which presents

an opportunity for effective local-level collaboration, buy-in, and improvement in climate action within PHCs. The study will generate evidence that can be incorporated into national health policies and strategies to enhance the climate resilience of health systems.

1.6 Research Framework

The World Health Organisation (WHO) developed the operational framework for building climate-resilient health systems to support governments and interested parties in strengthening their health systems to effectively mainstream climate change adaptation and mitigation in their operations (WHO, 2015). To aid the implementation of the framework, the WHO provided further guidelines on operationalizing the components of the health workforce, climate-resilient and sustainable technologies, infrastructure, and the management of the environmental determinants of health, which are prerequisites to enhancing the climate resilience and environmental sustainability of health care facilities (WHO, 2020). Both frameworks underscore the importance of functional health systems as a prerequisite to pursuing climate resilience. More robust health systems reduce population vulnerability and provide the springboard for the health system to effectively adapt to health risks arising from climate change, build resilience to climate hazards, and to take steps to pursue mitigation measures.

Even though the WHO framework for building climate–resilient health systems provide a shared understanding and a starting point for developing health systems' adaptation and mitigation to climate change, critics suggest many gaps arise due to its current form. Yoon (2020) argues that, the framework does not integrate the elements of people-centeredness and context-specific indigenous knowledge systems to enhance effectiveness and sustainability and the apparent non-consideration of the different levels and types of governance. For instance, Ghana has influential

traditional and local governance systems that can enhance the effectiveness and sustainability of health system adaptation and mitigation. This study adopts a bottom-up approach, exploring context-specific facilitators and barriers to mainstreaming climate change adaptation and mitigation into PHC systems primarily involved in policy implementation. This approach will incorporate local knowledge and experiences, thereby generating evidence for a conceptual contribution to the WHO Framework on mainstreaming climate change adaptation and mitigation to aid the transition from policy commitments to integration into health systems in low-resource settings like the Upper East region of Ghana.

The research seeks to achieve its objectives through pathways illustrated in the Research Framework in Figure 4.

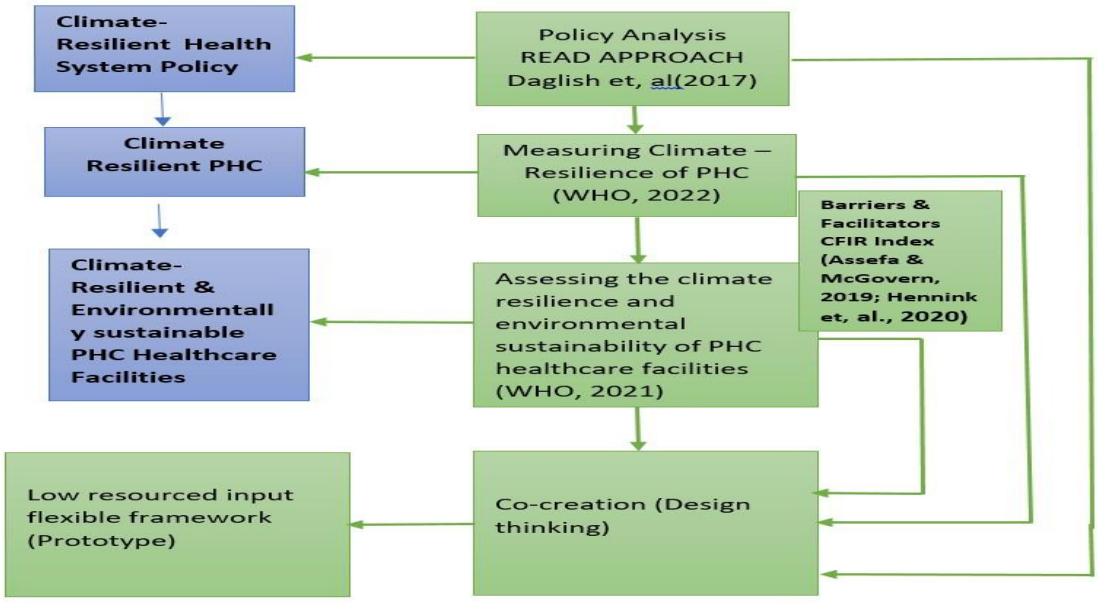

Figure 2: Research Framework

1.9 Organisation of this Thesis

This thesis comprises five sections: background, literature review, methods and materials, results, discussion, and conclusions. The background section introduced the reader to negative impacts of

climate change on human health and health systems, the WHO frameworks for vulnerability assessments of health systems and healthcare facilities. It also outlines the structure of Ghana's PHC systems and its journey towards achieving UHC and adapting its health systems to climate change. The chapter outlines the research questions, significance and research frameworks.

The Literature section discusses the theoretical underpinnings guiding the research, interconnectivity between climate change and health systems and presents scholarly arguments on why health systems must mainstream climate change adaptation and mitigation into their operations. The section also discusses global frameworks for health systems adaptation and mitigation to climate change, highlights examples, and discusses efforts to mainstream climate change adaptation and mitigation into Ghana's health systems. It also explores literature on context-specific barriers to health systems adaptation and mitigation. Finaly, it outlines the conceptual framework of the research.

The Materials and Methods section outlines the technical design of the study. It explains and justifies sampling methods, data collection tools, and data analysis.

The results are presented in the fourth chapter. This section presents study results in line with research questions. The chapter also highlights local responses of PHC systems to climate change, presents existing opportunities for mainstreaming climate change adaptation and mitigation into PHC systems and proposes a co-created framework for PHC adaptation and mitigation.

The fifth chapter discusses the study's results, draws conclusions, and recommends actions for mainstreaming climate action within PHC systems, and the sixth chapter summarizes key findings and recommendations.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

Climate change significantly threatens global health and well-being (Costello et al., 2009) directly due to extreme weather events and indirectly resulting from modifying effects of natural systems, as shown in Figure 4 (Smith et al.,2014), putting global populations at higher risk and increasing pressure on health systems(Zakari et al.,2023). The negative impacts of climate change on human populations require improving the adaptive capacity of health systems to anticipate, respond to, cope with, recover from, and adapt to climate-related shocks and stress to bring sustained improvements in health of the population despite an unstable climate (WHO, 2015). Ironically, health systems contribute to climate change due to the nature of their operation, accounting for 5% of global GHG annually (WHO, 2023).

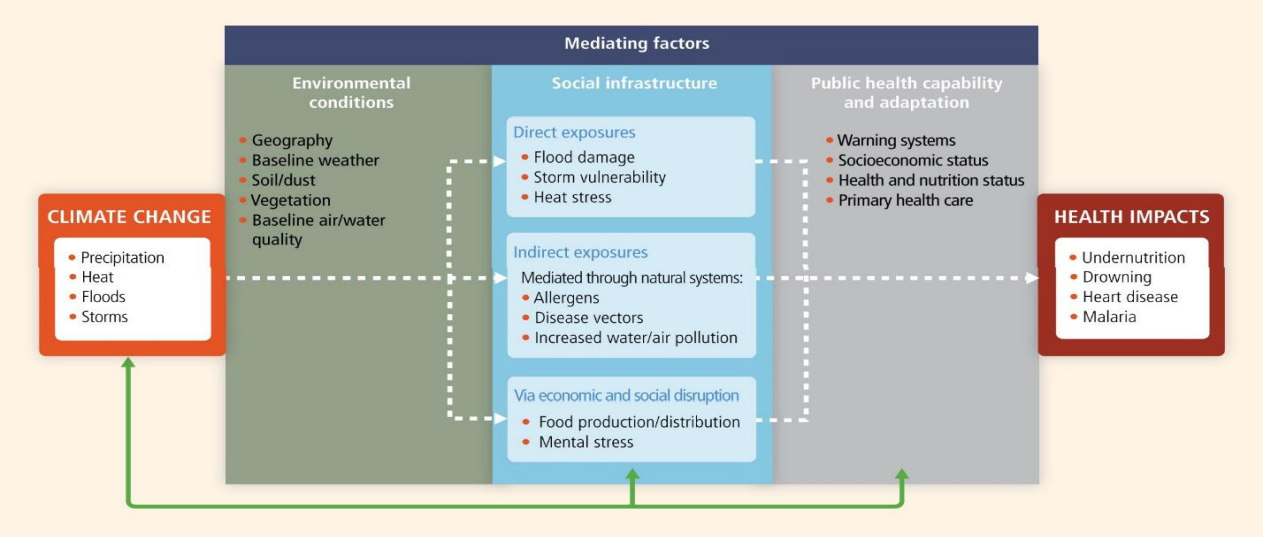

Figure 3: Pathways through which climate change affects human health.
Source: Smith et al. (2014)

Despite global consensus on the need for health systems to actively mainstream climate change adaptation and mitigation, substantial challenges hinder mainstreaming efforts within health systems. Uncertainties, technological limits, financial challenges, weak institutional collaborative

arrangements, poor risk perception of vulnerability and adaptive capacity (Huang et al.,2011), and poor human resource capacities (Hussey & Arku, 2020) hinder effective adaptation and mitigation efforts.

Sub-national systems actors like PHCs present opportunities for practical climate action (Pasquini et al., 2013) because negative impacts of climate change occur locally (Austin et al., 2018). Overcoming the challenges facing subnational actors like PHC requires policymakers to get an in-depth understanding of context-specific barriers and facilitators to tailor mainstreaming strategies to improve the efficacy of strategies (WHO, 2020). Tailoring climate change strategies is necessary because of regional variations in climate impacts, resource allocation, and community resilience require tailored approaches (IPCC, 2014; Mallen et al., 2022). Finally, tailored strategies informed by local knowledge and community engagement promote sustainability (Marín-Puig et al., 2021). Identifying context-specific factors enables health system policymakers to navigate the complexities of climate change, ensuring resilience and responsiveness to the unique challenges facing PHCs (Wheeler & Watts, 2018).

2.2 Definition of Concepts

This section operationalizes the relevant and critical concepts. Operationalizing concepts enabled researcher to accurately translate the conceptual design into concrete research activities to achieve the research outputs (Verschuren & Doorewaard, 2010).The following paragraphs define the fundamental concepts of the study:

The WHO defines a health system as all Organisations, institutions, and resources devoted to producing health actions (WHO, 2000). As shown in Figure 3, Ghana's Primary Health Care (PHC) facilities are all within the PHC systems. For this study, a PHC system is "all publicly

funded health facilities and management operating within the study Districts. District health systems shall be synonymous with PHC systems.

Community-Based Health Planning and Services (CHPS) is a national strategy to deliver essential community-based health services involving planning and service delivery with communities. A CHPS Facility shall be an approved structure consisting of a service delivery point and accommodation complex, which must be present (GoG/MOH, 2016). For this research, a CHPS facility shall be defined as a public-funded health facility located in a CHPS zone in the study districts with the mandate of being a "gatekeeper" within the PHC system.

Local actors are politically and democratically mandated or legitimized actors to interpret, advocate, and make the local community's common good and best interest prevail in the political process (Wollmann, 2010). However, for this study, local actors refer to PHC internal actors' diverse representatives of communities, Community health structures, and local government institutions and sectors whose activities interest health systems at the district level.

The study adopts the WHO definitions for vulnerability, climate-resilient health system, and climate-resilient and environmentally sustainable healthcare facility, as stated below.

Vulnerability is "the conditions determined by physical, social, economic and environmental factors or processes, which increase the susceptibility of an individual, a community, assets or systems to the impacts of hazards" (WHO, 2020). The study conducted vulnerability assessments of PHC systems and healthcare facilities.

A Climate-resilient health system can anticipate, respond, cope with, recover from and adapt to climate-related shocks and stress to bring sustained improvements in population health, despite an unstable climate" (WHO, 2015).

Climate-resilient and Environmentally Sustainable Health Care Facility (CRESCHF) can anticipate, respond to, cope with, recover from, and adapt to climate-related shocks and stresses while minimizing negative impacts on the environment and leveraging opportunities to restore and improve it to bring ongoing and sustained health care to their target population and protect the health and well-being of future generations" (WHO, 2020).

The WHO frameworks for operationalizing climate-resilient health systems and the checklist for assessing climate-resilient and environmentally sustainable healthcare facilities are tools developed by the WHO to support health systems' mainstream climate change adaptation and mitigation into their operations. Climate resilience is used synonymously with adaptation and environmental sustainability is synonymous with mitigation in the context of this thesis.

2.3Theoretical Review

Health systems, especially in subnational settings face multifaceted challenges in mainstreaming climate action due to regional variations in climate impacts, resource allocation, and community resilience requiring tailored approaches (IPCC, 2014; Mallen et al., 2022). The WHO frameworks for building climate-resilient health systems (WHO, 2015) and healthcare facilities (WHO, 2020) emphasize the need for integrating climate change adaptation and mitigation across health system building blocks. To address these complexities, this study anchors itself in Systems Thinking and Resilience theories, both of which provide systemic approaches to understanding and overcoming barriers to climate adaptation and mitigation in PHC operations. This review examines both theories, outlining their strengths, challenges, and their application to the study of climate change adaptation and mitigation of PHCs the Upper East Region of Ghana.

2.3.1 Systems Thinking Theory

Even though system thinking approaches has multiple origins, Bishai et al., (2014) and Peters, (2014) argue that Systems Thinking strengthens health systems research and presents opportunities to testing of societal challenges, leading to refined interventions. Furthermore, WHO (2009) underscores its potential in strengthening health systems through participatory intervention designs that align with health system frameworks. Recent research, such as Morgan et al. (2024), reinforces these claims, demonstrating that Systems Thinking fosters shared understanding among stakeholders and highlights systemic issues, thereby promoting actionable change.

Despite these strengths, applying Systems Thinking in health systems is not without challenges. Haynes et al., (2019) illustrate that while Systems Thinking deepens multi-sectoral collaboration and shared ambition, it is often resource-intensive, making it difficult to sustain in low-resource settings. Boswell et al., (2020) critique the practical barriers, such as competing interests among government agencies, funding constraints, and capacity gaps. These challenges are particularly pronounced in contexts like Ghana, where governance structures and resources may not align with the demands of Systems Thinking approaches. This necessitates not only building capacity among public health policymakers but also fostering collaboration across sectors that influence health determinants.

2.3.2 Resilience Theory

Resilience Theory, initially conceptualized in the context of individual and community adversity (Antonovsky, 1979), has evolved to address systemic resilience. Masten (2015) defines resilience as the capacity of a dynamic system to adapt successfully to disturbances, highlighting the importance of maintaining functionality and development under stress. This systemic perspective is crucial for health systems facing climate-related disruptions. Van Breda (2018) emphasizes that

resilience is a multilevel process, requiring a focus on mediating factors that influence positive outcomes amidst adversity. WHO (2015) builds on this, advocating for health systems to decrease vulnerability while building adaptive capacity to make informed decisions during crises.

However, critiques of Resilience Theory reveal its limitations, particularly its tendency to emphasize adaptation over transformation (Cote & Nightingale, 2012). While adaptation strategies ensure short-term survival, they may inadvertently reinforce existing vulnerabilities, preventing transformative change. Davoudi (2012) warns against the ambiguity of resilience as a "buzzword," arguing that its conceptual vagueness can hinder its practical application. Furthermore, resilience frameworks often lack attention to power dynamics and structural inequities, which are critical in low-resource settings like Ghana. Addressing these gaps is essential for ensuring that resilience-building efforts lead to equitable and sustainable outcomes.

2.3.3 Applications to the Study

The study adopted pragmatic views integrating System Thinking and Resilience theories to address wholistically context-specific facilitators and barriers to mainstreaming climate change adaptation and mitigation into operation of PHCs in the Upper East Region of Ghana. Systems Thinking offered a framework for identifying interconnections between national climate change agenda and climate action in the operations of PHCs enabling actors to collaboratively address systemic issues. Simultaneously, Resilience Theory provided a lens for understanding current PHC vulnerabilities and capacity challenges to mainstreaming climate change adaptation and mitigation into PHC operations aiding the identification of opportunities for mainstreaming climate action into PHC operations.

The integration of these theories is particularly relevant in the context of low-resource settings. Systems Thinking emphasizes the relevance of participatory approaches and context-specific interventions for effective engagement of stakeholders at multiple levels. However, as Boswell et al. (2020) highlight, the challenges of resource constraints and competing interests, requiring careful navigation. Resilience Theory complemented this by focusing on identifying context-specific vulnerabilities aiding the identification of important vulnerabilities to enhance adaptive capacity, as emphasized by Van Breda (2018) and WHO (2015). Adopting both theories provided a comprehensive framework outlined in Figure 6 for addressing complex systematic challenges associated with mainstreaming climate change adaptation(resilience) and environmentally sustainable(mitigation) PHC systems.

In conclusion, Systems Thinking and Resilience theories offered valuable insights for understanding and addressing the barriers to climate adaptation and mitigation in PHCs. While both frameworks have demonstrated their strengths, their application in low-resource settings required careful consideration of practical challenges, such as resource constraints, competing interests, and structural inequities. By integrating these theories, this study provided a nuanced understanding of the facilitators and barriers to mainstreaming climate action in PHCs in the Upper East Region of Ghana. This theoretical grounding not only aligns with WHO's frameworks but also contributes to the broader discourse on climate-resilient health systems in resource-constrained contexts.

2.4 Empirical Review

2.4.1 Adaptation Approaches

Generally, adaptation planning can be broadly categorized into mainstreaming climate change adaptation into sectorial policies and practices and "Dedicated Approach"(stand-alone) adaptation. Both have advantages and disadvantages; however, proponents of the latter argue that it enhances synergy and efficiency from "windows of opportunity" like new construction, effective adaptation measures, and promotion of innovations (Runhaar et al., 2017). Proponents of the dedicated approach argue that subnational governments provide services and information people rely on for their livelihoods; hence, they command considerable influence and have an in-depth understanding of their localities, which can be harnessed for concrete climate action and investments beneficial to tackling climate change with important lessons providing ingredients for appropriate national policy (UNDP, 2022). Even though both approaches have their advantages, it is worth noting that in resources-constrained sub-national settings like Ghana, where progress in health system adaptation is slow primarily due to a lack of technical expertise, collaborative frameworks for mainstreaming health systems adaptation, data, and finance (WBG, 2021; Tye and Waslander, 2021), adopting mainstreaming approaches can substantially benefit from “windows of opportunity” because of sustained investment in health systems by local government authorities (Yeboah et al., 2020)

Mogelgaard et al. (2018) suggest that for countries to bridge climate change adaptation gaps, they will require climate change policy frameworks, sustained leadership among actors, improved coordinating mechanisms, availability of information and tools, and supportive financial processes. Their conclusions are based on lessons from Rwanda's tea and coffee industry, agriculture, forest, water, health and infrastructure in Nepal, and Health in Germany. They argue that even though policymakers recognize the need to integrate climate change adaptation into

national programmes and policies and the availability of tools to enhance the process, there is limited action at the subnational level due to their inability to navigate the preconditions mentioned above. Even though the prerequisites identified by Molgegard et al. (2018) are essential for sustained health system adaptation at the subnational level, workloads, and capacity challenges might exist in low-resourced subnational settings, as reported by Godsmark et, al.(2018).

2.4.2 International Frameworks for Health Systems Adaptation and Mitigation

In responding to threats of climate change to health, researchers have developed frameworks for assessing the impacts of climate change on population health. For instance, Godsmark et al. (2018) developed a methodological framework to review and identify priority focus areas for sub-national settings of South Africa. Paterson et al. (2014) developed a framework for assessing Canada's healthcare facilities' resilience to climate change impacts. However, these frameworks and toolkits focus on adaptation, but the health sector accounts for 4.4% of global net emissions (Karliner et al., 2020) and must proactively mitigate its carbon footprints. Secondly, there is no consensus on both the validity and reliability of these tools; hence, most countries tend to use their own tools (Lestari et al., 2021)

The World Bank (2017) introduced the concept of Climate-smart healthcare. Climate-smart healthcare refers to health systems operations that improve health outcomes while reducing GHG and mitigating the impacts of its operations on climate change. Climate-smart healthcare involves adopting low carbon approaches in the various components of its operations by utilizing technologies efficiently and in an environmentally friendly manner. Climate-smart healthcare aims to promote and utilize sustainable and low-carbon approaches in healthcare delivery, including energy efficiency, waste management, transportation, water conservation, procurement, and service delivery models. The World Bank, with support from the World Health

Organisation(WHO), developed the "Diagnostic," which aims to support its staff and development partners to facilitate an action-oriented dialogue to identify climate-related events, shocks, and stressors that undermine the effectiveness of health systems nationally and sub-nationally with an overall aim of prioritizing interventions leading to the establishment of climate-smart health systems (Bouley et, al., 2018). The Diagnostic encourages broad intersectoral collaboration to mainstream climate change adaptation and mitigation into health systems projects. However, the Diagnostic is largely a qualitative process requiring time and adequate skills for implementation, which might present challenges to subnational actors like PHCs who face numerous constraints, including capacity challenges.

The Pan-American Health Organisation (PAHO) has developed several frameworks for assessing healthcare facility vulnerabilities to climate change and subsequent mainstreaming of adaptation and mitigation actions. Notable among these is the Hospital Safety Index, which has been widely used (WHO/PAHO, 2019) to assess and ensure the safety of hospitals during disaster events (Lestari et al., 2021). However, the Hospital Safety Index focuses on climate-proofing with little emphasis on mitigation. Users suggest the tool is difficult to navigate and requires comprehensive training and tailoring to different settings (Lamine et al., 2023). The Smart Hospital Initiative builds on the Hospital Safety Index and other initiatives to broaden its scope and focus on supporting hospitals to become safe and green (PAHO,2017). However, the Smart Hospital Initiative combines multiple tools, which can challenge health systems in low-resource settings that already lack capacity and resources.

The WHO Framework for operationalizing climate-resilient health systems, as shown in Figure 5, recommends reinforcing the six building blocks of health systems with ten climate-resilient components (WHO, 2015).

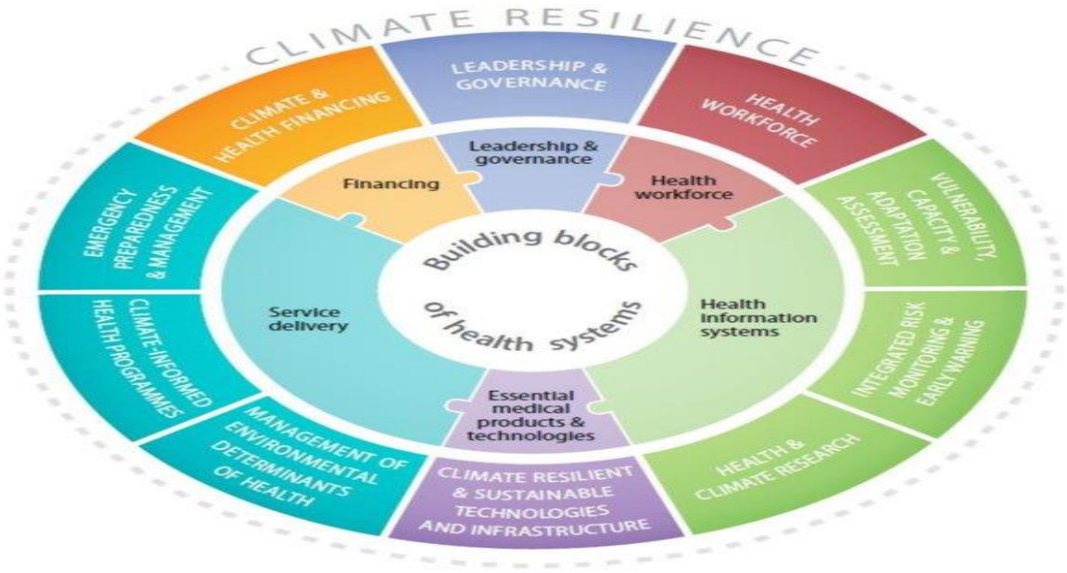

Figure 4: WHO operational framework for building climate-resilient health systems
Source: (WHO, 2015)

In order to help countries implement the WHO framework for operationalizing climate-resilient health systems, the WHO provided further guidance for assessing the vulnerability and environmental sustainability of healthcare facilities (WHO, 2020; WHO,2021) and measuring the climate resilience of health systems (WHO, 2022b). The guidance for building climate resilience and environmental sustainability of healthcare facilities, as shown in Figure 6, seeks to support member states and interested parties to operationalize the components of the health workforce, climate-resilient and sustainable technologies, infrastructure, and the management of the environmental determinants of health, as shown in figure 6, which according to the WHO are prerequisites for building climate resilience and environmental sustainability of health care facilities (WHO, 2020).

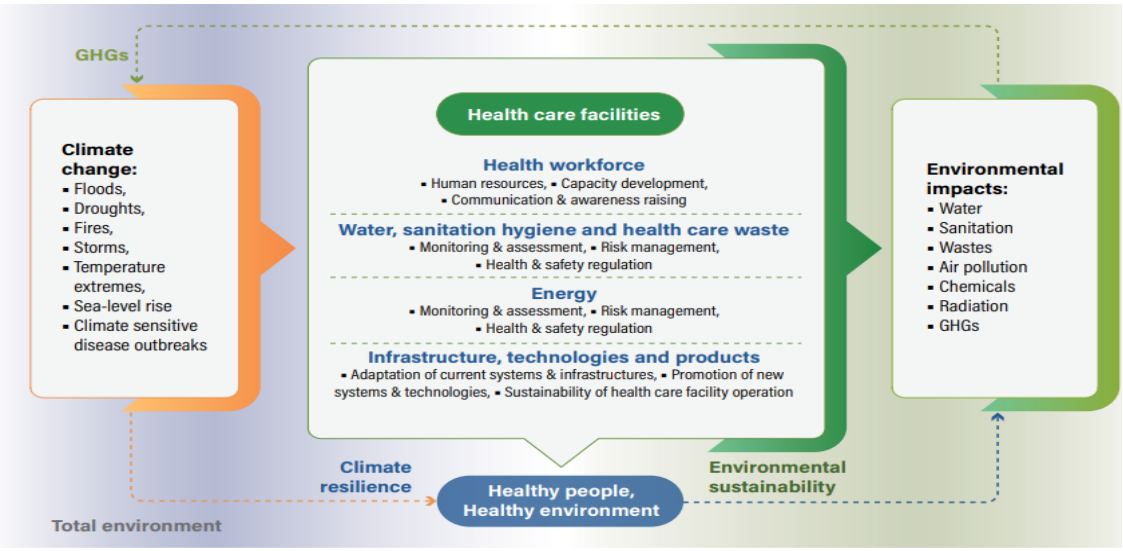

Figure 5: Framework for Building Climate-resilient and environmentally sustainable healthcare facilities
Source: (WHO, 2020)

Inadequate waste management practices by the health workforce expose health workers, clients, and communities to biological, chemical, and radiological hazards. Extreme weather events and changing patterns of climate-sensitive diseases may compromise the ability of the workforce to respond adequately and promptly. Interventions to enhance health workforce resilience to climate change require enough health workers and safe working conditions, with appropriate capacity to respond to climate risk, minimize environmental threats emanating from their operations, and promote the adoption and effective coordination of awareness-raising among actors on climate resilience and environmental sustainability (WHO, 2020 pp.33).

Increased climate variability and change may result in droughts worsening safe water access, whereas floods may damage sanitation systems (Corvalan et al., 2020). Water, sanitation, and waste management practices are prerequisites to infection control and prevention in health facilities (WHO, 2019). Ten to twenty-five percent of healthcare waste is hazardous, requiring proper disposal. Proper disposal will require healthcare providers to understand waste categories,

how they are handled and disposed of, and an organised approach to waste characterization through periodic assessments, practice segregation, waste-minimization measures, and appropriate storage transport and treatment (WHO, 2014). Ensuring sustainable Water, sanitation, and waste management practices requires health facilities to promote interventions of Monitoring and assessment, risk management, and health and safety regulation of Water, Sanitation, and Health care Waste Management systems (WHO, 2020, pp.40).

Reliable electricity is essential for providing adequate healthcare. Without electricity in all healthcare facilities, the world cannot achieve Universal Healthcare Coverage (WHO, 2023). Climate change negatively affects health facilities' access to energy due to extreme weather events. Meanwhile, excess heat increases electricity consumption, and inefficient equipment contributes to waste and air pollution. Promoting energy conservation and efficiency while pursuing renewable energy strategies and procurement and reducing GHG emissions is crucial to improving health facilities' climate resilience. Improving sustainable energy services requires interventions such as monitoring and assessment, risk management, and health and safety regulation of energy services (WHO, 2020, p.48).

Investments in technologies that reduce vulnerability to climate change are essential to achieving climate resilience of health infrastructure, medical technologies, and products. These include designing and building to resist extreme weather events, considering projected climate risk, and appropriate siting, including non-structural elements. (WHO, 2015, 2021). It also involves deploying sustainable technologies and approaches like information technology and satellite-based meteorology for weather warnings, surveillance, and risk monitoring. Notably, there is the need to deploy medical technologies and products with lower environmental footprints. Pursuing sustainable infrastructure and medical products requires adapting infrastructure, technology, and

products to withstand emerging climate risks and promoting new techniques and technologies for sustainable healthcare facility interventions (WHO, 2020.pp54).

As shown in Figure 5 & 6, functional health systems are fundamental to pursuing climate resilience. More robust health systems reduce population vulnerability and provide the springboard for the health system to effectively adapt to health risks arising from climate change, build resilience to climate hazards, and take steps to pursue mitigation measures.

The World Health Organisation frameworks provide for system-wide operationalization of climate-resilient and environmentally sustainable health systems (WHO, 2015). These frameworks adopt checklists containing context-specific indicators and provide a systems approach to mainstreaming climate change adaptation and mitigation into health/ PHC systems. The WHO checklist is generic and recommended for use in health systems and facilities of all sizes. This one-size-fits-all checklist might present challenges, especially for PHC facilities and managers who are thickly involved in the day-to-day administration of healthcare services with limited time and capacity to adapt. Secondly, the checklist does not provide consolidated scoring like the hospital safety index score, which presents challenges in measuring progress over time. The study adopted the WHO framework and guidance because the Ghana government recommends using WHO tools in climate change and health systems research and mainstreaming efforts (GoG/MESTI, 2015).

2.4.3 Implementation of the International Frameworks

Despite increased evidence on the impacts of climate change and human health (IPCC, 2014), few LMICs have developed national health adaptation Plans (Godsmark et al., 2019). The lack of National Health Adaptation Plans (H-NAP) in most LMICs presents challenges for translating national-level policies and commitments to action on the subnational level. In the following paragraphs, we discuss examples of health system mainstreaming efforts globally, focusing on Fiji, Benin, South Africa, and Ghana.

Fiji, an island state, has a health system that is highly vulnerable to climate change. Fiji's Ministry of Health developed a Climate Change and Health Strategic Action Plan (CCHSAP) 2016–2020 with support from external partners and the Ministry of Health's internal resources based on guidance from the WHO operational framework for building climate resilient health systems. The CCHSAP 2016-2020 outlined objectives, activities, expected outputs, outcomes, and indicators for measuring performance. An initial pilot harnessed momentum and support for the development of CCHASP 2016 -2020, the establishment of climate change, and a unit in the MOH tasked to build awareness and capacities for health adaptation (MoHMS, 2016). Subsequently, Fiji's MOH received support from the WHO to implement the Pacific Islands' Action Plan on Climate Change and Health, which aims to ensure all regional health systems are resilient to climate change and variability (WHO, 2018). In 2020, with the support of the WHO, national and international stakeholders, Fiji developed and launched Guidelines for climate–resilient and environmentally sustainable healthcare facilities in Fiji 2020, which contain comprehensive guidance for different types of health facilities on assessment, planning, and monitoring (MoHMS, 2020). Enablers of Fiji's drive for climate resilience of the health system include supportive policy frameworks leading to integration into policies and plans, strong multi-sectoral collaboration resulting from the establishment of inter-ministerial steering committees and climate change steering committees, additional funding and resources because of increased knowledge regarding the sensitivities of health policies at sub-national levels to climate change. Technical capacity results in difficulties in understanding the relationship between climate change and health among actors, lack of good and quality data for improved decision-making, and financial constraints (Tye and Waslander, 2021).

Benin's National Adaptation Programme of Action (2008) identified health as a sector heavily impacted by climate change, resulting in climate change being mainstreamed into the country's National Health Development Plan 2009-2018, which resulted in the MOH undertaking a study to identify municipal-specific related vulnerabilities. The country created environmental cells within all ministries, leading to the mainstreaming of climate change in sectoral budgets and MOH plans. In order to overcome financial challenges, the country established the United Nations Capital Development Fund Local Climate Adaptive Living facility to offer windows for subnational authorities to access to improve the health system's adaptive capacity. Despite firm political commitments in Benin to implement adaptation in the health sector, budgetary constraints, inadequate capacity at the subnational level, and frequent leadership changes remain challenges inhibiting subnational adaptation to climate change by its health systems (Tye and Waslander, 2021).

South Africa developed a National Climate Change and Health Adaptation Plan 2014-2019. However, Godsmark et al. (2018), in reviewing the Western Cap Climate Response Strategy 2014 and the Framework for Adaptation to Climate Change in Cape Town 2006, suggest that the health section of these essential strategies is limited mainly due to resourced and capacity deficient subnational departments leading to challenges in translating national or global information to suit local conditions. To overcome these challenges, they worked with local government officials to develop a five-step methodological framework to support the province of Cape Town in identifying priority focus areas, appropriate interventions, and gaps for health sector adaptation to climate change. Using the Framework resulted in co-creating an approach to help under-resourced sub-national governments generate local-specific information for developing adaptation strategies.

Ghana, a lower middle-income country, is increasingly experiencing the negative impacts of climate change on the health systems due to increased climate-sensitive diseases, increased frequency of climate hazards, and disruption of health services, intensifying pressure on Ghana's health budget and widening healthcare disparities (GoG/MESTI, 2013). In response to the negative impacts of climate change on Ghana's health systems, the Ministry of Health (MOH) piloted a climate change and health project between 2010 and 2015 (UNDP, 2010). This pilot experience resulted in the mainstreaming of adaptation actions into Health Sector Medium-term Strategic Development Plans 2010 and 2014 (GoG/MOH, 2010, 2014), and the development of relevant climate change and health tools and information (Tye and Waslander, 2021). Subsequently, Ghana developed a National Climate Change Policy (GoG/MESTI, 2013) and an action plan (GoG/MESTI, 2015) which emphasizes decentralised and mainstreaming approaches to adaptation (UNEP/UNDP, n/d; GoG/EPA, 2018). Specific to health, the plan estimated adaptation cost (GoG/MESTI, 2015) , recommends that the MOH spend 10% of its annual budget (USD 94 Million) on climate change and health (Asante et al., 2015) and take steps to normalize climate change considerations in their development planning process. The National Climate Change Policy Action Programme for Implementation: 2015–2020 prioritizes health systems and developed a mainstreaming methodology for climate change and health into the sector's development plans, emphasizing the need for mainstreaming to be infused into all levels of the health sector's planning frameworks. The methodology combined guidelines of the National Development Planning Commission (NDPC) for preparing strategic medium-term plans, sectoral monitoring, evaluation plans, and best practices from the Environmental Protection Agency's (EPA) strategic environmental assessment process. The Mainstreaming methodology involved a six-step process of Problem identification, evaluating policy options, policy option

recommendation, Communicating policy recommendations, implementation, monitoring, and evaluation (GoG/MESTI, 2015). Even though this policy mainstreaming process envisaged a systematic approach and inter-sectoral collaboration, it does not consider how mainstreaming can be effectively operationalized at the PHC, which are the basic operating units of the health systems and very crucial for any climate change adaptation and mitigation efforts in the health sector. Despite recognizing climate change impacts on health systems and the availability of policies to strengthen PHC resilience to climate change, progress is slow (World Bank, 2021). Ghana has not progressed beyond the pilot, primarily due to sectorial policy inconsistency leading to poor mainstreaming at the subnational level. Other barriers inhibiting scale-up include insufficient funding resulting from a lack of data due to limited technical capacity to integrate into budgets and limited political commitments due to changes in political leaders (Tye and Waslander, 2021).

2.5 Conclusion

The case studies above show that many enablers exist to mainstream climate change adaptation into subnational systems like PHC for sustained action. Policy commitments, either in the form of laws, policies, or guidelines coupled with leadership support, are important for starting efforts to mainstream adaptation in health. Lessons learned from pilots in Ghana and Benin suggest that grassroots /subnational participation is critical to effectively implement climate-resilient actions in health. However, lessons from Ghana also show that stand-alone or vertical climate action has not been sustainable due to sectoral policy inconsistencies, resulting in poor mainstreaming at the sub-national level. In South Africa, the availability of a multi-sectoral co-created framework aided relevant stakeholders in the province of Cape Town to comprehensively assess the effects of climate change on health and set the tone for developing a local adaptation plan. Funding and technical support also remain crucial for sustaining climate action; Fiji, with continuous internal and external support, has tremendously progressed from an initial pilot in 2016 to the development

of country-specific guidelines for climate–resilient and environmentally sustainable healthcare facilities tailored for the different types of health facilities with an inbuilt accountability mechanism.

Drawing from the lessons above, mainstreaming climate change adaptation and mitigation within health systems needs systematic approaches that guide subnational-level authorities and stakeholders. Mainstreaming climate action in national and subnational policy frameworks is vital for sustainable action.

2.6 Conceptual Framework

DFID (2011), adopted by WHO (2015), suggests that assessing a system's level of resilience or vulnerability is crucial to understanding and applying the concept. Hence, to actively pursue a trajectory of resilience, the first step will involve contextualizing and clearly understanding the group or system that must be resilient. Based on literature by the WHO (2015), this study, as shown in Figure 4, adopts a mixed method approach involving four -stages of :

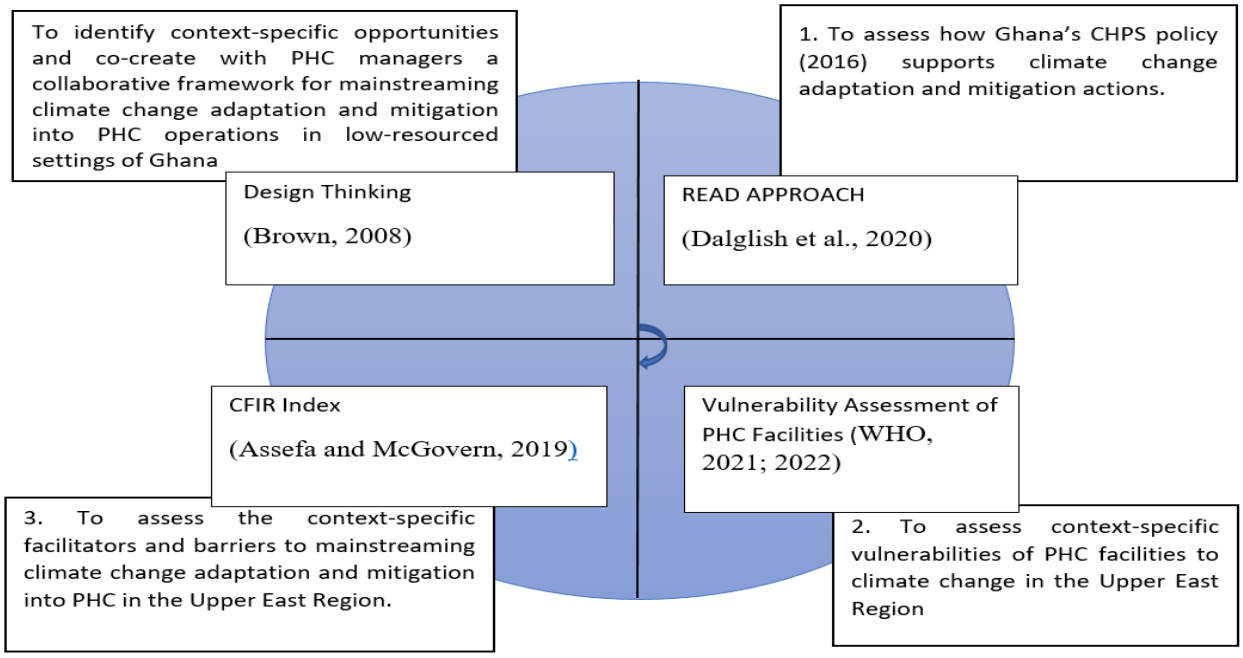

Figure 6: Illustration of Conceptual Framework

(1)Analysing Ghana's CHPS policy to understand how it supports climate change resilience (adaptation) and environmental sustainability (mitigation) interventions, (2) Conducting vulnerability assessments of PHC facilities to get insights to context-specific vulnerabilities (3) Identify context-specific facilitators and barriers to mainstreaming climate change adaptation and mitigation in PHC operations and, (4) Adopting design thinking methodology to identify opportunities and co-create with PHC actors a practical, flexible practical low- resource- input framework for mainstreaming adaptation and mitigation into PHC operations that can be replicated in similar settings, thereby making a conceptual contribution to the WHO framework for building climate-resilient health systems.

CHAPTER THREE

MATERIALS AND METHODS

3.1 Introduction

This chapter outlines the steps the study adopted to investigate and obtain answers to the research objectives, clearly outlining how data was collected, analysed, and presented. The study adopted a pragmatic worldview because it combined and adapted multiple concepts and methodologies to investigate the research questions with a central objective of enhancing climate action within PHC in low-resourced settings of northern Ghana (Creswell, 2003).

3.2 Research Approach

The study utilized mixed methods as illustrated in the research and conceptual frameworks in Chapter 1 and 2, involving iterative processes which are explained in the next paragraphs.

First, the READ approach for document analysis was utilized to assess how Ghana's CHPS policy (2016) supports climate change adaptation and mitigation actions because it is suitable for analysing single and multiple policy documents (Dalglish et al., 2020). The READ Approach is a systematic process of document analysis in health policy studies consisting of a four-step process of: Ready your materials involving the gathering, preparing and setting parameters for document analysis; extracting relevant data from documents using thematic coding; using thematic analysis to understand the meaning and implication of document and distilling findings by synthesizing analysed data to draw conclusions. Thematic analysis involved skimming (superficial examination), reading (thorough examination), and organizing information into categories related to the central questions of the research (Bowen, 2009). Bowen argues that document analysis provides background and context for mixed method studies; hence, a need for triangulation to enhance the credibility of document analysis.

Vulnerability Assessments of PHC systems and facilities were conducted using the WHO suggested checklist for measuring the climate-resilience of health systems (WHO, 2022) and the checklist for assessing climate resilience and environmental sustainability of healthcare facilities (WHO, 2021) to understand context-specific vulnerabilities of PHC systems and facilities.

Key informant interviews were used to collect data from PHC managers to understand context-specific facilitators and barriers to mainstreaming climate change adaptation and mitigation into PHC operation and identifying context-specific opportunities to co-create with PHC managers a collaborative framework for mainstreaming climate change adaptation and mitigation into PHC operations in low -resourced settings of Northern Ghana.

Finally, the study adopted design thinking to co-create with PHC managers a collaborative framework for mainstreaming climate change adaptation and mitigation into PHC operations. Design thinking is a human-centred design methodology aiming to create efficient, practical, and impactful innovations (Brown, 2008). Brown broadly categorizes a design thinking process into the Inspiration, Ideation, and Implementation phases. It is an iterative process involving problem identification, assembling multi-disciplinary teams, and exploring potential solutions to a problem by rapid prototyping, implementation, and testing or refinement. Naiman (2019), argues that applying design thinking methodologies improves the success rate of strategies or innovations because it minimizes the uncertainty and risk of innovation by engaging users or clients through prototypes, testing, and refinement of concepts or innovations. The study adopted Stanford's Framework for Design Thinking, which recommends a five-stage process of Empathize, Define, Ideate, Prototype, and Testing (Plattner, n/d).

The sections below in this chapter outline detail processes of sampling, data collection, analysis, and co-creation of a collaborative framework for PHC adaptation and mitigation.

3.3 Study Area

The study was conducted in the Upper East Region of Ghana because it is prone to extreme weather events, witnessing a rise in climate-sensitive diseases and disruption of health due to extreme weather events resulting in restricted access and provision of health services primarily for the poor, hard-to-reach communities (GoG/MESTI, 2013). The Region has poor health infrastructures and an inadequate health workforce, affecting the quality of essential services and resulting in slow progress in reducing maternal mortality (GHS, 2017; GoG/MOH, 2020), with 50.6% of the population having average travel time of between thirty and sixty minutes on a typical day to the nearest health facility compared to a national average of 41.4% (GSS, 2019). The region has high poverty rates (US & UNICEF et al., 2016) coupled with intermittent outbreaks of climate-sensitive diseases like Cerebral Spinal Meningitis (Akanwake et al., 2022) , zoonotic diseases (Aminu, 2023) and endemic malaria.

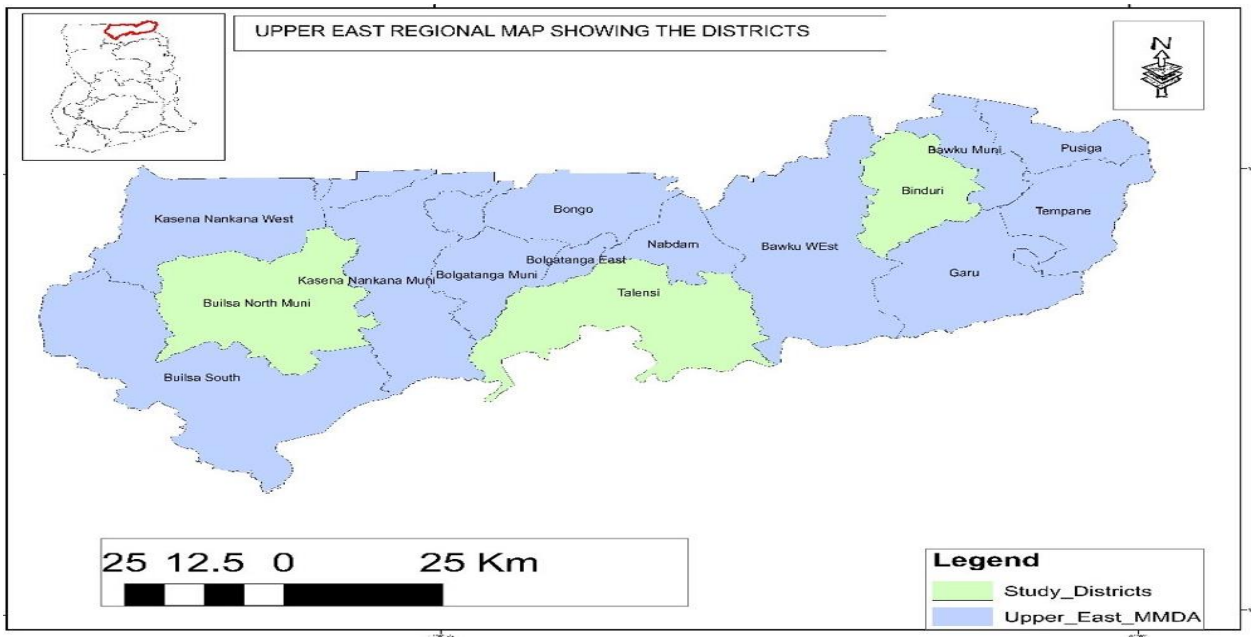

Figure 7: Map of the Upper East Region showing study PHCs areas shaded in light green ink
Source: Authors Construct

3.3.1 Sampling of Study Districts

Multi-stage sampling (Akudugu, 2019; Taherdoost, 2016) was adopted for field studies because PHC systems in Ghana are standardise and operate in the same prescribed manner (District Health Management Teams, District Hospitals, Sub-Districts, and Community –Based Health Planning and Services (Act 525, 1996). Districts in the Upper East Region have similar ecological socio-economic characteristics and exposures to climate variability. The study adopted the Upper East Regional Health Directorates Region zoning into clusters of the East, which is the Bawku Area, which consists of Six Districts (Bawku Municipal, Bawku West, Binduri, Garu, Tempane and Pusiga); Central, which consists of five Districts (Bolgatanga Municipal, Bolgatanga East, Talensi, Nabdam, and Bongo); and the West, which consists of five Districts (Kasena-Nankani East and West, Kasena-Nankani Municipal, Builsa North and South) (GHS, 2023; PHS/NHRC, 2016). Simple random sampling was applied by labelling districts and placing them in different boxes with a neutral person selecting one District from each cluster: Binduri, Talensi, and Builsa North Districts were selected from the East, Central, and West clusters, respectively.

3.4. Sampling of Study Participants

3.4.1 Policy Analysis

The study purposively sampled the Community-Based Health Planning and Services (CHPS) policy, 2016 because CHPS accounts for 65% of healthcare facilities in Ghana and witnessed a tremendous increase in numbers (63% or 2,086 facilities) between 2015 (GoG/GHS, 2015) and 2017 (GoG/GHS, 2017) with the local government authorities accounting for construction of 47.8% of them (Yebaoh et al., 2019). Secondly, the CHPS policy and guidelines were published after Ghana developed the National Climate Change Policy (GoG/MESTI, 2013) and an action plan (GoG/MESTI, 2015) which identified health as an essential sector for climate action, developed an adaptation mainstreaming guide for health systems, estimated cost of health systems

adaptation (GoG/MESTI, 2015)and recommended that the MOH spend 10% of its annual budget on Climate change and Health (Asante et al., 2015). Finally, CHPS is one of Ghana's critical strategies for attaining Universal Health coverage and is at the forefront of managing public health emergencies related to natural disasters (GoG/MOH, 2020).

3.4.2 Sampling of Vulnerability Assessment Participants

All District Health Management Teams (DHMT) of the respective study districts were invited to participate in the vulnerability and capacity assessment of PHC systems. Eight out of Nine in Binduri (89%), Ten out of eleven in the Builsa North District (90%), and Eleven out of twelve in Talensi (90%) participated.

Regarding PHC facilities, first a hazard identification template was administered to all PHC facility managers in the study districts. PHC facility managers who responded to the hazard identification template were invited to participate in a two-day district-based orientation, assessment, and co-creation workshop. Nineteen PHC facility managers (100%) from Binduri District/PHC, Twenty-one PHC facility managers (96%) from Builsa North District/PHC, and 25 PHC facility managers from Talensi District/PHC (96%) participated. In total, 65 PHC facilities from the three districts /PHC participated in vulnerability and impact assessments (96%).

3.4.3 Sampling of Key-Informant Participants

The study purposely interviewed the district directors of health services of each PHC. After interviewing the directors, they recommended other PHC managers for further interviews. Participation was based on their in-depth knowledge of the operations of PHCs and health sector policies and guidelines(Replay, 2014). The principle of saturation was adopted. A total of 18 PHC managers were interviewed, as shown in Table 1.

	Type of Managers	District			
		Binduri	Talensi	Builsa North	Total
1	District Director of Health Services	1	1	1	3
2	Medical Director of Hospital	0	1	0	1
3	Hospital Administrator	0	0	1	1
4	Health center in-charge (Sub-District manager)	3	2	2	7
5	CHPS In-charges (Facility Manager)	2	2	2	6
	Total	**6**	**6**	**6**	**18**

Table 1: Key Informant Interview respondent per PHC by type of PHC healthcare facility

3.4.4 Sampling of Participants-Co-creation of collaborative framework for mainstreaming

Thirty-two, 27, and 34 PHC managers from Builsa North, Binduri, and Talensi PHCs participated respectively. Participating managers comprised managers involved in the vulnerability assessments of PHC systems and facilities. The managers were purposively sampled because of their knowledge of PHC systems and policies, and the experience acquired conducting vulnerability assessments of their respective PHCs and health facilities.

3.5 Data Collection

3.5.1 Policy Analysis

Deductive codes and themes under the categories of Workforce, WASH and Healthcare Waste, Energy and Infrastructure, technology, products and processes of the WHO guidance for climate-resilient and environmentally sustainable healthcare facilities, and their synonyms were adopted for conducting searches in the CHPS policy and its policy implementation guidelines. The study explored other health sector complementary policies and guidelines to get deeper insights into CHPS policy recommendations that researchers did not deem clear enough. The READ approach is a four-step process outlined below:

First, the researcher searched published policies and guidelines of Ghana's Ministry of Health websites. The search yielded thirty-one policies. The researchers screened summaries of the 31

policies to assess their relevance to the question under investigation. Four complementary policies and guidelines were selected, and their contents explored further to understand some CHPS policy and implementation guidelines recommendations. The complementary policies selected include the National Health Policy (2020), Health Care Waste Policy (2020), MOH Procurement Manual and Standard Operation Procedures for Procurement in the Public Health Sector (2004), and Technical Guidelines for Integrated Disease Surveillance and Response (2002).

3.5.2 Context-Specific Vulnerability Assessments of PHCs

The study adapted the suggested checklist within the WHO framework for measuring the climate resilience of health systems (WHO, 2022) by removing questions targeting national health systems and restricting the checklist to short-term risk (less than ten years). The restriction of the checklist to short - medium term was because PHC managers typically implement policies which are guided by health system policies that have a typical cycle of five to ten years. A "remarks´ column was also created for participants to provide reasons for their answers. District Health Management Team (DHMT) members of the participating PHCs or Districts underwent a district-based half-day orientation on the framework. After orientation, each DHMT member assessed their respective PHCs individually. Participants answered the questions in the checklist using a 3-level scale: (3) Unprepared; unable to respond or unavailable, (2) incomplete or basic preparation or in progress, and (1) prepared; achieved or completed.

The WHO checklist for assessing the vulnerabilities of healthcare facilities (WHO, 2021) was applied for assessing the vulnerability of PHC facilities. First, a hazard identification template was administered to PHC facilities managers to determine observed health facility exposure to climate hazards between September 2021 and September 2022. After analysing and determining

healthcare facility-specific exposures to climate hazards, the managers of healthcare facilities who responded to the hazard identification template were invited to participate in a two-day orientation and vulnerability/ impacts assessments of their respective health facilities. Participants responded to questions in the checklist to assess risk related to Workforce; Water, Sanitation, Hygiene and Healthcare waste; Energy and Infrastructure; Technology; products; and processes based on three options: (3), Unprepared or high risk, (2) Incomplete preparation or medium risk and (1) Prepared or low risk.

Classification of impacts of climate hazards of PHC facilities was based on the WHO (2021), checklist for impact assessments. Classification of impacts into major, moderate and minor was based on a pre-classified checklist of impacts by the WHO (2021).

3.5.3 Key-Informant Interviews

In order to understand context-specific facilitators and barriers to mainstreaming PHC adaptations and mitigation, the study adopted the Consolidated Framework for Implementation Research Index (Assefa and McGovern, 2019) dimensions, which is an adaptation of the Consolidated Framework for Implementation Research (CFIR). The CFIR is a flexible and practical framework guiding systematic assessments of potential barriers and facilitators and tailoring implementation strategies to inform the design of implementation strategies (Damschroder et al., 2009). The CFIR allows for innovators to refine and adapt strategies of potential interventions or products before implementation (Kirk et al., 2015). The CFIR Index utilizes mixed methods approaches to examine context–specific facilitators and barriers to help tailor an intervention to context. The CFIR Index applies open-ended questions to conduct in-depth interviews or focus group discussions along the CFIR index dimensions of perceptions of the intervention, perceptions of the system and

community, perception of the programme, and perceptions of the clinicians who will use the intervention. The CFIR Index analyses transcripts classifying interview responses into facilitators and barriers. A Likert-type scale is used to quantify themes between -2 (extreme barrier) and +2 as extreme facilitator (Assefa and McGovern, 2019). This study adapted the CFIR Index interview guides to elicit participants' views on facilitators and barriers to mainstreaming the WHO framework along four dimensions: (1) Suitability of WHO framework for PHC, (2) PHC Systems and Stakeholders, (3) PHC programming Culture and (4) PHC managers identification with WHO Framework.

Before the interviews started, a PowerPoint presentation was shown to refresh participants' minds on the WHO framework for building climate–resilient health systems (WHO, 2015, 2022) and Guidelines for building Climate-resilient and environmentally Sustainable Healthcare facilities (WHO, 2020, 2021)which is referred to in the subsequent text as the "Framework." The Index dimensions mentioned above are operationalized in sections 3.5.3.1, 3.5.3.2, 3.5.3.3 and 3.5.3.4

3.5.3.1 Suitability of WHO framework for PHC

This index dimension sought to explore the suitability of the WHO framework for the PHC system. The interview explored seven sub-dimensions under this Index dimension to determine its suitability for PHC. The sub-dimensions are explained in the following sections.

Framework Source: The interview focused on understanding whether the non-participation of PHC in the development of the framework could negatively impact its acceptability.

Effectiveness: Interview questions focused on understanding the participant's belief in the effectiveness of the WHO framework for mainstreaming climate change adaptation and mitigation into PHC operations.

Relative Advantage: The study explored participants' perspectives on whether mainstreaming the WHO framework into PHC operations will be a priority of PHC managers.

Adaptability: Explored whether the WHO framework can be adapted to fit PHC operations better.

Testability: The interview explored whether PHC can accommodate piloting of the WHO framework to learn lessons for scale-up

Complexity: The interview explored participants' views on whether the WHO framework is complicated for PHC to use for mainstreaming adaptation and mitigation, and

Cost: The interview explored the PHC manager's thoughts on whether mainstreaming the WHO framework will be expensive for PHC or can be accommodated by PHC resources.

3.5.3.2 PHC Systems and Stakeholders

This dimension Index explored participants' views on the benefits of mainstreaming the WHO framework to clients and PHC incentives to undertake mainstreaming actions. PHC incentives explored included peer pressure within the health systems, the availability of policy support, and health system incentives like reimbursement or government funding. The interview explored four sub-dimensions outlined below:

Client's needs and resources: The interview explored participants' views on whether mainstreaming the framework aligns well with the expectations and needs of PHC clients.

Peer pressure: Interviews explored participants' views on whether the health systems provide a competitive environment for mainstreaming climate change adaptation and mitigation.

Network and Connectivity: Explored the availability of technical resources, information, and connection of PHC to Organisations with similar interests.

External Policy and Incentives: Interviews explored whether PHC had policies, financial capability, or health system incentives in the form of reimbursement or direct central government funding to undertake mainstreaming of the WHO framework.

3.5.3.3 PHC Programming Attributes and Culture

The CFIR Index dimension explored participants' views on how PHC structure, leadership, structure, and culture are flexible to change and how these attributes can positively or negatively impact mainstreaming the WHO climate change adaptation and mitigation framework. This dimension consists of fourteen sub-dimensions, explained in the next section.

Structural Characteristics: The interview explored how the current Organisation of PHC, physical structures, and institutions can facilitate or inhibit PHC mainstreaming PHC adaptation and mitigation.

Networks and Communication: Explores how formal and informal communication within the PHC enhances mainstreaming of the framework.

Culture: Explored whether the values, mission, and vision of PHC will impact the mainstreaming of the framework.

Implementation Climate: Explored the receptivity of PHC systems and structure to mainstreaming the framework.

Tension for Change: Explored whether there is a need for PHC to undertake mainstreaming of the framework.

Compatibility: Explored the degree to which PHC workflows and operations align with the framework.

Relative Priority: Explored whether PHC leadership will prioritize mainstreaming the framework.

Organisational Incentive: Interviews explored whether PHCs are already motivated to mainstream or need some form of incentives.

Goals and Feedback: Explored how PHC communication practices and standards, including feedback, can enhance mainstreaming of the framework.

Learning climate: Explored whether the PHC environment encourages innovation and learning and its implication of mainstreaming the framework.

Readiness for Implementation: Interviews explored whether current PHC systems and structures are ready for mainstreaming the framework into PHC operations.

Leadership Engagement: Explored PHC leadership commitment to innovations and PHC accountability mechanism and how it can impact mainstreaming the framework.

Resource Availability: Explored how PHC resources can support mainstreaming the Framework.

Access to Knowledge and Information: Explored whether PHC has access to information and tools to enhance the mainstreaming of the framework.

3.5.3.4 PHC Managers Identification with WHO Framework

This Index dimension explored the extent to which PHC managers feel connected to the WHO framework for mainstreaming climate change adaptation and mitigation, the value managers place on the framework, and their confidence in undertaking to mainstream the framework. The dimension has four sub-dimensions, which are explained below:

Knowledge and Beliefs about the WHO framework: Explored the value PHC managers placed on the framework.

Self-efficacy: Interviews explored PHC managers' confidence in their ability to use the framework for mainstreaming if adopted by PHC.

Motivation: Interviews explored whether PHC managers are excited to use the framework for mainstreaming climate change adaptation and mitigation.

Identification with Framework: Explored whether PHC managers will be committed to using the framework.

3.5.4 Co-creation of a collaborative framework for mainstreaming

Co-creation started with empathizing and Defining stages. The processes are outlined below.

3.5.4.1 Empathize Stage

After analysing the vulnerability and impacts of climate change on their respective health facilities, participants used a WHO planning template to propose low-cost interventions to respond to impacts observed by their respective health facilities. Participants formed five groups representing the five observed climate hazards of storms, floods, heatwaves, droughts, and wildfires, where they discussed, prioritized, and proposed low-cost, high-impact interventions.

3.5.4.2 Define Stage

The Define stage creates a point of view. After identifying high-impact interventions within their groups, group members except the group leader rotated to other groups to validate the interventions (30 minutes each). After the rotations, participants did a plenary presentation to discuss and synchronize the interventions.

3.6 Data Analysis

3.6.1 Policy Analysis

The study adopted deductive codes, themes and categories of the WHO framework .Keywords-in-context (Crawford, 2013) to examine the context of their usage in both policy frameworks (the WHO framework and the CHPS Policy). We extracted data by summarizing keywords- in the context of categories and themes of the National CHPS policy (2016) and the WHO guidance on

climate resilience and environmentally sustainable health care facilities. The study compared the recommended CHPS policy actions to recommended interventions of the WHO framework under each category and theme. Patterns in both documents were used to answer questions relating to (a) What each document says about the WHO categories and themes, (b) What similarities exist between the various themes of both documents, and (c) What variations exist between the themes of both documents.

Finally, the study adopted a rating matrix of low, medium, and high, which aligns with the rating used by the WHO checklist for assessing the vulnerability of healthcare facilities in the context of climate change. The level of mainstreaming of climate change adaptation and mitigation into the policy actions of CHPS was rated based on similarities with interventions recommended by the WHO Framework. The rating was based on number of similarities between the CHPS policy policy directions and the recommended interventions of the WHO framework for building climate-resilient and environmentally sustainable healthcare facilities. The study rated three or more similarities in each category as High, Two similarities as medium and one similarity or none as Low

3.6.2 Context -Specific Vulnerability Assessments of PHCs

Vulnerability of each PHC systems was determined by calculating the average score of individual assessments of all participating DHMT members. Based on the average score, we classified the level of climate resilience into 3 (Unprepared), 2 (incomplete preparation) or 1 (prepared). Average score of each health facility checklist was used to classify the level of vulnerability into three options of: (3), Unprepared or high risk, (2) Incomplete preparation or medium risk and (1) Prepared or low risk. PHC facility average score was rounded to the nearest whole number to facilitate easy comparison with WHO guidelines and to minimize potential errors during classification. Even though the WHO checklist does not provide consolidated scoring like similar

indexes (WHO & PAHO, 2019), the study adopted the average score per assessment to help participants get a clearer understanding of the overall preparedness or vulnerability of their respective PHCs and healthcare facilities.

Classification of impacts of climate hazards of PHC facilities was based on the WHO (2021), checklist for impact assessments. Classification of impacts into major, moderate and minor was based on a pre-classified checklist of impacts by the WHO (2021). Impacts is presented as frequency tables per type of health facility.

3.6.3 Key-Informant Interviews

3.6.3.1 Textual Preparation, Coding, and Description

The analysis of qualitative data involved the verbatim transcription of eighteen audio recordings of key informant interviews. Data from transcriptions were thoroughly read, identifying issues, reflecting on their meanings, and capturing them as codes (Hennink et al., 2020) Codes under each dimension index for each transcript were classified into extreme facilitator or barrier (all respondents agree or disagree index item is a facilitator or barrier), moderate (majority of respondents agree index item is a facilitator) or neutral (half of respondents agree or disagree whether it is a facilitator or barrier). The codes were organised along the four adapted CFIR Index dimensions of Suitability of the WHO framework for PHC, PHC System and Stakeholder, PHC programming attributes and culture, and PHC Manager's identification with the WHO Framework. We developed a codebook containing descriptions of the issues and the context, considering the breadth, depth, and nuance.

3.6.4 Co-creation of a Collaborative Framework for Mainstreaming

The second day of the vulnerability assessment and co-creation workshops was used for the co-creation process. This process involved the last two stages of ideation and prototyping. The stages are described below:

3.6.4.1 Ideation

Involves the exploration with critical stakeholders of possible practical measures to strengthen the system. It aims to generate ideas by brainstorming with stakeholders. After the plenary to validate and synchronize proposed low-cost interventions, participants returned to their respective groups to answer, "How can the suggested interventions be mainstreamed into all levels of PHC efficiently and effectively?" All groups proposed a process of mainstreaming. After that, there was another rotation to different groups (30 minutes each) for alignment and input.

3.6.4.2 Prototyping

This stage involves the rapid joint development of a low-resolution prototype for testing. After the group sessions, there was a plenary session where each group presented a proposed collaborative mainstreaming framework for PHC climate change adaptation (Resilience) and mitigation (Sustainability) process in PHC operations. The plenary group reviewed and asked for clarification for each group's work. After the presentation, the plenary session discussed and developed a "Thick Mainstreaming framework" for integrating climate action into PHC operations. The researcher organised the proposed framework into a diagram and validated it in a plenary session. After the workshop, the researcher synchronized the outputs of each district/PHC to produce a common framework.

3.6.4.3 Testing

The testing stage involves testing the prototype and learning lessons for fine-tuning. The study did not do testing. It is envisaged that testing will be after the study due to time and resource constraints in partnership with interested parties.

3.7 Ethical Considerations and Quality Assurance

The study underwent scientific and ethical review and received approval from the Navrongo Health Research Centre Internal Review Board, Ghana, in September 2022 (Approval ID: NHRCIRB 478). Participation was voluntary. All participants formally consented to their participation.

3.8 Conclusion

This chapter presented in detail the technical approaches to gathering and analysing data. It also thoroughly outlined adaptations to various frameworks and concepts applied by the study, quality control, and ethical measures undertaken to protect participants without losing data quality. The next chapter presents results using tables and figures accompanied by narrations.

CHAPTER FOUR

RESULTS

4.1 Introduction

This chapter presents the results of the study. It highlights how Ghana's CHPS policy supports climate change adaptation and mitigation actions, assessments of PHCs vulnerability to climate hazards of storms, floods, heatwaves, droughts, and wildfires, context-specific facilitators and barriers to mainstreaming adaptation and mitigation by PHC, and the co-created flexible, low-resourced collaborative framework for mainstreaming climate action in PHC operations.

4.2 Study Participants

Table 2 presents the categories of study participants. Sixty-five PHC facilities (97%) and 27 District Health Management Team members (82%) participated in vulnerability assessments. Eighteen PHC and district health facility managers participated in interviews (6 per district).

Quantitative Data										
	Binduri		Builsa North		Talensi		Total		%	
Type of Facility (HCF)	**P**	**NP**	**P**	**NP**	**P**	**NP**	**P**	**NP**	**P**	**NP**
CHPS	14	0	18	0	18	1	50	1	77	50
Health centre/Clinic	5	0	2	1	6	0	13	1	20	50
Hospitals	0	0	1	0	1	0	2	0	2	0
Sub-total (HCF)	19	0	21	1	25	1	65	2	99	100
% sub-total (HCF)	100	0	96	4	96	4	97	3	n/a	n/a
District Health Management Team members	8	3	10	1	9	2	27	6	82	18
Total	27	3	31	2	34	3	92	8	n/a	n/a

Qualitative Data										
	Binduri		Builsa North		Talensi		Total			
District Director of Health Services	1	n/a	1	n/a	1	n/a	3	n/a	n/a	n/a
Hospital Medical Director	0	n/a	1	n/a	0	n/a	1	n/a	n/a	n/a
Hospital Administrator	0	n/a	0	n/a	1	n/a	1	n/a	n/a	n/a
Health centre Manager (Sub-District Leader)	3	n/a	2	n/a	2	n/a	7	n/a	n/a	n/a
CHPS Manager (In-charge)	2	n/a	2	n/a	2	n/a	6	n/a	n/a	n/a
Total	**6**	n/a	**6**	n/a	**6**	n/a	**18**	n/a	n/a	n/a
CHPS denotes Community-Based Health Planning and Services, P= participated, NP= Not participated, n/a=not applicable										

Table 2: Overview of study participants per district

4.3 Policy Analysis: How Ghana's CHPS Policy Supports Climate Change Adaptation and Mitigation

The section outlines patterns, similarities, and differences between the recommended interventions of the WHO framework and Ghana's CHPS policy and implementation guidelines. To better understand some themes in the CHPS policy, complementary policies guiding health facility operations were explored for content deemed not explicitly clear in the CHPS Policy.

4.3.1 Health Workforce Interventions

Table 3, highlights similarities between Ghana's CHPS policy directives and the recommended interventions of the WHO framework in the category of the health workforce. The CHPS policy directives for an appropriate mix of health staff aligned with WHO recommendations for human resources. However, the communication, awareness, and human resource capacity development

categories do not align with the WHO recommendations. CHPS policy actions primarily focus on medical, transport, and logistics for comfortable housing.

	WHO Framework	CHPS Policy	Similarity
Category	Description	Description	
Human Resource	"Sufficient number of health workers"	Three (3) CHOs of appropriate staff mix, render 24-hour services and increase staff numbers based on needs	High
	Empower staff to undertake sustainable actions and manage health risk from climate change	Mainstream training and planning for emergencies, equipment, quality assurance, and referral system	Low
	Healthy and safe working conditions	Periodic fire risk assessment and training on safety procedures and fenced waste disposal pits, well-labelled waste containers	Medium
Communication and awareness	Coordinate and raise awareness of climate resilience and environmental sustainability among actors	Health education and promotion through durbars and home visits. - Creating awareness of environmental and health hazards associated with health care waste among stakeholders.	Low
Capacity Development	Training, information and knowledge management to enhance the ability to respond to climate risk & minimize environmental threats from operations	"Training requirements on the CHPS model, equipment use, motorbikes, HMIS, monitoring essential events, and disease surveillance".	Low
CHO denotes Community Health Officer, HMIS=Health Management Information systems			

Table 3: Key similarities & differences: WHO workforce guidelines vs. CHPS policy directives

The CHPS policy recommends "an appropriate mix of 3 staff per CHPS with the possibility of varying to meet the needs of a CHPS facility. The 24-hour service mandate of CHPS adds value to the WHO framework's recommendation of a "sufficient number of health workers" as it further strengthens geographical access to health services even in emergencies.

CHPS policy directives regarding staff empowerment primarily relate to medical, equipment, emergencies, and fire risk assessments. These align with the WHO recommendation of "safe

working conditions." However, CHPS policy does not emphasize empowering human resources to mainstream climate resilience and environmental sustainability in their operations.

Even though the CHPS policy does not recommend specific actions to raise awareness, it is essential to note that Ghana's Health Care Waste Management Policy (GoG/MOH, 2020) recommends

> "Creating awareness of environmental and health hazards associated with health care waste among health workers, patients, communities, relevant stakeholders, and institutions."

Essentially, both the CHPS policy and the Healthcare Waste Management Policy show some divergence from the WHO framework regarding communication and awareness. CHPS focuses only on health education around medical conditions and healthcare waste policies among stakeholders; however, the WHO framework recommends coordination and awareness creation among stakeholders on climate resilience and environmental sustainability to get their support.

Again, both documents show a significant degree of divergence in capacity development. The WHO framework emphasises building capacities of human resources to enhance knowledge management and strengthen the health workforce's ability to respond to climate risk and minimise environmental stress. The CHPS policy focuses on building technical, equipment, and Health Management Information Systems (HMIS) capacities. However, a robust health management information system enhances disease surveillance, providing an opportunity for integrating the monitoring of climate-sensitive diseases and essential events, hence improving the climate resilience of healthcare facilities.

4.3.2 Water, Sanitation, and Health Care Waste Interventions

As shown in Table 4a, CHPS, as a stand-alone policy mainstream, recommended WHO interventions in health and safety regulation but had minimal policy directives about monitoring,

assessments, and risk management; however, the healthcare waste policy (2020) strongly mainstreamed monitoring, assessments, and risk management of healthcare waste interventions.

	WHO Framework	CHPS Policy	Similarity
Category	Description	Description	
Monitoring & Assessment	Information about water, sanitation, chemical use, and health care waste management considers climate resilience and environmental sustainability for promoting action.	-Water quality of Health facility must meet Quality standards of GSA, Ensure adherence to proper methods, infrastructural and technological development of HCWM. -CHPS must have records on maintenance, enforce existing statutes and regulations on preventing surface water and groundwater resources pollution. Promulgate byelaws for HCWM considering specific local conditions and levels of the health facility	High
Risk management	Strengthen capacity of health care facilities to manage water, sanitation, chemicals, and healthcare waste risks to workers, patients, and served communities.	- Build the capacity of healthcare workers and waste handlers in the safe and proper management of healthcare waste -Rainwater harvesting integral part of CHPS -Infectious and hazardous waste should be disposed in accordance with GHS guidelines on HCWM and IPC	Medium
	Conducting Assessments on climate resilience and environmental sustainability in responding to hazards and identifying and reducing exposures and vulnerabilities.	-Conduct periodic reviews in assessing the effectiveness of HCWM systems at all levels. Monitor adherence to guidelines and Standard Operating Procedures (SOPs). - Conduct environmental impact assessment for incinerators and wastewater treatment plants when usage is initiated	High
GSA denotes Ghana Standards Authority, HCWM=Healthcare waste management, IPC=Infection Prevention and Control			

Table 4a: Key similarities & differences monitoring and risk management -WASH and Healthcare

The collective application of both policies enormously improves sustainability actions in the operations of CHPS facilities.

The CHPS policy recognizes improved water and sanitation as crucial to infection control and directs that adequate water, sanitation, and hygiene services be provided to all CHPS to minimize risk of cross-infection to PHC actors. The emphasis of the CHPS policy on improved water and sanitation aligns with the recommended interventions of the WHO. The framework emphasizes the need to undertake interventions to ensure health facilities always continue to access good-quality water and plan to have water-resilient systems.

In addition, the CHPS policy emphasizes the need for planned preventive maintenance which aligns with the WHO framework recommendations for continuous monitoring to ensure all systems are in good condition. The healthcare waste management policy also underscores the enforcement of existing regulations to avoid groundwater contamination (GoG/MOH, 2020). It is worth noting that a joint application of both policies at the local government level, which has primary responsibility for constructing, equipping, and managing CHPS facilities, can be a challenge due to limited capacity, which might present difficulties in integrating multiple policies into the operations of CHPS.

In the theme of risk management, CHPS, as a stand-alone policy, prioritises water harvesting and infection and hazardous waste control measures. The healthcare waste management policy recommends capacity building of health staff in healthcare waste management but has limited direction on medium and long-term climate-related water, sanitation, and hygiene challenges. For instance, neither policy highlights the need to institutionalise water and waste management plans, especially during emergencies and extreme climate events.

As shown in Table 4b, health and safety regulations are mainstreamed into policy actions of CHPS. For instance, the policy directs that water sources must be from approved public water supply

systems and waste should be disposed of in line with prescribed local authority and Ghana Health Service standards.

	WHO Framework	CHPS Policy	Similarity
Category	Description	Description	Similarity
Health and safety regulation	"Water safety regulations are implemented taking into consideration climate variability and change, and environmental sustainability"	"Use an approved public water supply system and boreholes with water pumps that provide portable and adequate water for facilities not connected to the public system." "Water at all workstations and water sources must meet GSA standards." "Rainwater harvesting must be incorporated into the CHPS structures."	High
	"Sanitation regulations are implemented by taking into consideration climate variability and change and environmental sustainability"	"Accessible and inclusive toilets must be on-site for staff and clients." Regularly maintain toilets and strengthen collaboration between the health sector and other relevant healthcare waste management institutions. -Excreta and sludge/wastewater are disposed of by prescribed procedures of relevant local authorities and shall not pollute the environment.	High
	"Chemical safety regulations are implemented taking into consideration climate variability and change and environmental sustainability"	"Liquid, solid, and other waste (infectious and hazardous wastes, including sharps) shall be disposed of per GHS Guidelines on Health Waste Management and Infection Prevention and Control (IPC)."	Medium
	"Healthcare waste regulations are implemented taking into consideration climate variability and change and environmental sustainability"	Promulgate bylaws for healthcare waste management, considering specific local conditions and the level of the health facility.	High

Table 4b: Key similarities & differences -Health and Safety regulation- WASH and Healthcare Waste: WHO guidelines vs. CHPS policy directives

The healthcare waste policy strongly complements efforts on climate resilience and environmental sustainability of CHPS by recommending the promulgation of byelaws for healthcare waste

management, considering specific local conditions and the level of the healthcare facility. Interventions suggested by the WHO guidelines have been reasonably incorporated into CHPS policy and strengthened by the health care waste policy.

4.3.3 Energy Interventions

As shown in Table 5, sustainable energy policy recommendations by the CHPS policy partially mainstream WHO recommendations. For example, the CHPS policy recommends installing solar-powered electricity for CHPS facilities, not on the national electricity grid. However, this makes solar power optional for facilities on the national grid. The non-promotion of renewable sources as an add-on to the national grid suggests divergence with the WHO, which recommends installing renewable energy sources in addition to national grids.

Even though the CHPS policy does not firmly integrate sustainable procurement, the health care waste policy recommends.

> "Green procurement, efficient infrastructure development, and use of technologies that do not compromise the environment's integrity."

However, there is no emphasis on sustainable use of energy services. CHPS policy recommends using locally friendly technologies, which improve the resilience of health facilities as they enhance prompt maintenance of equipment and energy services in the event of breakdowns or emergencies.

The CHPS policy does not adequately incorporate energy services' risk management and health safety regulations.

	WHO Framework	CHPS Policy	Similarity
Category	Description	Description	
Monitoring and assessment,	Renewable energies can be deployed using both centralized and decentralised approaches.	CHPS compounds located in areas without national power grid or safe water shall have solar power and boreholes as part of the standard requirements.	Medium
	Information about energy services should consider climate resilience and environmental sustainability to promote action.	"Green Procurement, waste minimization strategies, and development infrastructure that deals effectively with waste and does not compromise the environment's integrity (internationally approved temperature for the incinerator, i.e., 800°C-1200°C)".	High
	Plan developed for managing intermittent energy supplies or system failure and established maintenance plan to fix easily preventable energy problems	-Routine planned preventive maintenance of equipment -Put an effective maintenance programme in place to prevent the untimely breakdown of buildings and equipment. Technology should consider local capacities for maintenance and repair.	Low
Risk management	"Strengthened capacities of health care facilities to manage energy-related risks to workers, patients, and served communities by including assessments of climate resilience and environmental sustainability in responding to hazards and identifying and reducing exposures and vulnerabilities.	Develop appropriate guidelines and build CHPS zones' capacity to maintain the estate, transport, and equipment (equipment, procedures, training, etc.)	Low
Health and safety regulation	-Energy use and access regulations implemented, considering climate variability, change, and environmental sustainability. -Education awareness and energy conservation incentives	-Procurement procedures are consistent with National Procurement Law. "Procurement in the Ministry of Health and its agencies shall be based on attaining the best value for money by applying practices that consider efficiency, economy, and transparency in the procurement process through solicitation of bids from all eligible sources"	Low

Table 5: Key Similarities & Differences - Energy: WHO guidelines vs. CHPS policy directives

Even though CHPS recommends establishing appropriate guidelines and building capacity to maintain the estate, transport, and equipment (equipment, procedures, training, etc.), it does not pursue regular assessments to identify hazards and exposures relating to energy.

These policy actions of CHPS do not align with the WHO recommendation.

"Strengthened capacity of health care facilities to manage energy-related risk to workers, patients, and served communities by including climate resilience and environmental sustainability assessments in responding to hazards and identifying and reducing exposures and vulnerabilities."

The WHO guideline also recommends developing energy use and access regulations considering climate resilience and environmental sustainability. However, the CHPS policy does not contain policy actions regarding energy regulation. The policy recommends using the Ministry of Health (MOH) procurement procedure (2004), which does not consider green procurements but only emphasises considerations of efficiency, economy, and transparency. Awareness and energy conservation incentives have largely been silent in the CHPS policy.

4.3.4 Infrastructure, Technology, and Products Interventions

As shown in Table 6, the CHPS policy recommends standardization of CHPS infrastructure and technologies considering local capacity. Even though standardization ensures uniformity, the appropriateness and suitability of facilities for clinical and other services, the WHO guidelines recommend incorporation of resilience measures specific to different geographical zones to make them responsive to local needs.

The adoption of new technologies like satellite, GIS, telemedicine, and other mobile diagnostic services is not prioritised by the CHPS policy. However, the policy recommends providing essential communication services, especially in emergencies.

	WHO Framework	CHPS Policy	Similarity
Category	Description	Description	
Adaptation of current systems and infrastructures	"Building regulations are implemented in the construction and retrofitting of healthcare facilities to ensure climate resilience and environmental sustainability."	Promote the use of the approved standard design and monitor and ensure that all new construction of CHPS compounds across the country conforms to the requirements of the approved prototype. Technology shall take into consideration local capacities.	Medium
Promotion of new systems and technologies	Adopting new technologies and processes can provide climate resilience, environmental sustainability, and enhanced health service delivery.	- "Radio communication lines shall be established where there is no communication system." - "Efforts have been made to use emergent information technology to increase access to care and information management"	Low
Sustainability of healthcare facility operations	Adopt and procure low-environmental impact technologies, processes, and products to enhance climate resilience and environmental sustainability.	- "Procurement procedures that are consistent with National Procurement Law." -Coordinate the management and monitor the infrastructural development, transport, and equipment provision in CHPS zones.	Low

Table 6: Infrastructure, technology, products and processes - WHO guidelines vs. CHPS policy directives

Reducing the carbon footprints of health facilities is essential to reducing GHG emissions resulting from their operations. It is worth noting that the Healthcare waste management policy strongly recommends green procurement. The CHPS policy and MOH procurement procedures do not prioritise the adoption of green procurement.

In summary, the CHPS policy partially considered sustainable infrastructure, technology, products, and interventions. Recommendations for an appropriate siting and standardised design with locally sensitive technology somehow improve adaptation to specific climate conditions of different geographical locations. However, this can be problematic as the design may not be appropriate for other climatic conditions witnessed across different parts of Ghana. The use of

modern technology was limited to radio or phone communication, but the National Health Policy (2020) recommends the adoption of new technology for information management. However, both CHPS and National Health policies is not explicit on mobile diagnostic applications and telemedicine, which have the potential to enhance reach during emergencies.

4.3.5 Multisectoral Collaboration and Performance Indicators

Through District Health Management Committees, local government authorities are responsible for guiding the service delivery of CHPS in collaboration with state and non-state actors. The Ministry of Health and Ghana Health Service is also tasked with mobilizing resources, providing direction, building partnerships, and intersectoral collaboration for the effective functioning of CHPS (CHPS Implementation guideline, 2016 p43-45). The CHPS policy (2016), Healthcare Waste Management Policy (2020), and National Health Policy (2020) underscore the need for multisectoral collaboration in implementing policy actions. CHPS policy recommendations align with the WHO framework's overarching considerations of multisectoral collaborations, community approaches, and voices to strengthen health in principle. However, the focus is skewed toward developing, delivering, and monitoring classical health services of clinical and disease prevention.

Performance indicators of CHPS are primarily focused on traditional health indicators, as observed by Dovie et al. (2017) after assessing the climate sensitivity of health sector indicators in Ghana. The absence of climate-sensitive indicators in the CHPS policy presents a situation where climate resilience interventions prescribed by the CHPS might not be monitored. The only indicators of climate resilience identified in the CHPS implementation guidelines are the Equity Index (CHO per population ratio) and disease surveillance. The non-integration of resilient climate indicators

into the performance criteria of CHPS does not encourage active health adaptation and mitigation to climate change despite increasing risk.

4.4 Context- Specific Vulnerabilities of PHCs to Climate Change

4.4.1 PHC Systems

Table 7 presents an overview of the PHC systems' climate-resilience across the three districts. The average scores of ten components ranged from 2 (integrated risk and early warning systems, management of environmental determinants of health, climate informed programming) to 2.7 (health & climate change research), indicating overall PHCs were incompletely prepared (2.3) to respond to climate exposures.

District/PHC System	Leadership & Governance	Workforce	Vulnerability & Capacity Assesment	Integrated Risk & Early Warning	Health & Climate change Research Agenda	Climate-resilient Technology & Infrastructure	Mgt of Envt determinants of Health	Climate informed Programing	Emergency preparedness & Mgt	Climate Health Financing	Preparedness of DHMT
Binduri	2.6	2.5	2.1	2.1	2.6	2	1.8	1.8	2.2	2.1	2.2
Builsa North	2.4	2.4	2.3	2.1	2.9	2.5	2.3	2.2	2.4	2.8	2.4
Talensi	2.1	2.6	2	1.9	2.5	2.2	2	2.1	2	2.6	2.2
Average	2.4	2.5	2.1	2	2.7	2.2	2	2	2.2	2.5	2.3

Colour codes: Red=incomplete preparation or unabale to respond, Yellow =Incomplete preparation, Green=prepared or able to respond, PHC=Primary Health Care

Table 7: Vulnerability of PHC systems across the participating district from a scale 1 to 3

Variations existed between the ten components. PHCs were unprepared in the components of health and climate change research agenda (with average 2.6 Binduri, 2.9 Builsa North, 2.5 Talensi), climate health financing (average 2.5) and workforce (average 2.5). PHCs showed incomplete preparation in the component of integrated risk and early warning (2), management of environmental determinants of health (2), climate informed programming (2), emergency preparedness and management (2.2) and vulnerability and capacity assessment (2).

4.4.2 PHC Facilities

4.4.2.1 Exposure/Observed Impacts of Climate Hazards by PHC Facilities

Table 8 presents the type and number of recorded impacts of climate hazards on PHC facilities between September 2021 and September 2022. Healthcare facilities in Builsa North and Talensi experienced storms, heatwaves, floods, droughts and wildfires while Binduri experienced only three (storms, heatwaves and floods). Of the 65 PHC facilities surveyed, 82% (n=53) were exposed to multiple climate hazards between September 2021 and September 2022. Of these, 49% (n=32) of healthcare facilities reported two hazards, 26% (n=17) reported three hazards, and 6% (n=4) experienced four hazards. Talensi accounted for 39% of PHC facilities (84% multiple hazards), Builsa North 32% (with 94% multiple hazards) and Binduri 29% (with 79% multiple hazards).

As shown in Table 7, PHC facilities reported a total of 143 observed climate hazards over the study period, with an average of 2.2 hazards per facility, which was relatively stable across area (Binduri: 2.1, Builsa North: 2.2, Talensi: 2.3). Binduri observed 39 hazards (CHPS, 79%, HC, 21%,) and accounted for 27% of exposures. Builsa North experienced 46 hazards (with CHPS 83%, HC 13%, Hospital 4%) accounting for 32% of exposures. Talensi experienced 58 hazards (with CHPS 67%, HC 29%, hospital 3%) accounting for 41% of exposures. PHC facilities experienced an average of 48 storm-related hazards (34%), heatwave-related hazards (25%), 24 flood related hazards (17%), 22 drought -related hazards (15%) and 13 wildfire -related hazards (9%). Healthcare Facilities within the Binduri PHC experienced three of the five climate hazards (Storms, heatwaves, and Floods.

Type of Hazard Exposures of PHC Facilities by District

Hazard	Binduri								Builsa North								Talensi								Total							
	CHPS	%	HC	%	H	%	T	%	CHPS	%	HC	%	H	%	T	%	CHPS	%	HC	%	H	%	T	%	CHPS	%	HC	%	H	%	T	%
Storms	13	42	4	50	0	0	17	44	10	26	0	0	0	0	10	22	14	36	6	35	1	50	21	36	37	34	10	32	1	25	48	34
Heatwaves	12	39	3	38	0	0	15	38	9	24	1	17	1	50	11	24	6	15	4	24	0	0	10	17	27	25	8	26	1	25	36	25
Floods	6	19	1	13	0	0	7	18	7	18	2	33	1	50	10	22	5	13	1	6	1	50	7	12	18	17	4	13	2	50	24	17
Droughts	0	0	0	0	0	0	0	0	8	21	1	17	0	0	9	20	10	26	3	18	0	0	13	22	18	17	4	13	0	0	22	15
Wildfires	0	0	0	0	0	0	0	0	4	11	2	33	0	0	6	13	4	10	3	18	0	0	7	12	8	7	5	16	0	0	13	9
Total	31	79	8	21	0	0	39	27	38	83	6	13	2	4	46	32	39	67	17	29	2	3	58	41	108	76	31	22	4	3	143	100
No. of PHC Facilities	14	n/a	5	n/a	0	n/a	19	n/a	18	n/a	2	n/a	1	n/a	21	n/a	18	n/a	6	n/a	1	n/a	25	n/a	50	n/a	13	n/a	2	n/a	65	n/a
Average Exposure	2.2	n/a	1.6	n/a	0.0	n/a	2.1	n/a	2.1	n/a	3.0	n/a	2.0	n/a	2.2	n/a	2.2	n/a	2.8	n/a	2.0	n/a	2.3	n/a	2.2	n/a	2.4	n/a	2	n/a	2.2	n/a

Exposure of PHC facilities to Hazards

No of Hazards	CHPS	%	HC	%	H	%	T	%	CHPS	%	HC	%	Hosp	%	T	%	CHPS	%	HC	%	H	%	T	%	CHPS	%	HC	%	H	%	T	%
1 hazard	2	100	0	0	0	0	2	11	5	83	1	17	0	0	6	29	3	75	1	25	0	0	4	16	10	83	2	17	0	0	12	18
2 hazards	10	67	5	33	0	0	15	79	5	71	1	14	1	14	7	33	9	90	0	0	1	10	10	40	24	75	6	19	2	6	32	49
3 hazards	2	100	0	0	0	0	2	11	6	100	0	0	0	0	6	29	5	56	4	44	0	0	9	36	13	76	4	24	0	0	17	26
4 hazards	0	0	0	0	0	0	0	0	2	100	0	0	0	0	2	10	1	50	1	50	0	0	2	8	3	75	1	25	0	0	4	6
Total	14	74	5	26	0	0	19	29	18	86	2	10	1	5	21	32	18	72	6	24	1	4	25	38	50	77	13	20	2	3	65	100

NB: HC denotes Health Centre/Clinic, H; Hospital, n/a=not applicable, CHPS=Community- Based Planning and Services, PHC=Primary Health Care, H=Hospital, T=Total

Table 8: PHC Healthcare facility preparedness by component and type/size

4.4.2.2 Vulnerabilities of PHC Facilities

Figure 8 presents the degree to which the PHC facilities are prepared against or are vulnerable to the observed climate hazards. Overall, the healthcare facilities showed high vulnerability to climate hazards with no facility being completely prepared or able to respond to any of the recorded hazards (i.e. Lower risk). Instead, 83% of PHC healthcare facilities are unprepared or unable to respond (higher risk) to respond to climate hazards (n=118), while 17% (had basic or incomplete preparation (n=25) and hence have the capacity for low-level response to multiple exposures to impacts of storms, heatwaves, floods, droughts and wildfires (Medium risk).

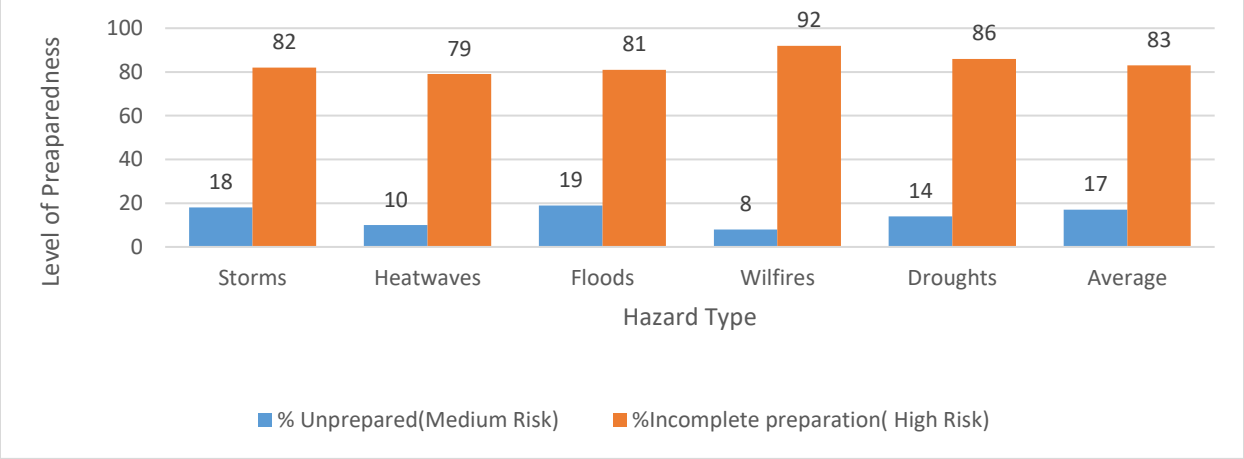

Figure 8: Observed Climate hazards by Healthcare Facilities and level of preparedness

4.4.2.3 Health Facility Vulnerability by Type

Table 9 presents the vulnerability of specific components within the PHC facilities (Workforce, WASH and healthcare waste, Energy, and Infrastructure, technology, and processes). Overall, within CHPS, these components were unable to respond (higher risk) to 100 out of 108 exposures (93%) while health centres were unable to respond (higher risk) to 18 out of the 31 exposures (58%). In contrast, all hospitals show basic or incomplete preparation (Medium risk).

When examining the preparedness of individual components, CHPS and health centres were prepared (i.e. low risk) against 1 exposure in the component of WASH and healthcare waste. In the component of infrastructure, technology, products and processes, health centres can respond to 7% of exposures (n=2). In the component of energy systems, all hospitals show medium risk (low level of response) to their exposures (n=4), CHPS show a higher risk (unable to respond) to 89% of exposures (n=96), health centres have higher risk to 48% of exposures (n=15). The workforce of all categories of PHC facilities are unable to respond to observed climate hazards.

Workforce																														
District/PHC	CHPS								Health Center/Clinic								Hospital								Total					
	LR	%	MR	%	HR	%	T	%	LR	%	MR	%	HR	%	T	%	LR	%	MR	%	HR	%	T	%	LR	%	MR	%	HR	%	T	%
Binduri	0	0	9	29	22	71	31	29	0	0	4	50	4	50	8	26	0	0	0	0	0	0	0	0	0	0	13	33	26	67	39	27
Builsa North	0	0	11	29	27	71	38	35	0	0	4	67	2	33	6	19	0	0	2	100	0	0	2	50	0	0	17	37	29	63	46	32
Talensi	0	0	13	33	26	67	39	36	0	0	7	41	10	59	17	55	0	0	2	100	0	0	2	50	0	0	22	38	36	62	58	41
Average	0	0	33	31	75	69	108	76	0	0	15	48	16	52	31	22	0	0	4	100	0	0	4	3	0	0	52	36	91	64	143	100
WASH and Healthcare Waste																														
	CHPS								Health Center/Clinic								Hospital								Total					
	LR	%	MR	%	HR	%	T	%	LR	%	MR	%	HR	%	T	%	LR	%	MR	%	HR	%	T	%	LR	%	MR	%	HR	%	T	%
Binduri	0	0	4	13	27	87	31	29	0	0	6	75	2	25	8	26	0	0	0	0	0	0	0	0	0	0	10	26	29	74	39	27.3
Builsa North	0	0	8	21	30	79	38	35	0	0	2	33	4	67	6	19	0	0	2	100	0	0	2	50	0	0	12	35	34	74	46	32.2
Talensi	1	3	6	15	32	82	39	36	1	6	9	53	7	41	17	55	0	0	1	50	1	50	2	50	2	3	16	40	40	69	58	40.6
	1	1	18	17	89	82	108	76	1	3.23	17	55	13	42	31	22	0	0	3	75	1	25	4	3	2	1	38	27	103	72	143	100
Energy																														
	CHPS								Health Center/Clinic								Hospital								Total					
	LR	%	MR	%	HR	%	T	%	LR	%	MR	%	HR	%	T	%	LR	%	MR	%	HR	%	T	%	LR	%	MR	%	HR	%	T	%
Binduri	0	0	4	13	27	87	31	29	0	0	6	75	2	0	8	26	0	0	0	0	0	0	0	0	0	0	10	31	29	26	39	27.3
Builsa North	0	0	3	9	35	92	38	35	0	0	4	67	2	33	6	19	0	0	2	50	0	0	2	50	0	0	9	28	37	33	46	32.2
Talensi	0	0	5	15	34	87	39	36	0	0	6	35	11	65	17	55	0	0	2	50	0	0	2	50	0	0	13	41	45	41	58	40.6
	0	0	12	11	96	89	108	76	0	0	16	52	15	48	31	22	0	0	4	100	0	0	4	3	0	0	32	22	111	78	143	100
Infrastructure, Technology Products and Processes																														
	CHPS								Health Center/Clinic								Hospital								Total					
	LR	%	MR	%	HR	%	T	%	LR	%	MR	%	HR	%	T	%	LR	%	MR	%	HR	%	T	%	LR	%	MR	%	HR	%	T	%
Binduri	0	0	3	10	28	90	31	29	1	12.5	1	12.5	6	75	8	26	0	0	0	0	0	0	0	0	1	50	4	18	34	29	39	27.3
Builsa North	0	0	6	16	32	84	38	35	0	0	2	33	4	67	6	19	0	0	0	0	2	100	2	50	0	0	8	36	38	32	46	32.2
Talensi	0	0	3	8	36	92	39	36	1	6	5	29	11	65	17	55	0	0	2	100	0	0	2	50	1	50	10	45	47	39	58	40.6
	0	0	12	11	96	89	108	76	2	6	8	26	21	68	31	22	0	0	2	50	2	50	4	3	2	2	22	18	119	83	143	100
PHC Facility Vulnerability(Preparedness)																														
	CHPS								Health Center/Clinic								Hospital								Total					
	LR	%	MR	%	HR	%	T	%	LR	%	MR	%	HR	%	T	%	LR	%	MR	%	HR	%	T	%	LR	%	MR	%	HR	%	T	%
Binduri	0	0	1	13	30	30	31	29	0	0	4	31	4	22	8	26	0	0	0	0	0	0	0	0	0	0	5	20	34	29	39	27
Builsa North	0	0	3	38	35	35	38	35	0	0	2	15	4	22	6	19	0	0	2	50	0	0	2	50	0	0	7	28	39	33	46	32
Talensi	0	0	4	50	35	35	39	36	0	0	7	54	10	56	17	55	0	0	2	50	0	0	2	50	0	0	13	52	45	38	58	41
	0	0	8	7	100	93	108	76	0	0	13	42	18	58	31	22	0	0	4	100	0	0	4	3	0	0	25	17	118	83	143	100
PHC denotes Primary Health Care, CHPS= Community-Based Health Planning and Services, LR=Lower Risk, MR=Medium Risk, HR=High Risk, T=Total																														

Table 9: PHC Healthcare facility preparedness by component and type/size

4.4.2.4 Impacts of Climate Hazards on Healthcare Facilities

PHC facilities experienced a total of 2551 impacts comprising 761 storm-related (30%), 634 floods-related (25%), 588 heatwave-related (23%), 407 drought-related (16%), and 161 wildfire-related (6%) between September 2021 and September 2022.

4.4.2.4.1. Impact of Storms on PHC facilities

Table 10 summarizes the impact of storms on Healthcare Facility (HCF) components. Workforce experienced 217 (28.5%), WASH and healthcare waste 199 (26.2%), Energy 109 (14.3) and Infrastructure, technology Products, and Processes (ITPP), 236 (31%).

Impacts of Storms on Workforce									
	Major	**%**	**Moderate**	**%**	**Minor**	**%**	**Total**	**%**	**% of Hazard**
CHPS	47	71.2	68	81.0	52	77.6	167	77.0	
HC	14	21.2	11	13.1	11	16.4	36	16.6	
Hospital	5	7.6	5	6.0	4	6.0	14	6.5	
Total	**66**	**30.4**	**84**	**38.7**	**67**	**30.9**	**217**	**100.0**	**28.5**
Impacts of Storms on WASH and Healthcare Waste									
	Major	**%**	**Moderate**	**%**	**Minor**	**%**	**Total**	**%**	
CHPS	60	83.3	65	78.3	32	72.7	157	78.9	
HC	7	9.7	14	16.9	9	20.5	30	15.1	
Hospital	5	6.9	4	4.8	3	6.8	12	6.0	
Total	**72**	**36.2**	**83**	**41.7**	**44**	**22.1**	**199**	**100.0**	**26.15**
Impacts of Storms on Energy									
	Major	**%**	**Moderate**	**%**	**Minor**	**%**	**Total**	**%**	
CHPS	29	63.0	17	56.7	25	75.8	71	65.1	
HC	14	30.4	10	33.3	7	21.2	31	28.4	
Hospital	3	6.5	3	10.0	1	3.0	7	6.4	
Total	**46**	**42.2**	**30**	**27.5**	**33**	**30.3**	**109**	**100.0**	**14.3**
Impacts of Storms on Infrastructure Technology and Processes									
	Major	**%**	**Moderate**	**%**	**Minor**	**%**	**Total**	**%**	
CHPS	64	78.0	84	79.2	40	83.3	188	79.7	
HC	18	22.0	22	20.8	8	16.7	48	20.3	
Hospital	0	0.0	0	0	0	0	0	0.0	
Total	**82**	**34.7**	**106**	**44.9**	**48**	**20.3**	**236**	**100.0**	**31.0**
TOTAL NUMBER OF IMPACTS							**761**	**29.8**	**100.00**
HC denotes Health centre/ clinic, CHPS =Community-Based Planning and Health Services									

Table 10: Impact of storms on PHC facilities by type and District

Workforce impacts included 66 major (30.4%), 84 moderate (38.7%), and 67 minor (30.9%). CHPS experienced 167 major impacts (77.0%), HC 36 (16.6%), and Hospitals 14(6.5%). Key Major impacts observed include loss of work capacity, increased risks of occupational hazards, including water-, food- and vector-borne diseases, animal bites, electrical shocks, and hazardous chemicals exposure, and increased health care demand for infectious diseases, non-communicable diseases, and toxic chemicals exposure. Key moderate impacts include reduced health workforce functions, restrictions on providing some healthcare services, and healthcare professionals not being able to arrive or depart from HCF. Key minor impacts are service delivery, programme delays, difficulty providing medication and home primary services to communities, and reduced functioning of health workers due to a lack of plans to respond to overcrowding of patients and visitors.

In the component of WASH and healthcare waste, CHPS recorded 157 impacts (78.9%), with 72 (83.3) being major, followed by HCs with 30 (15.1%) impacts and Hospitals 12 (6.0%). The major impacts that occurred included heavy rainfall, which risks the flushing of pathogens into water sources; damage to waste storage, which causes environmental contamination from biological and chemical hazards; and the inability of HCF to provide sanitation and hygiene services. Key moderate impacts include reduced capacity to provide efficient, clean services, reduced capacity to provide water for drinking and cooking, and reduced functioning of sanitation and hygiene practices. Notable minor impacts are reduced access to water for healthcare practices, reduced hygiene capacity (flush toilets, showers, etc.), and increased risk of breakdown of final waste collection and transportation in systems in HCF.

In the component of energy, CHPS experienced 71 (65.1%) impacts accounting for 29 (63%) impacts, HC recorded 31 (28.4%) with 14 (30.4%) major impacts and Hospitals 7(6.4%) with

3 (6.5%) been major impacts. Key major impacts include power outages (wind and lighting related), interruption of acute medical care or other services that rely on electricity, loss of vaccines and laboratory services, and essential refrigeration-dependent supplies. Moderate impacts include difficulty providing health services, resulting in clients being referred to other facilities, and reduced capacity to provide cleaning and disinfection services that need electricity. Minor impacts include no ambient cooling, increasing staff discomfort, and food loss or difficulty refrigerating food.

The component of infrastructure, technology, products and processes (ITTP) witnessed most of the impacts (82), representing 34.7.0% of all impacts in this component. CHPS experienced 188 impacts (79.7%), with 64 (78.0%) being major. HC experiencing 48 impacts, and Hospitals recording no impacts. Major impacts recorded include direct damage to infrastructure, loss or damage of essential supplies, disruption of HCF operations, breakdown of routine services such as immunization and maternity room, etc., damage to communication and information systems and assets, increased treatment demand for infections, cardiovascular and respiratory diseases, and structural failure of buildings.

4.4.2.4.2 Impacts of Heat waves on Health facilities

Table 11 summarizes the impact of heat waves on the components of HCF. HCF experienced 588 impacts (23%) across all components. The workforce recorded 201 impacts (34.2%), WASH and healthcare waste 125 (21.3), energy 132 (22.4%) and ITTP 130 (22.1%).

The health workforce experienced a total of 201 impacts (34.2%). Impacts included 72 major impacts (35.8%), 66 moderate impacts (32.8%), and 63 minor impacts (31.3%). CHPS experienced 143 impacts (71.1%), HC recorded 46 (22.9%), and Hospitals 12 (6.0%). Key major impacts

include increased respiratory diseases, loss of work capacity and reduced productivity, and increased likelihood of heat stress effects.

Impacts of Heatwaves on Workforce									
	Major	**%**	**Moderate**	**%**	**Minor**	**%**	**Total**	**%**	**% of Hazard**
CHPS	50	69.4	47	71.2	46	73.0	143	71.1	
HC	16	22.2	16	24.2	14	22.2	46	22.9	
Hospital	6	8.3	3	4.5	3	4.8	12	6.0	
Total	**72**	**35.82**	**66**	**32.8**	**63**	**31.3**	**201**	**100.0**	**34.2**
Impacts of Heatwaves on WASH and Health care waste									
	Major	**%**	**Moderate**	**%**	**Minor**	**%**	**Total**	**%**	
CHPS	40	72.7	24	72.7	28	75.7	92	73.6	
HC	11	20.0	7	21.2	7	18.9	25	20.0	
Hospital	4	7.3	2	6.1	2	5.4	8	6.4	
Total	**55**	**44.0**	**33**	**26.4**	**37**	**29.6**	**125**	**100.0**	**21.3**
Impacts of Heatwaves on Energy									
		Major	**%**	**Moderate**	**%**	**Minor**	**%**	**Total**	**%**
CHPS	37	68.5	25	73.5	28	63.6	90	68.2	
HC	12	22.2	6	17.6	15	34.1	33	25.0	
Hospital	5	9.3	3	8.8	1	2.3	9	6.8	
Total	**54**	**40.9**	**34**	**25.8**	**44**	**33.3**	**132**	**100.0**	**22.4**
Impacts of Heatwaves on Infrastructure Technology and Processes									
		Major	**%**	**Moderate**	**%**	**Minor**	**%**	**Total**	**%**
CHPS	45	72.6	34	64.2	9	60.0	88	67.7	
HC	10	16.1	16	30.2	5	33.3	31	23.8	
Hospital	7	11.3	3	5.7	1	6.7	11	8.5	
Total	**62**	**100.0**	**53**	**100.0**	**15**	**100.0**	**130**	**100.0**	**22.1**
TOTAL NUMBER OF IMPACTS							**588**	**23.0**	**100.0**

Table 11: Impact of heatwaves on PHC facilities by type and District

Key moderate impacts are increased threat to health workers due to individual-level risk factors and heat stress, significantly reduced performance capacity and increased heat affecting day and nocturnal conditions, and heightened workforce exposures. Minor impacts include increased thirst and headaches, reduction of health workforce functions, and increased infectious disease cases among the health workforce.

WASH and healthcare waste experienced 125 impacts (21.3%). This component recorded 55 major impacts (44%), 33 moderate impacts (26.4%), and 37 minor impacts (29.6%). Ninety-two impacts were experienced by CHPS (73.6%) and 25 (20.0%) by HC with hospitals experiencing 8 (6.4%). Key major impacts are increased water demand, shortage of safe water, no access to drinking water premises, and water source contamination. Moderate impacts include reduced capacity to provide sanitation and hygiene services and reduced capacity to use laundry equipment. Key minor impacts include reduced functioning of sanitation systems and hygiene practices and increased demand for drinking water from health workers engaged in outdoor activities.

Impacts on energy include 54 major (40.9%), 34 moderate (25.8%), and 44 minor (33.3%) impacts. CHPS experienced 90 impacts (88.2%), HC 33 impacts (25.0%), and Hospitals experiencing nine impacts (6.8%). Key major impacts include increased demand for energy consumption, power outages and disruption of medical equipment, storage of vaccines, and refrigeration-dependent medical supplies. Moderate impacts included power outages, intermittent access to electricity causing interruption of health care services, difficulty in providing some health care services, and use of some diagnostic equipment. Minor impacts included difficulty providing thermal comfort affecting health staff and clients, food loss or difficulty refrigerating food, and no ambient cooling.

ITPP recorded 62 major impacts (47.7%), 53 moderate impacts (40.8%), and 15 minor impacts (11.5%). Total impacts b category of HCF are CHPS 88 impacts (67.7%), HC 31(23.8%) and Hospitals 11(8.5%). Major impacts include increased cost of providing necessary measures to keep staff and infrastructure safe, medical and laboratory equipment damage, and increased electricity demand. Moderate impacts include increased demand for cooling and rest areas for staff and increased demand for adaptation plans to reduce health effects on staff and infrastructure.

Minor impacts include overwhelmed healthcare services and increased demand for coordinated strategies to ensure the implementation of measures with other sectors.

4.4.2.4.3 Impacts of Floods on HCF

Table 12 presents impact of floods on components of, PHC facilities. HCF experienced 634 impacts (24.9%). The workforce recorded 199 impacts (31.4%), WASH and healthcare waste 131(20.7%), energy 132(22.4%), ITTP 130(22.1%)

Impacts of Floods on Workforce									
	Major	**%**	**Moderate**	**%**	**Minor**	**%**	**Total**	**%**	**% of Hazard**
CHPS	47	66.2	50	65.8	36	69.2	133	66.8	
HC	5	7.0	10	13.2	6	11.5	21	10.6	
Hospital	19	26.8	16	21.1	10	19.2	45	22.6	
Total	**71**	**35.7**	**76**	**38.2**	**52**	**26.1**	**199**	**100.0**	**31.4**
Impacts of Floods on WASH and Health care waste									
	Major	**%**	**Moderate**	**%**	**Minor**	**%**	**Total**	**%**	**% of Hazard**
CHPS	29	58.0	26	60.5	24	63.2	79	60.3	
HC	5	10.0	5	11.6	4	10.5	14	10.7	
Hospital	16	32.0	12	27.9	10	26.3	38	29.0	
Total	**50**	**38.2**	**43**	**32.8**	**38**	**29.0**	**131**	**100.0**	**20.7**
Impacts of Floods on Energy									
	Major	**%**	**Moderate**	**%**	**Minor**	**%**	**Total**	**%**	**% of Hazard**
CHPS	11	32.4	14	50.0	6	50.0	31	41.9	
HC	10	29.4	6	21.4	3	25.0	19	25.7	
Hospital	13	38.2	8	28.6	3	25.0	24	32.4	
Total	**34**	**45.9**	**28**	**37.8**	**12**	**16.2**	**74**	**100.0**	**11.7**
Impacts of Floods on Infrastructure Technology and Processes									
	Major	**%**	**Moderate**	**%**	**Minor**	**%**	**Total**	**%**	**% of Hazard**
CHPS	41	47.1	55	57.3	27	57.4	123	53.5	
HC	14	16.1	15	15.6	9	19.1	38	16.5	
Hospital	32	36.8	26	27.1	11	23.4	69	30.0	
Total	**87**	**37.8**	**96**	**41.7**	**47**	**20.4**	**230**	**100.0**	**36.3**
TOTAL NUMBER OF IMPACTS							**634**	**24.9**	**100.0**

Table 12: Impact of Floods on critical components health facilities by type and District

The workforce impacts comprised 71 major impacts (35.7%), 76 moderate impacts (38.3%), and 53 minor impacts (26.1%). CHSP recorded 133 impacts (66.8%), HC 21(10.6%), and Hospitals

35 (22.6%). Key major impacts include health professionals being unable to arrive or depart from health facilities, significantly reduced performance capacity, loss of work capacity, and increased demand for health services from infectious diseases, animal bites, and zoonotic diseases and death, or life-threatening injuries. Moderate impacts include restrictions to provide services and reduced health workforce functions. Minor impacts include minor injuries to health workers not requiring immediate medical treatment, difficulty in providing usual treatment and medication, service delays, and reduced primary services at home and in the community.

WASH and healthcare waste impacts comprised 50 major impacts (38.2%), 43 moderate impacts (32.8%), and 38 minor impacts (29.0%). CHPS experienced 79 impacts (60.3%), HC 14(10.7%), and Hospitals 38 (29.0%). Key major impacts include the inability to provide hygiene services, water contamination, damage to waste storage causing environmental contamination, water supply and storage infrastructure, disruption of sewage water and waste system, and lost sharps and hazardous waste bins. Moderate impacts include the reduced capacity to maintain waste collection and treatment systems and cross-contamination from damages to the sewage system. Key minor impacts include the reduced capacity to provide cleaning services, reduced capacity to access drinking water, and possible rodent infestation around rubbish bins.

Energy systems experienced74 impacts (11.7%), comprising 34 major (45.9%), 28 moderate (37.8%), and 12 minor impacts (16.2%). CHPS experienced 79 impacts (60.3%), HC 14(10.7%), and Hospitals 38(29.0%). Key major impacts include power failure, the shutdown of the cold storage system, interruption in the provision of electricity-dependent devices, loss of vaccines, and loss of laboratory and other medical supplies. Key moderate impacts include difficulty providing critical health services like delivery, temporary power interruption, and reduced capacity to

provide electricity-dependent services. Key minor impacts include food loss, difficulty in refrigeration, and reduced ambient cooling.

ITTP experienced 230 impacts (36.3%), comprising 87 major impacts (37.8%), 96 moderate impacts (41.7%), and 47 minor impacts (20.4%). CHPS experienced 123 impacts (53.5%), HC 38 16.5%), and Hospitals 69 (30.0%). Key major impacts include healthcare delivery and operations disruption, partial destruction by floods causing land erosion, and breakdown of routine healthcare services. Moderate impacts include reduced service capacity due to damaged and reduced supplies, difficulty in transporting patients due to damaged or disabled transportation systems, and damage to roads disrupting access to health facilities. Minor issues include increased demand for cleaning and disinfection supplies, localized disruption of services with minor loss and damage, and possible indoor mould requiring special cleaning services.

4.4.2.4.4 Impacts of Droughts on Healthcare Facilities

Table 13 presents impact of droughts on PHC facilities. PHC facilities experienced 407 impacts (16%) The workforce recorded 132 impacts (32.4%), WASH and healthcare waste 153 (37.6%), energy 51 (12.5%) and ITTP 71 (39%). The workforce experienced 132 impacts (32.4%), comprising 38 major impacts (28.8%), 61 moderate impacts (46.2%), and 33 minor impacts (25.0%). CHSP recorded 116 impacts (87.9%), HC 16 (12.9%), and Hospitals experienced no impacts. Key major impacts include increased threat to health workers resulting in impacts to non-communicable diseases, higher temperatures, reduced performance capacity of health workforce, and increased threat to health workforce from infectious diseases from water contamination and vector breeding sites. Key moderate impacts include increased threats to the health workforce, resulting in impacts related to high temperature, low air humidity, less water ingestion, possible increase in dust-borne diseases, and reduced productivity. Key minor impacts include drought-

related illnesses among health workers requiring immediate attention, service delivery and programme delays, and reduced capacity for health workers to perform hygiene procedures, compromising safety.

Impacts of Droughts on the Workforce									
	Major	**%**	**Moderate**	**%**	**Minor**	**%**	**Total**	**%**	
CHPS	33	86.8	51	83.6	32	97.0	116	87.9	
HC	5	13.2	10	16.4	1	3.0	16	12.1	
Hospital	0	0.0	0	0.0	0	0.0	0	0.0	
Total	**38**	**28.8**	**61**	**46.2**	**33**	**25.0**	**132**	**100.0**	**32.4**
Impacts of Droughts on WASH and Health care waste									
	Major	**%**	**Moderate**	**%**	**Minor**	**%**	**Total**	**%**	**% of Hazard**
CHPS	35	89.7	68	89.5	36	94.7	139	90.8	
HC	4	10.3	8	10.5	2	5.3	14	9.2	
Hospital	0	0.0	0	0.0	0	0.0	0	0.0	
Total	**39**	**25.5**	**76**	**49.7**	**38**	**24.8**	**153**	**100.0**	**37.6**
Impacts of Droughts on Energy									
	Major	**%**	**Moderate**	**%**	**Minor**	**%**	**Total**	**%**	**% of Hazard**
CHPS	8	61.5	19	70.4	8	72.7	35	68.6	
HC	5	38.5	8	29.6	3	27.3	16	31.4	
Hospital	0	0.0	0	0.0	0	0.0	0	0.0	
Total	**13**	**25.5**	**27**	**52.9**	**11**	**21.6**	**51**	**100.0**	**12.5**
Impacts of Droughts on Infrastructure Technology and Processes									
	Major	**%**	**Moderate**	**%**	**Minor**	**%**	**Total**	**%**	**% of Hazard**
CHPS	25	92.6	29	93.5	12	92.3	66	93.0	
HC	2	7.4	2	6.5	1	7.7	5	7.0	
Hospital	0	0.0	0	0.0	0	0.0	0	0.0	
Total	**27**	**38.0**	**31**	**43.7**	**13**	**18.3**	**71**	**100.0**	**17.4**
TOTAL NUMBER OF IMPACTS							**407**	**16.0**	**100.0**

Table 13: Impact of droughts on health facilities by type

WASH and healthcare waste recorded 153 impacts (37.6%), comprising 39 significant impacts (25.5%), 76 moderate impacts (49.7%), and 38 minor impacts (24.3%). CHPS experienced 139 impacts (90.8%), HC 14(9.2%), and Hospitals recorded no impacts. Key major impacts include disruption of the water supply system shortage or lack of water. Key moderate impacts include

insufficient water availability to provide healthcare services, low water quality, reduced function of sanitation systems and hygiene, and reduced capacity to access drinking water for health workforce and clients. Key minor impacts include reduced water availability to provide healthcare services and reduced capacity to maintain the hygiene of toilets and bathrooms, etc.

Energy systems experienced 51 impacts (12.5%), comprising 13 major (25.5%), 27 moderate (52.9%), and 11 minor impacts (21.6%). CHPS recorded 35 impacts (68.6%), HC 16(31.4%), and Hospitals experienced no impacts. Key major impacts include power failure, shutdown of cold storage systems, and loss of vaccine sets and other refrigeration-dependent medical supplies. Key moderate impacts include reduced capacity to boil water, reduced capacity to provide disinfection services that need electricity, and intermittent power delivery. Key minor impacts include compromising energy supply and loss of food or difficulty keeping food refrigerated.

ITTP experienced 71 impacts (17.4%), comprising 27 major impacts (38.0%), 31 moderate impacts (43.7%), and 13 minor impacts (18.3%). CHPS recorded 66 impacts (93.0%), HC 5(7.0%), and Hospitals experienced no impact. Key major impacts include reduced capacity of routine healthcare services like maternity rooms and primary services due to reduced water supply, interruption of healthcare services delivery and operations, and damage to vital equipment from power outages. Key moderate impacts are the temporary suspension of services, reduced capacity to provide basic health services, and increased temperature and air quality within HCF.

Minor impacts include minimal impact on local operations equipment with no impact on healthcare service delivery, minimal impact on supply chain and high temperature, and reduced air quality in HCF due to lack of fans, air conditioners, and appropriate windows.

4.4.2.4.5 Impacts of Wildfires on Healthcare Facilities

As shown in Table 14, PHC facilities experienced a total of 161 impacts (6.3%). The workforce experienced 66 impacts (41%), WASH and healthcare waste 37(23%), energy 19(11.8%) and ITTP 39(24.2%). The workforce experienced 66 impacts (41.0%), comprising 20 major impacts (30.3%), 22 moderate impacts (33.3%), and 24 minor impacts (36.4%). CHPS experienced 45 impacts (68.2%), HC 21(31.8%), and Hospitals recorded no impacts.

Impacts of Wildfires on Workforce									
	Major	**%**	**Moderate**	**%**	**Minor**	**%**	**Total**	**%**	
CHPS	12	60.0	15	68.2	18	75.0	45	68.2	
HC	8	40.0	7	31.8	6	25.0	21	31.8	
Hospital	0	0.0	0	0.0	0	0.0	0	0.0	
Total	**20**	**30.3**	**22**	**33.3**	**24**	**36.4**	**66**	**100.0**	**41.0**
Impacts of Wildfires on WASH and Healthcare Waste									
	Major	**Percent**	**Moderate**	**Percent**	**Minor**	**%**	**Total**	**Percent**	
CHPS	4	30.8	8	50.0	4	50.0	16	43.2	
HC	9	69.2	8	50.0	4	50.0	21	56.8	
Hospital	0	0.0	0	0.0	0	0.0	0	0.0	
Total	**13**	**35.1**	**16**	**43.2**	**8**	**21.6**	**37**	**100.0**	**23.0**
Impacts of Wildfires on Energy									
	Major	**Percent**	**Moderate**	**Percent**	**Minor**	**%**	**Total**	**Percent**	
CHPS	0	0.0	2	33.3	1	20.0	3	15.8	
HC	8	100.0	4	66.7	4	80.0	16	84.2	
Hospital	0	0.0	0	0.0	0	0.0	0	0.0	
Total	**8**	**42.1**	**6**	**31.6**	**5**	**26.3**	**19**	**100.0**	**11.8**
Impacts of Wildfires on Infrastructure Technology and Processes									
	Major	**Percent**	**Moderate**	**Percent**	**Minor**	**%**	**Total**	**Percent**	
CHPS	5	55.6	10	55.6	9	75.0	24	61.5	
HC	4	44.4	8	44.4	3	25.0	15	38.5	
Hospital	0	0.0	0	0.0	0	0.0	0	0.0	
Total	**9**	**23.1**	**18**	**46.2**	**12**	**30.8**	**39**	**100.0**	**24.2**
TOTAL NUMBER OF IMPACTS							**161**	**6.3**	**100.0**

Table 14: Impact of wildfires on PHC facilities by type

Key impacts include disease requiring hospitalisation or medical treatment specifically for those with pre-existing health conditions, high risk of disease or death from chronic respiratory and cardiovascular disease, cessation of all programmes or services extending to other locations, and

life-threatening or severe harm or injuries from burnt and unstable structures. Key moderate impacts include increased incidences of non-communicable diseases, especially among pregnant women, older health workers, and outdoor workers, increased threat of exposure to dust, and cessation of some programmes or service availability. Key minor impacts include increased discomfort to health workers and patients due to air pollution, higher temperatures, difficulty or interruption in delivering services, including primary care services at home, emotional stress, and mental and physical fatigue.

WASH and healthcare waste experienced 37 impacts (23.0%), comprising 13 major impacts (235.1%), 16 moderate impacts (43.2), and eight minor impacts (21.6%). CHPS recorded 16 impacts (43.2%), HC 21(56.8%), and Hospitals experienced no impacts. Key major impacts include water contamination from wild ash, fire, or damaged water pipes, possible interruption of water pumping due to power outages, and water quality degradation from forested catchment areas. Key moderate indicators include likely unsafe water, increased dependence on less safe water, and reduced function of sanitation services and hygiene practices. Key minor impacts include minor disruption of health care delivery, increased demand for drinking water for health workers, especially for outdoor activities, and changes in water use.

Energy systems experienced 19 impacts (11.8%), comprising eight major impacts (42.1%), six moderate impacts (31.6%), and five minor impacts (26.3%). CHPS recorded three impacts (15.8%), HC 16(84.2%), and Hospitals recorded no impacts. Key major impacts include interruption of power, interruption of medical procedures that rely on electricity, and disruption of safe storage of medicines, vaccines, and other essential refrigeration-dependent medical supplies.

Key moderate impacts include intermittent access to electricity for thermal control, increasing discomfort to health workers and patients, loss of alternative energy sources, and threats to stored fuel. Key minor impacts include reduced capacity to use medical services that rely on energy and difficulty providing thermal cooling.

ITTP experienced 39 impacts (24.2%), comprising nine major impacts (23.1%), 18 moderate impacts (46.2%), and 12 minor impacts (30.8%). CHPS recorded 24 impacts (61.5%), HC 15 (738.5%), and Hospitals observed no impact. Key major impacts include fire damage to premises, interruption of the supply chain of essential medical and laboratory supplies, and damage to communication and information systems. Key moderate impacts include possible high indoor temperature, possible high indoor pollution, and increased demand for medication dispensation for respiratory problems. Key minor impacts include increased demand for coordinated strategies for health departments and other sectors, demand for adaptation measures, and increased cost of providing safety measures.

4.5 PHC Responses to impacts of Climate change.

Table 15 presents autonomous adaptations undertaken by PHC systems. These adaptations can be classified into policy responses through the Ministry of Health and local responses in collaboration with NGOs and other sub-national actors. Ghana's health system has introduced policy responses to support climate change adaption and mitigation of health systems. PHCs have undertaken autonomous adaptation and mitigation interventions. Hospitals financed these interventions from their revenues. For instance, hospitals constructed small water systems and purchased off-grid power systems (diesel generators).

Health system policy Responses			
Response	**Actors**	**Brief description**	**Remarks**
Healthcare Waste Management Policy for Ghana (2020)	MOH/GHS/ GEF/UNDP/ Private actors	Policy direction for efficient and sustainable management of healthcare waste.	The policy has increased the activity of NGOs in Water and waste management.
Technical Guidelines for Integrated Disease Surveillance and Response in Ghana (2002)	MOH/ Decentralised actors	Guideline for disease surveillance by PHC.	Recommends formation of district epidemic and rapid response teams.
Workforce Adaptation and Mitigation			
1. Focal person designated but no budget 2. Collaborate with the National Disaster Management Organisation (NADMO) and NGOs to train staff on emergency preparedness and WASH etc 3. Increased staff numbers	Formal sub-national state actors	1. There are informal agreements at the local government level for collaboration during preparedness and emergencies, but these are only done when needed. 2. Contingency plans exist for outbreaks of diseases	"Agreements are at the district assembly level, agreements are only done when the need arises" (Study participant, 2022)
WASH and Health Care Waste Adaptation and mitigation			
1. HCF water supply/HCW disposal systems and segregation 3. Use of closed pits for burning HCF waste 4. Training staff on WASH& HCW	Hospitals NGOS PHC	Hospitals are funded from their income, while HC and CHPS get support from NGOs (incinerators/water systems). PHC-financed segregation bins	Closed pits are a Local innovation by PHC
Energy			
1. Off-national electricity grid systems as backup	Hospitals NGOs	Hospitals funded from their income, while HC and CHPS got support from NGOs	(renewable and standby generators)
Infrastructure, Technology, products and processes Adaptation and mitigation			
1. Collaboration with traditional authorities for appropriate sitting of HCF 2. Tree-Planting and greening of HCF 3. Use of GIS 4. Installed Small-meteorological systems within PHC offices	PHC	1.PHC financed tree planting to serve as windbreaks and shades during heat and greening of the HCF environment 3. Using GIS for planning and programming 4.Use of Digitalized Health Information management systems	1. Negotiation is to get appropriate lands that are not prone to climate hazards, e.g. flood prone lands 2. Use fast growing to serve as windbreaks

Table 15: Health system and PHC responses to climate change

As shown in Table 15, lower-level PHC healthcare facilities also undertook autonomous adaptations. PHC autonomous adaptation and mitigation efforts occur through partnerships with NGOs and other local government actors. For instance, PHCs continue to negotiate with communities for lands with limited exposures to climate hazards for siting of health facilities, to plant shady trees for windbreaks and cooling during heat season, and to construct dug-out pits with lids for disposal of healthcare waste. NGOs partnered with PHCs to undertake adaptation and mitigation around WASH and healthcare waste and infrastructure, technology products, and processes for lower-level PHC healthcare facilities (Health centres and CHPS). NGOs are also involved in constructing small water and hygiene systems, building incinerators for waste disposal, and using GIS and digital health innovations for health delivery.

4.6 Context-specific Facilitators and Barriers to Mainstreaming Climate Change Adaptation and Mitigation.

This section presents participant views on the WHO framework along the four CFIR Index dimensions. The section highlights context-specific facilitators and barriers reported by participants, categorizing them into Extreme facilitators and moderate facilitators and barriers. The WHO framework is referred to as “the Framework” in the subsequent text.

4.6.1 The Suitability of WHO Framework for PHC

This CFIR Index dimension focused on understanding participants' perspectives on the framework's suitability for mainstreaming climate change adaptation and mitigation into PHC operations. The Index comprises seven sub-dimensions of source, effectiveness, relative advantage, adaptability, testability, complexity, and cost associated with mainstreaming the framework.

4.6.1.1Extreme Facilitators

Source of Framework

Participants reported that the framework would be useful even though they did not participate in its development. For instance, a participant remarked:

> "Whether it is developed by us or in collaboration, it will depend on how well we link up with the other sectors to understand its impact on health systems" [Participant 2]

The participant emphasizes that the source of the framework would not affect its acceptability within PHC, but successful implementation depends on effective collaboration with other PHC actors.

Effectiveness

Respondents reported that the framework would improve staff safety, access to services in emergencies, client satisfaction and safety, and collaboration among PHC actors. A participant remarked:

> “I think it will be very effective because even conscientizing the workforce to know about the effects of climate change will put them in a particular position to be able to appreciate the changes that come and how they should tackle it to at least minimize its impact on the health systems” [Participant 15].

Adaptability

Participants reported that the framework aligns well with key health systems components hence it is adaptable for PHC. A participant remarked:

"For me, looking at the components, the health workforce, the infrastructure, I do not think, maybe if something will be added, fine, but taking something out of it, I do not think it is necessary" [Participant 18]."

Testability

Participants reported that the PHC system is open to testing interventions that align with its vision, mission and goals. They emphasized that the framework aligns with the vision, mission, and goals of the Ministry of Health and Ghana Health Service making piloting acceptable before scale-up initiatives hence, PHC can pilot, and lessons learned incorporated into scale-up initiatives. A participant remarked:

"You know at least, a pilot will help us identify the implementation gaps and then based on the lesson learnt, you can adjust and adapt for a roll out" [Participant 2].

Participant reinforces that PHC is open to piloting the framework and suggests that, conducting a pilot is necessary to identify bottlenecks and adjust for scale-up processes if need be.

4.6.1.2 Moderate Facilitators

Relative Priority

Participants reported mixed views regarding the level of prioritization for mainstreaming the framework in PHC operations. Some respondents reported that the framework would strengthen the PHC systems, promote quality of care and meet clients' needs; hence, mainstreaming would be a top priority.

Some respondents reported that mainstreaming could take a backseat if PHC does not secure additional resources. A participant remarked:

"When the needed resources are not mobilized to get the initial implementation, then implementing the whole thing becomes a challenge" [Participant 15].

4.6.1.3 Neutral

Complexity of the Framework

Participants reported mixed views on the complexity of the framework. Some participants reported that the framework aligns with the building blocks of the PHC/ health systems; hence, it is not complicated. Other respondents reported that the framework could be complicated due to potential challenges in securing the buy-in of other PHC actors. Other participants reported that mainstreaming could be challenging due to substantial resource requirement. For instance, a participant remarked:

"For me, I don't think it is complicated" [Participant 11].

"Complicated in the sense that the way I am looking at things, it will involve a lot of human resources, financial resources, and other resources; a lot is needed for this approach to work, which makes it complicated" [Participant 8]

The participant suggests that mainstreaming climate change adaptation and mitigation into PHC operations will demand more human, financial resources and other resources which could be challenging due to current staff workloads and financial challenges.

4.6.1.4 Extreme Barriers

Cost

Cost is reported as an extreme barrier to mainstreaming primarily due to limited government funding and extreme delays in reimbursements of insurance claims. Two participants reported as follows:

"A facility like this depends on health insurance for reimbursement, and after reimbursement, we have much indebtedness due to the delays, so it makes it difficult even to carry out basic activities, let alone to talk of adding new policies like this" [Participant 4].

"In simple terms, I think those that do not involve money; I think it is something we can do, but most of the concepts involves money; that aspect will be challenging to achieve now" [Participant 14]

The statements from both participants suggest cost is a significant barrier. They also emphasize that PHC can implement interventions of the framework that do not require additional resources.

4.6.2 PHC System and Stakeholders

This CFIR Index dimension explored participants' views on the benefits of mainstreaming the framework to PHC clients, system-wide peer pressure for action, PHC connectivity to networks with similar interests, and policy and system incentives for mainstreaming and adaptation. The following sections highlight facilitators and barriers along four sub-dimensions: client and resources, peer pressure, network and connectivity, and external policy and incentives.

4.6.2.1 Extreme Facilitators

Clients' needs and resources

Participants reported that mainstreaming the framework will improve the quality of care, reduce cross-infection, improve the healthcare facility environment and access to healthcare services even in emergencies, and capacitate staff, and make efficient technology available. A participant remarked,

"Our clients coming to the facility, having the competent staff to provide them the service, not acquiring infections from the health care facility and get treated in a conducive environment, i.e., infrastructure and technology that support proper and standard health care."

4.6.2.2Extreme Barriers

Network and Connectivity

Participants reported that the framework was new and were not linked or affiliated to similar initiatives or networks except for the component of WASH and healthcare waste because of partnerships with NGOs. A participant remarked,

"No, I only got information from an NGO which recently had training with some of our staff. I learned they are working to support us with water and help us improve our water system. That is the Organisation I got such information from". The manager emphasizes that PHC has limited networks on the subject.

Peer Pressure

Participants reported not being aware of the mainstreaming or implementation of the framework in any PHC in the region. Some reported that they are only familiar with WASH and healthcare waste initiatives in other districts and within their districts, which were implemented mainly with the support of NGOs. A participant remarked:

"I am only aware of a district where I previously worked and then it was still the same just on water sanitation, hygiene and health and then maybe the infrastructure" [Participant 7]

External Policies and Incentives

Respondents reported that PHC has limited policies and incentives to support the mainstreaming of the framework. Participants cited varied reasons for their perception, including Top-down approaches, poor inter-sectoral collaboration, and late reimbursement of insurance claims. Two participants remarked:

> “I do not know, but I think at this level, you know the health system has a protocol; the best I can do is adhere to the health system protocols regarding service delivery and ensure that everything is in order” [Participant 4].

> "If they can implement it, there should be people who will monitor the projects so that if something is going wrong, we can bring it back and fix it"[Participant 18]

The participant observed that effective mainstreaming and implementation of the framework requires the institution of monitoring systems to ensure corrective action. The participant remarked:

Another participant remarked that:

> "Direct healthcare facility financing is quite difficult. As I said earlier, most of our Internally Generated Funds come from national health insurance, and sometimes, as I speak now, the NHIS owes us about ten months payments for services we have already rendered, and because of this, getting money to buy the essential supplies to take care of our clients has become very difficult. So, if we are to come and fund such an activity, it will be quite difficult".

The participants emphasized the poor liquidity of PHC health facilities, justifying their inability to mainstream the framework without external financial support from the government or development partners.

> "If they can implement it, there should be people who will monitor the projects so that if something is going wrong, we can bring it back and fix it."

Another participant said,

> "I will say leadership, if they are not showing leadership, it will affect the implementation because, if you do not have that leadership to ensure the sustainability, especially the implementation stage, there is no sustainability, they will finish implementing the whole thing, and you will go back to zero."

The participants suggest that leadership is the most important incentive, and if PHC puts all the incentives and funding in place and leadership is not proactive, mainstreaming the framework would still be a challenge.

4.6.3 PHC Programming Attributes and Culture

This dimension index explored how PHC organisational culture will likely impact mainstreaming climate change adaptation and mitigation efforts positively or negatively. The results are presented along the fourteen sub-index dimensions in the following sections:

4.6.3.1 Extreme Facilitators

Tension for Change

There was consensus among participants that the current gaps in the PHC system demonstrate a need for change. Hence, there will be support for mainstreaming climate change adaptation and mitigation into the operations of PHC systems. A participant noted:

> "You can see that the framework contains everything to help the health systems succeed, and climate change is affecting all these parameters, so if we can sustain all these parameters, it will improve the health system." [Participant 4]

Participants sought to explain that the framework strengthens the PHC system. They suggested that the current observed impacts of climate change on PHC systems necessitate mainstreaming adaptation and mitigation into PHC operations.

Network and Communication

Participants reported that the Ghana Health Service is well-structured and networked with PHC actors allowing for effective mainstreaming. A participant remarked:

> For me, it is good. I served in the same committee with the sub-district education director, the social welfare, the Agric and environmental agency; we have a good relationship. That is how I was able to get the classroom for our tools [Participant 7]

Compatibility

There was consensus among respondents that the framework aligns perfectly with the health system's building blocks; hence, it is compatible with the workflows and operations of PHC Systems.

Learning Climate

Participants reported that the framework aligns with PHC's goals, mission, and vision; hence, it will get leadership support for mainstreaming and implementation.

Readiness for Implementation

Most participants reported that PHC already has the systems, infrastructure, human resources, community networks, and systems to mainstream and sustain the framework.

4.6.3.2 Moderate Facilitators

Majority of participants perceive structural characteristics as moderate facilitators. Some respondents believe the framework aligns well with the GHS/PHC goals and experiences over the years, suggesting that the GHS structure is open to innovations promoting health and well-being. However, some respondents believe the opaqueness associated with programmes and projects could be challenging, while others reported the workload of PHC staff as a barrier to mainstreaming.

Implementation climate

Majority of participants reported that PHC is open to implementation mainstreaming because it aligns well with their goals of promoting health services if leadership do in-depth community entry and integration into policies and protocols. A participant remarked:

> "It will depend on how well it is integrated, if it is well integrated and the staff don't see it as a stand-alone project, so the integration of the programme into the health system interventions will influence its acceptability" [Participant 2].

Culture

Majority of participants reported that PHC welcomes innovations that aligns with their mission and vision. They perceived climate change adaptation and mitigation efforts as complementary to their work, so they do not foresee any challenges. For instance, a respondent remarked:

> "So, it is just like the family; we always have problems, but in general terms, I think we are doing better than other services. So, I can say there is unity and purpose in the Ghana Health Service, at least we all agree on one thing, that we want to give our clients the best of healthcare. So, in that sense I can say there is a kind of unity and purpose" [Participant 14].

Organisational Incentives

Majority of participants reported that capacitating staff to understand the linkages between climate change and health systems and mainstreaming them into PHC programmes would incentivize implementation. However, some participants perceived that financial incentives are necessary for staff due to their current constraints and workloads, and once the results show, more staff will be motivated to implement the concept.

Leadership Engagement

Majority of participants reported the mainstreaming climate change into PHC operations will get leadership support because it aligns well with health sector goals and helps deepen collaboration with community leadership. A participant remarked:

> "Very, very much in support. I don't know if you had the opportunity to talk with the [policymaker], I bet you he will tell you he is ready" [Participant 7].

However, some participants reported that PHC struggles to sustain vertical and donor-funded programmes after completion; hence, there could be difficulty in sustaining mainstreaming and implementation of the framework after initial pilots due to poor leadership commitment.

Goals and Feedback

Majority of participants reported that PHC systems have standard communication and feedback to enhance the implementation framework. However, some staff reported that feedback within PHC is not regular and unfair management reward practices could negatively impact the mainstreaming and implementation of the framework.

4.6.3.3 Neutral

Relative Priority

The relative priority of mainstreaming the framework had mixed views. Some participants reported that the framework would be a priority for PHC systems because it aligns with PHC goals. In contrast, others reported that PHC would only prioritize the framework if implemented gradually, starting with new projects, programmes, and infrastructure due to resource and time constraints.

4.6.3.4 Extreme Barriers

Resource Availability

There was consensus among respondents that staff workload, lack of expertise, and unavailability of funding will negatively impact mainstreaming the framework into health PHC.

4.6.3.5 Moderate Barrier

Access to Knowledge and Information

Majority of participants reported they did not have access to relevant information, tools, or knowledge about the framework, while others perceived that once the framework is mainstreamed, information will be accessible.

4.6.4PHC Managers Identification with the WHO Framework

CFIR Index dimension explored PHC managers' views on the framework's relevance, value, and ease of application. The sub-dimension explored included knowledge and values placed on the framework, Self-efficacy, Stage of motivation for the framework, and identification with the framework.

4.6.4.1Extreme Facilitators

Knowledge and value placed on the framework.

There was consensus among participants that mainstreaming the framework will support PHC in delivering a full range of services, improving health systems, and meeting clients' needs even in climate emergencies. A participant remarked:

> If it is implemented, it will help improve health systems and reduce communicable diseases in the district looking at the picture you showed us. For example, if we are siting a facility, since we know this, we wouldn't just accept it and put infrastructure there, but we will look at how good it is, whether when the facility is placed there, we benefit throughout our lives or it is going to be for a short period [Participant 17]

The stage of motivation

Most respondents perceived that mainstreaming the framework will enhance the quality of PHC systems and perfectly align with the mission and vision of the health sector; hence, they are ready for action. A participant noted as follows:

> "Yes, we are prepared because we are already feeling the effects of some of them especially storms and floods because of climate change. These have cost us a lot because the roofs of some buildings have been taken off before and then we have had to look for funds. So already that is how we have seen the benefits if this is well implemented" [Participant 2].

Identification with the framework

All participants reported they wholly identify with the framework because it aligns with the mission and vision of PHC, and once the framework is mainstreamed into PHC policies and protocols, they will be happy to implement it as noted by a participant:

> Yeah, I don't know whether I have the answers to your question, but one thing I know is that we usually think that, like when I came, you see I pointed to the way we dispose your things is that okay? You can improve upon it and then again, maybe energy issues if for now you don't have electricity, solar is an option, are you getting the point" [Participant 1]

4.6.4.2 Moderate Facilitators

Self-efficacy

Even though respondents were confident they could mainstream the framework in their operations, they suggested system-wide capacity building. Some also reported they have the necessary experience operationalizing health programmes and policies in PHC settings; hence, they should be able to implement the framework confidently. A participant reported:

"Confidence? Personally, I, there are a lot of new policies that come especially CHPS policy, so far as I am involved as a leader and with my experience and like I agree to this, and it is with regards to health service delivery, it will be easily implemented though I will have personal challenges because dealing with human beings is not easy and it is normal with every leader so, so far as I have the zeal, I have no problem with this, I think I will be able to push for this for it to be implemented"[Participant 4].

4.7 Context -Specific Opportunities and Cocreation of Collaborative Flexible Low - resource input Framework for Mainstreaming

This framework is a seven-step iterative process identifying the PHC legally mandated structures and planning cycles as levers for mainstreaming—the framework. The process is described in detail in the following sections.

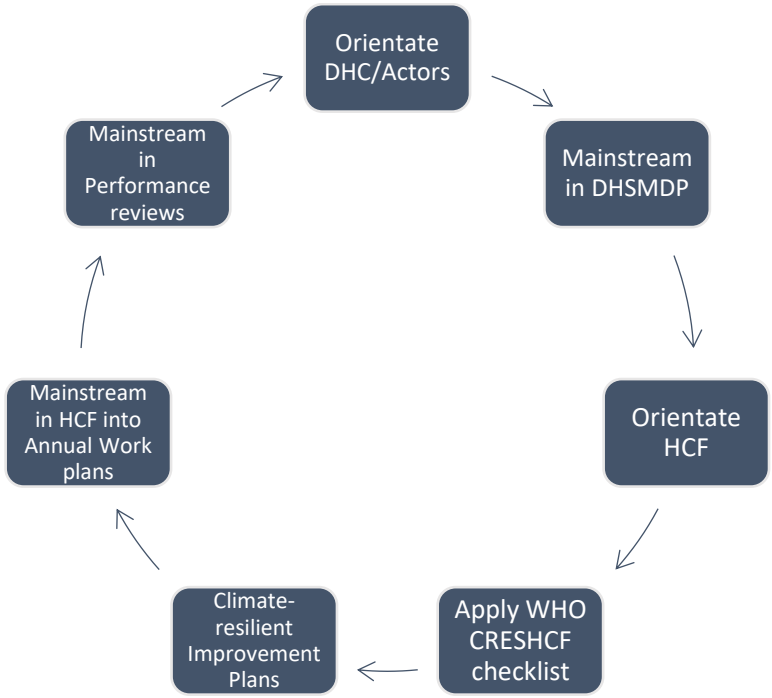

Figure 9: Collaborative Framework for mainstreaming climate change Adaptation and mitigation into PHC operations

4.7.1 Orientate District Health Committee (DHC) /Actors

The District Health Committee (DHC) is a legally mandated committee comprising formal local government actors, decentralised departments, and religious and community representatives with the responsibilities of advising the District Director of Health Services and performing delegated duties of the GHS council. The DHC compromises all important actors of the political systems at the local government level. The framework proposes that DHC should be first orientated on the nexus between climate change and health systems to get their buy-in, support, and commitment to PHC adaptation and mitigation. This orientation should be integrated into their quarterly or ad hoc meetings. As part of this orientation, PHC systems should apply the WHO checklist for measuring the climate -resilience of health systems, identify areas for strengthening, and draw PHC/District Climate adaptation and mitigation plans to guide mainstreaming into PHC medium-term development plans.

4.7.2 Mainstreaming in PHC Medium-term Development Plans

District/PHC medium-term Development plans are three-year planning windows open to annual revision. PHC medium-term Development plans are integrated into the district or local government plans, which the National Development Planning Commission approves. These plans form bases for budgets and fund allocation by central governments. After securing the support of the DHC, the next action is to integrate climate change considerations into the PHC Medium-term Health Development Plans.

4.7.3 Orientate HCF Managers

After mainstreaming and approval, the next step is to orient all staff on climate resilience and environmental sustainability of PHCs using the WHO Frameworks. These orientations can be standalone or integrated systematically into routine PHC capacity-building programmes and partner-sponsored events.

4.7.4 Apply the WHO Climate-Resilient and Environmental Sustainability (CRESHCF) checklist

After the orientation of PHC and healthcare facility managers, the next step is to apply the WHO checklist. Even though it will be best to tailor the checklist for the different categories of healthcare facilities, the emphasis at this stage, for beginners, is to learn through the process for future adaptation planning. Ideally, applying this checklist with local-level actors like the Community Health Management Committees (CHMCs), a mandated community-based structure facilitating, advising, and advocating for improved healthcare services would be better. Assessments should be conducted during CHMC quarterly meetings. The rationale for roping in the CHMC is to build their capacity on the nexus between climate change and health and to get support for mainstreaming climate change adaptation and mitigation into healthcare facility operations.

4.7.5. Develop Healthcare Facility (HCF) climate-resilient Improvement Plans

The emphasis of this plan should be on low-cost measures. For instance, this could include shade trees for cooling during the hot season, which can serve as windbreaks during storms. Another example can be the development of basic guidelines for energy conservation in clinic settings. A third example is the development of criteria for outreach locations during the different seasons or siting of healthcare facilities. The essence of this plan is to guide mainstreaming into HCF routine

work plans and advocacy by CHMC on behalf of the healthcare facility. The output of these assessments should be climate-resilient improvement plans.

4.7.6 Mainstreaming into HCF Work Plans.

Mainstreaming should take a systems approach. Climate-resilient improvement plans should be integrated into PHC facility and CHMC monthly, quarterly, and annual work plans. To ensure progress, the HCF team should agree to monitor milestones and communicate them to DHMT. The milestones should be integrated into the agendas of quarterly CHMC meetings and HCF internal reviews and reporting.

4.7.7 Mainstreaming into PHC Performance Reviews

Climate-resilient improvement plans of HCF and PHC should be monitored through quarterly, half-yearly, and annual reviews. Once climate resilience is integrated into the reviews, stakeholders can monitor progress and learn best practices. These reviews provide an opportunity for learning, reviewing frameworks for improvement in the next planning cycles, and documenting best practices for advocacy and bottom-up approaches.

4.8 Conclusion

CHPS policy minimally supports climate-resilient and sustainable actions. PHCs are incompletely prepared, and 80% of PHC facilities are at high risk despite the observed impacts of climate hazards. PHCs reported that the WHO framework is suitable for climate change adaptation; however, cost and lack of mainstreaming into PHC policies, protocols, and standards are reported as extreme barriers. Despite the challenges, health systems and PHC are undertaking policy responses and autonomous adaptations. The next chapter discusses the results.

CHAPTER FIVE

DISCUSSION

5.1 Introduction

The discussion focuses on key issues arising from policy analysis of Ghana's CHPS policy, the vulnerability of PHCs to climate hazards and context-specific facilitators and barriers to PHC Adaptation (resilience) and mitigation (environmental sustainability). Finally, the chapter discusses the co-created flexible low-resource input framework for mainstreaming climate change adaptation and mitigation of PHC operations.

5.2 Policy Analysis: How Ghana's CHPS Policy Supports Climate Change Adaptation and Mitigation

The CHPS policy, as a stand-alone policy, minimally mainstreams climate change adaptation and mitigation in the components of the Health Workforce, Water Sanitation Hygiene and Healthcare Waste, Energy and Infrastructure, Technology, Products, and Processes. However, applying the CHPS policy to the National Health Care Waste Policy (2020) and the National Health Policy (2020) leads to moderate mainstreaming of WHO-recommended actions. Applying multiple policies at the sub-national (local government & PHC) level, which has primary responsibility for constructing, equipping and managing CHPS facilities, presents challenges among stakeholders and health workers who may not have the adequate capacity(Hussey & Arku, 2020) to synchronize multiple policies.

Despite integrating climate change and health into the medium-term health sector strategic plan 2014-2017 and prioritisation of health in Ghana's national climate change policies and strategies, climate change adaptation and mitigation is not adequately mainstreamed into the CHPS policy. This calls for the development of mechanisms and building of capacity of health sector actors to mainstream national climate change agenda into health system policies. The absence of supportive

policy frameworks limits subnational actors' prioritization of mainstreaming efforts within PHC operations. This finding aligns with Mogelgaard et al. (2018) and Tye and Waslander(2021), who suggest that policy frameworks are important levers for guiding and supporting the mainstreaming of climate change adaptation.

The inability of Ghana to mainstream climate action into sub-national health policies presents missed opportunities for sustainable climate action at the sub-national level as outlined below.

PHC systems are responsible for policy implementation. Mainstreaming climate policy into PHC operations with adequate performance monitoring and accountability systems to track performance will catalyse climate action at the sub-national level because PHC systems are mandated to report in line with national accountability and reporting mechanisms. Mainstreaming will catalyse autonomous adaptation in PHC systems and deepen sustainable climate action because of the willingness of local government authorities to invest in the health system. The rapid growth in CHPS facilities over the last two decades, despite competition for resources and funding constraints (GoG/MOH,2020), demonstrates a high level of trust in the PHC systems by the local actors. Mainstreaming climate action in health sector policies and programmes presents an opportunity for the health sector to lead sustainable action in partnership with other relevant health-determining sectors and communities. For instance, CHPS facilities increased by 63% in Ghana between 2015 and 2017, representing an absolute increase of 2,086 facilities. The District Assembly, the local government authority, pioneered these investments, accounting for 47.8% of the construction nationally (Yeboah et al., 2020). This presents a missed opportunity to mainstream climate adaptation and sustainability dimensions into the physical projects that Runhaar et al. (2017) describe as “windows of opportunity."

The current situation requires the health system to adopt, "thick mainstreaming" approaches to enhance PHC adaptation and mitigation(Abugnaba-Abanga, 2023). This approach advocates mainstreaming national policy on climate resilience (adaptation) and mitigation (environmental sustainability) into sub-national health system policies, standards, programmes and protocols with built-in monitoring, accountability and participatory mechanisms. This approach is necessary because it comes with opportunities for holistic investment that considers climate resilience for PHC due to the current trajectory of decentralization.

5.3 Context- Specific Vulnerabilities of PHCs to Climate Change

Even though Ghana's national climate change agenda underscores the importance of health sector adaptation (GoG/EPA, 2018) and mitigation (GoG/MOH, 2020a; 2020b), this is not adequately translated into the mainstreaming of climate resilience in Primary Healthcare (PHC) operations in low resourced settings of Northern Ghana. This is despite the substantial exposure of PHC healthcare facilities to multiple climate hazards. PHC managers identified low human resource capacity on the nexus between climate change and health systems, cost and weak subnational inter-sectoral collaboration as barriers to mainstreaming. PHC managers identify systematically mainstreaming climate change adaptation and mitigation into PHC policies, protocols and standards with inbuilt accountability mechanism- "thick mainstreaming", leadership commitment, improved sub-national multi-sectoral collaboration, NGOs and improved workforce capacities as facilitators.

Ghana's National Climate Change Adaptation Framework(GoG/EPA, 2018) and Climate Change Master Plan 2015- 2020 (GoG/MESTI, 2015) underscore the need for mainstreaming climate action into policies of health systems. The master plan developed a mainstreaming methodology

to assist health systems mainstream climate action at all levels of planning. This finding aligns with that of Tye and Waslander (2021), who suggest that sectorial policy inconsistency leading to poor mainstreaming in health sector policies has resulted in limited climate action within the health sector(Tye and Waslander, 2021).The poor mainstreaming of climate action into health systems may have an implication for climate action within PHCs across the country because PHCs have the same structure, mandate with their operations guided by health systems policies (GoG/MOH, 2020).

Secondly PHC is the operating unit of the Ghanaian health system., accounting for over half of essential public health services, and is at the forefront of managing public health emergencies related to natural disasters (GoG/MOH, 2020). This presupposes that mainstreaming climate action into PHC policies and standards is crucial for moving from policy to action at the subnational level. Despite the current challenges, mainstreaming climate action into PHC policy and systems will trigger innovation and autonomous adaptation within PHC. For instance, training, new infrastructure and partnerships will be forced to integrate climate considerations, hence the potential to leverage resources for PHC mainstreaming agenda. This finding aligns with Mogelgaard et, al(2018) who argue that for countries to bridge the implementation gap for adaptation, they must achieve the five levers of leadership, policy frameworks, information and tools, coordination mechanism and, financial processes (Mogelgaard et, al., 2018).

Finally, it is worth noting that, progress made by PHCs in the resilience component of integrated monitoring and early warning systems, climate-informed programming and management of environmental determinants of health was primarily because of the availability of a protocol for an integrated disease surveillance and response system (GoG/MOH, 2002) which reinforces these resilience components and integrated them into the health management information systems of

PHC and its facilities (GHS, 2020). This example reinforces the position that mainstreaming climate action into PHC policies and standards with inbuilt accountability mechanisms will trigger systemwide action. It underscores the availability of some capacity to mainstream climate action into PHC.

PHC systems in the three study districts show incomplete preparedness (medium risk) to climate exposures. Participants from District Health Management Committee (DHMT) of PHCs credited collaborations with NGOs for climate action. For instance, NGOs were credited for the preparedness (low risk) of a few lower-level healthcare facilities in the components of WASH and healthcare waste (1% of CHPS, 3.0% of health of centres/clinics) and infrastructure, technology, products and processes (7.0% of health centres/clinics). The Health Sector Waste Management Policy developed in 2020(GoG/MOH, 2020b) triggered most of these collaborations and provides guidance for interventions. Collaborations with decentralised government departments and the National Disaster Management Organisation (NADMO) are cited for development of emergency preparedness plans for disease outbreaks and natural disasters. These collaborations provide a springboard for bottom-up approaches, buy-in and ownership by PHC actors, and infusion of context-specific knowledge and experience in future health system agenda on climate action. We recommend health system policymakers to adopt decentralised and bottom-up approaches for future mainstreaming efforts.

Incomplete preparation (medium risk) of PHC has not translated into deepening climate action in the operations of the majority of PHC facilities which they supervise. For instance, 93% of community-level CHPS which are community-based clinics with focus on close to client services and 58% of higher-level health centres/clinics which are the referral points for CHPS within the PHC system are unprepared; that is unable to respond to observed climate hazards. The inability

of PHC systems to translate their resilience and capacity, and associated knowledge to PHC facilities is primarily due to the ad hoc nature of collaborations. The ad-hoc nature of collaborations contributes to the disconnect between capacities and preparedness of PHC and PHC facilities. These collaborations may not always align with formal plans, budgets, knowledge dissemination, support and monitoring systems of PHCs; hence difficulties in translating PHC system capacities to practice by healthcare facilities. Even though these partnerships are enhancing climate action within PHC, we argue that these partnerships are not sustainable due to the short -term nature of donor funding. They lack a system-wide approach with institutional integration, limited learning and scale up opportunities due to poor transition management. This view was reinforced by a participant who suggested that capacity building for climate change adaptation should directly target lower level PHC facilities from inception to enhance sustainability. We recommend PHC broadens these collaborations to involve health research and health training institutions to undertake implementation research to enhance scale-up efforts. Government should take steps to integrate planetary health into training curricula for long-term sustainability as observed by a participant.

Secondly, mainstreaming climate action into PHC operations requires a shift in mindset and systems to broaden its systems to integrate climate considerations in their operations. This shift requires PHC to develop and incorporate into its systems, a strategy to help build and stabilize climate action while gathering the support of PHC actors to phase out the current mindset of focusing on delivering healthcare with minimum regard for climate action. This view aligns with Diercks et.al.(2022) concept of the X-curve which suggests the need to fill the gap of building and stabilizing alternative; in this case, climate-resilience and sustainable operations and destabilizing and declining the current practice or the status quo(Diercks, et, al., 2022).

5.3.1 Vulnerability of PHC Facilities

Despite the observed multiple exposures of PHC facilities to extreme weather events linked to climate change such as storms, heatwaves, floods, wildfires and droughts, 83% were unprepared (higher risk). The risk level differs by the size of the health facilities, with the larger healthcare facilities generally at lower risk. Half (50%) of District Hospitals, the most developed and resourced healthcare facilities within PHC (Wang, et,al., 2017) had lower risk compared to 58% of health centres/clinics and 93% of the community-based healthcare CHPS facilities. Low revenue generation capacity of lower-level healthcare facilities (CHPS and health centre) presents significant challenges to undertaking autonomous adaptation because they have a higher dependency on allocated financial resources which are erratic. The situation presupposes that health systems policymakers need to identify a funding mechanism for active PHC adaptation and mitigations. This finding aligns with the views of Tye and Waslander(2021) who identified funding as a significant challenge for progress in health system adaptation in Ghana(Tye and Waslander, 2021). On the contrary, hospitals financed their autonomous adaptations from their revenues because they generate higher incomes. For instance, interview participants from hospitals reported acquiring backup generators and localized water systems from their revenues.

Hospitals show more resilience in the energy component (none has a higher risk) primarily because of their ability to finance adaptation measures for energy, as reported by participants. The acquisition of diesel-powered generators provides the necessary backup for the provision of essential healthcare services when they encounter challenges with the national grid. Even though the investment in fossil fuel dependent technology provides some level of energy security, it also contributes to the carbon footprint of hospitals. This calls for increased investments in green technology to augment the power demands of healthcare facilities. For example, small solar units

can be used to provide alternative power for critical departments of the hospitals. Some CHPS and health centres/Clinics combine the national electricity grid and solar energy to maintain critical supplies in the departments. NGOs and central government projects largely financed these energy resilience efforts.

Infrastructure, technology, products and processes show significant unpreparedness (higher risk) across all categories of healthcare facilities (Hospital-50%, Health center-68% and CHPS-89%). This is partly because most health centres and hospitals were constructed decades ago hence, the need for substantial investments to improve their resilience and sustainability. The Ministry of Health through the CHPS policy has improved and standardise design for CHPS (GoG/MOH, 2016), with emphasis on adaptation to context; however, local government authorities do not use these designs because of cost and appetite for quick fixes for political gains as reported by respondents. The appetite for short-term gains by local government authorities results in a missed opportunity to incorporate context-specific climate considerations into projects, considering that CHPS have witnessed tremendous increase in numbers(63% or 2,086 facilities) between 2015(GoG/MOH, 2015) and 2017(GHS, 2017) with the local government authorities accounting for construction of 47.8% of them(Yeboah, et, al., 2019). They remain Ghana's key strategy for attaining universal Health Coverage (GoG/MOH 2020c). PHC should take steps to deepen collaboration with its actors to improve the understanding of the nexus between climate change and health through the relevant collaborative and community-based structures to secure buy -in of stakeholders for increased investments to avert cost in the future.

5.4 Context-specific Facilitators and Barriers to Mainstreaming Climate Change Adaptation and Mitigation.

PHC systems are reasonably ready for climate change adaptation and mitigation because mainstreaming frameworks align perfectly with the health systems' building blocks. PHC systems and structures can facilitate sustainable climate action. PHCs present an opportunity for sustainable climate action because they have structures at all subnational levels (District, sub-district, community and a network of community structures) and enjoy sustained investment, especially in the development of CHPS (Yebaoh et al., 2019) and trust of subnational stakeholders and local government authorities. The health sector can leverage the trust of stakeholders to sustain PHC adaptation and mitigation to climate change and extend its influence on other health-determining sectors, thereby fostering a multisectoral climate action at the sub-national level. However, critical barriers exist to mainstreaming climate change adaptation and mitigation into the PHC system. The next section discusses facilitators and barriers to PHC adaptation and climate change mitigation in Ghana's low-resource settings.

5.4.2 Key Facilitators

PHC managers are at the forefront of PHC programming; hence, their positive perception of the framework presents a foundation for action. There are challenges with PHC programming culture. These can be classified as context-specific and need appropriate management to enhance the mainstreaming and implementation of the framework. Notable among these are leadership engagement, structural characteristics, and relative priority. These are moderate facilitators and need to be improved. There is a strong sense of the suitability of the framework among PHC managers. However, some managers face challenges regarding their ability to implement the framework(self-efficacy). Capacity building on the framework is essential to enhance active

mainstreaming and implementation of PHC climate change adaptation and mitigation. To ensure maximum impact, a system-wide capacity building that includes all actors is necessary for effective inter-sectoral collaboration.

5.4.3 Key Barriers

PHC systems present challenging barriers that must be addressed to ensure optimum and sustainable mainstreaming of the framework into PHC operations. Even though PHC managers view the mainstreaming framework as beneficial to client needs, preferences and resources, extreme barriers exist to mainstreaming the framework. External policy and incentives are critical to mainstreaming efforts because the PHC systems operate based on policies, protocols and standards. A pre-condition for sustainable mainstreaming into operations of PHC is for health systems policymakers to coordinate with relevant actors to mainstream the framework into PHC policies, protocols, programmes and projects with an in-built accountability mechanism (Thick mainstreaming).

Funding is also a fundamental challenge to action due to limited government funding, low revenue generation capacity of PHC health facilities and delays in reimbursements by the National Health Insurance Authority. Thick mainstreaming is recommended amidst the current funding challenges because such an approach will introduce climate considerations into currently funded programmes and policies and PHC programming. It may catalyse innovation, autonomous adaptation, bottom-up approaches to climate action by PHCs and support from non-state actors like traditional authorities and NGOs who continuously pioneer innovation in health in partnership with PHCs. Thick mainstreaming measures will positively influence extreme barriers to peer pressure and network and connectivity.

5.5 Context -Specific Opportunities and Cocreation of Collaborative Flexible Low - resource input Framework for Mainstreaming (Thick Mainstreaming Framework)

Even though Ghana's national climate change response strategies are shifting towards sectoral and decentralised approaches (GoG/EPA, 2018), mainstreaming into subnational policies and programmes is still challenging. This situation presents difficulties for PHC managers and other sub-national authorities due to limited capacity, as observed by Hussey & Arku (2019), and poor understanding of the nexus between climate change and health systems(Tye & Waslander, 2021).

This framework allows PHC to integrate climate change adaptation and mitigation into PHC operations, leveraging existing systems and structures. Mainstreaming climate change action into PHC enables the PHC to take advantage of "windows of opportunity" that come with new projects and partnerships. For instance, development funding remains critical to the operations of PHCs because they finance most PHC public health programmes (GoG/MOH, 2020), while NGOs partner with PHCs to test innovations and support their operations. Mainstreaming will stimulate actors and partners to mainstream climate considerations in innovation, leveraging crucial resources for sustainable climate action. For instance, all training programmes, new infrastructure, and partnerships must integrate climate considerations.

Even though the WHO framework and checklist emphasize the need for political commitment, awareness creation and community engagement to gather support for mainstreaming, the framework does not provide a systematic methodology for mainstreaming. The "Thick Mainstreaming" framework enhances the usability of the WHO framework and provides opportunities for stakeholder buy-in and bottom-up approaches to climate action within health systems.

CHAPTER SIX

SUMMARY, CONCLUSION AND RECOMMENDATION

6.1 Introduction

Storms (34%), Heatwaves (25%), Floods (17%), Droughts (15%) and Wildfires (9%) are currently negatively impacting PHC facilities, with 80% of the facilities at high risk or unable to respond. CHPS, Ghana's key strategy for Universal Health Care, is the most impacted, with 93% of them unable to respond. The current vulnerability of CHPS has the potential to derail Ghana's progress toward achieving UHC by 2030. Secondly, the ability of PHCs, which are mostly at the forefront of responding to public health and climate emergencies at subnational levels, is compromised due to their high vulnerability to climate hazards.

Despite the current challenges, opportunities exist to build the climate resilience of PHC systems and facilities. Notable among these opportunities is the positive perception of the suitability of the WHO framework for; PHC programming attributes and culture and PHC managers' identification with WHO frameworks. However, mainstreaming climate action in PHC policies, protocols and standards remains a key barrier to climate action within PHC. Finally, decentralised governance systems present opportunities for systematically mainstreaming climate action into PHC operations.

The "Thick Mainstreaming" framework co-created with PHC managers for enhancing PHC adaptation and mitigation to climate change presents an opportunity to leverage the trust of PHC systems by local government authorities to foster transdisciplinary collaboration and sustainable action at the subnational level. This approach will stimulate autonomous adaptation and provide a framework for PHC to partner with NGOs, who are essential partners in developing PHC systems and leveraging their resources for climate action. It can also allow PHC to extend its influence on

health-determining sectors and community actors and strengthen bottom-up approaches for sustainable action.

6.2 Summary of Findings

6.2.1 Policy Analysis: How Ghana's CHPS Policy Supports Climate Change Adaptation and Mitigation

Ghana's MOH has not adequately mainstream climate change and health into the CHPS policy despite integration into the medium-term health sector strategic plan 2014-2017 and other national policies, namely: National Climate Change Adaptation Strategy, National Climate Change Policy, Ghana National Climate Change and Master Action Programmes for Implementation 2015-2020. This results in difficulties decentralizing climate action at the sub-national level for programmes like CHPS, hence the need to develop mechanisms and capacity to translate national policy to sub-national action in Ghana and other LMICs. The inability of Ghana to decentralize climate action in PHC policies presents missed opportunities or "windows of opportunity" for sustainable climate action.

6.2.2 Context- Specific Vulnerabilities of PHCs to Climate Change

Despite observing multiple climate hazard impacts, most PHC systems and healthcare facilities are unprepared (higher risk) for climate change impact (83%). The lack of action by PHC is largely due to a disconnect between the national climate agenda and health systems policies. Despite the challenges, PHCs are undertaking adaptation and mitigation actions using their internal resources and in partnership with NGOs and other government actors. Secondly, PHCs are already collaborating with other sub-national actors; hence, their experience is crucial for successful mainstreaming efforts by health system policymakers, sustainability and ownership.

6.2.3 Context-specific Facilitators and Barriers to Mainstreaming Climate Change Adaptation and Mitigation.

PHC systems at the sub-national level are reasonably ready for climate change adaptation and mitigation. However, the lack of mainstreaming Ghana's national climate change adaptation and mitigation agenda into health systems policies, protocols, standards and programmes results in non-prioritization of climate action by PHCs and sub-national actors because PHCs operate based on policy, standards and protocols. Another extreme barrier is the cost of adaptation and mitigation to PHCs due to the low revenue generation capacity of PHCs. Despite the challenges, mainstreaming climate action in PHC policies and protocols will trigger innovation and autonomous adaptation within PHC. For instance, all training programmes, new infrastructure and partnerships must integrate climate considerations. Partnerships with NGOs bring on board innovation and resources for PHCs; hence, mainstreaming climate action in PHC policies and protocols will require NGOs to add climate dimensions to their innovations, which has the potential to leverage resources for the PHC mainstreaming agenda.

6.2.4 Context -Specific Opportunities and Cocreation of Collaborative Flexible Low -resource input Framework for Mainstreaming

Even though the WHO framework and checklist emphasize the need for political commitment, awareness creation and community engagement, it does not provide a systematic methodology for mainstreaming. The thick mainstreaming framework enhances the usability of the WHO framework. Secondly, policy cycles typically involve the formulation and implementation phases. A thick mainstreaming framework enhances the systematic application of the WHO framework at the subnational or PHC level, as well as effective collaboration and buy-in. This approach will stimulate autonomous adaptation and provide a framework for PHC to partner with NGOs, who are essential partners in developing PHC systems. It also can allow PHC to extend its influence on

health-determining sectors and community actors and strengthen bottom-up approaches for sustainable action.

6. 3 Recommendations

The study highlights significant vulnerability of PHC facilities in Ghana's Upper East Region to climate hazards, highlighting the need for improved alignment between national climate agendas and health systems policies. To enhance climate change adaptation(resilience) and mitigation (environmental sustainability) in these low-resource settings, the study proposes the following recommendations:

6.3.1 Policy Implication

Given the critical role of PHCs in achieving Universal Health Coverage (UHC) and managing public health emergencies (GoG/MOH, 2020), it is concerning that 83% of PHCs in the Upper East are either unable to respond to climate hazards or are at higher risk. The increasing frequency and intensity of extreme weather events due to climate change threaten Ghana's ambition to achieve UHC by 2030. Therefore, incorporating climate considerations into PHC investments is imperative, despite scarce resources. The lack of integration of Ghana's national climate change and health systems agenda into PHC policies, protocols, standards, and guidelines, combined with limited funding and capacity, largely accounts for this disconnect.

1. **Mainstream National Climate Agendas:** Ghana's Ministry of Health and its implementing agencies should collaborate with stakeholders to integrate national climate change and health systems agendas into health policies, protocols, standards, and

management information systems. This "Thick Mainstreaming" approach can help PHCs leverage "Windows of Opportunity" (Godsmark et al., 2019) to enhance climate action, support autonomous adaptations, and foster sustainable bottom-up approaches. This will stimulate climate-sensitive investments in PHCs by local government actors and encourage partnerships with NGOs, extending PHC's influence on health-determining sectors and community actors for sustainable action.

2. **Allocate Funds for Adaptation:** Despite financial constraints, health system policymakers and managers should allocate funds for climate change adaptation, particularly in high-risk areas like the Upper East Region. Introducing budget lines for climate action in routine budgets will align with mainstreaming efforts in health system policies and enhance tracking of PHC operations.

6.3.2 Practical Applications

1. **Capacity Building:** Sustainable mainstreaming of climate change adaptation and mitigation requires system-wide capacity building for PHC staff and relevant sub-national actors. Building their capacity will improve risk perception, trigger ground-level action, and leverage trust from both state and non-state actors for sustainable climate action. This will also expand PHC's influence on other health-determining sectors and deepen multisectoral collaboration.
2. **Develop Climate-Resilient Strategies:** Health system policymakers must develop and incorporate strategies within PHC systems to stabilize and enhance climate action. This will support the transition from traditional health systems to climate-resilient and sustainable operations.

6.3.3 Future Research Directions

1. **Return on Investment:** Further research should focus on evaluating the medium to long-term impacts of mainstreaming climate action into PHC operations in low-resource settings. This will provide evidence of the effectiveness and return on investment of such interventions, incentivizing further investments in climate change adaptation and mitigation.
2. **Implementation Studies:** Improved support is needed for implementation studies to assess the impacts of mainstreaming climate action into PHC operations, providing appropriate evidence for informed context-specific decision-making and policy development.

6.4 Limitation of Study

Vulnerability assessments of PHC healthcare facilities were based on observed climate hazards specific to participating health facilities. Even though the Upper East Region shares similar ecological characteristics, there might be slight differences in climate change impacts on health facilities based on their location, level of exposure and vulnerabilities. Secondly, the results cannot be generalised for other zones experiencing different exposures, like coastal and forest belts. However, they can indicate the state of climate resilience among PHC facilities in these zones since PHCs are standardised and operate based on the same policies, standards and protocols across the country.

Even though the study adhered to high ethical standards, researchers' in-depth knowledge of Ghana's health systems could have influenced the findings of qualitative components of the study. However, transcription was conducted by a neutral team with no interest in the study. Coding of

transcripts and theming were carried out independently by the principal researcher and a field coordinator, after which they met to discuss and synchronize codes and themes to eliminate potential biases.

6.5 Strengths of the Study

The "Thick Mainstreaming" framework, co-created with PHC managers provides a framework to enhance systematic integration of climate change adaptation and mitigation into PHC systems. It addresses a critical gap in linking climate policy to action on the ground. The study's focus on low-resourced setting of the Upper East Region provides a context-specific understanding of PHC vulnerabilities to climate hazards in similar settings and the crucial role of PHCs in health systems adaptation and mitigation.

The study identifies opportunities for collaboration with subnational actors to foster sustainable, bottom-up climate actions. It provides practical recommendations for mainstreaming and scaling climate action into PHC operations aligning well with decentralized governance systems.

Interdisciplinary approaches adopted by the study contribute to global discourses on building climate-resilient and environmentally sustainable health systems, especially at the subnational level. Ethical rigor and measures adopted to minimize bias such as the utilization of independent transcriptions and multiple coders further strengthen the study. The study offers a foundation for future studies in similar contexts, providing valuable insights into mainstreaming climate action into health systems globally.

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Appendix I: Checklist for Assessing Vulnerability of PHC Systems

District / Sub-District Health Facility Cadre Function

1. Have you heard about climate change? (1) Yes (2) No
2. What are your thoughts on climate change and the health systems?
3. What are some of the ways climate change can affect your operations or access to quality services by your clients

Leadership and Governance					
Governance					
No	Question	Prepared	In-complete	Unprepared	Remark/
1	Are climate change and health focal points designated within the health ministry/RHMT/DHMT, with a specific programme of action and budget allocated?				
2	Climate change and health focal points or units collaborate with relevant climate-sensitive health programmes (e.g., vector-borne diseases, infectious diseases, nutrition, disaster risk reduction) to build the resilience of programmes.				
Policy					
	Question	Prepared	In-complete	Unprepared	Remark/
3	National strategy on health and climate change and/or H-NAP developed/ Do you have a climate change and health strategy in your District/Region?				
Cross-sectoral collaboration					
	Questions	Prepared	In-complete	Unprepared	Remark/
4	Agreements (e.g., Memoranda of Understanding) between the health ministry and main national/Regional/District stakeholders are signed, including specific roles and responsibilities in protecting health from climate change.				
5	Is health representation ensured in main climate change processes at national, regional, and global levels (e.g., UNFCCC meetings and COP, NAP, national communications to				

	the UNFCCC)/ Do you participate in the climate change process and programmes at the Regional and District levels?				
6	Do main policies and strategies from health-determining sectors reflect climate change and health considerations both in relation to adaptation (e.g., climate-resilient water safety plans) and mitigation (e.g., health co-benefits in transport policies)?				
10	Are health impact assessments conducted for new mitigation and adaptation policies and programmes in all health-determining sectors (per article 4.1.f of the UNFCCC)/ Have any health impact assessments been conducted in this region or district before?				

Health workforce					
Human resources					
No	Question	Prepared	In-complete	Unprepared	Remark/
1	Have any training courses on climate change and health topics targeting health personnel been conducted?				
2	Curricula on climate change and health developed and imparted at secondary and/or tertiary levels				NA- for RHD & DHMT
Organisational capacity development					
	Question	Prepared	In-complete	Unprepared	Remark/
3	Contingency plans are available for deploying sufficient health personnel in case of acute shocks, such as extreme weather events and outbreaks, developed at the appropriate level (i.e., national, provincial, local).				
4	Realistic and innovative capacity-building plans (e.g., from capacity or vulnerability and adaptation assessments) are developed to				

	address identified human resources and institutional capacity gaps.				
5	The management staff incorporated contingency, adaptation costs, and potential losses and damages from climate change into investment plans.				
Communications and Awareness-raising					
	Questions	Prepared	In-complete	Unprepared	Remark/
6	Development and implementation of internal and external communication plans (including developing knowledge products) to raise awareness of health and climate change and response options targeting key audiences, such as health professionals and decision-makers, communities, the media, and other sectors.				
7	Health professionals, the media, and community leaders are trained in risk communication, including communication of uncertainty.				
8	A stakeholder forum on protecting health from climate change established to engage health-determining sectors and the community.				
Health Information Systems					
Vulnerability, Capacity & Adaptation Assessments					
	Vulnerability	Prepared	In-complete	Unprepared	
1	Baseline rates and climate sensitivity of health conditions allow the selection of priority risks and continuous monitoring of changing risk conditions and assessed health status.				
2	Most vulnerable populations and areas prone to health risks of climate change are identified.				
3	Health impact assessments for key adaptation and mitigation policies and programmes of health-determining sectors conducted				
	Capacity	Prepared	In-complete	Unprepared	Remark

4	Baselines on existing human resources, technical and health service delivery capacity established, with identification of weaknesses				
5	Recommendations are made for addressing gaps and building health systems' capacity.				
	Adaptation Options	Prepared	In-complete	Unprepared	Remark
6	Assessment results are used to prioritize allocating resources and effective interventions in health and related –sectors for high-risk and vulnerable populations.				
7	Plan defined and mechanism established for iterative review of health vulnerability and adaptation plans				
Integrated risk monitoring and early warning					
	Integrated Disease Surveillance	Prepared	In-complete	Unprepared	Remark
8	Early detection tools (e.g., rapid diagnostics, syndromic surveillance) are used to identify changing incidents and trigger early action.				
9	Geographic and seasonal distribution of health risks and outcomes (i.e., risk mapping) tracked.				
10	Early warning systems for relevant extreme weather events and climate-sensitive diseases (e.g., heat stress, zoonotic diseases, undernutrition) have been established.				
	Monitoring	Prepared	In-complete	Unprepared	Remark
11	Indicators on climate change impacts, vulnerability, response capacity, emergency preparedness capacity, and climate and environmental variables are included in relevant national /Regional/District monitoring systems and reported over time.				

12	Periodic reviews for improvements or deterioration of capacities are identified in V&A assessments.				
13	Impacts of main environmental determinants of health monitored by the health sector				
	Communication	Prepared	In-complete	Unprepared	Remark
14	Communication strategy on climate risks to health developed and implemented, outlining the scope of information for diverse audiences (e.g., media, public, health personnel, and other sectors) and events, including who should communicate and the means of communication.				
15	Community engagement and feedback mechanisms are established to empower affected populations to respond to warnings and guide the development of future monitoring and warning systems.				
Health and Climate Change Research Agenda					
	Research	Prepared	In-complete	Unprepared	Remark
16	A National research agenda on climate change and health is defined by organizing a stakeholder forum involving representatives from health and other government ministries, research institutions, non-governmental Organisations, the private sector, and vulnerable populations.				NA-RHD and DHMTs
	Support Research	Prepared	In-complete	Unprepared	Remark
17	There is access to and linkage of data on meteorological information, health determinants, and outcomes enabled.				
18	Multidisciplinary research partnerships, knowledge management networks, and rosters of local experts established.				
18	Financial backing mechanisms to support research programmes and postgraduate training programmes are established.				

	Connect to Policy	Prepared	In-complete	Unprepared	Remark
19	A mechanism established for researchers to inform planning, policy, and stakeholder groups.				NA for DHMT
20	Policymakers are included in the definition and review of research agendas.				NA for DHMT

Climate-resilient and sustainable technologies and infrastructure					
Adaptation of current technologies and processes					
No	Question	Prepared	In-complete	Unprepared	Remark
1	Specifications for siting and construction of health facilities and energy, water, and sanitation provisions revised in line with projected climate risks.				
2	Training and recommendations for the prescription of pharmaceuticals during extreme heat conditions were revised.				
Promotion of new technologies					
3	Question	Prepared	In-complete	Unprepared	Remark
4	New technologies such as health or satellite imagery are used to improve health system performance.				
Sustainability of health operations					
	Questions	Prepared	In-complete	Unprepared	Remark
5	Impact of the health sector on the environment assessed, and appropriate mechanisms to monitor carbon emissions and environmental impacts developed.				
6	Sustainability in selecting products and procurement of services, including energy, water, transport, and waste management, is assessed and prioritized by health facilities.				
Service delivery					
	Management of environmental determinants of health	Prepared	In-complete	Unprepared	Remark
	Monitoring				

1	Integrated monitoring systems allow data collection and analysis of environmental hazards, socio-economic factors, and health outcomes.				
2	Evidence-based quality standards for climate-sensitive environmental conditions are defined.				
	Regulation	Prepared	In-complete	Unprepared	Remark
3	Regulations on key environmental determinants of health (air quality, water quality, food quality, housing safety, waste management) revised and enforced to reflect a broader range of expected climatic conditions.				
4	Building regulations and waste management infrastructure are environmentally sustainable and resistant to promoted local extreme events.				
	Coordinated management	Prepared	In-complete	Unprepared	Remark
5	The implementation of health impact assessments for policy and programmes in sectors such as transport, agriculture, and energy.				NA-RHD, DHMT
6	Joint multi-sectorial risk management approaches are undertaken to health risks related to disasters, water, waste, food, and air pollution (e.g., food safety, diarrheal disease control, integrated vector management, joined-up risk communication).				
	Climate Informed Programming	Prepared	In-complete	Unprepared	Remark
	Health Programming				
7	Medium- and long-term plans for disease control programmes are revised to consider capacities that may be stressed or exceeded by climate change.				

8	Investment plans are defined to address identified capacity gaps.				
	Delivery Interventions				
9	Risk maps and analysis of seasonal trends in diseases are used to target resources and preventive measures for those most at risk.				
10	Contingency plans for healthcare provision in extreme weather events or delivery of interventions to control infectious disease outbreaks in new locations are developed and tested.				
	Emergency Preparedness & Management	Prepared	In-complete	Unprepared	Remark
	Policies and protocols				
11	Climate-sensitive health risks are included in national disaster reduction strategies, plans, and broader development processes.				
	Risk Management				
12	Risk assessments for current and projected future exposure to extreme weather events are routinely used to inform health sector strategic development plans.				
13	Health sector contingency plans for extreme weather events developed, including risk reduction, preparedness, and response, in line with the WHO emergency response framework.				
14	Emergency response plans for individual health facilities are defined and implemented in case of need.				
	Community Engagement				
15	Establish stakeholder mechanisms to support participation, dialogue, and information exchange to empower civil society and community groups as primary actors in emergency preparedness and response.				

16	Implementation of capacity development programmes to identify and support the roles of local communities to determine risks, prevent exposure to hazards and take action to save lives in extreme weather events.				
Climate and Health Financing					
	Health-specific funding mechanisms	Prepared	In-complete	Unprepared	Remark
1	Resources to increase resilience to climate variability and climate change are included as a line item in national and/or subnational health investment plans.				
2	Proposals to external donors to support the control of climate-sensitive diseases (e.g., GFATM on malaria control) included climate variability and change.				
	Development funding in sectors influencing health				
3	Screening for climate variability, climate change risks, and health protection are criteria for selecting investments in key health-determining sectors, such as water and sanitation and food and nutrition security.				
4	The health impacts of climate change are monitored in programmes funded through financial mechanisms specific to health-determining sectors.				
	Climate change funding streams				
5	Projects and programmes on building health system resilience are submitted to and granted by the main international climate change funds (e.g., the GEF, Adaptation Fund, and bilateral donors).				

Appendix II: Key Informant Interview Guide

District | Sub-District | Health Facility | Cadre | Function

Name of Interviewer | Date of interview | 2022

A1-Strengths

1. Have you heard about climate change? Yes No
2. What are your thoughts on climate change and the health systems?
3. What are some ways climate change can affect your operations or access to quality services by your clients?

NB: Show participant presentation or short video on Climate resilience & environmentally sustainable health care/systems facilities.

Section A: Suitability of WHO Framework

Q. How well do you think this Framework will meet the needs of PHC clients?

Probes

-What are your thoughts about the effectiveness of the concept Climate-resilient & Environmental sustainability of health facilities (CRESCHF) / climate-resilient health system

-"Is it important whether the Framework was developed by people from your Organisation or outside your Organisation? Why or why not?"

"How convinced are you about the effectiveness of this intervention?"

Effectiveness

Q. What kind of information or evidence are you aware of showing whether the intervention will work in your setting?"

Probes

What are your general thoughts about the effectiveness of the WHO framework for PHC and What are your reasons for your thoughts?

What are your thoughts about the WHO Frameworks compared to other options?

How is mainstreaming the intervention better or worse than other options?

Can you tell me more about how mainstreaming the WHO Frameworks is better or worse than another intervention or what you already do?

Adaptability

Q. What kind of changes or alterations do you think you will need to make to the WHO Frameworks so it will work effectively in your setting?

Probes

What changes or modifications are necessary for the WHO Frameworks better to fit the Organisation's needs/providers/patients?"

Do you believe the WHO Frameworks can be modified if needed? Why or why not?

How would these modifications make for a better fit here?

Can you tell me more about how these modifications make for a better fit here?

Testability
Q. Would it be possible to pilot the WHO Frameworks before making it available to everyone?
Probes
What are your thoughts about the WHO Frameworks first being tested on a small scale?
Can you tell me more about how the WHO Frameworks might be tested on a small scale before rolling it out to the whole Organisation?

Complexity
Q. "How complicated is the WHO Frameworks?
Probe
"Are there components of the WHO Frameworks that are more or less complicated than others?"
"What are your thoughts about the WHO Frameworks complexity?
"In terms of its complexity, how would you characterize the WHO Frameworks?"
"Can you tell me more about the WHO Frameworks, regarding it being simple, straightforward, or complex?"

Cost
Q. What costs will be incurred to implement the WHO Frameworks?
Probes
What are your thoughts about the cost of the WHO Frameworks?
How, if at all, do the costs of the WHO Frameworks impact implementation?
Can you tell me more about how the costs of doing this WHO Frameworks might impact the Organisation?

System and Stakeholders
Clients & Resources
Q. How well do you think the WHO Frameworks will meet the needs of the individuals served by your Organisation?"
Probe
How, if at all, does the WHO Frameworks fit your patients' needs, preferences, and resources?
Can you tell me more about how the WHO Frameworks might address patient needs, preferences, and resources?

Network and Connectivity
Q. What kind of information exchange do you have with others outside your setting, whether related to the WHO Frameworks or your profession?"
Probes
How, if at all, is your Organisation connected with similar healthcare Organisations?
To what extent is the programme connected with other Organisations?
What type of networks are in place that connect you with other Organisations?
Can you tell me more about your Organisation's connection with others?

Could you describe how the different types of networks work?

Peer pressure

Q. Can you tell me what you know about other Organisations implementing the WHO Frameworks or similar programmes?

Probes

Are you aware of other Organisations that have implemented the WHO Frameworks?

What are your thoughts about other Organisations that have implemented the WHO Frameworks?

To what extent does the pressure to keep up with other agencies impact your decision to implement the WHO Frameworks?

Can you tell me more about how your organisation compares to other Organisations?

External policy and incentives

Q. What kind of financial or other incentives will influence the decision to mainstream the WHO Frameworks?

Probes

How, if at all, have policies and incentives influenced the implementation of the WHO Frameworks?

What are the different types of policies and incentives that influenced the decision to implement the WHO Frameworks?

Can you tell me more about their impact on the decision to implement the WHO Frameworks?"

Do you see these factors as supportive or inhibiting?

PHC Programming and Culture

Structural Characteristics

Q. How will your Organisation's infrastructure (social architecture, age, maturity, size, or physical layout) affect the mainstreaming of the WHO Frameworks?

Probes

How would things like the size or history of your Organisation influence mainstreaming this WHO Frameworks?

Can you tell me more about how PHC programme characteristics might influence the implementation of the WHO Frameworks?

Do you imagine it could make it easier or harder?

Networks and Communication

Q. Can you describe your working relationships with your colleagues?"

Probes

How would you describe the quality of communication with others in your Organisation?

Do you think the communication culture of PHC can impact mainstreaming of the framework and how?

PHC Culture

Q. How would you describe the culture of your Organisation? Of your setting or unit?"
Probes
How, if at all, does the culture here impact the implementation of the WHO Frameworks?"

Implementation Climate
What is the general receptivity within PHC for trying new things?
Probes
Do you think PHC will be happy to mainstream of the Framework? and what are the reasons for your thoughts?
What kinds of things would you say are good examples of this?"
Can you tell me more about the ongoing improvements being made here?"

Tension for Change
Q. Do you belief there is a strong need for the WHO Frameworks? And what are the reasons for your thoughts?
Probes
How would you describe the current situation regarding changes needed?
How imperative or critical is making this change?
Can you tell me more about what changes your Organisation needs?
Compatibility
How well does the WHO Frameworks fit your values and norms and the values and norms within the Organisation?"
Probes
How does the WHO Frameworks fit the Organisation's current state practice or philosophy?
Would you say it is compatible or really quite different from 'business-as-usual?
What kinds of things would you say are good examples of this?
Can you tell me more about the fit of the WHO Frameworks?

Relative Priority
To what extent might the implementation of the framework take a backseat to other high-priority initiatives?
Probes
"With all the things and pressures in your work, how much of a priority is mainstreaming this practice?
"How does it compare with other priorities?

Organisational Incentives
Q. What kinds of incentives are there to help ensure that the implementation of the WHO Frameworks is successful?"
Probe
Are there specific incentives that would motivate you and other staff?
Can you tell me more about how incentives might help ensure the WHO Frameworks implementation?"

Goals and Feedback
Q. Have you/your unit/your Organisation set goals related to similar interventions.
Probes
How are practice or quality goals communicated to staff in this Organisation?
How, if at all, will this influence the implementation of the WHO Frameworks?

Learning Climate
Q. To what extent can you try new things to improve your work processes?
Probes
How does your Organisation deal with education and training needs?
How, if at all, does the Organisation support an inquisitive and open-minded learning climate?
Can you tell me more about how your Organisation encourages getting new skills and knowledge?"

Readiness for Implementation
How ready is PHC for this framework? And what are the reasons for your thoughts?
Probes
What, if any, type of indicators have you seen that signal the Organisation is ready to go and committed to mainstreaming the WHO Frameworks?

Leadership Engagement
Q. What level of involvement has leadership at your Organisation had with similar interventions?
Probes
How would you describe your Organisation's leadership (managers, supervisors, or other people at the top)?"
How would you know if this is a priority for your leadership?
How would you know if this is important to the people at the top?

Resource Availability
Q. Do you expect to have sufficient resources to mainstream the WHO Frameworks?
Probes
How would you describe the level of resources needed to implement this WHO Frameworks?"
Do you think current PHC resources are adequate and why do you think so?

Access to Knowledge and Information
Q. What information and materials about the WHO Frameworks have already been made available to you?

Identification of PHC Managers with the Framework
Knowledge and Beliefs about the WHO Frameworks
Q. How do you feel about the WHO Frameworks being used in your setting?
Probes

Do you feel you understand the WHO Frameworks well and how it works?
What are your true thoughts about the WHO Frameworks?
How confident are you that the WHO Frameworks will make a difference?
Can you tell me more about what you think of the WHO Frameworks?

Self-Efficacy

Q. How confident are you that you will be able to implement the WHO Frameworks successfully?"
Probes
How confident are you to adopt the WHO Frameworks?
How, if at all, confident do you feel in your ability mainstream the WHO Frameworks well?
How easy or hard do you think it will be to do the WHO Frameworks?"

D3. Stage of Motivation for the WHO Frameworks

Q. How prepared are you to use the WHO Frameworks?"
Probes
How would you describe your readiness for the WHO Frameworks and its implementation?
What indicators have you seen that signal that the people who will be doing this are ready to go?

Identification with the WHO Framework

How much do you personally identify with this Organisation?
How much do you personally identify with this Organisation's goals and mission?
How much do you identify with the Framework and its strategies? What makes you say this?"

Appendix III: Hazards Identification Tool

District Sub-District Health Facility Cadre Function

Name of Interviewer Date of interview

PART A: Hazards (Should first be administered to identify hazards that are likely to affect the health care facility. Once identified, the user can proceed directly to the checklists of interest.).
Use "O" for current Observed Impacts and "X" for possible impacts with changed conditions.

	Climate Hazard Type	**Is Hazard or Exposure Present between sept 2021 and sept 2022? Yes/No**	**Health workforce**	**WASH and healthcare waste**	**Energy services**	**Infrastructure, technologies, products, processes**
1	Flood					
2	Storms					
3	Sea-level Rise					
4	Drought					
5	Heatwave					
6	Wildfire					

NB: After identifying Hazards, administer the vulnerability assessment tool for health facilities in the context of climate change.

PART B: Healthcare Facility Vulnerability Assessment tool
WHO Checklist can be assessed using the link below
: https://iris.who.int/bitstream/handle/10665/340656/9789240022904-eng.pdf?sequence=1
Pages 26-9

Appendix IV: Participant Information Sheets for Health Staff and Key Stakeholders in Health

Consent to participate in the study: "Climate-resilient Health Systems in Northern Ghana: Policy, Practice, and Challenges."

Title of Research Study: "Climate-resilient Health Systems in Northern Ghana: Policy, Practice, and Challenges" **Category of Participants: Health Managers/Staff and Key Stakeholders in the health sector**

1.0 Introduction/Purpose of Study

The impacts of climate change result in direct and indirect health threats to populations and the optimum functioning of health systems. To enhance the resilience of health systems to unstable and changing climates, the World Health Organisation (WHO) developed frameworks that guide countries in building climate-resilient health systems. The study explores context-specific challenges to implementing the "WHO framework for building climate-resilient health systems" in low-resourced sub-national settings of Ghana? The inability of the Government of Ghana (GoG) and its relevant ministries to scale up climate resilience of health systems despite strong capacities in-country and policy commitments since 2015 catches this study's attention.

The study uses Northern Ghana as a case study. Pragmatic worldviews guide this study because it seeks to understand the status of integration of Climate resilience into operations of Primary Health Care systems, barriers inhibiting integration in health systems, documents autonomous adaptations, and recommendations to improving the adaptability of the WHO framework in LMICs. The anticipated research outputs include a co-created flexible low-resource-input prototype of a climate-resilient and environmentally sustainable health facilities framework in Northern Ghana that can be adapted for other low resource settings and a conceptual contribution to the WHO framework on climate-resilient health systems.

2.0 Study Procedure/Methods

2.1 Procedure /Methods

The study adopts a three-stage process; (1) Policy Analysis using the READ approach to understand the level of support for climate-resilient interventions by the National Health Policy (2020) and the Community-Based Health Planning and Services (CHPS) policy (2016) which provides the framework for the operations of PHC health facilities. The study focuses on CHPS because it accounts for over 50% of Ghana's healthcare facilities. (2) Transformative mixed methods –sequential, by first using the WHO checklist for vulnerability assessments of health facilities in the context of climate change for a survey among health managers. After which, key informant interviews are conducted using an open-ended questionnaire (CFIR Index) to understand best practices, challenges, and recommendations to enhance the adaptability of the WHO framework and (3) Grounded theory methodologies to make a conceptual contribution to the WHO framework.

2.2 Estimate of the time that will be required to participate in the study.

The estimated time for a structured questionnaire will be 45 minutes. Key informant interviews will last 120 minutes. Vulnerability assessment of health facilities will last 2 hours.

2.3 Inclusion criteria

All managers of PHC level health institutions and stakeholders in the Builsa North, Talensi, and Binduri Districts of the Upper East Region and a representative each from the MOH and Upper East RHD

2.4 Responsibilities expected of the participant.

For this study, participants are expected to respond to a structured questionnaire and/or key informant interviews

3.0 Benefits/Risks of the Study

3.1 Expected risks or inconveniences to the subject.

The risk associated with this study will be minimal as all interviews and assessments will be conducted at their workplaces and do not involve any clinical procedures. The anticipated inconveniences will be the participant's time and the possibility of interviews exceeding the stipulated time.

3.2 Expected benefits.

Participants will not get monetary benefits. The study aims to adapt the concept of climate resilience to the local context and potentially facilitate a scale-up of climate-resilient and sustainable environmental interventions in health systems.

4.0 Confidentiality

4.1 Protection of the anonymity of the participant.

- Interviews and assessments will not solicit personal details like name, house number, and ethnicity.
- All information gathered will be digitalized and stored in a secured drive, and hard copies will be shredded.

- Only Principal Investigator will have direct access to your original study information, and by signing or thumb printing a written informed consent form, the participant or the participant's legal representative is authorising such access.
- Interviews will be recorded for observation purposes, but consent of members shall be sought before recording.
- Aggregated data may be shared with our partners for further analysis.

4.2 Compensation

- There will be no payments for participation in this study.
- This study does not expose you to any form of injury.
- There are no extra expenses for the participants, as interviews and assessments will be carried out in their respective clinics or communities/ offices of stakeholders.

4.3 Withdrawal from the study

- Participation is voluntary, and participants may withdraw from the interview or assessment without penalty.
- The participant will not be adversely affected if she declines to participate in the interview or assessments.
- A participant is not compelled to answer all questions, and you are at liberty to choose not to answer any question you are not comfortable with.

4.4 Questions

- The participants have the right to ask questions. The participants can contact Rudolf Abugnaba-Abanga (Principal Investigator) via phone on 0249690600 or email: r.abugnaba-abanga@ uu.nl / abugnaba@gmail.com for further clarifications.
- The participants can also contact NHRCIRB's Administrator (Tel: 0248276561 or email: irb@navrongo-hrc.org).

Consent Form

SIGNATURE OF VOLUNTEER WILLING TO PARTICIPATE

"I have read or have had someone read all of the above, asked questions, received answers concerning areas I did not understand, and am willing to consent me to participate in this study. I will not have waived any of my rights by signing this consent form. Upon signing this consent form, I will receive a copy for my personal records."

Name:_____

Signature/thumbprint of participant/his/her Legal representative

Witness to Consent Procedures **(Anybody who is not affiliated with the study)**

Name:

Signature

Investigator or attending Health Care Professional's Affidavit

"I certify that I have explained to the above individual(s) the nature and purpose of the study, potential benefits, and possible risks associated with participating in this research project. I have answered any questions that have been raised and have witnessed the above signature on the date indicated below."

Name:

_____

Signature: Date: