



Quantifying Ecological Wisdom and Thermal Adaptation of Traditional Zhuang Stilt Houses in Hot-Humid Climates

Authors: Shideng Lu
Prof. Shady Attia

E-mail: Shideng.Lu@uliege.be
Address: Sustainable Building Design Lab
Quartier Polytech 1
Allée de la Découverte 9
4000 Liege, Belgium
www.sbd.ulg.ac.be
Tel: +32 43.66.91.55
Fax: +32 43.66.29.09

ABSTRACT

Traditional stilt dwellings offer passive cooling in hot-humid regions, yet their microclimate mechanisms are poorly studied. This research combines field measurement, validated simulation and climate forecasting to reveal passive buffering rules for climate-adaptive architectural design.

KEYWORDS

Dynamic Indoor Microclimate, Thermal Comfort, Passive Cooling
Climate Adaptation, Traditional Stilt Dwellings

PROBLEMS

Current thermal comfort models and building performance assessments are primarily developed for enclosed and mechanically conditioned buildings. They insufficiently capture the dynamic indoor microclimates generated by naturally ventilated traditional stilt dwellings, particularly the buffering effects of transitional spaces and permeable building envelopes. Consequently, the physical mechanisms responsible for occupant comfort remain unclear, limiting the transfer of traditional passive design principles into future climate-resilient buildings.

OBJECTIVES

Quantify the microclimate buffering mechanisms of traditional Zhuang stilt envelopes to establish a data-driven framework for localized, climate-adaptive building.

WP1: Collect envelope data to build a representative typological framework.

WP2: Conduct continuous field monitoring to quantify microclimate buffering baselines.

WP3: Calibrate EnergyPlus/CFD models to decode thermal-airflow mechanisms.

WP4: Perform multivariate optimization to derive validated passive design parameters.

AUDIENCE

Building Physics Researchers, Thermal
Comfort Researchers
Sustainable Building Designers Architects

RESEARCH QUESTIONS

How and to what extent do the traditional stilt architecture features and envelope configurations of Zhuang dwellings regulate indoor dynamic microclimates and occupant thermal comfort under hot-humid climate conditions?

ORIGINALITY

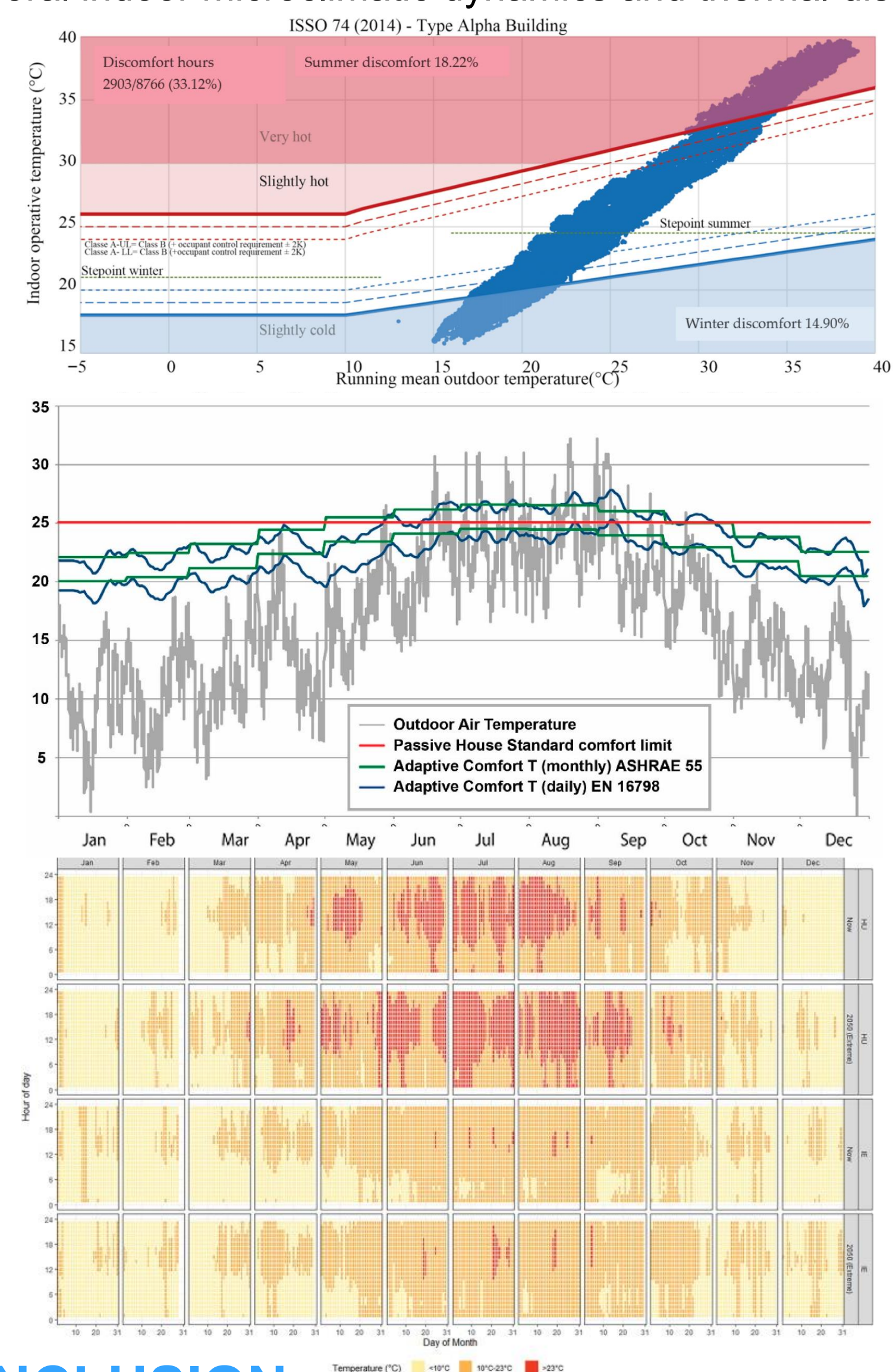
This study builds a dynamic microclimate framework for hot-humid stilt dwellings, quantifying passive buffering limits to derive validated design parameters—translating traditional wisdom into low-carbon architecture.

METHODOLOGY

This study employs a four-stage quantitative methodology—combining large-scale typological clustering, long-term hygrothermal field monitoring, calibrated EnergyPlus/CFD simulations, and multivariate statistical validation—to quantify the climate responsiveness of traditional Zhuang stilt houses and establish validated passive optimization strategies for hot-humid regions.

RESULTS

- Performance analyses based on the ASHRAE 55 adaptive model assessing indoor thermal environments, occupant comfort distributions, and operational compliance levels.
- Comparative dynamics of outdoor environmental conditions against multiple thermal comfort standards, combined with multi-zone, temporal indoor microclimatic dynamics and thermal distributions.



CONCLUSION

This study aims to reveal the physical mechanisms governing dynamic indoor microclimates and extend thermal comfort assessments beyond conventional models, thereby supporting climate-resilient passive building design.

RESOURCES

1. Zhang, Y., Wang, J., & Chen, H. (2011). Field study on thermal comfort and adaptation of naturally ventilated buildings in humid and hot regions of China. *HVAC & Warm Air Heating*, 41(9), 91–99.
2. Hu, L., Lu, L., & Zheng, W. (2025). Winter thermal comfort in Zhuang ethnic stilt-style dwellings: A case study of the Longsheng region with field measurement validation. *Case Studies in Thermal Engineering*, 67, Article 107412. <https://doi.org/10.1016/j.csite.2025.107412>
3. Attia, S., & Carlucci, S. (2015). Impact of different thermal comfort models on zero energy residential buildings in hot climate. *Energy and Buildings*, 102, 117–128. <https://doi.org/10.1016/j.enbuild.2015.05.017>