Title: Preparedness of Primary Health Care Facilities against Climate-Induced Health Effects in Bangladesh

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Preparedness of Primary Health Care Facilities against Climate-Induced Health Effects in Bangladesh

A thesis submitted in partial fulfilment of the requirement for the degree of Master of Science in Public Health and Health Equity by Naznine Nahar

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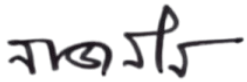

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Abstract

Climate change poses an escalating global health threat. Bangladesh, a nation highly vulnerable to climate change, experiences frequent climate-induced events that lead to substantial mortality, disease outbreaks, and damage to healthcare infrastructure. Primary healthcare (PHC) facilities, being the frontline and most accessible point of care, are crucial for community health and well-being. Therefore, strengthening PHCs climate resilience is imperative to ensure sustained health service delivery to communities. However, there is insufficient research assessing the capacity of PHCs services to effectively manage climate-induced health impacts.

This study aimed to explore the preparedness of primary healthcare facilities in Bangladesh to respond to and manage climate-induced health effects. Specifically, it assessed climate preparedness using the WHO operational framework, identified key challenges and enabling factors for adaptation, and drew feasible recommendations to strengthen PHCs facilities for becoming resilient in face of climate change.

Employing a case study approach, the study utilized mixed methods, including a literature review and key informant interviews. The findings reveal that despite of presence adequate policy framework, Bangladesh's primary healthcare system exhibits critical weaknesses across all components essential for an adaptive and climate-resilient health system. These operational gaps necessitate interventions such as the decentralization of health governance, enhanced capacity building for health professionals on climate change and health, significant investment in health infrastructure, and the development of sustainable funding mechanisms. Implementing these recommendations can significantly strengthen primary healthcare facilities, enabling them to respond more effectively to climate-induced health impacts and safeguard vulnerable populations.

Key words: Climate Change, Health System, Primary Health Care, Preparedness, Bangladesh

Word Count: 11,970

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Abbreviation

BBS	Bangladesh Bureau of Statistics
BCCP	Bangladesh Center for Communication Programs
BCCSAP	Bangladesh Climate Change Strategy and Action Plan
CC	Community Clinic
CCHPU	Climate Change & Health Promotion Unit
CFF	Climate Fiscal Framework
CG	Community Group
CSD	Climate Sensitive Disease
DGHS	Directorate General of Health Services
DHIS2	District Health Information Software 2
EWARS	Early Warning, Alert, and Response System
FY	Fiscal Year
GoB	Government of Bangladesh
HIS	Health Information System
HNAP	health national adaptation plan
KII	Key Informant Interview
LMIC	Lower and Middle-Income Country
MDG	Millennium Development Goals
MIS	Management Information System
MoHFW	Ministry of Health and Family Welfare
MoF	Ministry of Finance
NDC	Nationally Determined Contributions
NGO	Non-Government Organization
OP	Operational Plan
PHC	Primary Health Care
PTSD	Post-traumatic stress disorder
RD	Rural Dispensaries
UHC	Upazila Health Complex
UHFPO	Upazila Health and Family Planning Officer
UHFWC	Union Health and Family Welfare Center
UNFCCC	United Nations Framework Convention on Climate Change
UNDP	United National Development Program
UNICEF	United Nations Children's Fund
USC	Union Sub Center
V&A	Vulnerability and Adaptation
WHO	World Health Organization

Glossary of key terms

Climate Change: Climate change refers to the long-term changes in the Earth's climate that are warming the atmosphere, ocean and land. Climate change is affecting the balance of ecosystems that support life and biodiversity and impacting health. It also causes more extreme weather events, such as more frequent and more intense hurricanes, floods, heatwaves and droughts, and leads to sea level rise and coastal erosion (UNDP, 2023)

Slow and Rapid Onset Climatic Event: According to UNFCCC (2010), Slow onset events are gradual environmental changes that evolve from incremental shifts over many years or from an increased frequency and intensity of recurring events. Examples include Sea level rise, Increasing temperatures, Desertification and Land degradation, Ocean acidification, Glacial retreat, Salinization of coastal land and water, Loss of biodiversity. On the other hand, rapid onset events are sudden and discrete weather-related hazards that occur over a short period, typically from a few hours to a few days. Examples include Hurricanes and tropical cyclones, Flash floods, Heatwaves etc.

Climate Sensitive Diseases: Climate-sensitive diseases are illnesses whose incidence, intensity or distribution is impacted by climate and weather conditions. These diseases can be directly or indirectly influenced by variations in temperature, precipitation, humidity and extreme weather events (TRD, 2023).

Acknowledgement

I would like to express my sincere gratitude to my academic and thesis supervisors, who guided me throughout this entire process. I am also deeply thankful to my sponsor, "Valley Foundation," and “KIT Fund” for their financial support during my master's degree. My appreciation extends to Bindu, who provided me with invaluable support in field-level data collection, and to the interview facilitator, Jannatul Mouwa, who skillfully facilitated the interviews in the field.

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Introduction

Climate change has emerged as the most critical global health threat of the twenty-first century. These impacts are disproportionately severe in vulnerable nations like Bangladesh, which is consistently ranking among the most affected globally. Over half of Bangladesh's population lives in areas highly exposed to climate risks (Eckstein et al., 2021; Hasan & Macdonald, 2019).

Bangladesh experiences a dramatic increase in both rapid-onset events, such as cyclones and floods, leading to high mortality, injuries, and disease outbreaks, and slow-onset changes like rising temperatures, droughts, and salinity intrusion, which cause malnutrition, infectious diseases, and mental health issues (Kabir et al., 2025; Mahmud, 2024; Farah et al., 2025; Islam, 2025; Bakebillah et al., 2024). Crucially, these crises severely damage healthcare infrastructure, forcing facility shutdowns and impeding access to essential services, including maternal health (Rojas, 2025; Pathfinder International, 2024).

My professional experience in climate change and development in Bangladesh's coastal areas provided me direct insight into these escalating challenges and the strain on limited healthcare resources. This firsthand observation highlighted a critical gap, despite national efforts, primary healthcare (PHC) facilities at the local level often lack the necessary preparedness to effectively manage climate-induced health impacts. While, existing literature broadly covers climate change impacts, but rarely focuses on specific health system strengthening at the local level.

Therefore, this thesis aims to bridge this crucial knowledge gap by exploring the preparedness of primary healthcare facilities in Bangladesh to respond to and manage climate-induced health effects. And intended to provide sustainable and feasible recommendation to strengthen primary health facilities to become resilient against future climate induced health impact.

Chapter 1: Background Information of Context

This chapter presents the context of Bangladesh in terms of geographical location, demography, socioeconomic status, health system, and the impact of climate change on health, to have a better understanding of the setting of this study.

1.1 Geography: Bangladesh, a low and middle-income country, is situated in the eastern part of South Asia. Geographically, it lies between latitudes 20°34´ and 26°38´ North and longitudes 88°01´ and 92°41´ East. India borders the country on its west, north, and east, while a small strip in the southeast borders Myanmar, and the Bay of Bengal lies to its south. Bangladesh experiences a humid and warm climate, influenced by pre-monsoon, monsoon, and post-monsoon circulations. Its landscape is characterized by a low-lying, predominantly flat, and riverine topography (Bangladesh Bureau of Statistics (BBS), 2021).

1.2 Demography and socio-economy: Bangladesh is a highly populated country. In 2025, its total population is estimated at 175.7 million. The country is currently at the beginning of the third phase of its demographic transition (mortality is low, and birth rates begin to fall), as the total fertility rate has declined from 6.94 births per woman in 1971 to 2.01 in 2024 (Karim et al., 2024). Recent population census (BBS,2022) indicates that approximately 18.7% of the population lives below the poverty line. Furthermore, the country's literacy rate stands at 74.66%, with a dependency ratio of 52.64. Bangladesh ranked 129th in the Human Development Index (HDI) globally in 2024 (Nahr, 2024).

From 2020 to 2023, Bangladesh experienced an average GDP growth of 6.4%. However, ongoing political shifts and instability have impacted its economy, leading to a growth of 4.2% in fiscal year (FY) 2024, with projections for 3.9% growth in FY 2025 (Asian Development Bank, 2025).

1.3 Health System of Bangladesh:

The health system in Bangladesh operates on a pluralistic model, with four main stakeholders shaping its structure and function: the government, the private sector, NGOs, and donor agencies. The public sector offers a comprehensive range of services, including curative, preventive, promotive, and rehabilitative care. In contrast, the private sector primarily delivers for-profit curative services, with a limited presence of not-for-profit curative options at both national and subnational levels (Ahmed et al., 2016). Additionally, the informal private sector including trained healthcare providers (eg. village doctors), traditional healers, unqualified allopathic providers, and drug sellers, play a significant role, particularly in low-income and rural settings across Bangladesh (Ahmed et al., 2009). NGOs, mainly concentrate on providing preventive and basic care, especially for marginalized populations. Donor, on the other hand, provides assistance on strengthening health services and building resilience against emergencies (Bhuiyan & Haque, 2024).

The public health service delivery system follows the country's administrative hierarchy, extending from the national level down to districts, upazilas (subdistricts), unions, and finally to ward/village levels. Figure 01 explains the hierarchy of health system (S. M. Ahmed et al., 2009).

According to the Bangladesh National Health Accounts 2022, per capita health expenditure of this country is US$ 61 annually, 73% of current health expenditure comes through out-of-pocket payments. The Current Health Expenditure (CHE) accounts for 2.34% of the Gross Domestic Product (GDP), which is the lowest percentage among South Asian countries (WHO, 2023).

Despite facing financial constraints and an often-unstable socio-political environment, Bangladesh has achieved notable progress in enhancing life expectancy and reducing both child mortality and childhood immunization rates (Perry & Chowdhury, 2024).

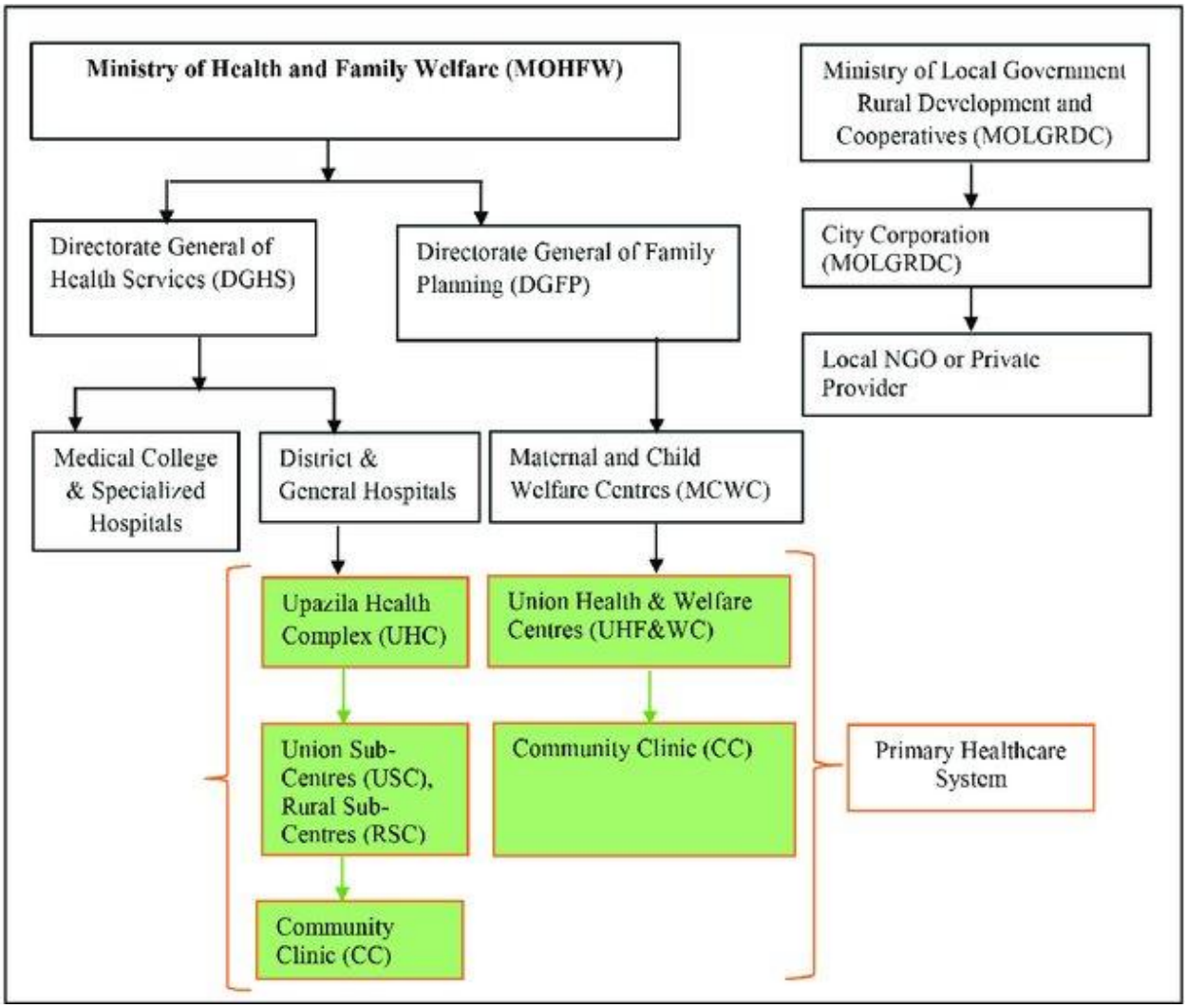

Figure 1:Health System Organogram, Bangladesh (Source: Ahmed ,2016)

1.4 Primary Health Care Facilities (PHC) Bangladesh:

The government's PHC services are located almost entirely in rural areas under the Ministry of Health and Family Welfare and administered through a three-tier system: Upazila level ("upazila" is the term used for an administrative geographical region, also called sub-district), union level (union is a council area within an Upazila) and village level (villages are the most basic units within a union) These three lower tiers of the health system are intended to provide free health care (Kabir. 2023).

Community clinics (CC) provide mostly preventive services, it offers maternal, neonatal and child health services, integrated management of childhood illness, reproductive health and family planning services, Immunization, basic treatment for acute respiratory infections, nutritional advice and supplements, identification of severe illnesses such as tuberculosis, malaria, pneumonia, and influenza, obstetric emergencies, and referrals to higher facilities (WHO, 2017). This is the lowest tier of the health system.

At the union level, there are three types of health facilities: rural dispensaries (RDs), union sub-centers (USCs), and Union Health and Family Welfare Centers (UHFWCs) which offer normal birth delivery (that is, without complications), basic emergency obstetric care services, and referral for complicated cases, along with provision of long-acting contraception methods (Government of Bangladesh,2022). Facilities at the upazila level Upazila Health Complex (UHC) are the first referral centers in the system and the highest tier of the primary health care system. It offers both inpatient and outpatient services along with diagnosis and some basic operative care, most of which are hospitals (WHO, 2017).

1.4 Climate Change-related hazards in Bangladesh

Climate change refers to long-term shifts in temperatures and weather patterns (United Nations, n.d.). These changes are directly contributing to humanitarian emergencies from different kinds of hazards (WHO, 2023). As a low-lying, densely populated country, Bangladesh is highly exposed to severe climate-related impacts (both extreme and slow-onset events). ((Brennan, 2018)). In 2023, the Government of Bangladesh's National Climate Vulnerability Assessment identified numerous climate-related hazards, such as rising temperatures, prolonged droughts, intense rainfall, increased flood risks, severe riverbank erosion, sea-level rise, salinity intrusion, landslides, and more intense cyclones, storm surges, and coastal flooding (GoB, 2023).

While Bangladesh as a whole is highly vulnerable to climate change, certain areas face heightened risks from specific hazards. The southern coastal region faces salinity intrusion, drought, storm surges, and coastal flooding, tropical cyclones, and coastal erosion (Minar et al., 2012). The northern part of Bangladesh are at risk of thunderstorms, floods, cold waves and heat waves, drought, riverbank erosion, scarcity of water (Karmakar, 2019) The *haor* wetlands and Sylhet, Sunamganj, and Netrokona, frequently suffer from flash floods (Sammonds et al., 2021). The Chattogram Hill Tracts are highly susceptible to landslides, especially during the monsoon season (Morshed et al., 2025). Central areas, such as Dhaka, are increasingly affected by heat stress and waterlogging, exacerbated by rapid urbanization (Haque, 2021).

1.5 Climate-sensitive health risk in Bangladesh

Human health is severely undermined by climate change in Bangladesh (UNICEF, 2019). The country is facing increased incidences of climate-sensitive diseases (CSDs). Extreme events like cyclones and floods contaminate water, causing outbreaks of waterborne diseases such as cholera, diarrhea, dysentery, skin infections, pneumonia, hepatitis, typhoid, and kidney disease (Moon, 2024). Rising temperatures and shifting rainfall patterns also contribute to vector-borne diseases like malaria, kalazor (leishmaniasis), dengue, and chikungunya. Additionally, excessive heat results in heatstroke, dehydration, and worsens chronic conditions like cardiovascular and respiratory illnesses (Hasib & Chathoth, 2016; Moon, 2024; Shamim, 2024).

Slow-onset events, including salinity intrusion and drought, also significantly affect health. Salinity compromises water quality and reduces access to safe drinking water, contributing to waterborne diseases, while prolonged drought exacerbates malnutrition, infectious diseases, and respiratory ailments. Drought impacts food production and reduces overall food consumption, and may therefore lead to undernutrition (Mani & Wang, 2014). Figure 02 illustrates the health risk of climate change in the context of Bangladesh.

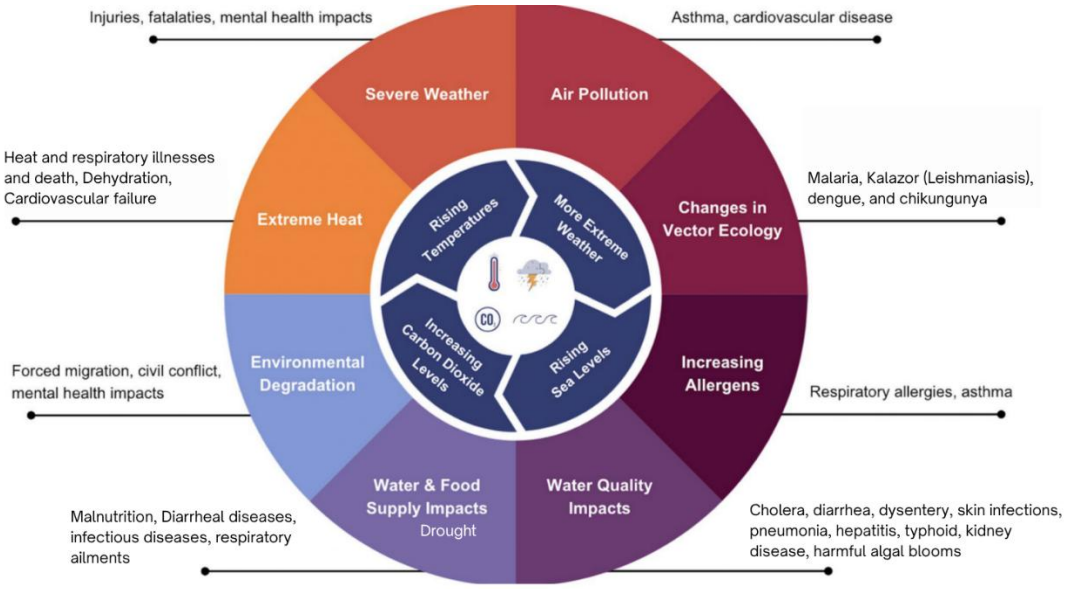

Figure 2: Climate-Sensitive Health Risk in Bangladesh (Adapted from Mirow et al., 2024)

Beyond direct health consequences, these climate events have indirect effects. For example, floods create crowded shelter conditions that complicate proper menstrual hygiene management for women and adolescent girls (Muralidharan et al., 2025). Some research also points to climate change's impact on mental health (Wahid et al., 2024). Furthermore, adverse climate events like cyclones and floods can damage healthcare facilities, reducing access to vital services such as maternal health (antenatal, delivery, and postnatal care), thereby increasing the risk of pregnancy complications and maternal mortality (Pappas et al., 2024).

Chapter 2. Problem statement, Justification, Objective, and Methodology

This chapter outlines the problem, knowledge gap, and justification the study. The broad and specific objectives have been stated, and the method has been described to achieve the objective. A conceptual framework is used for the guidance of the study, including analysis and synthesis of the findings.

2.1 Problem Statement and Justification

Although climate change is fundamentally a natural process, its recent rapid acceleration has made it a serious global concern. Climate change has become the greatest health threat of the twenty-first century (Lendrum et al., 2023). Since the mid 1970s climate change has already caused annually over 150,000 deaths and five million disability-adjusted life-years (DALY) (Patz & Olson, 2006), and it is expected to cause approximately 250,000 additional deaths per year Between 2030 and 2050, from undernutrition, malaria, diarrhea, and heat stress alone (WHO, 2023)

While all countries are affected by climate change, its impacts are not distributed equally. Bangladesh is one of the most climate-vulnerable countries due to its unique geographic, socio-economic, and environmental vulnerabilities. It ranked as the seventh most affected country by climate change between 1999 and 2018 (Eckstein et al., 2021), where about 90 million Bangladeshis (56% of the population) reside in "high climate exposure areas" (Hasan & Macdonald, 2019).

Bangladesh has experienced a dramatic increase in climate-induced events, leading to substantial health consequences and significant loss of life. The country has the world's highest mortality rate from natural disasters (Nahar 2014). It accounts for 60% of global cyclone-related deaths and 185 extreme weather events in the past two decades (Hasan & Macdonald, 2019; Kabir et al., 2025). Most of those direct deaths are from cyclones, storm surge and floods. Historic cyclones, in 1970 and 1991, claimed hundreds of thousands of lives. More recently, Cyclones Sidr (2007) and Aila (2009), killed 3,406 people while more than 55,000 sustained physical injuries, these events also caused widespread fatalities, injuries, and outbreaks of waterborne and respiratory illnesses (Kabir et al., 2016).

Annually, floods inundate 20-25% of Bangladesh's land, with extreme events submerging up to 60% (Letsch et. al., 2023). This flood not only case waterborne and infectious diseases but also take significant number of lives, As an example, the floods in August 2024 in Bangladesh triggered an unprecedented public health emergency impacted over 5.7 million people, claimed 71 lives (Mahmud, 2024), and caused diseases like cholera, enterotoxigenic e. coli, diarrhea, shigellosis, hepatitis, malaria and dengue (Rupa & Hossian, 2024).

Over the past 50 years, 20 severe droughts have plagued the country (Farah et al., 2025). On average, drought leads to a 40% reduction in agricultural production and affects 53% of the population (Farah et al., 2025). It significantly reduces agricultural output, causes malnutrition, and increases child stunting by 15% during severe periods (Le & Nguyen, 2022). Literature also

showed that water sources also contaminated due to drought, and outbreaks of bloody diarrheal disease have affected both adults and children (Dey et al., 2012)

Rising temperatures, a critical concern for public health in this country, as Bangladesh ranks second globally in exposure to elevated temperatures, have seen a 1.1°C increase in maximum temperature (Mahmud et al., 2024). This warming trend correlates with and contributes to a record high in dengue-related deaths. In 2023, Bangladesh witnessed a record high dengue-related deaths, a total of 321,179 dengue cases were reported, resulting in 1,705 deaths (Khan et al., 2024) Heat-related mortality, particularly among the elderly (+65 years old), has surged by 148% between 2000-2004 and 2017-2021, exacerbated by the interplay of heat and air pollution that intensifies cardiovascular, cerebrovascular, and respiratory diseases. (Leary et al., 2023)

Slow-onset climatic events like sea-level rise also pose severe threats. Between 1973 and 2009, there was an estimated 225% increase in the amount of land with salinity (Lam et al., 2021). A 65cm rise by the 2080s could lead to a 40% loss of productive land in southern Bangladesh (Islam, 2025). This also exacerbates salinity intrusion, which has expanded significantly from 0.83 million hectares in 1973 to over 1.056 million hectares in 2019 (SRDI, Islam, 2025). This salinity intrusion ultimately contributes to malnutrition and significantly increases the risk of hypertension in 20 million people and preeclampsia in pregnant women, further threatening water quality and security in coastal communities (Islam, 2025; Rahaman et al., 2025).

Beyond physical health, these events contribute to mental health issues. Literature showed a significant association with climate change events (eg. floods, cyclones, sea level rise, droughts, and river erosion with mental health conditions like depression, anxiety, stress, trauma, Post-traumatic stress disorder (PTSD), and various disorders (Bakebillah et al., 2024).

Furthermore, the healthcare facilities also got damaged due to the climate crisis. The flood of the Brahmaputra River in 2017 inundated at least 480 community health clinics (Rojas, 2025), floods in 2024 have forced the shutdown of 52% of primary health care facilities in the affected area (Pathfinder International, 2024). These shutdowns and damages reduce access to care, delay emergency responses, and hamper the early detection and treatment of diseases. Lack of access to vital services such as maternal health (antenatal, delivery, and postnatal care), thereby increasing the risk of pregnancy complications and maternal mortality (Pappas et al., 2024).

While the existing health infrastructure in Bangladesh, particularly at the local levels, primary health care facilities often struggle to cope with the routine burden of disease and operate under resource constraints, the added strain of climate-induced health crises poses an additional challenge (Nahian, 2023). As these facilities are the first point of contact for affected communities, their capacity to respond effectively is critical in mitigating morbidity and mortality.

The Bangladesh government, through the Ministry of Health and Family Welfare (MoHFW) and its various agencies, has initiated several strategic efforts to enhance the health system's capacity to respond to climate-induced crises. But the programs and planning do not effectively reflect local needs (Haque & Murshid, 2020). Most notably, the Bangladesh Health-National Adaptation Plan (HNAP) explicitly acknowledges the urgent need to integrate climate risks into health

planning and strengthen emergency preparedness and response. While the policies include some capacity-building programs on climate change and health for PHC staff, there remains a significant gap in strengthening PHC to adapt and respond to climate-induced health crises across other components like governance and leadership, technology and infrastructure, and early warning and emergency preparedness.

While there is a growing body of literature on climate change impacts in health. Much of the existing research tends to concentrate on policy frameworks or the broader epidemiological impacts of climate change (Rahman & Mainuddin, 2019; Sarker et al., 2020). But there is very few literature on health system strengthening to adapt and respond during climate induced health crisis, the and specific focus for those publications are is broader at the national level. The preparedness of local level in tackling climate-induced health crises remains underexplored. There is a critical lack of comprehensive understanding regarding the actual, on-the-ground preparedness of these local health facilities to effectively manage the escalating health impacts of climate change (Nahian, 2023).

So, this thesis aims to bridge this crucial knowledge gap by exploring the preparedness of PHC to respond to the health impacts of climate change. This research will prompt a rethinking of primary healthcare services in Bangladesh, specifically focusing on how they can be made truly climate resilient. This will ensure that essential healthcare services are not only accessible but also effective in safeguarding public health in the face of an increasingly unpredictable climate.

2.2 Study Objective

Overall General Objective: To explore the preparedness of primary health care facilities in Bangladesh to respond to and manage climate-induced health effects.

Specific Objectives:

1. Assess the climate preparedness of primary health care (PHC) facilities through the WHO operational framework
2. Identify the key challenges and enabling factors of PHC facilities to respond and manage climate-induced health effects
3. Draw recommendations to strengthen PHC facilities to promote a climate-resilient health system in Bangladesh

2.3 Methodology:

2.3.1 Conceptual Framework

This study employs the WHO Operational Framework for Climate-Resilient Health Systems (WHO, 2015) as its foundational conceptual framework. While exploring suitable frameworks, two other WHO documents, namely the WHO Guidance for Climate-Resilient and Environmentally Sustainable Health Care Facilities (WHO, 2020) and the Checklists to Assess Vulnerabilities in Health Care Facilities in the Context of Climate Change (WHO, 2021a), were identified as relevant for assessing health facility preparedness. However, the WHO Operational Framework for Climate-Resilient Health Systems has been chosen over the other two for its holistic view of climate resilience across the entire health system. While other tools offer specific

checklists or guidance primarily for facilities, this framework enables a comprehensive understanding of how a PHC facility's preparedness integrates into the broader context of a resilient health system.

The framework encompasses ten key and interrelated components: leadership and governance, health workforce, vulnerability and capacity assessment, health and climate research, integrated risk monitoring and early warning, climate-resilient technologies and infrastructure, management of environmental determinants, climate-informed health programs, emergency preparedness, and climate and health financing.

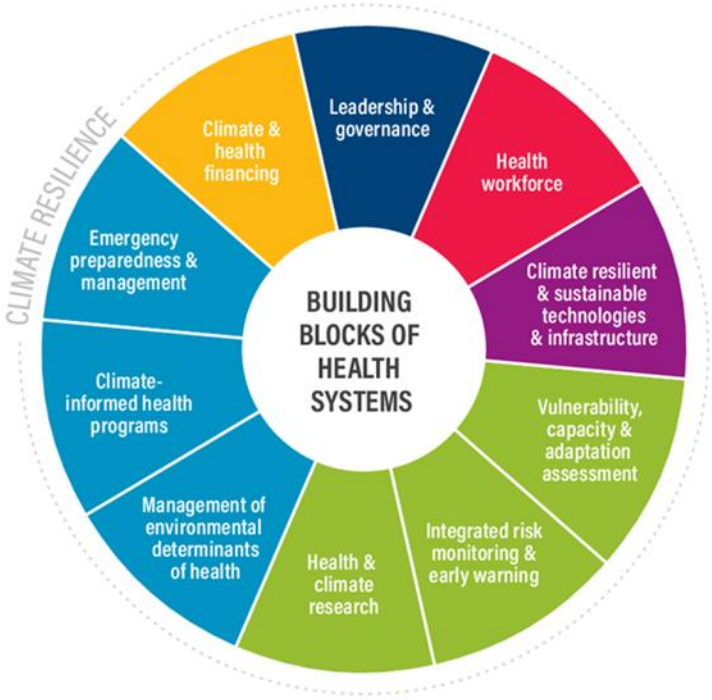

Figure 3: WHO Operational framework for Climate Resilience Health System (Source: WHO 2015)

To operationalize of the framework's concepts for the PHC facility level, the study adapted some potential indicators to guide the analysis. Although many indicators in the WHO framework are national level and structural/process indicators, the study translated some of the indicators into outcome-based indicators. Table 01 describes the potential subthemes and indicators under the ten components of the study framework.

Table 1: Sub-themes and potential indicators under WHO 10 components

WHO Component (Primary Category)	Key Sub-Themes/Concepts	Potential Indicators/Examples from Data (What to look for)	Reference
	Leadership	- PHC facilities meaningful participation in decision making	(WHO, 2023)

1. Leadership and Governance	Cross-Sectional Collaboration	-	Existing PHC collaboration with climate change and health-relevant stakeholders	(WHO, 2023)
	Policy development	-	PHC level policy suggestions in health national adaptation plans (HNAP)	(WHO, 2023)
2. Health Workforce	Workforce planning & deployment	-	Distribution and retention of health workers at the PHC level	(WHO, 2015)
	Training & capacity building (climate-health)	-	Access to training and workshops (Climate change and health)	(WHO, 2015)
3. Climate-Resilient & Sustainable Technologies & Infrastructure	Adaptation of current infrastructures, technologies, and processes	- -	Infrastructure, water/sanitation systems Energy supply	(WHO 2015)
	Sustainability of health operations	- -	Use of renewable energy Waster Management System	(WHO 2015)
	Promotion of new technologies	-	Adaptation of e-health	(WHO 2015)
4. Vulnerability, Capacity, & Adaptation Assessments	Vulnerability assessment (climate-related health)	- -	Climate-related health risk in the community Mapping vulnerable populations	(WHO 2021b)
	Capacity assessment (health system)	-	Assess the current capacity of the health system to address the risks of climate-sensitive health outcomes	(WHO 2021b)
5. Integrated Risk Monitoring & Early Warning Systems	Integrated disease surveillance and early warning	-	Availability of Early detection tools (e.g. rapid diagnostics, surveillance) at PHC facilities	(WHO 2015)
	Monitoring	-	Geographic and seasonal distribution of health risks and outcomes (i.e., risk mapping) tracked.	(WHO 2015)
	Communication	-	Communication strategy on climate risks at PHC level	(WHO 2015)
6. Health and Climate Research	Research and evidence generation	-	Research findings on “climate change and health” disseminated at the PHC level	(WHO 2023)
7. Management Environmental Determinants of Health	Monitoring	-	Mechanism of climate-sensitive environmental risks at PHC facilities level	WHO 2015

	Coordinated cross-sectoral management	-	Existing coordination to manage environmental determinants	WHO 2015
8. Climate-informed Health Programs	Health programming	-	Integration of climate change into health programs at the PHC level	(WHO 2015)
	Delivery of interventions	-	Risk maps and analysis of seasonal trends in intervention delivery	(WHO 2015)
9. Emergency Preparedness & Response	Existing protocols for emergency preparedness and response	-	Emergency and Contingency plans	(WHO, 2015)
	Risk Management	-	Risk assessment, Emergency response plan, Surge capacity, Supply chain management	(WHO, 2015), (WHO, 2024)
10. Climate Change & Health Financing	Health-specific funding and financing mechanisms	-	The national health budget addresses risks posed by climate variability and change	(WHO 2023)
		-	Allocation of the climate adaptation fund at the PHC facilities level	

2.3.2 Methods and tools

Type of Study: This research employed a case study approach, using applied mixed methods, including literature review and key informant interviews (KII). While the literature review served to review existing knowledge on the topic (Snyder, 2019), the KII was specifically designed to investigate the ground-level situation and address critical gaps identified in the literature review's findings. KII also allowed understanding on "How" and "Why" behind the findings of the literature review (Baxter & Jack, 2010).

2.3.2.1 Literature Review: A literature review was conducted to understand the preparedness of primary healthcare (PHC) to respond to and manage health impacts induced by climate change. To search the literature, the study used the PCC (Population, Concept, Context) framework. The details of the strategy search have been provided in Annex I.

The documents have been searched in PubMed, Web of Science, Google Scholar, VU library, and websites of different national and international organizations. The search encompassed peer-reviewed academic journals, policy papers, reports from national and international organizations, and databases (e.g., WHO, UNICEF, World Bank, relevant Bangladeshi ministries etc). Along with the database search, the study also followed the snowball method to identify additional literature from the reviewed document.

For the selection of relevant studies, the inclusion criteria were defined to follow: articles had to pertain to health systems; be written in English or Bengali; adopt a global, general, or specific focus on lower and middle-income countries (LMICs) or Bangladesh; and have been published

within the timeframe of 2010 to 2025. The detailed inclusion criteria are presented in Table 02. Any study not fulfilling these criteria was categorized as an exclusion.

Table 2: Inclusion Criteria

Area	Inclusion Criteria
Language	English and Bengali
Country	Global perspective, LMICs, and Bangladesh
Publication Year	2010 to 2025
Publication Type	Peer-reviewed article, Report, or database from a national/international organization, Govt, and international Policies, Project/program details from a well-known organization's website
Outcome	Health System

Selection of PHCs facilities for this study: The study considered UHC from upazilla level health facilities, UHFWC from union level health facilities, and CC from community level facilities to assess PHC facilities level preparedness. Although at the union level, there are three types of PHC facilities: Rural Dispensaries (RDs), Union Sub-Centers (USCs), and UHFWCs, this study focuses exclusively on UHFWCs . This choice is justified by the predominance of UHFWCs among union-level facilities, out of 5,377 union-level facilities across 3,924 are UHFWCs, and covering approximately 85% of all unions (GoB, 2022)

2.3.2.2 Key Informant Interview

To complement the literature review, KIIs has been conducted to gather in-depth, context-specific insights into primary health care facilities' preparedness and to identify local challenges and enabling factors associated with preparedness.

About the Study Area: While the study aims to understand the country's overall situation, due to resource and time limitations, the interviews have been limited to Shymnagar Upazilla (Subdistrict) under Satkhira district. It is the largest upazila in Bangladesh by area, covering about 1,968 square kilometers. About 366,000 people live in this area (BBS, 2022). This area is one of the highest climate-vulnerable areas in Bangladesh, frequently suffering from cyclones, storm surges, floods, drought, heatwaves, coastal erosion, and sea-level rise (Minar et al., 2012).

Collaboration with local NGO and Recruitment of data collectors:

This study collaborated with Bindu, a grassroots organization based in Satkhira to facilitate the KII into the field. The main goal of this collaboration was to involve community people in the interview process so that the interviews are conducted with a strong grasp of the local context, and also to triangulate the responses. A number of potential facilitators have been nominated by Bindu. After an online interview, one facilitator has been selected who is local, has previous experience in participatory action research, and has good knowledge of climate change and health.

Sampling and Recruitment of Participants: A total 10 interviews has been selected for interview from 3 levels of health facilities: (1) Upazilla Health Complex (UHC), (2) Union Level

Health facilities (UHFWC), and (3) Community Clinic (CC). Shymnagar upazilla health complex, has been chosen for UHC level interviewee selection. Under the Shymanagar upazilla, Gabura, Burigoalini, Ishwaripur and Kasimatri unions have been chosen for UHFWC level interviewee selection. These areas have been selected to cover the maximum variation in terms of geography and socio-economy with the consultation of Bindu. In the selected unions, there is a total of 04 UHFWCs and 13 CCs. All four UHFWCs has been chosen for UHFWCs facilities level interview, and among 12 CC, 04 have been selected. To mitigate potential bias in CCs selection, the study adhered to the official CC list order under each union from the government website. The interview invitation has been given via phone call. Once a participant agreed to be interviewed, BINDU ceased further calls from that specific segment of the list, ensuring that only the first agreeable candidate from a sequential selection was included.

Given that only one UHC exists at the Upazila level in Shyamnagar, an additional interview was conducted at a neighboring UHC that shares similar geographic and socio-economic characteristics. This measure was undertaken both to enhance data triangulation and to preserve participant confidentiality and anonymity.

Participants were purposively selected based on their professional expertise in healthcare delivery and their voluntary consent to participate. A detailed description of each participant is provided in Annex II. All interviews were conducted using a standardized topic guide (see Annex III) and were audio-recorded to ensure accuracy and support thorough qualitative analysis.

2.3.3 Data Collection, Management, and Analysis Process

The research team comprised three members: a principal investigator (PI), thesis supervisor, and a field-level data collector. The Principal Investigator was responsible for the overall project design, tool development, ethical approval, quality assurance, and comprehensive oversight.

A topic guide was developed by the PI for the interviews. The interview design involved both online and offline. When participants agreed to participate online, the PI conducted the interviews directly via WhatsApp call (end-to-end encrypted). When participants did not permit online interviews, a field-level trained facilitator conducted the in-person interview.

The facilitator was trained on the research goals, objectives, and ethical considerations for the interviews. All interviews and conversations were captured using an audio recording device. The interviewers also maintained "field notes" to complement the audio recordings, which allowed the study to understand the environment and nonverbal cues that may not have been adequately captured by the audio recording. All audio recordings were transcribed in verbatim. Before data analysis, all transcripts were verified for accuracy by the data collector and PI by listening to the recordings again.

The study employed a thematic analysis manually, primarily utilizing a deductive method. However, while applying predetermined codes, an inductive approach was also employed. During the in-depth analysis of KIIs, emergent categories were identified that were not covered by the initial codes.

2.3.4 Ethical Consideration

For the literature review, no ethical approval is required. For KII ethical approval has been obtained from the KIT Research Ethics Committee in the Netherlands and the Bangladesh Bioethics Society (BBS) in Bangladesh to ensure the well-being, confidentiality, and respect of the participants. A copy of ethical approval has been attached at annex IV. A detailed, explained consent form has been shared with the participants (see annex V), mentioning data privacy and their right to withdraw from participation at any time. A participatory environment has been created during the interview so that the interviewee feels respected, and their voices are listened to carefully.

2.3.5 Quality Assurance

For the literature review, the quality of the literature has been identified by the author. The author identified the literature based on the research objective and conceptual framework, and the inclusion and exclusion criteria, while using a systematic approach to do the review. For KII, a topic guide has been developed. Proper orientation and training has been provided to the data collector. A pre-test has been conducted by the data collector to identify and address any potential issues. The study also allowed Bindu has a local NGO for triangulation for data validation.

2.3.6 Limitation

A significant limitation of this research was the limited availability of literature on the study topic. Furthermore, the study didn't include informal health facilities, even though these sectors play a crucial role within the country's broader healthcare system. Additionally, in assessing "Health Service Emergency Preparedness" component, this study relied on the "Health Service Assessment report (2024) by Pathfinders," which only covered Bangladesh's northeastern region. Presenting the findings of this regional report as representative of the entire country introduces a potential generalization bias. Lastly, Additionally, the relatively small number of interviews conducted at both the UHC and UHFWC facilities affected data saturation, and the range and depth of insights from these particular groups may not have been entirely captured. Primarily the study had the plan to take interview from four UHFWCs but, due to unrest political situation in Bangladesh, two potential participants refused to give interview without higher authority consent. Due to the time limitation, the study couldn't manage the consent from their higher supervisory authority.

Chapter 03: Findings

This section examined the preparedness, challenges, and enabling factors of PHC facilities in responding and managing climate-related health effects. This exploration drew upon findings from both the literature review and KIIs. The findings are structured in alignment with the ten components of the conceptual framework. Furthermore, an additional subsection is included to address challenges and enabling factors identified through KIIs that did not align with any of the ten components of the conceptual framework.

Due to a lack of relevant documents, the most frequently used document in this section is "The Bangladesh Health Facilities Survey (GoB, 2022)", which offers a nationwide overview of the country's health services and infrastructure. The other study is the "Health Facilities Assessment Report (Pathfinder International, 2024)", which assessed the disaster preparedness and service readiness of the health facilities of the northeastern region of Bangladesh. The northeastern region is predominantly affected by floods, flash floods, and moderate drought (S. Ahmed & Khan, 2022).

3.1 Governance and Leadership

In Bangladesh, the government health system operates through a largely centralized system. Very few decisions in terms of planning, procuring, budget, budget execution, staff recruitment and transfers are made at the facility level (Sattar, 2021). In general, UHC and the lower tiers simply carry out the plans and programs decided at the national level. UHC plays a coordinating role in operating these plan in the UHFWC and CC levels (WHO, 2017).

Despite the overarching centralized structure, this study identifies a shift in decision-making authority during health emergencies or extreme climatic events. According to one interviewee from the UHC level, UHCs demonstrate meaningful participation in decision-making during disaster response (KII 08). As depicted in Figure 4 (the decision-making process during an emergency), UHCs actively participate in district-level meetings to formulate a PHC facilities-level plan to manage the emergency. This plan is then executed at the UHFWC and CC levels by UHC supervision. However, no participation in decision-making was found at the UHFWCs or CCs levels.

In addition to participating in decision-making, UHC also demonstrates coordination among various upazila-level government and non-government stakeholders like the disaster management committee, local government, security services, health department, and NGOs to address climate-induced emergencies (KII 05, KII 08). This collaboration is limited in the Upazila level. No further collaboration has taken place in the UHFWC and CC levels (KII 01, KII 02, KII 03).

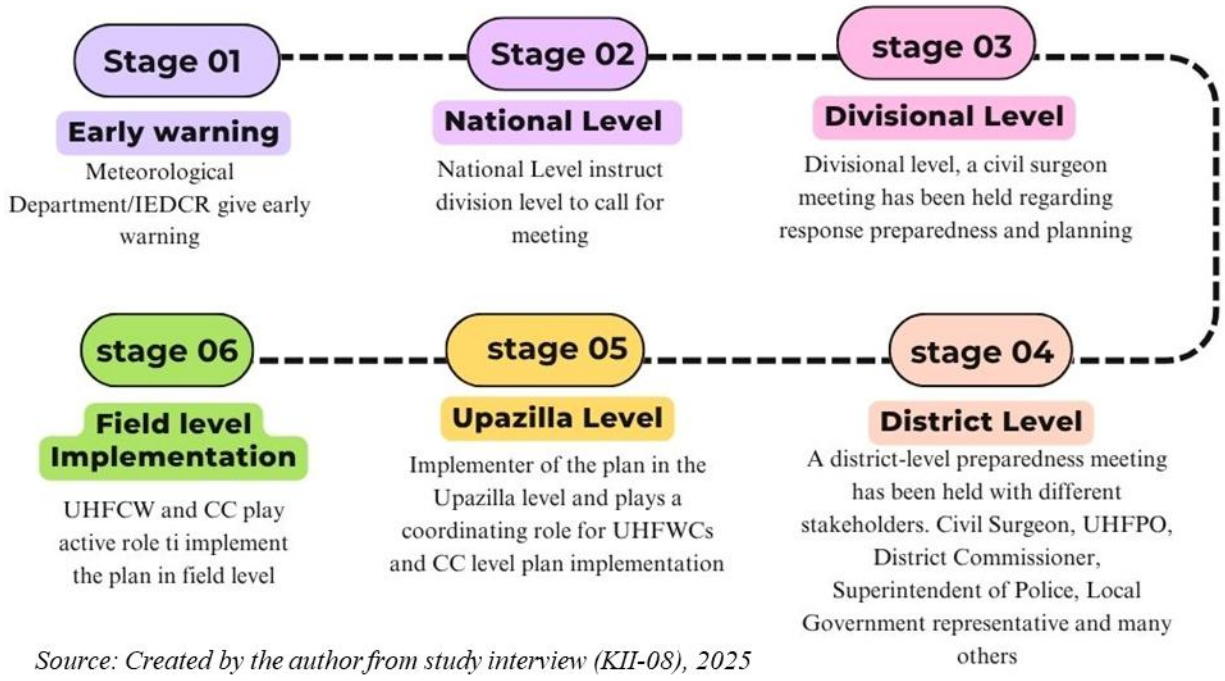

Figure 4: Decision-Making Process from National to Local Level during Emergency

Regardless of the field-level implementation, Bangladesh has made significant progress in developing climate change and health-related plans and policies. The country has already developed the Health-National Adaptation Plan (HNAP), which is solely focused on climate change and health. Additionally, the Bangladesh Climate Change Strategy and Action Plan (BCCSAP) also includes health as a priority area. While these plans acknowledge the importance of a community-based health care system, they often lack relevant strategies to strengthen PHC, which serves as the frontline in responding to climate-sensitive health impacts.

3..2 Health Workforce

Health professionals play a critical role in responding to protect individuals and the community against climate-related health risks. Rural Bangladesh, however, faces a significant shortage of health professionals, with only 1.1 doctors per 10,000 (Joarder et al., 2018) where the WHO recommends at least 10 doctors per 10,000 population to ensure adequate coverage (Kumar & Pal, 2018). This shortage also echoed by all key informants of this study. For instance, an interviewee at a community clinic reported serving 20,000 people, despite the clinic's design capacity of only 6,000 (KII 03). Similarly, at the UHFWC, number of health staff prescribed by the official organogram are frequently absent (KII 09). Shortages are also prevalent at UHCs; approximately 50% of the allocated doctors are unavailable at the hospital to serve the clients (KII 06).

Beyond the general shortage of personnel, this study identified a limited number of health workers possessing knowledge of "Climate Change and Health." While the Climate Change & Health Promotion Unit (CCHPU) of the Ministry of Health and Family Welfare (MoHFW) has

developed training modules to build the capacity of health professionals on this topic, the scope of these programs is restricted. The modules are specifically designed for Health Officers/Managers at the district and Upazila levels, excluding field-level health staff at the UHFWC or CC levels (GoB, n.d.).

Complementing the CCHPU's efforts, the Bangladesh Center for Communication Programs (BCCP) is facilitating capacity-building training in 21 districts across 11 climate-stressed areas. By 2024, this training had reached 499 health service providers. Of these, 136 were staff representing the UHC level, but no staff from the UHFWC or CC levels participated in the program (BCCP, 2024).

Key informants from UHFWC and CC facilities also highlighted this disparity in training. No staff from these facilities reported receiving "Climate Change and Health" training organized by either the government health department or the BCCP. Conversely, Upazila Health and Family Planning Officers (UHFPOs) from UHC facilities confirmed their participation in such training.

Despite the systemic challenges, interviewees identified the motivation and dedication of the health workforce as a key strength of the health system. According to participants, the hard work and commitment of health staff, even with limited resources, enable them to respond to previous health crises successfully (KII 01, KII 08).

3.3: Climate-Resilient and Sustainable Technologies and Infrastructure

Climate-resilient and sustainable technologies and infrastructure are crucial for a health facility to maintain services to its target population in a changing climate (Corvalan et al., 2020). However, the availability of technology and robust infrastructure is highly uneven across PHC facilities in Bangladesh.

The literature found a significant technological divide among different level of PHCs. While 99% of UHCs have functioning computing devices with internet access, this access drops significantly to just 32% for UHFWCs and 44% for CCs (GoB, 2022). Furthermore, although 86% of CCs possess some digital device, the limited digital literacy of CC staff often restrict them to use the device effectively (Begum et al., 2020).

Disparities are also evident in electricity supply. The supply is regular (defined as less than two hours of load shedding per day) in 90% of UHCs facilities but is less reliable at the UHFWCs (53%) and CCs levels (45%). Emergency power generation capacity is particularly weak, with 0% coverage in CCs, 5% in UHFWCs, and 40% in UHCs (GoB, 2022). Even where emergency power supplies exist, frequent dysfunction further constrains service delivery (KII 04).

"We have three generators to supply power, but two are non-functional.. We have one IPS to support official work. In emergency cases, when we experience continuous electricity outages for three to four days, we typically have to rent a generator to serve the people." – (KII 04)

Essential environmental services, such as water and sanitation, also present challenges. While functional latrines are available for nearly 90% of outpatient clients at UHCs, this figure drops

drastically to only 8% at CCs. National health facilities surveys 2022, report that improved water sources are available in a majority of facilities (77% of CCs, 89.6% of UHFWCs, and 92% of UHCs). However, the situation in KIIs study area (shymanagar) is different. Saline groundwater of this area, forces hospitals and health centers to depend on surface water (mostly a pond) for sanitation and hygiene purposes. The UHC can only afford to provide filtered water to the patients for drinking purpose (KII 08)

"I tried several times to build a tubewell to find sweet water but failed. Then I decided to use the Upazilla pond as a WASH water source. I took the pond from Upazilla Parisad, which was previously used for fish cultivation, and started to utilize it as WASH water source for indoor patients" -(KII 08)

Key informant interviews also revealed that CCs and UHFWCs buildings are prone to flooding during heavy rainfall, and the physical infrastructure of all primary health facilities including UHC are in a fragile condition (KII 01, KII 02, KII 04, KII 06). Despite the official Bangladesh Health Survey (GoB, 2022) reporting that regular structural inspections for maintenance occurred in 80% of UHCs, 36% of CCs, and 32% of UHFWCs, key informant interviews indicated a disconnect between these reports and reality. None of the health facilities, from UHCs, UHFWCs and CCs, had undergone structural inspection or maintenance in last ten years. This vulnerability was highlighted by an interviewee-

"In a regular rain, water leaks from the roof of the building. During cyclone Amphan 2020 the whole clinic was flooded, and I transferred all my office equipment into nearby glossary shop. I gave services from that shop until the water went out (KII-01)"

The lower-tier PHC facilities (UHFWC and CC) reported a shortage of medicine to serve CSDs in the community (KII 02). In addition to medicine shortages, health workers in both UHFWCs and CCs reported insufficient medical equipment and incomplete logistics. For example, some clinics had received glucometers without the necessary testing strips, rendering this equipment unusable. Moreover, while some clinics are tasked with screening diseases, such as malnutrition, they lack the means to provide the necessary follow-up treatment or supplements (KII 10). Despite of having a pathology lab, it remains unused due to a lack of technicians (KII 09). One interviewee further explained the situation, saying-

"Nowadays, skin diseases are very severe in my community. I only get six bottles of ointment (100ml each) to serve my whole community for two months. If a patient comes with a family of 4-5 members, I can only serve six families in two months. I have raised this issue many times, but the situation remains same." (KII 01)

The availability of emergency transportation at the primary healthcare level is also highly uneven. While UHCs have significant access (94.3%), it is extremely limited at lower levels, with only 1.1% of UHFWCs and 0.4% of CCs having such vehicles (GoB, 2022). Furthermore, even where an emergency vehicle exists, such as an ambulance at UHC level, poor road conditions can easily worsen the condition of a critically ill patient due road hazards and bumps (KII 07).

In an effort to build sustainable and green infrastructure, the Bangladesh government initiated the Urban Primary Health Care Services Delivery Project, which aims to upgrade PHC infrastructure into “green clinics” by incorporating solar energy and environmentally sound medical waste management. While solar energy has been introduced at all PHCs levels (KII 02, KII 04, KII 07), only a minority of facilities follow the recommended medical waste management practices (21% of CCs and 37% of UHFWCs). The use of incinerators remains very low (1% on average), with slightly higher use in UHCs (2%) but less than 1% in UHFWCs and CCs (Dihan et al., 2023). Due to a lack of proper equipment and training, CCs typically store all waste in a safety box and bury the box in a designated place (KII 01, KII 02, KII 03). UHFWCs have a slightly better scenario, as they burn infectious waste before burial (KII 04, KII 09).

Beyond foundational infrastructure, a climate-resilient health system requires integrating digital practices and technological innovations. Almost all public health facilities under the Directorate General of Health Services (DGHS) are being digitalized in terms of reporting. Furthermore, the telemedicine services and the nationwide call center ‘Shasthya Batayon’ enhance remote healthcare delivery, enabled consultations between CCs and UHCs via video conferences (Health Bulletin, 2019). However, in reality, telemedicine facilities were only found at the UHCs level, with no evidence of such services at the UHFWC and CC levels (KII 05, KII 03, KII 09).

3.4 Vulnerability, Capacity, and Adaptation Assessment

In Bangladesh, CCHPU Unit conducted a climate change and health vulnerability and adaptation (V&A) assessment in 2021 (GoB, 2021). This report aimed to assess the health system's vulnerability and preparedness to manage climate-sensitive diseases. The assessment identifies various climate-vulnerable geographic areas and a wide range of community climate-sensitive health risk across different geographical regions of Bangladesh. The assessment exhibits limitations in providing scientific evidence for establishing climate-sensitive health risks, except diarrhea. The assessment predominantly relied on community perceptions for identifying the health risks.

The assessment revealed significant challenges within the health system, identifying a lack of quality treatment, insufficient doctors, monitoring and supervision, data recording system, and health prevention activities to deal with the health effects during extreme weather events. The study also identified inadequate infrastructure and technical staff in the community clinics and hospitals. While the V&A report acknowledges that primary health facilities are indeed impacted by and face challenges during climate events, the assessment didn’t include their operational preparedness in climate-induced crises. Consequently, the study did not thoroughly elaborate on crucial aspects such as comprehensive contingency plans, supply chain resilience, specific training, and robust infrastructure (e.g., resilient power, water, and sanitation systems, or flood-proofing strategies) at the individual facility level for Community Clinics, Union, and Upazilla Health Complexes.

3.5 Integrated Risk Monitoring and Early Warning

Integrated risk monitoring is essential for generating a holistic perspective of health risks with real-time information, which can improve the preparedness of health facilities to manage

emergencies (Corvalan et al., 2020). In Bangladesh, regular risk monitoring is conducted through the routine health information systems (HIS) via the District Health Information Software 2 (DHIS2) (Asangansi et al., 2024).

At PHC facilities level, data collection and tracking usually performed by CCs and UHFWCs, and data aggregation occurs at the UHC and district levels (Begum et al., 2019). Crucially, CCs and UHFWCs have no independent authority or capacity to monitor data (KII 04).

The primary indicators collected through DHIS2 include emergency obstetric care, immunization, mortality, family planning, health education, reproductive health, human resources, and logistics (Begum et al., 2020). While no indicators related to climate change impacts, vulnerabilities, and adaptive capacities have been integrated into the database, the DHIS2 platform does include a general data entry form that allows users to record information on CSDs (KII-01). However, as noted by Begum et al. (2020), UHFWC and CC users have indicated a limited capacity to effectively utilize the data entry tools.

Besides DHIS2, Bangladesh also piloted a climate-sensitive disease surveillance system using the Early Warning, Alert, and Response System (EWARS) tool in a small humanitarian context (Shirin, 2023), focusing on diseases closely linked to climate variability (Khan et al., 2024). Integration of EWARS into the national DHIS2 platform is underway. But it currently only encompasses inpatient cases reported up to the UHC level, excluding outpatient data from both UHFWCs and CCs (GoB, 2023).

A further gap exists in risk communication among different PHC facilities levels. For risk communication, the Management Information System of the Directorate General of Health Services (MIS-DGHS) uses social media and bulk SMS for dissemination through official channels that exist up to the UHC level (GoB, 2020). In contrast, health service providers at UHFWCs and CCs receive early warnings through informal WhatsApp message groups (KII-2) and postal letters from the UHC (KII-3, KII-4).

3.6 Health and Climate Research

Building climate resilience requires both basic and applied research to reduce uncertainty and build an evidence base that can strengthen decision-making (WHO, 2015). As one of the world's most climate-vulnerable nations, Bangladesh has prioritized research through its HNAP. These national documents emphasize the critical role of research in understanding climate change impacts on disease patterns, identifying vulnerable populations, and developing effective health adaptation strategies.

While the Ministry of Health's Climate Change and Health Unit has initiated relevant studies, including V&A assessment, there is limited evidence of these research findings being translated into actionable plans and programs at the implementation level. For example, while the V&C assessment shows the geographical distribution of climate-induced health risks, resource allocation and distribution are the following the findings, noting that the same package of medicine and drugs is distributed to CCs, without considering local needs based on different types of climate-sensitive diseases (CSDs) (KII 03). Furthermore, while the DHIS2 data source

holds potential for research at the PHC level to inform decision-making and awareness-building, PHC staff's limited capacity prevents them from effectively utilizing this data for research purposes (Begum et al., 2019)

3.7 Management of Environmental Determinants of Health

While the health sector does not usually have direct control over environmental determinants, they have essential roles to play at both policy and programmatic levels in evidence generation, raising awareness and joint monitoring of environmental exposures and outcomes (WHO, 2015). Rural Bangladesh's main environmental constraints are its susceptibility to seasonal flooding, inadequate sanitation, and limited infrastructure for wastewater management (Gregory et al., 2010). At present, most PHC facilities in Bangladesh primarily address environmental determinants passively, playing a sentinel role in detecting and reporting diseases (Begum et al., 2020). Routine, direct monitoring of environmental hazards, such as air quality, chemical or biological water contamination, or local waste disposal practices, is not a standard part of PHC facility operations (Kabir et al., 2025). The study didn't find any evidence at the field level of PHC engagement in identifying the environmental determinants of health, but at the UHFWC level, field workers often provide awareness-building sessions in community and school level for awareness building about water, sanitation and hygiene-related good practices (KII-09).

3.8 Climate Informed Health Programme

According to WHO (2015) guidelines, health programming and operations should consider climate risks and vulnerability and increasingly become climate-resilient through program development and implementation. Bangladesh's health system is structured around 29 Operational Plans (OPs) under its sector-wide programmes and 13 of these OPs have incorporated climate change considerations into either their design or implementation (Nahian, 2023). The study found limited evidence that local health facilities, such as CCs, UHFWCs, and UHCs are actively engaged in adapting or shaping these programmes. The existing literature indicates that the only climate-informed health programs found at the PHC level are health promotional educational initiatives. Existing literature also shows that 8% of CC and 13% of UHFWC, compared to 60% of UHCs, are currently delivering community health education on health risks and protective behaviors (GoB, 2022). The interviews found that, only field staff from UHFWCs are facilitating community education and awareness-building initiatives on water and vector-borne diseases. Interviews also explored that field workers from UHFWCs are regularly trained on contemporary health issues, considering to seasonal trends like dengue, typhoid, malaria, and malnutrition to raise community awareness. However, these training sessions are designed at the ministry level and organized by the UHC, with no prioritization of local health needs (KII 04).

Interviewees from the CC also revealed that while CCs have a provision for promoting health education within the community, this responsibility is delegated to the voluntary Community Group (CG). Since CG representatives receive neither training nor incentives, these programs are often not implemented (KII 03).

3.9 Emergency Preparedness and Management

Outbreaks and health emergencies triggered by climate variability are one of the primary concerns for climate climate-resilient health system. As frontline providers, PHC facilities require robust preparedness plans and effective emergency systems to respond to such situations (WHO 2015).

A Pathfinder International report (2024) illustrates that while a majority of UHCs (50%) practice regular community disaster planning, only a small fraction of CCs (18%) and UHFWCs (16%) do the same. This gap is even more pronounced for crucial post-crisis recovery and evacuation plans. For example, post-crisis recovery plans are non-existent at the UHFWCs and are present in just 1% of CCs. All health workers at the primary level are reportedly equipped with full personal protective equipment (PPE). However, the infrastructure for effective communication is found at 90% UHCs and they are scarce in CCs (6%) and UHFWCs (8%) (GoB, 2022).

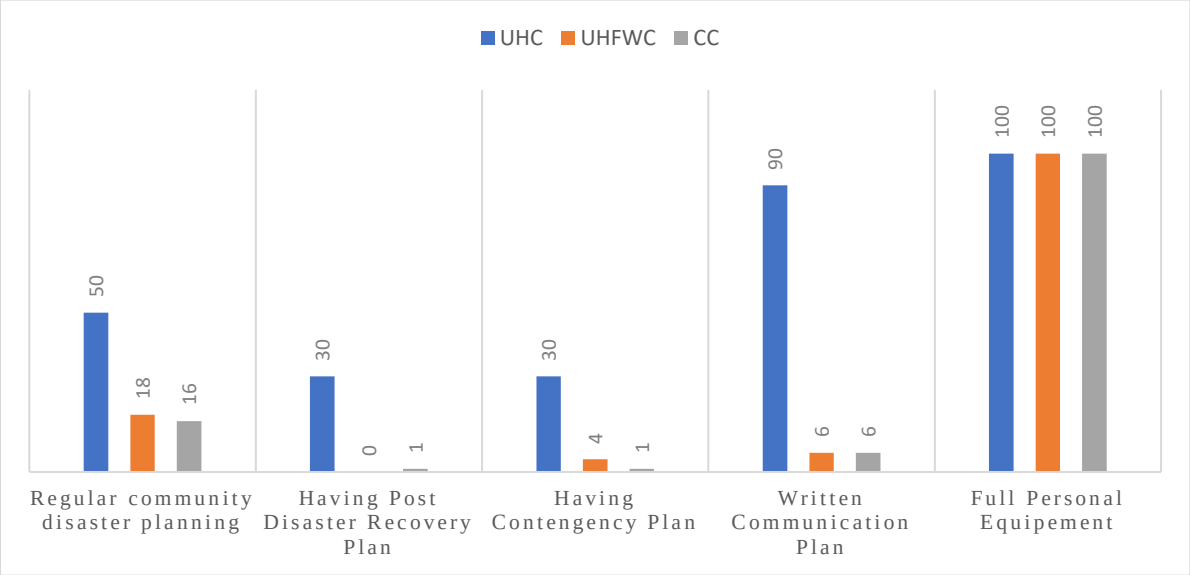

Figure 5: Disaster Preparedness Tools and Practices at PHC facilities level (% of facilities adapted the tools and practices) (Source: Pathfinder, international, 2024)

The interviews also documented disparities across different levels of PHC facilities, particularly in terms of emergency planning, post-crisis recovery plans, and written communication plans. The interview data confirmed that while contingency plans are present at UHCs, they are absent at the CC and UHFWC levels. A similar pattern was observed for both involvement in regular disaster planning and having written communication plans, which exist at the UHC level but are lacking in other PHC layers. Regarding personnel equipment, while the literature indicates that all levels of PHC have full personal equipment. CC interviewees, however, only partially confirmed this finding. They reported a complete absence of PPE for climatic extreme events. Yet one participant did received PPE during the COVID-19 pandemic but distribution was not

timely. He highlighted the issue of delayed, noting that "*PPE was supplied after two years of the emergence of COVID, in 2021, when the pandemic was about to end"* (KII-03).

As part of emergency planning, UHCs are responsible for formulating medical teams for each union and village. These teams are maintained in a state of readiness to serve the public; however, they are only activated upon request from the local government administration. Consequently, no medical team responds directly in the field without specific instructions from the UHC (KII 05).

Risk analysis is also considered an essential component of emergency preparedness at both the community and facility levels (WHO, 2015). The study found that while risk mapping exists across all health facility levels, its purpose is only tied to emergency preparedness at UHC facilities. At the CC level, the CG developed a topographic map based on the physical vulnerability of the area, not specific health or disaster risks. Conversely, at the UHFWC level, the risk map outlines the accessibility of different areas to support routine operations like a vaccine program while considering geographical challenges (KII 1, KII 04).

The availability of sufficient medicine and logistical supplies is a critical component of effective emergency management. At the PHC facility level, the study found that only UHCs maintain an emergency buffer of medicine and logistical stock. In contrast, no such buffer is available at UHFWCs or CCs. Consequently, these lower-level facilities do not receive additional logistics or medicines even when an emergency is anticipated. A participant noted that medicines for CCs are supplied directly from the Ministry, and the allocated amount remains constant regardless of the situation (UHFPO, KII 8). In an emergency, UNFPO tries to reallocate medicine from less impacted CCs to more severely affected areas; however, this is an entirely informal mechanism. Furthermore, interviewees at all health facility levels expressed concern about the hospital's lack of surge capacity, even under normal circumstances. They reported a limited ability to respond to any emergency. For example, a 50-bed UHC can only accommodate an additional 20 beds if any emergency event take place (KII 05).

Despite all above mentioned challenges, interviewees praised Bangladesh's comprehensive, well-coordinated disaster management system that significantly helps UHCs in responding effectively during a disaster (KII 05, 08).

3.10 Health and Climate Finance

Effectively protecting health from climate change incurs financial costs for health systems (WHO 2015). Recognizing this imperative, the Government of Bangladesh (GoB) established the Climate Fiscal Framework (CFF) in 2014. This framework currently encompasses 25 ministries and divisions, including the Ministry of Health (Khatun et al., 2024). For the fiscal year 2023-24, the budget specifically allocated for climate and health-related initiatives amounted to BDT. 5934.2 million (MoF, 2023). A significant portion, 40% of this total allocation, was directed towards food security, social protection, and health. Subsequent allocations included 17% for research and knowledge management and 13% for capacity building and institutional strengthening. However, the study couldn't find literature regarding the

precise distribution of these funds to PHC facilities at the local level, with the exception of dedicated budgets for emergency management.

The report by Pathfinder International (2024) indicated specific annual emergency preparedness budget allocations of 6% at CC, 0% at UHFWC, and 30% at UHC levels, relative to their total budgets. Conversely, the interviews conducted at health facilities revealed a notable absence of explicit emergency preparedness budget allocations at the facility level, presenting a contradiction with the findings presented by Pathfinder International (KII 08). Additionally, one participant highlighted the lack of accountability and transparency in budget allocation and implementation at the field level, remarking-

"Once we were told that if we completed a report, UNICEF would allocate 15 million USD to us. We did the report, the money came, but we never received any allocation in our community clinic."(KII 02)

3.11 Community and Youth Engagement

During the interviews, participants discussed the influence of communities trust and socio-cultural beliefs over service delivery. They also discussed the importance of engagement of youth and the community in health initiatives. One interviewee specifically highlighted that chronic shortages of medicine meant people often walked one to two kilometers and return to home empty-handed. This, in turn, eroded community trust in the CCs, leading to reduced acceptance of health promotional advice related to CSDs by CCs (KII 02).

Another participant further emphasized the challenge posed by communities' harmful beliefs and misconceptions regarding medicines, vaccines, or environmental and climatic determinants of health. These deeply held beliefs often led community people to disregard suggestions from field health workers and neglect taking preventive measures (KII 04). Despite of these challenges, participants highlighted the crucial roles of both youth engagement in delivering health services during climate-induced health emergencies and pandemic situation. In any crisis either national, regional or local, young people are often among the first to volunteer. They frequently take the lead in organizing fundraising initiatives and mobilizing resources to ensure affected individuals receive necessary health support.

So, all the preceding sub sections of this section, have thoroughly presented the findings regarding the preparedness, challenges, and enabling factors of PHC facilities in Bangladesh. To provide a consolidated overview of challenges and enabling factors, Table 3 below summarizes the key observations for each component.

Table 3: Key Challenges and Enabling Factors of PHC Facility Level

Component	Challenges	Enablers
Governance and leadership	-Centralized decision-making system, less meaningful participation from the PHC level -Lack of local need consideration in program planning and implementation	-Dedicated plans and policies framework regarding "Climate Change and Health"

Health Workforce	-Shortage of health workers specializing in climate change and health -Lack of a training programme on “Climate Change and Health” at the field level for health workers	-Health workers' motivation and dedication towards service delivery
Climate-resilient and sustainable technologies and infrastructure	-Fragile structure -Lack of water, sanitation, and hygiene facilities -Lack of sufficient medicine and logistics -Interpreted electricity, lack of alternative power supply -Lack of emergency transport -Poor medical waste management	-Digital device is available to every level of PHC -Introducing telemedicine and digital health services at PHC level -Use of solar as renewable energy
Vulnerability, capacity, and adaptation assessment	-Lack of application in health planning and resource allocation and distribution	
Integrated risk monitoring and early warning	-Lack of climate change and health indicators at DHIS2 -Lack of capacity building of PHC field level staff in identifying CSDs and digital input in the system -Lack of coordination among UHFWC and CC and other relevant stakeholders in risk monitoring and early warning	-Introduction of a climate-sensitive disease surveillance system
Climate and Research	-Lack of translation research findings to strengthen PHC facilities to better respond to climate-induced health situations	-Data and resource availability through the DHIS2 system for potential research
Management of environmental determinants of health	-Lack of training of PHC staff on identifying the environmental determinants and management	
Climate-informed health programme	-Lack of consideration of local context and need in climate-informed health program development (The study only discussed about health education program)	-Dedicated workforce for field-level health promotional and awareness-building program
Emergency preparedness and management	-Lack of UHFWCs and CCs leadership in emergency management -lack of necessary emergency preparedness protocols (contingency, recovery or communication plan at UHFWC and CC level) -Lack of skills to develop the protocols -Lack of occupational safety	-long-term experience of climate extreme events and emergency management - Strong disaster management mechanism

	-Lack of emergency medicine and logistic supply into UHPWCs and CCs	
Health and Climate Finance	- Lack of Transparency and accountability macahnism	-The government has allocated budget line for climate and health
Community and Youth engagement	-Socio-economic challenges of service seekers -Lack of incentives for the community group (CG) that demotivates the group in community engagement -Mistrusted by the community -Existing socio-cultural harmful beliefs on taking medication	Youth and Community's active participation in response

Chapter 04: Discussion

This chapter presents a comprehensive discussion of the key findings from the study. The section interpreted the findings in light of the conceptual framework, critically examining its relevance to the study's outcomes. Furthermore, the limitations and strengths of the analytical framework are thoroughly evaluated. Finally, this chapter concluded with suggestions for future research, building upon the insights gained.

4.1 Reflection of Result

This study aimed to explore the climate preparedness of Bangladesh's PHC facilities and also identify existing challenges and enabling factors to provide comprehensive recommendations for improving PHC facilities' preparedness to tackle climate induced health effects.

The findings revealed systemic barriers to effective climate adaptation at the facility level, despite the existence of robust national policies. By examining key domains such as governance, workforce, information systems, infrastructure, service delivery, and financing, this analysis identifies critical challenges, enabling factors, and actionable recommendations for strengthening climate resilience.

A significant theme emerged from the study is the disconnection between policy intent at the national level and its inconsistent operationalization at PHC facilities. Moreover, the centralized governance structure and prevailing top-down decision-making processes create operational vulnerabilities at the grassroots; lower tiers of PHC facilities such as UHFWCs and CCs are largely excluded from planning and decision-making, which contradicts WHO recommendations for community-based preparedness (WHO, 2015). This exclusion undermines timely and contextually appropriate responses for climate-vulnerable populations. International evidence also supports the positive impacts of decentralizing governance, financing, and service delivery in LMICs (Mahmood et al., 2024). However, in the context of Bangladesh, where transparent accountability mechanisms are often absent, governance reform must be combined with safeguards for accountability and capacity-building to ensure the effective results of decentralization (Hossan et al., 2024; Kruse et al., 2011)

Regarding the health workforce, the study identified critical capacity gaps, particularly among field staff at UHFWCs and CCs. These frontline workers, who are the primary link to communities, lack essential training on the intersection of climate change and health. This deficiency in the capacity to detect, report, manage, and provide education on climate-sensitive diseases (CSDs) significantly compromises community-level resilience. Even at UHCs, capacity-building initiatives disproportionately focus on managerial staff, leaving medical officers and field workers inadequately equipped. Addressing these challenges necessitates a robust government commitment, targeted resource allocation, and strategic initiatives aimed at the skill development of all health workers concerning climate change and health issues. Several LMICs, such as the Federated States of Micronesia, have committed to tangible targets, including a goal of a 100% health workforce with climate change and health education as part of their Nationally Determined Contributions (NDCs) (Clarke et al., 2025). Emulating these examples, Bangladesh could establish and pursue its own measurable targets for health workforce training in this area.

Data and information systems present a mixed picture. While Bangladesh has made considerable progress, such as the implementation of the DHIS2 for health risk monitoring, climate-specific indicators are not yet integrated. But many countries from Asia and Africa, including Mozambique, Malawi, Ethiopia, Tanzania, Togo, Rwanda, Uganda, Laos, Sri Lanka, and Nepal, has already included climate data into DHIS2 system (DHIS2, 2024).

Infrastructure remains a significant weakness within the health system. While UHCs exhibit relatively better equipping, including enhanced digital tools and emergency power, lower-tier PHC facilities frequently contend with unreliable electricity, inadequate generators, and substandard physical structures. These deficiencies critically threaten their operational functionality during climate emergencies. Though such basic infrastructural challenges are widespread across LMICs (Chawla et al., 2017), notable exceptions, such as Iran's near-universal hospital power supply, offer valuable examples for emulation. However, it is important to acknowledge that while technologies and infrastructure are a broad range of components, such as environmental management, information technology, low carbon infrastructure design, emergency mobility, and consideration of environmental impact in facilities and etc. (WHO, 2015), the study could not cover all those components in consideration.

Financial constraints represent a significant compounding factor that exacerbates the challenges impeding the preparedness of PHC facilities. Although Bangladesh allocates BDT 5,934.2 million (approximately US$ 48.05 million) to the health sector, the needs-based utilization of these funds is crucial to bolster the capacity and readiness of PHC facilities. Although, globally, a very small amount of total multilateral climate adaptation finance (only 5.7% of total funds allocated from 2009 to 2019) has been directed towards the health sector (Alcayna et al., 2023), a new multilateral “Climate Loss and Damage Fund” could be an opportunity to apply and secure additional resources funding (Borghi et al., 2024). This fund could enable Bangladesh to facilitate greater investment in the climate change and health nexus, and consequently strengthen PHC facilities to tackle climate-related health effects. However, community or locally led adaptation is a growing concept that increasingly prioritizes the necessity of community engagement and leadership in resilience building (V. Kumar, 2024). Many countries have successful stories of locally-led health adaptation; for instance, in Colombia, climate-informed disease prediction models were developed through a partnership between the Ministry of Health and local weather services (World Economic Forum, 2025). Therefore, Bangladesh can adapt good practices from other countries and could use local knowledge and the capacity of the community to build community resilience against climate-induced health risk.

Notwithstanding the above-mentioned challenges, Bangladesh has already taken notable steps forward in its pursuit of a climate-resilient health system. The country has developed a HNAP and is in the process of establishing climate-sensitive health surveillance systems. Moreover, to tackle the escalating impacts of extreme climatic events, Bangladesh already has a comprehensive disaster management framework that allows for coordinated response. These achievements reflect commendable commitment at the policy level, demonstrating that Bangladesh is not starting from scratch but building upon a foundation of proactive adaptation measures.

However, these national-level accomplishments have yet to fully translate into robust and consistent operational capacity at the facility level. The next crucial step is ensuring these advances are integrated into the daily functioning of local PHC facilities, strengthening the connection between policy and practice through empowered local governance, sustained financial investment, and tailored capacity-building.

In summary, building climate-resilient health infrastructure in Bangladesh depends not only on bridging the policy-implementation gap but also on empowering frontline facilities and staff, filling critical knowledge and capacity gaps, ensuring financing, and integrating climate intelligence into every aspect of PHC delivery. Only through such a multi-level, locally contextualized approach can PHC fulfill its pivotal role in protecting communities from the escalating impacts of climate change.

4.2 Applicability of Conceptual Framework

This study utilized the WHO Operational Framework for Building Climate-Resilient Health Systems as its conceptual and analytical lens. The applicability of this framework's core components is highly relevant in the context of Bangladesh because Bangladesh's National Health Adaptation Plan (NHAP) has been developed based on it.

Despite its strengths, while the framework identifies the essential components of a climate-resilient health system, the majority of its component outputs have been designed for national-level intervention and do not sufficiently reflect the local context. Consequently, this study struggled to frame all of its components at the PHC level.

4.3 Limitations of the Study

The study has several limitations. Firstly, the Bangladesh National Health Adaptation Plan (NHAP) was targeted for implementation between 2018 and 2023. As the timeframe for this plan has recently concluded, relevant official reports detailing the updated status of its policy implementation are not yet publicly available. Consequently, there is a potential for the study to have inadvertently omitted recent initiatives or advancements that have occurred in practice.

Secondly, the interviews were conducted during a period of political transition. This prevailing political climate may have influenced the responses of informants or led to hesitancy in sharing comprehensive information. While efforts were made to mitigate this potential bias by requesting interviewees to base their responses on past experiences rather than current situational reflections.

Thirdly, the findings may seem to place a greater emphasis on the health impacts of extreme climatic events. This is likely because the healthcare system has already integrated slow-onset health impacts into its routine operations, treating them as general health problems.

Fourthly, while this study maps facility-level preparedness, it acknowledges a gap in understanding community perceptions and experiences regarding these facilities. The absence of triangulation with community-level data means that certain nuances of preparedness from the perspective of the beneficiaries remain unexplored.

Finally due to constraints in both time and resources, interviews were exclusively conducted within a single Upazila (sub-district) in Bangladesh. This particular sub-district is highly climate-vulnerable and has been the focus of numerous government and non-governmental organization initiatives. This might also reflect the different level of preparedness than the than the other areas of Bangladesh.

4.4 Strength of the study

Combine insights from KIIs with existing literature and official reports (e.g., from the Government of Bangladesh, Pathfinder International) triangulate the data sources strengthens the validity and reliability of findings.

4.5 Suggestions for Future Research

In light of the previously presented limitations, Firstly, expanding the geographical scope of data collection to encompass diverse regions across Bangladesh would enable a more comprehensive and representative assessment of the country's overall situation. Secondly, while the ten components of the study's framework are comprehensive, there remains significant scope for in-depth analysis. Future research could focus on individually examining specific components to gain a more granular understanding of local health facilities' preparedness under each area.

Furthermore, the applicability of the conceptual framework could be further tested and validated within tertiary or secondary healthcare facilities. This could subsequently contribute to the development of a context-specific operational framework tailored for Bangladesh's unique healthcare landscape. Finally, given the increasing recognition of its importance, further research into community engagement and locally led health adaptation strategies constitutes a crucial potential area for future inquiry.

Chapter 05: Conclusion and Recommendation

This study investigated the preparedness of PHC facilities to address health challenges exacerbated by climate change. It specifically examined PHC level facilities capacity to effectively anticipate, respond to, cope with, recover from, and adapt to climate-related shocks and stresses, with the aim of protecting the health of population despite climate related impact.

Among the various tiers of PHC facilities, the study revealed that UHC facilities are considerably more prepared than UHFWCs and CCs in terms of emergency readiness, infrastructure, and services. This better preparedness is largely attributable to their administrative hierarchy, being positioned directly below the district level, and possessing a greater extent of power and authority in decision-making.

However, the study also highlighted that UHCs have less direct interaction with the community. In contrast, UHFWCs and CCs are deeply engaged with the communities they serve. These latter two types of facilities are crucial for understanding and addressing the health effects of climate change due to their embedded location within communities and their role as the first point of contact for many individuals. They also primarily conduct health promotion activities and preventive initiatives. Therefore, building the capacity of staff at these facilities, particularly in detecting CSDs and raising community awareness, is essential.

Building community awareness about climate change and its health impacts is key to effectively tackling climate induced health effects. Climate and health promotional and educational programs can empower and inform communities, enabling them to build health resilience against the negative impacts of climate change. This, in turn, could significantly reduce the health burden on the system.

Furthermore, granting UHCs greater autonomy for resource allocation and local-level planning for UHFWCs and CCs could empower PHC facilities to better address climate-related health problems by allowing them to reflect local needs and unique contexts.

Despite these identified operational gaps, the dedication and contributions of Bangladesh's healthcare workforce is outstanding. This committed workforce has been instrumental in enabling Bangladesh to achieve significant progress toward previous health-related targets, such as the Millennium Development Goals (MDGs). Nevertheless, locally led health adaptation remains an area that requires further exploration. Greater investment by researchers in this field could significantly enhance community awareness and responsiveness to climate-related health challenges.

In summary, Bangladesh’s PHC system exhibits critical weaknesses across several components necessary for an adaptive and climate-resilient health system. Addressing these challenges is urgent to safeguard vulnerable populations and ensure the health system’s long-term sustainability in the face of escalating climate risks.

Recommendations

To strengthen the preparedness of primary health care (PHC) facilities in Bangladesh to address climate-induced health challenges, the following recommendations are proposed. The

recommendations are presented in order of priority, with the most urgent and immediately actionable measures listed first.

1. **Development of tailored training module on "Climate Change and Health" for health workers and providing capacity-building in service training with a target to cover 100% of PHC facilities' health workers:** Given the diverse roles within the health system, ranging from patient care provided by doctors to health promotion and educational work by field staff, a differentiated approach to training is essential. Each distinct professional role necessitates a specific module for effective learning regarding climate change and health. CCHPU can develop these specialized modules and subsequently organize comprehensive training programs. Furthermore, a strategic target (e.g., 2025-2035) should be established to achieve 100% coverage of health professionals, complemented by the implementation of an annual monitoring mechanism to track the progress of the strategic target.
2. **Establish dedicated and sustainable financing mechanisms for climate-health adaptation at the PHC level and ensure equitable allocation:** The government should establish dedicated funding streams or reallocate existing budgets to ensure consistent financial support for climate resilience initiatives at the PHC facility level. Exploring innovative financing mechanisms and fostering partnerships with international organizations can also supplement national efforts to ensure the long-term sustainability of these crucial investments. Furthermore, this funding should be allocated considering local needs, vulnerabilities, and capacity assessments.
3. **Prioritize and invest in resilient infrastructure and reliable energy sources for PHC facilities:** Dedicated investment is needed to upgrade physical structures to withstand climate impacts, ensure a reliable electricity supply through robust generators or renewable energy solutions, and improve access to safe water, sanitation, and hygiene (WASH) facilities.
4. **Foster decentralization of governance and strengthen the "Climate Change and Health" adaptation operationalization at the PHC facility level:** Full autonomy should be granted to Upazila Health Complexes (UHCs) for planning, resource allocation and decision-making related to climate adaptation at the PHC level. Mechanisms should be established to ensure transparent accountability. Provide capacity-building support to local administrative bodies and facility management, to enable them to effectively manage resources and implement climate-resilient strategies. Furthermore, performance indicators specifically tailored for PHC facilities can be developed for regular monitoring and evaluation of climate change and health adaptation operationalization at the PHC level.
5. **Integrate Robust Community Engagement Strategies into Climate-Resilient PHC Planning and Service Delivery**: Tailored climate change and health promotion and awareness-building programs should be designed specifically for communities. PHC facilities' level staff should be trained and empowered to facilitate these programs at the community level. Establishing mechanisms to actively engage community youth and community groups (CG) in climate-related health promotion can significantly contribute to building community resilience.
6. **Enhance climate-sensitive health information systems and staff capacity for data utilization:** This is a critical need to integrate climate-specific indicators into DHIS2. This includes data on CSDs, climate-related health impacts, and the operational status of facilities

as well as climate, weather, environmental, and earth observation data. Furthermore, comprehensive training programs must be developed for local staff at UHFWC and CC levels to enhance their capacity in data collection and at the UHC level in analysis and utilization.

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Annex I: Literature Search Strategy

Population (OR)		Concept (OR)		Context (OR)
		Preparedness		Bangladesh
Primary Health Facilities		Readiness		South Asia
Local Health Facilities		Governance		Developing countries
Upazilla Health Complex		leadership		Low-income countries
Subdistrict Level Health Facilities		Health Workforce		Climate-vulnerable regions
Union-level Health Facilities		Emergency response		Flood-prone areas
		Early Warning		Coastal areas
Union Centre Facilities		Disaster management		Areas affected by cyclones/storms
Union Subcenter health facilities		Resilience		Drought-affected areas
Union Family Welfare Centre	AND	Capacity building	AND	Salinity-affected areas
Union Health and Family Welfare Centre		Health system strengthening		
Community Clinic		Climate change adaptation (health)		
		Disease surveillance		
		E-Health		
		DHIS		
		Research		
		Health Finance		
		Climate-sensitive health impacts		
		Outbreak response		
		Policies		
		Climate vulnerability (health sector)		
		Climate-Induced Health Crisis		

Annex II: Profile of KII interviewees

Participants ID	Profession	Institute	Role
KII 01	CHCP	Community Clinic	Play both the administrative and patient care roles in the CC level
KII 02	CHCP	Community Clinic	Mentioned previously
KII o3	CHCP	Community Clinic	Mentioned previously
KII 04	Health Assistant	UHFWC	Play both the administrative and patient care roles in the Union level
KII 05	UNFPO	UHC	Their Primary role includes the implementation of various health programs, health management, and the planning and execution of policies through administration
KII 06	Medical Officer	UHC	Play patients care role
KII 07	Medical Officer	UHC	Mentioned previously
KII 08	UNFPO	UHC	Mentioned previously
KII 09	Health Assistant	UHFWC	Mentioned previously
KII 10	CHCP	Community Clinic	Mentioned previously

Annex III: Topic Guide (Interview)

Estimated Time: 60-90 mins

Section 1: Introduction

-The interviewer will introduce himself/herself to the participants and will give thanks to the participants for their voluntary participation in the study.

-The interviewers will explain the background and purpose of the study to the interviewee

Explain the consent form and obtain the consent

-The interviewer will explain the key concept and terminologies related to the interview, like climate change and its impact on health (both long and short term), rapid and slow onset events, climate-sensitive diseases, and so on

-Interviewer will take consent from interviewee about recording

Section 2: Questions

1. Does your health facilities work under the directives of specific plans like the National Health Climate Adaptation Plan (NHAP), and how do such plans influence operations/translate into action at local facility's level? Is the plan helpful to tackle local health needs and the climatic crises?

2. When natural disasters or extreme weather events like cyclones, floods, or heatwaves happen (Rapid onset events), what preparations your health facilities make to tackle the health crisis? How have decisions been made? How the decisions been communicated to the local facilities?

3. How your facilities adapting to slow-onset climatic impacts? Did the health facilities bring any changes in arranging infrastructure and services (hints: number of beds increase, installation of any machinery, etc.)

4. To mitigate climate change-related impact, do your health facilities work together with other organizations, such as the Department of Public Health Engineering (DPHE), NGOs, or programs like the Cyclone Preparedness Programme (CPP)? If yes, could you please tell me how these collaborations usually happen? For instance, what are the steps involved, who does what, and what are the main benefits or challenges you experience when working with them during a crisis?

5. Is there any risk reporting, monitoring or early warning system/tools in the hospital level? How the health risk has been monitored over the year (explain for both slow-onset and rapid-onset problems). How does the early warning system work? From where your health facilities get the instruction, and how does it communicate the risk to the front-line health facilities level and also in the community level?

6. Do your health facilities has any community engagement and feedback mechanisms? How does it work? Which kind of feedback it getting most? How do the health facilities communicate the health risk within the community?

7. Does your department have any programmes/initiatives about improving other factors of health (eg. air pollution, water contamination, sanitation, hygiene etc.)? Do you have any long or short-term joint initiatives or coordination with other departments that are responsible for different environmental determinants, like DPHE, NGOs etc? If yes, how does the coordination take place?

8. Are your health facilities at risk of any natural climate hazards like flooding, cyclone, heatwave etc. What are the consequences (as an example, due to flooding, electricity function being hampered, the cold chain of medicine being damaged, or no transport facilities)) of those hazards to delivering your services? So, do your health facilities have any preparations to address these situations and continue to deliver the health services?

9. From previous challenges, did your health facilities make any changes in the infrastructure or services? Or do your facility have any alternative plans now? If yes, what are the changes/plans? If not, why couldn't I make the changes?

10. Does your facility have any plans or strategies in place to manage the longer-term health challenges that might become more significant due to climate change – for example, changes in disease patterns or the increasing burden of certain illnesses over time? If so, could you describe what these plans involve?

11. Does your facility have specific plans or step-by-step guides (sometimes called Standard Operating Procedures, or SOPs) to assess risks and respond to climate-related emergencies? Could you describe what these plans cover and how they are used?

12. To ensure the health facility can continue providing care during and after climate-related emergencies, does your facility have backup supplies of essential medical equipment, drugs, and other necessary items? Could you describe what kind of backup supplies are kept, and how you ensure they are sufficient?

13.. Regarding financial resources, is there a dedicated budget line allocated specifically for climate adaptation activities within your hospital? If so, could you describe how this budget is typically distributed?

14. Based on your experiences and our discussion today regarding the challenges and preparedness for climate-induced health crises, what do you believe are the significant challenges and weaknesses to improve the preparedness? (hints: Considering your local health need)

15. Thinking about how we could strengthen the health system's ability to cope with these climate-related health impacts, what do you see as some reasonable and practical next steps or actions that could be taken to make tangible improvements to preparedness?

Annex IV: Ethical Approval Copy

Ethics Review Committee. Bangladesh Bioethics Society

Promotes Research Ethics Culture in Bangladesh

Address: H/623, R/10, DOHS, Mirpur cantonment, Dhaka-1216, Phone: 880-01712522627 (Mobile)
Email: info@bioethics.org.bd, secretariate.bbs@gmail.com Web site: www.bioethics.org.bd

Ref: ERC-BBS|2025|1012-39|004|2025 Date: 15-07-2025

Ethical Clearance

Name of PI: Naznine Nahar
Affiliation: MSc Student,
Institute: KIT (Koninklijk of Royal Tropical Institute), Netherlands
Study Title: Preparedness of Local Health Facilities (District and Sub-district level hospitals) in Tackling Climate-Induced Health Crises in Bangladesh
Protocol No: 2025/00012-39/0004/2025
Protocol Submission date: 26.06. 2025
Place of study: Bangladesh
Sponsor: Self

Co-Investigator(s): X

Mode of Review:

Initial Review: ☐ Full Board Review (Meeting No. M/YYYY-XXth) ☑ Expedited review
Resubmission (1) ☐ Full Board Review (Meeting No. M/YYYY-XXth) ☐ Expedited review
Resubmission (n) ☐ Full Board Review (Meeting No. M/YYYY-XXth) ☐ Expedited review

Approval Date: 15.07.2025

Date of continuing review: Note: Please submit the Final Report on or before 31.12.2025.

List of documents(s) approved:

Protocol: Version No:.....1.... Dated: 04.07.2025.....
Informed Consent Form: Version No: .....1... Dated: 04.07.2025.....
Tools (Questionnaire/forms/guides/etc): 1....Dated: 04.07.2025.....
Others (Specify) .....: Version No. ... Dated: .....

Conditions for Approval:

1. This approval is granted for the scientific and ethical soundness of the study. The PI shall be responsible for seeking all other clearances/approvals required by law/policy, including permission from the study sites before conducting the study.
2. Report serious adverse events to ERC, BBS within 10 working days after the incident and unexpected events should be included in the continuing review report or the final report.
3. No biological material shall be used for other research purposes beyond what is specified in this protocol. 4. Any new research study with stored biological material from this study will need a new approval from the ERC before the study begins.
5. Any changes to the proposal or to the attachments (informed consent and research tools such as forms) shall be approved by ERC before implementation.
6. The final report of the study shall be submitted to ERC at the end of the study for review and protocol file closure.
7. If necessary, you can take ethical clearance in BMRC, Bangladesh.

Prof MA Shakoor
(Chairman and Professor of Physical Medicine & Rehabilitation, BMU)
Chair
Ethics Review Committee, BBS

Copy to:
1. Office file of ERC
2. Principal Investigator

KIT

Contact
Sandra Alba
s.alba@kit.nl

Amsterdam, 11 July 2025

Subject: Decision Research Ethics Committee regarding application 5-266

Dear Naznine Nahar,

The Research Ethics Committee (REC) of the Royal Tropical Institute has reviewed your application for a waiver for a study on "Preparedness of Local Health Facilities (District and Sub-district level hospitals) in Tackling Climate-Induced Health Crises in Bangladesh"" [5-266], that was originally submitted on 4-07-2025. Your proposal has been exempted from full ethical review based on the following considerations:

a. the participants will be involved in their professional capacity only; the issues to be covered in the topic list cover information related to the duties of the respondents and information in the public domain; questions related to any personal questions are not included;
b. the participants will be asked informed consent before the data collection. This to make sure voluntary and informed participation is taking place and the participant can decide to decline or withdraw participation at any moment during the process without any effect on reputation, or other consequences;
c. participating in this study does not bear any physical, psychological and/or socio-economical risk or discomfort;
d. all information will be derived, processed, stored and published anonymously;

This exemption means the REC has not conducted a full ethical review, which would include an assessment of the technical soundness of the research methodology. This waiver should thus not be interpreted as a full ethical clearance. Rather, based on the considerations above, the REC sees the risks for the participants as minimal in relation to the social, educational, or scientific value of the research.

The Committee grants this waiver provided that you inform the GDPR project officer about your research project for GDPR monitoring purposes. The Committee requests you to inform the Committee if substantive changes to the protocol are made, important changes to the research team take place or researchers are added to the research team.

Finally, the Committee requests you to send the final report of the research containing a summary of the study's findings and conclusions to the Committee, for research managing and training purposes of the REC.

Wishing you all the best with the research,

Sandra Alba
Co-chair of the KIT REC

1/1

Mauritskade 64 | 1092 AD Amsterdam | P.O. Box 95001 | 1090 HA Amsterdam | The Netherlands | www.kit.nl | KVK 33185213

Annex V: Informed Consent Form

Title	Preparedness of Primary Health Facilities against Climate-Induced Health Effects in Bangladesh
Introduction	You are requested to participate in a research study focused on understanding and strengthening health system resilience in the face of climate change. This consent form explains the purpose of the study, what your participation will involve, your rights as a participant, and how your information will be handled. Please read this form carefully and feel free to ask the facilitator any questions you may have before deciding to participate
Background of Study	Climate change is a present reality, disproportionately impacting vulnerable nations like Bangladesh, which is the world's 7th most climate-vulnerable country. Bangladesh faces intensified cyclones, flooding, rising sea levels, and salinity intrusion, all of which profoundly impact human health. The documented linkage between climate change and health places significant strain on healthcare systems, demanding their ability to effectively prevent, prepare for, respond to, and recover from climate-related shocks and stresses – a concept central to healthcare system resilience. In this study, we aim to explore the resilience of PHC level health facilities of Bangladesh, specifically their capacity to respond to and manage long-term climate-sensitive health risks. Your insights as a key informant are crucial because existing research lacks a comprehensive health system resilience component, particularly regarding the specific vulnerabilities, adaptive capacities, and systemic weaknesses of healthcare facilities and services in these coastal zones. By participating, you will help us address this critical knowledge gap and provide evidence on how local health systems are coping with climate-induced stresses
Procedures	Your participation in this study will involve a Key Informant Interview (KII). This will be a one-on-one discussion with the interviewer, lasting approximately 90-90 minutes. The interview will cover topics related to your experiences, perspectives, and expertise on the resilience of the health system in responding to climate change impacts, including infrastructure, service delivery, workforce preparedness, surveillance, and governance. We would like to audio record the interview to ensure accuracy and capture the nuances of your valuable insights
Voluntary Participation and Withdrawal	Your participation in this study is entirely voluntary. You are requested to participate and can decide to decline or withdraw your participation at any moment during the process without any effect on your reputation, or other consequences like loss of benefits, professional repercussions, or impact on

	services received. You do not have to answer any question that makes you feel uncomfortable.
Confidentiality and Profile Disclosure	We are committed to protecting your privacy and the confidentiality of your responses. While your personal name will remain confidential and will not be used in any reports or publications, we intend to disclose your professional role and institutional affiliation (e.g., "a District Health Officer from X Hospital" or "a representative from Y NGO") in our analysis and reports. This is essential to provide context for your valuable insights, as your expertise is directly linked to your position and experience within the health system. The audio recordings will be transcribed, and all identifying information will be handled with strict confidentiality. Only the research team members and a professional transcriber (bound by a confidentiality agreement) will have access to the raw data during the study.
Potential Risks and Benefits	Risks: Participating in this study does not bear any physical or significant psychological discomfort. This study involves only confidential, one-on-one interviews, posing no physical demands. Discussions will focus on professional insights into health system strengthening, minimizing psychological distress. However, given that your professional role and affiliation will be used to contextualize your insights, it is important to acknowledge a minimal potential for indirect professional or reputational repercussions. We will take every measure to present information thoughtfully and avoid linking sensitive comments directly to identifiable individuals in a detrimental way. Benefits: While there are no direct personal benefits for participating, your insights are invaluable. Your contributions will directly help us address a critical knowledge gap by providing empirical evidence on how local health systems are coping with climate-induced stresses. This will inform practical recommendations for improving health system resilience in Bangladesh's climate hotspots, ultimately benefiting vulnerable communities and guiding future climate adaptation strategies
Data Handling and Storage	The audio recordings and anonymized transcripts will be stored securely on a password-protected computer for a period of 2 years after the study's completion. After this period, all raw data will be securely destroyed. Anonymized data may be kept for long-term archival for future research or verification purposes.

Researcher Contact Information	If you have any questions about the study or your participation, please do not hesitate to contact: Naznine Nahar, naznin140424@gmail.com or n.nahar@student.kit.nl
Statement of Consent	Your signature indicates that you are at least 18 years of age; you have read this consent form or have had it read to you; your questions have been answered to your satisfaction and you voluntarily agree that you will participate in this research study. You will receive a copy of this signed consent form. I agree to participate in a research led by Naznine Nahar. The purpose of this document is to specify the terms of my participation in the project through being interviewed. 1. I have been given sufficient information about this research. The purpose of my participation as an interviewee in this project has been explained to me and is clear. 2. My participation as an interviewee in this project is voluntary. There is no explicit or implicit coercion whatsoever to participate. 3. The interview will take approximately 60 minutes. I allow the researcher to take written notes during the interview. 4. I allow the audio/video recording of the interview. It is clear to me that in case I do not want the interview to be taped I am at any point of time fully entitled to withdraw from participation. 5. I have the right not to answer any of the questions. If I feel uncomfortable in any way during the interview, I have the right to withdraw from the interview. 6. I have been given the explicit guarantees that the researcher will not identify me by name in any reports using information obtained from this interview, and that my confidentiality as a participant in this study will remain secure. In all cases subsequent uses of records and data will be subject to standard data use policies at the EU (GDPR Data Protection Policy). 7. I understand that the KIT Research Ethics Committee did not conduct a full ethical review of this research, but a waiver of ethical clearance has been obtained for the interviews. For research-related complaints or any other question regarding the research, the KIT Research Ethics Committee may be contacted through researchethics@kit.nl.

	8. I have read and understood the points and statements of this form. I have had all my questions answered to my satisfaction, and I voluntarily agree to participate in this study.	
Signature	Name of Participant: Signature:	Name of Principal Investigator:
Date		

Annex VI: Declaration of AI Use

KIT Institute (Masters or Short course) Participants
Declaration for Use of Generative AI (GenAI)

Please complete and submit this form as an annex on the last page of your assignment file; and not as a separate document.

Check the box that applies to your completion of this assignment:

☐ I confirm that **I have not used** any generative AI tools to complete this assignment.

☒ I confirm that **I have used** generative AI tool(s) in accordance with the *"**Guidelines for the use of Generative AI for KIT Institute Master's and Short course participants".*** Below, I have listed the GenAI tools used and for what specific purpose:

Generative AI tool used	**Purpose of use**
1. Grammarly	Grammar check
2. Perplexity	To understand the explanation of the relevant topics and idea generation
...	