

Innovative Housing Solutions for Flood Resilience and Thermal Comfort in Jakarta, Indonesia

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Abstract

This thesis explores innovative housing solutions aimed at enhancing flood resilience and thermal comfort in Jakarta, Indonesia, a city that faces significant challenges due to its tropical climate characterized by intense heat and frequent flooding. Drawing from successful case studies in Bangkok, Thailand, and Singapore, this research examines the integration of architectural and urban planning strategies tailored to mitigate these environmental challenges. In Bangkok, elevated housing structures and community infrastructure demonstrate effective flood management techniques, while Singapore's implementation of green buildings showcases advanced passive cooling methods and sustainable urban practices. This study proposes specific architectural models for Jakarta, integrating elevated designs, green roofs, and advanced passive cooling strategies. By adapting these proven solutions to Jakarta's unique context, the thesis aims to provide practical frameworks that improve the city's resilience to climatic adversities and enhance the quality of urban life.

Keywords: flood resilience, thermal comfort, Jakarta, tropical architecture, green buildings, urban sustainability, passive cooling

1. Assessment of Climatic Challenges in Jakarta

Jakarta, the capital city of Indonesia, faces significant climatic challenges that heavily influence urban living conditions. Situated on the northwest coast of Java, Jakarta is notoriously known for its tropical wet climate, which includes high temperatures and intense rainfall throughout the year. The city frequently experiences severe flooding, a problem exacerbated by its low-lying geography and the fact that it is sinking at an alarming rate due to excessive groundwater extraction. These flooding events disrupt daily life, damage infrastructure, and pose health risks.

The temperature in Jakarta remains consistently high, with average daily temperatures often exceeding 30°C. This heat is intensified by the urban heat island effect, where concrete and asphalt store heat during the day and release it at night, leading to higher temperatures than the surrounding rural areas. The combination of high temperatures and humidity reduces the comfort levels and increases the reliance on air conditioning, which in turn contributes to increased energy consumption and higher greenhouse gas emissions.

Historical climate data indicates a trend of rising temperatures and an increase in frequency and severity of rainfall events over the past few

decades. Climate projections for the region suggest that these trends will continue, with potentially dire consequences for the city's sustainability and livability. Rising sea levels associated with global warming pose an additional threat, suggesting that without significant interventions, large parts of Jakarta may be underwater by 2050.

The city's response to these climatic challenges must be multi-faceted, incorporating flood resilience measures, strategies for cooling, and sustainable urban planning to mitigate the effects of high temperatures and heavy rainfall. This understanding forms the basis for exploring innovative housing solutions tailored to Jakarta's unique environmental challenges, aiming to enhance resilience and improve the quality of urban life.

2. Principles of Flood-Resilient Housing Design

In addressing the principles of flood-resilient housing design, it's essential to consider both the lessons learned from global practices and the unique context of Jakarta's environmental conditions. This approach ensures that the strategies developed are both effective and appropriately tailored to local needs.

Across the world, architects and urban planners have pioneered various flood-resilient architectural techniques that can be analyzed for their applicability to Jakarta. For instance, elevated structures are a common solution, with buildings raised on stilts or platforms to prevent water from entering living spaces during floods. Another technique involves the use of flood walls and barriers that can be either permanent or deployable when needed. Additionally, resilient materials that withstand water damage, such as concrete and treated wood, are crucial components of flood-resilient design. Beyond structural adaptations, landscape solutions like rain gardens, swales, and permeable pavements help manage surface water runoff and reduce the burden on urban drainage systems.

Adapting these techniques to Jakarta requires consideration of the city's specific challenges, such as its high population density and the subsidence issues that exacerbate flooding risk. For Jakarta, combining elevated housing with community-scale flood defenses could be particularly effective. This could include integrating water-absorbent green spaces around housing clusters to enhance surface

water absorption and reduce runoff. Additionally, developing modular homes with flexible, water-resistant materials could provide both affordability and resilience, aligning with the economic conditions and urban fabric of Jakarta.

Moreover, the adaptation strategy must include community engagement to ensure that the solutions are culturally acceptable and practically feasible. Education and community-based planning can foster resilience by enabling residents to actively participate in the management and maintenance of flood-resilient features.

By analyzing global best practices and adapting them to the local context, Jakarta can develop comprehensive housing solutions that not only mitigate the impacts of flooding but also enhance overall urban resilience. This approach not only addresses immediate flood risks but also contributes to the long-term sustainability and livability of the city.

3. Strategies for Enhancing Thermal Comfort in Residential Buildings

To enhance thermal comfort in Jakarta's residential buildings, it's crucial to integrate passive cooling strategies and carefully select materials that help maintain comfortable indoor temperatures despite the city's hot and humid climate. This approach focuses on reducing reliance on energy-intensive air conditioning, aiming for a more sustainable and comfortable living environment.

Passive Cooling Strategies: Passive cooling involves architectural and design techniques that naturally reduce heat build-up in buildings. One effective method is maximizing natural ventilation, which can be achieved through strategic placement of windows, doors, and vents that allow cross ventilation, effectively drawing cooler air into a building and expelling warmer air. Another strategy is the use of high ceilings and vented roof designs that promote the rise and escape of hot air, keeping living spaces cooler.

Shading is also critical in reducing direct solar gain. This can be achieved through the use of overhangs, shaded facades, and planting trees strategically around buildings to block direct sunlight. Additionally, the incorporation of reflective materials on roofs and exteriors can significantly reduce heat absorption.

Integration of Modern and Traditional Materials: The choice of building materials plays a pivotal role in enhancing thermal comfort. Modern materials such as insulated glazing, reflective tiles, and thermally resistant bricks can be used to prevent heat accumulation inside homes. Alongside these modern solutions, traditional design elements that are well-suited to the local climate can be integrated. For instance, the use of lightweight and porous materials like bamboo, which is culturally resonant and has excellent properties for thermal comfort, can be effective.

Moreover, incorporating green roofs or roof gardens not only adds insulation but also absorbs heat, reducing the temperature of the roof surface and the overall building. The evapotranspiration from the plants further aids in cooling the air around them.

Combining these passive cooling strategies and materials requires a thoughtful approach to architectural design, ensuring that buildings are not only habitable but also environmentally sustainable. By leveraging both innovative and traditional methods, residential buildings in Jakarta can achieve higher levels of thermal comfort, making them more adaptable to the climatic challenges posed by the region. This strategy not only improves the comfort levels within these spaces but also contributes to reducing the city's overall energy consumption and enhancing its resilience to climate change.

4. Case Studies and Proposed Housing Models

4.1 Bangkok, Thailand

Bangkok has long been synonymous with flooding due to its geographical location and the prevalence of monsoon seasons. To combat this, the city has adopted innovative architectural solutions focused on elevated housing. The practice of building homes on stilts, deeply rooted in traditional Thai architecture, has been modernized to suit the dense urban fabric of the city. These modern stilt houses are designed with durable materials such as reinforced concrete and weather-resistant wood, which can withstand both the weight of the structure and the harsh environmental conditions brought about by frequent flooding.



Figure 1.

Beyond individual homes, Bangkok has also implemented elevated public infrastructure. Roads, walkways, and even some public transport lines are raised above ground level to ensure continuous operation during floods. This integration of elevated structures extends to community facilities such as markets and communal centers, which are essential for maintaining the social fabric of the city during disruptive weather events.

The architectural designs are complemented by water management systems that include large-scale drainage projects and barrier constructions to control water flow, effectively reducing the impact of floods on daily life and the urban economy.

4.2 Singapore

Singapore's approach to addressing its hot and humid climate is through the widespread implementation of green buildings, exemplified by projects like the EDITT Tower. This structure is notable for its extensive use of vertical gardens that cover much of its exterior, serving multiple functions including air purification, thermal insulation, and aesthetic enhancement. The gardens are part of an integrated design that includes high-performance, energy-efficient systems.

The tower and other similar buildings in Singapore are equipped with passive cooling designs that significantly reduce the need for mechanical air conditioning. Architectural features such as reflective tiles on roofs, high albedo materials on external walls, and strategically placed windows enhance natural ventilation and reduce heat gain. The city also employs advanced technologies such as automated shade systems that adjust based on

the sun's position to optimize indoor temperatures throughout the day.



Figure 2. EDITT Tower Singapore: Ecological Design

Moreover, Singapore's commitment to sustainable urban development is showcased in its water sustainability practices. Buildings like the EDITT Tower use rainwater harvesting systems that collect and recycle water for irrigation and flushing toilets, further reducing the environmental footprint of urban structures.

These case studies from Bangkok and Singapore highlight their respective successes in using architecture and urban planning to address specific environmental challenges. By studying and potentially adapting these strategies, Jakarta can enhance its resilience against flooding and improve thermal comfort in its residential buildings, thereby improving overall urban livability.

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