SVILUPPO ENERGETICO SOSTENIBILE

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Developing a Parametric Urban Forest Tool

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Keywords

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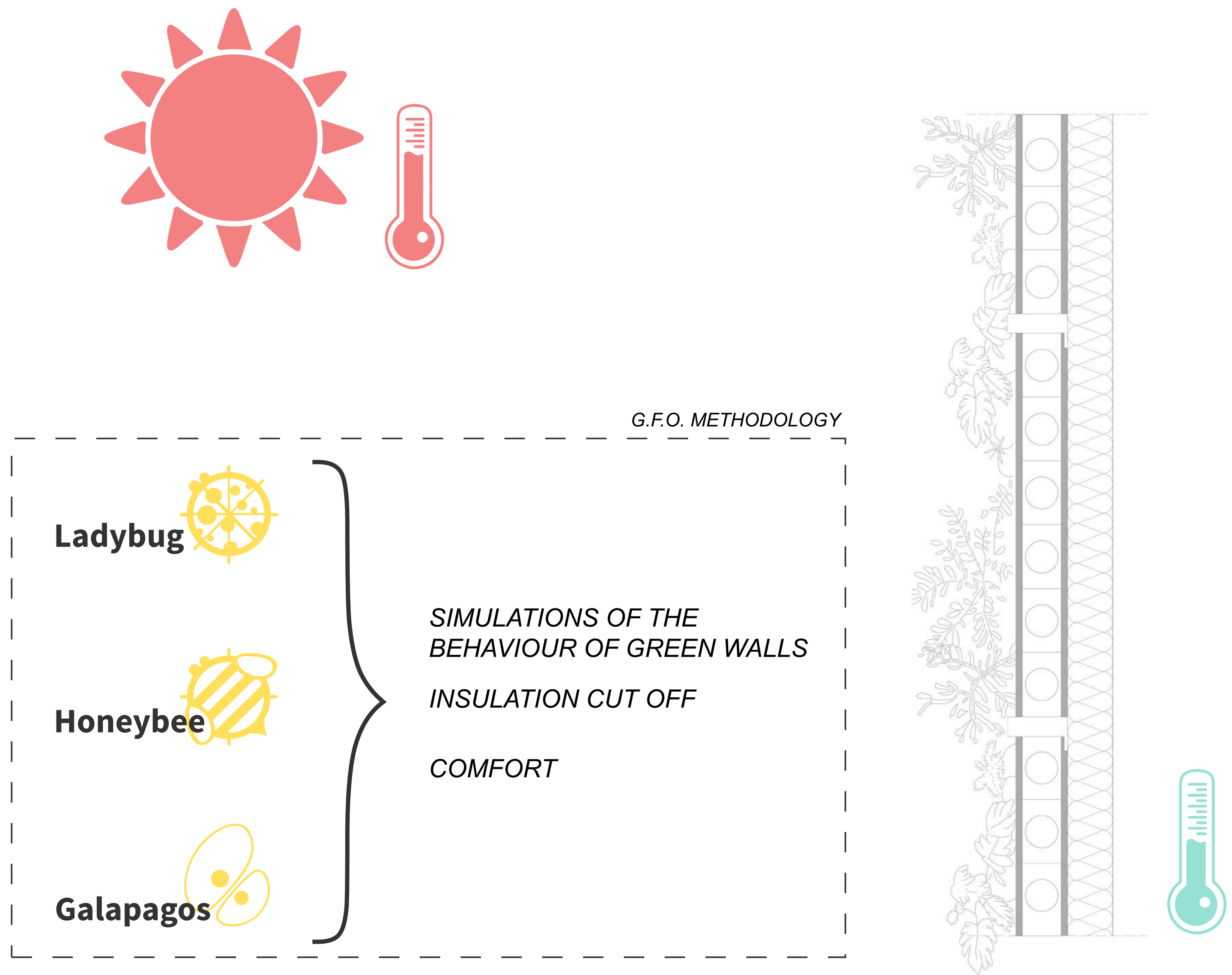
ABSTRACT

Green roofs and plant façades are today's new frontier in the relationship between nature and architecture. The technique has given architecture operational concreteness, offering unexpected possibilities for people's primary desire to live in and with nature. Intended thus, the plant-related element is no longer proposed just as a theatre set; rather, it becomes a component of the project just like any industrialized material. In this way, vegetation adds to the quality of the overall housing system, adding a sign of increased sharing to the principles of sustainability required by environmental challenges. The aim of this work is to present an optimization analysis to determine some important parameters, such density, green typologies, vertical or horizontal direction, insulation thickness etc, to define the thermal behaviour of green devices and to proposed an optimal system strategy that not only improves the outdoor thermal comfort, but also improves the urban microclimate, reducing the cooling load of the buildings. A parametric method was developed to optimize the green façade (green façade optimization, GFO) in order to consider the characteristics of the growing media, irrigation and vegetation characteristics, and to account for shading and insulation effects as well as evapotranspiration from the substrate and plants. The method uses 3D parametric tools, Grasshopper in particular, which is a graphical algorithm editor integrated with Rhinoceros, a 3D modelling program. Specifically, the research uses a variety of Grasshopper plug-ins, such as Ladybug, Honeybee and Galapagos, a mathematical computation solver. Small interventions in specific sites of the urban city can bring about a considerable improvement in the quality of life of the citizens, outdoor comfort and cooling load reduction. By implementing an optimized strategy that combines green shading, vegetation and cool materials, the city can reach its goals to-ward the city sustainability plan.

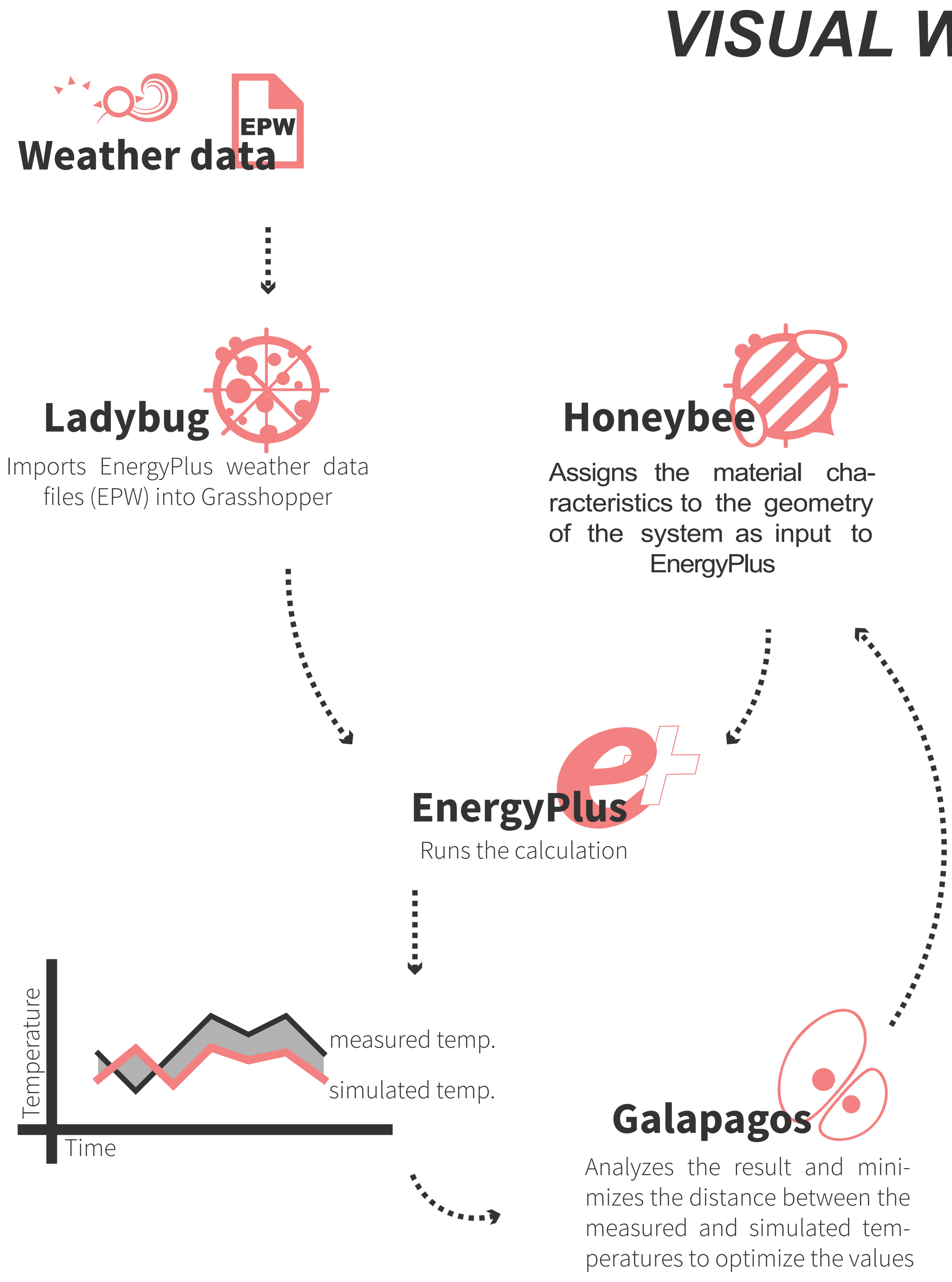
The main goal of the research is to establish a thickness above which the behaviour of

the green façade becomes isothermal and its performance do not improve. Future developments will show better outdoor and also indoor temperatures, with cooler environments in summer compared to the standard design solutions. The results are discussed and recommendations for simulating green devices are made.

OBJECTIVE



VISUAL WORKFLOW



METHOD

The simulation can be summarized in the following five steps.

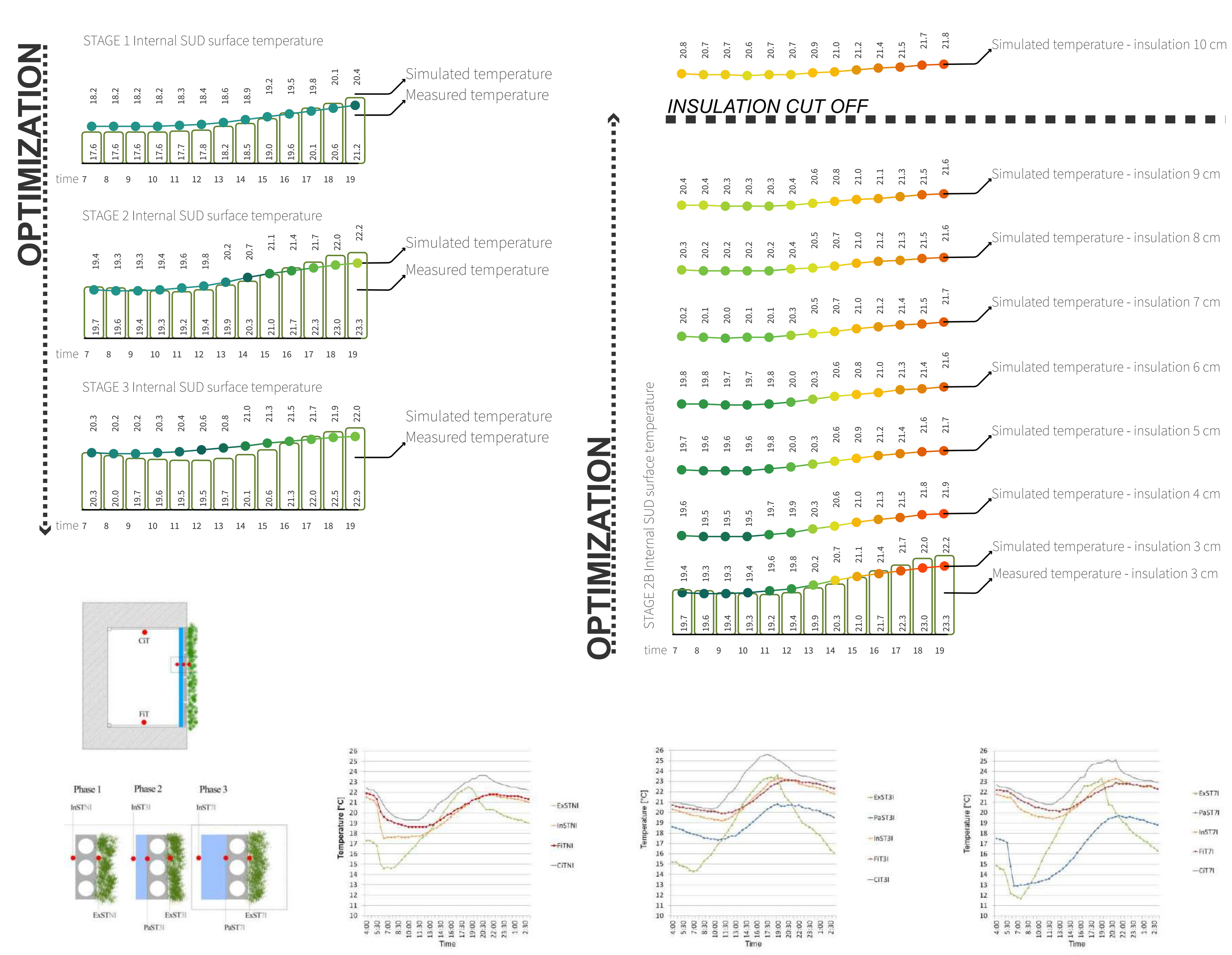
- **First phase:** single layer (outside) with a RoofVegetation/EnergyPlus material that con-
sidered the soil and green layer;
- **Second phase:** exterior layer as in phase 1, as well as an internal layer with a 3-cm-thick insulating material;
- **Third phase:** exterior layer as in phase 1, as well as an internal layer with a thicker (7 cm) insulating material.

Input to the simulation includes the characteristics of the material in the RoofVegetationmodule. Different aspects of the green roof are specified, such as root depth, thermalproperties, the density of leaf coverage, plant height, and stomatal conductance, as wellas soil humidity and irrigation. The complexity of the calculation system in RoofVegetation module means that a large number of parameters are required to describe the details of the green roof construction system. The RoofVegetation module only deals withthe soil substrate, i. e., the last component of the roofing unit. It generally includes thedrainage, insulation, and anti-root layers, which are modelled in the EnergyPlus "Materials" sheets.The last phase (3) was selected for validation, considering all of the previous materialvalues with the depth of the insulating layer changed from 3 to 7 cm. A period duringdaylight hours was considered because most of the urban mitigation potential of greenwalls can be observed at that time. Due to selected monitored data, a direct comparisonwas considered to validate simulated data. July 2011 and 2012 were considered andthree days were selected as similar study scenarios. The third scenario (Phase 3, 12July 2012) represents boundary conditions for the validation, so that only one diurnalbehaviour can be used. Numerous studies have shown that a direct comparisonpoint-by-point is feasible when small amounts of carefully selected data are compared.

CONCLUSION

The main goal of this research was to understand the importance of insulation thickness in a green façade. A new parametric optimization methodology called GFO(green façade optimization) was therefore developed and validated using real datamonitored in an experimental box located near Madrid (Spain). The GFO methodologywas developed to find all the unknown variables that well-known thermal simulationtools need to simulate the thermal behaviour of green façades. Comparison of thesimulations to experimental data allowed the model to be validated. The model wasthen used to simulate the behaviour of the green wall, varying the insulation thicknessfrom 3 cm to 13 cm.

RESULTS



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