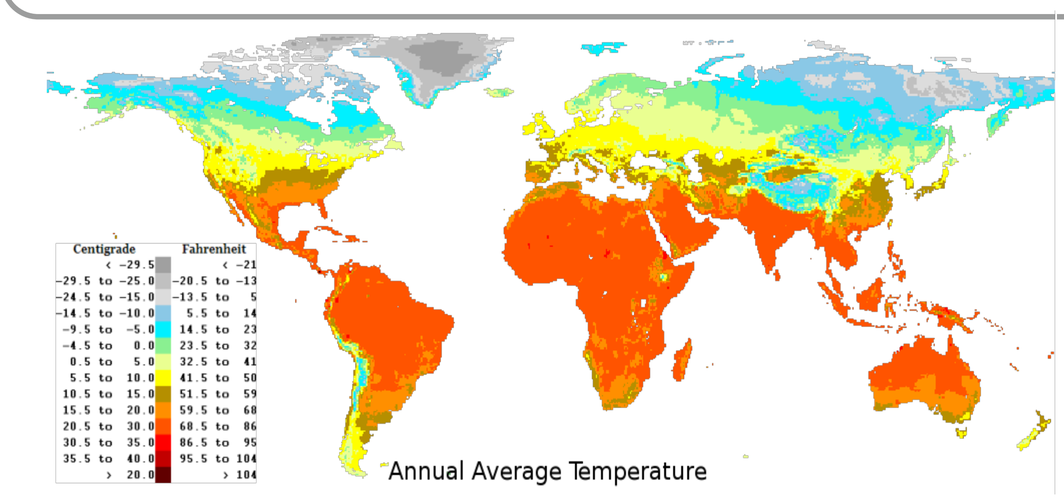
Thermally Autonomous Housing

Tata Fellow Emma Nelson
Professors Leon Glicksman and John Ochsendorf

Massachusetts Institute of Technology
Hunnarshala Foundation, Bhuj

Motivation

- Inadequate protection from extreme heat was cited as one of the six major concerns for healthy housing environments by the WHO
- An estimated **1 billion** people, nearly **10%**, of the world's population inhabit arid desert regions (National Geographic)
- Extreme heat can lead to cardiovascular and respiratory disease
- May 2015, **2,500** lives taken as a result of heat waves India (EM-DAT)
- "Most of the world's population growth over the next 20 years will occur in low and middle income cities" (WHO 2010, p. 17).
- About **21.9%** of India's urban population still subsists on incomes that are below the poverty line (World Bank 2011)
- Housing needs to be affordable and provide adequate protection in order to meet the demands of rapid urbanization



Annual Average Temperatures. Red represents regions with average temperatures of 40°C

Background

Thermal Autonomy: Achieving thermal comfort though passive means

- Night Flush Ventilation
- Heat Avoidance and radiant barriers
- Combination of thermal mass and proper insulation

Design for Development

- Local partner, Hunnarshala, for co-design and dissemination of results
- Housing for all by 2022, India Ministry of Housing and Urban Poverty Alleviation Program to reduce slum growth and encourage incorporation of innovative technology in building design.

Research Progress

Define current slum archetypes

- Walls: Sandstone, rocks, concrete, earth
- Roof: Corrugate concrete asbestos sheets, plastic covering, cloth, thin thatch, tin sheets

Look to existing housing for successful passive cooling technique

Conduct field tests to study

- Effects of insulation
- Ventilation schedules
- Various roof types

Informal housing, Bhuj, 2016

Next Steps

The researchers will now examine how other factors (apart from roofs) affect indoor thermal comfort. Investigation will primarily focus on

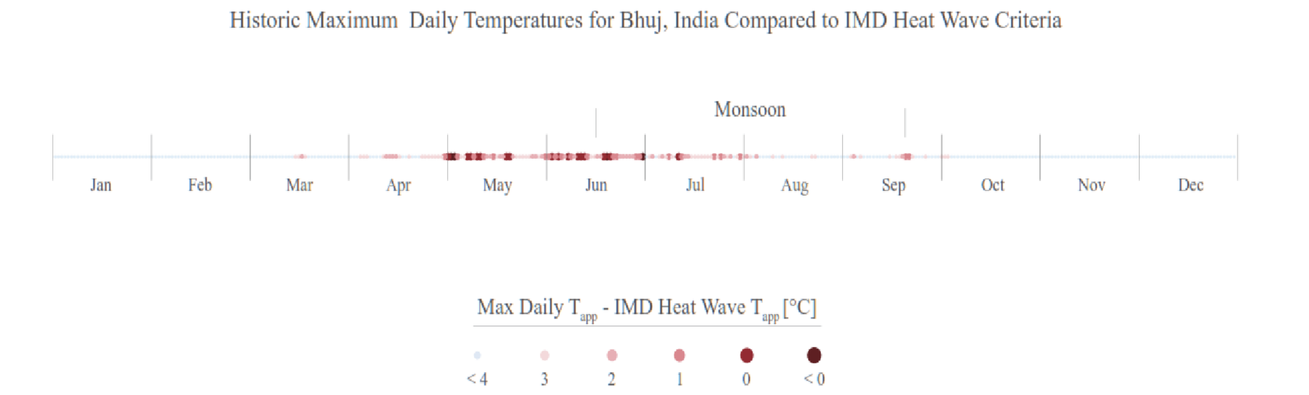
- Fan operation scheduling.
- Optimization of roof design. The design will incorporate local resources and artisan skills.
- Wall design to further improve thermal autonomy.

Iterations of innovative designs for layered roof assemblies, fan schedules, and wall insulation panels will be tested in Bhuj to determine what small changes of building component design will have the greatest impact on the thermal environment.

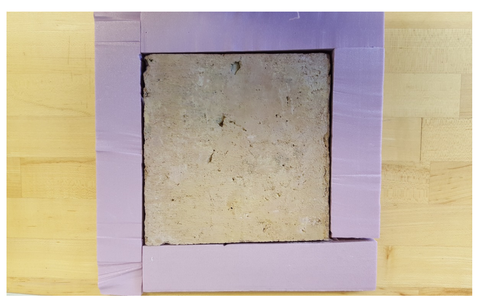
Bhuj, Gujarat, India

Bhuj: A case Study

- Located near the epicenter of 2001 earthquake which left hundreds of thousands homeless
- Economic resource constraints, **33%** of the Bhuj population lives in slums (Hunnarshala Foundation, 2013)
- Extreme heat: Exceeds **43°C (109.4°F)** with nightly **20°C (3b°F)** temperature drop



Heat wave risk for Bhuj, India according to the India Meteorological Department definition

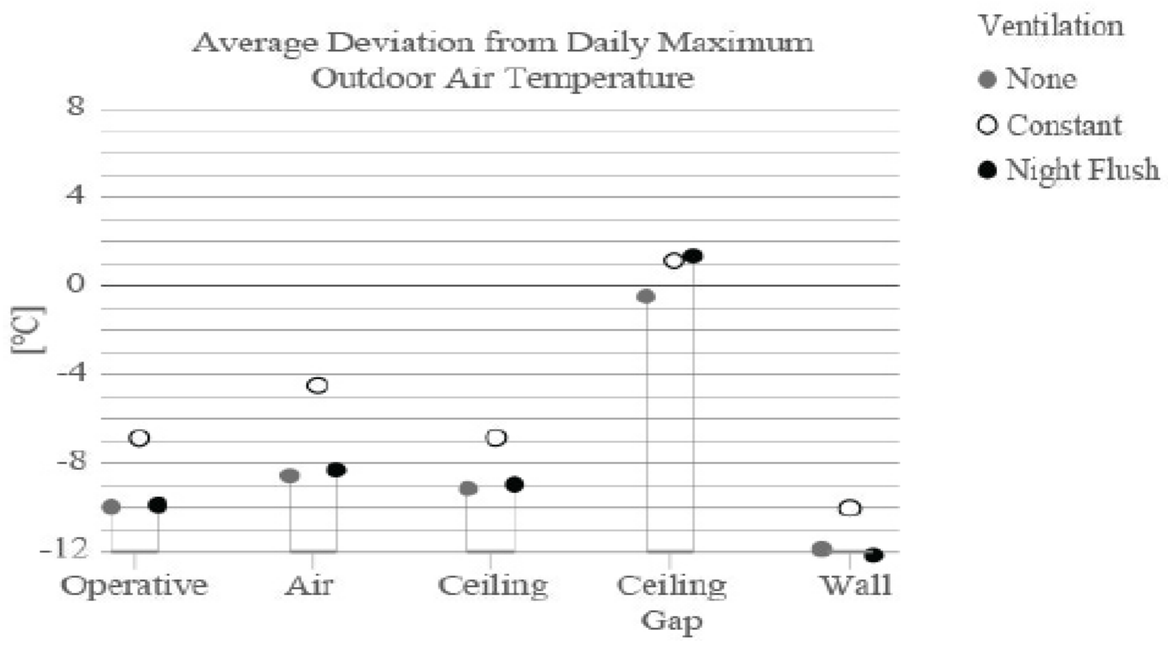


Material survey

Field Experiments testing various roof types

Research Methodology

- Identify market, audience, and cost points
- Run simulations and calculations to predict thermal performances
- Conduct field tests to verify proposed solutions
- Survey existing materials



Acknowledgments
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References

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