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CLIMATE RESILIENCE IN DISPLACEMENT: Examining UNHCR's SuLMER Intervention in Cox's Bazar, Bangladesh

Research Report

December 2025

Publication information

This research was implemented by CGIAR researchers from the Alliance of Bioversity International and CIAT and was carried out with support of the CGIAR Food Frontiers and Security, and Climate Action Science Programs. We would like to thank all funders who supported this research through their contributions to the CGIAR Trust Fund: https://www.cgiar.org/funders/

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Acknowledgments

The authors would like to thank Md. Shamsud Douza (Office of the Refugee Relief and Repatriation Commissioner), Mohammad Faysal Saleh (UNHCR), Md. Sultan Mahmud (UNHCR), George Omondi Odour (UNHCR), Jing Song (UNHCR), Juliette Murekeyisoni (UNHCR), Md. Iltemas Amin Adee (UNHCR), Jana Birner (UNHCR), Kate Pochapsky (UNHCR), Shahadat Hosen (ACTED), Salma Alam Alina, Taslima Akter, Rubel Barua, Paval Barua, Brinda Dev Mishi, Anrul Arafatul Mina, Muhammad Jamir Hossain, Md. Sohel Islam, Somaiya Siddika Shoma, Shahab Uddin, Anna Belli (The Alliance), and Victor Villa (The Alliance), for their significant contributions to this research.

Recommended citation

Vaselli, A., Khalid, S., Savelli, A., Craparo, A., Basel, A., Minoarivelo, H.O., Tsoka, J, Suza, M., Barua, N., Hoque, M.E., Sarma, S., Keogh, S., Mastrorillo, M., Pacillo, G, Läderach, P. 2025. Policy Brief on Climate Resilience in Displacement: Examining UNHCR's SuLMER Intervention in Cox's Bazar, Bangladesh. The Alliance of Bioversity and The International Center for Tropical Agriculture; Office of the United Nations High Commissioner for Refugees. 104 p.

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Executive Summary

The Alliance of Bioversity International and CIAT, through the CGIAR Science Program on Food Frontiers and Security, partnered with the UNHCR Country Office in Bangladesh and Regional Bureau for Asia and the Pacific to identify technical entry points for enhancing the resilience outcomes of the Sustainable Land Management and Environmental Rehabilitation (SuLMER) initiative in Cox's Bazar, strengthening its contributions to humanitarian, development, and peace objectives.

As of July 2025, Bangladesh hosted 1,148,529 Rohingya refugees[1] forcibly displaced from Myanmar since the 1980s due to armed violence and ethnic persecution (Government of Bangladesh & UNHCR, 2025b). Cox's Bazar, one of Bangladesh's most climate-vulnerable districts, hosts approximately 968,981 refugees in Ukhiya and Teknaf (Government of Bangladesh & UNHCR, 2025a). The Kutupalong Mega Camp (KMC) in Ukhiya is home to approximately 909,790 Rohingya refugees (UNHCR & GoB, 2025) and 44,960 households from local host communities (UNHCR's personal communication with Camp-in-Charge office staff). Rohingya refugees live in precarious, overcrowded conditions and face high exposure to climate-related hazards, including cyclones, storms, floods, and landslides, compounded by environmental degradation and waste pollution.

In response to recurring floods and general environmental degradation in KMC, in 2019, UNHCR began developing the Sustainable Land Management and Environmental Rehabilitation (SuLMER) intervention that is currently being implemented in Camps 1W and 2W in 2021 with the support of international donors. This initiative aims to mitigate environmental hazards and reduce pollution by increasing water flow, reducing solid waste, stabilising unsteady hillside slopes, decommissioning WASH facilities that were non-functional or susceptible to contamination, and introducing nature-based solutions for environmental challenges. Additionally, the program focuses on integrated site planning, restoring riparian vegetation, increasing tree density and biodiversity, and fostering social cohesion between host and refugee communities.

The objective of this research, based on data collected in October 2024, is to provide insights into how UNHCR's SuLMER intervention in Camps 1W and 2W can support humanitarian, development, and peace (HDP) outcomes by contributing to the household resilience of those affected by severe rainfall or flooding along the *Shoa Ma'r Jhiri* stream. The mixed-method research presented here is premised on the concepts of resilience, defined as the ability of households to anticipate, withstand, recover from, and transformatively adapt in the face of climate-related hazards, and human security, or holistic wellbeing comprised of economic, social, and environmental security.

[1] *The Government of Bangladesh refers to Rohingya who fled from Myanmar to Bangladesh from 2017 onward as "Forcibly Displaced Myanmar Nationals (FDMN)." In this report, we refer to "Rohingya refugees," in line with United Nations terminology.*

Sub-Types of Resilience in the Conceptual Framework*

- **Anticipation:** The ability of individuals and groups to understand and effectively prepare for hazards before they occur.
- **Withstanding:** The ability of individuals and groups to mitigate the negative impacts of hazards as they are taking place.
- **Recovery:** The ability of individuals and groups to re-establish wellbeing after the impacts of a hazard are felt.
- **Transformative adaptation:** The ability of individuals and groups to address root causes of vulnerability and catalyse social transformation through empowerment, equity, and sustainability.

*For more detail, see *Section 4.2 Conceptual Framework.*

Data collection consisted of a survey that explored human security and subjective resilience outcomes among intervention participants within the SuLMER catchment and from a control group of respondents outside the catchment (*see 4.4 Study area and sample selection and Annex 1.2 Human Security and Resilience Survey* for further details). The research team also spent several weeks in the field, observing the intervention and the area's local social-ecological systems. During this time, key informant interviews were conducted with the intervention's participants, community leaders, UNHCR personnel, their operational partners, the Office of the Refugee Relief and Repatriation Commissioner (RRRC), and local governmental organisations. Finally, a mapping of baseline (current) and projected climate hazards, along with remote mapping of physical terrain characteristics, supports an understanding of how drought, extreme heat, flood, and compound hazards will impact Camps 1W and 2W by 2040, facilitating the development of recommendations geared toward medium-long-term resilience.

The results and recommendations detailed in this report align with a larger body of research showing that climate action and resilience building are both critical and feasible in protracted refugee settings (Al-Zu'bi, 2025; FAO, 2025; Fransen et al., 2024; Jaskolski et al., 2024; Perry, 2024; USA for UNHCR, 2024). While acknowledging that structural limitations undermine the agency and wellbeing of the Rohingya in Cox's Bazar, UNHCR can meaningfully collaborate with refugees, host communities, government authorities (including RRRC), and other HDP actors to strengthen refugees' resilience to climate risks. By leveraging cross-sectoral coordination and investing in inclusive, community-driven approaches, UNHCR can support climate adaptation, household resilience, and social cohesion amongst refugee and host communities.

Key results[2] from the research are summarised below, with a focus on intervention strengths and opportunities going forward:

Summary for HDP Practitioners

Intervention Strengths	Opportunities Going Forward
• By rehabilitating the Shoa Ma'r Jhiri waterway, SuLMER had a positive effect on flood-vulnerable households' subjective resilience, i.e., their abilities to anticipate, withstand, recover from, and transformatively adapt to future instances of severe rainfall or flooding	• With compound climate hazards in the SuLMER catchment projected to reach extreme levels by 2040, urgent, integrated, and coordinated HDP action is essential to effectively address intertwined environmental and socio-economic risks
• Women and men reported similar gains in resilience, though women reported a 10% greater increase in their capacity to withstand hazards as they are occurring than men	• Integrate block-level SuLMER volunteer roles for refugee and host community members to enhance participatory governance, community ownership of landscape management activities, and social cohesion
• SuLMER had a positive effect on households' environmental security by reducing public health risks related to waterborne and zoonotic disease, enhancing mobility within the camps, and strengthening people's affinity with the landscape	• Expand community-led waterway restoration to include additional activities (riparian vegetation, slope protection and terrace gardening in uphill areas), new geographies (upstream and tertiary canals), and support systemic waste management improvements
• SuLMER's Cash for Work opportunities provided valuable earning opportunities for households that were able to partake	• Develop a participatory landscape management plan, involving host and refugee communities and supported by capacity-building initiatives, to empower households to actively participate in the design and implementation of future DRR efforts in the catchment

[2] *Results are based on a non-experimental mixed-methods assessment that estimates the effect of SuLMER on participants' self-reported (subjective) resilience levels. The results should not be interpreted as definitive causal impacts.*

Intervention Strengths	Opportunities Going Forward
• SuLMER's kitchen gardens increased food security for households that received them, enabling them to engage in subsistence and limited market-oriented production. This increased their access to nutritious food, helped them save money, and connected them to cultural practices from Rakhine	• Scale Cash for Work opportunities for rehabilitation and development activities by improving how opportunities are distributed, expanding their geographic focus, implementing capacity development activities
• Overall, SuLMER strengthened environmental awareness and households' engagement with the landscape through improved ecosystem services	• Expand kitchen gardens and implement homestead gardening techniques to improve household food security
	• Strengthen community-led dispute resolution mechanisms to mitigate conflict over sand extraction, youth recruitment by organised groups, and systemic inequalities within the camps
	• Leverage strategic research and implementation partnerships to grow the evidence-base for larger-scale landscape management and ecosystems restoration interventions throughout KMC, Ukhiya, and Cox's Bazar

Section 1: Introduction

This report is based on fieldwork conducted in October 2024 in collaboration with UNHCR's Bangladesh field office within the Kutupalong Mega camp (KMC) of Ukhiya Upazila, Cox's Bazar. This research was performed by the CGIAR Science Program on Food Frontiers and Security, which generates research on three food systems of growing importance: fragile and conflict-affected food systems (FCAS), urban and peri-urban food systems, and island food systems (CGIAR, 2025). These systems are highly vulnerable to shocks and crises, marked by food and water insecurity, contain large youth populations, and face recurrent environmental threats and ecological degradation. There tends to be weak governance across these social-ecological systems, and innovative solutions and investments must be catalysed to support residents, who are among the world's most vulnerable. General literature on the interconnectedness of climate, conflict, and mobility outcomes highlights how compounding risks can lead to diverse forms of insecurity (Savelli, Schapendonk, et al., 2023). However, by examining how these risks are filtered through locally specific social, political, economic, and environmental factors, opportunities emerge for communities and HDP actors to bolster wellbeing, development, and peace in FCAS.

As of July 2025, Bangladesh hosted 1,148,529 Rohingya refugees[3] forcibly displaced from Myanmar since the 1980s due to armed violence and ethnic persecution (Government of Bangladesh & UNHCR, 2025b). Most arrived after 2017, following intense violence in Rakhine State. Cox's Bazar shelters approximately 968,981 refugees in overcrowded conditions across 33 camps in Ukhiya and Teknaf Upazilas (Government of Bangladesh & UNHCR, 2025a). The Rohingya who arrived since 2017 are not recognised as refugees by the Government of Bangladesh (GoB), which is not party to the 1951 Refugee Convention and its 1967 Protocol or the 1961 Convention on the Reduction of Statelessness. The GoB's official policy, both before and after the July Revolution of 2024, is that the Rohingya being sheltered in Bangladesh should repatriate to Myanmar as soon as it is safe to do so (Inter Sector Coordination Group, 2025a). However, due to the ongoing conflict in Myanmar, Bangladesh temporarily hosts forcibly displaced Rohingya with support from humanitarian stakeholders under the Strategic Executive Group (SEG). UNHCR currently manages 16 camps in Cox's Bazar and the refugee response on Bhasan Char, providing essential services to over one million Rohingya refugees (UNHCR Bangladesh, 2024).

To address urgent refugee needs and support host communities, the 2025-26 Joint Response Plan (JRP) seeks USD 934.5 million for 2025 (Inter Sector Coordination Group, 2025a).

[3] *The Government of Bangladesh refers to Rohingya who fled from Myanmar to Bangladesh from 2017 onward as "Forcibly Displaced Myanmar Nationals (FDMN)." In this report, we refer to them as "Rohingya refugees" in line with United Nations terminology.*

However, as of September 2025, only 37.8% of the 2025 annual funding target has been achieved, continuing a multi-year trend (OCHA Services, n.d.); just 56% of the target was achieved in 2024, 47% in 2023, and 69% on average between 2017-2022 (Inter Sector Coordination Group, 2022, 2023a, 2024a). The 2025 shortfall is likely to be compounded by the current humanitarian financial crisis, with general funding from traditional, large donors expected to remove between 34% and 45% of funding from the overall humanitarian finance ecosystem, as compared to 2023 (ALNAP, 2025). In March 2025, UNHCR's Public Health Chief warned that in the current funding landscape, thousands of refugees in Bangladesh are poised to lose essential health services, including 40,000 pregnant women, 19,000 acutely malnourished children, and 10,000 persons with life-threatening conditions (UNHCR, 2025c). Additionally, aid cuts are severely affecting food distribution and educational programmes in the camps, with UNICEF having already cut thousands of learning centres as of June 2025, and WFP warning that food assistance may need to cease by end of year (Human Rights Watch, 2025).

Bangladesh is highly vulnerable to climate change impacts, with large populations facing low adaptive capacity but high exposure to both slow- and sudden-onset hazards, including droughts, sea level rise, riverbank erosion, extreme heat, cyclones, storm surges, and floods (Ministry of Environment, Forest & Climate Change, 2023). In 2023, Cyclone Mocha triggered 1.3 million displacements, followed by Cyclone Remal in 2024, which displaced 1.5 million people, destroyed approximately 237,673 houses, and severely impacted 4.8 million agriculture-dependent people (FAO, 2024; IDMC, 2024b; United Nations Bangladesh, 2024). In the Kutupalong Mega Camp (KMC) in Cox's Bazar, where refugees and host communities live in overcrowded and precarious conditions, households face high exposure to climate-related hazards, including cyclones, storms, floods, and landslides.

In response to recurrent floods and increasing environmental degradation in KMC, UNHCR launched the Sustainable Land Management and Environmental Rehabilitation (SuLMER) initiative in 2019. The project aims to reduce disaster risk and pollution by improving water flow in the *Shoa Ma'r Jhiri* watershed by managing solid waste and introducing nature-based solutions. SuLMER was developed with the financial and technical support of international donors, including the Swiss Agency for Development and Cooperation (SDC) and the United Kingdom's Foreign, Commonwealth and Development Office (FCDO).

The SuLMER intervention in Cox's Bazar illustrates UNHCR's efforts to integrate humanitarian programming with sustainable solutions to displacement that are climate-informed, peace-positive, and ecosystem-based. To support this shift, UNHCR Bangladesh invited a research team from the CGIAR Science Program on Food Frontiers and Security to conduct mixed-methods research on how SuLMER, through its contribution to the resilience of displaced communities in Cox's Bazar, also supports humanitarian, development, and peace outcomes, and how it can do so more effectively. This report presents the CGIAR team's research methodology, key findings, and evidence-based recommendations for strengthening similar interventions.

After outlining the social, economic, political, and climatic context *(Section 2: Cox's Bazar, Bangladesh: Local context)*, the report provides an overview of UNHCR's programming *(Section 3: UNHCR in Bangladesh and Cox's Bazar) and summarises the research methodology (Section 4: Research Methodology).* The findings *(Section 5: Results)* are followed by targeted recommendations *(Section 6: Recommendations*) developed to support the SuLMER intervention achieve HDP outcomes. Lastly, opportunities for research impact are presented, accompanied by a summary table for HDP actors that highlights the intervention's strengths and potential areas for enhancing its efficacy going forward *(Section 7: Conclusions).*

Section 2: Cox's Bazar, Bangladesh: Local context

2.1. Social, Economic, and Political Context

Bangladesh is one of Asia's most populous countries, with 172 million residents, including 59.5% living in urban areas (World Bank Group, n.d.). Most workers[4] are employed in the agricultural sector (43.9%), followed by services (37.0%), and 19.1% in industry (Bangladesh Bureau of Statistics, 2024b). Remittances also play a key role, totalling $22.2 billion in 2022 (World Bank Group, n.d.).

Despite modest long-term gains in life expectancy, poverty reduction, and other key socio-economic indicators (Bangladesh Bureau of Statistics, 2024b; Ministry of Finance, 2022), widespread, extreme poverty remains a major challenge for sustainable development in Bangladesh. Bangladesh's GDP grew by an average of 6.35% annually between 2009 and 2022, mainly supported by the expansion of the ready-made garment sector through low-cost labour (Ministry of Finance, 2022). However, the benefits of growth were not evenly distributed, as evidenced by unchanging income inequality between 2006 and 2022 (World Bank, 2022). According to the 2019 Multidimensional Poverty Index (MPI), 24.6% of Bangladesh's population was classified as multidimensionally poor, with an additional 18.2% vulnerable to multidimensional poverty (UNDP, 2024). During the same period, the unemployment rate rose from 3.6% to 4.6% of the total labour force (ILO, 2025). Furthermore, food security has remained nearly unchanged over the past decade, with approximately 31% of the population experiencing moderate or severe food insecurity. Food insecurity peaked at 32.2% between 2014 and 2016 and reached its lowest point at 30.5% between 2021 and 2023 (FAOSTAT, n.d.).

Since gaining independence in 1971, Bangladesh has experienced alternating periods of democratic governance and military rule characterised by rivalry between its two major political parties, the Awami League (AL) and the Bangladesh Nationalist Party (BNP). Bangladesh's first democratic elections in 1991 marked the onset of a sustained democratic process, with the government largely controlled by the Awami League from the early 2008 to 2024. While this period was characterised by economic growth, concerns over human rights abuses and electoral fairness also grew. Following widespread student-led protests in June 2024, former Prime Minister Sheikh Hasina resigned and fled the country amidst growing unrest, leading to the formation of an interim government led by Muhammad Yunus, with national elections expected to take place in 2026.

Located on Bangladesh's southeastern coast, Cox's Bazar is home to one of the world's longest sandy beaches and is a major domestic tourist destination.

[4] *Employed population above 10 years of age.*

It is a coastal and hilly district in the Chattogram division, bordering Myanmar to the south and east, Mizoram district to the north, and the Bay of Bengal to the west. As of 2022, Cox's Bazar had a population of approximately 2.8 million people, with urban population[5] growing quickly at 8.0% annually, while rural areas shrink at -1.0% per annum (Bangladesh Bureau of Statistics, 2024a). The majority of residents are Muslim (94.6%), followed by Hindus (3.8%), Buddhists (1.5%), Christians (0.1%), and other religious groups (0.03%) (Bangladesh Bureau of Statistics, 2024a). The poverty rate in Cox's Bazar's is higher than many other districts, with 40% of people facing multi-dimensional poverty (General Economic Division, 2025). Just 37.3% of residents are employed[6], while 28.9% engage in household work, and 32.4% are unemployed (Bangladesh Bureau of Statistics, 2024a). Most work in the service sector (49.8%), followed by agriculture (38.8%), and industry (11.3%) (Bangladesh Bureau of Statistics, 2024a). Among agricultural households, 70% are landless or own marginal land (<1.5 acres), 28.4% have small to medium landholdings (between 1.50 and 7.49 acres), and just 1.57% own large farms larger than 7.5 acres (FAO, 2020). The main crop is rice, which is rainfed in the summer and irrigated in winter (FAO, 2020). Due to its coastal geography, 18% of residents work in the fishery sector, which is a growing industry despite declining catches and resource depletion (FAO, 2020). Other industries include salt production, with fields covering 63,532 acres and involving 43,500 salt farmers, and mineral extraction (*Cox's Bazar District,* n.d.).

As of December 2024, Bangladesh hosted a total of approximately 1,005,520 Rohingya refugees, with approximately 968,981 residing in 33 camps across the Ukhiya and Teknaf Upazilas in Cox's Bazar, and an additional 36,539 on Bhasan Char Island (Government of Bangladesh & UNHCR, 2025a). The Rohingya refugee crisis stems from decades of systematic persecution in Myanmar's Rakhine State, which led to multiple waves of cross-border forced migration in 1978, 1992, 2012, 2016, and (the largest in) 2017 (Inter Sector Coordination Group, 2025a). The majority of Rohingya refugees currently in Bangladesh, 978,647 individuals, arrived from 2017 onwards in response to spiralling violence in Rakhine State (Government of Bangladesh & UNHCR, 2025). Approximately 36,873 arrived in the 1990s (Government of Bangladesh & UNHCR, 2025). Of these, only those among the 250,000 who arrived in 1991-1992 have been formally registered by the GoB as refugees (UNHCR, 2007), while the Government of Bangladesh refers to the majority of Rohingya refugees, who fled Myanmar in 2017, as "Forcibly Displaced Myanmar Nationals (FDMN)." In practice, these groups have the same access to services and face similar limitations in Bangladesh, including restrictions on movement, employment, and education.

[5] *This data is from the Bangladesh Bureau of Statistics' 2022 Population and Housing Census (Bangladesh Bureau of Statistics, 2024a) and excludes populations from the refugee camps in Ukhiya and Teknaf.*

[6] *Employed population above 10 years old.*

Violent conflict and human rights violations are widespread in Myanmar, including in Rakhine State, frequently triggering new instances of displacement internally and across borders (ACLED, 2024b; Mon, 2024). Although the exact number of fatalities is unknown, as of 2024, it is estimated that approximately 90% of Myanmar's population has been exposed to violence since 2021 (ACLED, 2024a, 2025a). Estimates suggest that the conflict has triggered 4 million internal displacements[7] between 2021-2024, with 3.5 million IDPs as of August 2024 (IDMC, 2024b).

The 2017 refugee influx to Cox's Bazar and the resulting international response have transformed the district's ecological and political landscape. To construct shelters and support facilities for such a large number of refugees, large swaths of forest were felled, hills were cut, and farmland was converted into building sites. This rapid land-use change harmed local ecosystems and decreased agricultural productivity for host communities (Quader et al., 2021). Refugees in camps live in overcrowded and precarious conditions, without access to legal employment opportunities, depend on humanitarian assistance, and are highly exposed to climate hazards like cyclones, storms, floods, and landslides (Inter Sector Coordination Group, 2024d).

Protection, shelter, and service delivery are coordinated by the GoB and the Strategic Executive Group (SEG) of humanitarian actors through an annual Joint Response Plan (JRP). The 2025-2026 JRP is oriented toward five strategic objectives: 1) Work towards the early, voluntary, and sustainable repatriation of Rohingya refugees/FDMNs to Myanmar; 2) Strengthen the protection and resilience of Rohingya refugee/FDMN women, men, girls, and boys; 3) Deliver life-saving assistance to populations in need; 4) Foster the well-being of host communities; and 5) Strengthen disaster risk management and combat the effects of climate change (Inter Sector Coordination Group, 2025a).

However, continued funding shortfalls are severely restricting aid delivery in the Cox's Bazar camps, exacerbating households' vulnerability to climate-related hazards and other protection risks. Since its inception in 2017, the Joint Response Plan (JRP) has consistently fallen short of its funding targets. As of May 2025, only 15% of the 2025-2026 JRP target has been funded, continuing a multi-year trend of financing shortfalls (Inter Sector Coordination Group, 2022, 2023a, 2024a, 2025b). These funding gaps have severely hampered the provision of basic services in the camps, resulting in reduced food rations and consequent spikes in malnutrition, diminished hygiene supplies, weakened emergency responses, and cuts to education and livelihoods programs (Inter Sector Coordination Group, 2025a).

[7] *According to the terminology of the Internal Displacement Monitoring Centre (IDMC), "internal displacement" refers to "each new forced movement of person within the border of their country recorded during the year." For more details, see IDMC, 2024.*

Funding cuts compound protection risks in the camps by limiting access to vital services and responses to escalating crime, conflict, and recruitment by organised groups (Inter Sector Coordination Group, 2025a). Against this backdrop, in 2024 security risks increased by 48% compared to 2023, largely driven by organised groups' activity, with refugees reportedly forcibly recruited to fight in Myanmar (UNHCR, 2025a). Militant activity by the Arakan Rohingya Salvation Army (ARSA) and the Rohingya Solidarity Organisation (RSO) has intensified in the camps, including targeted killings and violent clashes (ACLED, 2025b). Despite the recent arrest of ARSA's leader, militants are expected to continue violent actions, including murders, kidnappings for ransom, targeted intimidation, and gender-based violence (ACLED, 2025b). As conflict intensifies throughout Myanmar and in Rakhine State specifically (ACLED, 2025b), there is a growing risk that violence will increasingly spill over into Bangladesh, particularly as ARSA and RSO compete for influence within the camps. This ongoing violence perpetuates cycles of vulnerability and insecurity, undermines social cohesion, and lowers the barriers for youth to join organised groups or engage in criminal activities.

2.2. Climatic Context

Bangladesh is a low-lying country with a sub-tropical climate, experiencing yearly average temperatures between 15°C and 34°C (Ministry of Environment, Forest & Climate Change, 2023). Mean annual precipitation reaches 2,400 mm, with 70% of rainfall occurring during the monsoon season (June-September) (Ministry of Environment, Forest & Climate Change, 2023). Its geography, mainly characterised by floodplains and coastal areas, renders large areas highly vulnerable to tropical cyclones, floods, and tidal surges (Ministry of Environment, Forest & Climate Change, 2023). Cyclones and monsoon floods often lead to significant internal displacement. In May and June 2025, torrential rain severely impacted the country, with eastern districts, including Cox's Bazar, worst affected (Bangladesh Red Crescent Society & IFRC, 2025; OCHA, 2025). At least five casualties[8] and thousands of displacements were reported, along with significant damage to homes and agricultural infrastructure (Bangladesh Red Crescent Society & IFRC, 2025). In 2024, Cyclone Remal displaced 1.5 million people, destroyed approximately 238,000 homes, and negatively impacted 4.8 million people dependent on agriculture through severe damage to crops, livestock, and fisheries (FAO, 2024; United Nations Bangladesh, 2024). Just one year earlier, Cyclone Mocha triggered 1.3 million displacements in the Chattogram division, mostly because of preventive evacuation plans. The cyclone made landfall in Cox's Bazar, where it destroyed more than 3000 homes and left at least 13,000 people in internal displacement as of the end of the year (IDMC, 2024a).

[8] *Data refer to those available as of June 1st, 2025 (Red Crescent Society & IFRC, 2025)*

Due to geography, climate, and socio-economic challenges, including high population density, agricultural dependence, poverty, and inadequate infrastructure, Bangladesh is highly vulnerable to climate change (Jihan et al., 2025; Ministry of Environment, Forest & Climate Change, 2023). Under the RCP8.5 scenario, average minimum and maximum temperatures in the country are expected to increase by 1.85°C and 1.75°C, respectively by 2060, and by 4.07°C and 3.85°C by 2100 (Islam et al., 2023). Precipitation is expected to intensify, with rainfall increasing by up to 33.2% during the monsoon season by 2100 (Islam et al., 2022). These changes undermine agricultural productivity and livelihoods, exacerbate poverty, increase health risks, and worsen food and nutrition insecurity, especially among marginalised groups such as youth and women (Ahmed & Khan, 2022; IPCC, 2023; Ministry of Environment, Forest & Climate Change, 2023). Lower crop yields due to weather variability and hazards like floods, saltwater intrusion, degrading freshwater in coastal areas, and increased groundwater stress during droughts are expected to strain agriculture-dependent communities (Ministry of Environment, Forest & Climate Change, 2023; Moon, 2023). Loss of livelihoods and hazard exposure are anticipated to drive malnutrition, displacement, and involuntary migration (Ministry of Environment, Forest & Climate Change, 2023). Additionally, more frequent flooding linked to intensified rainfall may increase health risks for hazard-exposed communities through the spread of waterborne and vector-borne diseases such as diarrhoea, dengue and malaria (Ministry of Environment, Forest & Climate Change, 2023; Moon, 2023).

According to the 2022 INFORM Risk Index, Cox's Bazar is Bangladesh's second most risk-prone district due to its high exposure to climate hazards and limited coping capacity due to lack of resources and capacity across key sectors, including local governance, DRR, physical infrastructure, and access to WASH, healthcare, and communication networks (Bangladesh Ministry of Disaster Management and Relief, 2022). The district is particularly exposed to storms and cyclones, and the landscape's natural defences have been degraded by widespread deforestation and hill-cutting (Roy et al., 2024). Additionally, the refugee influx after 2017 has significantly affected local forest ecosystems, contributing to significant environmental degradation that negatively impacts the district's drainage capacity (see Section 3.2: *UNHCR's Sustainable Land Management and Environmental Rehabilitation (SuLMER) Initiative in Camps 1W and 2W)*. Refugees in Cox's Bazar, who live in overcrowded shelters with inadequate infrastructure, are highly vulnerable to extreme weather events that frequently cause floods, landslides, and waterlogging. In 2023, Cyclone Mocha affected all 33 refugee camps in Cox's Bazar, triggering the temporary relocation of around 30,000 refugees, destroying 40,000 shelters, and damaging camp facilities and infrastructure (IDMC, 2024a; Inter Sector Coordination Group & United Nations Bangladesh, 2023).

In 2024, just one month after Cyclone Remal struck Bangladesh, monsoon rains triggered flash floods and landslides in Cox's Bazar, causing 10 fatalities, affecting at least 7,794 refugees, and damaging 1,191 shelters (Inter Sector Coordination Group, 2024e). In September 2024, heavy rains caused again severe flooding in the camps with 379 landslides reported, resulting in three deaths, 7,404 temporary displacements, damage to 1,177 shelters, and the relocation of 1,504 refugee households (Inter Sector Coordination Group, 2024b). WASH infrastructure was also affected, with 301 latrines, 58 bathing cubicles, seven water networks, and five faecal sludge facilities damaged or flooded (Inter Sector Coordination Group, 2024b). In May and June 2025, heavy rains reportedly impacted approximately 65,000 people across the 33 camps in Cox's Bazar, triggering floods and extensive damage (IOM, 2025; UNHCR, 2025d).

While Bangladesh has developed several policies to support climate adaptation and disaster risk reduction nationwide, financial and institutional challenges hinder effective coordination and implementation (Raihan & Raihan, 2025; UNDP Bangladesh, 2025). The National Adaptation Plan 2023-2050 provides an overarching policy framework for cross-sectoral climate adaptation (Ministry of Environment, Forest & Climate Change, 2022). It is oriented toward six goals, including strategies formulated along disasters, agriculture, nutrition and livelihood security, cities, nature-based solutions, governance, and transformative capacity through innovation (Ministry of Environment, Forest & Climate Change, 2022). In addition, other relevant policies and programs include the National Plan for Disaster Management 2021-2025 (Government of the People's Republic of Bangladesh, 2020), the Bangladesh Delta Plan 2100 (General Economics Division, 2018), and the Mujib Climate Prosperity Plan 2021-2041 (Ministry of Environment, Forest and Climate Change, 2022). However, it is estimated that to pursue effective climate adaptation, Bangladesh requires at least $12.5 billion annually, or nearly 3% of GDP, but as of 2025, investments are falling short (UNDP Bangladesh, 2025).

Section 3: UNHCR in Bangladesh and Cox's Bazar

UNHCR has been operating in Bangladesh since 1992 and currently manages 16 camps in Cox's Bazar and the refugee situation in Bhasan Char. In partnership with the GoB and other international partners, UNHCR provides protection and other essential services for more than one million Rohingya refugees (UNHCR Bangladesh, 2024). The priorities outlined in UNHCR Bangladesh's 2023-2025 strategy include:

1. Promoting an environment that respects basic rights and ensures refugees' access to protection services and education;

2. Safeguarding refugees' well-being by maintaining adequate and safe living conditions and access to essential services in a climate-smart environment;

3. Advancing a comprehensive solutions package, including preparations for eventual voluntary repatriation and third-country solutions, supported by skills development, livelihoods and capacity-building activities;

4. Engaging diverse partnerships, particularly with development and private sector actors, to create innovative approaches and galvanise support for the refugee response with an emphasis on greater localisation;

5. Leading the narrative on the Rohingya refugee response, improving public attitudes towards Rohingya refugees, and promoting peaceful coexistence between Rohingya refugees and host communities" (UNHCR, 2025b).

3.1. Camp 1W and Camp 2W in Ukhiya, Cox's Bazar

Camps 1W and 2W are part of the Kutupalong Mega Camp (KMC) in Cox's Bazar's Ukhiya Upazila. KMC comprises a cluster of 23 individual camps that are home to 909,790 Rohingya refugees (187,690 households) who arrived after 2017 and approximately 44,960 households from the host community (UNHCR Bangladesh Country Office, personal communication).

Camp 1W was established in 2017 and is managed by UNHCR in collaboration with ACTED as a supporting agency. The camp covers 534,951 m^2 and hosts approximately 39,656 refugees, with an average household size of five members (Inter Sector Coordination Group, 2023b). Youth (under 18 years of age) account for 45% of the camp's population, 43% are aged 18-59, and 6% are above 60 years of age (Inter Sector Coordination Group, 2023b).

The 2023 Joint Multi-Sector Needs Assessment (J-MSNA), a comprehensive survey collecting households' perceptions, identified a high number of households experiencing living standard gaps across multiple sectors, including shelter and non-food items (76% of households), livelihoods (64%), education (62%), WASH (58%), and protection (54%). Respondents also reported shortages in the health sector (30% of households) and food security (9%) (Inter Sector Coordination Group, 2023b). Access to food, shelter materials, shelter upgrades, electricity, solar lamps, and batteries are among the highest-ranked household priorities. As of 2023, 70% of camp residents reported having to borrow money in order to satisfy their basic needs, while 66% borrowed food or purchased it on credit (Inter Sector Coordination Group, 2023b). The rate of regular school attendance for children over 11 years is only 34% for boys and % for girls; 51% of households have at least one school-age child who does not regularly attend educational facilities (Inter Sector Coordination Group, 2023b). Protection risks in the camp are significant, with the most reported concerns including general crime and violence (45% of households), recruitment by criminal groups (20%), and restrictions on movement (17%) (Inter Sector Coordination Group, 2023b). The shelters are particularly exposed to weather events, with 42% of households experiencing leaks during rain (Inter Sector Coordination Group, 2023b).

Camp 2W was also established in 2017 and is managed by UNHCR in collaboration with BRAC. It is home to 24,976 refugees spread across 392,273 m^2 of land area. Similar to Camp 1W, the average household has five members and 56% of the camp's population is under 18 years old (Inter Sector Coordination Group, 2023b). According to the J-MSNA, common living standard gaps at household-level relate to WASH (73% of households), shelter and non-food items (81%), education (65%), livelihoods (60%), protection (52%), health (24%), and food security (14%) (Inter Sector Coordination Group, 2023). Despite this, improved access to food is the highest priority for 74% of households, with 80% relying on borrowing or purchasing food on credit. School attendance rates are higher than in Camp 1W, with 62% of boys and 52% of girls aged 5 to 18 attending school regularly (Inter Sector Coordination Group, 2023b). However, 43% of households have at least one child in this age group who does not attend school regularly (Inter Sector Coordination Group, 2023b). The most commonly reported protection risks include crime and violence (47% of households), recruitment by criminal groups (29%), and issues related to environmental degradation (12% of households) (Inter Sector Coordination Group, 2023b). Additionally, similar to Camp 1W, 44% of households report rainwater leakages as one of the most common types of shelter damage (Inter Sector Coordination Group, 2023b).

In this context of high climate vulnerability, restrictions on refugees' freedom of movement, livelihood opportunities, and infrastructure development pose significant challenges to disaster risk reduction and overall climate resilience in Cox's Bazar (Inter Sector Coordination Group, 2025a; UNHCR, 2025a). To address these challenges, UNHCR and the ISCG coordinating with the GoB to coordinate emergency preparedness and response (EPR), aiming to minimize losses and damage for refugee and host communities (Inter Sector Coordination Group, 2025a). This includes environmental and risk management systems such as the Flood Forecasting & Alert System (with alerts issued at 72-hour, 48-hour, and 24-hour intervals), a Landslide Monitoring and Alert System (with alerts issued five days in advance), and Standard Operating Procedures (SOP) on cyclone emergency and preparedness response developed by a multifunctional team of camp stakeholders (Rohingya Refugee Response Bangladesh, n.d.; RRRC & Inter Sector Coordination Group, 2025)

3.2. UNHCR's Sustainable Land Management and Environmental Rehabilitation (SuLMER) Initiative in Camps 1W and 2W

In 2021, UNHCR began implementation of the Sustainable Land Management and Environmental Rehabilitation (SuLMER) initiative to restore the *Shoa Ma'r Jhiri* watershed, which runs through parts of Camps 1W and Camp 2W. The *Shoa Ma'r Jhiri* watershed (hereafter referred to as SuLMER catchment, denoting the intervention's target area) includes Camp 1W's Block E, Block F, and Block G, which together shelter approximately 15,796 people, and Camp 2W's Block D, home to approximately 6,141 residents. While a majority of the catchment's population consists of Rohingya refugees, 106 host households live in Camp 1W, while no hosts reside in Camp 2W.

Following the massive forced displacement of Rohingya families from Myanmar in 2017, refugees settled in Cox's Bazar adjacent to existing refugee settlements formed during earlier displacement waves, with UNHCR facilitating the process. Since then, the *Shoa Ma'r Jhiri* watershed, located in the area now hosting Camps 1W and 2W, has undergone substantial ecological degradation. Satellite pictures (see *Figures 1, 2, 3, and 4,* below) show significant land-use change, including loss of vegetation (trees, plants, and shrubs) and an increase of barren lands due to deforestation and clearing activities to accommodate settlement needs (Bappa et al., 2022; Sakamoto et al., 2021). Additionally, some host households converted forest areas to agricultural land (see *Figures 3 and 4,* below). Although a reduction in forest cover was already evident between 2009 and 2012 (see *Figures 1 and 2,* below), land use changed dramatically between 2017 and 2019 (see *Figure 3,* below).

These changes have negatively affected the watershed's drainage capacity, exposing households in Camps 1W and 2W to floods and landslides risks (Ministry of Environment and Forests et al., 2018). Additionally, overcrowding and inadequate solid waste management systems have caused environmental pollution that further limits water flow and poses serious health risks to residents of Camps 1W and 2W (Ministry of Environment and Forests et al., 2018). In response to these challenges, the SuLMER intervention aims to improve the livelihoods, health, and wellbeing of refugees and host communities living in the environmentally degraded and polluted *Shoa Ma'r Jhiri* watershed. Additionally, by addressing environmental degradation and related risks, improving overall living conditions in the catchment area, and generating environmental benefits for both host and refugee communities within the camp, SuLMER aims to foster better relationships between host and refugee populations. The intervention has three specific objectives:

1. Reducing disaster risk and pollution by improving water flow, managing solid waste, and implementing nature-based solutions;

2. Creating riparian vegetation by increasing tree density and biodiversity in the watershed;

3. Improving social cohesion between host and refugee communities.

Key components of the SuLMER initiative included community engagement to encourage environmentally responsible behaviours; the relocation of approximately 39 households, several WASH facilities, and three learning centres to create space for stream rehabilitation; increased solid waste collection activities to remove garbage from the waterway; improved slope protection using geotextiles and bamboo to reinforce the stream's banks; the construction of walkways along the stream; the planting of riparian vegetation and kitchen gardens along the stream's banks; and the installation of solar street lights. *Figure 4,* below, shows satellite imagery of the SuLMER catchment in 2025, after the implementation of these measures along the *Shoa Ma'r Jhiri* stream and some of its smaller tributaries.

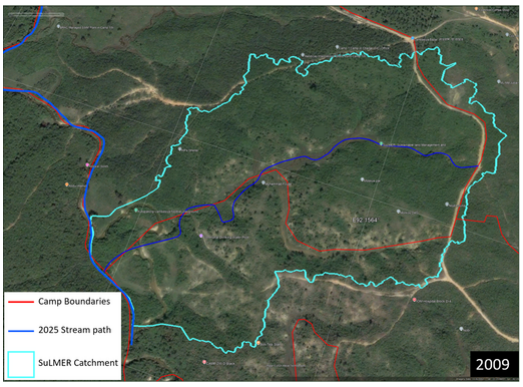

Figure 1. Aerial imagery of the SuLMER catchment area in 2009, before the construction of Camps 1W and 2W (Google Earth and GIS layers provided by UNHCR).

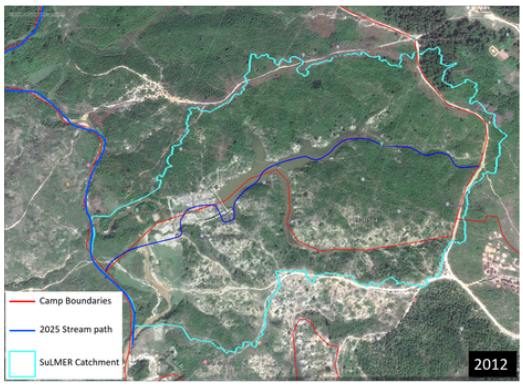

Figure 2. Aerial imagery of the SuLMER catchment area in 2012, before the construction of Camps 1W and 2W. Compared to 2009, small-scale deforestation and construction of homes is evident (Google Earth and GIS layers provided by UNHCR).

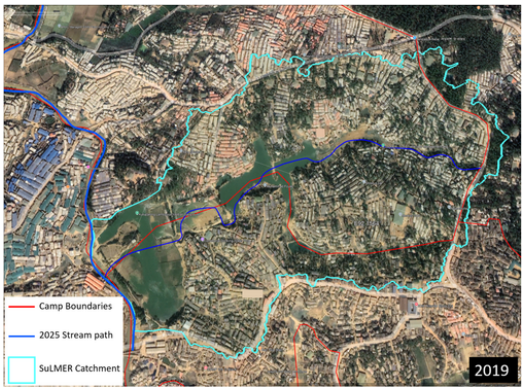

Figure 3. Aerial imagery of the SuLMER catchment in 2019, after the construction of Camps 1W and 2W. Large-scale deforestation and land-use change are evident. (Google Earth and GIS layers provided by UNHCR).

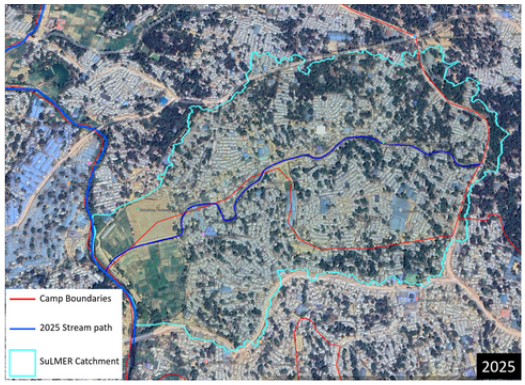

Figure 4. Aerial imagery of the SuLMER catchment in 2025, after the rehabilitation of the *Shoa Ma'r Jhiri* stream and some of its smaller tributaries. (Google Earth and GIS layers provided by UNHCR).

UNHCR began developing SuLMER in 2019, and a problem assessment was conducted in 2021 with technical support from the Swiss Development Agency (SDC) and in alignment with the water resource management plan for Kutupalong Mega Camp. In January 2021, UNHCR and the Center for Natural Resource Studies (CNRS) conducted a series of focus group discussions (FGDs) and key informant interviews (KIIs) with host and refugee households along *Shoa Ma'r Jhiri* stream and three of its tributaries. These were used to understand environmental conditions in the camp (e.g., changes in the stream, forest, wildlife, and waste management), general living conditions (e.g., issues related to WASH, energy, mobility, and livelihoods), and existing environmental and risk management systems.

In the same year, a Cash for Work scheme was rolled out in which refugees were paid to support the re-excavation of three tributaries (80 meters, 150 meters, and 380 meters in length, respectively) that flow into the *Shoa Ma'r Jhiri.* The project also included establishing a narrow walkway and bank protection.

Cash for Work differs from regular employment in that it is a programmatic approach to provide cash incentives to "beneficiaries" who have been identified through selection criteria that are often based on vulnerability. Cash for Work participants are guaranteed a predetermined number of workdays, in this case 14 days, and paid a flat daily rate of 350 BDT, which is based on 75% of the Minimum Expenditure Basket[9] (Office of the Refugee Relief and Repatriation Commissioner Cox's Bazar & Inter Sector Coordination Group, 2018). As a follow-up, UNHCR carried out a series of community engagement and advocacy activities to spread awareness of the upcoming rehabilitation. These included additional FGDs and KIIs with camp households, youth- and teen-targeted knowledge and engagement campaigns, workshops with key stakeholders, and the launch of the "Youth Stewardship Programme" to integrate environmental education into the camps' school curricula. The majority of SuLMER's waterway rehabilitation activities were implemented during 2022 and 2023.

By the end of 2022, UNHCR and CNRS re-excavated and rehabilitated 570 meters of degraded stream, while by 2023, UNHCR rehabilitated an additional 250 meters. Rehabilitation activities included relocating infrastructure, such as shelters and latrines, and removing waste, dredging and excavating the streambed. The streambed was then protected with geotextile, and the banks were stabilised with bamboo and the plantation of riparian vegetation, while 13 grid chambers were installed to trap floating solid waste. New walkways and bridges were constructed to enhance accessibility, while fencing and protective nets were installed along the stream to ensure safety and prevent waste disposal into the stream. Additionally, billboards promoting environmental awareness were installed, and solid waste management activities, including waste collection, segregation, and transfer, were conducted with support from FCDO.

As of July 2025, two female and 15 male Cash for Work volunteers are engaged in the daily collection and disposal of solid waste accumulating in the stream. The selection process of Cash for Work volunteers is conducted in three phases: it begins with community mobilisation and registration through outreach, data collection, and eligibility verification; then proceeds with screening, vulnerability scoring, quota adjustments, and MEAL (monitoring, eligibility, accountability, learning) verification; finally, selected workers are notified, trained, and onboarded to work teams with clear communication and tracking systems. Male volunteers are normally engaged in the collection of waste from the stream, while women dry and sort waste for disposal. Additionally, 26 volunteers are still[10] involved in the upkeep and maintenance of SuLMER infrastructure, including reinforcing the streambank's protection where needed, removing silt that accumulates in the streambed, reinstalling the geotextile that safeguards the streambed where damaged, constructing pathways and footbridges, and engaging in trash collection and processing.

[9] *The Minimum Expenditure Basket in Bangladesh is calculated according to the cost of a food basket of 2100 kcal and is based on average current food- and non-food expenditures for a households of five people (WFP & Bangladesh Food Security Sector, 2019).*
[10] *As of July 2025.*

Figure 5. An excavated and stabilised area of the *Shoa Ma'r Jhiri's* upstream section.

Figure 6. An excavated and stabilised area of the Shoa Ma'r Jhiri's midstream section.

Figure 7. An excavated and stabilised area of the Shoa Ma'r Jhiri's downstream section.

At the time of the research, in October 2024, activities were ongoing downstream, including drainage work near a playground and pond management to secure water for firefighting. Since October 2024, UNHCR also planned a series of integrated water management activities to ensure sufficient water flow, promote efficient agricultural water use, and enhance overall water quality. These include additional waste trap installations, community waste removal, riparian tree planting, silt removal, prevention of direct sewerage discharge into the stream, and ongoing community awareness and consultation sessions. Looking forward, the initiative aims to further engage both host and refugees in agriculture-based livelihood activities, including community-led climate-smart agricultural techniques, vertical and multilayer gardening, and organic and zero-tillage farming.

Figure 8. Cash for Work labourers performing regular maintenance activities to stabilise the Shoa Ma'r Jhiri banks

Figure 9. Construction of a metal and brick bridge across the Shoa Ma'r Jhiri's midstream section.

Section 4. Research Methodology

This section outlines the key terms, framework, and methods used in the research to explore how UNHCR's SuLMER intervention contributes to resilience and humanitarian, development, and peacebuilding (HDP) outcomes among displaced communities in Camps 1W and 2W in Cox's Bazar, Bangladesh. For a more detailed overview of the methods, see *Annex 1. Additional methods.*

4.1. Key Terms

This research builds on the concepts of resilience and human security, which are reciprocal, interdependent, and primarily modulated by agency[11]. We define *resilience* as the ability of households to anticipate, withstand, recover from, and transformatively adapt in the face of climate hazards, particularly severe rainfall and flooding (*see 4.3 Methods*, *below,* for details on how resilience was assessed). By anticipating, we mean the ability of individuals and groups to understand and effectively prepare for hazards before they occur. Withstanding relates to the capacity of individuals and groups to mitigate the negative impacts of hazards as they are taking place. Recovery is the ability of individuals and groups to establish wellbeing after the impacts of a hazard are felt. Finally, transformative adaptation involves actions that address the root causes of vulnerability and catalyse social transformation through empowerment, equity, and sustainability. *Human security* is defined as "[living] in freedom and dignity, free from poverty and despair … with an equal opportunity to enjoy all [one's] rights and fully develop [one's] human potential" (UN General Assembly, 2012). Despite addressing different aspects of wellbeing, resilience and human security are closely related as they build on shared assumptions of security, development, and equity. As such, we generally expect that higher levels of resilience will correspond with higher levels of human security, and vice versa. Additionally, resilience and human security are both shaped by agency, or "the ability to define one's goals and act upon them" in line with "the meaning, motivation and purpose [that] individuals bring to their [activities]" (Kabeer, 1999).

4.2. Conceptual Framework

The conceptual framework of the research highlights how climate action interventions relate to resilience outcomes and HDP objectives within the social-ecological system in which HDP actors operate (see *Figure 10*, below). A social-ecological system is defined by structural factors (including historical, political, social, economic, and environmental variables) and is affected both by climate-related hazards and purposive interventions to mitigate their negative impacts.

[11] *For a more detailed discussion of these concepts and how they are related see Annex 1.1: Key concepts.*

In areas where climate-related hazards and/or related climate action interventions are common, both play a notable role in determining individual and household agency. Agency is prominently shaped by larger structural variables that facilitate or restrict one's ability to make important decisions about their life or livelihood. Agency occurs within and contributes to the configuration of social-ecological systems through its influence on resilience.

Agency, through its contributions to resilience, plays a key role in determining humanitarian, development, and peace outcomes within climate action interventions. By HDP outcomes, we refer to contributions to refugees' protection, agentic socio-economic development, and inter- and intra-community positive and negative peace. Humanitarian outcomes entail emergency relief from crises, including the provision of shelter, safety, and other basic needs. Development outcomes are tied with sustainable, community-led improvements to economic, social, political, and environmental conditions. Peacebuilding relates to both negative peace, or the absence of violent conflict, and positive peace, which describes a sustainable and adaptive environment shaped by collaboration and coordination amongst groups rather than competition between them. In this research, we acknowledge that structural limitations to refugees' agency in the camps limit the potential for achieving HDP outcomes. Additionally, greater agency does not directly or necessarily result in greater resilience or human security. However, in contexts where resilience and human security levels are low, increased agency is generally assumed to have a positive impact on both. In turn, the more agency that community members are able to exercise over interventions intended for their benefit, the more we expect those interventions to support HDP outcomes.

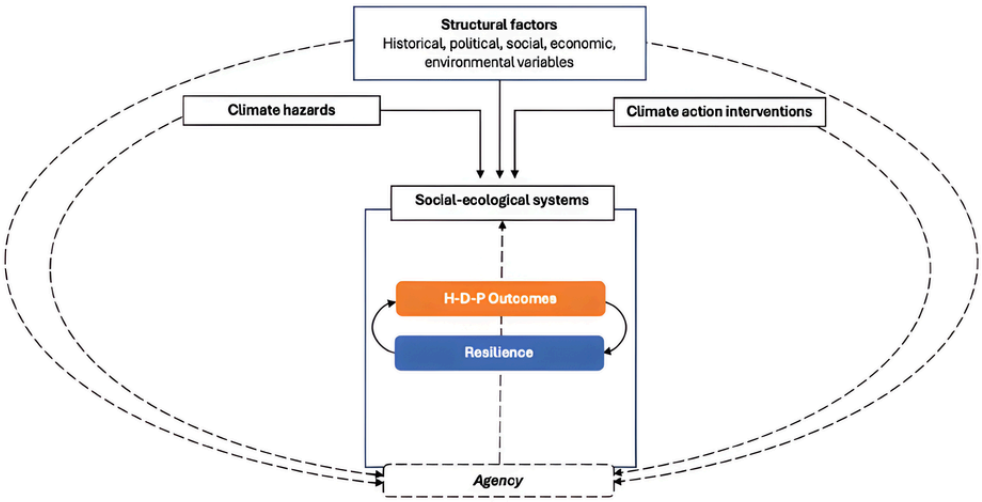

Figure 10. A visual representation of the theoretical framework linking resilience outcomes and HDP objectives to climate action interventions.

The relationships between the above concepts are at the core of this research, and their interlinkages are represented in the framework above by dotted arrows: structural factors are linked with agency, and agency is linked with climate hazards and climate action interventions. Building on this framework, our methodology focuses on how climate action interventions, through their contribution to resilience, support HDP outcomes.

4.3. Methods

A non-experimental mixed-methods approach was employed to explore how UNHCR's SuLMER intervention contributes to resilience outcomes across the humanitarian-development-peace nexus in Cox's Bazar (Savelli, Khalid, et al., 2023). This combination of quantitative and qualitative approaches allows us to explore the complexity of resilience outcomes from multiple angles. Recognising that resilience is a complex and subjective phenomenon, we analysed the intervention's contribution by comparing participants' self-reported life changes with those of non-participants who faced similar socio-environmental challenges. Thus, we avoid framing resilience outcomes as quantifiable shifts from a numerical baseline; instead, resilience is measured as a subjective concept that is shaped by individual agency and perceptions of human security. Specifically, contributes to resilience are assessed here in relation to future instances of severe rainfall or heavy flooding, hereafter referred to as severe rainfall or flooding.

Resilience was assessed through a quantitative survey and semi-structured key informant interviews. The survey aimed to measure the subjective resilience of respondents by asking them the extent to which they agreed with a series of statements about their current resilience capacities as compared to the period before the SuLMER initiative, in 2021. Respondents' ability to anticipate future severe rainfall or flooding events was measured through their reported access to information about upcoming extreme weather events, household preparedness, ability to temporarily relocate (if needed), physical protection of assets, and financial security. Respondents' ability to withstand future hazards was measured through their household assets that could be sold for cash (if needed), the strength of household construction materials, access to official emergency services and information sources, and the presence of community-led DRR initiatives. Respondents' ability to recover from future hazards was measured through their reported ability to rapidly resume income-generating activities, ability to access support from and efficacy of government-, NGO-, or community-led recovery initiatives, ease of returning and rebuilding if displacement were to occur, and ease of resolving disputes that may arise between households related to aid distribution.

Respondents' ability to transformatively adapt in the face of future hazards was measured through their reported ability to engage in income-generating activities that are less exposed to severe rainfall or flooding, permanently relocate (if desired), their perception that all households in the community equally benefit from recovery projects and other external support, the availability of opportunities to influence community decision-making related to DRR/DRM, and the overall level of trust and cooperation between households within the community. Variations of these questions were again asked to participants during KIIs, allowing for a deeper exploration of key insights.

Table 1, below, provides a brief overview of the research methods. For more information on the design of the survey and key informant interviews, and on the analysis of climate hazards projections and survey data, see *Annex 1.2 Human Security and Resilience Survey, Annex 1.3 Key informant interviews, Annex 1.4 Development of climate hazards indices, and Annex 1.5 Data analysis: Models and Regression Output.*

Table 1. Overview of research methods

Method	Detail
Projection of climate hazards and remote mapping of physical terrain characteristics	Climate indices for drought, extreme heat, flood, and compound hazards are constructed to develop mid-term climate hazard projections for Ukhiya by 2040. Remote mapping of terrain and soil analysis is constructed to better understand current physical terrain characteristics.
Field observation	The research team spent 12 days in Ukhiya meeting with stakeholders to observe the intervention's implementation and studying local socio-ecological systems.
Survey	Human security and resilience outcomes were explored to understand how the intervention has been experienced by a diverse group of household participants from host and displaced communities. Treatment: n=278; control: n=261.
Key informant interviews with UNHCR and partners and local stakeholders	Semi-structured interviews with intervention implementers and community leaders explored the intervention's objectives, design, implementation, and outcomes; additionally local stakeholders have been interviewed to collect background information.
Key informant interviews with household participants	Semi-structured interviews with household participants used most significant change (MSC) and positive deviance (PD) approaches to take learn from household participants who experienced adversely positive outcomes from the intervention. Interviews were conducted in Rohingya and Chittagonian by a team of bilingual or trilingual Bangladeshi and Rohingya researchers, along with an English-speaking research team.

4.4. Study Area and Sample Selection

The research team collected data from two areas, both chosen in collaboration with UNHCR and partner field teams: a treatment area within SuLMER's target geography, where households may have been affected by the intervention, as well as a control area outside the intervention's target geography, where households would not have been affected by the intervention. Both areas are in Camps 1W and 2W in KMC and are characterised by similar exposure and vulnerability to severe rain, flooding, and landslides. The research areas are detailed in *Figure 11*, below.

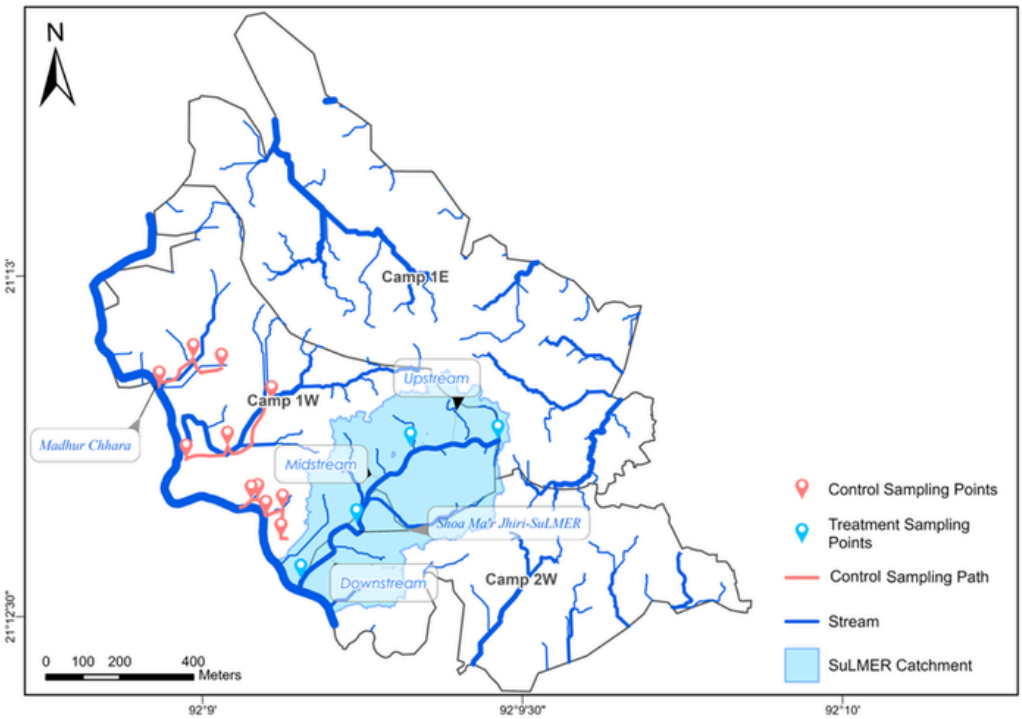

Figure 11. Overview of study area.

The households located closest to the waterways in Camps 1W and 2W (those most exposed to flooding) were predominantly populated by refugees. To ensure statistical relevance and comparability in flood exposure, the survey sample included only refugee participants. Key Informant Interviews (KIIs) were primarily carried out with refugee households from the treatment group and employed most significant change and positive deviance approaches. They were arranged through purposive sampling in the treatment area. However, several KIIs were carried out with host community leaders for background information. The survey sample was selected using a semi-random approach in both control and treatment areas, ensuring comparable exposure to flood risks. For more details on sampling, see *Annex 1.2 Human Security and Resilience Survey.*

4.5. Research Assumptions

The quantitative results presented in this report are built on four key assumptions. First, when assessing the survey data, we empirically confirmed the balance of demographic variables between households in the treatment (SuLMER catchment area) and control groups (comparison group) by ensuring no statistically significant differences. We used t-tests and standardized mean differences for continuous variables, and chi-square tests for categorical variables. In the absence of baseline data to validate comparability between groups, we are dependent on observed demographic and socio-economic data, as well as expert input from local stakeholders confirming that the groups faced similar socio-economic and environmental risk levels prior to the intervention. Second, we assume that both groups have been equivalently affected by external shocks or changes such as insecurity within the camps, climate hazards, or government policies. Third, we assume negligible hidden confounders, meaning any unmeasured biases do not materially influence the trend in our estimates. Fourth, we assume no interference between units (households), meaning that one household's participation in SuLMER does not significantly influence the resilience outcomes of other households in the treatment sample. However, how each household experiences resilience can vary. Since our analysis is based on self-reported outcomes, it is important to acknowledge that some effects of SuLMER may extend past individual households to influence broader community-level dynamics.

4.6. Research Limitations

Several research limitations should be recognised. First, the study was conducted with the assistance of UNHCR and partner field teams, who facilitated connections between the research team, local stakeholders, and household participants. Although the Alliance research team explained they were not formally affiliated with UNHCR, household participants may have engaged in demand bias where they toned down negative responses or exaggerated positive ones due to expectations of additional support and services. UNHCR's partners may have also modified their responses to safeguard their relationship with UNHCR. Additionally, semi-random sampling of survey respondents and snowballing for key informant interviews may have introduced selection biases. Potential selection and response biases were mitigated by triangulating data sources and cross-validating qualitative and quantitative findings. Finally, data collection commenced after the intervention had begun implementation, which means the effect of the intervention on household subjective resilience could not be evaluated against a pre-intervention baseline. The research team worked to isolate the intervention's effect by comparing the subjective resilience of household participants (treatment group) against results from a control group comprised of respondents from a nearby area that shares similar social-ecological characteristics, including high storm and flood vulnerability, but is located outside the SuLMER catchment.

Hence, the control area should not have benefited from SuLMER's waterway restoration or flood mitigation components. However, because the data used is cross-sectional and lacks baseline information (as opposed to panel data that could be used to compare indicators before and after the intervention), our ability to establish a cause-and-effect relationship between the intervention and household resilience is limited. Therefore, the results below cannot be interpreted as expressing a direct causal linkage between the intervention and resilience outcomes. Rather, we use data related to perceived changes in resilience as reported by the respondents, which we feel accurately describes the perspectives and lived experiences of target households and triangulate these results with data from key informant interviews and field observations.

Section 5: Results

5.1. Projected Climate Hazards in Ukhiya through 2040 and Remote Mapping of Physical Terrain Characteristics

This section examines the key climate and environmental hazards that impact households in Camps 1W, 2W, and 1E in the Kutupalong Mega Camp (KMC), and how these hazards are projected to increase in both frequency and intensity under future climate scenarios. The main *Shoa Ma'r Jhiri* waterway flows through Camps 1W and 2W only, where the SuLMER intervention occurred, and the research sample was drawn. Although the intervention focused on waterways in Camps 1W and 2W, Camp 1E is closely connected upstream. Therefore, some SuLMER community engagement and waste management activities were extended to Camp 1E to reduce waste dumping and its negative effects on upstream tertiary channels. For these reasons, climate and terrain data for Camp 1E are included here to provide a more contextualised assessment of hazards and terrain across the catchment.

Heat stress, drought conditions, and flooding risk, as well as the compound effects of these hazards occurring simultaneously, are assessed. This assessment also examines how the physical terrain characteristics in Camps 1W, 2W, and 1E interact with these climate threats. Figure 12, below, provides a summary of the baseline (1980-2010) and projected future (2020-2040) climate hazards in Camps 1W, 2W, and 1E of Ukhiya, Cox's Bazar[12]

Risk Level Matrix

Hazard Type	Baseline (1980-2010)	Future (2020-2040)
Heat	High	Extreme
Drought	Moderate	Severe
Flood	Extreme	Extreme
Compound	Severe	Extreme

Climate Hazard Index
- Low
- Moderate
- High
- Severe
- Extreme

Figure 12. Summary of baseline (1980-2010) and projected future (2020-2040) climate hazards in Camps 1W, 2W, and 1E in Ukhiya, Cox's Bazar. Climate hazards range from low to extreme levels. Compound hazard refers to the simultaneous occurrence of drought, extreme heat and flooding hazards.

[12]*More details on the definition of hazard indices can be found in Annex 1.4: Development of climate hazards indices.*

Ukhiya experiences a tropical monsoon climate characterised by distinct wet and dry seasons. Historical data show that Ukhiya, including Camps 1W, 2W, and 1E, experienced high heat levels between 1980 and 2010. Under future climate scenarios (2020-2040), heat levels are projected to reach extreme levels (see *Figure 13*, below), with a Heat Index value equal to or above 41°C for 72 or more days per year. These levels pose major risks to human health and wellbeing in the camps, particularly for vulnerable groups including the elderly, undernourished children, lactating mothers, pregnant women, people with disabilities, and those with pre-existing health conditions (Inter Sector Coordination Group, 2024c). This is especially concerning given that the camps' shelters, mainly made of bamboo and tarpaulin, lack insulation and appropriate ventilation (Inter Sector Coordination Group & SCCCM Sector, 2024).

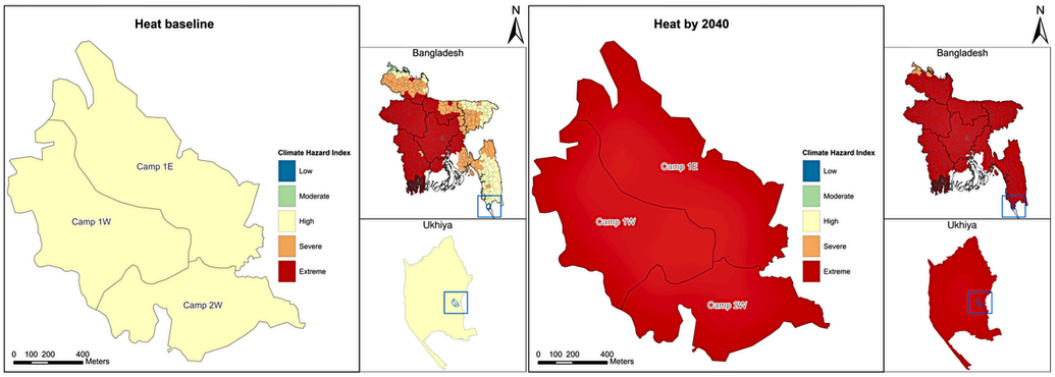

Figure 13. Projected levels of heat across Camp 1W, 2W and 1E in Ukhiya, Cox's Bazar. The left map indicates baseline levels (1980-2010) and the right map shows projected levels through 2040 (Craparo et al., 2024).

Ukhiya has historically experienced moderate drought conditions during the dry season. However, projections indicate an intensification to severe drought conditions by 2040 (see *Figure 14*, below). The escalation in drought intensity by 2040 is particularly concerning for households in KMC, including Camp 1W, 2W, and 1E, where water access is already strained and heavily dependent on groundwater resources. Particularly, seasonal water scarcity during the dry season poses significant challenges to groundwater availability within the camp (Akhter et al., 2020; Areez Tanbeen Rahman, 2019). In exceptional cases, such as technical failures in the water network or the need to supply water to fire-affected camps, water is trucked into the camps, placing additional strain on already limited resources. Climate change-related increases in drought severity may further exacerbate health risks associated with water scarcity in the camps, as water shortages may lead to worsening unhygienic conditions (Shapna et al., 2023). Furthermore, overcrowding, poor shelter insulation, and unsafe cooking areas have led to frequent fire accidents in Cox's Bazar refugee camps (Inter Sector Coordination Group & SCCCM Sector, 2024). These incidents are anticipated to worsen under intensified drought conditions, which will further constrain water availability for firefighting efforts (UNHCR, 2024).

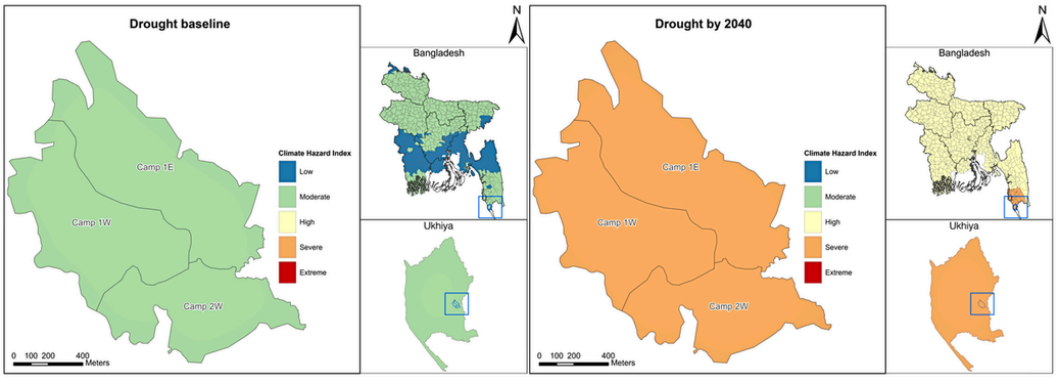

Figure 14. Projected levels of Drought across Camp 1W, 2W and 1E in Ukhiya, Cox's Bazar. The left map indicates baseline levels (1980-2010) and the right map shows projected levels through 2040 (Craparo et al., 2024).

Due to its location in a coastal region highly susceptible to monsoon rains and cyclones, Ukhiya faces extreme flood hazards under both baseline and future conditions (see *Figure 15*, below). The topography of Camps 1W, 2W, and 1E is characterised by hills and valleys that exacerbate household vulnerability to flash floods and landslides during intense rainfall. These risks were amplified by the extensive deforestation required to accommodate the Rohingya influx in 2017, which disrupted natural drainage systems and increased flood risks (Sarkar et al., 2023). In response, reforestation has been carried out in suitable and accessible sites with the long-term aim of restoring key ecosystem services, such as soil stabilisation and water cycle recovery (Regina De La Portilla, 2021; United Nations Bangladesh, 2020). Despite recent reforestation efforts, full forest landscape restoration that includes soil stabilisation and water cycle recovery has yet to be realised. Plantation interventions remain unevenly distributed, leaving many areas with relatively low vegetation cover. Despite ongoing mitigation efforts, during the monsoon season, flooding, landslides, and waterlogging damage shelters and critical infrastructure, displace households, disrupt humanitarian services, and heighten the spread of waterborne diseases. In extreme cases, they can result in fatalities (Inter Sector Coordination Group, 2024b). The fragile shelters, often made of bamboo and tarpaulin, are particularly vulnerable to flood conditions, leaving refugees exposed to recurring loss and damage. Moreover, models suggest that while the frequency of tropical cyclones may not dramatically increase, stronger storms combined with sea-level rise will amplify flooding impacts. Recent studies warn that by the end of the 21st century, extreme storm-tide events that historically occurred only once in 100 years could strike about once every decade in Bangladesh under high-emissions scenarios (Qiu et al., 2025).

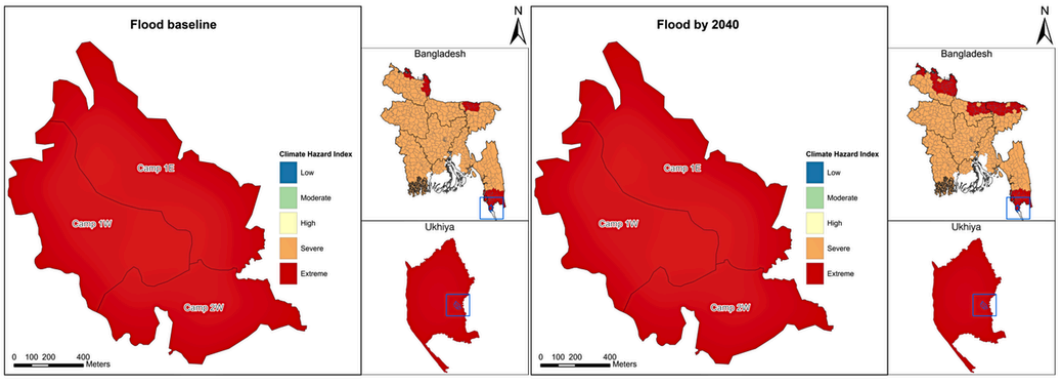

Figure 15. Projected levels of flood across Camp 1W, 2W and 1E in Ukhiya, Cox's Bazar. The left map indicates baseline levels (1980-2010) and the right map shows projected levels through 2040 (Craparo et al., 2024).

The compound impact of hazards that co-occur within a year in the same geography, including a combination of droughts, heatwaves and floods, can substantially amplify household losses and damage, particularly in vulnerable contexts such as the camps in Ukhiya. Under baseline conditions (1980-2010), Camps 1W, 2W, and 1E faced severe compound droughts, heatwaves, and flood hazards. However, by 2040, the compound effect of these co-occurring hazards is projected to worsen and reach extreme levels (*Figure 16*, below). The projected intensifying co-occurrence of drought, heat, and flood hazards in these camps is expected to amplify environmental degradation, infrastructural damage, and health risks (physical and psychosocial). During the dry season, more severe droughts are likely to exacerbate crop and vegetation loss, reducing soil absorption capacity and increasing waterlogging and runoff (Barendrecht et al., 2024). This heightened vulnerability to flooding during the monsoon season can lead to a greater risk of waterborne and mosquito-borne diseases associated with standing water after floods. Furthermore, floods often damage or destroy household assets and critical infrastructure, such as shelters, WASH facilities, healthcare centres, and assistance points. This reduces households' capacity to prevent or cope with flood-related diseases and exacerbates other illnesses due to limited access to care (Inter Sector Coordination Group, 2024b; Patwary & Rodriguez-Morales, 2022). Heat hazards can further compound health risks by disproportionately affecting vulnerable groups already suffering from illnesses (Inter Sector Coordination Group, 2024c). Similarly, droughts can lead to temporary water shortages that negatively impact hygiene practices and facilitate the spread of pre-existing diseases (Shapna et al., 2023). Overall, the combined impacts of consecutive and co-occurring droughts, heatwaves, and floods disrupt household daily life and may result in significant psychological stress, particularly for refugees already dealing with the trauma of ethnic persecution, violence, and protracted forced displacement (Shahirah Majumdar, 2023; Tay et al., 2019).

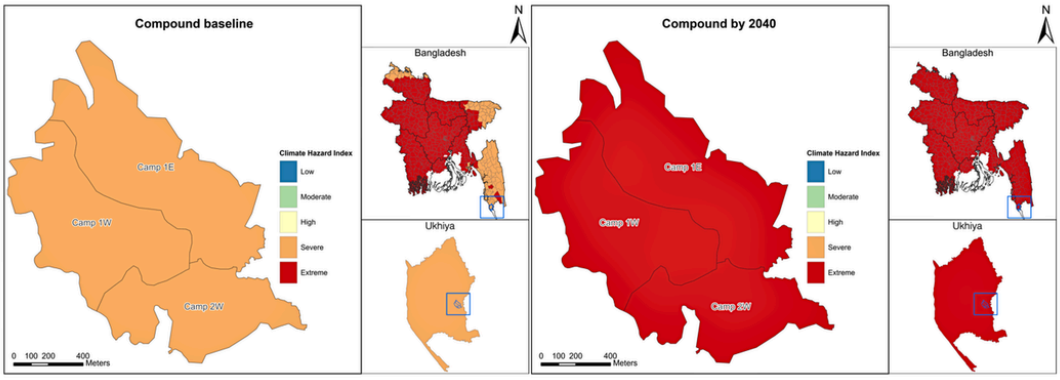

Figure 16. Projected levels of compound hazards across Camp 1W, 2W and 1E in Ukhiya, Cox's Bazar. The left map indicates Baseline levels (1980-2010) and the right map shows projected levels through 2040 (Craparo et al., 2024).

Understanding the physical terrain characteristics of Camps 1W, 2W, and 1E is crucial for assessing how these projected climate hazards, particularly floods, will interact with and impact local landscapes. Soil texture mapping across the camps (see *Figure 17*, below) reveals a distinct pattern of clay loam and sandy clay loam soils. The western zones, especially around Camp 1W and the control sampling areas, are dominated by clay loam (58% aerial coverage), while central and downstream zones near the *Shoa Ma'r Jhiri* transition to sandy clay loam (42% aerial coverage). Clay loam soils, while naturally fertile, have high water retention and become highly unstable when saturated during intense rainfall events, increasing landslide risk on slopes during heavy rainfall. This soil characteristic is particularly concerning given the extreme flood hazard levels identified in both baseline and future scenarios, as clay soils have low permeability and high-water retention properties, leading to increased surface runoff and soil instability during heavy precipitation events. The presence of sandy clay loam in central areas provides marginally improved drainage characteristics compared to pure clay loam, but still presents significant management challenges during intense rainfall conditions.

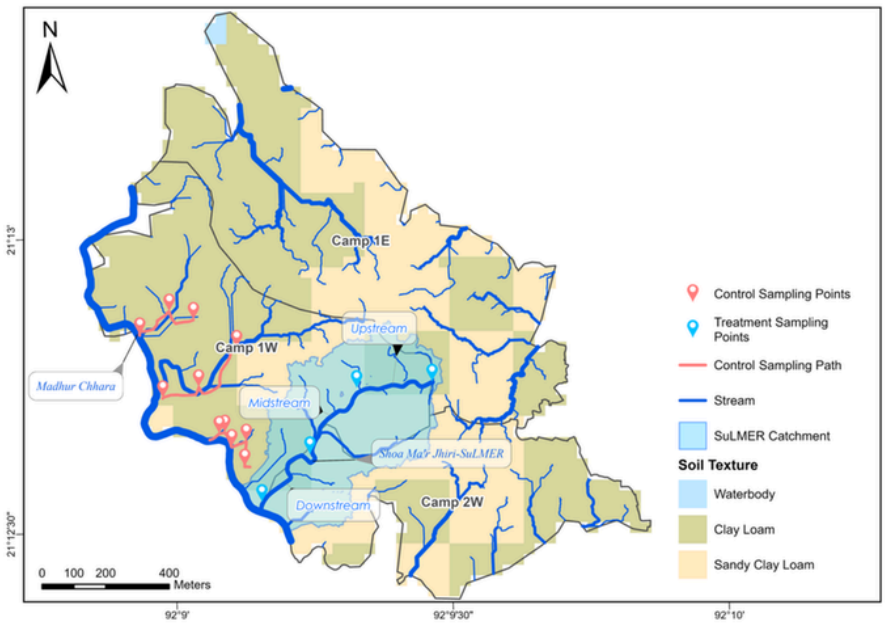

Figure 17. Soil composition across Camps 1W, 2W and 1E in Ukhiya, Cox's Bazar, based on SoilGrids data (Hengl, T. et al., 2017)

Elevation analysis (see *Figure 18*, below) reveals substantial variation across the study area, with surface heights ranging from 0–5 meters above sea level[13] (mASL) in the lowest zones to over 35 mASL in isolated upland pockets. Most of the area lies between 5–25 mASL, accounting for more than 94% of the mapped extent. These moderate elevations shape drainage pathways that can rapidly convey runoff during intense rainfall, increasing downstream flood risks. Low-lying areas, including those near the control and treatment sampling points, remain vulnerable to high flow accumulation and flooding threats, which are likely to worsen under projected climate-driven rainfall patterns.

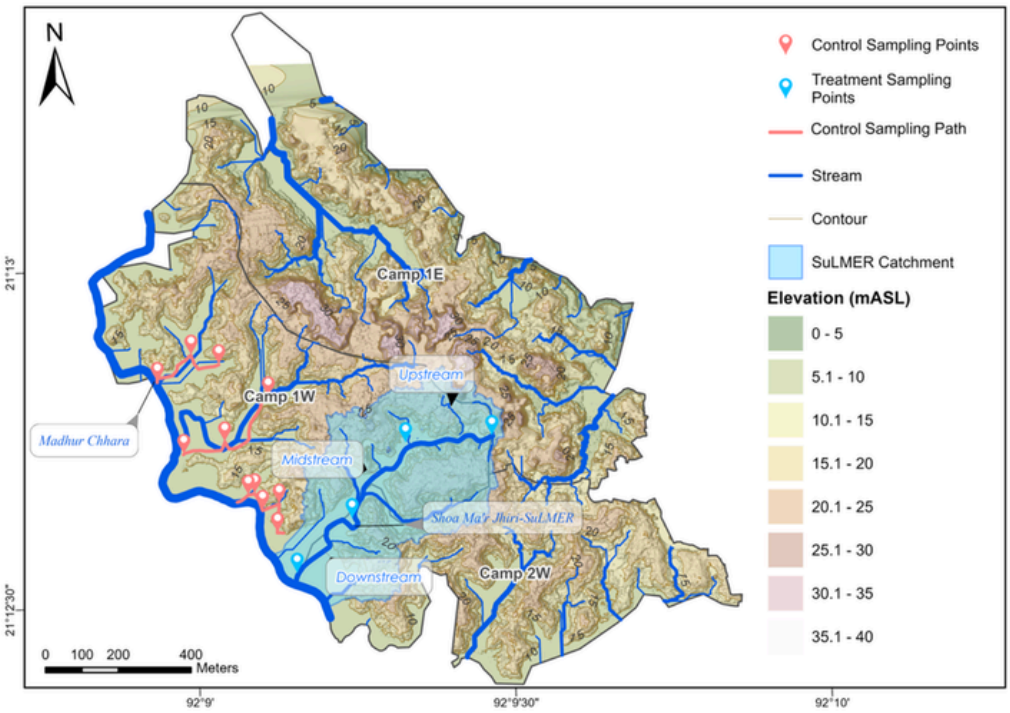

Figure 18. Elevation across Camps 1W, 2W and 1E in Ukhiya, Cox's Bazar, derived from SRTM data (NASA JPL, 2013)

Slope analysis (see *Figure 19 and Figure 20*, below) shows that moderate to very steep slopes cover nearly 69% of the study area, while gentle slopes occupy about 31%. These slopes, combined with clay-rich soils, create conditions highly prone to landslides, especially under the intense rainfall projected with climate change. Interventions, such as emergency slope stabilisation structures and stream modification near the treatment and control sampling points, may unintentionally worsen these hazards if inadequately designed, constructed, or maintained. Altogether, the combination of heavy rainfall, soil composition, and rugged terrain increases the likelihood of slope failures and flash flooding, highlighting the urgent need for targeted disaster risk management measures.

[13] *The mASL metric indicates a location's altitude in relation to the mean sea level.*

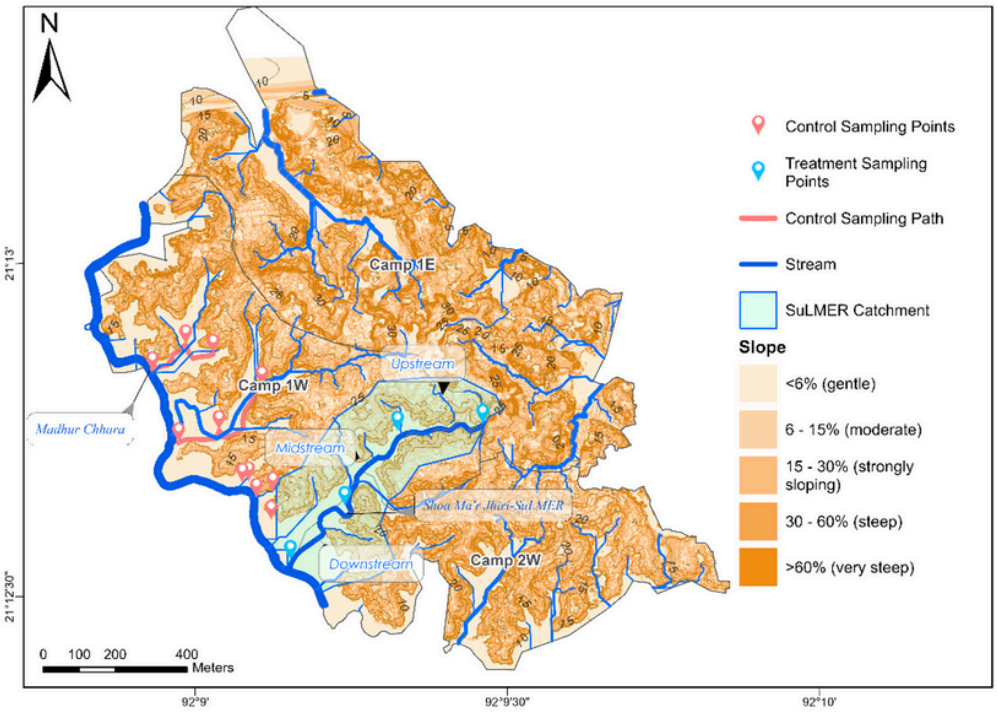

Figure 19. Slope across Camp 1W, 2W and 1E in Ukhiya, Cox's Bazar, derived from SRTM data (NASA JPL, 2013).

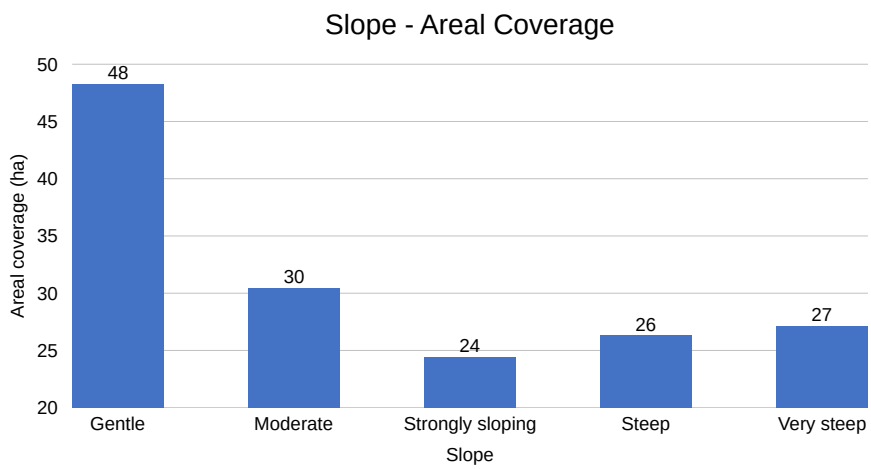

Figure 20. Areal coverage of slope classes in the study area

Projected increases in flood and compound hazard risk by 2040, in combination with low-lying topographies that are prone to flooding, clay-rich soils that retain water, and steep gradients, significantly amplify landslide risks in Camps 1W and 2W. These impacts are exacerbated by the compounding ecological and socio-economic effects that consecutive and co-occurring extreme heat, droughts, and flood hazards have on household and camp infrastructure.

5.2. Household Subjective Resilience: Anticipation, Withstanding, Recovery, and Transformative Adaptation

UNHCR's Sustainable Land Management and Environmental Rehabilitation (SuLMER) initiative has notably improved respondents' subjective resilience, or, in other words, how resilient target households feel they are to future instances of severe rainfall or flooding (see *4.2. Methods for details on measuring subjective resilience*)[14]. Respondents in the SuLMER intervention's target area, referred to hereafter as household participants or participants, reported 10.87%[15] higher levels of overall subjective resilience (the average score for all resilience sub-types: anticipate, withstand, recover, transformatively adapt) than those in the control group outside SuLMER's intervention area (see *Figure 21*, below). The percent-change between the 'Control' and the 'Modelled Intervention Effect – Treatment Group' in *Figure 21* highlights the estimated contribution of the intervention, measured as the difference in subjective resilience that can be associated with the intervention as reported by respondents from the treatment (households located along the SuLMER project site) and control group (households located in a nearby area with similar topography that were not affected by the SuLMER project). This measurement accounts for potential biases by adjusting for external factors[16] that may affect reported resilience or are unevenly distributed between the treatment and control groups. This approach improves confidence that the differences observed between the treatment and control groups can be attributed to the intervention rather than extraneous factors. However, findings are limited by a lack of panel data collected at more than one point in time, which could be used to establish a causal relationship between the intervention and reported changes to subjective resilience, free of extraneous factors (see *4.6 Research Limitations*).

[14] *These results are based on a non-experimental mixed-methods assessment that estimates the effect of SuLMER on participants' reported (subjective) resilience. The results should not be interpreted as definitive causal impacts.*

[15] *The value of 10.87% does not reflect an objectively measured increase in resilience from pre-intervention levels. Instead, it represents the difference in how participants self-reported their resilience since the intervention, compared to similar respondents who did not participate in the intervention. As such, it reflects the subjective perception of intervention participants as shaped by their individual experiences.*

[16] *Adjusting factors include human security variables (economic, social, environmental), socio-economic variables (age, gender, household size, education, income estimate, income sources, livestock, debt), non-SuLMER support received from aid agencies (food, shelter, nonfood items, WASH, community infrastructure, health, agricultural, case management), climate hazards, and frequency of exposure to violent incidents. For more details on the quantitative analysis of the survey data, see Annex 1.5: Data Analysis: Models and Regression Output.*

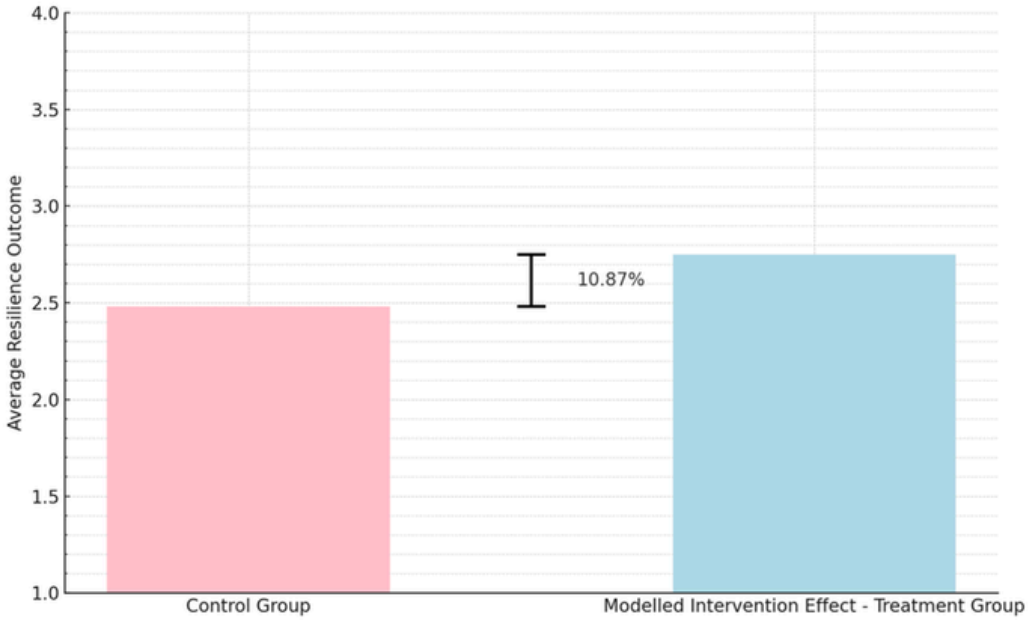

Figure 21. Average overall subjective resilience levels reported by the control group (left) are compared with the modelled effect of the intervention on the treatment group (right). The percent-change between groups represents the intervention's estimated contribution to respondents' reported subjective resilience (anticipate, withstand, recover, transformatively adapt) that can be associated with the treatment/intervention, after adjusting for external factors.

In addition to improvements in overall subjective resilience, the intervention is also associated with increases in participants' reported ability to (individually) anticipate, withstand, recover from, and transformatively adapt to future instances of severe rainfall or flooding. However, its effect on each subtype of subjective resilience varies, with stronger effects on participants' reported ability to transformatively adapt and withstand, followed by recovery and anticipation.

Intervention participants reported 6.76%[17] higher abilities to anticipate future instances of severe rainfall or flooding (before they occur) than non-participants from the control group (see *Figure 22*, below). However, this improvement can only be partially attributed to the initiative. Typically, anticipatory capacities are supported by mechanisms such as hazard early-warning systems, agro-climatic advisory services, or forecast-based financing, none of which were the focus of SuLMER. Nonetheless, many respondents likely feel their household assets are better protected from future instances of severe rainfall or flooding as a result of SuLMER's rehabilitation of the *Shoa Ma'r Jhiri* stream (see *Result 5.4* for additional details). Additionally, respondents may feel more confident in their ability to anticipate such events due to participation in SuLMER's community engagement and environmental awareness activities (see *Result 5.4*), which enhanced their access to information, a key factor in anticipatory capacity.

[17] *The value of 6.76% does not reflect an objectively measured increase in resilience from pre-intervention levels. Instead, it represents the difference in how participants self-reported their resilience since the intervention, compared to similar respondents who did not participate in the intervention. As such, it reflects the subjective perception of intervention participants as shaped by their individual experiences.*

Furthermore, the construction of pathways and bridges as part of the SuLMER intervention reportedly enhanced mobility, likely contributing to respondents feeling more prepared to temporarily relocate to safer areas in the event of severe rainfall or flooding events (see *Result 5.4*).

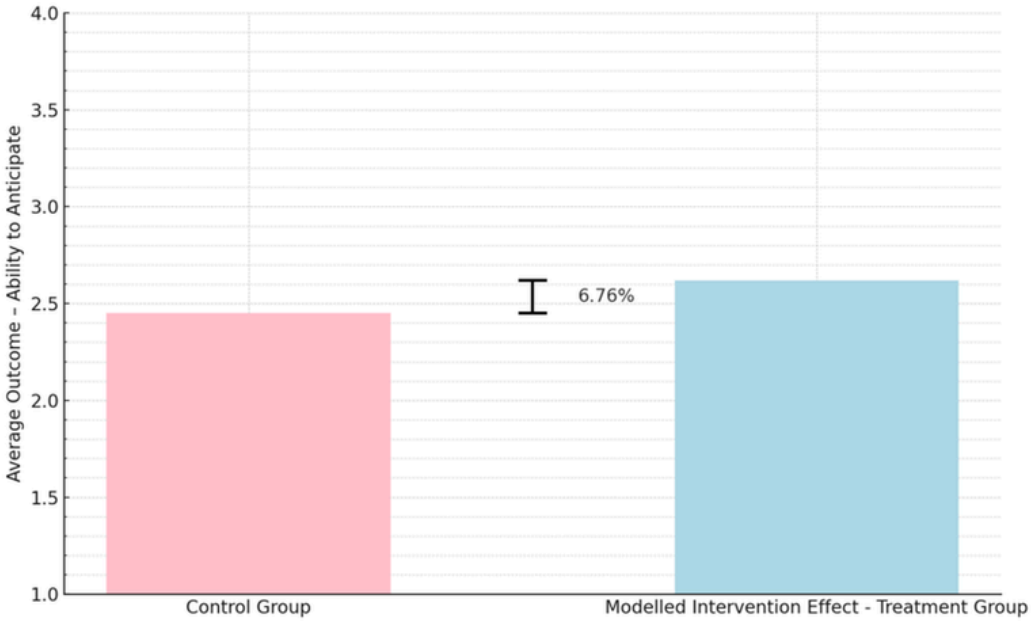

Figure 22. Average abilities to anticipate future hazards reported by the control group (left) are compared with the modelled effect of the intervention on the ability of respondents in the treatment group to anticipate future hazards (right). The percent-change between groups represents the intervention's estimated contribution to respondents' reported ability to anticipate future hazards that can be associated with the treatment/intervention, after adjusting for external factors.

Intervention participants reported 10.18%[18] higher abilities to withstand future instances of severe rainfall or flooding (as they are occurring) than non-participants from the control sample (see *Figure 23,* below). Several aspects of the SuLMER intervention directly reduced risks associated with severe rainfall or flooding (see *Result 5.4*), including solid waste removal, streambed dredging and excavation to enhance water flow and capacity, and installing geotextiles to protect against soil erosion and landslides. Additionally, bamboo structures and riparian vegetation were added to stabilise the banks, while fencing and protective nets have been added to enclose the stream, mitigate littering, and prevent falling accidents. However, respondents noted that further reinforcement is needed, as some of the bamboo infrastructure and geotextile had already been damaged by monsoon rainfall (see *Result 5.4*).

[18] *The value of 10.18% does not reflect an objectively measured increase in resilience from pre-intervention levels. Instead, it represents the difference in how participants self-reported their resilience since the intervention, compared to similar respondents who did not participate in the intervention. As such, it reflects the subjective perception of intervention participants as shaped by their individual experiences.*

Similar to the intervention's effect on anticipation, the construction of new pathways and bridges likely enhanced households' access to emergency services while severe rainfall or heavy flooding is occurring, thereby contributing to the participants' reported abilities to withstand these events.

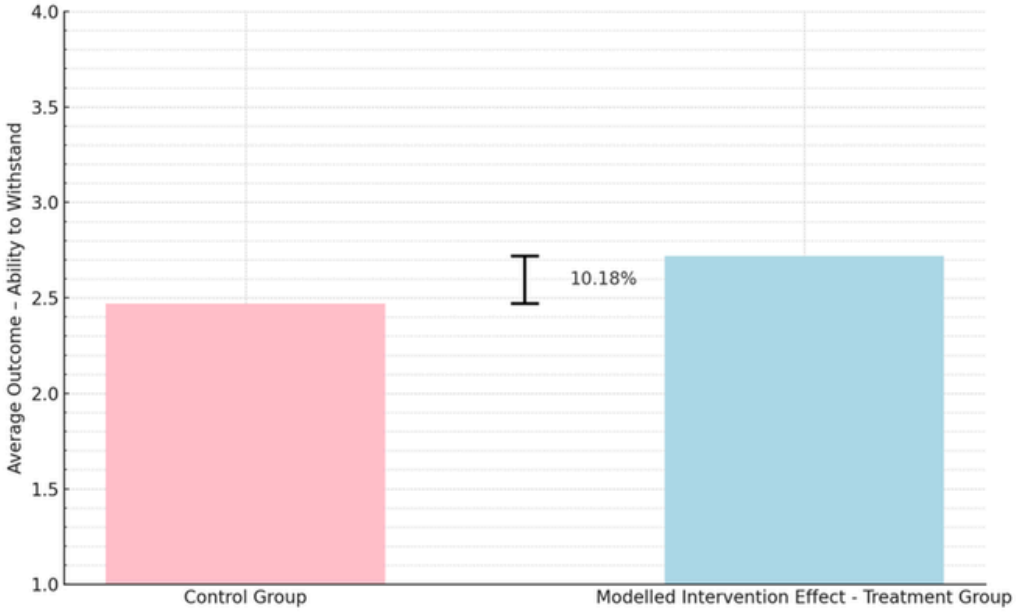

Figure 23. Average abilities to withstand future hazards reported by the control group (left) are compared with the modelled effect of the intervention on the ability of respondents in the treatment group to withstand future hazards (right). The percent-change between groups represents the intervention's estimated contribution to respondents' reported ability to withstand future hazards that can be associated with the treatment/intervention, after adjusting for external factors.

Intervention participants reported 7.30%[19] higher abilities to recover from severe rainfall or flooding than non-participants from the control group (see *Figure 24,* below). This is likely due to SuLMER's positive, though uneven, contributions on incomes and food security, as well as participants' expectations that humanitarian relief agencies will be better able to support future recovery efforts, one of the indicators used to measure respondents' reported ability to recover from future hazards. For the few households who received small kitchen gardens, subsistence production contributed to their food security and, in some cases, allowed households to generate a small income through sporadic instances of surplus production and market sales (see *Result 5.5)*. Similarly, the limited number of participants who engaged in short-term Cash for Work opportunities (98 of 278 respondents in the treatment group) highly valued the income generated (see *Result 5.5*). This supplement income from Cash for Work or savings from reduced food expenditure may allow respondents to allocate more resources towards resuming daily activities, replacing lost or damaged assets, and restoring living conditions.

[19] *The value of 7.30% does not reflect an objectively measured increase in resilience from pre-intervention levels. Instead, it represents the difference in how participants self-reported their own resilience since the intervention compared to similar respondents who did not participate in the intervention. As such, it reflects the subjective perception of intervention participants as shaped by their individual experiences.*

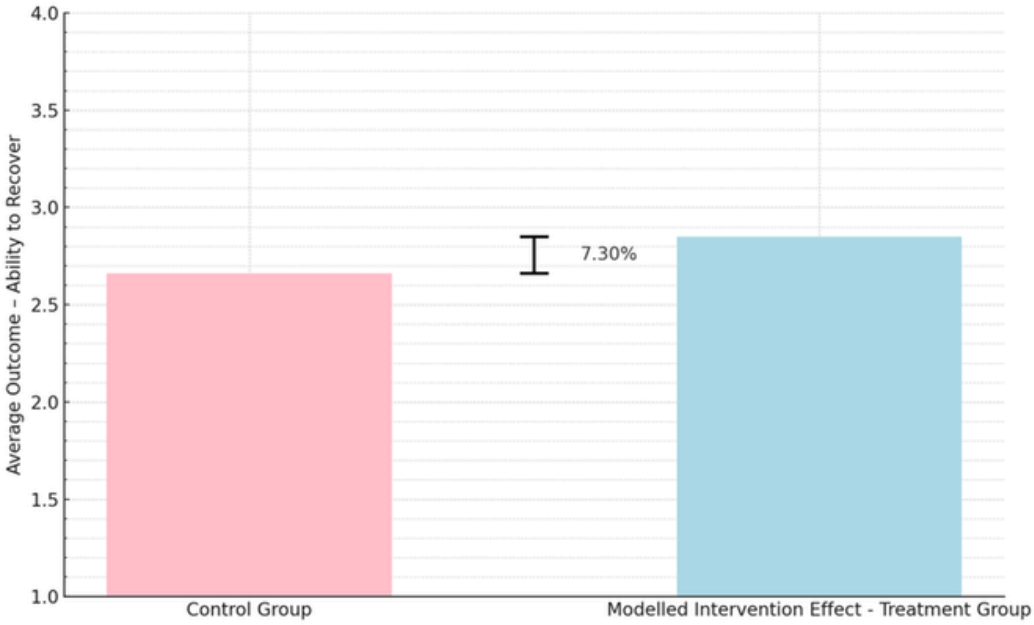

Figure 24. Average abilities to recover from future hazards reported by the control group (left) are compared with the modelled effect of the intervention on the ability of respondents in the treatment group to recover from future hazards (right). The percent-change between groups represents the intervention's estimated effect on respondents' reported ability to recover from future hazards that can be associated with the treatment/intervention, after adjusting for external factors.

Finally, SuLMER participants reported 19.9%[20] higher abilities to transformatively adapt in the face of severe rainfall or flooding than non-participants from the control group (see *Figure 25,* below). Transformative adaptation involves making significant changes to livelihoods or lifestyles to address the root causes of vulnerability. While structural barriers, such as Rohingya refugees' exclusion from Bangladesh's formal economy and political system, restrictions on movement, overcrowded camps, and lack of supportive policies for long-term infrastructure limit systemic change, SuLMER nonetheless facilitated modest but meaningful improvements in participants' adaptive capacities. Interventions targeting transformative adaptation may involve the promotion of climate-resilient livelihood activities, support participants' ability to relocate from hazard-prone areas or contribute to improved economic and/or political agency through civil society development. Although SuLMER's positive effects on environmental security were felt broadly, only a small proportion of participants benefited directly from income and savings generated through Cash for Work opportunities and small kitchen gardens. Yet this small number of respondents reported disproportionately high levels of subjective resilience, positively skewing the treatment group's results for transformative adaptation. As such, we can only partially attribute the overall increase in transformative adaptation capacities to SuLMER, as the key drivers of this result were distributed unequally throughout the sample.

[20] *The value of 19.90% does not reflect an objectively measured increase in resilience from pre-intervention levels. Instead, it represents the difference in how participants self-reported their resilience since the intervention, compared to similar respondents who did not participate in the intervention. As such, it reflects the subjective perception of intervention participants as shaped by their individual experiences.*

Still, SuLMER's Cash for Work opportunities had notable benefits for the small number of refugees who took part, who are otherwise heavily reliant on external financial support. Income generation is a significant challenge for Rohingya households, who are barred from formal employment in Bangladesh. Seeking informal employment outside the camps exposes them to risks such as exploitation, abduction, and harassment. Thus, SulMER's Cash for Work opportunities provided individuals with safe income-generating opportunities within the camps, even if only for a short duration (see *Result 5.6*). These Cash for Work activities have been especially valuable for women, who face additional barriers to earning income due to traditional gender roles that prioritise unpaid homemaking and caregiving, as well as cultural norms that restrict women's public presence (Inter Sector Coordination Group, 2017; Karin et al., 2020).

Similarly, the SuLMER initiative's allocation of small kitchen garden plots to a limited number of families living along the *Shoa Ma'r Jhiri* has enhanced their ability to cultivate crops (see *Result 5.6*). Participants highly value the gardens for their moderate contribution to food security and disposable income, which they achieve by reducing spending on otherwise costly market products. Furthermore, food produced in these garden plots serves as a limited buffer for households against fluctuations in external support due to aid cuts, as well as price and supply chain fluctuations in the market (see *Result 5.6*). The kitchen gardens also restore a culturally significant practice, as many refugee households cultivated crops in Myanmar but were hitherto unable to do so in the camps (see *Result 5.4)*.

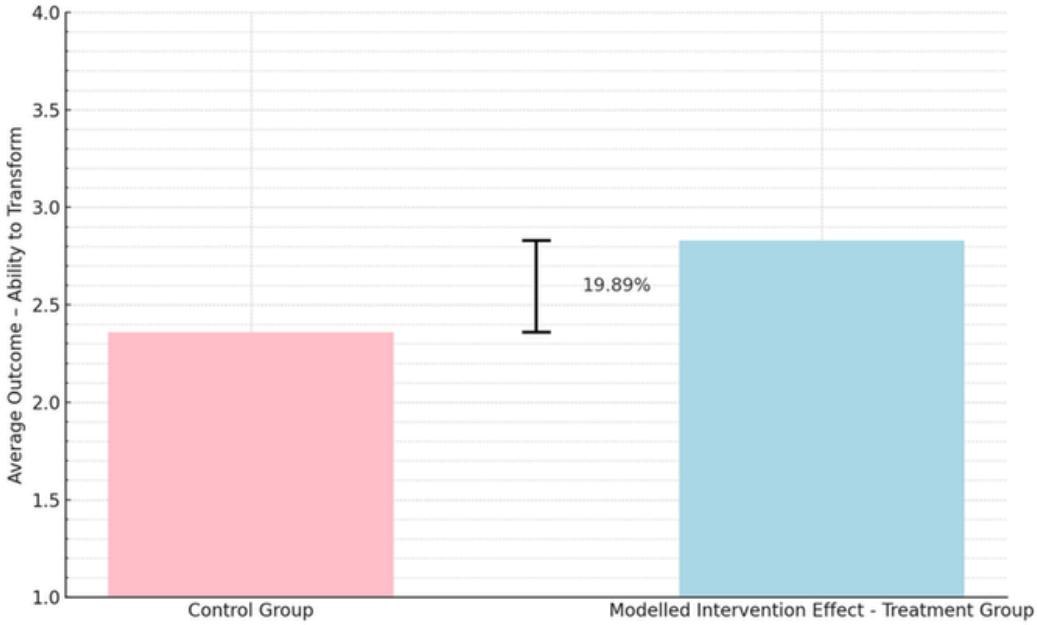

Figure 25. Average abilities to engage in transformative adaptation reported by the control group (left) are compared with the modelled effect of the intervention on the ability of respondents in the treatment group to transformatively adapt (right). The percent-change between groups represents the intervention's estimated effect on respondents' reported ability to transformatively adapt that can be associated with the treatment/intervention, after adjusting for external factors.

5.3. The role demographic indicators and household variables play in resilience outcomes

While the SuLMER intervention led to improvements in participants' overall subjective resilience (see *Result 5.2)*, the intervention had varying effects on different socio-economic groups. By controlling for various demographic indicators (including household size[21], gender, education, income source, indebtedness, and support received from other programmes), intersectional barriers and entry points for more inclusive resilience outcomes are highlighted.

Overall, women and men[22] reported comparable improvements in their capacities to anticipate, recover, and transformatively adapt to future instances of severe rainfall or flooding after SuLMER. This is true at community-level (comparing the modelled difference in resilience outcomes between women and men, irrespective of their households, in the treatment group to the modelled difference in resilience outcomes between women and men in the control group) and household-level (comparing the modelled difference in resilience outcomes between women and men from the same household in the treatment group to the modelled difference in resilience outcomes between women and men from the same household in the control group).

However, when specifically asked about their capacity to withstand severe rainfall or flooding while these events were occurring, women from the treatment group reported a 10% greater improvement than men. While additional gender-specific research is needed to understand the underlying causes of this variance, it likely reflects the initiative's mitigation of the risks and vulnerabilities faced by women in the camps, especially during and immediately after severe rainfall and flood events. Women in KMC are disproportionately affected due to restrictive gender norms that confine them to domestic roles, limit their mobility and income opportunities, and reduce their access to emergency support (Inter Sector Coordination Group, 2017; UN Women, 2020). During hazards, these constraints expose women to heightened risks, including gender-based violence, health issues, and discomfort due to loss of privacy, especially when shelters and WASH infrastructure are damaged by storms or floods (ADRA et al., 2024). Women are also responsible for cleaning water, dirt, mud, and debris out of inundated shelters immediately after flood events, while men tend to focus more on structural repairs. While SuLMER did not directly address these social and infrastructural vulnerabilities, by mitigating immediate household risks related to flooding and waterlogging, the programme reduced acute risks for women during these hazards.

[21] *No statistically significant correlation between household size and resilience outcomes was found.*

[22] *Only one respondent with a non-binary gender identity was sampled, meaning there are no statistically robust results for this group.*

The intervention did not produce significantly different effects on the subjective resilience of respondents with different levels of education, likely due to the limited income-generating opportunities available to refugees in Cox's Bazar. Typically, higher education levels are linked to increased adaptive capacity and a greater likelihood of adopting new practices that positively impact income and/or food security (Deressa et al., 2009; Destaw & Fenta, 2021; Gebre et al., 2023). Therefore, it was expected that intervention participants with varying education levels would experience the SuLMER intervention differently, adopt varied adaptation practices and, consequently, report different levels of subjective resilience outcomes post-intervention. However, access to income-generating activities is highly constrained by refugees' limited access to natural resources (land, most critically) and prohibition on formal employment (Inter Sector Coordination Group, 2025a). As a result, household incomes are meagre, irregular, and largely generated through compensation for volunteer or Cash for Work programs run by UN agencies and INGOs, along with small-scale market exchanges and informal labour (Hoque & Yunus, 2022; Talukder et al., 2022). Nearly one-quarter of respondents had no income in the last 12 months, while approximately 30% engaged in unskilled non-agricultural wage labour, only 9% participated in skilled wage labour, and 8% generated income from non-agricultural self-employment. Though higher levels of education do not guarantee access to higher-skilled employment opportunities, these figures highlight a significant disparity between educational attainment and job opportunities for Rohingya refugees.

This gap is critical not only to economic development per se, but also in light of risks connected to ongoing recruitment of refugees, especially youth, by criminal groups in the camps (Inter Sector Coordination Group, 2025a). As emphasised by a Mahji, youth are targeted by these groups "because they don't have any jobs." He further highlighted the need "to make sure that youth are engaged in productive work [as] 80% of recruits don't have any work at all." Consequently, addressing the education-to-employment gap represents an opportunity for future interventions to strengthen resilience and positive peace outcomes among refugees (see *Recommendation 6.3*).

Intervention participants with debt reported 3.5% lower improvements in overall subjective resilience compared to those without debt. Overall, 47.5% intervention participants sampled were indebted, and among these 86.4% had taken on debt to cover daily living expenses such as food and healthcare. Among those in debt in the treatment group, just 10.8% had used loans to fund activities that could generate larger financial returns, such as investing in non-agricultural businesses (5.6%) or financing family members' travel abroad (5.2%).

While taking loans to manage short-term shocks from climate hazards is a known coping mechanism, a growing body of literature shows that indebtedness not only persists but tends to deepen over time, increasing vulnerability and undermining long-term adaptive capacity overall (Guermond et al., 2022; Haq & Md, 2022; Ramprasad, 2019). This highlights an opportunity for future interventions to enhance resilience by leveraging SuLMER's effect on economic security to address indebtedness (see *Result 5.5*).

Lastly, SuLMER participants who received support from other UN- or INGO-implemented interventions in the camps reported higher resilience levels post-SuLMER than those who did not, highlighting the importance of integrated programming approaches. For example, SuLMER participants who received healthcare services from other UN or INGO-provided programs in the camps reported overall subjective resilience scores 23.8% higher than those who had not. While SuLMER supported health outcomes by reducing standing water and, in turn, water and mosquito-borne diseases, these gains seem to be amplified for residents who also availed of health services in the camps. Similarly, those who received non-food items from other UN- or INGO-implemented interventions reported overall subjective resilience levels 12.6% higher than those who did not. Moreover, while SuLMER improved shelter security by reducing flooding, the provision of tarps, ropes, plastic sheets, bamboo, mosquito nets, sanitation kits, and cooking fuel allowed recipient households to capitalise further on these gains. These results highlight the importance of multi-sectoral, integrated, complementary programming approaches for resilience building (Frankenberger & Constas, 2014; Hawkins et al., 2013; Troxler et al., 2021).

5.4. SuLMER's contribution to environmental security in the *Shoa Ma'r Jhiri* watershed: Lower flood risks and disease exposure, enhanced mobility within the camps, and increased environmental awareness

The SuLMER intervention has improved the environmental security[23] of households along the *Shoa Ma'r Jhiri* stream by reducing their vulnerability to severe rainfall or flooding, mitigating risks of waterborne and mosquito-spread diseases, and improving mobility within the camps. Additionally, participants report an increased appreciation for the local environment and stronger connection with the shared social and ecological spaces around the stream.

[23] *In this report, environmental security and economic security refer to the perception of security as reported by respondents at the time of research through survey responses and key informant interviews. It does not represent objective assessments of safety.*

However, flood and landslide risks remain, and the sustainability of environmental upgrades depends on continued funding, community oversight, and behavioural change within the communities.

According to participants, the SuLMER intervention successfully addressed persistent storm-related flooding and waterlogging issues along the waterway. The rehabilitation of the *Shoa Ma'r Jhiri* drainage stream included waste removal, excavation and stabilisation of the streambed, and reinforcement of the stream banks, which together improved water flow and drainage during intense rainfall. This has significantly reduced flooding along the stream, in turn mitigating safety risks and preventing water and debris from entering nearby shelters. Additionally, installing protective nets over the *Shoa Ma'r Jhiri* and running awareness campaigns on the importance of proper waste disposal reduced the accumulation of rubbish in the stream. While not all households in the catchment experienced severe flooding before SuLMER, many who did (i.e., those living on or near the banks of the *Shoa Ma'r Jhiri)* have benefited greatly from improved drainage and reinforced stream banks. One refugee who has lived in the area for five years describes how, before the project, flood waters would rise to his knees, forcing him to relocate: "before the project there would be heavy flooding. But now I am much safer. The fact that I can live safely is the most important change." A young refugee added that now many hours of rain are needed to induce flooding, whereas "previously, 2–4 hours of rain caused waterlogging, forcing people to relocate to higher ground."

Figure 26. Detail of reinforced banks and fencing installed along the *Shoa Ma'r Jhiri.*

Anecdotal evidence suggests SuLMER reduced public health risks by reducing standing water and, in turn, the risk of water- and mosquito-borne diseases in the catchment area. Before the project, the *Shoa M'ar Jhiri* was heavily polluted with garbage, resulting in unpleasant odours and stagnant water. This environment facilitated the spread of water-borne diseases such as diarrhoea, cholera, and dysentery, as well as mosquito-borne diseases such as dengue, which poses major threats in the camps (Health Sector Cox's Bazar, n.d., 2025). While quantified disease incidence was not measured in this research, participants repeatedly noted that these risks have become less prevalent since SuLMER, resulting in a safer, cleaner environment. Some households specifically highlighted a drop in diarrhoea cases among children, for whom the affliction poses the greatest threat. A refugee woman shared that "now the latrines and the area close to the house are clean. Also, what is very important is that kids can play around. There are no mosquitoes or trash." A refugee man added: "before SULMER, filth created smells and caused diseases among children, like diarrhoea. But now these things are better. The children have benefited a lot as they were more vulnerable".

Respondents also reported that the infrastructure developed as part of SuLMER has led to freer movement in the catchment area. New pathways alongside the waterway, footbridges crossing it, and lighting installations have significantly improved mobility and nighttime visibility. This is especially important for vulnerable groups like pregnant women and people with disabilities. One refugee said that "before SULMER, during heavy rain and flood it was difficult to move through the camp. Now it is much easier to move under all conditions." Another added: "my place is on higher ground compared to others. The floods never came inside my home but the area around was very muddy. Before SuLMER it was difficult to move around." A young refugee also noted that the new pathways enhance access to mosques, schools, and play areas. Furthermore, he suggests that in the event of a fire, a major threat in KMC, emergency vehicles will have better access, which could improve response times.

While environmental improvements added functional value and strengthened residents' affinity with the landscape, preserving these gains depends on continued funding for upkeep and community oversight. Respondents report that awareness campaigns discouraging the dumping of trash have helped maintain a cleaner environment, preserving some of the gains achieved by SuLMER. Similar campaigns sought to communicate the importance of proper garden maintenance, the protection of banks and walkways, and the risks of sand extraction. These environmental awareness campaigns have resulted in a growing appreciation of the landscape and greater recognition among households of the need to preserve these benefits. One woman spoke at length about this, noting she was "hopeful that the community will continue to value the waterways and protect the gardening spaces to sustain the project's positive impact."

Another woman whose household received a kitchen garden noted the benefits of subsistence production, and also that being able to grow food helped connect her to her past lifestyle in Myanmar, motivating her to participate in garbage collection activities.

Despite SuLMER's benefits, challenges remain in ensuring the long-term sustainability of infrastructural and environmental upgrades. In an environment characterised by poverty and cramped, low-quality housing, some community members have dismantled paths, taking bricks for personal use. As families grow, households sometimes extend their shelters beyond approved boundaries, encroaching on pathways and restricting access. While daily garbage collection from the stream is currently supported through Cash for Work activities (see *Result 5.5*), the system does not prevent pollution but rather limits its impacts. In the absence of a systemic waste management system and despite awareness-raising efforts, some residents continue to discard waste into the *Shoa Ma'r Jhiri.* Though residents have reported that camp authorities have implemented hard control measures to prevent improper waste disposal, such as threats of relocation or food aid reductions for households caught littering, they viewed these efforts as ineffective and overly harsh. This highlights that waste management remains a challenge both in terms of infrastructure and community behaviour at the catchment and camp levels, extending beyond the solid waste collection and awareness activities within the SuLMER intervention area.

Many participants also expressed concern that the current infrastructure may not withstand future intense rainfall events and called for the use of bricks to further reinforce the stream bed and banks. At the time of the research, some sections of the stream banks were visibly damaged from the previous monsoon season and required further reinforcement. One refugee explained that "there are landslides in the alley just outside of my house that used to happen during heavy rains. This is still a risk. Bamboo and geobags (on the stream banks) are not enough to protect the wall from falling. Bricks are necessary." However, UNHCR stakeholders highlight that concrete reinforcements in other areas of the watershed have proved costly, required similar levels of ongoing maintenance, led to habitat reduction for benthic organisms, and reduced (rather than increased) horizontal water. Ongoing concerns and differences in preferred approaches highlight challenges with infrastructural maintenance and communication with residents (see *Recommendation 6.2*). Moreover, some respondents highlighted that non-rehabilitated tertiary streams upstream of the main *Shoa Ma'r Jhiri* drainage still pose flood risks in the catchment. These streams were not targeted by SuLMER and may overflow during severe rain, leading to flooding in the *Shoa Ma'r Jhiri* and compromising recent upgrades to the main drainage system. Finally, while day-to-day maintenance of the waterway may be trusted to community members, more technical repair work or severe damage would require external support and funding, neither of which is guaranteed.

Lastly, while respondents generally speak positively of the intervention, some trade-offs exist between SuLMER's shared environmental benefits and private costs. Households along the stream highly value SuLMER's flood-mitigation benefits, but many had to reduce their shelter's footprint to make room for bank reinforcement, pathways, and kitchen gardens. Though some felt a slightly smaller dwelling was a reasonable trade-off for reduced flood vulnerability, the impact of shelter downsizing varies based on socio-economic factors, particularly household size. Larger households may face greater challenges in adjusting to smaller living spaces, while smaller households might find the adjustment more manageable. Similarly, households relocated outside of the SuLMER catchment area have seen mixed outcomes depending on individual circumstances: some reported positive outcomes, such as improved living conditions or enhanced community integration, while others have faced negative consequences, including worsened environmental conditions (see *Result 5.7*). These varied outcomes highlight an opportunity to better balance the benefits of environmental improvements with the private costs borne by households, ensuring that outcomes are equitable and sustainable in the long term.

Figure 27. Detail of rehabilitated downstream section of the Shoa Ma'r Jhiri.

Figure 28. Detail of bamboo bridge and protective nets on the Shoa Ma'r Jhiri.

5.5. SuLMER's contribution to economic security: Cash for Work opportunities and kitchen gardens

The SuLMER intervention had a positive effect on the economic security[24] of some households through the provision of Cash for Work opportunities and small kitchen gardens. While both provided participants with valuable income opportunities and improved food access, challenges remain in ensuring the sustainability of Cash for Work initiatives and promoting more equitable access to the benefits derived from both Cash for Work and kitchen gardens.

[24] *In this report, environmental security and economic security refer to the perceptions as reported by respondents at the time of research through survey responses and key informant interviews. They do not represent objective assessments of safety.*

Cash for Work activities provide highly valued but limited income-generating opportunities for refugees, offering safer alternatives to informal labour, especially for women. In Camps 1W and 2W, refugee households have taken part in Cash for Work as part of SuLMER[25]. During the implementation phase, men were primarily involved in excavating, dredging, and stabilising the streambed and banks, as well as constructing bridges and pathways, while women were engaged with sorting and drying solid waste ahead of disposal. Currently, men are mainly responsible for the daily collection of garbage from the stream, while women handle waste sorting and disposal, inspect the stream's fencing, and support hygiene and re-greening initiatives. Although Cash for Work is only offered through short-term contracts lasting 14 days, the opportunities are prized by refugees, who are legally unable to engage in formal employment. As female refugees are less likely than male refugees to engage in income generation outside the household (see *Result 5.2*), Cash for Work through SuLMER was, for some, their first time earning money since their forced displacement from Myanmar. SuLMER's Cash for Work opportunities are also safer than the informal labour opportunities outside the camp that many households depend on. A Majhi explained that seeking informal work is particularly risky as "[refugees] need to cross multiple checkpoints, sometimes they get harassed, there's no guarantee they'll get work outside the camp, sometimes people are paid less than their promised, abductions can happen and then the people are ransomed back." But despite high demand from refugees, the number, length, and scope of Cash for Work opportunities are limited as Cash for Work is designed for shortterm labour rather than long-term employment. This "supply" shortage has rendered Cash for Work opportunities even more valuable to households. However, respondents believe that the local power brokers who were responsible for selecting Cash for Work participants favoured family and friends when distributing opportunities, leading to dissatisfaction with the program's selection process (see *Result 5.6*).

Figure 29. Cash for Work labourers collecting garbage in a midstream section of Shoa Ma'r Jhiri.

Figure 30. Cash for Work labourers collecting garbage in a downstream section of Shoa Ma'r Jhiri.

[25] *Approximately 8,179 paid days of work were allocated under SuLMER's Cash for Work scheme in 2023. In 2024, 251 volunteers were engaged, and, as of July 2025, 82 were engaged.*

Small kitchen gardens were also highly valued by participants for their positive effect on food and economic security, but available only to a small number of households. As rehabilitation work freed up small plots of land adjacent to bankside shelters, these households received gardening tools, seeds, and fences to delineate plots. Some households extended their garden space by growing climbing vegetables on protective nets installed over the waterway. Although only large enough to house a handful of plants, these gardens enabled families to grow vegetables and divert savings toward other household needs like children's education and medical expenses. While most households reported yields only sufficient for subsistence consumption, some were able to sell or barter surplus produce for additional income. Despite these benefits, the sustainability of kitchen gardens is threatened by limited investment and heavy rains. Inputs (tools and seeds) that were initially provided by SuLMER to establish the kitchen gardens must now be purchased by households. For those already under financial stress, there is no guarantee that they will be able to maintain the level of investment needed to keep the gardens productive. Crop losses from intense rainfall and theft further complicate sustainability. The latter illustrates the potential for kitchen gardens to inadvertently become a flashpoint for intra-communal tensions (see *Result 5.6)*. Despite these challenges, kitchen gardens seem to be a net gain, supporting food security and providing an alternative to market procurement for some households.

Figure 31. Fenced kitchen garden on the *Shoa Ma'r Jhiri's* banks.

Figure 32. Mango and banana trees planted in a kitchen garden on the *Shoa Ma'r Jhiri's* banks.

Figure 33. Vegetables are grown on protective nets spanning the rehabilitated *Shoa Ma'r Jhiri.*

5.6. SuLMER's contribution to social cohesion: Balancing resource allocation and the equitable distribution of benefits

Largely due to the challenging implementation context in Camps 1W and 2W, rife with poverty, disenfranchisement, and pre-existing social tensions, SuLMER has had mixed effects on social cohesion. As discussed in the previous section, demand for SuLMER's kitchen gardens and Cash for Work components outstripped supply, leading to unequal benefit distribution and, potentially, jealousy among residents. Additionally, improved water flow led to an unintended increase in downstream siltation and disputes over sand extraction.

Most refugee households have no access to land for agricultural cultivation. What is currently available is consistently diminished as the camp population grows, more public paths are constructed, and shelters are expanded by residents. Although the assigned plots for SuLMER's kitchen gardens are small, they provide valuable economic benefits and foster a sense of stability (see *Result 5.5*). They were constructed alongside shelters where environmental rehabilitation activities took place, meaning only households adjacent to the *Shoa Ma'r Jhiri* stream can utilise these spaces for kitchen gardening. Although these households were the most exposed to flooding before SuLMER, access to newly created garden spaces was based on location rather than a targeted vulnerability assessment that, for example, considered economic or food security.

This means that households who received garden space were not necessarily the most vulnerable and that more at-risk households may have been excluded, potentially exacerbating pre-existing inequalities. Although SuLMER's kitchen gardens are highly valued by households who received them, multiple recipients shared that vegetable theft and vandalism are common. One woman who owns a garden believes these acts are linked to "jealousy and competition among residents" as "some community members are displeased when they see others producing better crops." In a context where poverty and food insecurity are widespread, incidents of theft are unfortunate but relatively predictable. While these occurrences are not directly due to SuLMER, the unequal distribution of kitchen gardens may play into pre-existing grievances, drive new ones, or exacerbate inequality in the catchment.

Similarly, many respondents perceived that the limited Cash for Work opportunities were distributed more on the basis of social proximity to community leaders or the ability to make a financial contribution than on individual or household needs. Camp and block Majhis (refugee community leaders appointed by camp authorities) played a crucial role in selecting Cash for Work participants. However, the selection process was unclear to residents, who reported a variety of ways to secure work. These included applying directly to the Majhis, waiting for door-to-door selection, paying Majhis or other influential community members, and leveraging personal relationships or social influence to improve their chances of being selected. A woman shared her discontent with the selection process: "we are not sure who we should give the money to, as none of us do it, but we heard that if you want to work, you need to give money to someone in power, in the highest rank." She adds: "I would like that everyone here could get opportunities [but] always the same people get opportunities again and again. If everyone gets opportunities, [it] is better." Similarly, a male refugee shared, "There is a rumour that the Majhis responsible for hiring cash workers made the process biased. Some people suspect that Majhis took the bribes and prioritised hiring their relatives." Another woman believes that Social Mobilisation Support volunteers, or refugees who support the implementation of programming in the camps, also influenced the selection of Cash for Work participants, noting that "the volunteers selected their relatives [for work opportunities, and] as I don't have any relatives working as volunteers, we did not get work opportunities." Many respondents felt unable to navigate these power dynamics and feared repercussions if they spoke up, becoming excluded from the Cash for Work process as a result. While some Majhis may have a standard and fair process for selecting participants, the majority of respondents we spoke with felt improvements were needed to guarantee a more equitable distribution process. While these claims should be verified, perceptions that Cash for Work did not benefit all within the catchment equally may exacerbate pre-existing grievances rooted in the camps' social structure and challenging living conditions.

The relocation of households for the SuLMER intervention has also had varied effects, with some families reporting improved socio-economic conditions and others dissatisfied with their new living conditions. Some households located immediately along the banks of the *Shoa Ma'r Jhiri* were asked to relocate to different shelters, both to clear space for SuLMER intervention and because these shelters were located on highly flood-prone lands that could not be reinforced. These relocations had varying effects on affected households, often depending on socio-environmental conditions in relocation sites and household characteristics. For example, one Rohingya woman explained that she was reluctant to move but felt pressured by camp authorities to relocate to a shelter on higher ground in a neighbouring camp block. However, she now feels the relocation was beneficial, as increased proximity to the market and Madrassa facilitated economic and social opportunities for her husband. She is so satisfied with the relocation that she does not mind missing out on the benefits of the kitchen garden, which now occupies the land where her former shelter was relocated, instead expressing happiness that it can contribute to the food security of other community members. However, others reported less positive outcomes. Despite no longer being exposed to floods, one man said his family was "less happy than before" because their new shelter is smaller, offers less privacy, and faces sewage issues. In their home's previous location, the family had space to grow pumpkin and bottle gourd, which the family would eat and occasionally sell in the local market. He explained that while "people [now] living near the stream can grow vegetables and enjoy more benefits," his family, for the first time, now relies entirely on food rations from the World Food Programme. He was further embittered by the fact that, despite relinquishing his family's shelter for SuLMER, no one from his household was selected to participate in the intervention's Cash for Work activities.

Finally, as SuLMER improved water flow through the *Shoa Ma'r Jhiri,* increased siltation in downstream areas has led to sand mining, causing safety risks and tensions between community members. Sand has many domestic uses in the camps and extracting it locally rather than purchasing it from the market is free and convenient. While most sand is used for household construction projects, some is sold for profit. Different views exist on the practice. Some respondents are concerned about safety and suggested that camp authorities should take stronger action against sand extraction. Children, who are often involved in extractive activities, are particularly at risk of sudden water surges during severe rainfall. Others see the sand as a natural benefit that the community should take advantage of. Additionally, sand extraction sometimes results in disputes, both among individuals competing for sand and between extractors and the nearby households attempting to stop them. These tensions, which often involve youth, can escalate into intra-community violence. UNHCR and camp authorities have tried to stop sand extraction through joint awareness campaigns highlighting the social and environmental risks connected to this practice.

These include soil erosion, weakened stream bank protection, waterlogging in adjacent areas, degraded stream water quality, increased flood and landslide incidence, disrupted ecosystem services, and compromised shelter stability. Awareness session are led by camp management officials, community leaders, refugee volunteers, and UNHCR focal persons, and intended to discourage the practice. However, sand extraction persists, posing challenges related to protection and social cohesion.

Section 6: Recommendations

Based on the results above, a series of recommendations has been developed with UNHCR to strengthen future stages of SuLMER and/or similar interventions in Cox's Bazar. While the primary aim of the intervention is to rehabilitate the *Shoa Ma'r Jhiri* waterway, increasing water flow and decreasing flooding, there are opportunities for SuLMER to simultaneously support climate resilience, sustainable development, and social cohesion. While these recommendations are context-specific, they contribute to a growing body of literature on humanitarian-development-peacebuilding programming more generally and will hopefully prove relevant in areas characterised by similar socio-ecological circumstances, where forced displacement overlaps with environmental hazards, poverty, and political marginalisation. The proposed recommendations are interconnected and cross-cut humanitarian, development, and peace outcomes, which are themselves linked. *Recommendation 6.2* (on environmental security) and *Recommendation 6.4* (on food security) can particularly support humanitarian agencies in protecting refugees and ensuring basic needs and living conditions. *Recommendation 6.3* (on economic security) can inform development efforts to reduce refugees' dependency on external aid by promoting economic opportunities and social development. Similarly, *Recommendations 6.1* (on landscape management, resource governance, and social cohesion) and *Recommendation 6.5* (on sand extraction and conflict mitigation) can inform conflict-sensitive, peace-positive programming by highlighting the importance of addressing interconnected environmental and social development challenges in KMC. Lastly, *Recommendation 6.6* informs multi-sectoral knowledge generation and research efforts to support future evidence-based interventions in KMC.

6.1. Integrate block-level SuLMER volunteer roles for community-led landscape management, resource governance, and social cohesion

UNHCR can facilitate community-led waterway oversight by creating block-level volunteer roles for refugees and hosts. While SuLMER engaged camp volunteers to implement Cash-for-Work activities and environmental awareness campaigns, additional roles can support ongoing maintenance efforts as well as participatory design and oversight of future intervention phases. These roles should be organised within existing camp governance structures to enhance cross-sectoral coordination and avoid administrative overlap. Convening regular meetings of block-level SuLMER volunteers would support the intervention's sustainability by enhancing household engagement in landscape management, promoting community ownership of SuLMER, and strengthening social cohesion.

During SuLMER's inception phase, UNHCR and partners conducted preliminary focus group discussions to identify community priorities and integrate them into intervention objectives. During these sessions, community members expressed strong interest in actively addressing local environmental and sanitation issues, proposing block-level consultation meetings to prevent waste from entering drains and streams, stop unauthorised sand extraction, address pathway and stream bank encroachments, monitor plantations and fences, and receive seeds for cultivating vegetables at home and along the stream. Despite these contributions and that many households reported that they were well-informed about SuLMER's scope, most also reported having no role in its design or decision-making processes. Similarly, despite the ongoing presence of thematic working groups in the camp and the engagement of some individuals in advocacy activities, most households in the catchment have had limited involvement in the project's development. Ultimately, opportunities remain to increase the meaningful participation of local households in future project cycles.

Block-level volunteer roles, in which a cluster of host and refugee community members are made primarily responsible for upkeep of the waterway portion they live nearest to, would directly link households with the management of ecosystem services within the catchment. With support and oversight from UNHCR, volunteers and community members could participate in regular meetings to discuss the design, implementation, scaling, and long-term maintenance of SuLMER's activities, including the distribution of Cash for Work opportunities and kitchen gardens (see *Recommendation 6.3 and Recommendation 6.4*), supporting accountability and bottom-up accountability.

Block-level volunteers could also support SuLMER to deliver the capacity-building programs and training activities proposed in *Recommendation 6.2* and *Recommendation 6.3*, linking them with practical development and maintenance efforts within the catchment. Capacity-building should focus on participatory natural resource management and environmental education, ensuring that community members are equipped to actively participate in block-level meetings and shape the agenda of the catchment's participatory management plan (see *Recommendation 6.2*). Measures should be taken to support the active involvement of women in these roles and generally ensure equal representation of different socio-economic groups. By supporting capacity-building initiatives and facilitating regular exchanges between SuLMER volunteers from different blocks through existing camp community groups, UNHCR and partners can identify and promote best practices to address common challenges across blocks, such as shelter relocation and land access. In doing so, they can support the alignment and scaling of efforts at both the catchment and camp levels.

By promoting collaboration over natural resources and infrastructure development in the camps, SuLMER's block-level volunteers would contribute to intra- and inter-group collaboration, build trust among competing households and groups, and foster social cohesion (Krampe et al., 2021). To the greatest extent possible, volunteers should represent host and refugee households and ensure representation for marginalised groups. Additionally, through partnership with peace actors (e.g., respected community members and elders, and NGOs and INGOs focused on environmental peacebuilding, mediation, and conflict transformation) UNHCR can leverage regular SuLMER volunteer meetings to address tensions around the intervention's benefits, increase its conflict-sensitivity, support dispute resolution, and actively contribute to positive peace (see *Recommendation 6.2*, *Recommendation 6.3, and Recommendation 6.5*). These activities can also support soft skills development for conflict mediation, transformation, and resolution, thereby enhancing community resilience within the camps and, potentially, upon return if that is at some point possible. Fostering inclusive, community-led governance will allow SuLMER to support conflict mitigation in the camps and contribute to the Joint Response Plan's peacebuilding goals, including reducing potential tensions between host and refugee communities (Inter Sector Coordination Group, 2025a).

Beyond SuLMER, block-level volunteers could feed into the design and implementation phases of future interventions (e.g., under the broader KMC Watershed Restoration Plan and the Macro Site Plan), supporting alignment between community needs and larger development priorities. This approach would also enhance collaboration, mitigate potential tensions, and foster local ownership of intervention benefits.

6.2. Expand community-led waterway restoration, slope stabilisation, and waste management to improve environmental security

SuLMER's effect on flood and landslide mitigation can be strengthened by expanding riparian vegetation along the *Shoa Ma'r Jhiri* stream, rehabilitating tertiary canals upstream, implementing slope protection combined with terrace gardening in uphill areas, and supporting improved waste management. Additionally, developing a participatory landscape management plan would support community-led landscape restoration and maintenance within the catchment, along with localised early warning and DRR.

Soil erosion and damaged bankside reinforcements along the *Shoa Ma'r Jhiri* stream pose continuing risks for nearby households. This highlights an opportunity to expand soil stabilisation and slope protection measures through riparian vegetation and cover crops that reduce water-induced erosion. While SuLMER has successfully limited major flooding along the *Shoa Ma'r Jhiri,* some respondents expressed concerns that the bamboo, geobags, and geotextile currently reinforcing the banks and streambed may eventually deteriorate, re-exposing surrounding areas to severe floods. Though SuLMER included the plantation of riparian vegetation, at the time of research, the banks of the *Shoa Ma'r Jhiri* canal remained largely bare and highly susceptible to soil erosion, especially in the upstream and midstream sections. In some areas, kitchen gardens provide limited vegetation cover along the banks; their primary service is food production rather than soil protection. As most seasonal crops grown in kitchen gardens have shallow root systems that offer only modest soil stabilisation benefits, the integration of edible perennials (e.g., Leucaena leucocephala, Cocos nucifera, or Albizia saman), cover crops during fallow periods, and the application of organic mulches can reduce surface runoff and improve moisture retention (Fan et al., 2023; Hasan & Alam, 2006; Koudahe et al., 2022; Zhang et al., 2011). To further mitigate flooding, gully erosion, and landslides, riparian vegetation can be significantly scaled up by the establishment of multi-layered vegetation along stream banks. This approach, which includes grasses, shrubs or other woody plants, and trees, helps reduce rain-induced erosion by intercepting and redirecting rainfall at various heights. Additionally, the deep root systems of trees and woody plants are crucial for soil stabilisation and landslide reduction.

To ensure the sustainability of these measures, households should be actively involved in their design, implementation, and maintenance. Although many community members remain sceptical about the effectiveness of nature-based solutions, instead favouring hard infrastructure such as bricks and cement for stabilisation, there are significant advantages to adopting natural approaches. Hard infrastructure can be expensive, environmentally damaging, and has not been approved for use in the camps by the Government of Bangladesh. Instead, less permanent or durable materials have been used. While UNHCR should advocate to develop hard infrastructure as necessary, nature-based solutions can offer a more cost-effective and politically viable option to grey solutions. Additionally, by addressing disaster risk reduction through the restoration of ecosystem functionality, nature-based solutions can provide complementary ecosystem services, such as improved water filtration, soil stabilisation, and enhanced biodiversity (UNDRR et al., 2021). To address communities' concerns and align the intervention with their priorities, the value of nature-based measures should be clearly communicated to and discussed with residents, who should be actively engaged in identifying the type and location of activities.

The intervention can also be scaled to higher elevation areas adjacent to the current target geography to address landslide risk. As SuLMER's benefits were primarily concentrated among highly flood-vulnerable households adjacent to the streambank, uphill landslide mitigation efforts would benefit additional households. Several slope stabilisation techniques have proven successful in similar camp settings in Bangladesh. These include the application of biochar[26], which enhances soil water retention and infiltration capacity, improving resistance to erosion pressure (Meem et al., 2022); the implantation of recycled plastic pins, jute geotextiles, and steel bars for soil anchoring[27], which increases the soil's tensile and shear strength (Kamal et al., 2023; Meem et al., 2022); and slope terracing[28], which reduces erosion, improves water infiltration, slows water runoff, and enables terrace gardening (Kamal et al., 2023). Slope terracing is of particular interest for its potential to enhance food security (see *Recommendation 6.4*) and deepen household engagement in ecological stewardship. To determine which slope stabilisation techniques are appropriate for specific areas, technical teams and community members can work in tandem to balance geological factors such as slope angle, weight loading, soil type, availability of raw materials, costs, and maintenance requirements, with the needs of specific camp blocks.

As tertiary canals upstream of the *Shoa Ma'r Jhiri* are still highly vulnerable to flooding and landslides, SuLMER's geographic scope can be expanded to improve drainage capacity and flood and landslide mitigation throughout the catchment. Efforts should include dredging, excavation, streambed and bank stabilisation, the planting of riparian vegetation, and slope stabilisation. Cash for Work and community planning should be used to support livelihood and civil engagement in these areas.

While SuLMER has made progress in addressing environmental risks, current waste removal and sanitation measures can't compensate for the lack of a comprehensive waste management system at the catchment and camp levels. While a comprehensive and systematic waste collection, management, and safe disposal system should be implemented at camp level, alongside upgrades to WASH infrastructure, an intervention of this scale is out of SuLMER's purview. However, smaller improvements at catchment level can help prevent littering, mitigate waterborne health risks, and improve food safety. In addition to the grid chambers that trap floating waste, the protective nets that have already been installed over some portions of the waterway should be expanded to cover as much of the waterway as possible. Not only do nets prevent the dumping of trash in the waterway, but they also increase cultivable areas for small-scale gardening.

[26] *Biochar is a carbon-rich substance created by heating biomass such as wood, leaves, manure, and sludge at low temperatures in the presence of little or no oxygen supply.*

[27] *Steel bars, commonly known as "nails," are inserted into a slope to reinforce the soil and improve its stability.*

[28] *Slope terracing is a land management technique where a slope is converted into a series of stepped platforms or terraces.*

Despite improved water flow and decreased standing water, solid waste and grey and black water from households and some latrines continue to be discharged into the *Shoa Ma'r Jhiri*, posing significant health risks. As kitchen gardens along the stream are exposed to this contaminated water, pathogens such as bacteria (e.g., Salmonella and E. coli), viruses, and parasites may contaminate food and infect humans. Latrines that separate solid and liquid waste through the use of soak pits and septic tanks can mitigate these risks by enabling the gradual infiltration of filtered liquid waste into the ground, reducing surface runoff and contamination. While the technical units responsible for shelter, WASH (Water, Sanitation, and Hygiene), and camp management must take the lead in implementing and maintaining these infrastructure solutions, SuLMER can play a supporting role by actively engaging local communities and advocating for environmentally sound waste management practices. By applying a behavioural-change model, SuLMER can assess community attitudes and behaviours related to waste collection, management, and disposal, identifying barriers and opportunities for improvement. Additionally, SuLMER can support the mapping and monitoring of littering hotspots, wastewater feeder streams, and other water channels flowing into the catchment, enabling targeted interventions to prevent pollution and protect water quality.

To manage increasing climate risks, an integrated, climate-informed, and participatory landscape management plan should also be developed to manage ecosystem services and support multi-hazard mitigation through community-led DRR along the Shoa Ma'r Jhiri. While the KMC watershed management plan provides a large-scale blueprint for the rehabilitation and development of ecosystem services in the mega-camp, a more localised and participatory approach is needed to support ecosystem services and hazard mitigation at the catchment level. This comprehensive landscape management plan should combine both hard components (e.g., grey and green engineering measures, including flood barriers and improved drainage systems) and soft components, focusing on community engagement and capacity-building. Host and refugee households should co-develop these measures in partnership with camp authorities and local agencies (e.g., Union Parishad, Forest Department), ensuring active community involvement throughout design and implementation. This engagement is critical for the plan's sustainability and alignment with local priorities. Building on this catchment plan, a meso-level plan could then be developed that bridges the KMC plan with the Macro Site Plan, ensuring that landscape management components are aligned.

Existing analytical approaches to transforming food, land, and water systems can inform the development of community engagement strategies, foster local ownership, and help stimulate individual and collective action for environmental custody (Freed et al., 2025). Participatory design methods that have been successfully leveraged in other refugee settings (Albadra et al., 2021; Conti et al., 2020) can be adapted for SuLMER.

These include participatory scenario planning to identify, value, and prioritise ecosystem services and restoration activities (Malinga et al., 2013; Metzger et al., 2017) and participatory risk assessments that inform early warning systems and emergency plans (Tan, 2023). Additionally, capacity sharing related to environmental management and waste management will enable households to actively participate in and, where possible, lead the plan's implementation. These capacity sharing efforts can be coordinated through existing community groups and facilitated by block-level SuLMER volunteers (see *Recommendation 6.1*). Building on SuLMER, this model of community-led, participatory landscape rehabilitation and DRR action can be scaled up to inform broader landscape management initiatives, such as the Kutupalong Mega Camp (KMC) Watershed Restoration Plan (UNHCR et al., 2021).

As Camps 1W and 2W are projected to face increasingly severe and compounding climate hazards through 2040 (see Result 5.1), integrating early warning systems and community-led DRR action in the SuLMER catchment can further enhance resilience. Topographic risks, steep slope gradients, and clay-dominant soils within the camp also pose significant risks for landslides. Though beyond the scope of the SuLMER project, integrating early warning systems and DRR activities with ongoing rehabilitation and community engagement activities would improve preparedness. By leveraging existing community groups and block-level SuLMER volunteers, UNHCR and camp authorities can engage affected households directly in early warning activities.

6.3 Strengthen SuLMER's Cash for Work opportunities to build skills and enhance the economic security of host and refugee households

Strengthening the system through which Cash for Work opportunities are distributed and expanding access to the programme can build skills and generate temporary but important economic benefits for households. Most households in our sample exhibited high levels of economic vulnerability, characterised by very low monthly incomes, limited earning opportunities, and no access to formal employment. Consequently, most relied on external support for survival, with cash assistance and paid social work among the most common income sources in the research sample. As respondents repeatedly noted the positive effect of Cash for Work opportunities, expanding the program to include a wider variety and greater number of opportunities, while ensuring their equitable distribution, should be priorities moving forward. Additionally, incorporating capacity development activities into Cash for Work programs and extending skills-building activities to host households can help tackle the wider socio-economic challenges faced by both communities.

To maximise its effect, the Cash for Work programme should prioritise rehabilitation and development activities that strategically leverage limited resources by supporting projects that incrementally strengthen community resilience and environmental sustainability. These activities may include constructing new infrastructure, cleaning and dredging additional waterways for rehabilitation, stabilising slopes in high-risk areas, or reinforcing severely damaged parts of the watershed. Where basic upkeep is managed through Cash for Work, but systemic solutions are lacking, this approach may, in the long term, limit opportunities to promote agency and behavioural change. For example, it is recommended that ongoing garbage collection from rehabilitated streams be integrated into a structured waste management system that prevents pollution at the source while providing more financially sustainable and effective Cash for Work opportunities.

Importantly, the process through which Cash for Work opportunities are distributed should be reformed for improved transparency and equity. Refugees have reported dissatisfaction and a sense of unfairness with the influence reportedly exercised by Mahjis in the distribution of Cash for Work opportunities. To rectify this, UNHCR and relevant partners can provide oversight, with community volunteers (see *Recommendation 6.1*) involved to improve transparency. Ideally, Cash for Work opportunities could be distributed according to household vulnerability or needs-based criteria that account for the environmental and socio-economic determinants of risk, including gender (e.g., including a focus on female-headed households and households with pregnant women), education, income, indebtedness, and support received from other programmes (see *Result 5.3*).

However, conditions in the camp change rapidly, and ongoing needs assessments may be overly resource-intensive. In this case, a randomised allocation could be employed to ensure equitable access to opportunities. This could be implemented through a stratified lottery mechanism or other methods that can ensure transparency. Either would help rein in the Majhis' influence over the process, limiting potential for cash for work to be abused.

The scope of activities that utilise Cash for Work labour should also be expanded to support new SuLMER activities and geographies. These include those proposed in *Recommendation 6.2,* including enhancing riparian vegetation, extending stream rehabilitation to tertiary streams, and implementing hillside stabilisation measures in uphill areas of the catchment. By involving community members in the design and implementation of these new activities through block-level SuLMER volunteer roles and meetings (see *Recommendation 6.1*), Cash for Work can foster a sense of individual agency, environmental stewardship, and overall community ownership of the intervention.

Integrating capacity development and skills-building activities (including financial literacy) into Cash for Work can help address the broader socio-economic challenges faced by refugee communities and provide long-term benefits. Vocational training in higher-skilled construction, masonry, carpentry, welding, metalwork, and heavy machinery tasks would allow for a wider swathe of labour needs to be filled through Cash for Work opportunities and help equip refugees with employable skills for use later in life. As refugee women in KMC face gender-specific barriers to income opportunities and livelihood development (see *Result 5.3*), gender-specific efforts should be made to increase their participation in Cash for Work programs. Additionally, providing meaningful income opportunities for refugee youth can help mitigate recruitment by organised groups (see *Result 5.3* and *Recommendation 6.5)*.

Lastly, Cash for Work and vocational training opportunities can be extended to nearby host communities. Training modules can be used to upskill host community members in construction, agriculture, and environmental stewardship, which enhance employability and income-generation outside the camps. Additionally, training on environmental management, based on the SuLMER model, can support ecological stewardship throughout the watershed.

6.4. Support food security by scaling homestead gardening

Expanding SuLMER's kitchen garden components to include space-intensive homestead gardening approaches will improve the intervention's contribution to food and economic security. Kitchen gardens are oriented towards growing a limited variety of vegetables and herbs in small plots near the home, primarily for household consumption. In contrast, homestead gardening utilises roofs, walls, balconies, and other structural elements of shelters, along with small adjacent land areas, to cultivate a wider variety of crops for both subsistence and market-oriented production (Alam et al., 2024). These shelter- and community-level interventions can support food security, enhance dietary diversity, and boost household financial resources by saving money on food purchases. Moreover, by marginally reducing aid dependency and mitigating stress related to fluctuating market prices, they can have positive knock-on effects for psychosocial health (Tarchahani & Loos, 2023).

Homestead gardening techniques are already employed in some of the camps and include pit planting, sack gardening, trellising, vertical growing, or multi-layered systems that combine these methods (FAO et al., 2022). Pit planting involves creating small, enclosed areas that are framed with bamboo or biodegradable sheeting and partially integrated into the soil. Sack planting replaces fixed pits with movable sacks filled with the same soil–compost mix and mulch, with seeds or seedlings sown on the surface. These sacks are kept in sunny, flood-safe areas near homesteads and can be moved if necessary. Trellising involves constructing a lightweight horizontal bamboo framework that provides a canopy for climbing plants grown in pits or sacks beneath the trellis. In contrast, vertical growing uses a self-supporting bamboo frame that can be positioned near shelter walls to maximise space (FAO et al., 2022). Similarly, expanding the use of protective nets, which currently cover some sections of the rehabilitated *Shoa Ma'r Jhiri* stream, would provide additional growing areas for climbing crops such as bottle gourd, pumpkin, eggplant, and other climbing vegetables. In addition to supporting food security, protective nets help prevent the dumping of waste in the canal, reducing litter accumulation and supporting water flow and drainage capacity. The nets also act as a natural guardrail by enclosing the stream, preventing children from falling into the waterway, allowing them to play freely while minimising exposure to water-related hazards. Lastly, multilayer growing combines a soil bed (bottom layer), a trellis (middle layer), and a horizontally spread nylon net (top layer) to enable cultivation of a wider variety of vegetable species (FAO et al., 2022). With prior structural reinforcement, multilayer growing may be suitable for shelter rooftops. All of the above methods are well-suited to the soil-related challenges common in the camps, including salinity, stony or infertile soils, waterlogging, and erosion, while requiring minimal arable land and accommodating a range of seasonal crops (FAO et al., 2022).

Moreover, these household-level measures can be combined with community terrace gardening (see *Recommendation 6.2*) to further enhance household food security.

Given limited land access and food insecurity within the camps, actively engaging households in designing gardening interventions is essential. This promotes effective community resource management and helps ensure solutions meet local needs. Involving households in the design of home gardening projects can enable participants to take action over their own health and contribute to overall wellbeing through increased sociality and interconnectedness (Budowle & Porter, 2022). Food production and vegetation management activities can be mainstreamed as part of SuLMER's participatory landscape management plan (see *Recommendation 6.2*) and coordinated through SuLMER's block-level volunteers (see *Recommendation 6.1*). Collaboration with agriculture and food security-focused organisations such as FAO, WFP, and the Cox's Bazar Food Security Cluster can provide technical expertise and development resources to ensure the sustainability of these initiatives. Additionally, working with the Bangladesh Forest Department can support scalability beyond Camps 1W and 2W, potentially as part of the broader Kutupalong Mega Camp (KMC) Watershed Restoration Plan (UNHCR et al., 2021).

6.5. Strengthen community-led dispute resolution mechanisms and address underlying vulnerabilities to mitigate disputes over sand extraction

By successfully improving the *Shoa Ma'r Jhiri's* water flow and drainage capacity, SuLMER has inadvertently led to siltation downstream, where the stream flows into the Madhur Chhara waterway. This has resulted in unregulated sand extraction that threatens the stability of the stream banks and walkway, and triggers intra-communal conflicts, both among those attempting to extract sand and between extractors and nearby households seeking to prevent resource depletion (see *Result 5.6*). These dynamics intersect with developmental and environmental challenges in the camps and present a significant protection challenge for UNHCR.

A two-pronged approach is needed to support conflict mitigation and social cohesion in downstream areas affected by sand extraction: immediate efforts to defuse ongoing tensions through increased conflict resolution measures, and a longer-term approach that addresses the underlying vulnerabilities that lead to conflict in the camps. To defuse ongoing tensions, SuLMER can quickly develop community-led conflict resolution mechanisms to manage disputes arising from sand extraction. These mechanisms should be rooted in locally recognised mediation structures, ensuring that grievances are addressed before they lead to violence.

Block-level SuLMER volunteers (see *Recommendation 6.1*) can facilitate mediation efforts, support conflict resolution and, where appropriate, enable interpersonal contact between individuals with pre-existing grievances. Additionally, collaboration with community leaders, refugee representatives, and relevant authorities can support dialogue and establish clear, enforceable guidelines for sustainable sand use. As a common-pool resource, sand can be managed collectively through local bodies that ensure sustainable extraction and equitable benefit-sharing arrangements. Community-based resource governance can enhance local livelihoods and ecosystem services, ensure sustainable resource use and mitigate the conflicts that have increased in SuLMER's wake.

To address the underlying vulnerabilities that drive sand mining, as well as recruitment by organised groups and other criminal activities in the camps more generally, programming should aim to provide alternative pathways to social and economic empowerment. Youth are especially vulnerable, as limited access to education, income, and personal development opportunities lower the opportunity costs for them to join organised groups or engage in criminal acts (see *Result 5.3*). Although youth engagement programming is ongoing[29], gambling, crime, and recruitment are growing issues among the camps' youth. Despite not being able to formally work, livelihood and skills development programs can provide youth with skills that may benefit themselves and their communities. However, a lack of commensurate employment opportunities may drive frustration once training is complete. Advanced educational initiatives that provide higher education would keep more children in school longer, as current school programming stops at the 11th grade. As Madrassas are cultural cornerstones of the Rohingya community, faith-based initiatives could foster collaboration between religious and humanitarian education providers. Joint programming can then be used to mitigate youth recruitment by organised groups (Protection Sector, 2025). Existing athletic and recreational activities (such as football, volleyball, badminton, *sepak takraw,* indoor games, and cultural activities) should also be expanded, and equal access ensured for girls and boys. However, in the absence of real opportunities for personal fulfilment and economic development, the root causes of violence in the camps will grow more severe, posing an increasing safety threat for refugees.

[29] *Currently, 25 training centres across 21 camps provide educational lessons up to grade 11 that follow following a Myanma-style curriculum. Additionally, skills development initiatives are available for 15-24 year However, these initiatives are scheduled to be reduced due to impending funding cuts (Human Rights Watch, 2025).*

6.6. Continue building the evidence-base to strengthen resilience-oriented HDP interventions in Ukhiya

Until refugee return is safe and voluntarily possible, evidence-based humanitarian, development, and peacebuilding interventions remain essential for building resilience in displacement. Drought, heat, floods and compound hazards are projected to intensify or remain at extreme levels in Ukhiya by 2040 (see *Result 5.1*), posing increasing risks for refugee and host communities alike. To support the design and implementation of integrated interventions, timely, locally relevant evidence can be generated through strategic partnerships. Working through the Inter Sector Coordination Group (ISCG) and in collaboration with its members (FAO, IOM, UNFPA, UNICEF, WFP, and WHO), UNHCR is well-positioned to facilitate knowledge generation through collaboration with civil society organisations, government agencies, and research organisations. At the project level, SuLMER has made notable progress in this regard through partnerships with WFP (e.g., on Cash for Work support and on Small and Medium Engineering Project on grey solutions for land stabilisation), FAO (e.g., on planting techniques and materials), the International Union for the Conservation of Nature, and, for this research, the Alliance of Bioversity International and CIAT, a CGIAR research centre.

Future research to support HDP efforts in the catchment and, more broadly, in KMC and the Cox's Bazar camps can build on this report by assessing the climate resilience of host and refugee households at different geographic scales and across longitudinal points in time. Comparative assessments of environmental rehabilitation efforts in different geographies with similar socio-economic and environmental traits can support cross-contextual knowledge transfer. Moreover, future research can adopt a broader, integrated landscape approach that considers the effect of compound hazards and integrated programming on interconnected ecosystems in Cox's Bazar. Severe rainfall, floods, droughts, and heat waves damage ecosystems by reducing vegetation cover, accelerating soil erosion, and disrupting water flows. In turn, degraded ecosystems are less capable of mitigating hazard impacts, thereby increasing the vulnerability of communities in KMC and Ukhiya over time. Variations in landscape features such as slope, soil quality, vegetation cover, and land use patterns also influence how impacts are distributed across households. Mapping these complex interrelated factors and related effects can help expand the scope and scale of the SuLMER initiative beyond the *Shoa Ma'r Jhiri* watershed. By doing so, future research can support UNHCR and other HDP actors to design larger-scale landscape restoration initiatives.

Although Cash for Work programs have provided short-term relief for refugees, they are not sustainable long-term solutions. As such, mixed-method feasibility studies could identify which ecosystem-based livelihood activities, e.g., homestead gardening and small-scale agricultural production, aquaculture, and tree nursery (FAO, 2022, 2023; WorldFish, 2011), are viable within the camps.

Despite restrictions on movement and formal market activities, as well as a shortage of arable land and clean water, some of these activities can likely be scaled up to support household economic security and local development. Integrated cooperative models that involve both host and refugee communities can help ensure the benefits of local production are shared equitably. Moreover, business models incorporating both refugees and host community members may support market access and inter-group social cohesion. All of these activities require preliminary research to assess feasibility and scaling potential.

Finally, follow-up studies with similar methodologies can collect data at multiple time points, providing stronger evidence for (or against) the results presented here. Resilience is grounded in long-term sustainability, and the collection of data at multiple time points will help understand SuLMER's long-term effects and develop panel data that improves our ability to establish causality.

Section 7: Conclusion

The results and recommendations detailed in this report align with a larger body of research showing that climate action and resilience building are both critical and feasible in protracted refugee settings (Al-Zu'bi, 2025; FAO, 2025; Fransen et al., 2024; Jaskolski et al., 2024; Perry, 2024; USA for UNHCR, 2024). While acknowledging that structural limitations undermine the agency and wellbeing of the Rohingya in Cox's Bazar, UNHCR can meaningfully collaborate with refugees, host communities, government authorities, and other HDP actors to strengthen refugees' resilience to climate risks. By leveraging cross-sectoral coordination and investing in inclusive, community-driven approaches, UNHCR can support climate adaptation, household resilience, and social cohesion amongst refugee and host communities.

Though this research focused on the current phase of the SuLMER initiative, with data collection occurring in October 2024, the recommendations presented above are applicable to ongoing humanitarian, development, and peace (HDP) programming in the Kutupalong Mega Camp (KMC) and, more broadly, in refugee camps throughout Cox's Bazar. By highlighting the interplay of environmental, social and economic factors, these recommendations provide technical entry points for further collaboration among HDP actors. Specifically, they can support Strategic Objective 2 of the 2025-26 Joint Response Plan (Strengthen the protection and resilience of Rohingya refugee/ FDMN women, men, girls, and boys), as well as the Plan's general protection framework, most notably Protection Pillar 3 on Promoting a safe and protective environment, by highlighting how protection priorities intersect with the need for integrated development and peacebuilding efforts.

Developed in response to the social, economic, and environmental challenges faced by flood-affected households in the *Shoa Ma'r Jhiri* catchment, our recommendations are relevant for other flood-affected refugee camps in Cox's Bazar and similar contexts of protracted international forced displacement. By building on the achievements of UNHCR's SuLMER initiative and identifying areas for enhancement, this research aims to support scaling efforts and inform future resilience programming for Rohingya households facing interconnected climate, mobility, and conflict risks. This research can inform future phases of SuLMER in the *Shoa Ma'r Jhiri* watershed and, more broadly, the KMC Watershed Restoration Plan and the Blue Green Network component of the Macro Site Plan, thereby contributing to the evidence base for landscape restoration and watershed rehabilitation projects throughout the camps in Cox's Bazar.

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Annex 1. Additional methods

Annex 1.1: Key Concepts

Resilience

In this report, we define resilience as the agency of individuals and groups to achieve wellbeing by anticipating, withstanding, recovering from, and transformatively adapting to hazards (Savelli et al., 2023[30]). As such, it combines operationally-oriented definitions, such as that of the Sendai Framework for Disaster Risk Reduction 2015-2030 (UNISDR, 2015[31]), with transformative notions of agentic development and human freedom (Sen, 2019[32]). This acknowledges that resilience relates not just to objective technical parameters, but also to individuals' self-defined wellbeing and adaptation preferences (Coulthard, 2012[33]), and an understanding of the structural "root causes of [their] experienced (dis)advantage" (Poveda & Roberts, 2018: 6[34]).

- By anticipating, we mean the ability of individuals and groups to understand and effectively prepare for hazards before they occur.
- Withstanding relates to the capacity of individuals and groups to mitigate the negative impacts hazards as they are taking place.
- Recovery is the ability of individuals and groups to establish wellbeing after the impacts of a hazard are felt. While these "before, during, and after" stages of change are, in reality, not always discrete, they are conceptually useful as they allow for an analysis of change from different temporal viewpoints.
- Finally, transformative adaptation involves actions that address the root causes of vulnerability and catalyse social transformation through empowerment, equity, and sustainability (Colloff et al., 2017[35]; Fedele et al., 2019[36], 2020[37]; Few et al., 2017[38]; Hellin et al., 2022[39]; Kates et al., 212[40]).

[30] *Savelli, A., Khalid, S., Vaselli, A., & Sarzana, C. (2023). Assessing climate action interventions along the humanitarian-development-peace nexus: A methodology tailored for evaluating contributions to resilience in destination areas.*

[31] *UNDRR(2015). Sendai Framework for Disaster Risk Reduction 2015-2030 (p. 32). United Nations Office for Disaster Risk Reduction (UNDRR).*

[32] *Sen, A. (1999). Development as freedom. Oxford University Press.*

[33] *Coulthard, S. (2012). Can we be both resilient and well, and what choices do people have? Incorporating agency into the resilience debate from a fisheries perspective. Ecology and Society, 17(1).*

[34] *Poveda, S., & Roberts, T. (2018). Critical agency and development: applying Freire and Sen to ICT4D in Zambia and Brazil. Information Technology for Development, 24(1), 119-137.*

[35] *Colloff, M. J., Martín-López, B., Lavorel, S., Locatelli, B., Gorddard, R., Longaretti, P. Y., ... & Murphy, H. T. (2017). An integrative research framework for enabling transformative adaptation. Environmental Science & Policy, 68, 87-96.*

[36] *Fedele, G., Donatti, C. I., Harvey, C. A., Hannah, L., & Hole, D. G. (2019). Transformative adaptation to climate change for sustainable social-ecological systems. Environmental Science & Policy, 101, 116-125.*

[37] *Fedele, G., Donatti, C. I., Harvey, C. A., Hannah, L., & Hole, D. G. (2020). Limited use of transformative adaptation in response to social-ecological shifts driven by climate change. Ecology and society, 25(1).*

[38] *Few, R., Morchain, D., Spear, D., Mensah, A., & Bendapudi, R. (2017). Transformation, adaptation and development: relating concepts to practice. Palgrave communications, 3(1), 1-9.*

[39] *Hellin, J., Amarnath, G., Challinor, A., Fisher, E., Girvetz, E., Guo, Z., ... & You, L. (2022). Transformative adaptation and implications for transdisciplinary climate change research. Environmental Research: Climate, 1(2), 023001.*

[40] *Kates, R. W., Travis, W. R., & Wilbanks, T. J. (2012). Transformational adaptation when incremental adaptations to climate change are insufficient. Proceedings of the National Academy of Sciences, 109(19), 7156-7161*

This implies "the re-evaluation of current interactions between humans and nature, through new management, use, benefit distribution, and values that challenge or redirect the dominant feedback loops" within a social-ecological system (Fedele et al., 2020: 9[41]). Thus, transformative adaptation is concerned with more than just day-to-day survival; it is oriented toward the wholesale reconfiguration of social-ecological systems for greater equity, sustainability, and revolutionary capacity.

Acknowledging that resilience is a subjective notion (Jones & Tanner, 201742) rather than an objective benchmark, we operationalise the term here to compare local notions of resilience that emerge from intervention participants' values, knowledge, and experiences (Jones & d'Errico, 201943) with that of the research team.

Human Security

Human security is defined by the UN as "[living] in freedom and dignity, free from poverty and despair … with an equal opportunity to enjoy all [one's] rights and fully develop [one's] human potential" UN general Assembly, 2012[44]). Rooted in the recognition of social, political, and environmental rights, human security calls for "context-specific and prevention-oriented responses that strengthen the protection and empowerment of all people and all communities" (UN general Assembly, 2012[45]). In this research, the concept serves to characterise how threats to economic, social, and environmental security manifest within a given social-ecological system to undermine individual agency. Building on Adger et al. (2021[46]) and Le et al.[47], human security is operationalised here through a survey questionnaire we use to construct a Human Security Index (HSI). The HSI functions as a measurement of how intervention participants perceive their own human security and, thus, also helps to identify ways of strengthening human security through resilience-oriented intervention.

[41] *Fedele, G., Donatti, C. I., Harvey, C. A., Hannah, L., & Hole, D. G. (2020). Limited use of transformative adaptation in response to social-ecological shifts driven by climate change. Ecology and society, 25(1).*

[42] *Jones, L., & Tanner, T. (2017). 'Subjective resilience': using perceptions to quantify household resilience to climate extremes and disasters. Regional Environmental Change, 17, 229-243.*

[43] *Jones, L., & d'Errico, M. (2019). Whose resilience matters? Like-for-like comparison of objective and subjective evaluations of resilience. World Development, 124, 104632.*

[44] *UN General Assembly. (2012). A/RES/66/290. Follow-up to Paragraph 143 on Human Security of the 2005 World Summit Outcome Document*

[45] *Ibid.*

[46] *Adger, W. N., de Campos, R. S., Siddiqui, T., Gavonel, M. F., Szaboova, L., Rocky, M. H., ... & Billah, T. (2021). Human security of urban migrant populations affected by length of residence and environmental hazards. Journal of Peace Research, 58(1), 50-66.*

[47] *Forthcoming*

Linking resilience and human security

Despite addressing different aspects of wellbeing, resilience and human security are closely related as they build on shared assumptions of security, development, and equity. As such, we generally expect that higher levels of resilience will correspond with higher levels or human security, and vice versa. Additionally, resilience and human security are both shaped by agency, or "the ability to define one's goals and act upon them" in line with "the meaning, motivation and purpose [that] individuals bring to their [activities]" (Kabeer, 1999: 438[48]). Through its ability to determine the qualitative and quantitative aspects of human security and resilience, agency relates directly to wellbeing. Agency is shaped by a mix of locally-contextual factors (including the structural, historical, political economic, and environmental nature of a social-ecological system) as well as "external" interventions, including those by humanitarian-development-peace actors. While greater agency does not directly or necessarily result in greater resilience or human security, in contexts where resilience and human security levels are low, increased agency is generally assumed to have a positive impact on both. In turn, the more agency that community members exercise over humanitarian-development-peace interventions intended for their benefit, the more we expect the intervention to achieve its aims.

Annex 1.2: Human Security and Resilience Survey

The survey employed a version of (Adger et al., 2021[49]) Human Security Index that has been modified for rural contexts (Le et al., Forthcoming[50]). The survey consisted of four sections. Section 1 employed a range of demographic questions to categorise participants according to gender, age, ethnicity, income, and other relevant socio-economic markers. In Section 2, a Human Security Index was constructed to serve as the independent variable. Here, human security is defined as a set of environmental, economic, and social variables that affect individual wellbeing. A Human Security Index, based on respondent scores, is used as a control variable to account for variations in perceived human security, which may be influenced by local economic, social, or environmental variables. These perceptions can affect how respondents report their own resilience outcomes, regardless of the intervention's actual benefits. Controlling for these variables enhances confidence in the analysis of the interventions' contributions to households' resilience.

[48] *Kabeer, N. (1999). Resources, agency, achievements: Reflections on the measurement of women's empowerment. Development and change, 30(3), 435-464.*

[49] *Adger, W. N., de Campos, R. S., Siddiqui, T., Gavonel, M. F., Szaboova, L., Rocky, M. H., ... & Billah, T. (2021). Human security of urban migrant populations affected by length of residence and environmental hazards. Journal of Peace Research, 58(1), 50-66.*

[50] *Forthcoming.*

Human security elements	Description
ECONOMIC SECURITY	
Employment	Stability of income
Housing	Housing quality and tenure security
Food Security	Availability and stability of food
SOCIAL SECURITY	
Crime	Frequency of crime and general feeling of safety, including sexual, racial and other forms of harassment
Political voice	Opportunities for civic engagement and participation in governance processes
Discrimination	Prejudicial treatment of demographic groups, including the poor, less educated, women, and ethnic/religious minorities
ENVIRONMENTAL SECURITY	
Healthcare	Quality and availability of medical services
WASH	Access to clean water and gender-appropriate hygienic sanitation services
Hazards	Exposure to environmental hazards

Table 3 Economic, social, and environmental dimensions of individual-level human security index adapted from Adger et al. (2021[51]) and Le et al., (Forthcoming).

[51] *Ibid.*

In Section 3, respondents were asked a series of questions probing how well they believe the intervention has addressed issues of resilience, as defined by the research team (in helping them to anticipate, withstand, recover from, and transformatively adapt to hazards) (Savelli et al., 2023[52]). Finally, Survey Section 4 provided open space for respondents to elaborate on issues of importance that they would like to see prioritised in future interventions. While Section 2 describes respondents perceived human security levels independent of the intervention, Sections 3 and 4 help explore how the respondents' perceived resilience has changed since participating in the intervention. A matrix analysis assesses how the intervention was perceived by and (may have) contributed to the resilience of participants with varying levels of human security. Additionally, by comparing intervention-related outcomes across demographic groups (disaggregated by gender, age, income, location of origin, etc.), we performed an intersectional assessment of which community members benefited most and least from the intervention.

A quasi-random mixed-method sampling approach was used for the survey. For the treatment group, respondents were selected from the pre-defined SuLMER catchment area. The area was divided into three sampling points (downstream, midstream, and upstream) distributing the stream into equal segments. To identify sampling areas for the control group, a field visit was conducted to areas that were geographically adjacent to the SuLMER catchment, shared similar ecological characteristics, and had comparable exposure to rainfall and flooding events, but that were hydrologically sequestered from the Shoa Ma'r Jhiri so that they would not have experienced any downstream effects of SuLMER's rehabilitation activities. Three portions of streams, which also flow into Madhur Charra, were identified for the control group (refer to Figure 11 for map of Treatment and Control group sampling points). These areas had experienced similar vulnerabilities to rainfall and flooding, but were not influenced by the SuLMER intervention. Similar to the treatment group, each chosen stream in the control group had three sampling points (upstream, midstream, and downstream). At each sampling point, in both the treatment and control groups, a team of enumerators (one male and one female), supported by a Social Mobilisation Suppport (SMS) volunteer selected alternate households along the stream and perpendicularly along the tertiary streams. One male and one female respondent were selected from each household, depending on availability. At the time of the research, households located closest to the waterways in Camps 1W and 2W (those most exposed to flooding) were predominantly refugees. To ensure statistical relevance and comparability in flood exposure, the survey and key MSC/PD informant interviews included only refugee participants. Overall, the survey was conducted with 502 respondents: 267 from the treatment group and 235 from the control group. Data analysis was performed to assess the effect of the treatment intervention on resilience outcomes. Linear models were used to assess treatment effects, while multivariate models utilising Seemingly Unrelated Regression (SUR) techniques were applied to explore the treatment's effects on the sub-types of resilience) anticipation, withstanding, recovering, and transformative adaptation (across both simple and interaction models. Robust standard errors and bootstrapping methods were employed to ensure the reliability of the estimates, and diagnostic tests were conducted to validate the models.

[52] *Savelli, A., Khalid, S., Vaselli, A., & Sarzana, C. (2023). Assessing climate action interventions along the humanitarian-development-peace nexus: A methodology tailored for evaluating contributions to resilience in destination areas.*

VARIABLES	TREATMENT GROUP (N = 241) - AVERAGE	CONTROL GROUP (N = 218) - AVERAGE
SUBJECTIVE RESILIENCE (MAX - 4)	2.45	2.49
HUMAN SECURITY INDEX (MAX - 4)	2.04	2.42
TOTAL HOUSEHOLD MEMBER	5.6	5.3
AVERAGE AGE OF RESPONDENT	36	31
% OF FEMALE RESPONDENTS	47.3%	50.2%
ESTIMATED INCOME PER MONTH (TAKA)	37,360	26,456
# OF YEARS SINCE MIGRATED	7.0	6.85
% - NO SCHOOLING	36.7%	27.6%
% - PRIMARY SCHOOL	54.3%	52.9%
% - SECONDARY SCHOOL	9.0%	14.5%

SCHOOL		
SOURCES OF INCOME	Unskilled wage (29.3%) Cash assistance (21%) Skilled wage (12.0%) Paid social work (10.9%) Self-employment (6.5%)	Unskilled wage (29.1%) Cash assistance (5.7%) Skilled wage (8.4%) Paid social work (12.3%) Self-employment (9.2%)
% OF PEOPLE WITH DEBT	49.43%	69.36%
NON-UNHCR SUPPORT RECEIVED	Shelter (46.81%) NFI (62.17%) Health services (72.28%) Community infra.(27.71%)	Shelter (46.81%) NFI (62.17%) Health services (72.28%) Community infra.(27.71%)
CLIMATE HAZARD EXPOSURE	Severe Rainfall (24.8%) Cyclones/Storms (29.6%) Heavy flooding (14.9%) Waterlogging (16.1%) Extreme Temperatures (14.5%) (heat waves)	Severe Rainfall (26.6%) Cyclones/Storms (21.1%) Heavy flooding (24.3%) Waterlogging (13.1%) Extreme Temperatures (14.9%) (heat waves)
EXPOSURE TO VIOLENCE	Gunshot/Killing (44.94%) Theft (42.32%) Violence within community (43.8%) Verbal harassment (28.83%) Human Trafficking (17.60%)	Gunshot/Killing (48.94%) Theft (48.09%) Violence within community (25.11%) Verbal harassment (26.38%) Human Trafficking (34.04%)

Table 4 Demographic variables distribution across treatment and control groups

Annex 1.3: Key informant interviews

Key informant interviews with UNHCR and local stakeholders

A series of semi-structured key informant interviews (KIIs) were performed with stakeholders involved in the intervention's design, implementation, and MEL process, to elicit information on the camps' social-ecological systems and on how resilience was conceptualised and incorporated into the intervention. Interviewees included UNHCR employees, camp authorities (including the Camp in Change and the Camp Manager officers) camp volunteers, Bangladeshi households in the camps, local governmental Union representatives, and refugee leaders appointed in the KMC camps (Mahjis).

Key informant interviews with participant households

A series of semi-structured interviews employing most significant change and positive deviance approaches were performed with household participants. Interviews aimed to understand how and why certain individuals may have experienced disproportionately positive outcomes because of the intervention, as well as how these outcomes might be scaled to additional participant groups. Extreme (or deviant) case sampling, a form of purposive sampling, was employed to isolate household participants who have experienced significantly better outcomes compared to the mean. Participants were identified through community participants and in consultation with the research partners.

Most significant change is a narrative evaluation technique that explores how an intervention is experienced by participants (Tonkin et al., 2021[53]). Positive deviance aims to identify individuals who have experienced relatively better outcomes because of a project or intervention, identify the uncommon practices or enabling factors that led to this disproportionately positive outcome, and devise ways of scaling these practices or enablers to a larger group of participants (Marsh et al., 2004[54]). By combining these two approaches, KIIs aim to 1) understand participants' experiences of the intervention generally and in relation to various outcomes (positive, negative, no change), and 2) drill deeper into the experiences of those with positive outcomes to identify ways of improving future interventions, or new iterations of the current one.

[53] *Tonkin, K., Silver, H., Pimentel, J., Chomat, A. M., Sarmiento, I., Belaid, L., ... & Andersson, N. (2021). How beneficiaries see complex health interventions: a practice review of the Most Significant Change in ten countries. Archives of Public Health, 79, 1-8.*

[54] *Marsh, D. R., Schroeder, D. G., Dearden, K. A., Sternin, J., & Sternin, M. (2004). The power of positive deviance. Bmj, 329(7475), 1177-1179.*

Annex 1.4: Development of climate hazards indices

In order to develop hazard indices, baseline (1980-2010) and future (2020-2040) annual climate data were extracted from the Phase 6 Coupled Model Intercomparison Project (CMIP6). CMIP6 is a global initiative that provides climate projections simulated from a comprehensive set of the latest state-of-the-art climate models. An ensemble of several general circulation models from different modelling centers globally was used to generate climate data, which was gridded to a common 0.7°×0.7° grid resolution.

Climate hazards are classified on a scale ranging from low to extreme based on standardised thresholds derived from historical climate data (1980-2010). The classification methodology for each hazard type is as follows. The assessment of heat hazard is based on the Heat Index (HI), which combines temperature and humidity to reflect perceived temperature by the human body (NOAA, 2023[55]). This combination provides a "real feel" temperature more relevant to human comfort and health impacts, making it a more accurate measure of heat stress than temperature alone. Our severe threshold is defined as 30 or more days per year with HI ≥41°C, representing dangerous to extremely dangerous conditions where prolonged exposure can lead to heat stroke and other serious health impacts. The extreme threshold is defined as 72 or more days per year with HI ≥41°C (the 99th percentile of the baseline distribution).

Drought conditions are assessed using the 12-month Standardized Precipitation Evapotranspiration Index (SPEI-12), which accounts for both precipitation and evapotranspiration. Our severe threshold corresponds to SPEI values under -1.0, while extreme conditions are defined as SPEI values of -2.0 or lower, aligning with the standard classification of extreme drought conditions that significantly impact water resources and agriculture (McKee et al., 1993[56]).

Flood risk is evaluated using the Simple Daily precipitation Intensity Index (SDII), measuring the average rainfall intensity on wet days (≥1mm rainfall) which quantifies how intense rainfall events lead to a likelihood of pluvial flooding (Frich et al., 2002[57]). Our severe threshold is set at 10 mm/day (corresponding to moderate rain intensity that becomes hazardous when sustained), while the extreme threshold is 14.6 mm/day (the 99th percentile of values above 10 mm/day), indicating intense rainfall highly likely to cause flooding. We consider only SDII values above 10 mm/day in our distribution, focusing on rains at least as intense as moderate according to standard rainfall classifications (Bhatla et al., 2019[58]; Wang et al., 2021[59]).

[55] *NOAA. (2023). https://www.noaa.gov/jetstream/synoptic/heat-index*

[56] *McKee, T. B., Doesken, N. J., & Kleist, J. (1993, January). The relationship of drought frequency and duration to time scales. In Proceedings of the 8th Conference on Applied Climatology (Vol. 17, No. 22, pp. 179-183).*

[57] *Frich, P. A. L. V., Alexander, L. V., Della-Marta, P., Gleason, B., Haylock, M., Tank, A. K., & Peterson, T. (2002). Observed coherent changes in climatic extremes during the second half of the twentieth century. Climate research, 19(3), 193-212.*

[58] *Bhatla, R., Verma, S., Pandey, R., & Tripathi, A. (2019). Evolution of extreme rainfall events over Indo-Gangetic plain in changing climate during 1901–2010. Journal of Earth System Science, 128, 1-14.*

[59] *Wang, W., Hocke, K., & Mätzler, C. (2021). Physical retrieval of rain rate from ground-based microwave radiometry. Remote sensing, 13(11), 2217.*

Normalisation and Composite Index Construction:

Compound climate events manifest through the interaction of hazards and/or climate drivers, such as extreme heat and drought or strong winds and heavy precipitation (Ridder et al., 2020[60]; Zscheischler et al., 2018[61]). The individual hazards themselves do not necessarily need to be extreme, but it's rather the co-occurrence or compound nature that renders them a serious threat. To enable comparison across different hazard types, individual indices are normalised to the interval [0,1] and aligned using the severe thresholds as reference points. Each severe threshold is positioned at 0.6 on the normalised scale, ensuring consistent interpretation across hazards. Values are then rescaled so that extreme conditions fall within the 0.8-1.0 range, with proportional scaling for moderate (0.2-0.4) and high (0.4-0.6) categories. The composite hazard index employs a Euclidean norm approach with negative inverse transformation: $Ic = -1/\sqrt{(\sum Ik^2)}$, where Ik represents each individual hazard index. This is designed to satisfy two key principles: (1) capture the severity of individual hazards when any reach extreme values, rather than allowing averaging to mask critical risks, and (2) reflect compounding effects when multiple hazards co-occur simultaneously. This mathematical approach ensures that both isolated extreme events and compound moderate events are appropriately weighted in the final risk assessment.

Categorical Classification Rationale:

The resulting composite index values are divided into five equal-range categories (Low: 0.0-0.2, Moderate: 0.2-0.4, High: 0.4-0.6, Severe: 0.6-0.8, Extreme: 0.8-1.0) that represent relative risk rankings rather than absolute physical thresholds. These categories provide actionable information for humanitarian planning and climate adaptation.

Annex 1.5: Data Analysis: Models and Regression Output

In this analysis, four regression models were used to assess the intervention's effect on subjective resilience. The first model served as the base model, which explored the relationship between the treatment and outcome (subjective resilience). This model used a standard linear regression approach, where subjective resilience was the dependent variable, and treatment and other control variables were the main predictors. The second model, a more complex variation of the first, employed Seemingly Unrelated Regression (SUR) to model the four resilience sub-types simultaneously, accounting for the potential correlation between the error terms across these equations. This model allowed for more efficient estimation by capturing the interdependence between different resilience outcomes, which may not be independent of each other.

[60] *Ridder, N. N., Pitman, A. J., Westra, S., Ukkola, A., Do, H. X., Bador, M., ... & Zscheischler, J. (2020). Global hotspots for the occurrence of compound events. Nature communications, 11(1), 5956.*

[61] *Zscheischler, J., Westra, S., Van Den Hurk, B. J., Seneviratne, S. I., Ward, P. J., Pitman, A., ... & Zhang, X. (2018). Future climate risk from compound events. Nature climate change, 8(6), 469-477.*

Furthermore, to assess how the treatment's effect on subjective resilience varies with other factors, the third model (an extension of the first) incorporates interaction terms between the treatment variable and selected explanatory variables. This method examines whether the relationship between the treatment and the outcome varies based on these covariates. Such an approach helps identify if the treatment's impact differs across various subgroups or under different conditions, thereby providing deeper insights into its effectiveness in specific contexts. The fourth model extended the second model by interacting treatment with selected explanatory variables, similar to the third model but within the context of the SUR framework. The explanatory variables remained consistent in all models, but several steps were taken to ensure the robustness of results. First, outliers were identified using statistical methods such as the IQR (Interquartile Range) method or z-scores, which helped to detect and exclude extreme values that could distort the results. Secondly, for both the simple regression and SUR models, robustness checks including tests for multicollinearity, heteroscedasticity, and autocorrelation were conducted to ensure the reliability and validity of the model estimates.

GENERAL EQUATION FOR THE FIRST AND SECOND MODELS:

$$\text{Resilience}_i \sim \beta_0 + \beta_1 \cdot \text{Treatment}_i + \beta_2 \cdot X_i + \epsilon_i$$

where:
Resilience_i represents the subjective resilience outcome for individual i,
Treatment_i is the treatment indicator (0 for control, 1 for treatment),
X_i are the control variables (e.g., age, gender, income),
ϵ_i is the error term.

GENERAL EQUATION FOR THE THIRD AND FOURTH MODELS:

$$\text{Resilience}_{i1} \sim \beta_0+\beta_1\cdot\text{Treatment}_i+\beta_2\cdot X_i+\epsilon_{i1}$$
$$\text{Resilience}_{i2} \sim \beta_0+\beta_1\cdot\text{Treatment}_i+\beta_2\cdot X_i+\epsilon_{i2}$$
$$\text{Resilience}_{i3} \sim \beta_0+\beta_1\cdot\text{Treatment}_i+\beta_2\cdot X_i+\epsilon_{i3}$$
$$\text{Resilience}_{i4} \sim \beta_0+\beta_1\cdot\text{Treatment}_i+\beta_2\cdot X_i+\epsilon_{i4}$$

where:
Each equation represents a different sub-types of resilience
(Resilience_{i1} is anticipation, Resilience_{i2} is withstanding, Resilience_{i3} is recovering, Resilience_{i4} is transformative adaptation),

The model is estimated with the SUR technique, accounting for the correlation between ϵ_{i1}, ϵ_{i2}, ϵ_{i3}, ϵ_{i4} (the residuals).

	Model 1: Resilience	Model 2: Anticipate	Model 2: Withstand	Model 2: Recover	Model 2: Transform
	Estimate (SE)	Estimate (SE)	Estimate (SE)	Estimate (SE)	Estimate (SE)
Intercept	0.560 (0.206)***	0.549 (0.212)**	0.715 (0.251)**	0.559 (0.260)*	0.415 (0.278)
Treatment_Group	**0.271 (0.048)*** **	**0.166 (0.050)*** **	**0.251 (0.059)*** **	**0.195 (0.061)** **	**0.470 (0.065)*** **
HSI	1.085 (0.061)***	1.024 (0.063)***	1.018 (0.075)***	1.128 (0.077)***	1.171 (0.083)***
Age	-0.001 (0.001)	-0.001 (0.001)	-0.001 (0.001)	0.0001 (0.002)	-0.002 (0.002)
Education_Any	-0.035 (0.034)	-0.059 (0.035)	-0.049 (0.042)	-0.028 (0.043)	-0.006 (0.047)
DebtYes	-0.056 (0.031)*	-0.075 (0.032)*	-0.021 (0.038)	-0.063 (0.040)	-0.067 (0.043)*
Estimated_income	8.13e-07 (4.75e-07)	1.95e-06 (4.90e-07)***	9.75e-07 (5.79e-07)	9.10e-07 (6.00e-07)	-5.81e-07 (6.43e-07)
Household_HeadYes	-0.087 (0.040)*	0.002 (0.041)	-0.103 (0.049)*	-0.125 (0.050)*	-0.123 (0.054)*
Gender2	-0.475 (0.058)***	-0.308 (0.060)***	-0.297 (0.071)***	-0.650 (0.073)***	-0.645 (0.079)***
Livestock_ownershipYes	0.016 (0.048)	0.109 (0.050)*	-0.073 (0.059)	0.060 (0.061)	-0.032 (0.065)
Household_size	-0.002 (0.007)	-0.001 (0.008)	-0.002 (0.009)	-0.002 (0.009)	-0.005 (0.010)
Conflict_num	-0.056 (0.012)***	-0.030 (0.013)*	-0.049 (0.015)**	-0.085 (0.016)***	-0.060 (0.017)***
NonUNHCR_food	0.106 (0.085)	0.132 (0.088)	0.027 (0.104)	0.122 (0.108)	0.144 (0.115)
NonUNHCR_shelter	0.105 (0.038)**	0.119 (0.039)**	0.088 (0.046)*	0.096 (0.047)*	0.115 (0.051)*
NonUNHCR_nonfood	-0.101 (0.037)**	-0.045 (0.038)	-0.095 (0.045)*	-0.107 (0.047)*	-0.157 (0.050)**
NonUNHCR_sanitary	-0.080 (0.040)*	-0.112 (0.041)**	-0.048 (0.049)	-0.103 (0.051)*	-0.057 (0.054)
NonUNHCR_waterdrinking	-0.036 (0.037)	-0.013 (0.038)	-0.031 (0.045)	-0.054 (0.046)	-0.045 (0.050)
NonUNHCR_wateragri	-0.074 (0.048)	-0.086 (0.050)	-0.009 (0.059)	-0.072 (0.061)	-0.128 (0.065)*
NonUNHCR_health	0.083 (0.047)	0.070 (0.049)	0.018 (0.058)	0.192 (0.060)**	0.050 (0.064)
NonUNHCR_CI	0.173 (0.049)***	0.123 (0.050)*	0.199 (0.060)***	0.182 (0.062)**	0.189 (0.066)**
NonUNHCR_Agri	-0.036 (0.042)	-0.010 (0.043)	-0.076 (0.051)	-0.015 (0.053)	-0.041 (0.057)
NonUNHCR_CMS	0.081 (0.071)	0.034 (0.073)	0.057 (0.086)	0.051 (0.089)	0.180 (0.095)*
Income_source_AG_A	-0.106 (0.075)	-0.100 (0.077)	-0.068 (0.091)	-0.061 (0.094)	-0.194 (0.101)*
Income_source_AQ_A	-0.641 (0.160)***	-0.510 (0.165)**	-0.568 (0.195)**	-1.040 (0.202)***	-0.446 (0.216)*
Income_source_AQ_C	-0.473 (0.311)	-0.149 (0.321)	-0.867 (0.379)*	-0.360 (0.393)	-0.515 (0.421)
Income_source_SW	0.115 (0.051)*	0.081 (0.053)	0.122 (0.062)*	0.102 (0.065)	0.154 (0.069)*
Income_source_SE	-0.092 (0.054)	-0.156 (0.055)**	-0.082 (0.065)	-0.101 (0.068)	-0.029 (0.073)
Income_source_CA	-0.143 (0.049)**	-0.197 (0.050)***	-0.157 (0.059)**	-0.170 (0.061)**	-0.046 (0.066)
Income_source_PVW	0.081 (0.048)	0.029 (0.050)	0.067 (0.059)	0.103 (0.061)*	0.126 (0.065)*
Climate_hazard_A	-0.286 (0.052)***	-0.338 (0.054)***	-0.359 (0.064)***	-0.199 (0.066)**	-0.249 (0.071)***
Climate_hazard_B	0.037 (0.039)	0.039 (0.040)	0.004 (0.048)	0.075 (0.050)	0.030 (0.053)
Climate_hazard_D	0.117 (0.038)**	-0.019 (0.039)	0.157 (0.046)***	0.104 (0.048)*	0.224 (0.051)***
Climate_hazard_E	-0.070 (0.045)	-0.046 (0.046)	-0.056 (0.055)	-0.060 (0.057)	-0.118 (0.061)*
Climate_hazard_G	-0.253 (0.037)***	-0.170 (0.039)***	-0.144 (0.046)**	-0.179 (0.047)***	-0.519 (0.051)***
Climate_hazard_H	0.321 (0.305)	0.164 (0.315)	0.550 (0.372)	0.330 (0.385)	0.241 (0.413)
Fit Statistics:					
Observations	502	502	502	502	502
Degrees of Freedom	467	467	467	467	467
Residual Std. Error	0.298 (df = 467)	0.308 (df = 467)	0.364 (df = 467)	0.377 (df = 467)	0.404 (df = 467)
R-Squared	0.809	0.793	0.716	0.723	0.763
Adjusted R-Squared	0.795	0.778	0.695	0.703	0.745
F-Statistic	58.13*** (df = 34; 467)	-	-	-	-

Note: *** p¡0.01, ** p¡0.05, * p¡0.1

Table 5 Regression output table for Model 1(base) and Model 2 (Treatment interacted) to analyse the effect of intervention on outcome (subjective resilience)

Variable	Model 3: Resilience	Model 4:Anticipate	Model 4:Withstand	Model 4:Recover	Model 4:Transform
Intercept	0.8142 (0.2019)***	0.6786 (0.2259)**	0.8193 (0.2607)**	0.9185 (0.2748)***	0.8004 (0.2554)**
Treatment_Group	0.0506 (0.1448)	0.2184 (0.1619)	0.1558 (0.1868)	-0.2053 (0.1970)	-0.0013 (0.1830)
HSI	0.9333 (0.0591)***	0.9140 (0.0645)***	0.9307 (0.0744)***	0.9970 (0.0785)***	0.9434 (0.0729)***
Age	0.0006 (0.0011)	-0.0008 (0.0012)	-0.0002 (0.0014)	0.0016 (0.0014)	0.0015 (0.0013)
Education_Any	-0.0069 (0.0297)	-0.0353 (0.0332)	-0.0127 (0.0383)	0.0046 (0.0403)	0.0057 (0.0375)
DebtYes	0.0025 (0.0363)	0.0105 (0.0406)	0.0089 (0.0468)	0.0027 (0.0493)	-0.0218 (0.0459)
Estimated_income	8.08e-08 (6.17e-07)	2.46e-06 (6.91e-07)***	8.55e-07 (7.97e-07)	6.68e-08 (8.40e-07)	-2.95e-06 (7.81e-07)***
Household_HeadYes	-0.1904 (0.0439)***	-0.0655 (0.0491)	-0.1743 (0.0567)**	-0.2486 (0.0598)***	-0.2622 (0.0556)***
Gender2	-0.3803 (0.0711)***	-0.2136 (0.0796)**	-0.3203 (0.0918)***	-0.4614 (0.0968)***	-0.5160 (0.0900)***
Livestock_ownershipYes	0.0371 (0.0416)	0.0991 (0.0466)*	-0.0510 (0.0538)	0.0668 (0.0567)	0.0378 (0.0527)
Household_size	-0.0122 (0.0063)	-0.0124 (0.0071)	-0.0125 (0.0082)	-0.0094 (0.0086)	-0.0158 (0.0080)*
Conflict_num	-0.0739 (0.0146)***	-0.0479 (0.0164)**	-0.0727 (0.0189)***	-0.0914 (0.0199)***	-0.0812 (0.0185)***
NonUNHCR_food	0.1352 (0.0742)	0.1368 (0.0831)	0.0613 (0.0958)	0.1171 (0.1010)	0.2339 (0.0939)**
NonUNHCR_shelter	0.1028 (0.0580)*	0.1251 (0.0648)	0.1002 (0.0748)	-0.0355 (0.0789)	0.2031 (0.0733)**
NonUNHCR_nonfood	-0.2044 (0.0513)***	-0.1461 (0.0569)**	-0.1848 (0.0657)**	-0.2196 (0.0692)**	-0.2391 (0.0644)***
NonUNHCR_sanitary	-0.1341 (0.0688)*	-0.2034 (0.0760)**	-0.0528 (0.0877)	-0.2153 (0.0925)*	-0.0203 (0.0860)
NonUNHCR_waterdrinking	0.0218 (0.03196)	0.0315 (0.0358)	0.0200 (0.0413)	0.0090 (0.0436)	0.0251 (0.0405)
NonUNHCR_wateragri	-0.0200 (0.0423)	-0.0541 (0.0474)	0.0068 (0.0547)	-0.0333 (0.0577)	0.0050 (0.0536)
NonUNHCR_health	-0.1221 (0.0606)*	-0.0973 (0.0677)	-0.1754 (0.0781)*	0.0285 (0.0824)	-0.2619 (0.0766)***
NonUNHCR_CI	0.4832 (0.0715)***	0.4037 (0.0787)***	0.6055 (0.0909)***	0.4917 (0.0958)***	0.3800 (0.0890)***
NonUNHCR_Agri	-0.0261 (0.0365)	0.0029 (0.0408)	-0.0793 (0.0471)	-0.0115 (0.0497)	-0.0073 (0.0462)
NonUNHCR_CMS	0.0747 (0.0631)	0.0587 (0.0707)	0.0135 (0.0815)	0.0243 (0.0860)	0.2094 (0.0800)**
Income_source_AG_A	-0.0375 (0.0648)	-0.0516 (0.0725)	0.0221 (0.0837)	-0.0171 (0.0882)	-0.1071 (0.0820)
Income_source_AQ_A	-0.4832 (0.1397)***	-0.3421 (0.1565)*	-0.4312 (0.1806)**	-0.8726 (0.1904)***	-0.2826 (0.1769)
Income_source_AQ_C	-0.6829 (0.2702)*	-0.4144 (0.3021)	-1.0764 (0.3485)**	-0.4856 (0.3674)	-0.8290 (0.3415)**
Income_source_SW	0.2117 (0.0702)**	0.1064 (0.0786)	0.1228 (0.0907)	0.2765 (0.0957)**	0.3401 (0.0889)***
Income_source_SE	-0.02596 (0.0650)	-0.1178 (0.0728)	-0.0706 (0.0840)	-0.0516 (0.0886)	0.1342 (0.0823)
Income_source_CA	0.2230 (0.0744)**	0.0383 (0.0833)	0.2083 (0.0961)**	0.2095 (0.1013)**	0.4427 (0.0942)***
Income_source_PVW	0.1564 (0.0617)*	0.0109 (0.0690)	0.1028 (0.0797)	0.1758 (0.0840)**	0.3287 (0.0781)***
Climate_hazard_A	-0.3078 (0.0998)***	-0.2277 (0.1115)**	-0.3173 (0.1286)**	-0.3643 (0.1356)**	-0.2928 (0.1260)**
Climate_hazard_B	0.0621 (0.0621)	0.0422 (0.0416)	0.0202 (0.0480)	0.0212 (0.0506)	-0.0309 (0.0470)
Climate_hazard_D	0.2317 (0.0612)***	-0.0352 (0.0663)	0.2163 (0.0765)**	0.2823 (0.0807)***	0.5245 (0.0749)***
Climate_hazard_E	-0.0306 (0.0461)	0.0005 (0.0514)	0.0176 (0.0594)	-0.0289 (0.0626)	-0.0958 (0.0582)
Climate_hazard_G	-0.2703 (0.0370)***	-0.0860 (0.0565)	-0.1287 (0.0651)*	-0.1928 (0.0687)**	-0.6841 (0.0638)***
Climate_hazard_H	0.1869 (0.2609)	0.0873 (0.2923)	0.5202 (0.3373)	0.2082 (0.3556)	-0.0557 (0.3305)
Treatment:Estimated_income	1.52e-06 (8.32e-07)	-1.07e-06 (9.32e-07)	5.30e-07 (1.07e-06)	2.04e-06 (1.13e-06)	4.56e-06 (1.05e-06)***
Treatment:Household_HeadYes	0.2371 (0.0647)***	0.1371 (0.0725)	0.1844 (0.0836)*	0.3214 (0.0882)***	0.3061 (0.0819)***
Treatment:DebtYes	**-0.0885 (0.0496)***	**-0.1264 (0.0556)****	-0.0482 (0.0641)	-0.1044 (0.0676)	-0.0666 (0.0628)
Treatment:Gender2	0.0195 (0.0903)	-0.0803 (0.1009)	**0.2374 (0.1165)***	-0.0240 (0.1228)	-0.0782 (0.1141)
Treatment:Conflict_num	**0.0491 (0.0201)****	0.0368 (0.0222)	**0.0547 (0.0256)***	0.0367 (0.0269)	**0.0546 (0.0251)***
Treatment:NonUNHCR_shelter	**-0.1184 (0.0704).**	-0.1388 (0.0788)	-0.1274 (0.0909)	0.0853 (0.0959)	-0.2954 (0.0891)***
Treatment:NonUNHCR_nonfood	**0.2192 (0.0679)****	**0.1372 (0.0757)***	**0.1713 (0.0873)***	**0.2279 (0.0920)***	**0.3142 (0.0855)*****
Treatment:NonUNHCR_sanitary	0.0845 (0.0781)	0.1442 (0.0869)	0.0452 (0.1003)	0.1711 (0.1057)	-0.0592 (0.0983)
Treatment:NonUNHCR_health	**0.3729 (0.0819)*****	**0.3100 (0.0915)*****	**0.3001 (0.1055)****	**0.2639 (0.1113)***	**0.5923 (0.1034)*****
Treatment:NonUNHCR_CI	**-0.5553 (0.0814)*****	**-0.4779 (0.0896)*****	**-0.6983 (0.1033)*****	**-0.5230 (0.1089)*****	**-0.4611 (0.1012)*****
Treatment:Income_source_SW	-0.1369 (0.0898)	-0.0006 (0.1006)	-0.0041 (0.1160)	-0.2622 (0.1223)*	-0.2683 (0.1137)*
Treatment:Income_source_SE	-0.01597 (0.0942)	0.0036 (0.1056)	0.0758 (0.1218)	0.0257 (0.1284)	-0.1651 (0.1194)
Treatment:Income_source_CA	-0.4838 (0.0901)***	-0.2895 (0.1009)**	-0.4684 (0.1165)***	-0.5381 (0.1228)***	-0.6289 (0.1141)***
Treatment:Income_source_PVW	-0.1234 (0.0846)	0.0273 (0.0946)	-0.0474 (0.1092)	-0.1307 (0.1151)	-0.3232 (0.1070)**
Treatment:Climate_hazard_A	0.1916 (0.1152)	0.0236 (0.1286)	0.1064 (0.1484)	0.3070 (0.1564)*	0.2907 (0.1454)*
Treatment:Climate_hazard_D	**-0.2765 (0.0754)*****	-0.0207 (0.0826)	**-0.2543 (0.0953)****	**-0.3365 (0.1005)*****	**-0.5578 (0.0934)*****
Treatment:Climate_hazard_G	**0.1566 (0.0679)***	-0.0540 (0.0760)	0.0360 (0.0876)	0.1206 (0.0923)	**0.5414 (0.0858)*****
Treatment:Climate_hazard_E	**-0.3468 (0.0844)*****	**-0.3600 (0.0934)*****	**-0.3713 (0.1077)*****	**-0.2708 (0.1136)****	**-0.4386 (0.1056)*****
Residual Std. Error	0.2518 (df = 448)	0.2822 (df = 449)	0.3256 (df = 449)	0.3433 (df = 449)	0.3190 (df = 449)
R-Squared	0.8695	0.8329	0.7811	0.7791	0.8578
Adjusted R-Squared	0.8541	0.8135	0.7557	0.7535	0.8414
F-Statistic	56.32*** (df = 53; 448)	58.13*** (df = 34; 467)	-	-	-

Table 6 Regression output from 'Seemingly Unrelated Regression' (SUR) on model 3 and 4 to assess if the relationship between the treatment and the outcome varies based on the covariates

Key Variables	Description	Measurement/ Scale & Transformations
Dependent Variables		
Resilience	Score for resilience index, which measures respondents' subjective overall resilience. Respondents reported their resilience relative to the period before the intervention. The index was constructed by averaging responses from multiple survey items, each on a 1–4 scale.	Original scale: 1–4 per item with 0.5 increments.
Anticipate	Score of the each of the four subcomponents of resilience. These measure respondents' subjective ability to anticipate, withstand, recover and transformatively adapt to future storms and floods. This was constructed by averaging responses to several survey items, each scored on a 1–4 scale.	Original scale: 1–4 per item with 0.5 increments.
Withstand		
Recover		
Transform		
Independent Variables		
HSI	Score for Human Security Index, which measures respondents' current perception of human security. This composite index is constructed by averaging the three subcomponent scores: economic, social, and environmental.	Original scale:1–4 per item with 0.5 increments; subcomponents averaged
Treatment_ Group	A binary indicator for treatment group of respondents. A value of 1 indicates that the respondent is in the treatment group, while a value of 0 indicates that the respondent is in the control group.	0 = Control Group; 1 = Treatment Group.
Education_ Any	A binary indicator for any completed level of education of respondents. A value of 0 indicates that the respondent has not completed any level of schooling (religious and conventional), while a value of 1 indicates that respondent has completed at least primary level of education.	Binary (0 = No schooling; 1 = schooling)

Key Variables	Description	Measurement/ Scale & Transformations
Debt	A binary variable indicating debt status. A value of 1 indicates that the respondent has any outstanding debt, whereas 0 indicates no outstanding debt.	Binary (0 = No Debt; 1 = Debt)
Age	A continuous variable representing the respondent's age in years.	Continuous (measured in years)
Household_ Head	A binary variable indicating household head status of the respondent.	Binary (0 = Not household head; 1 = household head)
Estimated_in come	Respondents' total estimated household income over the last 12 months, measured as the cash received from all sources. For households engaged in sharecropping, the income is based on the cash received at the end of the season or year.	Continuous (monetary units, e.g., local currency)
Gender_2	A binary variable indicating the respondent's gender. A value of 1 represents female and 0 represents male.	Binary (0 = Male; 1 = Female)
Livestock_ ownership	A binary variable indicating livestock ownership. A value of 1 indicates that the respondent owns livestock, while 0 indicates that they do not own any livestock.	Binary (0 = no livestock; 1 = owns livestock)
Household_ size	A count of all individuals living in the respondent's household. This includes both males and females, above 14 years of age (adults) as well as children under 14 years.	Discrete count (integer; e.g., 0, 1, 2, …)
Conflict_num	A count of various types of violent incidents to which respondents were exposed within the camps in the last 5 years.	Discrete count (integer; e.g., 0, 1, 2, …)

Key Variables	Description	Measurement/ Scale & Transformations
NonUNHCR_food	A binary variable indicating whether respondents received support services external to the intervention from the given options: • Food – food rations • Shelter – e.g Help improving current home, building a new one, or paying rent • Nonfood – e.g Household items (Cooking fuel, tarps, bamboo, kitchen utensils, clothes, bedding, toiletries etc) • Sanitary – e.g latrines / wash basins / soak pit or septic tank etc. • Waterdrinkging – New or improved water supply for drinking/cooking water • Wateragri – New or improved water supply for agriculture or other economic activities • Health – Temporary health camps, clinics, hospitalsCI – Community infrastructure, such as access roads, community centres etc • Agri – Agricultural inputs (seeds, fertilizers, feed, fodder, medicine etc.) • CMS – Case Management support	Binary (0 = Did not reported receiving the support; 1 = Reported receiving the support)
NonUNHCR_shelter		
NonUNHCR_nonfood		
NonUNHCR_sanitary		
NonUNHCR_waterdrinking		
NonUNHCR_wateragri		
NonUNHCR_health		
NonUNHCR_Agri		
NonUNHCR_CMS		

Income_source _AG_A Income_source _AQ_A Income_source _AQ_C Income_source _SW Income_source _SE Income_source _CA Income_source _PVW	A binary variable indicating whether the respondent's primary source of income is one of the specified options, where: • AG_A: Agricultural production (betel leaf, crops, livestock) - Daily/weekly labour, they own neither crops/animals nor land • AQ_A: Marine or aquacultural production (fishing, salt production, shrimp production) - Daily/weekly labour, they do not own the boats or seaside land • AQ_C: Marine or aquacultural production (fishing, salt production, shrimp production) – They rent the boats or seaside land • SW: Non-agricultural skilled wage labour – skilled work (**Requires** formal qualifications, licenses, or certifications) • SE: Non-agricultural self-employment (street vendor, handicrafts, etc.) • CA: Cash assistance from government/NGO/UN etc • PVW: Paid Volunteer work with organisations	Binary (0 = No ; 1 = Yes)
Climate_hazard _A Climate_hazard _B Climate_hazard _D Climate_hazard _E Climate_hazard _G Climate_hazard _H	A binary variable indicating whether the respondent has experienced any of the following environmental hazards within the camps since 2021. • A: Severe rainfall • B: Heavy flooding • D: Cyclone/Storm (severe rainfall and wind) • E: Extreme temperatures (Heat waves) • G: Waterlogging • H: Agricultural pests or disease (crops or livestock)	Binary (0 = No ; 1 = Yes)

Table 7 Description of key variables used in regression analysis.

CLIMATE RESILIENCE IN DISPLACEMENT: Examining UNHCR's SuLMER Intervention in Cox's Bazar, Bangladesh

RESEARCH REPORT

December 2025

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