Method development for the provision of basic data for material and substance flow analyses in solid waste management

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The aim was to provide case-specific basic data for material and substance flow analyses in solid waste management. For this purpose, an extensive data model was developed and a corresponding database (DB) was designed and implemented. The DB consists of two major parts: a waste management material database (AM-DB) and a waste management technology database (AT-DB). The AM-DB stores raw literature data on materials relevant to waste management and the AT-DB stores the technical parameters for simulating the process sequence of technical processes.
The focus is on the case-specific provision of basic data on waste composition with identification of the chemical-physical characteristics contained in the individual waste fractions. For this purpose, several methods were developed which make it possible to generate an aggregated Material-Basic-Matrix (MBM) from the raw literature data in the AM-DB. Based on selection and aggregation criteria, this contains weighted mean values for the stored waste fractions and chemical-physical parameters. In addition, a standardization to uniform reference values is carried out. From this MBM, one or more so-called Input-Material-Substance-Matrices (I-MSM) can be generated for specific cases of application. This is achieved by modelling the waste composition by selecting the waste fractions contained in the waste and specifying the percentage by mass of the model waste, supplemented by selecting the relevant substances or chemical-physical parameters. The I-MSM thus generated contains the specific basic data, representing the input into a waste management system or a waste technology scenario, consisting of the waste composition with identification of the associated chemical-physical parameters and based on the previously specifically selected and aggregated raw data from the literature.
Besides, this approach was supplemented by additional methods to provide analog basic data after mechanical processing. To reach this goal, simulation models of sorting/treatment plants were integrated. This allows to combine any set of technical processes of a mechanical waste treatment plant in order to simulate the material flows for each process stage and the plant as a whole. In this way, a tracking of origins, paths, and remains of the materials in the system input is possible. The associated substance flows and chemical-physical characterizations result from the respective material compositions in the output streams of the simulated processes.

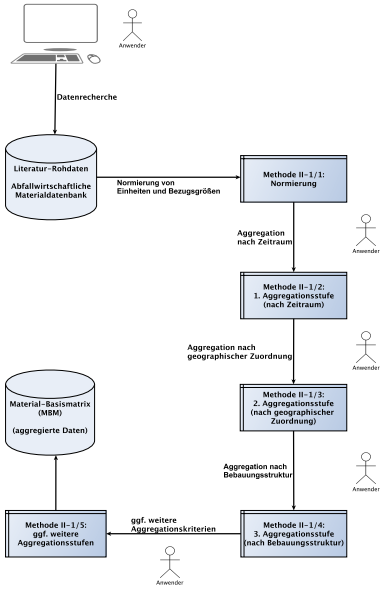

figure 1: Methodology II-1 for the generation of the "Material-Basis-Matrix" (MBM)

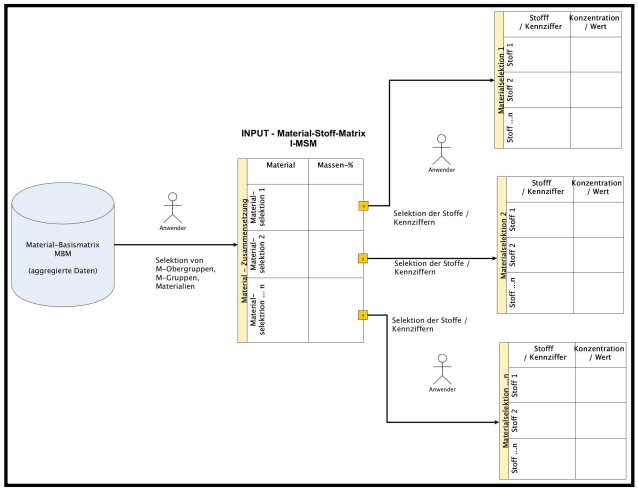

figure 2: Methodology II-2 for the generation of the INPUT - Material-Substance-Matrix (I-MSM)

The result of this modelling of a specific material flow processing then again provides case-specific basic data with identification of the waste composition according to fractions, substances and the chemical-physical characterizations.
The developed methods have finally been implemented using an example from municipal waste management. This was a hypothetical scenario in which municipal waste was first modelled and described using an I-MSM as described above. This I-MSM was then used as input flow into a process aiming on mechanical flow separation, in which several technical processes are connected in series as process steps. The output flows from this exemplary process configuration are described by the respective Material-Substance-Matrix (MSM). Afterwards, these specific basic data are available for waste material and substance flow analyses and can be used as a basis for the classification, evaluation and optimization of the investigated waste management system. The integration of further technical systems into such a system analysis can be carried out by using transfer factors and transfer formulas for waste materials and chemical substances that can be stored in the database. This is demonstrated by an example.

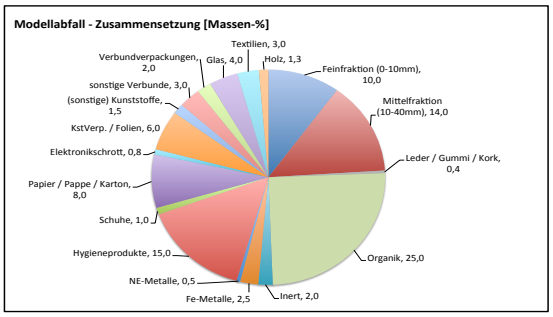

figure 3: Modelled waste - composition / fractions

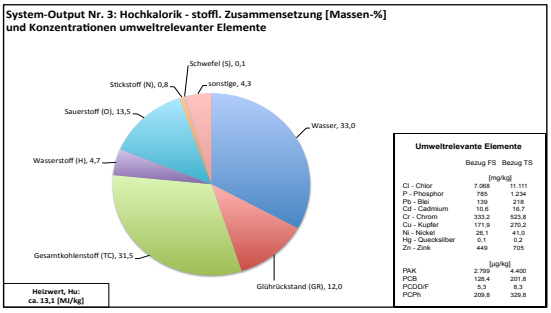

figure 4: Modelled waste - chemical-physical characterization

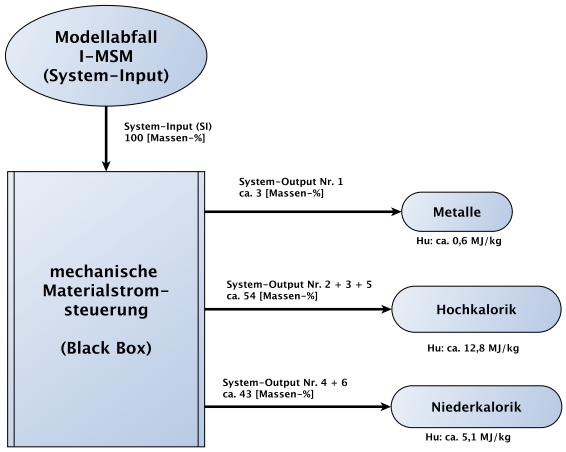

figure 5: simulation of mechanical material processing

To sum up, it has been possible to develop a methodology that makes it possible to provide the desired case-specific basic data for material and substance flow investigations. The methods developed here are also suitable for programming software with database connection.
From a scientific point of view, the new methodology provides an important addition to the implementation of waste management material and substance flow analyses. With the possibility to create detailed case-specific basic data, this existing gap is closed. In addition, a tool was developed to build up an extensive database with basic waste management data. It is already possible to compose a typical municipal waste with relevant chemical-physical characteristics using the basic data entered in the databases as examples. As soon as the data basis has reached a certain level, a more detailed modelling of waste composition and chemical-physical characterization can be carried out.