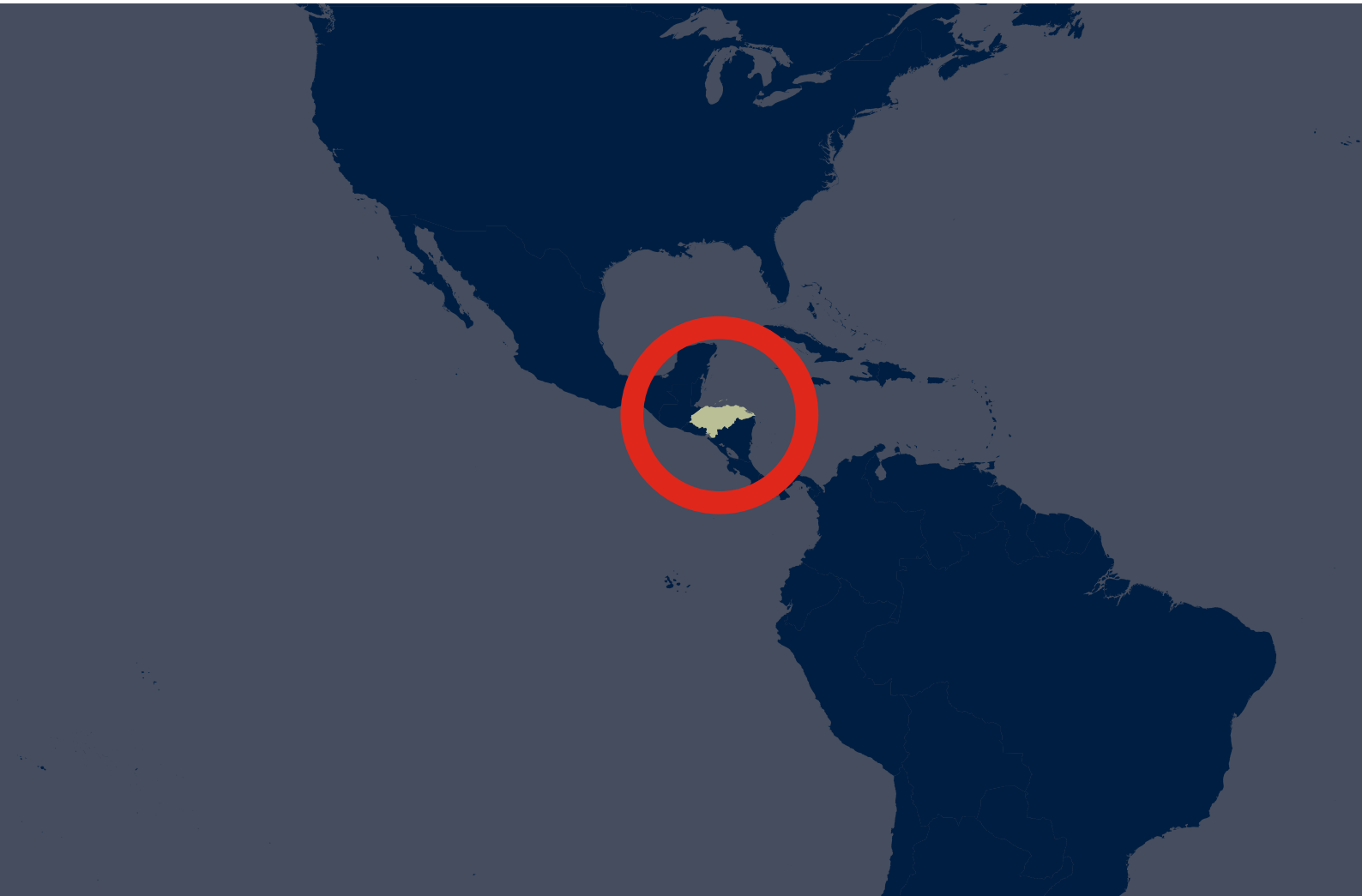


Report

Heat threshold report

Honduras



Introduction

Extreme heat is a growing climate-related risk with significant impacts on public health, particularly in tropical countries such as Honduras. The sustained increase in temperatures, driven by climate change, accelerated urbanization and socioeconomic conditions, has increased the frequency, duration and intensity of extreme heat events, resulting in higher risks of morbidity, mortality, productivity losses and increased pressure on health systems (IPCC, 2022; WHO, 2021).

Traditionally, early warning systems have relied on universal temperature thresholds or absolute values to define extreme heat events. However, this approach is not suitable in diverse climatic contexts, as populations adapt physiologically and socially to their prevailing climate conditions. Consequently, the same temperature can lead to very different impacts across regions, limiting the effectiveness and credibility of warning systems when thresholds are not locally calibrated (Gasparri *et al.*, 2015; Mora *et al.*, 2017).

In this context, the definition of locally calibrated heat thresholds is essential for linking climate information to real health risks. Local thresholds allow for the identification of relevant thermal anomalies relative to normal climatological conditions and support the timely activation of prevention and response actions.

Purpose

The purpose of this analysis was to co-develop heat thresholds specific to the city of Choluteca, Honduras, to serve as a technical basis for activating heat early warning systems, particularly in contexts where such systems are nonexistent, incomplete or not fully integrated into the national system. This work contributes directly to anticipatory action and to strengthening preparedness in public health and other sectors facing increased risks from extreme heat events.

Methods

Methodological approach

The development of heat thresholds was based on a relative climatological approach, widely recommended in the scientific literature for the analysis of temperature extremes (Perkins & Alexander, 2013; Zhang *et al.*, 2011). This approach was selected because of the persistently warm climate in Choluteca, where absolute thresholds do not adequately discriminate exceptional events.

Heatwaves were defined as periods of three or more consecutive days during which the daily maximum temperature exceeds specific percentiles of the historical monthly climatology. Percentiles 90, 95 and 99 were analysed, enabling the differentiation of watch monitoring and alert levels with operational relevance.

Data used

The analysis used historical daily maximum temperature records from the Choluteca meteorological station, covering the period from November 1963 to July 2025. These data were analysed and validated in coordination with the Center for Atmospheric, Oceanographic and Seismic Studies (Centro de Estudios Atmosféricos, Oceanográficos y Sísmicos, CENAOS) in Honduras – the institution officially responsible for meteorological and climatological monitoring as well as issuing weather and climate forecasts in the country.

Additionally, the Heat Index of the National Oceanic and Atmospheric Administration (NOAA) in the US was explored for comparative purposes. While it was not adopted as the primary criterion for defining thresholds due to its limitations in tropical climates, the next step will involve adapting some of its parameters as an additional indicator of extreme heat.

Data limitations

Key data limitations include the lack of systematic urban-level health data, which means that direct quantitative relationships between temperature thresholds and morbidity or mortality cannot be established. Furthermore, although the climate time series from the Choluteca station is extensive, uncertainties arise from changes in instrumentation as well as in the location of the station over time.

Interaction with the national meteorological service

CENAOS actively participated in the development of the thresholds, data validation, review of the methodological approach and discussions on the operational applicability of the proposed thresholds. This interaction was essential and will help ensure that the results can be integrated into forecasting products and existing early warning systems.

Results and discussion

Identified heat thresholds

The analysis identified monthly maximum temperature thresholds based on percentiles, reflecting the seasonality of extreme heat in Choluteca.

Table 1. Monthly maximum temperature thresholds for Choluteca (°C)

Month	P90 (Watch Monitoring)	P95 (Alert)	P99 (Dangerous)
March	39.0 °C	39.4 °C	40.2 °C
April	39.5 °C	40.0 °C	40.6 °C
May	38.9 °C	39.5 °C	40.4 °C
July	36.8 °C	37.2 °C	38.4 °C
August	37.4 °C	38.0 °C	39.4 °C

These values indicate that the months from March to May and July to August represent the highest extreme heat risk, with thresholds significantly higher than during the rest of the year.

Watch monitoring and alerting

To facilitate the operational application of the thresholds within a heat early warning system, a clear differentiation between watch monitoring and alert levels is proposed. The watch monitoring level is activated when the daily maximum temperature exceeds the monthly 90th percentile (P90) for three consecutive days, indicating a relevant temperature anomaly relative to normal conditions and justifying enhanced monitoring, inter-institutional coordination and preparedness actions.

The alert level is activated when the daily maximum temperature exceeds the monthly 95th percentile (P95) for three consecutive days, representing more exceptional temperature conditions with a higher likelihood of adverse health impacts. This level justifies issuing early warnings and activating anticipatory actions, including risk communication to the population, protection of vulnerable groups and coordination across the health, disaster risk management and social protection sectors.

Considerations and limitations

The identified thresholds should be interpreted as climatic indicators of elevated risk rather than absolute limits for health impacts. Factors such as humidity, elevated nighttime temperatures, air pollution and social vulnerability also play an important role in shaping heat-related impacts but were not explicitly integrated into this analysis. It is also important to highlight that the analysis was conducted using data from the Choluteca meteorological station only and information from other cities – such as San Lorenzo and Marcovia – could not be included due to the lack of available data from CENAOS.

Conclusions

The locally calibrated heat thresholds developed for Choluteca provide a solid technical foundation for strengthening heat early warning systems. Their use enables the progressive activation of actions, from monitoring to alerting, facilitating the implementation of anticipatory measures to protect public health.

Additional analyses would strengthen this work, particularly by integrating morbidity and mortality data, using heat-stress indices that incorporate humidity and assessing social vulnerability. These elements would allow for more robust validation of the proposed thresholds.

CENAOS is committed to continuing this work through the integration of the thresholds into its operational products, coordination with health authorities and the periodic updating of values as climatic conditions and population exposure patterns change.

It is important to emphasize that heat thresholds should not be considered static values. Climate change, urban expansion, socioeconomic transformations and population adaptation processes progressively modify the relationship between temperature and health risk. Therefore, thresholds should be reviewed and recalibrated regularly – ideally, every 5–10 years or when new climate or health data become available – to ensure that early warning systems maintain their relevance, credibility and effectiveness over time. Regularly reviewing and updating thresholds is essential to maintaining the effectiveness of early warning systems in a changing climate.

Acknowledgements

This analysis was conceptualized and led by **Dr. Juan Bazo**.

We would like to thank the following individuals for their support in conducting the analysis and validation:

Francisco Argenal Pinto, CENAOS; **Jorge Castellanos Osegura**, CENAOS; **Víctor Anderson Ortega**, CENAOS; **Carlos Alejandro Alfaro Sifontes**, National Autonomous University of Honduras (Universidad Nacional Autónoma de Honduras, UNAH); **Gabriela María Reyes Rodríguez**, UNAH; **Mildred Jaylin Santos Lagos**, UNAH.

We would also like to thank **Carolina Pereira Marghidan** for her review that helped to improve the analysis.

Copy-editing is by Sarah Tempest.

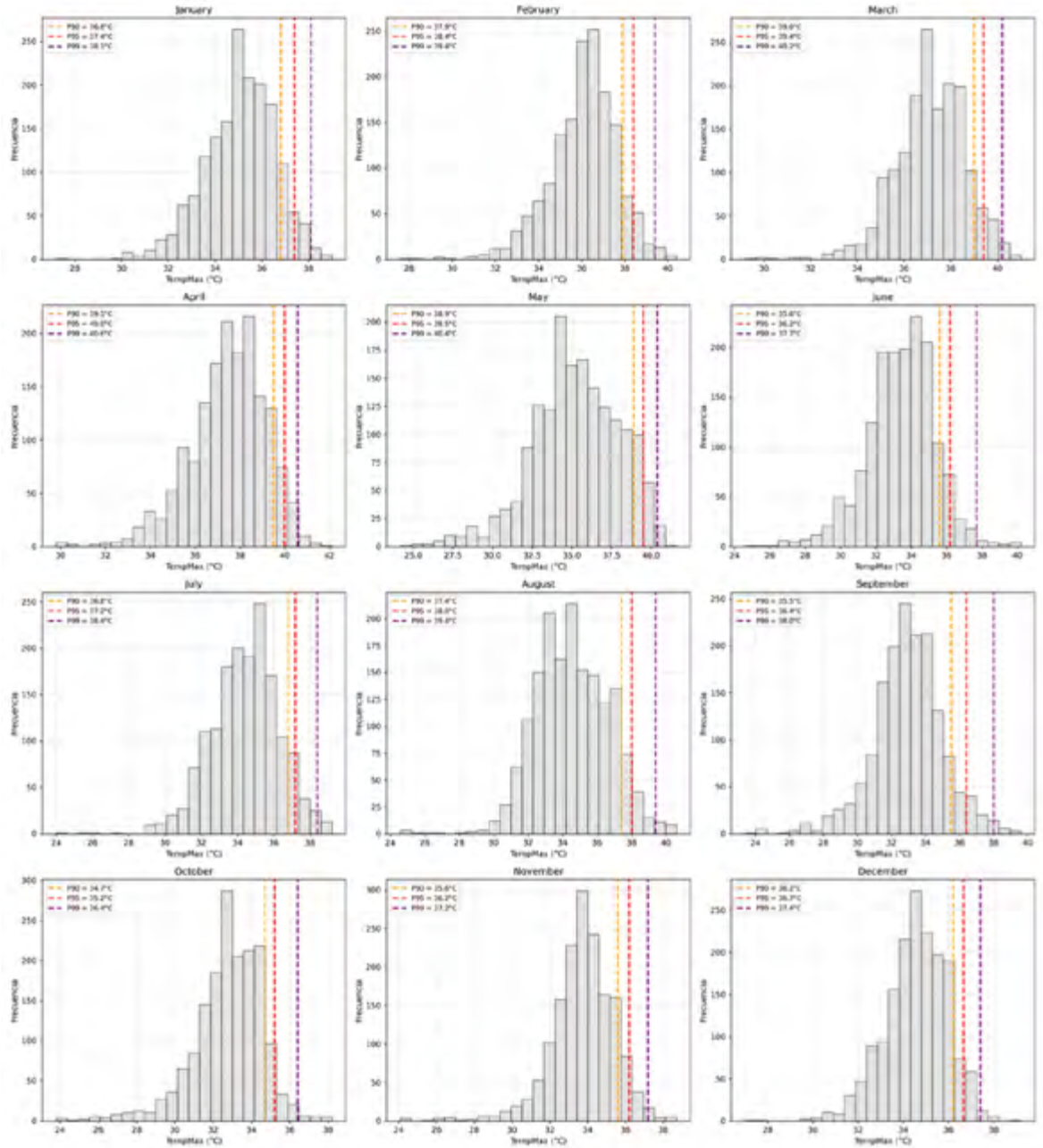
Design is by Eszter Sarody.

References

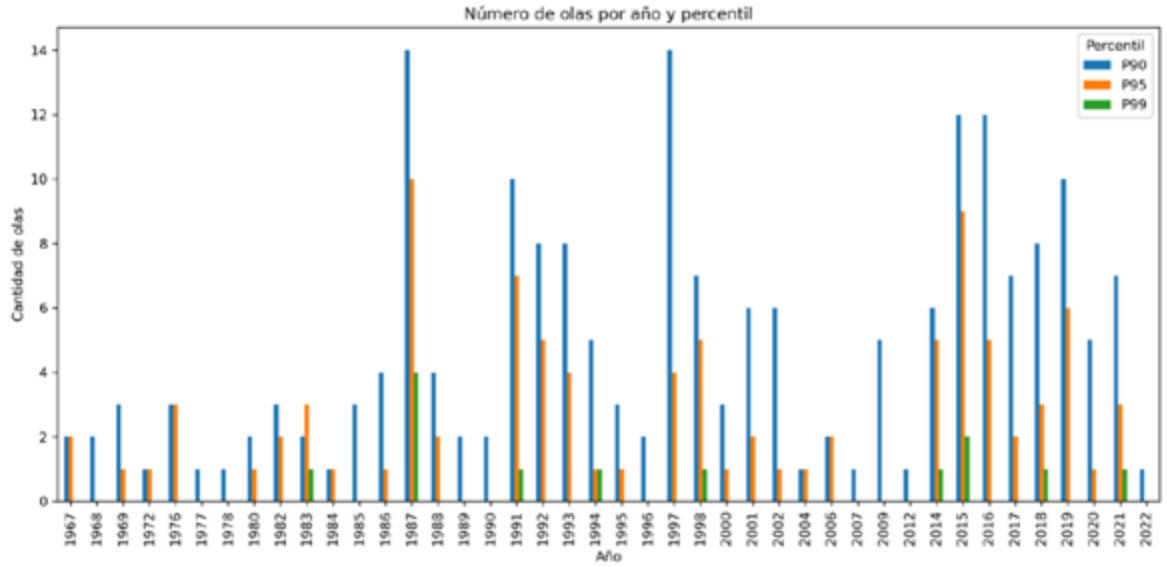
- Gasparri, A., Guo, Y., Hashizume, M. *et al.* (2015). 'Mortality risk attributable to high and low ambient temperature: A multi-country observational study', *The Lancet*, 386(9991), 369–375.
- IPCC (2023). *Sixth Assessment Report (AR6): Climate Change 2023*. Intergovernmental Panel on Climate Change. <https://www.ipcc.ch/report/ar6/syr/>
- Mora, C., Dousset, B., Caldwell, I. *et al.* (2017). 'Global risk of deadly heat', *Nature Climate Change*, 7, 501–506. <https://doi.org/10.1038/nclimate3322>
- Perkins, S.E., & Alexander, L.V. (2013). 'On the measurement of heat waves', *Journal of Climate*, 26, 4500–4517. <https://doi.org/10.1175/JCLI-D-12-00383.1>
- WHO (2021). *Heat–Health Action Plans*. World Health Organization.
- Zhang, X., Alexander, L., Hegerl, G.C., Jones, P., Klein Tank, A., Peterson, T.C., Trewin, B., & Zwiers, F.W. (2011). 'Indices for monitoring changes in extremes based on daily temperature and precipitation data', *Wiley Interdisciplinary Reviews: Climate Change*, 2(6), 851–870. <https://doi.org/10.1002/wcc.147>

Annex:

Maximum temperature distribution and monthly percentiles in Choluteca station.



Annual heatwave detection by percentiles



Retrospective examples of detected heatwaves

