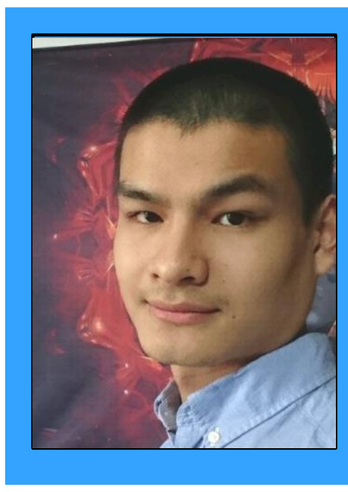


Analysis Tool for Bioclimatic Design of Urban Settlements in Madagascar

Authors: Theo LACOMBE
E-mail lacombe.projet@gmail.com

Supervisor : Shady Attia

Address: Building Design Lab (SBD)
Quartier Polytech 1
Allee de la Decouverte 9
4000 Liege, Belgium
www.sbd.ulg.ac.be
Tel: +32 43.66.91.55
Fax: +32 43.66.29.09

ABSTRACT

Madagascar climate has been analyzed and classified into zones. Tool to evaluate climate in hot tropical zone has been developed and design recommendations for two urban settlements have been made.

KEYWORDS

Bioclimatic Design strategies, Affordable local solutions, climate classification, Thermal comfort

PROBLEM

Madagascar is confronted to a high urban expansion (>4%). Authorities want to adapt their construction method to achieve bioclimatic design but local climate studies are insufficient and actual thermal comfort model are proven not suitable for hot and humid countries. Therefore climate analysis have to be conducted and thermal comfort boundaries set for the local climates. Design solution need to be proposed taking into account the lack of reliable energy supply.

OBJECTIVES

Goal : Inform architects and building professional about bioclimatic sustainable building design

Objectives :

- Define bioclimatic zones of Madagascar
- Develop new climate analysis tool
- Define thermal comfort boundaries
- Propose design recommendation

AUDIENCE

Building professionals and researchers

RESEARCH QUESTION

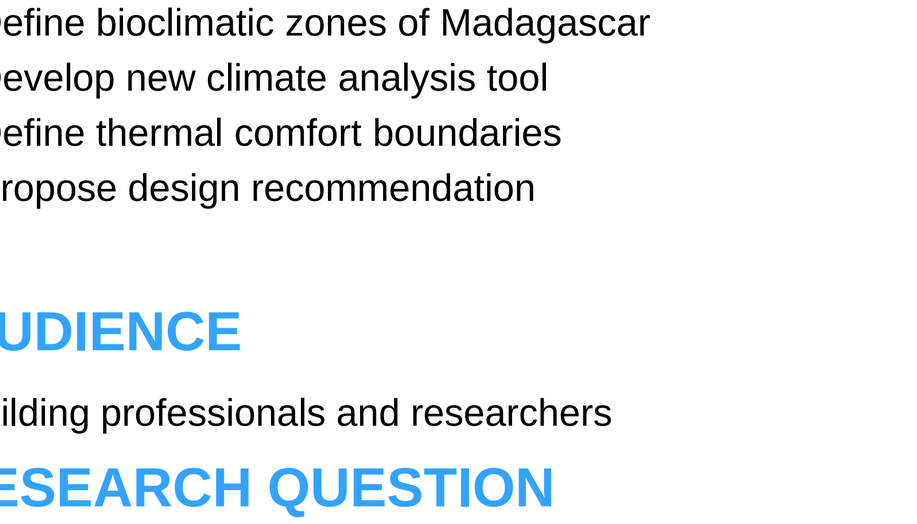
How can we improve thermal comfort in Madagascar with a climate analysis ?

ORIGINALITY

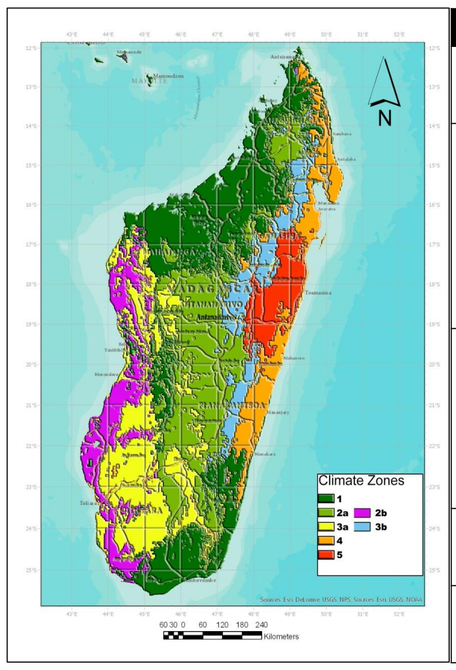
Development of a new climate mapping for Madagascar

Development of a new climate analysis tool for Hot Humid Climate

METHODOLOGY

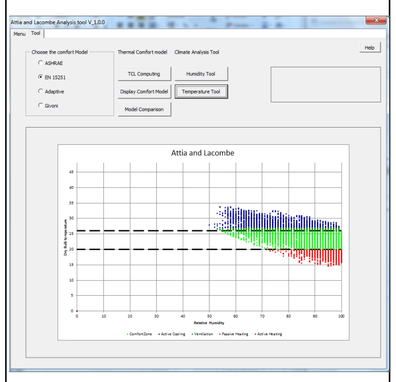


RESULTS



Zones	Characteristics	Locations
1	Low altitude >23°C average 22-23000 KJ/m²/day	North and South plains
2a	High altitude <15 - 23°C average 21-22000 KJ/m²/day	Central Highlands
2b	Low altitude 23 - >27 °C average >23000 KJ/m²/day	South-West Coast
3a	Medium Altitude <27°C average >23.000KJ	South-West
3b	Medium Altitude <23°C average <21000KJ/m²/day	East Highlands
4	Low Altitude >23 - 27°C average <21000 KJ/m²/day	East Coast
5	Low to Medium altitude >23-27°C average <20000KJ/m²/day	East Coast till Highlands

Climate Mapping and zones characteristics

Climate tool	Antananarivo		Toamasina	
	Min Temperature	5°C	Min Temperature	15°C
	Max Temperature	33°C 19°C	Max Temperature	34°C 24°C
	Average Temperature		Average Temperature	
	Needs (in % of hours)	60% Heating 55% Dehumidifying	Needs (in % of hours)	30% Cooling 14% Heating 71% Dehumidifying
	Recommended comfort model is : ASHRAE-55 Static		ASHRAE-55 Adaptive	

Climate tool and results given by climate tool

Main recommendations

Antananarivo : Thermal Insulation with local coconut fibers, S orientation of bedrooms and passive dehumidifying system

Toamasina : Thermal Insulation with local coconut fibers, E orientation of bedrooms, shading on N & E sides and active dehumidifying system

CONCLUSION

Madagascar has 7 distinct climatic zones. Antananarivo is in the temperate humid highland and Toamasina hot humid coastal region. The most suitable existing thermal comfort model are the ASHRAE-55 static for Antananarivo and ASHRAE-55 Adaptive for Toamasina. Thermal insulation should increase thermal comfort sensation in both city and reduce the need for active system. Humidity is very high and should be accounted for when designing the building. Additional research to determine comfort model should be made and simulations must be realized to assess the previous guidelines.

RESOURCES

- Rakoto-Joseph, O., Garde, F., David, M., Adelard, L., & Randriamanantany, Z. A. (2009). Development of climatic zones and passive solar design in Madagascar. Energy Conversion and Management, 50(4), 1004–1010. https://doi.org/10.1016/j.enconman.2008.12.011

Lacombe T. (2018), Simple Climate Tool V1.0.0.xslx, Available at : http://www.sbd.ulg.ac.be/research/tools/Simple%20Climate%20Tool%20V1.0.0.xlsm

- Razanamanampisoa, H., Randriamanantany, Z. A., Rakotondramiarana, H. T., Garde, F., & Boyer, H. (2013). Simulation of a typical house in the region of Antananarivo, Madagascar. Determination of passive solutions using local materials. arXiv preprint arXiv:1305.2322.

SBD LAB
Sustainable Buildings Design Lab

LIÈGE université