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Regionalizing the Environmental Impact of Bamboo-Based Buildings by Integrating Life Cycle Assessment with Geographic Information Systems. A Comparative Case-Study in Colombia

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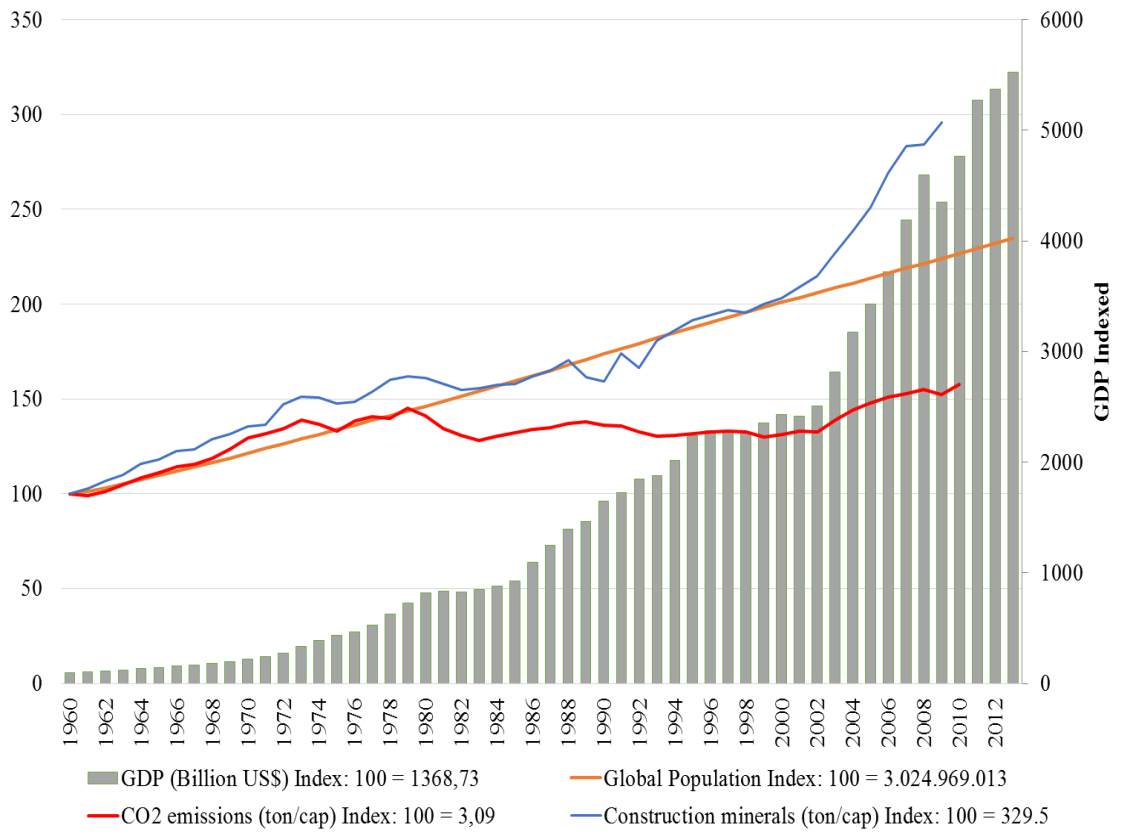
Background – Population growth

- Unprecedented population growth
- More than 50% of the population lives in urban areas
- Decreased mortality rate
- Increased life expectancy

Significant increase in:

- GDP
- CO_2 emissions per capita
- Extraction of construction minerals



Background - Bamboo

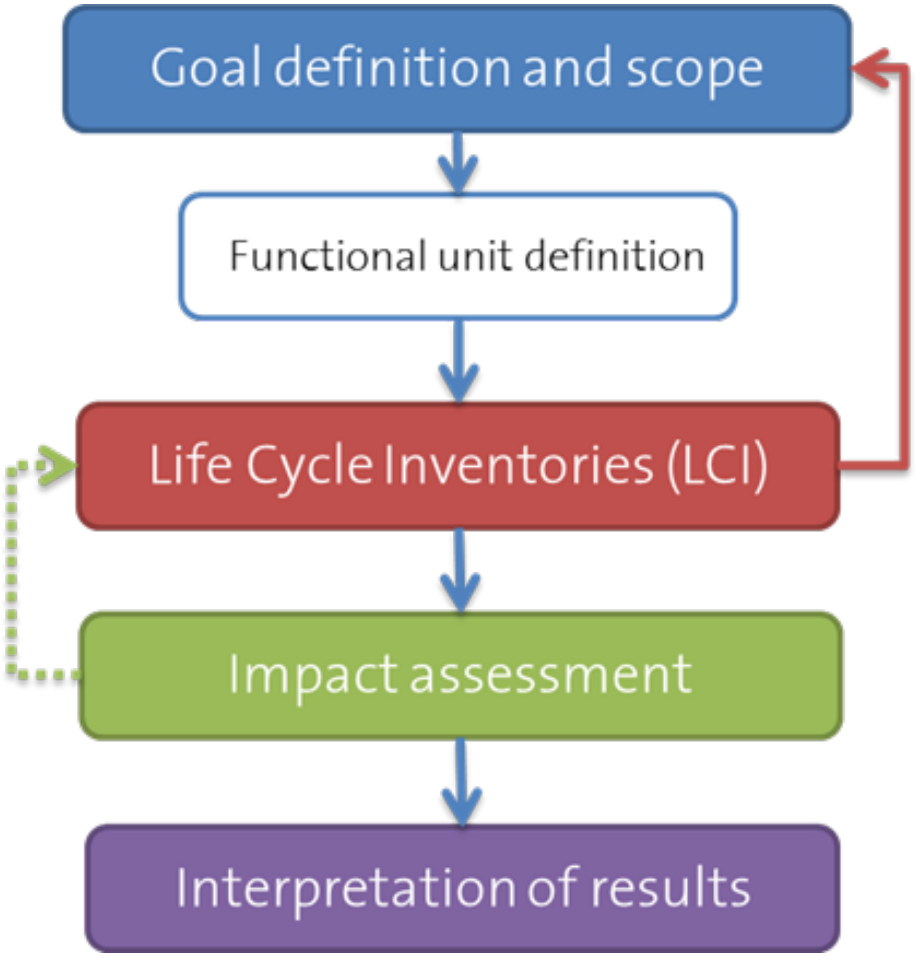
- Bamboo is one of the fastest growing plant, with high yield per year and area

- Bamboo can be used in construction on its raw form (poles) or as an industrialized product (glue laminated bamboo)

- The use of bamboo based construction materials can bring associated benefits, like job creation and improvement of livelihoods in both rural and urban areas

Background - LCA

- Cause-effect relationship human – environment
- Described on the ISO 14040
- Four main steps
- Iterative process
- Limitations due to data availability and evaluation method
- Requires significant financial and human talent investments



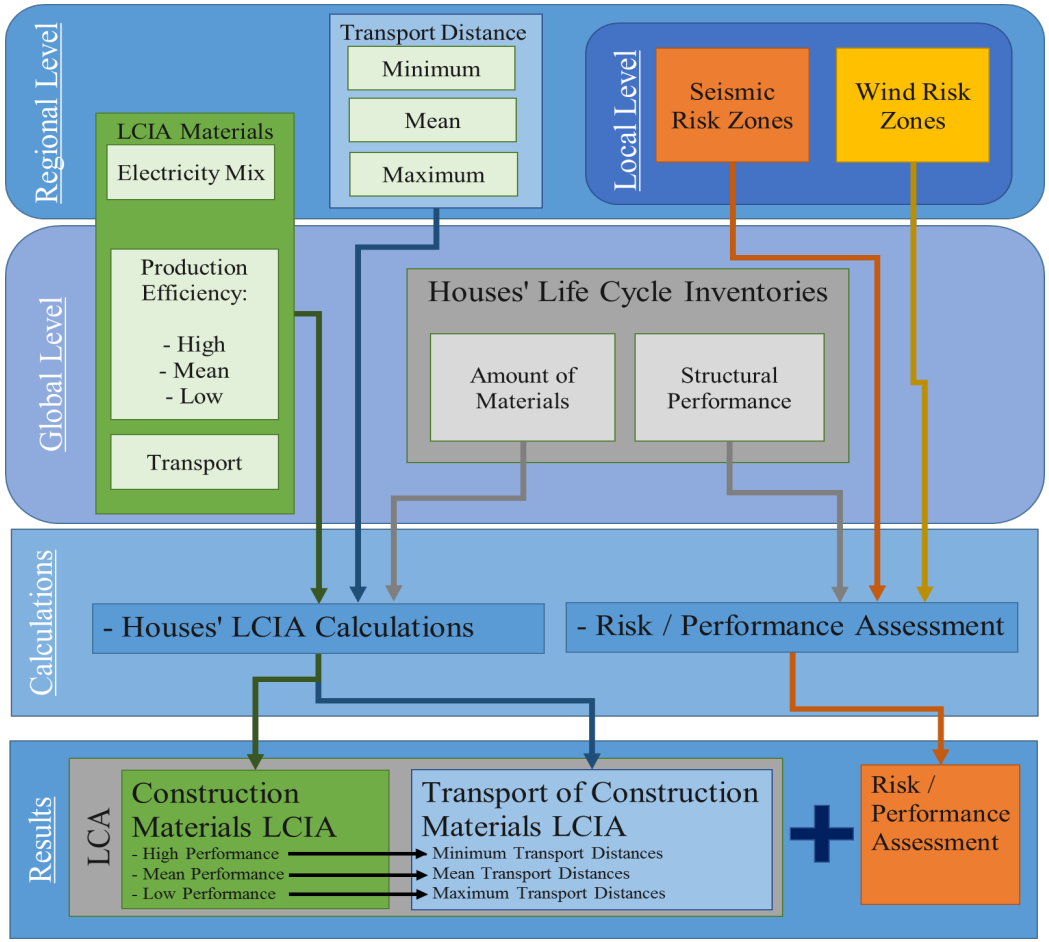
Data and Methods

Three levels of geo-referenced data:

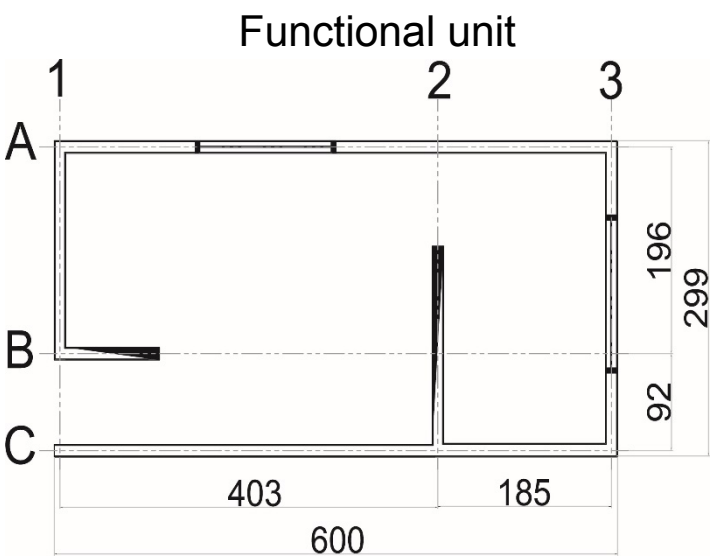
- **Global**: represents data that are valid worldwide
- **Regional**: contains data that can be linked to the specific country or administrative unit of study
- **Local:** represents data of risk zones. Location of construction materials production centres and cities

The methodology contains three interconnected steps:

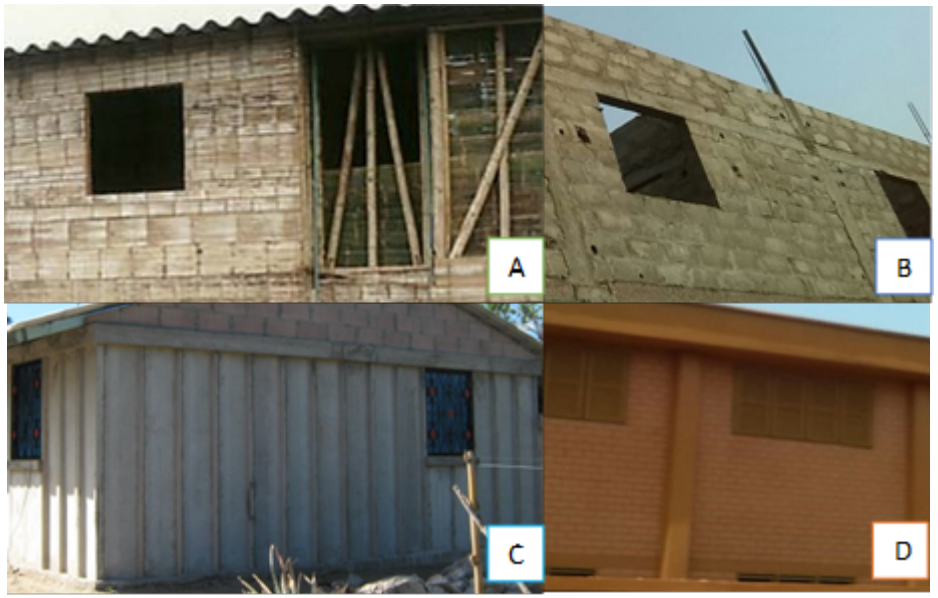
- Regionalization of the LCIAs
- Building's LCA
- Identification of seismic and wind risk zones



Data and Methods



- Only structural elements considered
- Cradle to gate analysis
- Amounts of materials used for each constructive system



(A) Bamboo frame (bahareque)
(B) Concrete hollow block
(C) Ferro-cement panel
(D) Soil stabilized brick

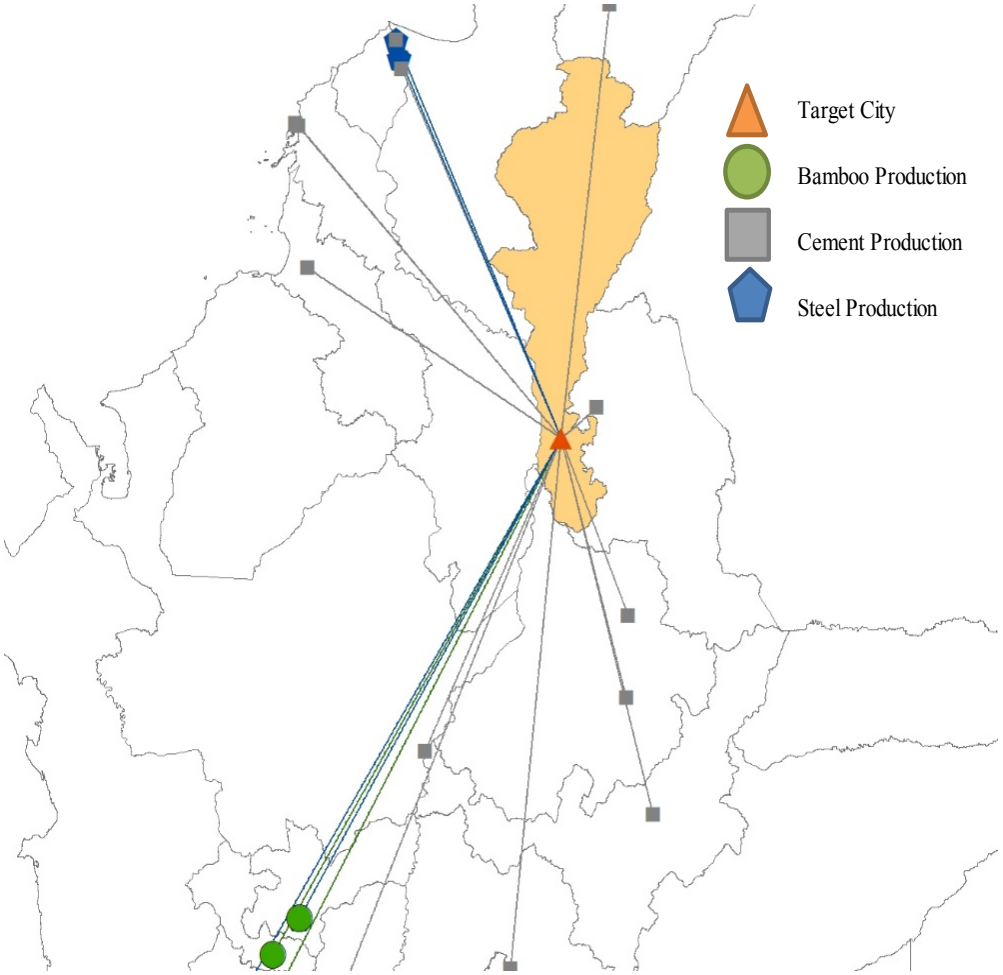
Data and Methods

Identification of production centres of:

- Bamboo
- Cement
- Steel

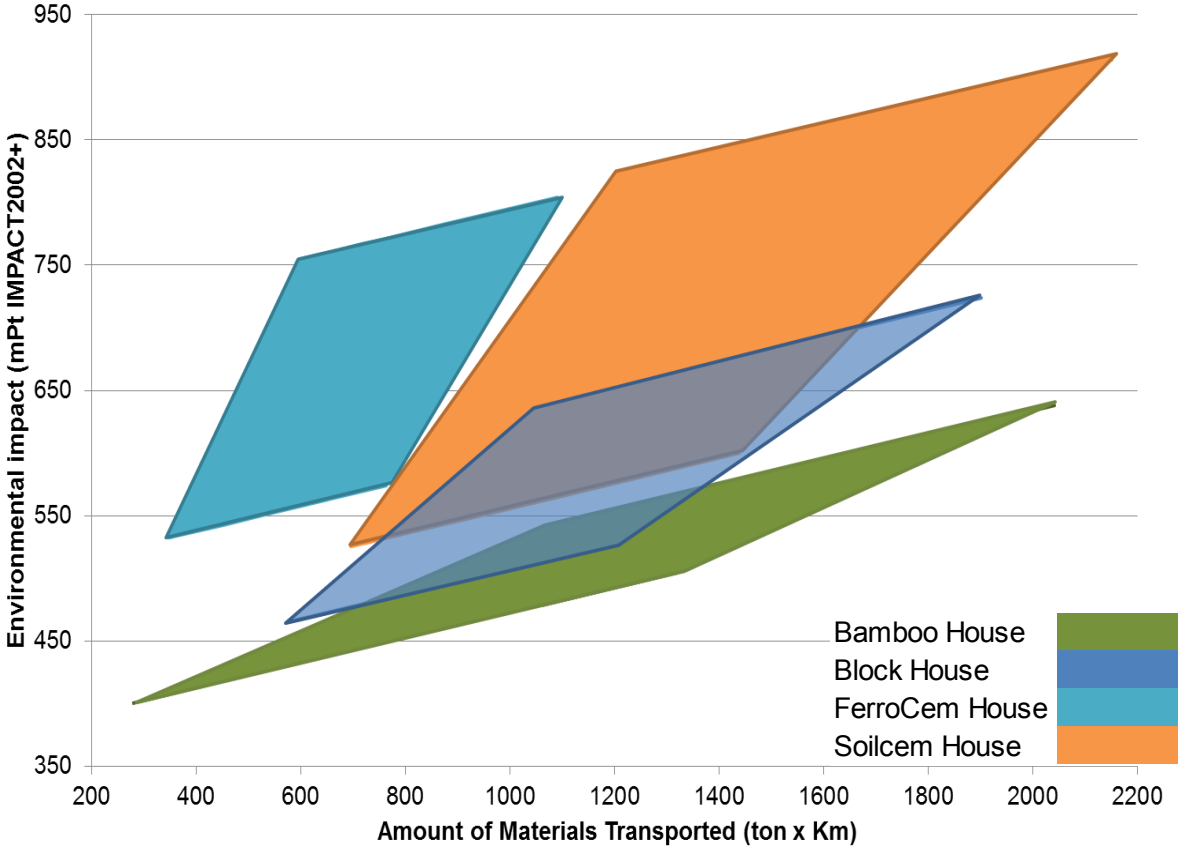
Distances calculated as geodesic lines between target cities and centres of production

Transport regimes calculated based on regional administrative unit's (department) area



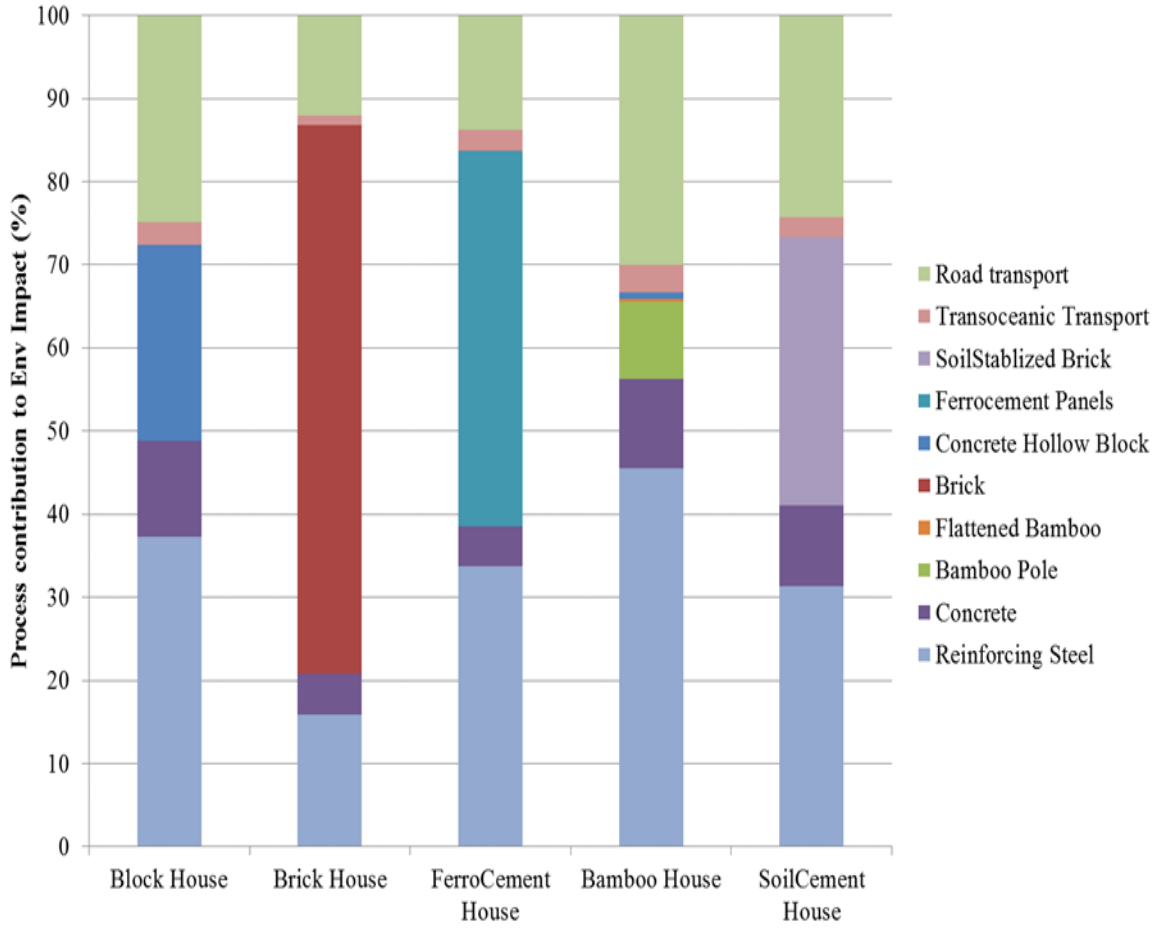
Results – Environmental Impact Vs Transport

- Bamboo has the lowest impact (high performance scenario)
- Low performance Bamboo overlaps with high performance concrete hollow block
- Environmental performance cannot be directly correlated to specific construction materials
- Appropriated use at the specific location, the efficiency of production and the transportation of construction materials are key factors of the environmental impact



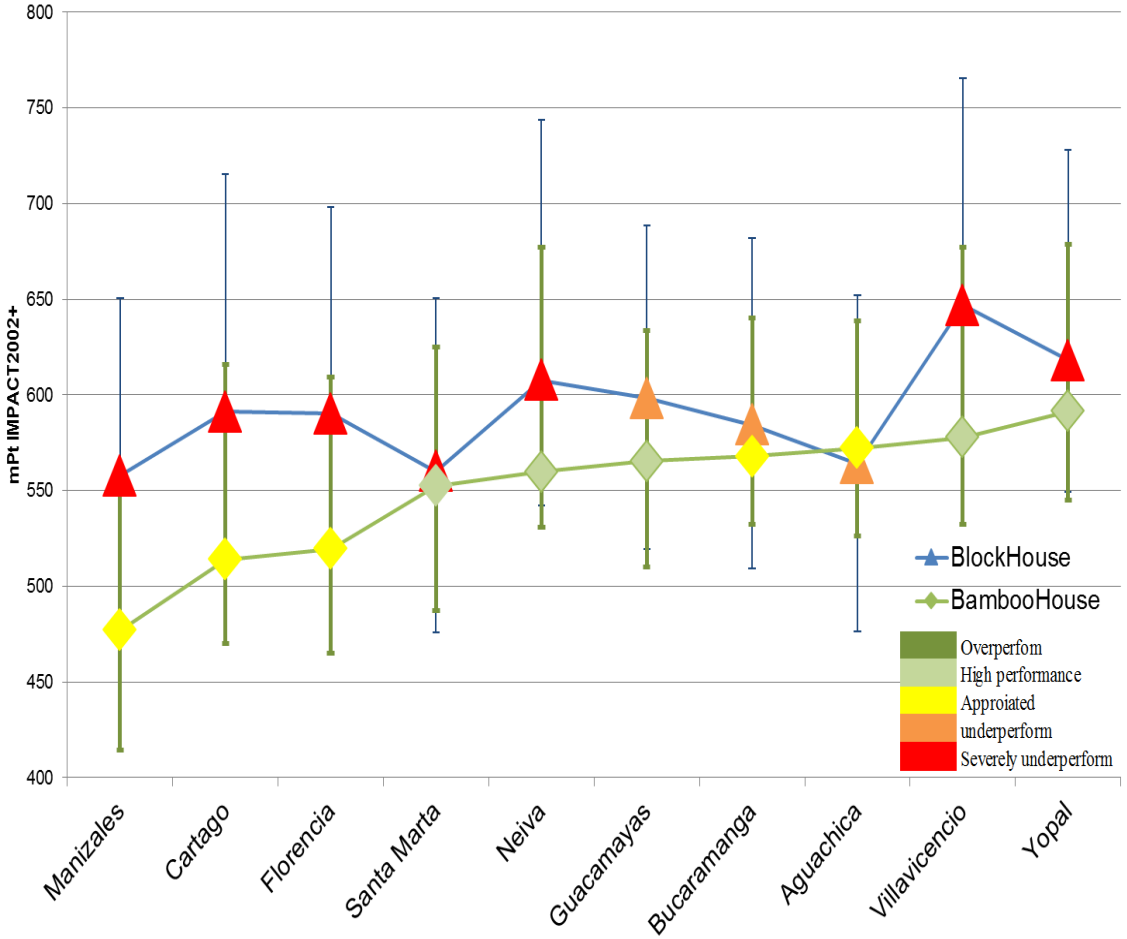
Results – Process contribution to Env. impact

- Construction materials contribute 70% of the impact, while transport represents between 15 and 30% of the total environmental impact
- Reinforcing steel is the main contributor to the environmental impact (30 to 40%)
- The bamboo house is the most sensitive to transport distances and amounts of steel reinforcement
- The impact of the brick house is mainly driven by the impact of the construction material



Results – Structural performance at risk zone

- The bamboo house presents a lower environmental impact and a better structural performance
- In some cases the bamboo house has a higher impact than the block house still has better structural performance
- A decision maker/designer has to prioritize between environmental impact and structural performance, depending on the local conditions and material availability



Conclusions

- The proposed methodology was able to represents the diversity of data inputs considering country-specific transport distances from centres of production to target cities.

- The results showed that under the high performance scenario, the bamboo house has the best environmental performance

- The transport of construction materials and reinforcement materials are the main contributors to the environmental impact

- Bamboo is the most sensitive construction material to both transport and amount of materials used

- The use of the proposed methodology can allow for the assessment of building designs in the early stages, where the uncertainty is the highest, identifying the improvement potential of each design and recognizing the structural needs of specific locations.

Acknowledgement

The authors will like to thank **HILTI AG** for their long term support in the development of the present research project.

Questions?