Data reconciliation under fuzzy constraints applied to wood flows in Austria

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Due to data limitations, material flow analyses are confronted with uncertainties affecting the reliability of the results. Using quantitative methods as a treatment for uncertainty by assuming that the flows within a system have specific density functions is typically not justified in situations of poor information. Fuzzy set theory provides a tool to deal with scarce and imprecise input data arising rather from vagueness than due to randomness alone. It enables to distinguish between the different types of data uncertainty in order to not confuse what is known with what is assumed. Membership functions are used to characterise the given information, allocating a certain positive "degree of belonging" to each value within the possible range of a flow belonging to the system.

In this study a method for data reconciliation under fuzzy constraints is presented and applied to the wood flows in Austria. Wood is a renewable resource with highly competing end-uses. Material uses of wood as construction materials, in furniture or in other products conserve the resource and therefore (potentially) enable another use of wood at the end of the product lifetime, either via energy recovery or material recycling. However, the current understanding of wood flows in Austria does not allow for a reliable assessment of the resource efficiency of wood use. Therefore, it is an ideal resource for testing and using reconciliation procedures for fuzzy data to identify critical issues with respect to input data quality as well as wood management mechanisms. The major challenges for establishing the Austrian wood budget are, on the one hand, the data gaps in the lifecycle phases of wood processing and the management of waste wood flows, and on the other hand, the disparity of measures used for quantifying the amount of traded wood and wood-containing products. As a result of the data reconciliation procedure, consistency levels are determined for each flow of the reconciled model, indicating the agreement between the given data and the mass balance constraints defined in the model. On this basis, the reliability of the data for a specific flow is evaluated relative to the other data used for the balances. Finally, sensitivity analysis is used to derive management scenarios for specific wood flows as a basis for improved decision support for the future wood management in Austria.