Transforming the Humble Brick: Mosquitoes-Protective Building Materials

Michael Serrano[1], Elijah D. Rutkowski[1], Elizabeth L. McCormick[1,2] [0000-0002-7548-2951]
[1]University of North Carolina at Charlotte, USA
[2]North Carolina State University, USA

KEYWORDS: Mosquitoes, Malaria, Brick, Tanzania

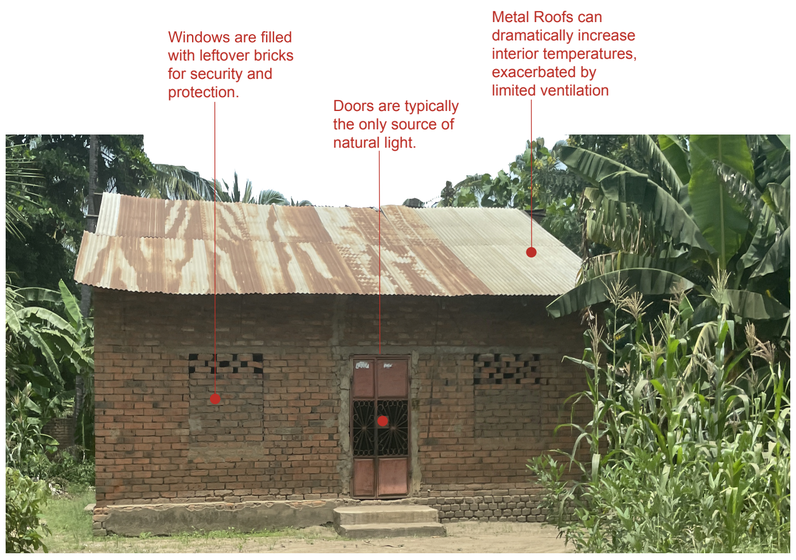
Studies indicate that climate change impacts will dramatically increase vulnerabilities in rural communities where those living off the land are at increasing risk from extreme weather events such as heat waves, famine and drought. Additionally, more than 80% of the world is at risk from at least one vector-borne disease, and Malaria is a leading cause of death in the developing world. However, most research in this field addresses this public health crisis in the form of pesticides, chemical interventions, and genetic modification, with little consideration for the role of the built environment, particularly in limited resource settings. Recent efforts to make housing more protective, however, often lead to dwellings that have reduced air transmission and poor indoor environmental quality. Additionally, modern, sustainable buildings can be technologically complex and prohibitively expensive.

The brick, however, is the most commonly used building material in the world. By studying the material aspects of this humble material in tandem with the synergistic relationships of energy, comfort, and disease, this humble material has the potential to become a greater part of the urban resiliency and public health strategy. Working collaboratively with engineers, entomologists, social scientists, and regional experts, student researchers explored the capability of masonry construction materials made from accessible, low-impact resources to control the transfer of heat, moisture, and mosquitoes in housing in rural Tanzania. By challenging conventional norms of construction and global health, these prototypes explore the intersection between design, disease and a rapidly changing climate.

PROJECT STATEMENT

The brick is the most commonly used building material in the world - in fact, one-third of the world's population lives in buildings entirely or partially made from earth (Barnaure et al. 2021). Developing countries, especially in regions like sub-Saharan Africa, aspire for a modern presence on a global stage while facing distinct health challenges related to housing, particularly related to vector-borne diseases. These issues are typically addressed through extensive global health initiatives, operating independently of considerations related to the built environment.

The unprecedented population growth in sub-Saharan Africa presents a unique opportunity to integrate innovative material and housing concepts that can dramatically improve human health and well-being. In response, this project addresses the interdisciplinary innovations that reconceive modular earthen materials and challenge existing norms of construction and material science, exploring the intersection between design, disease, and a rapidly changing climate.

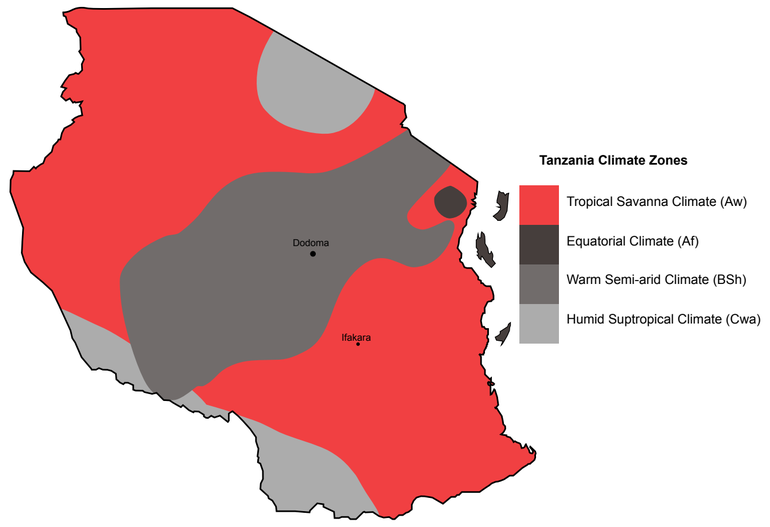


BACKGROUND

Mud-brick homes are prevalent across many sub-Saharan African countries. Recent research conducted by Bofu et al. (2023) in southern Tanzania reveals that a significant majority of surveyed homes (78.1%) feature brick walls and metal roofs, attesting to the widespread use and acceptance of these materials in the region as opposed to the more traditional wattle and daub construction typology. As African nations modernize, the allure of contemporary alternatives often overshadows the rich local architecture and materials. While mud and burned brick are familiar building materials in sub-Saharan Africa, they are heavy and easily store heat and obstruct airflow, making them challenging for hot-humid climates (von Seidlein et al. 2019).

Historically, housing improvements have been a critical aspect in the realm of public health (Shaw 2004; Krieger & Higgins 2002). However, this domain has not been fully leveraged in malaria control efforts while competing household priorities further complicate the situation. Although other control measures such as window screens and sealing of cracks prove valuable, they often require financial investment that many families find burdensome. Consequently, introducing a supplementary option that enhances thermal comfort and indoor air quality without entirely displacing existing strategies becomes imperative.

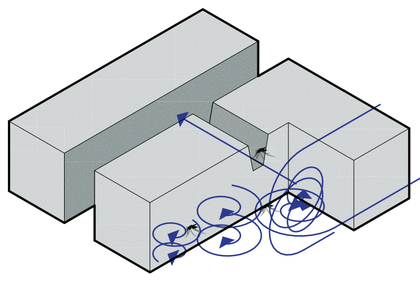
CLIMATE

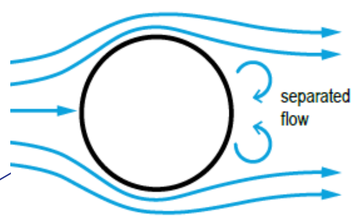


Located in East Africa just south of the equator, Tanzania contains several distinctive climatic zones, including hot desert, cool mountains, and humid subtropical. Vector-borne disease is one of the biggest threats to Tanzania residents. Long identified as a disease associated with poverty; today over 90% of malaria cases and fatalities are concentrated in the world's poorest countries, with a preponderance of disease burden in Sub-Saharan Africa (Worrall 2005). Paradoxically, as homes are built in phases and openings are covered up, interior conditions become inhospitable and unhealthy, particularly when cooking occurs indoors. In response, this project looks to improve the breathability of the building envelope while maintaining vernacular styles and cultural expectations.

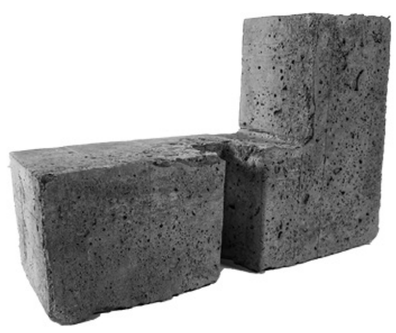
STUDENT PROPOSALS

VORTEX BRICK by Michael Serrano

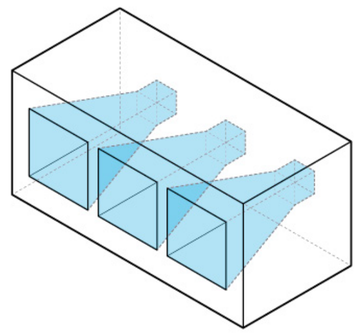


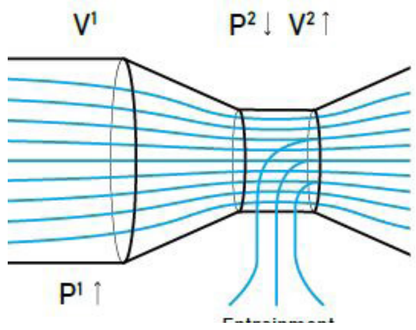


Mosquitoes generally prefer calm environments for movement and have difficulty navigating turbulent conditions. This project utilizes the phenomenon of vortex shedding, which involves the creation of vortices, or convective pockets, on the back side of a mass. This pocket is then used to trap mosquitoes while allowing fresh air to pass through the wall. The strategic placement prevents mosquitoes from accessing interior areas and reduces the transmission of vector-borne diseases. To create an effective barrier, the cortex bricks should be laid in a row-style pattern, closing the tunnel of the brick. this configuration will provide enhanced protection in areas where mosquitoes are most likely to enter.



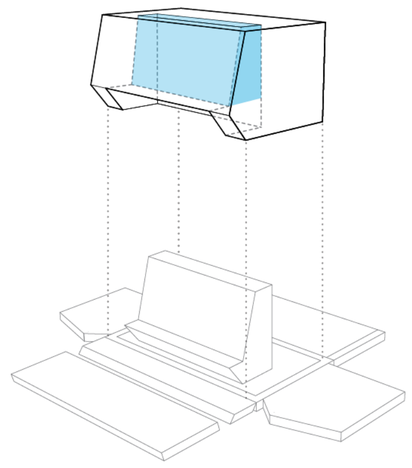
VENTURI BRICK by Nate Smith





The Venturi Brick is a module that uses a truncated, horizontal hollow core to employ the principles of the venturi effect, which state that a decrease in pressure will lead to an increase in velocity. These cone-shaped cores increase the air movement within a building, which create a much needed cooling effect but also creates turbulent air conditions that challenge mosquito flight. This block has the potential to passively address the issues of human comfort and vector control without dramatically shifting local building practices.

POROTHERM BRICK by Vishna Krishna Kamatham



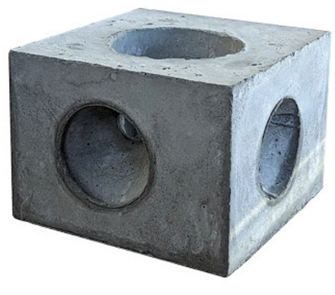
The term Porotherm is used for this type of brick due to is porosity and desired thermal characteristics. The aim of this wall system is to provide air movement through the bricks while maintaining a certain level of visual privacy so that it can be used as external wall system. Air can circulates through the brick, fueled by buoyancy flow, wile the slope of exterior face protects the wall from solar heat and rain. A recess is provided underneath to let the rick breath and promote a continuous flow of air, so that thermal comfort is achieved passively.

ADDITIONAL BRICK PROTOTYPES

Flow brick
Eric Jackson

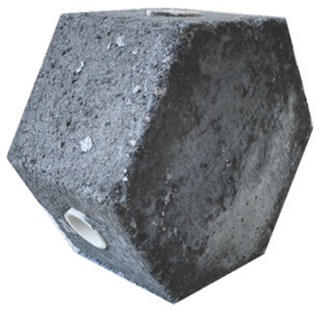
Water Collecting Brick
Sarika Merchant

Bee Brick
Elijah Rutkowski



All Around
Amir Heydarpour

Solar Brick
Keenan Madden



Waters Brick
Sarah Auger

CONCLUSION

Across culture and context, the home is a source of pride - it is a material instantiation of social progress, a reflection of the aspirations of its inhabitants (Archambault 2018). Capitalizing on those commitments to craft a home that is safe and livable, not only has potentially major public health dividends, but can foster new understandings of the act of construction and its role in ensuring local wellbeing. Working with brick can help bring about a critical paradigm shift in global health from the technocratic minimalism of humanitarian design, to locally-driven and adapted interventions that make substantial improvements in everyday living–a process of innovation where global health, urban resilience, environmental sustainability and dignified existence converge.

The brick emerges as a catalyst for change, challenging conventional norms in construction and public health. Its integration into local communities signifies a paradigm shift towards community-driven, culturally attuned, and sustainable solutions at the nexus of architecture and global health. While it remains to be seen the degree to which these bricks can be rendered legible as global health tools, it is our hope that they might foster a different set of questions around the relationship between global health and development—and the importance of comfort in cultivating a more secure future.

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