EXTREME HEAT IN HUMANITARIAN CONTEXTS

Research from Bangladesh and South Sudan

Padmini Iyer, Oxfam GB

Nuzhat Nueary, Oxfam International

www.oxfam.org

OXFAM

This report was written by Padmini Iyer, Research Lead (Conflict & Fragility), Oxfam Great Britain, and Nuzhat Nueary, Water Insecurity & Climate Policy Coordinator, Oxfam International. The study was funded by the Foreign, Commonwealth and Development Office (FCDO).

Field research in Bangladesh was conducted by Nuzhat Nueary, Atiya Islam and Md Moniruzzaman from Oxfam in Bangladesh, partners Breaking the Silence (BTS) and Community Development Centre (CODEC), and community volunteers. In South Sudan, the research was conducted by Padmini Iyer and Gathoth Majok Jang, Community Health Promoter, Oxfam in Renk.

The authors are immensely grateful to a multitude of team members (administrative, programme, logistics and others) of Oxfam in Bangladesh and South Sudan, and partners BTS and CODEC in Bangladesh for their support in executing this work in a short amount of time. Padmini Iyer especially thanks Gathoth Majok Jang for his collaboration and assistance in this study as well as his delightful company in Gerbana; Vincent Ogira, Mandela Nelson, Jackline Juru, Paul Bul, and Isaac Tema for support with administrative and logistical aspects of the study; and the entire team in Oxfam in Renk for their care and camaraderie. Thanks also to Vimbayi Mazanhi and various colleagues in Juba. Nuzhat Nueary specially acknowledges the contribution of Md Tazbib Rahman, Atiya Islam, Md Moniruzzaman, Khwaza Nuzhat Zerin Fatmi in the field research, and partner colleagues, especially Meraz Uddin Talukdar for his overall supervision, Abdul Khaleq, Shariful Islam. Thanks also to Ashish Damle, Jubaida Akhter, Dabaraj Dey, and Md Moniruzzaman for the overall guidance in Bangladesh. Many thanks to Dr Katrice King, Humanitarian Adviser, FCDO for her collaboration in designing and executing this study. We are equally grateful to colleagues in the Water Insecurity Group and colleagues from the Global Humanitarian Team in Oxfam for their support in all stages of this research. Our greatest gratitude is for all those who generously gave of their time to answer our questions – especially communities in Gerbana, Satkhira and Cox's Bazar – as well as humanitarian and government representatives.

For further information on the issues raised in this paper please email nuzhat.nueary@oxfam.org

Cover Photo: Excessive Arsenic in Tubewell Water, Shyamnagar Upazila, Satkhira; Jahangir Alam, Oxfam In Bangladesh

Contents

Executive Summary

This report presents findings from a research project undertaken by Oxfam in collaboration with the FCDO's Humanitarian and Stabilisation Operations Team. The project examines the impact of extreme heat on crisis-affected communities, particularly through the lens of water systems, with the aim of developing heat-risk informed guidance for humanitarian responses. Primary research was conducted in Renk, South Sudan and Satkhira and Cox's Bazar in Bangladesh between January and March 2025. The study investigates the following interrelated questions:

- What are the impacts of extreme heat on communities, especially in relation to nutrition, food security, livelihoods, health, mobility, and protection?
- What is the relationship between extreme heat and water access, availability, and quality, and how do these water-related challenges influence overall well-being?
- What coping and adaptation mechanisms are currently used by different community groups, and how effective are these strategies?
- To what extent does current humanitarian programming integrate extreme heat considerations and what gaps and priorities are being overlooked in humanitarian response efforts?

Key Findings

- Across South Sudan and Bangladesh, extreme heat significantly and negatively affects water availability, access, and quality. Water scarcity has a disproportionate impact on coastal areas such as Satkhira, Bangladesh, which is highly vulnerable to saltwater intrusion. This has led to freshwater shortages and ongoing agricultural challenges. Despite being surrounded by water and equipped with deep tubewells, water is often contaminated with salt, iron, and arsenic; salinity further increases during extreme heat. On the other hand, in displacement settings of Renk and Cox's Bazar, increasing heat has resulted in groundwater depletion.
- Research participants in Bangladesh and South Sudan reported dizziness, dehydration, skin diseases, and fatigue among heat-related illnesses. Children were considered the most vulnerable group. A rise in incidence of diarrhoea among children during the hot season was reported in South Sudan. Diarrhoea, dysentery, and dehydration during peak summer months was also reported in Bangladesh.
- In displacement affected contexts, the growth in refugee populations and the lack of adequate sanitation infrastructure are critical drivers of disease diffusion. Heatwaves or the hot season exacerbate risk of disease diffusion due to the risk of pathogen proliferation in high temperatures.
- In both study locations, the water crisis during the hot season negatively influences food production, as crop agriculture and livestock production are heavily dependent on the availability of rainfed water sources. Shrimp and crab farming have emerged as alternative livelihood options in Satkhira due to high soil and water salinity. However, when conducted without proper regulation, these practices can negatively affect crop production.
- Extreme heat severely affects shelter conditions, particularly for those living in protracted displacement settings. For instance, in Rohingya camps, the temperature felt inside the camps can reach nearly 50°C during the June-July period, making it impossible to stay indoors for extended periods. In Renk, South Sudan,

refugee and returnee homes are less durable than those of the host community (tukul homes), which have the best average performance as a shelter style because of the low ecological footprint and they maintain a moderate temperature for the greater number of hours a year.

- While extreme heat negatively affects mobility due to physiological impacts, mobility is also used as an adaptation strategy for extreme heat related water shortage. In Renk, host communities reported moving to areas with water sources when their local water sources dried up; this was particularly the case for women and children. In Bangladesh, extreme heat restricts movement, particularly for the elderly and women with disabilities, who face physiological issues such as dehydration and dizziness when accessing water and essential services.
- Communities in Bangladesh and South Sudan have adopted a variety of strategies to cope with extreme heat related water shortages. In Bangladesh, people collect and purify rainwater, store it in tanks and clay pots, and rely on communal ponds and tube wells for water. They also cool indoor spaces by covering roofs with palm leaves, spraying water on walls, using thick curtains, and adjusting daily routines to avoid peak heat. In South Sudan, people cover jerricans to keep water cool, design homes for thermal comfort, and, depending on income, use fans, plant trees, or build temporary shelters. To protect children, some wrap them in wet cloths.
- Addressing extreme heat remains in its early stages in both countries. In Bangladesh, there is greater relative progress on heat related issues among government and humanitarian stakeholders than in South Sudan. A major challenge for extreme heat planning is the lack of early warning and forecasting systems in rural and remote areas.
- Planning and action in response to extreme heat remain ad hoc and uncoordinated. Humanitarian actors in both countries have acknowledged the importance of anticipatory action and early warning systems for heatwave response, but in practice, both are significantly behind, as issues like flooding take higher priority—especially in South Sudan and Bangladesh. However, in Bangladesh, an intersectoral coordination mechanism exists, particularly within the Rohingya response, where heatwaves were identified as an emerging issue last year, and the mechanism issued a heatwave alert. In contrast, in South Sudan, intersectoral coordination among clusters and working groups faces major implementation challenges due to ongoing insecurity.

Importantly, in both contexts, increasing heat is one aspect on the continuum of climate change and variability. Where in Bangladesh, rising sea levels have led to widespread salinity intrusion, in South Sudan, changes have been observed in the water table in aquifer areas. In all locations of research, increasing heat has varying impacts on people's lives, livelihoods and wellbeing – the situation is particularly grave for those on the move due to either the crowding of refugee camps or the lack of any supportive infrastructure to accommodate new arrivals. In severely water stressed scenarios, there may be a risk of extreme heat to assume crisis proportions due to the health-related impacts of dehydration, especially for vulnerable groups.

Key Recommendations

- In both countries, long-term heat action planning is of critical importance. Heat action planning should be localized and integrated into both emergency response

plans and protracted crisis settings including climate policies. These plans, along with their dissemination, must involve 'last mile' communities and be contextually tailored through active community engagement.

- Humanitarian actors and governments should strengthen data collection and analysis for heat at lower administrative levels which can be linked with national level forecasting and monitoring mechanisms. Regular and localized climate modelling would help identify heat 'hotspots', especially those with a high risk of mortality. This data can support response preparedness, enabling a more targeted and rapid heat crisis response.
- Within humanitarian settings, intersectoral coordination mechanisms must work collaboratively with communities and local/national organizations to identify and assess heat-related risks to health, livelihoods, food security, and nutrition, and jointly develop mitigation strategies. Furthermore, the intersectoral coordination agencies in both countries should consider supporting heat action planning for managing extreme heat risk on multiple outcomes, such as health, livelihoods, food security and nutrition. Humanitarian organizations and donors should work with local and national actors, including the government where possible, to map and finance supply chains to ensure increased delivery of water in extreme heat affected areas.
- WASH actors operating in contexts of increasing heat must address impacts on water supply such as algae growth, disinfectant loss, and saltwater intrusion. Key mitigation strategies include enhanced monitoring of water reservoirs, nutrient management, shading of infrastructure, using heat-resistant materials, and adjusting installation practices such as burying pipes deeper.
- Humidity plays a crucial role in how heat is experienced, and humanitarian agencies should consider location specific humidity while planning for interventions. Humanitarian actors working in displacement contexts should ensure cross-sectoral coordination for enhanced coordinated action in heatwave response.
- Medical personnel operating in these contexts (including hospitals, medical centers, and community clinics) should receive training to provide targeted advice on heatwave risks to vulnerable groups. Public health promotion activities should be specifically designed to address heatwave risks.
- International and national humanitarian agencies should promote community-based innovations that combine local knowledge with affordable solutions, and international response efforts should actively support these initiatives.
- Humanitarian responses must prioritize local engagement to ensure a people-centred approach. Agencies should promote community dialogue, leverage local knowledge and experience, and design responses that are cost-effective, scalable, and better suited to the needs of those most vulnerable to extreme heat. International actors should collaborate with local organizations which have better relationship and access to affected communities.

Background

The climate crisis is disproportionately affecting communities living in climate hotspots. Oxfam's previous work[1] has shown the increasing impacts of climate change on water systems are leading to heightened food insecurity, displacement, and disease proliferation in the top 20 climate hotspots. Among all other adverse climate impacts, heatwaves[2] have been increasing in both frequency and intensity, and will continue to do so, thereby significantly affecting water availability, access and quality. Despite the significance of extreme heat on wellbeing, particularly in climate stressed and crisis affected areas, humanitarian programming frequently shows deficits in integrating this concern. Moreover, the impacts of heatwaves, particularly gendered dimensions and coping mechanisms in rural and urban environments, remain relatively understudied[3]. Lastly, while heatwaves are generally considered a climate phenomenon, they are particularly salient to humanitarian action and adapting humanitarian response systems to manage future heat risks.

This report presents findings from a research study that examines the impact of extreme heat on crisis-affected communities, particularly through the lens of water systems. The research explores the following questions employing a 'water security' lens in framing and analysis.

- What are the impacts of extreme heat on communities, particularly vulnerable groups, especially as related to nutrition, food security, livelihoods, health, mobility and protection?
- What is the relation between extreme heat and water access, availability and quality? How does this affect communities, particularly vulnerable groups, especially as related to health, nutrition, food security, livelihoods, mobility and protection?
- What coping and adaptation mechanisms are commonly used by communities in extreme heat situations (disaggregated by groups)? To what extent are these measures proving effective?
- How are current humanitarian responses/programming integrating context-specific extreme heat issues? To what extent are these measures proving effective? What priorities and concerns are currently missing from humanitarian responses?

Research for this study was conducted in Bangladesh (Satkhira District and Cox's Bazar) and South Sudan (Gerbana and Renk) between January and March 2025. The study was undertaken by Oxfam in coordination with the Humanitarian Stabilisation and Operations Team on behalf of the FCDO (Foreign, Commonwealth and Development Office) and was commissioned through the Operational Excellence (OpEx) Extreme Heat workstream. The aim of this study is to improve FCDO's operational excellence by increasing the humanitarian team's ability to provide a more climate smart, strategic and evidence-based humanitarian response in extreme heat. This research also include implications and recommendations for humanitarian organizations and related entities working in contexts of extreme heat to support humanitarian planning, response management, programming and coordination.

Limitations

A conceptual limitation of this study is the interchangeable use of 'extreme heat', 'heatwave' and 'hot weather'. Whereas some findings refer to increasing heat, others refer

to acute periods of threat – or heatwaves – which carries a greater health and mortality risk than increasing temperature. In addition, as would be expected given the short timeframe, findings may not be widely representative of the larger population or applicable to various contexts (even in the same country). However, as this study contributes to a topic of growing interest within humanitarian response and climate change, we have made a concerted attempt to ensure that the findings reported below can facilitate guidance and application beyond the contexts of research.

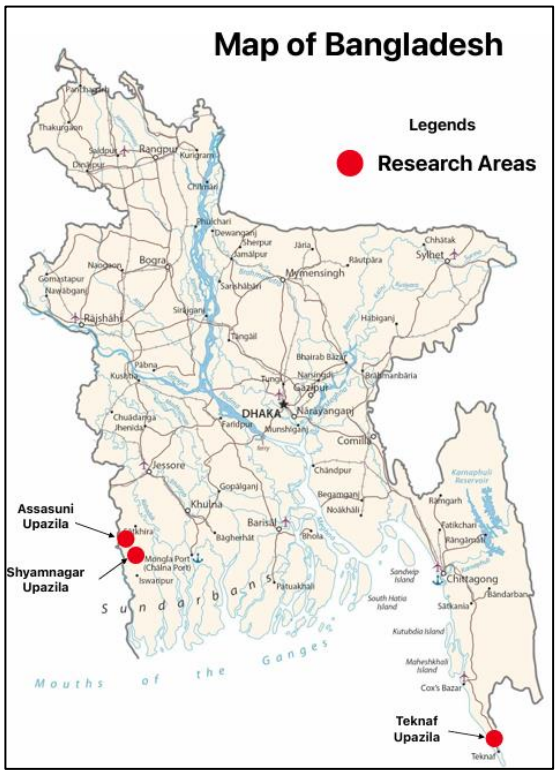
Furthermore, due to the limited timeframe and fast changing situation in Renk, discussions with community members (especially women) had to be abbreviated to accommodate such factors as household responsibilities (collection of water), increasing temperatures during the day, and security requirements on the team leaving the location by 2 PM. Finally, as the research was conducted by a team associated with Oxfam, discussions inadvertently led to water scarcity, possibly because of Oxfam's visible role in water provision in the area. Whereas the main framing of this analysis is around water systems, for questions where it may not have been pertinent, every attempt was made to investigate other factors related to extreme heat.

Description of Contexts

Satkhira District, Bangladesh

This research was conducted in Gabura, Atulia, Burigoalini Unions in Shyamnagar Upazila and Sreeula Union in Assasuni Upazila in Satkhira District. Located in the southwestern part of Bangladesh, Satkhira district is an area highly vulnerable to climate-induced hazards due to its geography and topography. Gabura is one of the most remote char [4] islands separated from the mainland by rivers, while the village in Atulia Union is nestled within the Sundarbans Forest. All four unions face varying degrees of climatic challenges including tidal surge and floods. As a low-lying coastal district, Satkhira is particularly susceptible to salinity intrusion from the sea, making freshwater scarce and agriculture increasingly problematic[5]. One of the most devastating climatic events in Satkhira's history was Cyclone Aila in 2009, which destroyed rice fields, vegetable plots, and fishponds, further reducing freshwater availability by inundating the land with saltwater. In some areas, waterlogging persisted for years, rendering agricultural land unusable and exacerbating food insecurity[6]. Despite being surrounded by water bodies and having deep tubewells, water remains a critical issue in Satkhira due to presence of salt, iron and arsenic [7]. A survey from 2021 showed that 73% of people living in Asashuni and Shyamnagar upazilas are drinking unsafe saline water[8] .

With traditional agriculture (rice farming) in decline, many farmers have converted croplands into shrimp and crab enclosures, as these industries can withstand saline conditions[9]. However, this transition has further degraded soil quality, leading to overreliance on aquaculture-based livelihoods, which in turn affects water availability and food production[10] . Similarly, Burigoalini, Atulia, and Sreeula Unions face salinity-related challenges caused by commercialized shrimp farming and unregulated policies, which have degraded soil fertility and reduced crop productivity. These factors have directly affected water availability and quality, with water sources turning saline and conditions worsening during peak summer. These challenges are closely linked to food security, livelihoods, and health, which are discussed in detail further below.



Map of Bangladesh showing research locations, courtesy: Wikipedia

Cox's Bazar, Bangladesh

In Cox's Bazar, research was conducted in two villages within Whykong Union under Teknaf Upazila, one village in Unchiprang Camp 22, and one village each in Sabarang Union and Hnila Union, also in Teknaf Upazila. Cox's Bazar is home to nearly 3 million Bangladeshi host communities and the world's largest refugee settlement where close to 1 million Rohingya refugees have lived since 2017[11]. When the Rohingya communities first arrived in Teknaf in the 1990s, shallow tube wells were installed to meet their water needs. However, the arrival of a large number of refugees in 2017 overwhelmed the existing infrastructure[12] . By mid-2023, the demand for water in the densely populated camps and towns had risen sharply, with refugee camps alone requiring, according to one estimate, 22 million litres of water per day[13].This has placed an unsustainable strain on groundwater. Thousands of shallow tube wells were drilled to serve communities and camps, but many have now failed. Groundwater levels are dropping by 10–15 feet annually, far faster than they can be replenished. A recent assessment found that about 23% of the 31,000 tube wells in Cox's Bazar have already dried up or become unusable. Almost all the old shallow wells are now useless – when pumped, they often bring up salty or muddy water[14].

Today, due to groundwater depletion, most communities in the camps rely on treated surface water from treatment plants accessed through tap stands. However, Rohingya communities depend on water rationing system where access to water is limited to specific times of the day. And those living far away struggle more to access water. Water shortage is even more severe in the summer and fails to meet the growing demand of the population. Even during our visit to Cox's Bazar, the camp was under strict monitoring with the daily water limit per person reduced to 3–4 litres. Additionally, while latrines were gradually installed, poor waste management has led to unsanitary conditions and disease outbreaks.

Renk and Gerbana, South Sudan

Renk is the northernmost county of South Sudan, and borders Sudan's Blue Nile, Sennar and White Nile States. On the eastern bank of the White Nile River, Renk County is categorized as the northern sorghum and cattle livelihood zone: the main economic activities include crop and livestock agriculture alongside fishing and charcoal and gum Arabic production[15]. Crop agriculture (sesame, groundnuts, sorghum etc.) depends on seasonal flooding, as well as rainfed and mechanized production; Renk is one of the most productive food producing counties of South Sudan[16] . Given its proximity to Sudan and the presence of a port on the White Nile, Renk is also an important location for trade between Sudan and South Sudan.

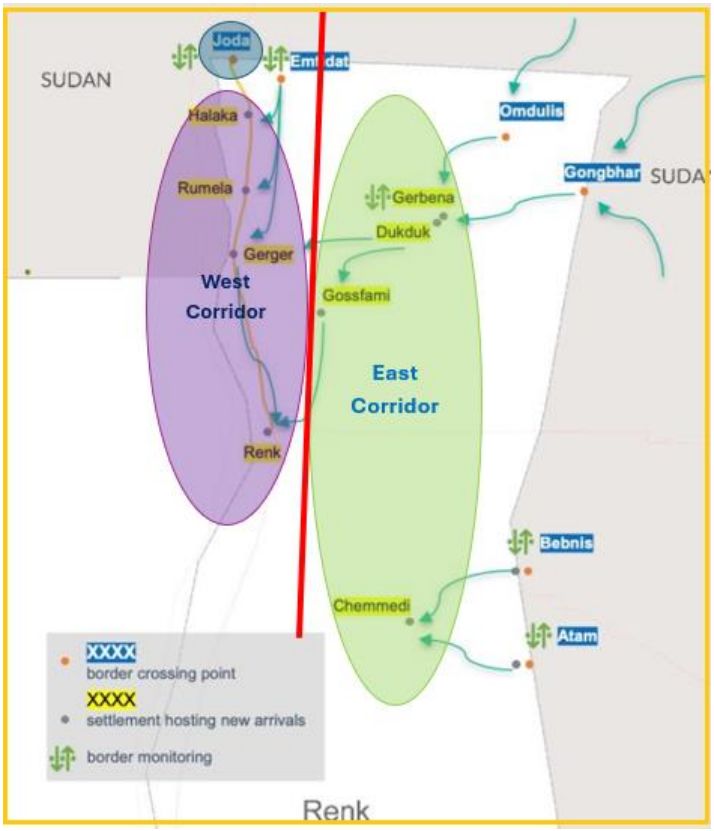
Map showing Renk in South Sudan, courtesy: Radio Tamazuj

Renk is one of the key transit points for refugees and returnees from Sudan – as of January 19, 2025, a total of 117, 744 people have arrived in Renk since the beginning of the war in Sudan, the vast majority from the northwestern border crossing of Wunthou[17]. The escalation of the war in Sudan's White Nile, Sennar and Blue Nile States led to a tripling of average number of daily arrivals in December 2024. The two transit centres in Renk have exceeded capacity by about four times. According to the UNHCR, villages such as Gerbana, as a result of these large-scale movements, also tripled in size in a matter of a few weeks[18]. Oxfam's emergency response team is based in Renk Town and is implementing WASH, protection and multipurpose cash assistance projects in the Transit Centres in Renk as well as in the refugee hosting boma of Gerbana (approx. 52 KM from Renk Town).

We selected Gerbana boma as a research site for a few key reasons. First, it is an area that, at the time of research, was experiencing significant movement of returnees and refugees from Sudan, in addition to having host communities in villages and settlements scattered on Gerbana's peripheries. This demographic composition provided insights from three different but related perspectives from displacement affected communities[19]. Secondly, unlike Renk town centre and the Transit Centres that have various types of humanitarian responses, Gerbana was mainly benefiting (at the time of research) from basic water provision and some non-food item distribution. To that end, it also allowed for the possible exploration of community-based coping and adaptation mechanisms.

Gerbana lies close to the Gongbhar border crossing in Sudan. Gerbana is a vibrant boma which is a major livestock market in addition to having a market with availability of grains, vegetables, oil production, sesame byproduct as animal feed, small shops selling

cigarettes, food and other items, as well as small eateries. We were told that some of this activity in the market is a product of the arrival of large numbers of people from Sudan.



Map of Renk WaSH Response showing Gerbana in the East Corridor, courtesy UNHCR

Water access and provision in Renk (as well as the emergency response) depend on the White Nile River, from which water is derived for the main Surface Water Treatment System managed by IOM and made available to the transit centres (directly) and to other areas through water trucking. Hafirs are particularly important to the discussion that follows as the research was conducted at a time of growing water needs, rising water stress, and the impending hot season (March/April). Hafirs are surface water catchment structures or earth dams that provide critical water storage in areas of northern South Sudan as well as Sudan. This water is both for domestic and livestock use and has long featured in discussions of water access in South Sudan. In 2013, a rapid water sector needs assessment in South Sudan conducted by the World Bank called into question the sustainability of modernized hafirs because of the cost required to construct these and capacity required for operation and maintenance[20] . Today, the hafirs in the Eastern Corridor of Renk (see map above) are said to be heavily contaminated due to animal waste, human intervention, and turbidity levels exceeding 300 NTU[21] . In addition to hafirs, people in Gerbana also have access to some shallow wells, which has raised concerns about groundwater availability in the area. At the time of the Renk Response's assessment (Jan 2025), the two shallow wells in Gerbana were dry. Information on groundwater is lacking. Informal discussions revealed that groundwater salinity has deterred the digging of wells as well as the abandoning of boreholes, especially in Renk and Wunthou crossing [22].

Findings

Extreme Heat and Water Availability, Access and Quality

It is important to note that while a great number of research studies have explored the impact of extreme heat/heatwaves in Bangladesh, there is almost no research on this issue in South Sudan. Concerns related to heatwaves in South Sudan are either unaddressed or focus primarily on the urban environment of Juba[23]. During the field research, the Government of South Sudan declared the closure of schools due to extreme heat for two weeks starting February 21, 2025[24]. At the time of research in mid-late February, the temperatures had risen to 41 degrees Celsius in Gerbana. However, heatwave related advisories and actions are typically undertaken at the national level, and at the devolved levels, little information related to early warning and early action is available[25]. Whereas coordination and communication are maintained with state capitals by the humanitarian coordinating body, localized data and information are not available. This is not surprising considering the sociopolitical and economic situation in South Sudan where much of the service provision is managed by the humanitarian system rather than the State.

With that said, concerns over extreme heat in Renk (but also elsewhere) are inextricably tied to concerns over water. Access to water is the dominant issue in Renk's Eastern Corridor given the over-reliance on surface water sources, the area's aridity, the high population pressure on existing sources, and the rising heat. Across South Sudan, water security is a critical concern – one in four people live in areas exposed to high and potentially deadly flood hazards and, at the same time, drought events are especially pronounced in some states, including Upper Nile[26]. Renk County, including Gerbana, faces high aridity conditions during the main food production season (May – September). Nonetheless, mechanized production of sesame, groundnuts and sorghum, reliant on rain and seasonal flooding, is a mainstay of the economy and a major source of subsistence for several people from the host communities with whom we spoke.

Hafirs, on which much of the host community and now returnee and refugee population depend, are susceptible to extreme heat due to their design. There is greater evaporation and thus drying up of hafirs during a typical hot season; however, the rapidly dwindling water in hafirs, or in some cases entirely dried out hafirs, around Gerbana today are a result of a combination of the heat index and population pressure[27]. The rapid and substantive increase in refugee and returnee population in Gerbana has had a direct and grave impact on access to hafir water, particularly from those hafirs closer to the boma. Of the three hafirs, only one had water that was being pumped out to fill barrels attached to donkey carts (called karlo), which are filled either for household use, but also frequently for sale. A barrel of water can be sold for 8000 South Sudanese Pound (SSP; ~GBP 1.6); in crowded areas and times of greater demand, this can be 15,000 SSP (~GBP 3). The donkey carts pay 500 SSP for the water to be pumped into barrels[28] .

Hafir on the road between Renk and Gerbana showing donkey carts being filled, author photo

The quality of the water in hafirs is poor and has high turbidity as viewed observationally as well as from discussions with WaSH sector personnel in Renk. Although at the time of research the cholera epidemic in Renk was under control, a similar outbreak was being reported across the border in Sudan's White Nile State. According to MSF, this outbreak was a result of a mass power outage after the power plant in Rabak was hit by a projectile in the ongoing war, leading to water pumps going out of service and resulting in the community's reliance on water procured from donkey carts[29]. In response to the cholera outbreak in Renk at the end of 2024, humanitarian partners made treated water available also to donkey carts in Renk to curtail the spread of cholera[30].

Even for water treated for provision to transit centres or other locations by humanitarian partners, it is thought that during extreme heat, there is high turbidity and high algae content in water from the River Nile, thus requiring greater quantities of chemicals[31] . However, in general, turbidity is higher during the rainy season (between 10 and 5 NTU) compared to below 5 NTU during the hottest season[32]. A secondary issue that has been reported in urban water supply in Renk is the leakage of pipes, which could possibly be a result of expansion due to heat.

Water scarcity and stress are also a critical concern for communities in Cox's Bazar and Satkhira, although the drivers and nature of this differ. In Satkhira, unregulated saltwater farming has intensified salinity issues, whereas in Cox's Bazar, massive deforestation has negatively affected water availability. In both locations, demand for water peaks during summer, leading to widespread shortage. In some locations in Satkhira, families must travel long distances—sometimes up to two hours on foot—to collect water, which can cost 10–20 Bangladeshi Taka (300 BDT monthly for 15 days a month of water collection, or 2 GBP) per drum[33]. On the other hand, in Cox's Bazar, due to massive deforestation, the local waterfall has dried up, forcing communities to rely solely on treated surface water from a treatment plant in the refugee camps. In some areas, households rely on tap stands and tube wells, but many struggle with the affordability and availability of water. For instance, some families in Cox's Bazar pay 600 BDT per month (~ 4 GBP) for water from tap stands, yet access remains unpredictable. People regularly associate heatwaves with decreasing water availability.

Additionally, people in Teknaf experience severe surface water crisis, with no access to groundwater. Previously, they were able to acquire twenty litres of water per day, but due to increasing water scarcity, they now manage to get only ten litres per day. In Rohingya

camps, due to limited water availability, communities cannot bathe daily; instead, they manage with one bath every three weeks[34]. During extreme heat, the time window for collecting water is limited, making access even harder. Women face additional burdens as they must juggle household responsibilities along with the physically demanding task of fetching water. Vulnerable populations, such as disabled individuals face greater mobility challenges in the time of fetching water.

In addition to the challenges of water availability and access, water quality is an additional concern – previous research has shown how in coastal areas such as Gabura, dangerously high arsenic contamination in drinking water is linked to rising sea levels and flooding, which decreases dissolved oxygen in water[35]. People we spoke to for this research in Cox's Bazar linked increasing salinity in surrounding water sources to heat – many reported that drinking water during extreme heat is unpleasant. The local agriculture representative from Satkhira mentioned that the salinity of water has increased dramatically, reaching levels as high as DH 12–25, which is far beyond the safe range of DH 0–6. This high salinity has a negative impact on soil structure and crops. During extreme heat, even chemically treated water changes in colour and taste, raising concerns about its safety. People in Atulia reported having to buy water for the past several years due to lack of freshwater. They also remarked on how extreme heat affected the salinity of drinking water and seeing salt deposits on utensils after washing them. Additionally, they observed changes in pond watercolour and density, as well as high iron content in tube well water, which allegedly gives cooked rice a reddish colour[36] .

The left image shows a tubewell stand in a village in Teknaf, Cox's Bazar and the right image shows the current state of water collected from a pond in Atulia Union, Satkhira, Author Photo

Impact of Extreme Heat

Extant literature on extreme heat shows the multifaceted and interconnected negative impacts on such aspects as human health, livelihoods, food security and nutrition, among others. For this study, we explored the impact of extreme heat on communities in Bangladesh and South Sudan through the lens of 'water security'. Water security is "the capacity of a population to safeguard sustainable access to adequate quantities of acceptable quality water for sustaining livelihoods, human well-being, and socio-economic development, for ensuring protection against water-borne pollution and water-related disasters, and for preserving ecosystems in a climate of peace and political stability"[37]. As described above, water security remains the foremost concern in the study locations, ranging from water scarcity to overabundance, and influences all aspects of human well-being in Bangladesh and South Sudan. As such, while examining the impact of extreme heat on various aspects of human well-being, we have attempted to highlight the

mediating and moderating[38] effects of water. We also comment on possible mediating effects of humidity and use publicly available information for this.

Extreme Heat and Health

The health consequences of heatwaves are well known and rising temperatures have been linked to increased cases of heatstroke, dehydration, respiratory illnesses, and skin-related diseases. Additionally, those with pre-existing medical conditions, such as cardiovascular disease, hypertension, diabetes, and respiratory illnesses, were more likely to experience severe complications during the heatwave, as well as a heightened morality risk. Demographic groups especially vulnerable to heatwaves are pregnant women and women doing outdoor labour; one possible reason is due women's higher basal temperatures during pregnancy, hormonal cycles, and reduced thermoregulatory efficiency compared to men[39].

Research participants in Bangladesh and South Sudan echoed some of these well-known impacts of extreme heat on human health during discussions, including dizziness, dehydration, fatigue, and a general increase in 'health related issues'. Participants from Satkhira reported that during hot periods, many people experience dizziness and 'illness', which prevented them from working effectively, especially performing outdoor labour. Women participants from Sreeula Union highlighted a rise in health issues, particularly among manual labourers and farmers. One participant shared that many people faint while working in the fields, some even losing their lives, during the rice harvest season. Many children are said to suffer from pneumonia, respiratory issues, and allergies, making them more susceptible to infections during heat.

In comparison, much of the discussion in South Sudan related to the impact of heat centred on access to and availability of water, although some health-related issues were mentioned when probed on vulnerabilities. Across the board, children were considered the most vulnerable group to extreme heat – a rise in incidence of diarrhoea among children was reported in several interviews in Gerbana. Diarrhoea, dysentery, and dehydration during peak summer months was also reported in various FGDs in Bangladesh. One young woman who is a South Sudanese returnee from Sudan posited that the shortage of water caused her children to have greater incidence of diarrhoea in the heat[40] . This relationship is supported by evidence showing a plausible association between drought conditions and diarrhoea due to the accumulation of faecal contamination of water sources, aerial transport of faecal material from dry soil, and sharing of water sources between humans and animals[41]. People from Sudan also mentioned a rise in cholera during the hot season, and flies were thought to have vector potential in spreading cholera risk.[42]

Skin related conditions were another category of heat related illness reported in Bangladesh. Bathing in turbid or saline water led to rashes and irritation and women were said to be particularly affected[43]. Pregnant women face additional risks, including oxygen deprivation, which, in some cases, has led to infant mortality. In South Sudan, besides children, other vulnerable groups are women (for their outdoor labour which increases risks of heat-related illnesses), and people with 'allergies' and diabetes. The link between extreme heat and diabetes was made particularly by Sudanese refugees and not by people from host communities[44].Migraines and headaches were also reported to rise in hot weather.

Additionally, poor hygiene and inadequate waste disposal contribute to unsanitary conditions in latrines, increasing the spread of diarrheal diseases. In all study locations,

as has been well established previously, sanitation presents a great risk for the spread of pathogens. In displacement affected contexts of Cox's Bazar and Renk/Gerbana, the growth in population numbers and the lack of adequate sanitation infrastructure are critical drivers of disease diffusion – heatwaves or the hot season only exacerbate this situation due to the risk of pathogen proliferation in elevated temperatures. However, the evidence base for the association between heatwaves and diarrheal disease remains weak, although high temperatures as a risk for diarrhoea is well studied[45]. A systematic review from 2022 of disease outbreaks in the aftermath of climatic events (floods, droughts, heatwave and cyclones) found a significant lack of evidence on how extreme climate events, especially long-term droughts or extended heatwaves, affect ecological systems (changing species composition and organization, proximity of humans and animals, agriculture productivity) and its impacts on disease outbreaks[46]. Participants in Cox's Bazar also reported a rise in mosquito-borne diseases, such as dengue, in higher temperatures – systematic reviews do show a correlated incidence of high temperature and risk of dengue infection, but the evidence on heatwaves and dengue remains limited[47]. Overall, epidemiological evidence points to a stronger association between extreme climatic events and water-borne diseases than for vector-borne diseases[48].

Extreme heat has also affected mobility in Bangladesh, which is closely linked to overall community health. The elderly are particularly vulnerable, with frequent instances of heat strokes, fainting, and sudden strokes, especially while fetching water[49]. Women with disabilities face greater mobility challenges while trying to access essential services during heatwaves[50] . One respondent from Satkhira noted that the nearest health complex was 4 km away, another 17 km away, and the hospital 25 km away, thus presenting serious challenges particularly for pregnant women[51].

Extreme Heat and Livelihoods, Food Security and Nutrition

Heavily reliant on crop and livestock smallholder agriculture to meet household and income needs, communities in all three locations experience the tangible impacts of heat stress on livelihoods and food security. People living in Satkhira District, in Bangladesh's coastal belt, depend on rice cultivation, fishing and other farming as a mainstay of the economy. As the coastal cropland has become less suitable for crop agriculture because of greater soil and water salinity (related to wider processes of climate change), shrimp[52]and crab farming have become alternative livelihood options in Satkhira. However, extensive shrimp aquaculture has had severe negative impacts on soil organic matter content thereby also affecting rice production[53]. During an interview, a representative of the social forestry department from Satkhira explained that the commercial and unregulated market penetration of fish and crab farming has made the land and soil increasingly saline thereby preventing tree growth in their area. This heightened salinity is further exacerbated during heatwaves.

In Renk, on the other hand, crop agriculture is mainly rainfed and mechanized, thanks to the abundant – or sometimes overabundant – rainfall in Upper Nile State. As one of South Sudan's most productive areas, Renk has large scale farms (about 200 hectares known as mushroor), as well as traditional farms (20 hectares) alongside large-scale farms[54]. Over the years, sorghum cultivation has decreased in favour of sesame cultivation due to demand from Sudanese traders for re-export. In addition to crop agriculture, livestock production also depends greatly on the availability of water sources and pasture.

In the case of climate reliant livelihoods, extreme heat affects both the producer and the production. Outdoor work in fields, unsurprisingly, becomes more difficult during extreme heat, especially for women[55]. In Bangladesh, many workers have been forced to reduce their working hours to avoid the intense heat and must work from early in the morning and stop by 8-9 AM and resume work after 4-5 PM[56]. Reduction of work hours may also lead to loss of wages. Some labourers reported that even if they start work earlier, they are still expected to work the number of hours previously determined, which is challenging in hot weather.

Food production is affected in various ways due to extreme heat and water security plays a fundamental intermediate role. In Bangladesh, bagda shrimp (tiger prawn) farming has increasingly led to economic losses due to the impact of extreme heat (as well as salinity intrusion) on shrimp larvae, causing them to die prematurely[57]. Considering the reliance on shrimp aquaculture in Satkhira, the impact of heatwaves on shrimp mortality is a significant concern for households. For instance, the Satkhira District Shrimp Growers Association reported the loss of approximately 40% of all shrimp in 2023 during a heatwave, which resulted in a financial loss of USD 1.8 million[58].

Bagda shrimp farming in Satkhira; courtesy: Seafood Network Bangladesh

Heat stress is also a critical concern for livestock production. Participants from Satkhira and Cox's Bazar mentioned that livestock, including cattle and poultry, suffer from heat stress, dehydration, and pox-like diseases, which may cause production losses. In South Sudan, whereas heat stress was not particularly discussed in terms of livestock health, IGAD's Climate Prediction and Application Centre has noted the possible impact of extreme temperatures in the IGAD region on 'reduced grazing time for animals due to excess thermal heat comfort[59]. Observational and qualitative data reveal that for animal herders from Sudan who have been displaced to Gerbana, access to water for animals is a greater concern (which, then, is related to livestock health). Animals and humans were observed drinking from the same hafirs around Gerbana, which is a source of stress to the water source and leads to contamination. We also observed larger herds of cattle being driven to the Nile as there is sufficient water there. People with animals – especially those from Sudan – are currently settled on the outskirts of Gerbana boma to avoid the destruction of grass-thatched homes and fences by ruminants. Whereas pasturage is scarce in the arid area around Gerbana, herders feed animals with fodder as well as by-products of sesame oil production[60].

Extreme heat (and extreme rainfall) has deleterious effects on crop agriculture – in Sreeula, Satkhira, crop losses from extreme heat was reported, while in Hnila Union, Cox's Bazar, participants mentioned that frequent outbreaks of crop diseases had an adverse impact on yields. Concurrently, irrigation costs have also increased according to farmers in Satkhira. The groundwater table in Bangladesh has fallen at a pace of 4 cm a year; according to one estimate, Bangladeshi farmers were spending nearly 30% of the entire cost of rice production on irrigation (in 2022)[61]. In contrast, in South Sudan, much of the agricultural production relies on rainfall, and while there is variability in yearly production, Renk continues to produce high amounts of sorghum, sesame, groundnuts and other crops. For displaced communities from Sudan, purchasing food in Gerbana is the only option, especially for those who have agricultural land back in Mezmoum. Some people rely on firewood sales to purchase food, as well as water, while others are able to sell small stock for cash. Host communities rely on harvests from the previous season supplemented with purchased food.

Lastly, food spoilage was reported in Bangladesh as an impact of extreme heat. In Gabura, Satkhira, heat causes food to spoil quickly, making storage difficult. Similarly, in Sreeula Union, Satkhira, a female participant noted that vegetables fail to grow properly under the harsh sun. Overall, due to declining food production (because of worsening ecological conditions) and consequent decline in income, many people reported food shortages. Extreme heat has also altered food consumption habits. In Gabura, Satkhira, many families have reduced their food intake, cooking only one or two meals per day (Gabura FGD, Satkhira). In Cox's Bazar, families struggle with food spoilage, frequent electricity cuts, and the lack of gas for cooking, further complicating food security[62]. In Burigoalini, Satkhira, families have started cooking three times a day instead of twice, as food spoils quickly in extreme heat.

Extreme Heat and Shelter

The Global Shelter Cluster has engaged with the issue of extreme heat recently by setting up a working group to address extreme heat risks in shelters and settlements. The Group's aim is to provide a mechanism for the Cluster to incorporate extreme heat into shelter programming and engage with other Clusters on a common approach to minimizing additional harm, primarily to displacement affected populations. Some strategies to address extreme heat events in humanitarian contexts include assuring ancillary support (such as misters and fans) in climate-appropriate shelters and construction material and natural ventilation in shelter design. The settlements approach – which considers the whole population and multistakeholder and multisectoral perspectives and support – calls for a coordinated cross-sectoral approach to providing support during extreme heat events and for settlement design and facilities that reduce heat stress.

Whereas the Cluster has several programmes on winterization, 'summer'-ization, or heat adapted shelters, is a work in progress[63]. Much of the experience of managing extreme heat is informed by contexts such as Europe or North America and not appropriate for humanitarian contexts. Examples of context and heat appropriate shelter designs include the adoption of swamp coolers in eastern Yemen, run on solar panels and adapted to a low battery, low tech and low electricity supply context. The Shelter Cluster, in developing the working group, is especially interested in exploring heat as well as humidity, given the operational challenges associated with humid heat.

Extreme heat has a noticeable impact on shelter conditions in both Cox's Bazar and

Satkhira, particularly for those living in tin-roofed and tarpaulin-covered houses - structures that trap heat and become unbearably hot. In Rohingya refugee camps, the plastic and tarpaulin sheets used for shelters intensify the heat, making the living environment untenable. During heatwaves, the felt temperature inside the camps can reach nearly 50°C, making it impossible to stay indoors for long periods[64]. In camps, with no access to electricity or fans, residents struggle to cool their homes[65]. The houses outside the camps are similarly either tin-roofed or covered with tarpaulin.

In Gerbana, refugee/returnee homes and host community homes are different – the latter more durable and permanent. Host community shelters are in the well-known tukul style, which has previously been shown to have the best average performance as a shelter style because of its low ecological footprint and that it maintains a moderate temperature for the greater number of hours a year[66]. Tukul roofs, made with locally available grasses, are tightly woven and layered, which ensures excellent insulation and a comfortable living space in various weather conditions[67]. The design also allows hot air to rise, because of the high roof, and for cool air to circulate through openings. As such, this design provides the best thermal comfort compared to prefab or tent-based shelters. By contrast, refugee/returnee shelters are temporary structures made from locally available grass and do not have walls of mud bricks typical for tukuls. Although little can be said about their durability in the rainy season, from our experience in the hot, dry season, the shelter appeared to be optimal with regard to availability of material in the surroundings and ventilation[68]. We did observe one such shelter catch fire during our visit due to the dry grass and possibly an open fire in the vicinity.

Gerbana refugee shelter (foreground) and host community tukul with rounded roof (background), author photo

In analysing overall comfort and wellbeing in extreme heat, a discussion on humidity levels is essential. Extreme heat, when combined with high humidity, can lead to the multiplication of various health risks as sweat evaporation decreases[69]. As an arid area, Renk and Gerbana have very low humidity, compared to the extremely high humidity in Satkhira and Cox's Bazar. Refugee hosting structures (built by external partners) are typically made with iron sheets in the Renk transit centre and bamboo and tarpaulin in Cox's Bazar. In the Renk transit centre, shelter partners were (at the time of research) exploring heightening the roof and placing openings above windows to increase air circulation and facilitating descending of cool air, as the shelters get hot in the hottest season (starting in February)[70]. According to one humanitarian representative, people

preferred being indoors because of the high outside temperature and the lack of shaded areas or trees near the transit centre. Meanwhile, in Gerbana, communities from Sudan and South Sudan utilize a structure (called rakuba or diwan) built from wood and grass that provides shade and ventilation for the hottest hours. In Cox's Bazar, communities expressed the need for alternative housing materials to reduce heat retention – however, extreme heat issues are dwarfed by risk of water related disasters such as landslides, storms and floods, which have devastating consequences for shelters, in addition to affecting water and sanitation issues within crowded camp settings[71].

Rakuba shelter under construction, Kueleng Thoi village, Renk, author photo

Adaptation to Extreme Heat

Communities in Bangladesh and South Sudan utilize a range of adaptation measures to deal with extreme heat and its impacts. Whereas these measures are continuously strained due to worsening climate conditions in all locations, understanding these is important for future responses. These adaptation mechanisms can be broadly categorized as adaptations for water management and storage, housing and shelter modifications, mobility, and modifications to livelihoods.

In Bangladesh, several people reported collecting rainwater at the end of May and using alum for purification. In some cases, communities have begun storing rainwater in tanks, but supplies are not sufficient for the year. To address water shortage, some communities also maintain a large communal pond for water for cooking and farming. One participant also remarked that there is greater reliance on tube well water as it stays cooler[72]. As well, people have started using clay pots for water storage. Similarly, in Gerbana, women reported covering their jerricans with sacks to keep the water cool[73].

In Satkhira, some communities collect rainwater in tanks provided by NGOs, but access remains unequal as not all households receive or can afford these systems, author photo

In their living environment as well, communities in Satkhira have made several adjustments – for example, many cover their roofs with coconut/palm leaves and branches (golpata in Bangla; Nypa fruticans), and regularly spray water on roofs and walls to reduce indoor temperatures[74]. To lower indoor temperatures, thick fabric curtains are sometimes hung inside houses along the roof and walls. Some women sew cloth-based materials to cover their homes to keep them cooler but making these is expensive (approximately 3000 BDT for a house roof, which is ~20 dollars for a household)[75]. Other modifications to deal with extreme heat include modifying daily outdoor work routines to escape the worst of the heat, resting under trees, sleeping on floors, and adjusting times for water collection to reduce exposure to heat[76].

In the same vein, as mentioned earlier, communities in Gerbana have a household design that is a natural extension of the landscape and allows for optimal thermal comfort. Some refugees from Sudan also mentioned having fans and air conditioners to deal with heat, demonstrating the socioeconomic levels of the often-homogenized refugee population[77]. Women from Mezmoum relayed that families with money can afford air conditioning to deal with heat; those who do not have much money plant big trees in their gardens for respite from hot weather; and the very poor families who do not have proper homes or areas for trees construct rakuba[78]. To protect children from the effects of extreme heat, women described wrapping them in water-soaked cloths to bring body temperature down[79].

For host communities in Gerbana, another key adaptation strategy is mobility. Before this recent arrival of refugees of Sudan, when the area around Gerbana experienced less than optimal rain to fill the local hafirs, people would send lorries to areas such as Geiger (on the White Nile) or Kilo Khamsa (where there is a large hafir) to draw water and bring to

Gerbana [80]. Furthermore, families would also move to these areas during the hot season to have water access; in some cases, women and children would move either to Geyger, Kilo Khamsa or as far as Renk town and live with relatives[81].

Extreme Heat in Humanitarian Response

Our review of available documents on humanitarian response and discussions with practitioners in Bangladesh and South Sudan shows that addressing extreme heat related issues remains in its early stages in both countries. In Bangladesh, there is greater relative progress on heatwave related issues than in South Sudan. During our interviews with humanitarian actors in Bangladesh, we found that that organizations such as the Bangladesh Red Crescent Society (BDRCS), International Federation of Red Cross and Red Crescent Societies (IFRC), the World Food Programme (WFP) and Save the Children, among others, have engaged in heatwave-related work. A BDRCS representative mentioned that structured efforts to address heatwaves began in 2019; since then, the Bangladesh Red Crescent has collaborated with the Ministry of Disaster Management to activate Early Action Protocols. As part of these efforts, three designated resting shelters have been established in Dhaka City, equipped with separate beds for men and women and cooling appliances such as fans. Awareness campaigns, water provision, distribution of baseball caps, and cash vouchers are some of the interventions that have been implemented, primarily in Dhaka. BDRCS also conducts vulnerability assessments to identify affected groups, including people who have lost income due to heatwaves, slum dwellers, and outdoor workers. As part of the response last year, BDT 5,000 was provided (GBP 30) to 4,000 households to assist the most affected people in different parts of Bangladesh which included Satkhira. Additionally, to enhance public understanding of heatwave risks, Heat Action Day has been observed annually in Bangladesh since 2021 featuring awareness initiatives such as flash mobs, local plays, and promotional campaigns.

In South Sudan, heatwaves have typically made headlines when the government has decreed the closure of schools as it did in 2024 and 2025. Discussions with various humanitarian actors and others revealed that despite being of concern, extreme heat issues do not feature in planning and response. Flooding is, overall, the vastly greater concern for humanitarian response due to its devastating impacts on life, health, food security, and displacement. As of November 2024, over 1.4 million people remain affected by flooding, largely in Jonglei and Northern Bahr el Ghazal states[82]. In conversations with Juba-based humanitarian actors, the severity and relatively enormous impact of flooding (compared to heat) on people as well as humanitarian response was repeatedly mentioned, alongside security concerns. For instance, WaSH related activities in South Sudan are unable to keep pace with the 'original amount of water' (interpreted as Sphere Standard requirements); therefore, how people's water related needs differ during extreme heat is, by necessity and circumstance, a secondary concern[83]. In fact, the discussion on weather-related risks to humanitarian response is dominated by floods, whereby these discussions tend to cease after October when the active flooding season has ended.

A second issue affecting heat response planning in both countries is the general lack of early warning and forecasting. Bangladesh's Meteorological Department, for instance, faces a shortage of weather stations, thus limiting accurate heatwave forecasting especially for rural and remote areas. In South Sudan, the Government launched the Early Warnings for ALL Initiative in November 2023, with a roadmap for implementation in areas of risk informed knowledge, forecast-detection and monitoring, and dissemination of Early Warning information to at risk communities[84]. Progress of this roadmap currently remains

unknown. Similarly, the Strengthening the Capacity of Government and CommUnitieS in South Sudan To Adapt to Climate ChaNge (SUSTAIN) project – a joint initiative of IGAD and UNDP - aims to strengthen the national capacity on early warning systems, infrastructure and technical capacity development[85]. The project description, while mentioning floods and droughts, does not make reference to extreme heat. Although organizations in Renk are thinking about extreme heat and its impacts, modifications to planning currently mainly involve working hours for staff, provision of water to offices etc. This is not to say the importance of extreme heat is not a consideration for the response itself – in multiple conversations, the growing need for and the rising scarcity of water in the arid area of Renk was brought up by humanitarian staff. According to one humanitarian representative with whom we had an informal conversation in Gerbana, the team conducting border monitoring had noted the return of Sudanese refugees back to Sudan from Gerbana due to rising water shortage.

Planning and integration of extreme heat, however, remains ad hoc and reactive. Whereas in both countries, various Clusters and Working Groups consider anticipatory action and early warning, the capacity to implement initiatives is constrained. For example, in Cox's Bazar, the Inter Sectoral Coordination Group (ISCG) shared a heatwave alert issued by the Bangladesh Meteorological Department to the Clusters in 2024. While some discussions on the impact of heatwaves were initiated within the Clusters, efforts have largely remained focused on raising awareness through messaging rather than implementing specific interventions. Considering the potential impact of heatwaves on both host and refugee communities, the Inter-Sector Coordination Group (ISCG), which leads the Emergency Response Plan, will be the key entry point for coordination in Cox's Bazar if an intervention is planned to address heatwaves in the future.

Conversely, in South Sudan, the work of clusters, working groups and other coordination measures faces significant barriers in implementation due to persistent insecurity and the failure of the revitalized peace agreement to pave the way for inclusive development. Discussions with humanitarian representatives, and drawing from Oxfam's own experience in South Sudan, extreme heat appears lower down in the list of risks as well as priorities due in part to the much larger and vastly more devastating impact of floods and the continual constraints to humanitarian access and response because of conflict and insecurity. Although this may come as no surprise, it is a critical consideration for present and future crisis response planning and disaster preparedness, especially in contexts of protracted political conflict and instability.

Humidity is a key variable in considering climate impacts on humanitarian response. Renk and surrounding areas experience low humidity and heat does not pose as great an issue as for areas such as in Central Equatoria where humidity hinders sweat evaporation[86]. In Renk, even the research team experienced hot weather conditions, and shaded areas and tree cover were a source of great respite. Where the critical challenge remains is the availability or provision of water which makes an otherwise 'bearable' situation of dry heat unbearable. With Ramadan approaching at the time of research, water is thought to be the single biggest concern. At the beginning of the emergency response in Renk (~ 2023), the concern was lack of clean water; in March 2025, the concern is 'no water' given the large population of refugees and returnees.

Considerations for Humanitarian Response and Coordination in Extreme Heat

Our research contributes to the growing literature on the impact of extreme heat on communities in rural and displacement affected areas of Bangladesh and South Sudan, and how water security plays a mediating role. Whereas this report uses extreme heat/heatwave and rising heat interchangeably, a distinction is necessary to understand their specific impacts and for tailoring future response. Globally, temperatures are on the rise every year, and this steady rise negatively influences water security, food security, livelihoods, health and nutrition. An episode of extreme heat or a heatwave, however, is an acute threat that poses danger to human health and significantly increases mortality risk. It is particularly dangerous for the elderly, very young children, pregnant women, and those living with underlying chronic cardiovascular, respiratory, or kidney disease[87]. Therefore, health and mortality concerns are dominant in any future planning for extreme heat and heatwaves.

In both countries, increasing heat is one aspect on the continuum of climate change and variability. Where in Bangladesh, rising sea levels have led to widespread salinity intrusion, in South Sudan, changes have been observed in the water table in aquifer areas[88]. In Gerbana, there is an almost total lack of understanding of groundwater due to the long-term reliance of communities on earth dams (hafirs). In all locations of research, increasing heat has varying impacts on people's lives, livelihoods and wellbeing – the situation is particularly grave for those on the move due to either the crowding of refugee camps (as in Cox's Bazar) or the lack of any supportive infrastructure to accommodate new arrivals (as in Gerbana). In severely water stressed scenarios, there may be a risk of extreme heat to assume crisis proportions due to the health-related impacts of dehydration, especially for vulnerable groups.

This research also provides further evidence of certain tensions within humanitarian response on minimum standards and realistic potential. For instance, key indicators for water access and quantity according to the Sphere Standard are a minimum 15 litres per day per person – neither in Gerbana, nor in Cox's Bazar (esp. certain camps) is this standard being met. For a context like Gerbana, which is neither a transit centre nor a refugee camp, the sudden increase in population has meant, on the positive side, an integrated host community and refugee/returnee response from the beginning. On the downside, water provision is severely constrained due to lack of groundwater mapping, infrastructure, and funding (in Oxfam's intervention, water trucking of 40 cubic meters costs approx. USD 18,000 per month). In a context without a camp coordination and management structure and the integration of refugees and host communities, rapidly decreasing water sources present a threat for hitherto peaceful relationships.

Further to addressing the basic issues of water provision, WASH actors working in contexts of increasing heat must address the impact on water supply. These impacts include elevated risk of algae and cyanobacteria, accelerated loss of disinfectant in distribution system, and intrusion of saltwater in coastal areas. For these, some effective mitigation strategies are increasing monitoring of water reservoirs for algae and cyanobacteria, careful monitoring and application of disinfectant, and nutrient management in the catchment. Other solutions to excessive or extreme heat related issues in WASH programming include the following: 1) surface water heating: shading, choice of tank materials; 2) excessive heat causing pump seals to deteriorate: shading; 3) Excessive heat leading to brittle pipes: necessary to understand pipe specifications and

bury deeper.

We know from comparable studies in other contexts that heat poses a grave risk to those on the move or in transit, and certain vulnerable categories, such as the elderly, very young children, pregnant women and those with cardiovascular or respiratory disease. Due to the acute risk posed by heatwaves, it may be difficult to understand the impacts, especially on mortality, in a data-poor context of displacement such as South Sudan. **Humanitarian actors working in such contexts should consider closer coordination with health actors and authorities to identify and target people with special vulnerabilities to extreme heat.** Medical personnel working in these contexts (including hospitals, medical centres, community clinics) can be trained to provide targeted advice for heatwave risks to vulnerable groups. For contexts that allow it, such as Bangladesh, early screening of cardiovascular, respiratory and kidney disease would be recommended to target individuals with heat-related interventions. In addition, **utilizing the public health promotion structure in place to engage communities in heatwave risk education and prevention is a cost-effective option**. Public health promotion activities should be designed to respond to heatwave threats and messaging should increase in line with direct threats.

Communities in Gerbana, Cox's Bazar and Satkhira have various adaptive strategies to mitigate risks posed by extreme heat that are appropriate for the context. These include long term strategies such as the building of homes that are a natural extension of the landscape and designed for the climate, to more recent strategies such as increasing tree cover for shade. In a coordinated camp context, such as the Cox's Bazar or the transit centre in Renk, these adaptive strategies may be unavailable to displaced communities because of the structured coordinated response and decisions. Nonetheless, **our research supports calls for strengthening a people-centred and localized approach in response.** The use of rakuba shelters in arid areas of Sudan/South Sudan by communities provides one possible intervention pathway for external actors – agencies working in informal settlements should collaborate with local administrators and communities to support the building of such shelters that are appropriate for the landscape, uses ecologically suitable and easily available materials, and can be built at low cost. Placing these temporary structures around livestock grazing areas (esp. where tree cover may be low) and in midway points between settlements and water points/reservoirs would also decrease the likelihood of exhaustion and dehydration during the hottest time of the year. In hot and humid climates, the general aim is to remove moisture where possible (e.g. through ventilation), shade surfaces and reduce heat gain.

In hot-humid environments like Bangladesh, certain heat protection techniques can improve shelter conditions[89]. Among these, roof shading, which uses reflective coatings to block solar radiation, is a recommended option. In the study locations, communities use golpata above the roof as a cooling technique. The feasibility of these locally sourced materials can be further explored as key heat protection strategies with proper guidelines. Breathable insulation (such as vapor-permeable wool) is also recommended which can be installed externally to prevent heat buildup while allowing moisture to escape. In Satkhira, communities use cloth-like material as insulation, while Rohingya communities highlighted the importance of lightweight, breathable walls to draw out indoor moisture. Natural ventilation and orientation adjustments (e.g., wing walls) which enhance airflow can be applied in both hot-humid locations, though high humidity may reduce effectiveness. Lastly, both the guidance and our field observations emphasize the importance of increasing vegetation and water bodies that provide cooling through shading and evaporation.

Heat Action Plans have also gained traction over some years and are essential for protecting people, infrastructure, and ecosystems from the increasing impacts of extreme heat. Heat Action Plans help communities organize immediate responses, build long-term resilience, and streamline the necessary actions across various sectors and governance levels [90]. Much of the progress on Heat Action Planning has occurred in countries of the global north, and few low-income countries – and no African countries – have adopted such plans [91]. **There is evidence that investing in heat action planning can pay large dividends**. Bangladesh has included heatwaves in its national adaptation plan (NAP, 2023–2050), which aims to strengthen heatwave and disease outbreak advisory services for urban populations by developing targeted emergency healthcare infrastructure in vulnerable areas. As well, the Directorate General of Health Services (DGHS) with support from UNICEF, has launched a national guideline for heat related illness in 2024, which aims to protect children and vulnerable populations from heat-related health risks. Although both these efforts prioritize the health sector, and in the event of an acute threat from heatwave this would be essential, there remains a need for coordinated early action planning for increasing heat and its impact on water, food, nutrition and livelihoods.

Future intersectoral humanitarian response in countries such as South Sudan and Bangladesh should consider supporting heat action planning for managing extreme heat risk on multiple outcomes such as health, livelihoods, food security and nutrition. Heat action planning should be localized and can be integrated into response plans for specific emergencies or for protracted crises contexts. This planning as well as the dissemination must involve 'last mile' communities and should be tailored contextually with the engagement of communities[92]. For example, interviews with humanitarian representatives in Bangladesh indicate that local volunteers are already working through the Bangladesh Red Crescent Society (BDRCS) and have direct engagement with communities to raise awareness on extreme heat. Similarly, community health promoters in Renk and Gerbana are the backbone of public health programming and messaging. Finally, it would be equally essential to **strengthen data collection and analysis at lower administrative levels** - these should be linked with expanding national level forecasting and monitoring mechanisms[93] to remote areas.

In addition to heat action planning, regular and localized climate modelling can be undertaken to identify heat 'hotspots', particularly those where mortality might be a risk. Humanitarian organizations and donors should also map supply chains for increased delivery of water to these areas. For example, in Gerbana, people do not want to move away from the border areas as it allows for greater movement and market access (and possibly more autonomy) than in transit centres or refugee camps. **A people-centred approach to emergency response would be highly attuned to intentions of displacement affected communities, and would ensure accessibility, storage and reuse of water, and hygiene, sanitation and water quality testing that is dynamic and mobile**. Such an approach may reduce exceedingly negative impacts on health and mortality, as well as secondary displacement due to increasing heat and subsequent water needs.

Within humanitarian settings, such as Cox's Bazar and Renk, the inter-sector coordination mechanism is the principal body for ensuring early warning and early action for extreme heat. The Inter-sector meeting group in the Rohingya Response and the Refugee Operation and Coordination Team that are both responsible for different aspects of operational and technical level guidance. In Renk, UNHCR (at the time of writing) is the inter-sector coordinator for the response. Both these mechanisms work closely with governments at local administrative and national levels. To that end, these intersectoral coordination mechanisms must work closely with communities and local/national organizations on identifying and assessing heat risks on health, livelihoods, and food security and nutrition,

and collaboratively develop mitigation plans.

At the global level, policymakers and financial partners must accelerate on existing commitments to meet humanitarian needs as efficiently as possible and address the root causes, including climate change**. In line with commitments under the Grand Bargain, donors and humanitarian actors should scale up anticipatory action programs and systems**. In line with climate goals, States should offer bilateral and multilateral support to national climate adaptation plans, including the provision of climate finance in humanitarian settings. Where possible, stakeholders at the global and national levels should collaborate to sustainably develop national infrastructure that can realise the rights of citizens to essential services. These development efforts must be done in full collaboration with national civil society and marginalised groups.

Notes

[1] Oxfam International. 2023. Water Dilemmas: The cascading impacts of water insecurity in a heating world.

[2] We use 'heatwaves' and 'extreme heat' interchangeably in this report. A heatwave is an "extended period of unusually high temperatures and often high humidity that causes temporary modifications in lifestyle and may have adverse health effects on the affected population". The World Meteorological Organization (WMO) defines a heat wave as a period during which the daily maximum temperature exceeds for more than five consecutive days the maximum normal temperature by 9 degrees Fahrenheit (5 degrees Celsius), the normal period being defined as 1961–1990. https://www.ifrc.org/sites/default/files/2021-06/10-HEAT-WAVE-HR.pdf

[3] OCHA, IFRC & Red Cross Red Crescent Climate Centre. 2022. Extreme Heat: Preparing for heatwaves of the future

[4] Char refers to riverine islands and sandbars that form from the accumulation of sediments from major rivers and their tributaries) of Bangladesh.

[5] Fahim, T. C., & Arefin, S. (2023). Climate Change-induced Salinity Intrusion and Livelihood Nexus: A Study in Southwest Satkhira District of Bangladesh. International Journal of Rural Management, 20(1), 106-123.

[6] Chakraborty, T. K., & Kabir, A. H. M. E. (2016). *Impact and adaptation to Cyclone Aila: Focus on water supply, sanitation, and health of rural coastal community in the southwest coastal region of Bangladesh*. *Journal of Health and Environmental Research, 2*(3), 13. https://doi.org/10.11648/j.jher.20160203.11

[7] https://www.dailypost.net/health/fresh-water-crisis-across-in-southwest-coastal/8965

[8] https://www.dhakatribune.com/bangladesh/bangladesh-environment/342400/salt-in-our-waters

[9] Abdullah, H. M., Ahmed, S. M., Khan, B. M., Mohana, N. T., Ahamed, T., & Islam, I. (2021). Agriculture and fisheries production in a regional blending and dynamic fresh and saline water systems in the coastal area of Bangladesh. *Environmental Challenges, 4*, 100089. https://doi.org/10.1016/j.envc.2021.100089

[10] Information gathered via interviews for this study

[11] https://data.unhcr.org/en/country/bgd

[12] https://plumbersoftheworld.org/OXFAM-BOOK.pdf

[13] https://www.licas.news/2025/03/12/the-hidden-cost-of-water-scarcity-in-coxs-bazar-bangladesh/?amp

[14] https://www.licas.news/2025/03/12/the-hidden-cost-of-water-scarcity-in-coxs-bazar-bangladesh/?amp

[15] This information was originally available on FEWSNET, which does not exist. Information also available - https://www.csrf-southsudan.org/county_profile/renk/

[16] The World Bank, 2023. Rising from the Depths: Water Security and Fragility in South Sudan. https://openknowledge.worldbank.org/entities/publication/91048a50-eacb-5a24-9fa4-30cf8a9a9c9b; https://www.csrf-southsudan.org/county_profile/renk/

[17] https://data.unhcr.org/fr/documents/download/114053

[18] https://www.unhcr.org/uk/news/briefing-notes/unhcr-and-partners-rush-aid-sudan-arrivals-overwhelm-south-sudan-border

[19] Although, as we note in the *Limitations* section, we do not claim to have exhaustive evidence of these different views.

[20] https://openknowledge.worldbank.org/server/api/core/bitstreams/c5a2c70e-27fd-5e9f-8e47-53b32c31b696/content

[21] From UNHCR coordinated Renk WASH Response Plan presentation

[22] Discussion with Oxfam WASH Response Team in South Sudan

[23] Lamanna, Camillo. "Too hot to handle? Heat resilience in urban South Sudan." South Sudan Medical Journal 12.1 (2019): 24-27. A recent study from 2025 uses climate modelling to estimate extreme heat events and impacts in South Sudan under 1.3 degrees Celsius warming conditions, but is not locationally specific, and is based entirely on historical data – see World Weather Attribution, 2025. Women and girls continue to bear disproportionate impacts of heatwaves in South Sudan that have become a constant threat. https://www.worldweatherattribution.org/wp-content/uploads/WWA-scientific-report-South-Sudan-heatwave.pdf

[24] https://www.radiotamazuj.org/en/news/article/south-sudan-closes-schools-as-heatwave-intensifies

[25] KII with local representative; KII with INGO representative in Renk

[26] The World Bank, 2023. Rising from the Depths: Water Security and Fragility in South Sudan. https://openknowledge.worldbank.org/entities/publication/91048a50-eacb-5a24-9fa4-30cf8a9a9c9b

[27] KII with local representative, Gerbana

[28] KII with local representative, Gerbana

[29] https://prezly.msf.org.uk/over-2700-cholera-patients-treated-92-dead-in-msf-supported-facility-in-sudans-white-nile-state

[30] KII with humanitarian representative, Renk

[31] KII with Renk WaSH Cluster representative

[32] KII with humanitarian representative, Renk

[33] KII with humanitarian representative, Renk

[34] FGD with Rohingya women, Camp 22, Cox's Bazar
[35] https://www.euronews.com/green/2024/01/18/half-of-bangladeshi-drinking-water-is-polluted-with-arsenic-and-climate-change-is-making-i
[36] FGDs with Women, Atulia, Satkhira
[37] Working definition from UN Water - https://www.unwater.org/sites/default/files/app/uploads/2017/05/unwater_poster_Oct2013.pdf
[38] We borrow from statistical understandings of moderator and mediator variables and apply them here.
[39] Rahman, Juma, et al. "Environmental heat stress among young working women: a pilot study." *Annals of Global Health* 82.5 (2016): 760-767.
[40] Interview with returnee, Gerbana
[41] Levy K, Woster AP, Goldstein RS, Carlton EJ. Untangling the Impacts of Climate Change on Waterborne Diseases: A Systematic Review of Relationships between Diarrheal Diseases and Temperature, Rainfall, Flooding, and Drought. Environ Sci Technol. 2016;50(10):4905–22.
[42] FGD with men from Sudan, Gerbana
[43] FGD Burigoalini, Satkhira & FGD Atulia, Satkhira
[44] Sudan has a 16% prevalence of adult diabetes, although urban residence is one of the key risk factors of diabetes in Africa https://idf.org/our-network/regions-and-members/middle-east-and-north-africa/members/sudan/; Peer, Nasheeta, et al. "Diabetes in the Africa Region: an update." *Diabetes research and clinical practice* 103.2 (2014): 197-205.
[45] Alcayna, Tilly, et al. "Climate-sensitive disease outbreaks in the aftermath of extreme climatic events: A scoping review." *One Earth* 5.4 (2022): 336-350.
[46] Alcayna et al., 2022. *ibid*
[47] Damtew, Yohannes Tefera, et al. "Effects of high temperatures and heatwaves on dengue fever: a systematic review and meta-analysis." *EBioMedicine* 91 (2023).
[48] Alcayna et al., 2022. *ibid*
[49] FGD Gabura, Satkhira & FGD Atulia, Satkhira
[50] KII with woman, Satkhira
[51] FGD with women, Atulia, Satkhira
[52] This farming system is known as *gher,* which involves the modification of a rice field to enable joint production of fish, shrimp and rice.
[53] Kabir, Md Humayun, and I. J. Iva. "Ecological consequences of shrimp farming in Southwestern Satkhira District of Bangladesh." *Austin J Earth Sci* 1.1 (2014): 7.
[54] FAO & WFP. (2019). Special Report: FAO/WFP Crop and Food Security Assessment Mission to South Sudan. Retrieved from http://www.fao.org/3/ca3643EN/ca3643en.pdf
[55] FGDs from South Sudan and Bangladesh
[56] Various FGDs with women in Satkhira
[57] FGD in Atulia and Burigoalini; see also https://thefishsite.com/articles/heatwave-sets-back-opening-of-bangladeshs-shrimp-season
[58] https://thefishsite.com/articles/heatwave-sets-back-opening-of-bangladeshs-shrimp-season
[59] https://www.icpac.net/documents/960/Heat_wave_infographic.pdf
[60] Discussions in Gerbana
[61] https://www.cgiar.org/news-events/news/farmers-participatory-evaluation-of-alternate-wetting-and-drying-irrigation-method-on-greenhouse-gas-emission-water-productivity-and-paddy-yield-in-bangladesh/
[62] FGD with women, Noyapara, Bottoli, Whykong, Cox's Bazar
[63] KII with Global Shelter Cluster
[64] KII in Cox's Bazar
[65] FGD with Rohingya men, Cox's Bazar
[66] Domínguez-Amarillo, Samuel, et al. "Architecture of the scape: Thermal assessment of refugee shelter design in the extremes climates of Jordan, Afghanistan and South Sudan." *Journal of Building Engineering* 42 (2021): 102396.
[67] Every Shelter, 2023. Examinations in Relief Architecture. The Tukul of Eastern Sub-Saharan Africa. https://everyshelter.org/wp-content/uploads/2023/11/Every-Shelter-Tukul-Pages.pdf
[68] This is not a scientific assessment.
[69] Baldwin JW, Benmarhnia T, Ebi KL, Jay O, Lutsko NJ, Vanos JK. Humidity's Role in Heat-Related Health Outcomes: A Heated Debate. Environ Health Perspect. 2023 May;131(5):55001. doi: 10.1289/EHP11807. Epub 2023 May 31. PMID: 37255302; PMCID: PMC10231239.
[70] KII with humanitarian personnel, Renk
[71] https://bangladesh.un.org/sites/default/files/2024-09/Flash%20Update%20-%20Landslides%2C%20Flooding%20%26%20Waterlogging_12-14%20Sept%202024.pdf
[72] FGD with women, Atulia, Satkhira
[73] FGD with host community women, Gerbana
[74] FGD in Gabura
[75] FGD with women, West Konapara, Cox's Bazar
[76] Discussions in Bangladesh
[77] However, there may only be a few people from upper socioeconomic levels in Gerbana – many people who

could afford transport (cars) had supposedly gone from Sennar to Blue Nile State, instead of coming to South Sudan.

[78] FGD with women refugees, Gerbana

[79] FGD with women refugees, Gerbana

[80] FGD with host community women, Gerbana

[81] FGD with family, Gerbana

[82] https://www.unocha.org/publications/report/south-sudan/south-sudan-floods-snapshot-29-november-2024

[83] KII with national WaSH representative, Juba

[84] https://afrp.undrr.org/publication/south-sudan-official-statement

[85] https://www.icpac.net/documents/836/Sustain_2024.pdf

[86] Humanitarian Representative, Renk

[87] https://lancetcountdown.org/explore-our-data/

[88] Discussion with WaSH representative, Juba

[89] Oxfam GB and ADAPT Initiative. Passive cooling guidance. *Forthcoming*

[90] https://sheltercluster.org/extreme-heat-working-group/documents/assessment-heat-action-plans-global-standards-good-practices

[91] OCHA, IFRC & Red Cross Red Crescent Climate Centre. 2022. Extreme Heat: Preparing for heatwaves of the future.

[92] IFRC & CREWS 2020. People Centered Early Warning Systems: Learning from National Red Cross and Red Crescent Societies.

[93] IFRC & CREWS 2020. People Centered Early Warning Systems: Learning from National Red Cross and Red Crescent Societies.

OXFAM

www.oxfam.org