Sensitivity analysis and uncertainty propagation to investigate the results' robustness of building life cycle assessment

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Abstract:

Building life cycle assessment (LCA) tools aim at helping the decision-making towards more sustainable built environments. In order to reach this goal, such tools need to be robust. However, practitioners are facing many choices in a project, leading to uncertainties in the results. In order to understand which factors induce the most uncertainty, sensitivity analysis (SA) is commonly applied, followed by uncertainty analysis (UA). Of particular interest is the possible influence of the uncertainty on the ranking of compared alternatives.

UA&SA methods were applied on a case study consisting of a single family house. 22 uncertain factors were investigated, mostly concerning the building's envelope, occupancy, lifetime and context. The building LCA tool novaEquer, linked with the dynamic building energy simulation tool Pléiades+COMFIE, was used. Twelve indicators were calculated based on environmental data from ecoinvent.

SA methods enabled to identify the most and less influential factors. For the less influential, default values can be used so that practitioners can focus on the most influential ones for the data collection. The results given by four SA methods were compared. Local SA, Morris screening, ANOVA on the Hadamard matrix and global SA methods have different computation time versus precision compromise. All of them identified the building lifetime, the electricity production mix and some parameters affecting the energy consumption (e.g. thermal bridges) to be very influential. But the relative influence of the factors varied according to some characteristics of the methods (consideration of linearity; type of probability distribution; calculation of effects or variance).

In our comparison study, UA was performed to study the impacts difference between two alternatives: using electricity or gas for heating and preparing hot water. For each indicator, the probability that an alternative had smaller impacts than the other was calculated. Choosing a different sampling strategy yielded small changes in the probability for a given number of simulations. However, the precision of the uncertainty characterisation (definition of probability distributions) influenced the results.

In a next step, UASA will be done considering a wider range of uncertain factors of the building LCA model, and will be extended to the district. The influence of long term scenarios will be investigated in a prospective approach.