Considering Uncertainties in the Functional Unit: Development of a More Flexible Strategy to Achieve the Goal of an LCA Study

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LCA studies are often based on a well-accepted assumption that the parameters comprising the functional unit, such as quantity and time, are known. This assumption can be true, but in some cases the values of these parameters have a certain degree of uncertainty such as when mean, most probable or target values are used. This uncertainty can significantly reduce the quality of an LCA, particularly in compared LCA studies. In this type of LCA, uncertainties associated with the functional unit can drastically modify the final results and should not be ignored. These uncertainties can be found in site remediation. The level of contamination is often an average of sample concentrations spread over the entire site. In addition, many remediation technologies are not fully effective.

The METEnvOrs (*Model for the Evaluation of a Technically and Environmentally Optimal Remediation Strategy*) model, based on a technico-economic multi-period decision model (METEORS), has been developed to manage these two additional types of uncertainty associated with some parameters of the functional unit. This model explores different ranges of possible values for the uncertain parameters of the functional unit. This environmental decision model has been used to select the optimal remediation strategy for a diesel-contaminated site for which two remediation technologies were being considered: the biopile (fully effective) and the *in situ* bioventing (not fully effective). Compared to the deterministic case (the technology having the lowest environmental impact considering a traditional LCA), the optimal remediation strategy has a main advantage. It allows the decision-maker to review the chosen technology according to the reduction in contamination, meaning that during the remediation process a part of the real functional unit parameters are revealed to him. This flexibility insures that a minimum of environmental impact is produced during the site remediation considering all the possible occurrences resulting from the uncertainties in the functional unit. As another advantage, the strategy presents all possible scenarios that could occur during the remediation strategy application and caused by the uncertain parameters of the functional unit. For a decision-maker, knowing all the possible scenarios is a way to manage the uncertainties surrounding the functional unit and to stay with the most favourable position regarding the remediation goals.

The optimal remediation strategy obtained is compared to the deterministic case. If the impact of the deterministic case lies between the worst and the best scenarios comprising the strategy, it is nevertheless higher than the expected impact of the optimal remediation strategy. For this case study, 75 % of the 28 scenarios (for a total probability of occurrence of more than 70 %) have a lower environmental impact than the deterministic case. Considering the uncertainties associated with the functional unit, this not only shows clearly that worst cases than traditionally expected are possible, but also that more valuable cases ignored by the deterministic approach can occur.