CASE STUDY: CLIMATE INFORMATION SERVICES FOR HEALTH SYSTEMS STRENGTHENING

A Health Early Warning System to Reduce Extreme Heat Impacts in Senegal

USAID Climate Adaptation Support Activity

CASE OVERVIEW

The frequency, intensity, and duration of heat waves are increasing due to climate change.[1] The Sahel region, including Senegal, is experiencing unprecedented heat threats with more frequent and severe heat waves which pose significant risks to health and health systems. Heat stress adversely affects human health, both directly and indirectly, and especially impacts vulnerable groups like the elderly, children, and pregnant women. Direct risks of extreme heat include gestational diabetes, lower birth weights, stillbirths, malnutrition, heat stroke, occupational illnesses and injuries, cardiovascular and respiratory disorders, and death.[2,3] Indirectly, it strains healthcare systems with increased hospitalizations and emergencies, while also stifling economic and educational opportunities.

Despite evidence of the benefits of heat early warning systems and adaptation measures, the current capacity for heat monitoring and forecasting across Africa is low and in need of investment.[4] This case study profiles the efforts of the United States National Oceanic and Atmospheric Administration (NOAA) and other partners to enhance the region's preparedness and response capabilities, mitigating the health threats of climate change through heat-health early warning (HHEW) systems in the Sahel. An initial pilot, launched in Senegal in 2023, was led by the National Agency of Civil Aviation and Meteorology (ANACIM) and the Directorate General of Public Health (DGSP) at the Ministry of Health and Social Action (MSAS).

Case Study by the Numbers

5 out of the world's top 10 hottest countries are in the Sahel (based on average yearly temperature).[5]

Record-breaking heat waves in Senegal of over 45°C / 113°F for 3 successive days or more: in 2013, 2016, 2018 and 2023.[6]

In the Sahel region, **temperatures are expected to rise 1.5 times faster than the global average**.[7]

In West Africa, the number of potentially **lethal heat days per year is projected to increase from <50** in the 1995–2005 period to **100–250 if global warming reaches 2.5°C /6.5°F above pre-industrial levels**.[8]

As part of this collaboration, NOAA funded and supported meteorological staff from ANACIM and health professionals from the DGSP to strengthen national capacity to co-produce heat-health early warning systems, including disseminating a HHEW bulletin.

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The bulletin provides information about the timing of expected heat waves, offers practical advice on actions to reduce heat strain, and is designed to be accessible to individuals, public officials, and local community groups. As part of the pilot, ANACIM and the DGSP conducted a survey through local Red Cross and Red Crescent volunteers to better understand how forecasted information impacted people's behavior. The pilot also tested different communication channels – such as community radio and targeted outreach to vulnerable groups – and evaluated the accuracy of global products for early warnings on heat at the local level.

Pilot programs with localized approaches, such as the one in the Fatick region, play a crucial role in evaluating the effectiveness of health-targeted Climate Information Services (CIS) and offer insights for the development of Health Systems Strengthening (HSS) at scale. Implementing actionable, locally relevant HHEW requires accurate and timely forecasts, clear communication and community engagement, and inter-disciplinary and cross-governmental collaborations. Securing long-term support, as well as sufficient financing, from critical stakeholders is also vital.

BACKGROUND

Global temperatures set new records in 2023.[9] The frequency and intensity of heat waves are increasing worldwide, and extreme heat – defined as higher-than-normal temperatures and humidity for a specific location in a given time period – is occurring in areas that were previously less impacted. This trend is evident in the Sahel, including Senegal, where despite warmer-than-average global temperatures, heat waves have increased in frequency, intensity, and duration in recent decades.[10] Definitions of extreme heat vary according to higher-than-normal temperatures (usually 90th percentile) or are based on temperature combined with humidity thresholds for a specific location within a given time.

The Sahel is a semi-arid region that stretches across several countries from Senegal to Sudan. It is sandwiched between the humid savannas to the south and the Sahara Desert to the north. Heat waves in the Sahel occur mostly in the period of March-June and can exceed 52°C, a dangerous threshold for human health.[11] In addition to higher temperatures, climate change is likely producing higher humidity in the region.[12] Heat and humidity are both linked to increased mortality and morbidity – limiting evaporative cooling and the coping mechanisms of healthy individuals and disproportionally affecting vulnerable groups such as the elderly, children, and pregnant women. Heat stress is linked to gestational diabetes, adverse birth outcomes, malnutrition, and hypertension, and poses a particular threat to expectant mothers.[13,14] Outdoor workers, including nomadic and pastoral shepherds, agricultural laborers and market vendors, also face heightened health dangers due to their exposure to extreme temperatures, including dehydration, liver disease, heat stroke, and exacerbated respiratory and cardiovascular diseases.[15]

Primary Partners Engaged

Senegal's National Agency of Civil Aviation and Meteorology (ANACIM) and the Directorate General of Public Health (DGSP) at the Ministry of Health and Social Action (MSAS) lead on setting up an HHEW system and testing it in the Fatick region.

NOAA and its African Desk provides funding, tailored training opportunities, and global temperature products to trial at the local level.

The local government of Fatick supports the HHEW pilot rollout in the region, disseminating the bulletin and deploying response efforts. Local representatives from the Ministries of the Environment, Health, Interior, Community Development, Youth and Sports are engaged.

Radio stations and local media are partners in communicating the bulletin in local languages.

Civil society groups, like the National Red Cross and Red Crescent Member Society, Association of Sports and Culture, Badiénou Gokh (a Women's Leadership group), and the local fire brigade are consulted on the pilot design and evaluation.

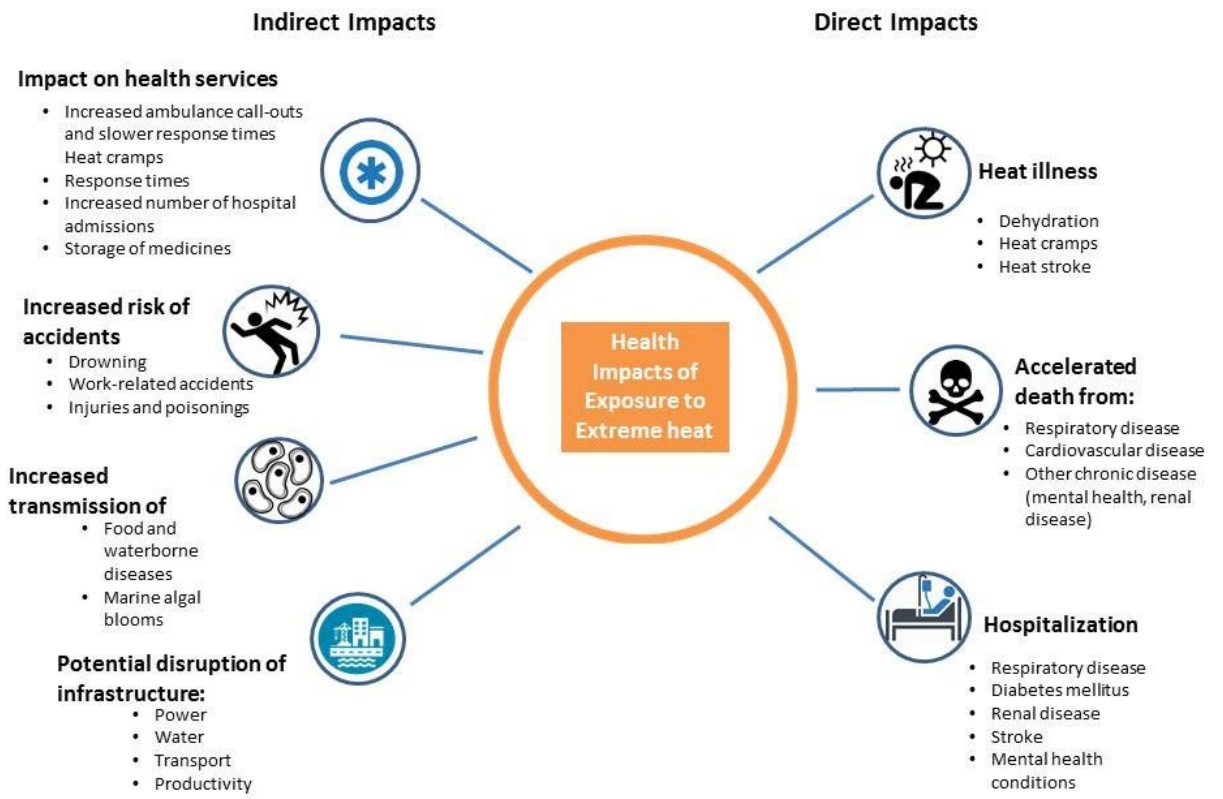

Figure 1: Heat-related impacts on health. Source: https://www.who.int/news-room/fact-sheets/detail/climate-change-heat-and-health

Indirectly, heat stress disrupts healthcare services by elevating hospital admissions and amplifying the risk of food and waterborne diseases, among other negative impacts (see Figure 1).[16] The urban heat-island effect intensifies the impact of heat waves, making them especially problematic in cities. Given the growing percentage of populations living in urban areas, these risks are concerning.[17] In the Fatick pilot, impacts on young children were also identified, with increased fainting in classrooms and disrupted school days, as well as community concerns over animal health and livelihoods during extended heat waves.

Effective early warning and protection strategies, such as HHEW, are crucial for safeguarding vulnerable populations from the detrimental health effects associated with heat waves by providing timely and accurate notifications and public health advice enabling preventive measures.[18]

This is especially the case in the Sahelian region, where air conditioning and other potential coping strategies are limited. HHEW involves forecasting heat waves based on a defined trigger, taking into account demographic and vulnerability factors to assess health impacts, and effectively communicating and rolling out a response plan.

Leveraging long-standing collaborations with meteorological institutions in the region, the African Desk at NOAA's Climate Prediction Center (CPC) held several regional workshops preceding the pilot to identify concerns raised by both the climate and health communities in the Sahel. Heat risks were noted as a priority, reinforced by feedback from healthcare practitioners. Senegal, at the forefront of monitoring and forecasting heat waves in the region, was selected as the pilot country to test new methodology and localized approaches to HHEW.[4]

APPROACH

The pilot project benefited from many longstanding investments in strengthening African meteorological services in the Sahel, particularly those focused on improving weather and climate data for the agriculture sector to improve food security. From 2016 onwards, several workshops funded by NOAA's National Weather Service (NWS) were specifically dedicated to exploring opportunities to leverage these investments for early warning systems for health.

Following regional consultations in East Africa and the Sahel, NOAA first convened national stakeholders in Senegal in 2019 to devise a road map for translating heat forecasts into early action planning. NOAA's African Desk subsequently hosted staff from ANACIM and the DGSP for training and the development of experimental heat wave forecasts.

Collaborations advanced throughout 2020-2022, despite the COVID-19 pandemic, and in 2023 the pilot HHEW roll-out engaged critical national and community stakeholders.[4]

The bulletin developed through these efforts (see Figure 2) includes a one- to three-week forecast of the likelihood of heat waves in specific geographic locations. It also provides public health advice in an accessible format. ANACIM and DGSP worked together to improve the bulletin and issue it regularly. For the pilot, a heat wave was defined as a period of at least three consecutive days in which the daily maximum temperature exceeded the local 90th percentile threshold values (ranging between 38-45°C or 100.4-113°F), using NOAA's global model for forecasting temperatures.[4] Vulnerability mapping was conducted, taking into account the population's access to health facilities, air conditioning, and natural cooling opportunities, as well as demographic variables, categorizing specific areas into different vulnerability zones. The combined data (heat wave and vulnerability) was then overlayed onto a heat-health risk map.

ANACIM and DGSP led the operational roll-out starting in March 2023, focusing on the heat wave-prone Fatick region in the middle of Senegal, with the support of the local governor.

A local advisory group – with participation by civil society organizations, including the National Red Cross and Red Crescent Member Society, the Association of Sports and Culture, women's groups, firefighters, and other community members – was established. The group was consulted on the pilot design and dissemination and provided valuable insights on how to promote the use of this information and identify strategies to address the risk in the wider public.

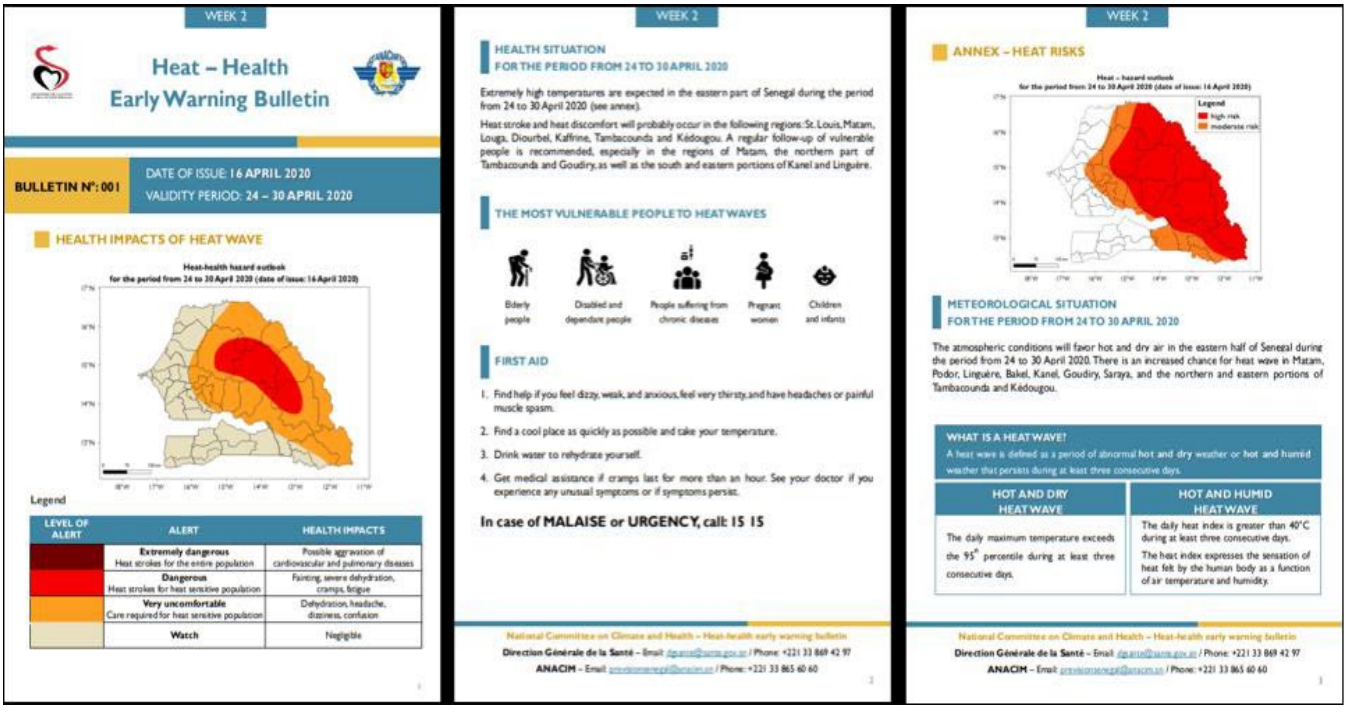

Figure 2: Heat-health early warning bulletin Source: Thiaw et al. (2022), Bulletin of the American Meteorological Society 103, 8; 10.1175/BAMS-D-20-0140.1
See: https://journals.ametsoc.org/view/journals/bams/103/8/BAMS-D-20-0140.1.xml

The Fatick public was informed about impending heat waves through a variety of communication channels, including through the engagement of a network of women already active in health-related activities for children and through the dedicated outreach of the National Red Cross and Red Crescent Member Society and its volunteers. Text messaging was also used to reach at-risk individuals directly. Community radio was used to reach a wide audience in different languages.

To evaluate the impact and uptake of this information, approximately 600 questionnaires were distributed across the region, including in restaurants, farms, public transportation, hospitals and households. The feedback received was crucial in better understanding the actions taken by the population, probing the clarity of the bulletin and its messaging, and identifying the most effective channels for information dissemination.

IMPACT

The pilot project in Fatick demonstrated the success of CIS for health systems strengthening based on experimental heat forecasting tools and comprehensive HHEW. Evaluation of the pilot is still underway, though preliminary positive outcomes include:

Awareness raised and behaviors changed at the community level. The project improved awareness of heat waves at the local level. As part of the pilot roll-out, a comprehensive survey with over 600 participants was conducted to assess the impact. Local residents reported frequently modifying their behavior in response to the disseminated information and recommendations. For example, local soccer teams shifted the timing of their practice sessions or cut certain practice days altogether to avoid the highest temperatures. Shepherds did not move their herds during the hottest periods to reduce the risk of animal dehydration and exhaustion. The information was also critical for schools, where classrooms were overcrowded and lessons were taking place during hot periods of the day (noon) with students prone to fainting, enabling them to plan breaks, early school closures, and the distribution of water.

Improved capacity for health professionals at the DGSP and meteorological staff at ANACIM. Through the support of NOAA, several meteorological staff were trained to improve the forecasting of heat waves and were paired alongside DGSP staff to co-develop effective, experimental HHEW tools. The project also secured the backing of the Minister and visibility for the HHEW bulletin, creating a supportive environment for future efforts.

Health systems better prepared. With the HHEW in Fatick, medical staff and emergency response workers were better prepared for an increase in the number of patients. They could also more effectively locate vulnerable populations, providing access to safe drinking water, treatments, shelter and recommendations to limit heat exposure. The active participation of MSAS staff in the pilot meant existing health infrastructure and systems could be leveraged to communicate and prepare for additional heat-related risks.

LESSONS LEARNED

The collaboration between NOAA, ANACIM, and DGSP led to the development of a vital tool for HHEW and has set a precedent for similar initiatives in the region and beyond. Lessons learned include:

Investing in local capacity is key. Training is critical to help meteorologists enhance skills in forecasting, access new tools, and take advantage of continuous advances in numerical modelling. Health professionals also need to be supported to understand heat wave forecasts and protocols to integrate these forecasts with other health risk factors. Collaboration between meteorologists and health professionals is essential in creating operationally effective health impact-based heat forecasts. Furthermore, local governments and community organizers should be consulted and better informed on heat risks. A multifaceted approach to training is fundamental in building local capacity to manage the increasing threats posed by heat waves and enabling an effective public health response.

Local HHEW should be actionable. Effective communication with the public regarding the risks and potential responses to extreme heat is critical. It is important to iterate on and sharpen messages while identifying the most appropriate and effective communication channels. Working with various groups that are already integrated into the community was a critical

component of the process of information dissemination that took place in this pilot.

High-level support is critical. When the pilot project revealed a significant increase in hospitalization rates due to heat waves, ANACIM and DGSP shared these findings with the regional governor of Fatick, actively involving her and her team in the project. This strategy was effective in gaining the governor's support for this initiative. Long-term support and ownership among high-level decision-makers is critical for the success and legitimacy of HHEW initiatives; engaging senior leadership across Ministries and government levels is key.

Piloting, feedback, and impact assessments improve practice and scale-up. Despite initial far-reaching consultations across the Sahel region, the pilot program was originally launched only in Fatick – soliciting feedback from a local advisory group and planning for a pilot survey to test assumptions about the uptake of information. Without this commitment to learning from the first operational deployment of an HHEW in Senegal, this initiative might have missed opportunities for improvement and gaining insights and trust at the community level.

Community interest extends beyond human health. The pilot focused on human health, but the community was also interested in heat's impact on animal and plant health and livelihoods. This broader perspective – as well as the collaboration between practitioners with expertise in different sectors are essential – is essential for developing comprehensive strategies to address the impacts of climate change and rising temperatures holistically.

> **"The local level is where decisions are taken and where you learn. Funding to better understand needs and impacts more systematically before an intervention is designed and implemented is critical for climate information services to have relevance for the community."**
>
> Ousmane Ndiaye, Director of Meteorological Operations, ANACIM, Senegal

KEY RESOURCES

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Note: The collaborations detailed in this case study did not receive direct funding support from USAID and are featured here as an external best practice case study.

ENDNOTES

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