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Batch generation of agricultural LCIs: comparison of strategies

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1. INTRODUCTION

Often, agricultural LCA practitioners need to handle large datasets representing individual LCIs, either from field surveys or from model outputs. To model such unit process datasets "by hand" can be time consuming with most LCA software usable only via graphical interface, especially if direct field emissions need to be computed.

To address this limitation, we propose three strategies for batch generation of agricultural LCIs, using open or semi-open access tools or services.

2. METHODS

A dataset of farm survey data (Avadí and Dosso, 2023) was used to construct an inventory file describing all inputs and outputs associated with each technical itinerary, including direct field emissions. ~800 technical itineraries (i.e. a technical description of an individual distinctive cropping system) were included in the inventory file. Direct field emissions were computed using context-optimal models, as recommended in (Basset-Mens et al., 2021). These models were the simplest, due to the need to perform the computations for 800 systems in Excel: EMEP/EEA 2019, IPCC 2019, SALCA-P, RUSLE2. Emissions associated with pesticide application were modelled with PestLCI, through its online batch computation capabilities (https://pestlciweb.man.dtu.dk/batchcalculation), as recommended in (Nemecek et al., 2022). The PestLCI web model implementation is inaccessible since end of August 2023.

Three batch generation strategies were tested, as depicted in Figure 1, labelled "ELDAM", "MEANS-InOut" and "Hestia". The three strategies are depicted in **¡Error! No se encuentra el origen de la referencia.**. For all three strategies, an initial data curation for data issues (e.g. internal consistency) was performed.

For the "ELDAM" strategy, the CIRAD LCA research infrastructure (Biard et al., 2011) was used for LCA computations, complemented with ELDAM software (Coste et al., 2021), PestLCI (Dijkman et al., 2012) and R (R Core Team, 2020) for automation. A random technical itinerary from the dataset was used to construct a generic model in SimaPro, which was exported as a MS Excel file and transformed into an ELDAM (MS Excel-based) file. An R script was used to replicate the template ELDA file by updating each instance from the inventory file, where each column represents an individual technical itinerary (included pre-computed direct field emissions). The resulting set of ELDAM files were reimported into SimaPro to produce ~800 individual processes, which were included into calculation setups to generate impact assessment results, which were then downloaded from SimaPro for each technical itinerary in the survey.

For the "MEANS-InOut" strategy, the data were aligned with the reference framework of technical itinerary descriptions used by MEANS-InOut (Auberger et al., 2019) (the MEANS platform's graphic user interface) in an Excel file and then uploaded for ingest. An Excel template is provided for data input, together with nomenclature keys and processed remote sensing data at the country x GAEZ region nomenclature (Fischer et al., 2021), necessary to inform direct field emissions models. The data were then automatically converted to the MEANS-InOut format (Java object) and screened for coherence and nomenclature. A built-in API then generates all LCIs, including data for direct field emissions. Direct field emissions were computed according with a hardcoded selection of direct field emission models (chosen as to minimise the requirement of additional data: EMEP/EEA 2019, IPCC 2019, SQCB 2009, SALCA-

P, RUSLE2, OLCA-Pest), and automatically integrated into LCIs. Finally, full LCIs were generated and exported in ecoSpold format, for impacts computation in SimaPro, as well as in Excel format (direct field emissions only). In MEANS-InOut there is the possibility of calculating impacts seamlessly with OpenLCA. Future refinements will enable more flexibility on direct field emission models selection, including additional remote sensing data for filling data gaps. Calculated impact assessment results were then downloaded from SimaPro for each technical itinerary in the survey.

For the "Hestia" upload, the data were aligned to the schema and glossary in a CSV file (manually, by the user). The data were then automatically converted to Hestia format (JSON), validated to the schema, automatically screened for data inconsistencies, and finally manually checked before being indexed on https://hestia.earth/. Once indexed, data gaps were filled using remote sensing data where possible. Field emissions were then calculated to the highest tier possible given the resolution of the data, using a default set of models. Inventory flows for each individual farm were then aggregated, classified, and characterised towards all impact categories where corresponding characterisation factors were available for all inventory flows. Calculated field emissions and impact assessment results were then downloaded from Hestia for each technical itinerary in the survey.

3. RESULTS AND DISCUSSION

The three strategies successfully generated exploitable LCIs, but "ELDAM" required manual computation of direct field emissions, while the other two strategies used the respective platforms' built-in computation capabilities to do so. On the Hestia platform, a default choice of direct field emission models is retained, adapted to the type of modelled system (users can chose direct field emission models only by using the Hestia Community Edition, but not through batch upload). Similarly, in MEANS-InOut the choice of models is made following expert-based parametrisation relying on the (predominantly) French context (Koch and Salou, 2022), thus also proposing a default choice. MEANS-InOut also requires additional data to inform direct field emission models, while Hestia fills all required data from prerendered remote sensing (geolocalised) products, albeit without the user's control on data selection. Hestia generates full LCIA results seamlessly using Brightway (Mutel, 2017) for background processing and their own model for foreground processing), while MEANS-InOut requires either exporting LCIs to be computed on SimaPro or seamlessly computing impacts through an OpenLCA API (which returns editable OpenLCA projects in addition to the LCIA results).

Both the MEANS-InOut and Hestia approaches required extensive data curation, due to the internal check routines associated with both platforms.

Comparative results from the three approaches will be available at the conference. ELDAM-based results are presented in Dosso et al. (this conference).

4. CONCLUSIONS

All three strategies proved useful for batch generation of agricultural LCIs, subject to different constraints. Particularly for the web platform-based ones, the ingestion of user data requires time-consuming manual curation and schema/nomenclature matching, thus an automation of these routines would be the expected evolution, especially given that batch LCI generation and impacts computation needs are increasing throughout the LCA community.

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6. REFERENCES

Auberger, J., Biard, Y., Colomb, V., Grasselly, D., Auberger, J., Biard, Y., Colomb, V., Grasselly, D., Martin, E., 2019. MEANS-InOut : user-friendly software to generate LCIs of farming systems, in: 11th International Conference on Life Cycle Assessment of Food 2018 (LCA Food), Oct 2018, Bangkok, Thailand.

Avadí, A., Dosso, M., 2023. Données opératives issus des enquêtes auprès des producteurs maraîchers urbains et périurbains de la Côte d'Ivoire, 2022. Yamoussoukro, CIRAD Dataverse, V2. https://doi.org/10.18167/DVN1/FFV3W6

Basset-Mens, C., Avadí, A., Acosta-Alba, I., Bessou, C., Biard, Y., Payen, S., 2021. Life Cycle Assessment of agri-food systems. An operational guide dedicated to developing and emerging economies. Quae, Versailles. https://doi.org/https://doi.org/10.35690/978-2-7592-3467-7

Biard, Y., Basset-Mens, C., Bessou, C., Payen, S., Benoist, A., Avadí, A., Tran, T., Vigne, M., CIRAD, 2011. LCA-CIRAD Platform: Life Cycle Assessment of Tropical Agricultural Products. https://doi.org/10.18167/INFRASTRUCTURE/00008

Coste, G., Biard, Y., Roux, P., Hélias, A., 2021. ELDAM: A Python software for Life Cycle Inventory data management. J. Open Source Softw. 6, 2765. https://doi.org/10.21105/joss.02765

Dijkman, T.J., Birkved, M., Hauschild, M.Z., 2012. PestLCI 2.0: A second generation model for estimating emissions of pesticides from arable land in LCA. Int. J. Life Cycle Assess. 17, 973–986. https://doi.org/10.1007/s11367-012-0439-2

Fischer, G., Nachtergaele, F.O., van Velthuizen, H.T., Chiozza, F., Franceschini, G., Henry, M., Muchoney, D., Tramberend, S., 2021. Global Agro-Ecological Zones (GAEZ v4) Model Documentation. FAO & IIASA.

Koch, P., Salou, T., 2022. AGRIBALYSE®: Rapport Méthodologique- Volet Agriculture- Version 3.1 ; version initiale v1.0 ; 2014, AGRIBALYSE v3.1. Ed ADEME, Angers, France.

Mutel, C., 2017. Brightway: An open source framework for Life Cycle Assessment. J. Open Source Softw. 2, 236. https://doi.org/10.21105/joss.00236

Nemecek, T., Antón, A., Basset-Mens, C., Gentil-Sergent, C., Renaud-Gentié, C., Melero, C., Naviaux, P., Peña, N., Roux, P., Fantke, P., 2022. Operationalising emission and toxicity modelling of pesticides in LCA: the OLCA-Pest project contribution. Int. J. Life Cycle Assess. 527–542. https://doi.org/10.1007/s11367-022-02048-7

R Core Team, 2020. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria [WWW Document]. URL http://www.r-project.org/index.html

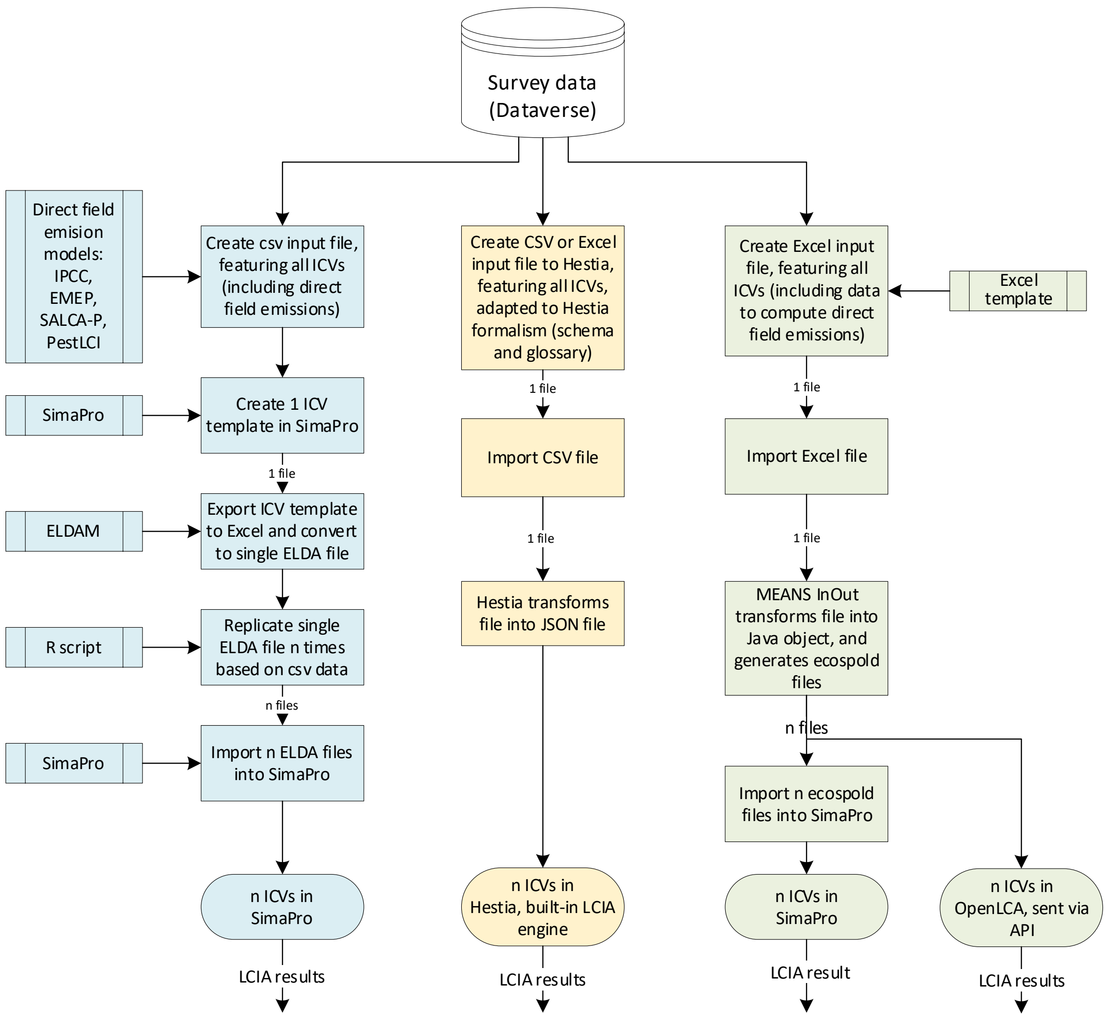

Figure 1. Three strategies for batch generation of agricultural LCIs from survey or statistical data