

From Vernacular Earthen Wisdom to Smart Adaptive Systems: A Hybrid Model for Climate-Resilient Housing



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ABSTRACT

Climate change poses increasing challenges to the built environment, particularly in regions characterized by high thermal variability, seismic risk, and resource constraints such as the Mediterranean basin. In this context, vernacular earthen architecture provides valuable insights due to its low embodied energy, passive environmental control strategies, and strong integration with local ecosystems and cultural practices. Despite these advantages, traditional earthen construction techniques sometimes fall short of meeting contemporary requirements related to structural performance, durability, and user comfort under rapidly changing climatic conditions. This study proposes a hybrid design model that integrates vernacular earthen knowledge with smart adaptive systems and biophilic design principles to enhance climate resilience in housing.

For this purpose, a multi-layered methodology was adopted, combining a literature review, environmental performance analysis, and a comparative evaluation of traditional and contemporary building systems. Key spatial and material characteristics of earthen architecture—such as thermal mass, hygroscopic behavior, natural ventilation, and tactile materiality—are examined and reinterpreted through a biophilic framework that prioritizes human-nature interaction, sensory comfort, and psychological well-being. The proposed model incorporates adaptive technologies including sensor-based environmental monitoring, climate-responsive ventilation systems, and modular construction techniques, enabling real-time responses to climatic variations. Simultaneously, biophilic parameters—such as daylight optimization, airflow continuity, vegetation integration, and material authenticity—are embedded into the architectural design to improve indoor environmental quality and occupant health. Focusing on the Mediterranean context, the study addresses critical climate-related risks including extreme heat waves, humidity fluctuations, and seismic activity. A conceptual housing diagram is developed to illustrate the integration of earthen materials, smart systems, and biophilic strategies within a coherent design framework. The design proposal is evaluated in terms of energy efficiency, thermal comfort, and adaptive capacity. In this context, it is believed that integrating local wisdom with advanced technologies and biophilic design can significantly enhance both environmental and human-centered performance. This hybrid approach aims not only to bridge the gap between heritage-based knowledge and contemporary architectural practice, but also to contribute to the development of environments that are resilient, sustainable, and healthy in the face of global climate challenges.

KEY WORDS:

Keywords: Earthen architecture, Climate-resilient housing, Biophilic design, Smart adaptive systems