A dataset of characterization factors for biodiversity impact assessment in OpenLCA and LCA for Experts

Julian Quandt , Jan Paul Lindner , Nico Mumm

PII: S2352-3409(25)00228-8
DOI: https://doi.org/10.1016/j.dib.2025.111496
Reference: DIB 111496

To appear in: *Data in Brief*

Received date: 24 February 2025
Revised date: 9 March 2025
Accepted date: 14 March 2025

Please cite this article as: Julian Quandt , Jan Paul Lindner , Nico Mumm , A dataset of characterization factors for biodiversity impact assessment in OpenLCA and LCA for Experts, *Data in Brief* (2025), doi: https://doi.org/10.1016/j.dib.2025.111496

Data in Brief
Open access
Article template

DATA ARTICLE TEMPLATE V.19 (DECEMBER 2024)

ARTICLE INFORMATION

Article title

A dataset of characterization factors for biodiversity impact assessment in OpenLCA and LCA for Experts

Authors

Julian Quandt[1,2,3], Jan Paul Lindner[1,*], Nico Mumm[1,2]

Affiliations

[1] *Institute for Materials Resource Management, Augsburg University, Am Technologiezentrum 8, 86159 Augsburg*

[2] *corsus – corporate sustainability GmbH, Großneumarkt 50, 20459 Hamburg*

[3] *corsus research gUG, Großneumarkt 50, 20459 Hamburg*

Corresponding author's email address and Twitter handle

jan.paul.lindner@uni-a.de

Keywords

life cycle impact assessment; life cycle assessment; environmental sustainability assessment; LCA software

Abstract

The accelerating loss of biodiversity and ongoing ecosystem degradation rank among the most pressing global challenges today. Life Cycle Assessment (LCA) has emerged as a pivotal tool for evaluating the environmental sustainability of production systems; however, the integration of biodiversity impact assessments into LCA studies remains constrained by significant data gaps, limited spatial resolution, and methodological complexity. This dataset addresses these challenges by providing and integrating ready-to-use characterization factors for biodiversity impact assessment in current LCA software packages.

Characterization factors (CF) were calculated for land occupation flows of three LCA databases (Agribalyse 3.1.1, Ecoinvent 3.10, and Sphera LCA For Experts) following the Biodiversity Value Increment (BVI) method. The CF are applicable at global and country level, considering both land-use intensity and location. The integration into current LCA Software packages (OpenLCA 2.1.0 and Sphera LCA For Experts), enhances accessibility for LCA practitioners, supporting more comprehensive evaluations especially in terms of biodiversity impact assessments.

Data in Brief
Open access
Article template

SPECIFICATIONS TABLE

Subject	Earth & Environmental Sciences
Specific subject area	Dataset of characterization factors for biodiversity impact assessment in OpenLCA and LCA for Experts
Type of data	Table (.xlsx format and .csv format); OpenLCA Impact category (.zip format, JSON-LD format)
Data collection	Characterization factors were calculated in Excel based on the default naturalness levels provided by Fehrenbach et al. (2019) for the land use flows endorsed by the EU JRC [3]. As described by Lindner et al. (2020), the biodiversity value is derived from the hemeroby level, upon which the characterization factor is subsequently calculated [6]. The occupation flow list was collected from Agribalyse 3.1.1, Ecoinvent 3.10 and the Sphera LCA For Experts database. The occupation flow list follows a tiered approach, with descriptions ranging from very generic to more specific, e.g., from "arable" to "arable, non-irrigated, monotone-intensive". Various levels of fertilization and tillage are implicitly included within these categories. The spatial resolution is limited to country and global level, meaning that characterization factors apply to, for example, "occupation, arable, non-irrigated, monotone-intensive, Brazil". Each characterization factor refers to 1 m² of annual land occupation and accounts for both the intensity level of land use and its geographic location, as far as these are made explicit in the flow name. The BVI characterization factors were implemented as a new impact assessment category within OpenLCA 2.1.0 and Sphera LCA For Experts. From this system, the method can be readily applied by LCA practitioners, including those without specific expertise in biodiversity assessments.
Data source location	Institution: Institute for Materials Resource Management, University of Augsburg, Germany
Data accessibility	Repository name: Zenodo Data identification number: 10.5281/zenodo.14907019
Related research article	none

Data in Brief
Open access
Article template

VALUE OF THE DATA

- The dataset can be readily used and enables an easy-to-use implementation of a biodiversity impact assessment category, ensuring compatibility with current LCA software packages.
- Biodiversity impact assessments can be utilized without high data demands, even in complex LCA models, making the method practical and efficient.
- The characterization factors can be directly applied to both existing and newly developed LCA models without requiring modifications to workflows or model structures.
- The dataset is available in multiple formats, facilitating convenient integration into OpenLCA and LCA for Experts, ensuring compatibility across different tools.
- Dedicated conversion plugins for OpenLCA allow format transformation, enabling seamless integration with software such as SimaPro.
- The method is replicable, ensuring future updates and improvements while maintaining data consistency and applicability.

BACKGROUND

The accelerating loss of biodiversity and ongoing ecosystem degradation are among the most pressing global challenges confronting humanity today [8]. Life Cycle Assessment (LCA) has become an essential tool for evaluating the environmental sustainability of production systems [1]. Various models and methodologies have been developed to quantify biodiversity-related impacts within global supply chains. However, despite these advancements, biodiversity integration in LCA remains limited. While numerous academic case studies have contributed to the development of biodiversity impact assessment in LCA, no universally accepted methodology has been established. The main challenges hindering widespread adoption include limited data availability, restricted spatial resolution and high complexity in application [5].

One method, that is appreciated by various stakeholders, is the Biodiversity Value Increment (BVI) method developed by Lindner et al. [5, 6].

This study presents a practical approach to overcoming key barriers faced by LCA practitioners when evaluating biodiversity impacts in global supply chain using this method. By offering ready-to-use characterization factors, this work facilitates the integration of biodiversity assessments into LCA models, enhancing their applicability and consistency.

DATA DESCRIPTION

The characterization factors are provided in several formats. A way of integrating the BVI Generic method in OpenLCA is to import it as an impact category (File: *BVI_Gen_OpenLCA_v1_1_02_2025.zip).*

EF 3.1 Method (incl BVI v1_1)_Agribalyse.zip and *EF 3.1 Method (incl BVI v1_1)_ecoinvent.zip* provide a version of the EF3.1 impact assessment method for Agribalyse/ecoinvent with integrated BVI generic impact assessment category. To import an impact category or an impact method in OpenLCA this manual can be followed: https://greendelta.github.io/openLCA2-manual/lcia_methods/importing_lcia_methods.html.

Data in Brief
Open access
Article template

Please note: The BVI-Method in the above-mentioned version of the EF3.1 impact assessment method is not considered when calculating the single score based on EF3.1.

The *CF_BVI_Gen_v1_1_02_2025.xlsx* includes the excel version of the characterization factors for Sphera LCA For Experts and for OpenLCA. The sheet *LCA_for_Experts_BVI_Gen* can be used to copy the characterization factors in Sphera LCA For Experts. The sheet *OpenLCA_BVI_Gen* can be used to copy the characterization factors in Open LCA. Instructions on how to create a new impact assessment category in OpenLCA can be found here: https://greendelta.github.io/openLCA2-manual/lcia_methods/creating_new_impact_assessment_method.html

CF_BVI_Gen_LCA_4_Experts_v1_1_02_2025.csv and *CF_BVI_Gen_OpenLCA_v1_1_02_2025.csv* are the csv-versions of the excel file.

EXPERIMENTAL DESIGN, MATERIALS AND METHODS

The dataset was compiled by mapping elementary terrestrial occupation flows from the Sphera LCA For Experts database, Ecoinvent 3.10 database [9], and Agribalyse 3.1.1 database [4] to their respective hemeroby values. These values were assigned to all occupation flows within the databases based on generic hemeroby values building on previous work by Fehrenbach et al. (2019) and the LC.biodiv.IA project [3,6]. The resulting characterization factors are linked to specific occupation flows, such as “occupation, arable, non-irrigated, monotone-intensive, Brazil”, thereby incorporating both land-use intensity and geographical location into the assessment.

Depending on its naturalness level, each occupation flow was assigned a hemeroby value ranging from one to seven. For instance, the occupation flow “arable, non-irrigated, monotone-intensive, Brazil” received a hemeroby value of six. In conjunction with the corresponding ecoregion factor (e.g. Brazil), this value was used to compute the characterization factor following the methodology outlined in [6]. To calculate the characterization factors the following equation was used:

$$CF_{i,k} = EF_k * (1 - \left(1.017626088 * \left(1 - e^{-4.055847776*\left(\frac{7}{6} - \frac{Hem_i}{6}\right)}\right)\right))$$

With EF_k representing the ecoregion factor in country *k*. For occupation flows, which are not regionalized, the global average ecoregion factor EF_{GLO} =7.675 was used. Hem_i is the hemeroby value corresponding to the land use occupation flow *i*.

The characterization factors refer to 1 m² of annual land occupation. The BVI value is calculated by multiplying the CF with the land occupation of the corresponding land occupation flow as it is done with the inclusion of the impact category in the LCA-software. The resulting unit is BVIm²a.

Data in Brief
Open access
Article template

LIMITATIONS

These characterization factors are derived from the naturalness assessment of occupation flows. While this approach enables biodiversity impact assessments, it is subject to certain limitations:

- Only occupation flows are currently considered, while transformation flows remain excluded. However, future methodological developments may facilitate their integration.
- The spatial resolution is restricted to the national level, limiting the granularity of regional biodiversity assessments.

ETHICS STATEMENT

All authors have read and followed the ethical requirements for publication in Data in Brief and confirm that the current work does not involve human subjects, animal experiments, or any data collected from social media platforms.

CRediT AUTHOR STATEMENT

Julian Quandt: Conceptualization, Methodology, Data curation, Writing, Original draft preparation, Reviewing and Editing. **Jan Paul Lindner:** Conceptualization, Methodology, Data curation, Reviewing and Editing, Funding acquisition. **Nico Mumm**: Methodology, Reviewing and Editing

ACKNOWLEDGEMENTS

This work was conducted as part of the BioVal project, funded by the german federal ministry of education and research (Grant No.: 01UT2110C). The authors are grateful for the support.

DECLARATION OF COMPETING INTERESTS

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

REFERENCES

[1] Crenna, E., Marques, A., La Notte, A., & Sala, S. (2020). Biodiversity Assessment of Value Chains: State of the Art and Emerging Challenges. Environmental Science & Technology, XXXX. https://doi.org/10.1021/acs.est.9b05153

[2] Fehrenbach H, Grahl B, Giegrich J, Busch M. 2015. Hemeroby as an impact category indicator for the integration of land use into life cycle (impact) assessment. The International Journal of Life Cycle Assessment, 20, 1511-1527.

[3] Fehrenbach H, Rettenmaier N, Reinhardt G, Busch M. 2019. Festlegung des Indikators für die Bilanzierung der Ressource Fläche bzw. von Naturraum in Ökobilanzen. ifeu Paper 02/2019, Heidelberg, Germany.

[4] Koch, P., Salou, T., Asselin-Balençon, Broekema, R., Teulon, H., Gastaldi, G., Houssier, J., Moutia, A., Rousseau, V., Wermeille, A., Colomb, V., Auberger, J., Cornelus, M., Ceccaldi, M., Doucet,

M., Vasselon, H., & Wilfart, A. (2024). *AGRIBALYSE® versions 3.1 3.1.1* [Dataset]. Recherche Data Gouv. https://doi.org/10.57745/B5DTRR

[5] Lindner JP, Fehrenbach H, Winter L, Bloemer J, Knuepffer E. 2019. Valuing biodiversity in life cycle impact assessment. Sustainability, 11(20), 5628.

[6] Lindner, J. P., Fehrenbach, H., Winter, L., Bischoff, M., Blömer, J., & Knüpffer, E. (2020). Biodiversität in Ökobilanzen. Weiterentwicklung und vergleichende Studien (575; BfN Skripten). Bundesamt für Naturschutz. https://doi.org/10.19217/skr575

[7] Lindner JP, Koch P, Fehrenbach H, Buerck S. 2022. Bringing the Biodiversity Value Increment method to Agribalyse. ADEME, Angers, France.

[8] WEF. (2024). The Global Risks Report 2024. World Economic Forum. https://www.weforum.org/publications/global-risks-report-2024.

[9] Wernet, G., Bauer, C., Steubing, B., Reinhard, J., Moreno-Ruiz, E., & Weidema, B. (2016). The ecoinvent database version 3 (part I): Overview and methodology. *The International Journal of Life Cycle Assessment*, *21*(9), 1218–1230. https://doi.org/10.1007/s11367-016-1087-8