PhD Thesis Proposal
Global sensitivity analysis of a green roof model

Context

Within the last ten years, green roofs have become a very important component of sustainable urban development both in North America and in many European countries, but only very recently in France. Growing environmental awareness as well as striking economical and ecological advantages are the main driving forces for their increasing success. Green roof means that building is covered with vegetation and a growing medium, both typically planted over a waterproofing membrane. It may also include additional layers such as a root barrier and drainage and irrigation systems. Green roofs offer a unique and sustainable approach to stormwater management. They also confer many benefits to the life expectancy and energy balance of a building, such as providing insulation and creating a habitat for wildlife.

Study of green roof behaviour is relatively recent as an area of research. Many questions still arise regarding the better understanding of their performance. Modeling and simulation of their behavior are thus essential to quantify the potential thermal benefits and facilitate the design process.

Problem statement

Green roof models have been proposed in the literature [1, 2]. They describe the thermal and hydric behavior of the green roof and depend typically upon the hygrothermal properties of the different materials involved in the roof. The models are governed by a set of partial differential equations based on the energy mass balance and the water balance of the roof system. They depend upon many parameters including, for example, the type of soil, vegetation, and rainfall. These parameters are often uncertain due to a lack of measurements or knowledge. Among all the parameters, however, some of them are decisive for the green roof temperature. Uncertainty and sensitivity analysis can help to evaluate the impact of this lack of knowledge on the model response, which here is the green roof temperature. In [3], it has been highlighted that some hydrological parameters are correlated. In this case, usual methods of sensitivity analysis based on Sobol' indices cannot further been used directly.

The objective of the thesis is to analyse the influence of the hygrothermal parameters of a green roof model on the green roof temperature, in order to better understand its behavior and to optimize its performance. The challenge is to propose methods of global sensitivity analysis for dynamical models with correlated parameters, appropriate for the analysis of a green roof model. Data measurements stemming from the green roof covering the Centre d'Etudes et d'expertise sur les Risques, l'Environnement, la Mobilité et l'Aménagement (CEREMA), in Nancy (France) will be available for this study.

The thesis will be supervised by Gilles Millérioux, professor, and Floriane Collin, associate professor at the Université de Lorraine (Nancy, France) and in collaboration with Rémy Claverie of CEREMA (Nancy, France).

References

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[3] R. Bouzouidja. *Fonctionnement hydrique d'un Technosol superficiel - application à une toiture végétalisée*. Thèse de l'Université de Lorraine, 13 novembre 2014.

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Keywords: global sensitivity analysis, dynamical model, correlated parameters, green roof model

Profile: The candidate must hold a Master's degree in Applied Mathematics or Control Theory

Laboratory: Université de Lorraine (France) - Research Center for Automatic Control of Nancy (Centre de Recherche en Automatique de Nancy, cran.univ-lorraine.fr)

Place: Esstin - 2 Rue Jean Lamour - 54500 Vandoeuvre Lès Nancy, FRANCE

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Contact: Floriane COLLIN, Associate Professor at Université de Lorraine
Email: floriane.collin@univ-lorraine.fr
Phone: +33 (0)3 83 68 51 39