

Effects of the Variability in the Hygrothermal Properties of Raw Earth on the Energy Behavior of Buildings: STD Coupling and Stochastic Approach

Approach

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Context:

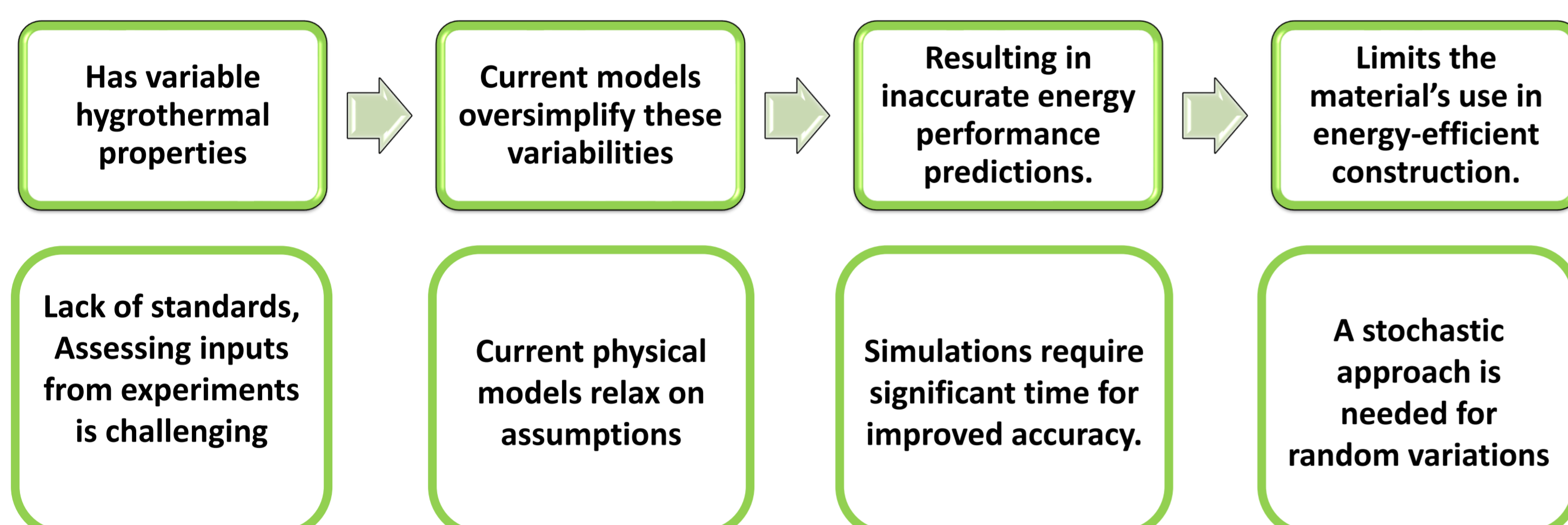
- Raw earth is gaining attention for sustainable construction due to its thermal mass and moisture-regulating properties. However, its natural variability in hygrothermal properties poses challenges for accurate energy performance predictions.
- This research uses an STD (Simultaneous Transfer of Heat and Moisture) approach and stochastic modeling to analyze → How variations in raw earth hygrothermal properties affect building energy behavior.

Objectives:

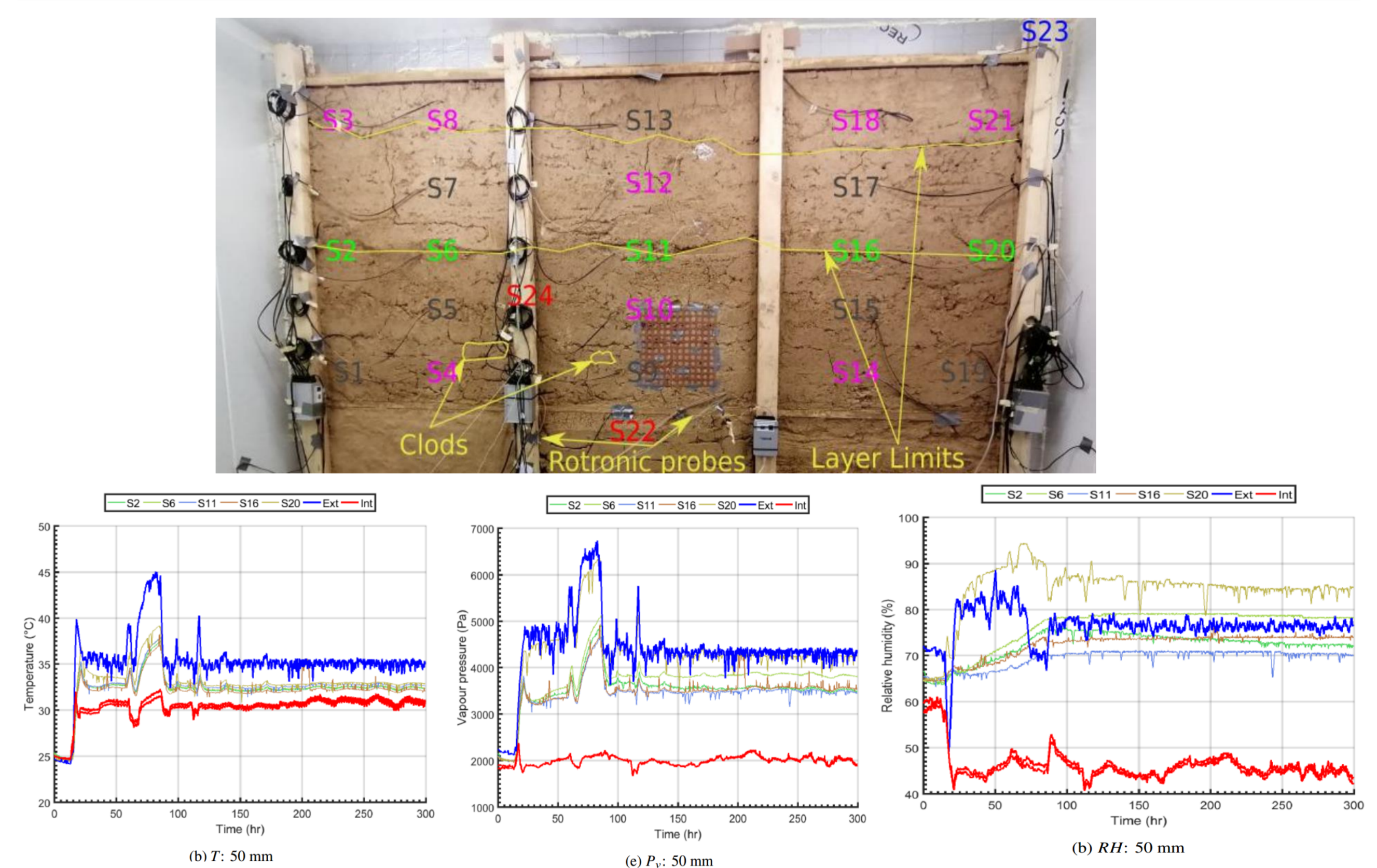
- Create coupled heat and moisture models for better predictions across conditions.
- Use a stochastic approach in TRNSYS to model variability at material, wall, and building scales.
- Provide guidelines for eco-friendly, energy-efficient building design using bio-based materials.

Problem Statement:

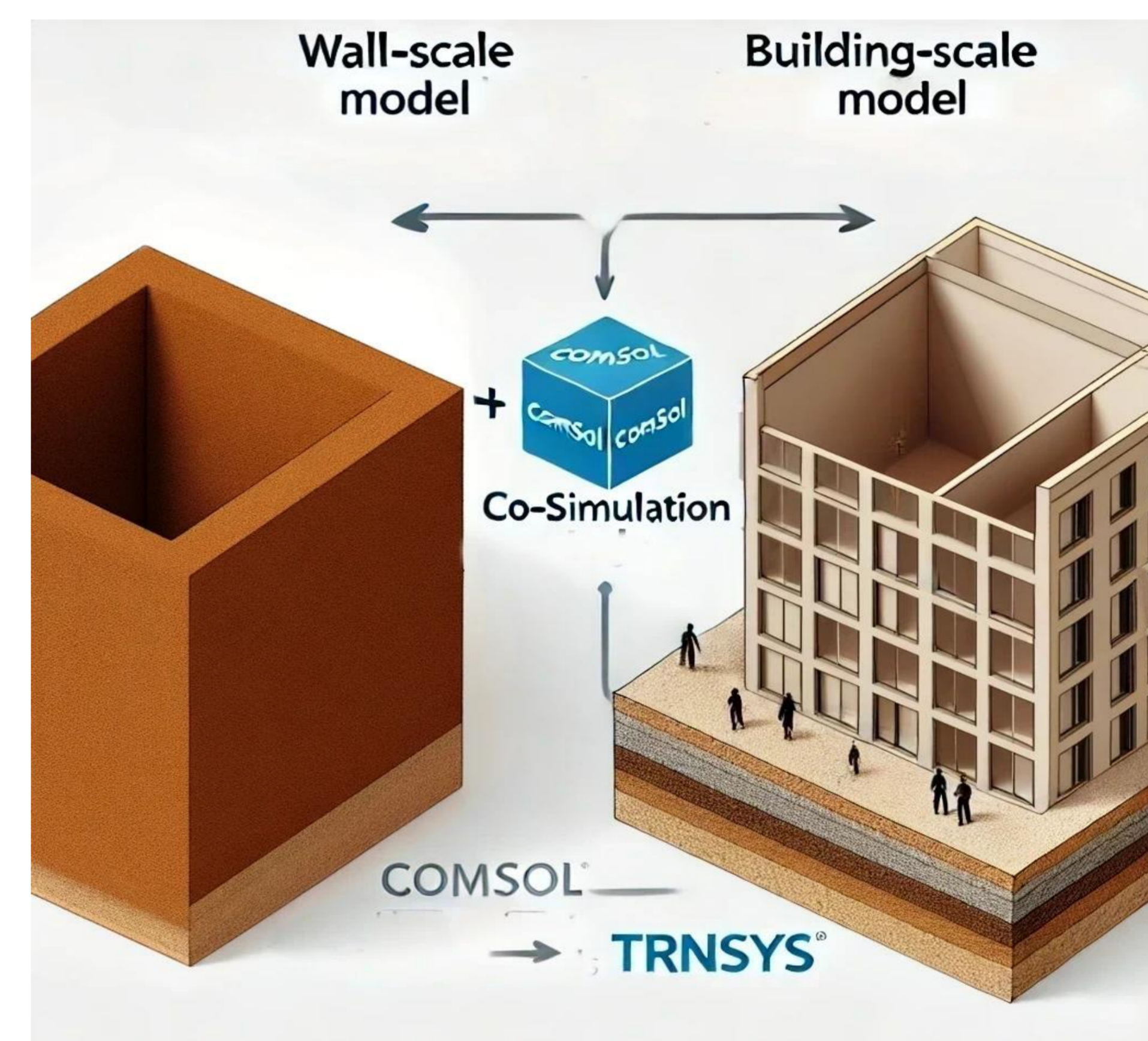
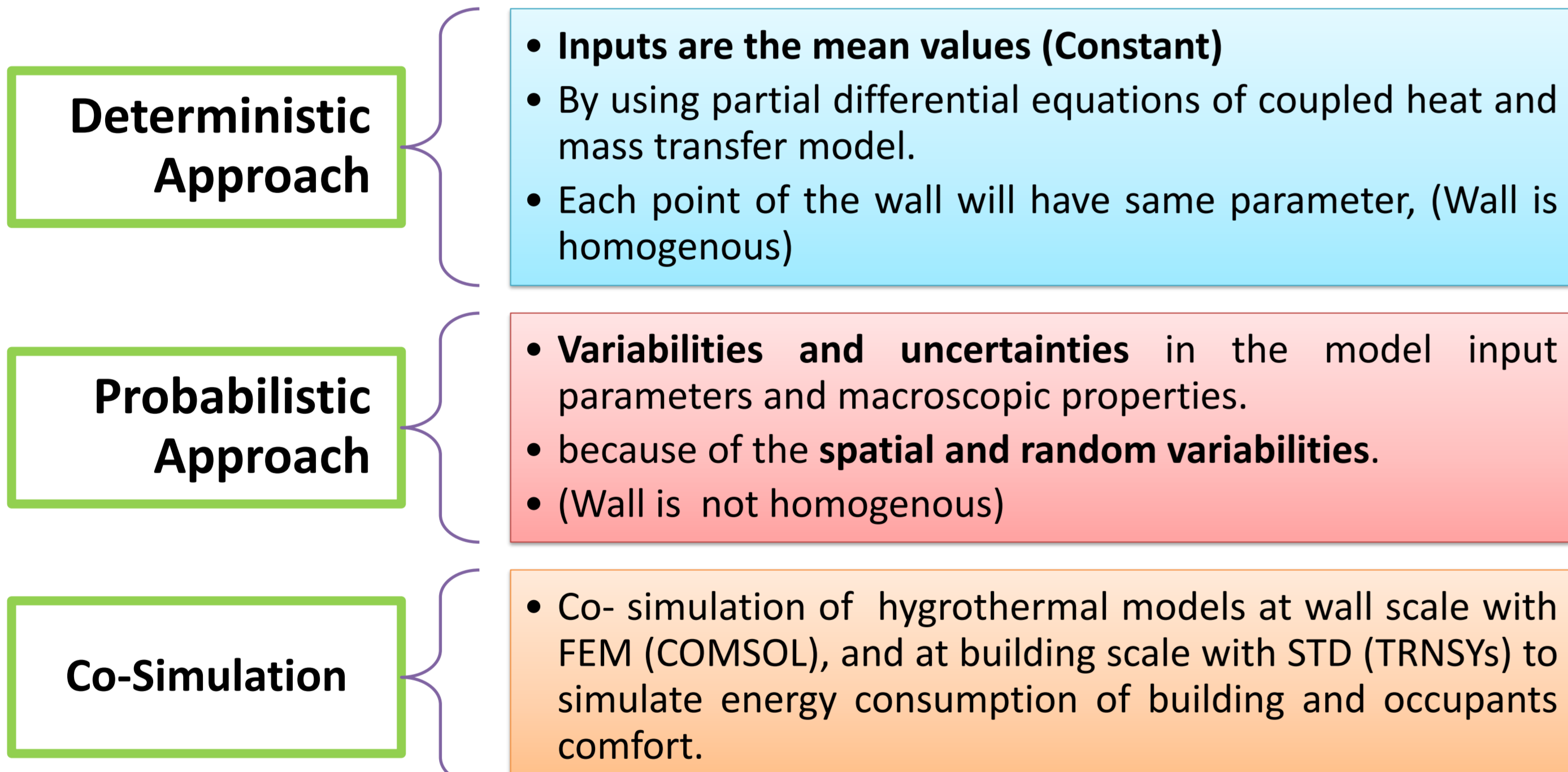
Raw Earth as Building Material



Spatial variability of hygrothermal properties of a cob wall. TCHIOTSOP(2019-2022)



Key Steps:



Expected Outcomes :

- To design a simulation model that will:
- 1- Provide High-Accuracy Predictions of Energy Behavior in Earthen Buildings
 - 2-Reduce Simulation Time While Maintaining Model Precision
 - 3- Integrate All Key Hygrothermal Parameters for Comprehensive Modeling
 - 4- Rank Influential Input Parameters Systematically to Inform Material Selection
 - 5- Support Development of Standards for Sustainable Use of Earthen Materials

Conclusion:

- This research underscores the importance of accurately modeling the variability in raw earth's hygrothermal properties to improve energy efficiency predictions in sustainable buildings.
- By using a coupled heat and moisture transfer approach with stochastic modeling, we can better address natural material variability, leading to more reliable simulations.
- The findings will help develop guidelines for bio-based materials in eco-friendly construction, advancing sustainable building standards.

References:

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- [2] Qin, M. (2006). Étude des phénomènes de transfert hygrothermiques dans les parois des bâtiments. Revue Européenne de Génie Civil, 10(6-7), 849-864.
- [3] Kiema, B., Coulibaly, O., Chesneau, X.. (2024) Numerical Modelling of Coupled Heat and Mass Transfer in Porous Materials: Application to Cinder Block Bricks. Open Journal of Applied Sciences, 14, 2360-2373.

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