Process on “Global Guidance for LCA Databases”

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Abstract In early February, 48 participants from 23 countries gathered in Shonan Village, southeast of Tokyo, for a Pellston workshop to develop global guidance on principles to create, manage, and disseminate datasets through databases for the purpose of supporting life cycle assessments of globally produced products and services. Participants were organized into six topical tracks, based on responses to a series of eight stakeholder engagements held around the world over the past 18 months. The main topics for the work groups were: 1) unit process data development, 2) aggregated process data development, 3) data review and documentation, 4) adaptive LCI approaches, 5) integration and cross-fertilization, and 6) future knowledge management. The discussions, including both the consensus recommendations and the alternative views, where objectively supportable, are documented in the "Shonan Guidance Principles." The week deepened the appreciation among the different approaches, schools and philosophies related to dataset development, modeling, reporting and review. The conclusions from controversial discussions were drawn in a spirit of inclusion rather than separation.

1 Introduction

As products and services have become more geographically diverse in their sources of resources, manufacturing and assembly operations, usage, and final disposition, the need for Life Cycle Assessment (LCA) users to obtain data that accurately and consistently quantify the resource consumption and emissions of those activities has never been more acute. Providing a sound scientific basis for product stewardship in business and industry and life cycle based policies in governments, ultimately helps to advance the sustainability of products and society's economic activities.

To address the need for global guidance on life cycle inventory (LCI) data collection and data processing into databases for widespread use, the United Nations Environment Programme (UNEP) and the Society of Environmental Toxicology and Chemistry (SETAC) are collaborating within the Life Cycle Initiative. The process was launched at the first Stakeholder Engagement Meeting, “Towards Global Guidance for LCA Databases," in Boston on the 30th of September in 2009, where the high attendance confirmed the international interest in the UNEP/SETAC proposal.

The importance of the project is highlighted by the fact that a global network of data is required for informing the management of supply and production chains in a global economy. As production and consumption become more globalized, the materials and energy sources comprising the product or process can be spread across countries and continents. To develop credible LCAs across such a scale, it is essential that databases have uniform data requirements to allow consistent modeling and reliable decision support. The LCI data are used in various models and tools, including LCA and Carbon and Water Footprint, the results of which guide decisions to improve the environmental sustainability of processes and products.

The seven stakeholder meetings (in Mumbai, Beijing, Tokyo, Florianópolis, Seville, Montreal, and Portland) following the launch and initial stakeholder meeting in Boston in 2009 have informed stakeholders about this plan for the development of a global guidance document. The central activity in the process consisted of a five-day Pellston-type Workshop in early February 2011, organized by the Secretariat of the Life Cycle Initiative on behalf of UNEP and SETAC. The vision for the workshop was to create guidance that would:

1) Serve as the basis for improved dataset exchangeability and interlinkages of databases worldwide,

2) Increase the credibility of existing LCA data, the generation of more data, and enhance overall data accessibility, and

3) Complement other data-related initiatives at the national or regional level, particularly those in developing countries and where more prescriptive guidance has been developed.

The discussion and conclusions of the workshop were documented and are known as the "Global Guidance Principles for LCA Databases", also informally called the "Shonan Guidance Principles."1

2 Approach

SETAC Pellston workshops convene about 40-50 invited experts, who, through a combination of working groups and plenary sessions, address and write about specific goals in a highly structured, intensive week. The 'Pellston' approach has been used successfully for over 30 years and more than 50 publications demonstrate how these workshops have advanced the state of environmental science (http://www.setac.org/node/104). Previous Pellston workshops have produced practical recommendations to LCA practitioners and policymakers.

To ensure the validity of the guidance, participants were selected for their technical expertise as well as geographic breadth and their perspective in the "data supply chain". The final mix of participants consisted of a balance of data and study providers (primarily consultants and industry associations) along with data and database users, including IGOs, government, industry, NGOs, and academics. The emphasis of the workshop was on development of and access to datasets within databases, since there is already a set of international ISO standards on methodology and conduct of LCAs.

Participants were organized into six topical tracks, based on responses to a series of eight stakeholder engagements held around the world over the past 18 months. Issues papers were prepared for each area and previously published information extracted into a database for use in preparing these papers and for consultation during the workshop. Topics for the work groups included:

1) Unit process data development - defining a data collection approach and mechanism that results in unit process datasets with the desired quality attributes and adequate documentation, specifying data modeling requirements to accurately transform raw data into life cycle inventory datasets, and collaborating with the review and documentation group to address verification and transparency issues,

1 Note: The text/results discussed and the figures presented in this article are taken from the Shonan Guidance Principles.

2) Aggregated process data development – defining and validating procedures and requirements for combining unit process data into multi-process datasets and into product systems covering full life cycles, specifying requirements on additional information to be provided with such datasets to users to allow determination of suitability, and collaborating with the review and documentation group to address verification and transparency issues,
3) Data review and documentation – detailed analysis of requirements and procedures for review of datasets prior to their acceptance into databases, overall management roles and responsibilities for database managers, and description, along with dataset development work groups on necessary documentation for primary data and supplemental (metadata) characteristics,
4) Adaptive LCI approaches – data demands and enhanced aspects of LCI questions accessible with non-conventional methodologies, such as input/output table-based techniques, time dynamic LCI, spatially-explicit LCI, and hybrid methods.
5) Integration and cross fertilization – identify intersecting ideas and promote creative thinking across the work groups, especially regarding current practices.
6) Future knowledge management – anticipating how emerging information and knowledge management techniques could be used to more efficiently produce increased numbers of LCI datasets while maintaining quality and oversight, linking such datasets to databases, as well as the prospects of other distribution mechanisms.

All of these discussions maintained a clear user perspective with regard to their needs for data and assuring the credibility of the data. Efforts were made to define users within various organizations for purposes of tailoring the guidance as appropriate.

3 Summary Results

The following section provides a high level overview of the workshop findings. These summary results cannot begin to capture the breadth of discussion and careful deliberation that took place on each topic. Likewise, alternative views, where objectively supportable, are incorporated in the document in a number of

ways, but due to length constraints this article is based only on consensus recommendations.

3.1 Speaking the same language

In addition to providing guidance on technical and operational aspects of datasets and databases, it was discovered that there remains differences in terminology usage and inconsistencies in principles definitions such as completeness, exchangeability and transparency. Part of this situation is caused by the evolution of LCA in different regions/cultures, part by language and part by ambiguity in existing definitions. Thus, one of the initial exercises was to develop a terminology glossary and dictionary of principles to provide a consistent basis of reference for participants. Although not intended as a general reference, the glossary may find use externally. Where possible, the definitions were based on existing ISO standards language, however, in many cases the ISO definition was ambiguous, incomplete, or lacking.

3.2 Current practice

Much time and effort was spent assessing the current state-of-practice regarding developing datasets, incorporating them into databases, and then managing those databases. From an operational standpoint, recognition that the target audience of the document is database managers (or database management teams) serves to position them as central actors in the data supply chain (Fig. 1). This is not to say that there are not other actors who will benefit from the guidance. Far from it, data providers, study commissioners, reviewers, and ultimate users all will find useful insights and recommendations in the document.

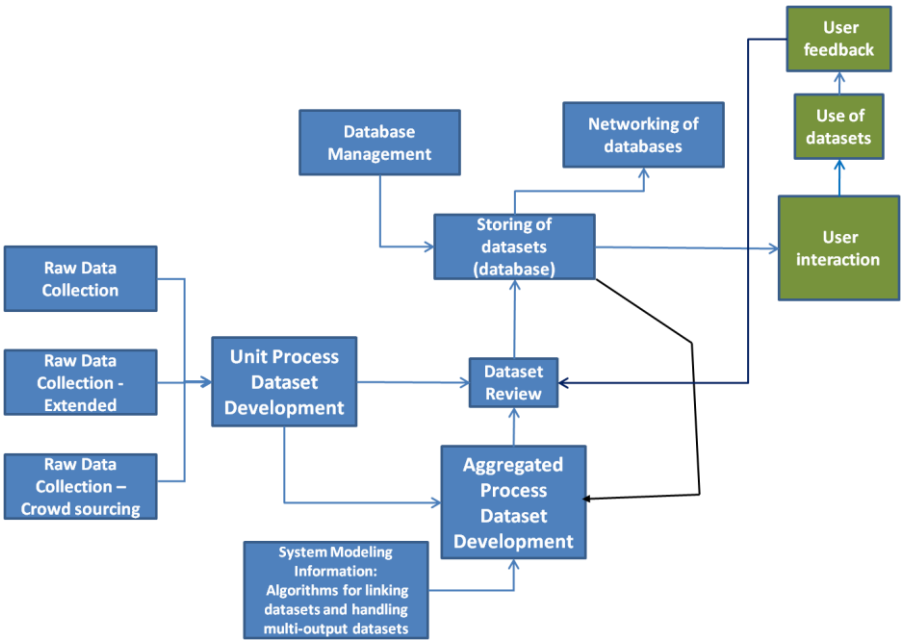

Fig. 1: Data supply chain.2

Providing high quality unit process level datasets begins with targeted data sourcing and a well defined data collection plan with the end result firmly in mind to produce datasets that are consistent, complete and exchangeable (Fig. 2). Once raw data are collected according to the plan, then the unit process dataset is created by defining specific mathematical relationships between the raw data and various flows associated with the dataset and a defined reference flow. Data developers are provided with guidance on identifying and selecting raw data, defining the appropriate relationships, and supportive information to be included to describe both the decision rules and the nature of the relationships. In some unit process datasets these relationships are defined parametrically.

2 Note that the user feedback to the review function is applicable for comments on datasets. Alternately, feedback on the database or contained datasets could be to the database management function.

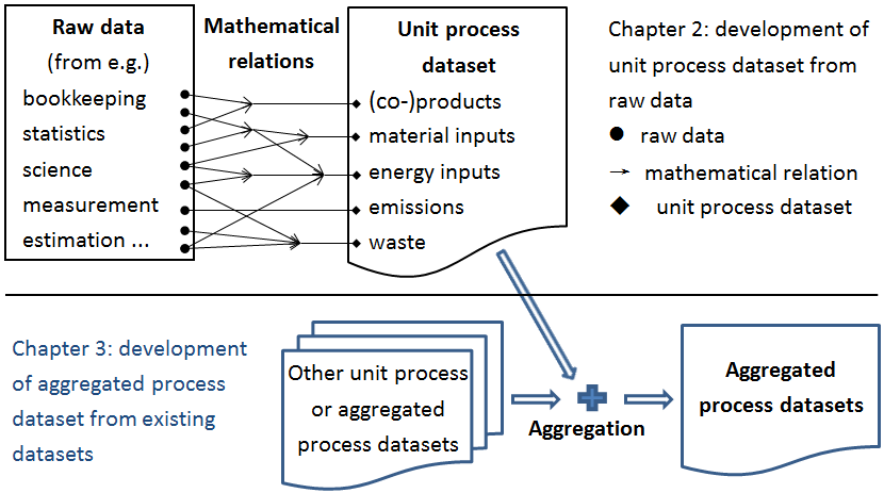

Fig. 2: Dataset(s) production from raw data.

There are good reasons to provide datasets on a unit process level. Firstly, it provides maximum transparency, allowing the users of the database to understand which ones are used in the life cycle inventory of a given reference flow and how these unit processes are linked. Secondly, it makes the database flexible and adaptable in the sense that specific unit processes in a life cycle inventory can be adapted or replaced to better reflect the situation to be assessed. Thirdly, it can improve the interpretation of life cycle studies because the high resolution of unit process-based assessments allows a user to identify the key unit processes through sensitivity analysis by varying methodological and other assumptions as well as parameters, inputs and outputs.

There are several reasons to aggregate datasets. First of all, it is considered convenient to work with aggregated process datasets (cradle to gate, cradle to grave) in a number of LCA software systems and in simplified tools to reduce calculation time and memory size, when answering questions typically addressed by LCA. Furthermore, from a user perspective it can be beneficial to work with aggregated or pre-connected unit process datasets if the user does not have the technical or engineering know-how to model a complex process chain. Finally, the aggregation of datasets may be required due to confidentiality reasons. Confidentiality may be ensured by different levels of aggregation (e.g., by establishing an industry average, by aggregating some selected unit process datasets along the supply chain or by aggregating unit process datasets with selected inputs being followed up to the cradle). For the cases presented above an aggregated, reviewed dataset with comprehensive documentation can be an

appropriate choice. For the first time, the Shonan Guidance Principles show the various aggregation possibilities in a graphical and self-evident way (Fig. 3). It is recommended to carry out an independent verification of the unit process dataset and of the product system model used to generate aggregated process datasets.

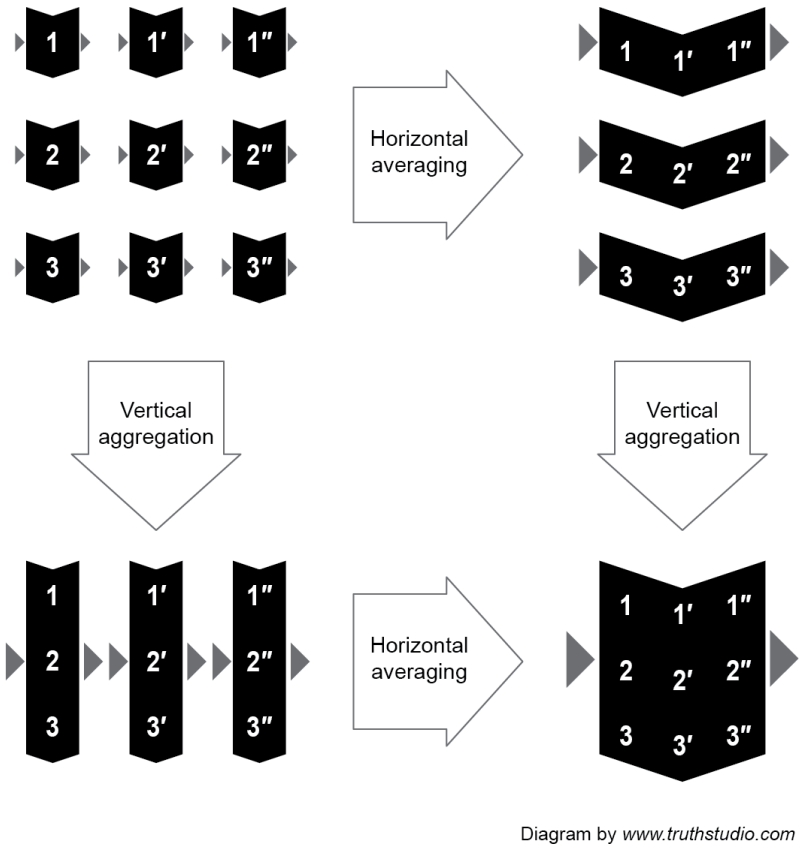

Fig. 3: Horizontal averaging and vertical averaging.

Datasets (from databases) can be used in different modeling approaches, as the latter can be individually chosen by the users. Consistency is key in order to allow these choices to be made by users. Different approaches exist to model product systems. These approaches can be the basis for generating aggregated cradle-to-gate or cradle-to-grave process datasets. The modeling approaches are different but it is not recommended to point to one approach as the general best approach without looking at the explicit modeling and without looking at the explicit decision context. It is recommended to model aggregated process datasets as

consistently as necessary and to document inconsistencies when relevant. It is recommended to be very clear about the modeling approach used when creating the aggregated process datasets.

The documentation of aggregated process datasets is highly important. It is strongly recommended to provide sufficient information and to be as transparent as possible. The provision of the unit process datasets used in the product system of an aggregated process dataset is preferable. When there is sufficient basis not to provide the information at the unit process level, it is strongly recommended to include other information in the aggregated process dataset, for example about key drivers of the overall environmental impacts, data sources used, assumptions, key process operational figures and the like.

The primary target audience of database managers and/or operators has the role and responsibility to decide not only what the datasets themselves must include but also what additional information is required and what would be considered recommended or necessary in terms of validation and review prior to data being stored in a database. In order to accomplish these functions, it is strongly recommended that the database management team issues a written protocol. Due to the additional need for datasets to be both accurate depictions of reality and compliant with the requirements of the database they reside in, validation and review are considered to be critical. The guidance describes a number of ways in which validation, as an internal "quality-check" process or mechanism, and review, as a more formal and often external procedure, is advised to take place. In particular, the guidance recommends that before a dataset is included in an LCI database it undergoes a defined validation process to ensure it meets the database protocol.

An LCI database is an organized collection of ISO 14040- and 14044-compliant LCI datasets that sufficiently conform to a set of criteria including consistent methodology, validation or review, interchangeable format, documentation, and nomenclature and allow for interconnection of individual datasets. LCI Databases store LCI datasets, allowing for their creation, addition, maintenance and search. LCI databases are managed by a responsible management, which enables identifying and tracing the responsibilities of the database creation, content, maintenance and updating.

In contrast, an LCI dataset library contains datasets that do not sufficiently meet the above criteria and care must be taken when using them in a life cycle model. If the aspects above apply but the LCI database is limited regarding covered

impact categories (e.g. only cover Carbon Footprint information) or have a specific focus for certain applications or schemes, the recommendation is to flag this limitation clearly in the documentation as inconsistent with the inclusive nature of LCI datasets.

3.3 Moving Beyond Current Practice

Some workshop participants identified a need for additional data and data management to allow LCA databases to provide more comprehensive answers and to answer more comprehensive questions, such as spatially differentiated models, developments over time, and issues related to social and economic impacts. Another aspect addressed was the filling of data gaps with data estimations from non-process based approaches.

The workshop participants analyzed the different additional data sources, such as geospatial data, data from national environmentally extended economic Input-Output Tables and environmental accounts, data on social indicators and data on costs. In general, it was found that all of these data sources could be used in a complementary way to existing raw data in the development of unit process datasets for some purposes, if the technological specificity and methodological differences are fully taken into account and documented.

Current trends in information technology are expected to shape users' expectations regarding data, software functionality, and interoperability in ways that will alter the scope of what can be done with LCA data. It is important to anticipate these trends along with market drivers in order to be better prepared to properly manage the development of life cycle information with a need to maintain quality. Increased potential for data "mobility" would allow data from various sources to more easily find its way into LCA databases, and then into a wide range of new applications. Such enhancements can potentially bring significant progress toward sustainable consumption and production.

There are new ways to access the information in LCA databases, which do not change the way where the data are generated or stored, but the way in which users access the data. While not a radical departure from the status quo, the infusion of new technologies into existing database applications is occurring now and will continue into the near future.

Global coordination among LCI dataset developers and LCA database managers has been identified together with capacity building and data mining as components of priority roadmaps to move towards a world with interlinked databases and overall accessibility to credible data.

Disclaimer: Involvement in the process towards a "Global Guidance for LCA Databases" does not imply an agreement or endorsement of the outcomes of the workshop or subsequent scientific reports.

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