ecoinvent database as a tool for waste treatment modelling and Life Cycle Assessment

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ecoinvent is the world`s most consistent and transparent life cycle inventory (LCI) database. It currently includes more than 19000 reliable LCIs, whilst it is updated and maintained yearly. The database is used worldwide by thousands of users from academia and industry as a support decision making tool, and for the implementation of studies, such as Life Cycle Assessment (LCA), Green House Gas (GHG) reporting, Environmental Product Declaration (EPDs), Sustainable Product Design, Corporate Sustainability Reporting, etc. It covers a wide range of industrial sectors such as agriculture, construction materials, chemicals, plastics, energy, forestry, wood, fuels, metals, infrastructure, wastes, textiles, transport, pulp and paper, water, etc.

The waste sector, more specifically, contains the management of more than 300 wastes generated in a wide variety of sectors. It is built by numerous datasets, as each dataset represents the treatment of a waste with a dedicated technology, in a given country. For example, the dataset "treatment of municipal solid waste, incineration, ES" models the treatment of municipal solid waste via incineration in the country of Spain. The sector can be subdivided into solid waste management (SWM) and wastewater treatment (WWT). SWM covers treatment, recycling, and disposal (landfilling) activities, while WWT covers the treatment of wastewater. The geographical coverage for both SWM and WWT includes more than 50 countries across the globe. The service of waste transport is also provided, by accounting for the transport distances and modalities of a waste from generation to treatment site.

Enhanced granularity is offered for the most common urban waste fractions. These fractions include thirteen different wastes of five different streams, such as plastics (polypropylene, polystyrene, polyurethane, polyvinylchloride, polyethylene, polyethylene terephthalate, plastic mixture), paper (graphical paper, packaging paper, paperboard), glass, wood, and mixed municipal solid waste (MSW). Specific market mixes have been set up for these waste fractions, in order to cover the mix of treatment technologies taking place in every country of the European Union and a dozen other countries all around the world. For example, the market for MSW in Greece represents the national mix of treatment technologies for MSW.

However, there are still challenges to overcome in order to enhance users` experience and facilitate the usage of treatment datasets. In the past (up until and including version 3.8 [2021]), treatment processes in the database have been modelled as aggregated datasets by merging multiple inventories together. This modeling approach combines the final fate of a waste and all the wastes being generated in the meantime in one single dataset. For example, treatment of sanitary landfill of a waste generates a sequence of other by-products – wastes to be treated, such as leachates, sewage sludge from the leachate treatment, bottom ash from the incineration of the sludge, etc. All these wastes in the supply chain were merged in the dataset of sanitary landfill (Figure 1a). Despite this being comfortable for several users and modelling situations, employing these datasets implies that users are in agreement with predefined assumptions imposed by the model developer, leaving no room for customized modelling adaptations.

In order to tackle aggregated treatments, full disaggregation of the sector is carried out. The process subdivides merged treatments, by transparently quantifying all waste flows and emissions generated during all different treatments (Figure 1b). In the current version 3.9.1 of ecoinvent database, all wastewater treatments have been successfully disaggregated. The same concept has already been applied to the solid wastes of the database and aimed to be published in the next updated version of 3.10 [2023].

Furthermore, geographical and technological representativeness of treatments should be expanded to better represent wastes and treatment mixes of different regions around the globe. Attention is drawn to the geographical and technological coverage of MSW. The MSW composition is aimed to be regionalized for every country of the European Union, while the treatment mix is aimed to represent technologies implemented at a national level.

Moreover, there is lack of consensus with regards to the naming conventions of treatment datasets, given the fact that several names might not be immediately intuitive. As a result, misinterpretations of the actual dataset content can occur. This nomenclature ambiguity is targeted by adding the feature of "Product Information". A short and concise text is attributed to every waste of the database. It provides valuable information regarding wastes` type such as residential, industrial, construction & demolition, or institutional & commercial. It also describes key physical and chemical details of more than 300 wastes (water content, dry mass, elemental composition of major elements like C, N, P etc.), hazardousness status, generation activities, and treatment options. Guidance is also provided on how users should employ wastes and the different modelling options they have.

The newly introduced changes offer great benefits to ecoinvent database users. Thanks to the disaggregation process, system boundaries are respected in terms of time and space. Further, transparency is enhanced as wastes

produced within treatment processes are now reported in separate datasets. This enables users to fully understand the data they are using, while they can adapt it according to the needs of their own LCA studies. Moreover, market datasets are introduced between the newly disaggregated treatments to take into consideration transport of different wastes. Therefore, a realistic modeling approach is depicted, while the supply chain of waste treatment can be meaningfully analyzed. Users are also enabled to model their own collection and transportation schemes that feature regional parameterization. The process of disaggregation also allows wastes to be considered as potential valuable resources, since they can be used as inputs in producing activities and support circular business models. In addition, users are able to perform a more efficient GHG reporting, as they can account properly for all types of emissions registered in the respective activity producing them.

The new naming convention of wastes and their treatments enhance users understanding and employing the data by having a consistent naming convention that allows them to dive into the differences of specific wastes. Additionally, users can receive a quick feedback on the physicochemical properties of the wastes that can help them to properly choose the ones that qualify best for their studies.

Enhancement of regional granularity will offer unlimited possibilities for users to model any case specific scenario in every country of the European union. It will also enable them to consistently assess the impact and/or impact contribution of their wastes in their LCA studies or simply assess different scenario in order to design waste management collection, transportation and treatment schemes with high level of regional granularity.

Apart from the above-mentioned changes, a variety of future projects are assessed and shaped. Future goals target to strengthen sorting and recycling processes of different waste types, such as various plastic polymers, paper, paperboard, metals, glass, etc.

This presentation aims to provide an overview of the waste sector on the ecoinvent database in order to guide users on how to use it properly and explore all the offered potentials. Methodological challenges and data gaps are addressed, accompanied by suggestions on how to overcome them. Newly implemented projects and features are explained to highlight the benefits and opportunities related to waste treatment modeling. Finally, newly developed ideas and projects to come are presented, by focusing on the future paths ecoinvent intends to follow at the topic of waste management.

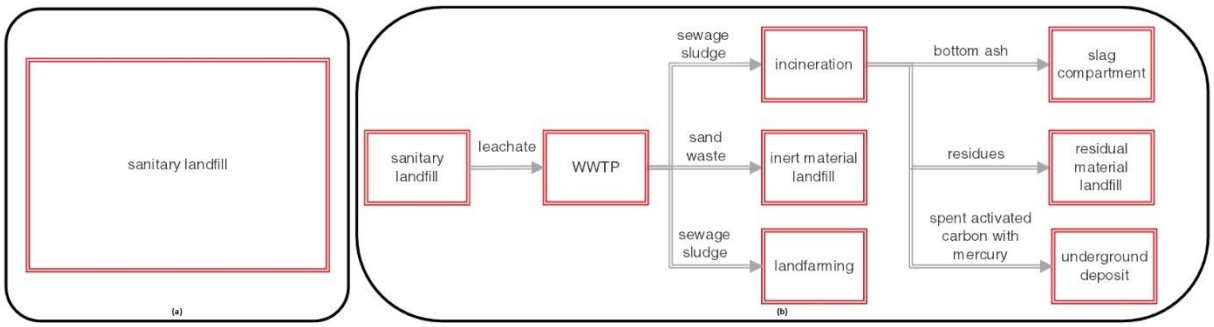

Figure 1. (a) example of aggregated dataset, (b) example of disaggregated dataset

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