Soca v.2 add-on – Adding social impact information to ecoinvent

Description of methodology to map social impact information from PSILCA v3 to ecoinvent v. 3.7.1

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GreenDelta GmbH,

gd@greendelta.com

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1 Background and motivation

This document presents an update to the social impact add on, the "soca database", created as an extension of the ecoinvent v3.7.1 database which in turn was released in December 2020.

ecoinvent is the internationally recognised LCA database with users worldwide, developed by the ecoinvent center in Zurich, Switzerland[1]. ecoinvent provides comprehensive life cycle inventory data on energy supply, resource extraction, material supply, chemicals, metals, agriculture, waste management services, and transport services. Each data set is provided as a unit process and aggregated LCI results.

In 2020, the ecoinvent centre launched ecoinvent v.3.7.1, containing essential updates and additions. In the released version, ecoinvent contains data about resource use, and emissions, used for calculating environmental impacts, and information about costs of products, to be used in a life cycle costing context, for the economic assessment. To carry out an entire sustainability assessment, including environmental, economic, and social impacts, only the last part is missing. Soca was developed to fill this gap, to add social information to ecoinvent v.3.7.1 to combine Social and Environmental Life Cycle Assessment (S-LCA, E-LCA) and Life Cycle Costing (LCC) in one single database. At the moment, soca is available for openLCA.

2 Methodology

Since about five years, GreenDelta has developed PSILCA, a full, comprehensive, and transparent database for social LCA. Meanwhile, version 3 is released[2]. PSILCA aims to cover the whole world economy, per country and sector, and is meant for social and socio-economic assessment alone.

The PSILCA v3 database is taken to "extract" the information for soca.

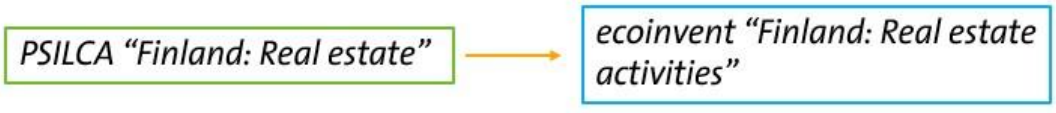
These social aspects and effects are assigned to every activity/ process in ecoinvent v.3.7.1 of all system models (APOS, cut-off, and consequential). Exceptions are market processes and activities used for database administration and modeling. As for the "traditional" version of PSILCA, the social impacts are risk-assessed, i.e., based on indicator results for a given process, the risk-level of a social impact is determined, and then the worker hours are added to the risk-class. The exact procedure and methodology are explained in the following.

2.1 Data mapping

To assign social data from PSILCA to ecoinvent, the categories of ecoinvent processes (for specific countries and regions) were mapped with the country-specific sectors (CSS) of PSILCA. As a result, all processes and products within a country or region belonging to the same category receive the same social information.

Since the regional structure in PSILCA differs from the one in ecoinvent, different mapping cases arise. Therefore, the following steps and rules were applied to map the data:

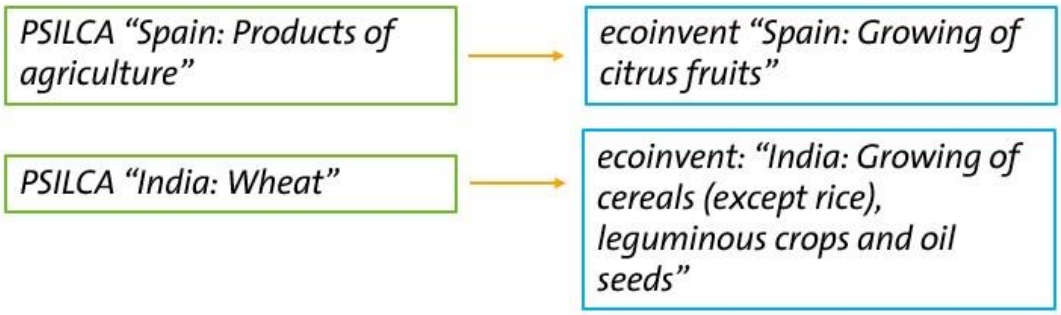
a) Locations of ecoinvent process and PSILCA sector are identical:
   a. If a process category for a specific country in ecoinvent corresponds to a CSS in PSILCA, social information is mapped directly, without any modification.



   b. If there is no corresponding CSS in PSILCA for a process' category-country-combination in ecoinvent, social information is interpolated or extrapolated from a more general or detailed sector, without additional modification.

[1] Ecoinvent for openLCA is available here: https://nexus.openlca.org/database/ecoinvent; ecoinvent's original site and data: https://www.ecoinvent.org/

[2] https://nexus.openlca.org/database/PSILCA, www.psilca.net



b) Location of ecoinvent process is a sub-region:
    a. If the location of an ecoinvent process is a sub-region (such as *China, Shandong (*山东*)*, or *Canada, Ontario*), it is mapped to matching sectors of the respective country in PSILCA (i.e., China, Canada). The sector mapping is identical to the approach described in a).

c) The location of the process is a trans-national region.
    a. In case the location of a process is a macro- or trans-national region (e.g., *Al producing Area; Asia, without China and GCC*; or *Europe*), in a first step, corresponding countries of PSILCA are assigned to these regions. Then, all the mapped countries are combined with the respective category of the region, and these combinations are mapped with the best matching PSILCA CSS. Finally, a non-weighted average is calculated across all the mapped CSS from PSILCA and assigned to the ecoinvent category.
    b. All PSILCA countries are combined with the belonging categories and mapped to the PSILCA CSS for activities with global locations. After that, a non-weighted average is calculated and applied to the ecoinvent processes. This approach implicates that the social information for *global* processes can encompass a broader range of country data than the industrial information in ecoinvent because PSILCA includes more countries than the ecoinvent database. However, this method was selected to stick to the overall PSILCA approach.

d) *Rest-of-World* (ROW) is understood – as in ecoinvent – as *Global* except for the locations that already have individual values for the same product or category. Hence, categories with the location *ROW* are assigned to all PSILCA countries except those already existing as individual country-category-combinations. The remaining combinations are then mapped with the best matching CSS of PSILCA, and the average is calculated.

    This approach differs slightly from the ecoinvent approach, but it was selected to ensure consistency among the social information.

After country and sector mapping, all indicator values are risk-assessed. The risk evaluation of the raw indicator values (including averages) is based on the same schemes and ranges as PSILCA.

2.2 Activity variable

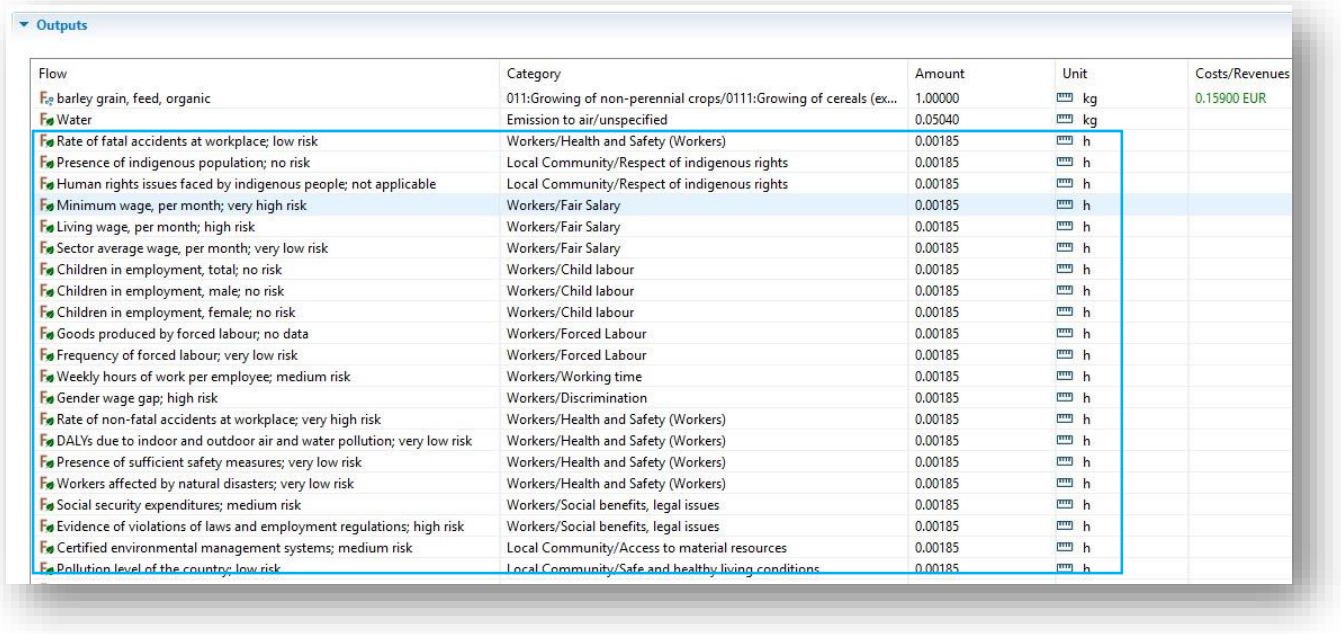
To describe the relevance of the social impacts caused by a process in a life cycle, so-called activity variables are necessary (Norris 2006). The activity variable is the measure of a process activity which can be related to process output (see UNEP/SETAC 2009, p. 98). In PSILCA, worker hours are selected for all indicators. This variable determines the working time (in person-hours) required to produce the reference product.

To calculate the working time for each process in ecoinvent, first of all, the values for working hours per USD output from PSILCA are mapped to the corresponding ecoinvent processes. The mapping procedure is equivalent to the method described in chapter 2.1. Processes with transnational or global locations receive an average overall working time of the mapped CSS.

In a second step, these assigned values are multiplied with the cost for the reference product provided in ecoinvent. It has to be considered that these costs are independent of the country and of the specific technology, i.e., global average values were taken. This calculation, of course, distorts the values of working time.

For some ecoinvent processes – mainly waste material and their disposal – no costs are specified. For these processes, parameters for working hours were defined, which the user can change individually. These parameters are determined per unit of the processes because it is assumed that a broadly similar working time is required to produce the same amount (e.g., 1 kg or 1 km) of different products. Since waste material and disposals (for which the parameters are relevant) should not require long working hours in general, the parameters are calculated as the quintiles (=quantile $Q_{0.2}$) of the set of worker hour values of all products with the same unit.

Figure 1 shows a process with some social effects measured by its specific working time.

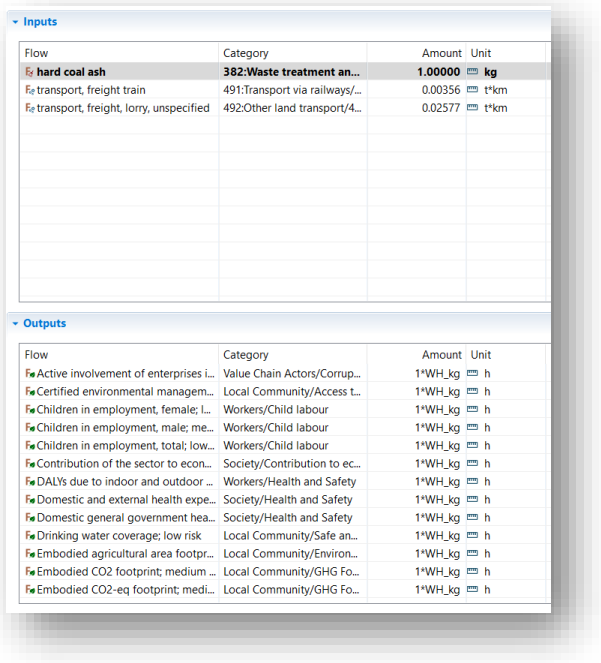


Outputs

Flow	Category	Amount	Unit	Costs/Revenues
barley grain, feed, organic	011:Growing of non-perennial crops/0111:Growing of cereals (ex...	1.00000	kg	0.15900 EUR
Water	Emission to air/unspecified	0.05040	kg	
Rate of fatal accidents at workplace; low risk	Workers/Health and Safety (Workers)	0.00185	h	
Presence of indigenous population; no risk	Local Community/Respect of indigenous rights	0.00185	h	
Human rights issues faced by indigenous people; not applicable	Local Community/Respect of indigenous rights	0.00185	h	
Minimum wage, per month; very high risk	Workers/Fair Salary	0.00185	h	
Living wage, per month; high risk	Workers/Fair Salary	0.00185	h	
Sector average wage, per month; very low risk	Workers/Fair Salary	0.00185	h	
Children in employment, total; no risk	Workers/Child labour	0.00185	h	
Children in employment, male; no risk	Workers/Child labour	0.00185	h	
Children in employment, female; no risk	Workers/Child labour	0.00185	h	
Goods produced by forced labour; no data	Workers/Forced Labour	0.00185	h	
Frequency of forced labour; very low risk	Workers/Forced Labour	0.00185	h	
Weekly hours of work per employee; medium risk	Workers/Working time	0.00185	h	
Gender wage gap; high risk	Workers/Discrimination	0.00185	h	
Rate of non-fatal accidents at workplace; very high risk	Workers/Health and Safety (Workers)	0.00185	h	
DALYs due to indoor and outdoor air and water pollution; very low risk	Workers/Health and Safety (Workers)	0.00185	h	
Presence of sufficient safety measures; very low risk	Workers/Health and Safety (Workers)	0.00185	h	
Workers affected by natural disasters; very low risk	Workers/Health and Safety (Workers)	0.00185	h	
Social security expenditures; medium risk	Workers/Social benefits, legal issues	0.00185	h	
Evidence of violations of laws and employment regulations; high risk	Workers/Social benefits, legal issues	0.00185	h	
Certified environmental management systems; medium risk	Local Community/Access to material resources	0.00185	h	
Pollution level of the country; low risk	Local Community/Safe and healthy living conditions	0.00185	h	

Figure 1: Selected outputs of a sample process with working hours

Figure 2 shows a process with the working time determined by a parameter which in turn is defined as shown in Figure 3.



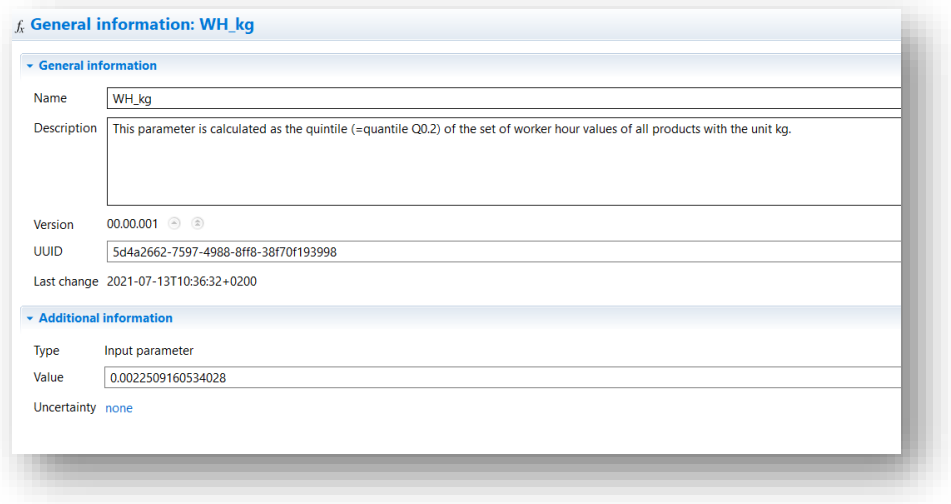
Inputs

Flow	Category	Amount	Unit
hard coal ash	**382:Waste treatment an...**	**1.00000**	**kg**
transport, freight train	491:Transport via railways/...	0.00356	t*km
transport, freight, lorry, unspecified	492:Other land transport/4...	0.02577	t*km

Outputs

Flow	Category	Amount	Unit
Active involvement of enterprises i...	Value Chain Actors/Corrup...	1*WH_kg	h
Certified environmental managem...	Local Community/Access t...	1*WH_kg	h
Children in employment, female; l...	Workers/Child labour	1*WH_kg	h
Children in employment, male; me...	Workers/Child labour	1*WH_kg	h
Children in employment, total; low...	Workers/Child labour	1*WH_kg	h
Contribution of the sector to econ...	Society/Contribution to ec...	1*WH_kg	h
DALYs due to indoor and outdoor ...	Workers/Health and Safety	1*WH_kg	h
Domestic and external health expe...	Society/Health and Safety	1*WH_kg	h
Domestic general government hea...	Society/Health and Safety	1*WH_kg	h
Drinking water coverage; low risk	Local Community/Safe an...	1*WH_kg	h
Embodied agricultural area footpr...	Local Community/Environ...	1*WH_kg	h
Embodied CO2 footprint; medium ...	Local Community/GHG Fo...	1*WH_kg	h
Embodied CO2-eq footprint; medi...	Local Community/GHG Fo...	1*WH_kg	h

Figure 2: Outputs of a sample process with working time defined by a parameter



General information: WH_kg

General information

Name: WH_kg

Description: This parameter is calculated as the quintile (=quantile Q0.2) of the set of worker hour values of all products with the unit kg.

Version: 00.00.001

UUID: 5d4a2662-7597-4988-8ff8-38f70f193998

Last change: 2021-07-13T10:36:32+0200

Additional information

Type: Input parameter

Value: 0.0022509160534028

Uncertainty: none

Figure 3. Global parameter for the working time-related kg

2.3 Data quality

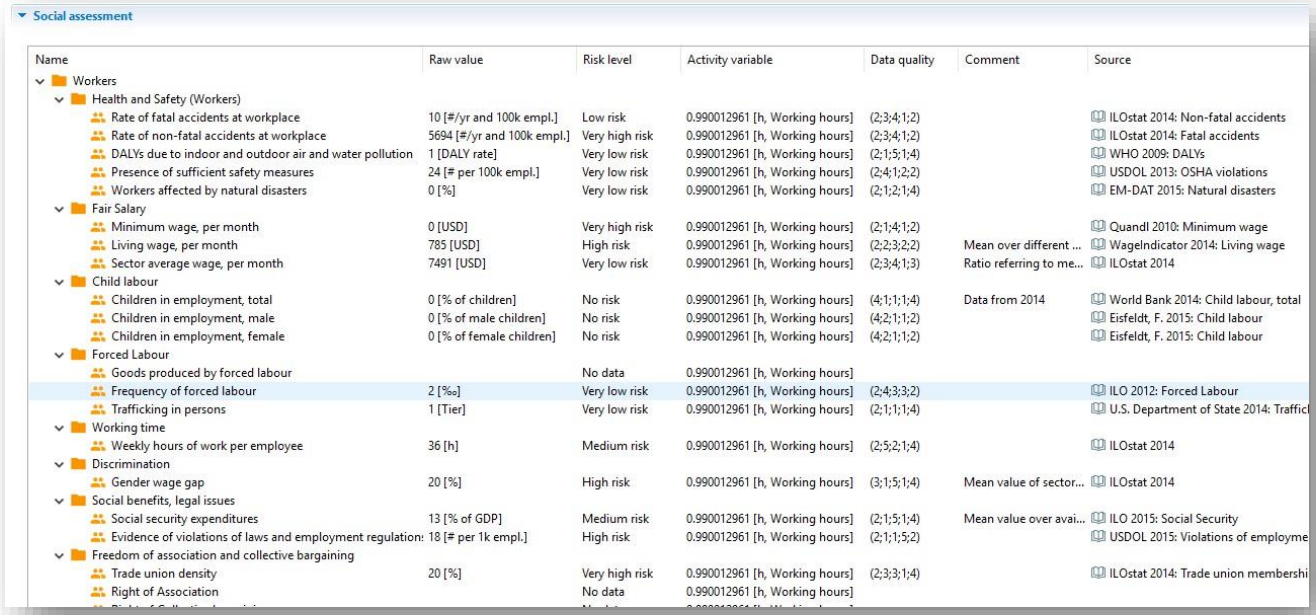
The social aspects in soca also include the evaluation of data quality. Again, the same approach used in PSILCA is followed, where data quality is assessed by a pedigree matrix consisting of five quality indicators measured by 5 scores (see Figure 4).

Score / Indicator	1	2	3	4	5
Reliability of the source(s)	Statistical study, or verified data from primary data collection from several sources	Verified data from primary data collection from one single source or non-verified data from primary sources, or data from recognized secondary sources	Non-verified data partly based on assumptions or data from non-recognized sources	Qualified estimate (e.g. by expert)	Non-qualified estimate or unknown origin
Completeness conformance	Complete data for country-specific sector/ country	Representative selection of country-specific sector / country	Non-representative selection, low bias	Non-representative selection, unknown bias	Single data point / completeness unknown
Temporal conformance	Less than 1 year of difference to the time period of the dataset	Less than 2 years of difference to the time period of the dataset	Less than 3 years of difference to the time period of the dataset	Less than 5 years of difference to the time period of the dataset	Age of data unknown or data with more than 5 years of difference to the time period of the dataset
Geographical conformance	Data from same geography (country)	Country with similar conditions or average of countries with slightly different conditions	Average of countries with different conditions, geography under study included, with large share, or country with slightly different conditions	Average of countries with different conditions, geography under study included, with small share, or not included	Data from unknown or distinctly different regions
Further technical conformance	Data from same technology (sector)	Data from similar sector, e.g. within the same sector hierarchy, or average of sectors with similar technology	Data from slightly different sector, or average of different sectors, sector under study included, with large share	Average of different sectors, sector under study included, with small share, or not included	Data with unknown technology / sector or from distinctly different sector

Figure 4: Pedigree matrix for data quality assessment

The values for the *reliability of sources, Temporal* and *Completeness conformance* were taken over from the original data in PSILCA. Regarding the assessment of *Geographical* and *Technical conformance* of the datasets, the specific mapping and attribution procedures between PSILCA and ecoinvent were taken into consideration. These were compared to the original values of data quality, and the worse score respectively was selected. For example, if geographical conformance for a data point in PSILCA is 1, but an average value over countries is used for the ecoinvent process (hence data quality assessment of 3), the worse score 3 is selected for geographical location conformance of that dataset.

Data quality assessment, indicator, raw values, risk levels, comments, and the source are documented in the social aspects tab of every process (see Figure 5).



Social assessment

Name	Raw value	Risk level	Activity variable	Data quality	Comment	Source
Workers						
Health and Safety (Workers)						
Rate of fatal accidents at workplace	10 [#/yr and 100k empl.]	Low risk	0.990012961 [h, Working hours]	(2;3;4;1;2)		ILOstat 2014: Non-fatal accidents
Rate of non-fatal accidents at workplace	5694 [#/yr and 100k empl.]	Very high risk	0.990012961 [h, Working hours]	(2;3;4;1;2)		ILOstat 2014: Fatal accidents
DALYs due to indoor and outdoor air and water pollution	1 [DALY rate]	Very low risk	0.990012961 [h, Working hours]	(2;1;5;1;4)		WHO 2009: DALYs
Presence of sufficient safety measures	24 [# per 100k empl.]	Very low risk	0.990012961 [h, Working hours]	(2;4;1;2;2)		USDOL 2013: OSHA violations
Workers affected by natural disasters	0 [%]	Very low risk	0.990012961 [h, Working hours]	(2;1;2;1;4)		EM-DAT 2015: Natural disasters
Fair Salary						
Minimum wage, per month	0 [USD]	Very high risk	0.990012961 [h, Working hours]	(2;1;4;1;2)		Quandl 2010: Minimum wage
Living wage, per month	785 [USD]	High risk	0.990012961 [h, Working hours]	(2;2;3;2;2)	Mean over different ...	WageIndicator 2014: Living wage
Sector average wage, per month	7491 [USD]	Very low risk	0.990012961 [h, Working hours]	(2;3;4;1;3)	Ratio referring to me...	ILOstat 2014
Child labour						
Children in employment, total	0 [% of children]	No risk	0.990012961 [h, Working hours]	(4;1;1;1;4)	Data from 2014	World Bank 2014: Child labour, total
Children in employment, male	0 [% of male children]	No risk	0.990012961 [h, Working hours]	(4;2;1;1;2)		Eisfeldt, F. 2015: Child labour
Children in employment, female	0 [% of female children]	No risk	0.990012961 [h, Working hours]	(4;2;1;1;2)		Eisfeldt, F. 2015: Child labour
Forced Labour						
Goods produced by forced labour		No data	0.990012961 [h, Working hours]			
Frequency of forced labour	2 [‰]	Very low risk	0.990012961 [h, Working hours]	(2;4;3;3;2)		ILO 2012: Forced Labour
Trafficking in persons	1 [Tier]	Very low risk	0.990012961 [h, Working hours]	(2;1;1;1;4)		U.S. Department of State 2014: Traffic
Working time						
Weekly hours of work per employee	36 [h]	Medium risk	0.990012961 [h, Working hours]	(2;5;2;1;4)		ILOstat 2014
Discrimination						
Gender wage gap	20 [%]	High risk	0.990012961 [h, Working hours]	(3;1;5;1;4)	Mean value of sector...	ILOstat 2014
Social benefits, legal issues						
Social security expenditures	13 [% of GDP]	Medium risk	0.990012961 [h, Working hours]	(2;1;5;1;4)	Mean value over avai...	ILO 2015: Social Security
Evidence of violations of laws and employment regulation:	18 [# per 1k empl.]	High risk	0.990012961 [h, Working hours]	(2;1;1;5;2)		USDOL 2015: Violations of employme
Freedom of association and collective bargaining						
Trade union density	20 [%]	Very high risk	0.990012961 [h, Working hours]	(2;3;3;1;4)		ILOstat 2014: Trade union membershi
Right of Association		No data	0.990012961 [h, Working hours]			

Figure 5: Social aspects of a selected process

2.4 Impact Assessment

For calculating social impacts for a specific product system, the impact assessment method from PSILCA is provided. Since social impact assessment is still investigated, and no generally accepted method has been developed so far, the so-called "Social Impacts Weighting Method" is rather rudimentary, with typically impact categories corresponding to one indicator. Only proxy indicators, e.g., "Living wage, per month," are combined with other indicators into one impact category (see Figure 6 and Figure 7).

Impact categories

Name	Description	Reference unit
Anti-competitive behaviour or violation of anti-trust and monopoly legislation		AC med risk hours
Association and bargaining rights		ACB med risk hours
Biomass consumption		BM med risk hours
Certified environmental management system		CMS med risk hours
Child Labour, female		CL med risk hours
Child Labour, male		CL med risk hours
Child Labour, total		CL med risk hours
Corruption		C med risk hours
DALYs due to indoor and outdoor air and water pollution		DALY med risk hours
Drinking water coverage		DW med risk hours
Education		E med risk hours
Fair Salary		FS med risk hours
Fatal accidents		FA med risk hours
Fossil fuel consumption		FF med risk hours
Frequency of forced labour		FL med risk hours
Gender wage gap		GW med risk hours
Goods produced by forced labour		GFL med risk hours
Health expenditure		HE med risk hours
Illiteracy		I med risk hours
Indigenous rights		IR med risk hours
Industrial water depletion		WU med risk hours
International migrant stock		IMS med risk hours
International migrant workers (in the sector/ site)		IMW med risk hours
Minerals consumption		MC med risk hours
Net migration		NM med risk hours

Figure 6: Selected impact categories of the "Social Impacts Weighting Method"

Impact factors

Impact category: Fatal accidents

Flow	Category	Flow property	Unit	Factor	Uncertainty
Rate of fatal accidents at workplace; high risk	Workers/Health and Sa...	Duration	FA med risk hours/h	10.0	none
Rate of fatal accidents at workplace; low risk	Workers/Health and Sa...	Duration	FA med risk hours/h	0.1	none
Rate of fatal accidents at workplace; medium risk	Workers/Health and Sa...	Duration	FA med risk hours/h	1.0	none
Rate of fatal accidents at workplace; no data	Workers/Health and Sa...	Duration	FA med risk hours/h	0.1	none
Rate of fatal accidents at workplace; very high risk	Workers/Health and Sa...	Duration	FA med risk hours/h	100.0	none
Rate of fatal accidents at workplace; very low risk	Workers/Health and Sa...	Duration	FA med risk hours/h	0.01	none

Figure 7: Flows and impact factors belonging to impact category "Fatal accidents"

The reference unit of each impact category is medium-risk hours. So, impact factors are scaled to the medium risk of an indicator. Typically, the impact factors listed in Table 1 are applied.

Table 1: Impact factors for most impact categories

Risk level	Factor
Very low risk	0.01
Low risk	0.1
Medium risk	1
High risk	10
Very high risk	100
No risk	0
No data	0.1

3 Results

With the current version of openLCA (1.11), results can still be provided only separately for social impacts (not in combination with environmental impacts). They are displayed and visualized in the form of charts and tables. The following figures (Figure 8 – 11) show a selection of different forms of result presentation.

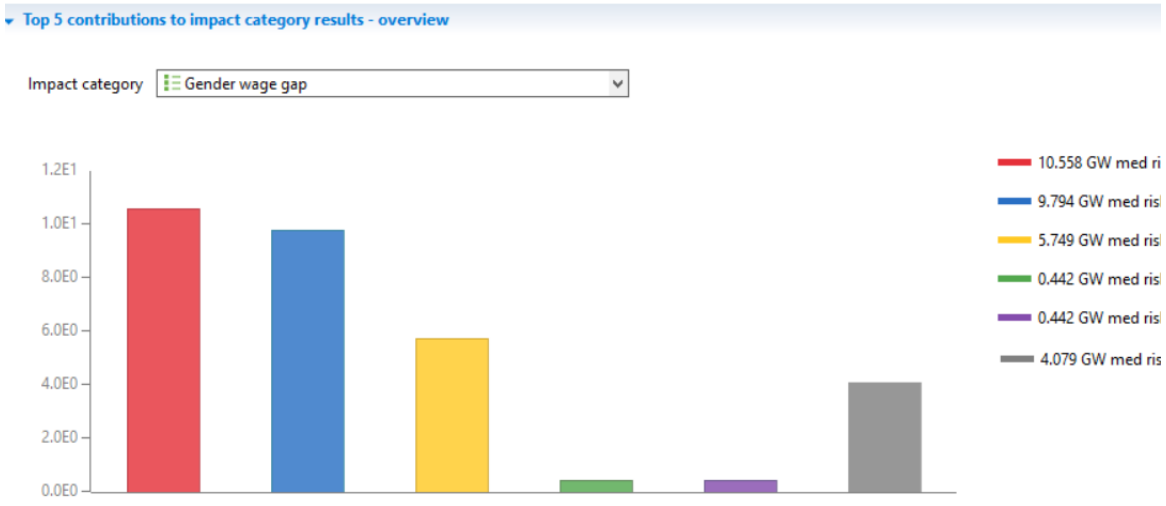
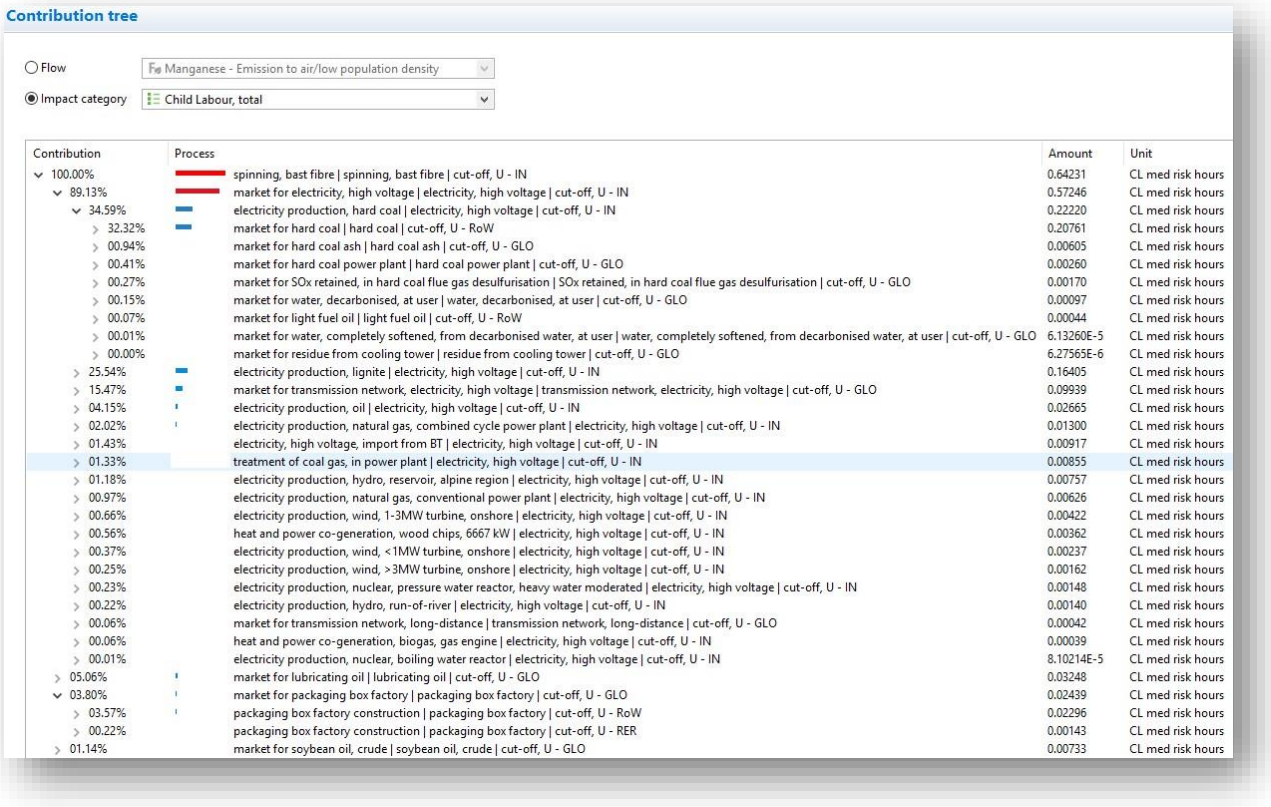
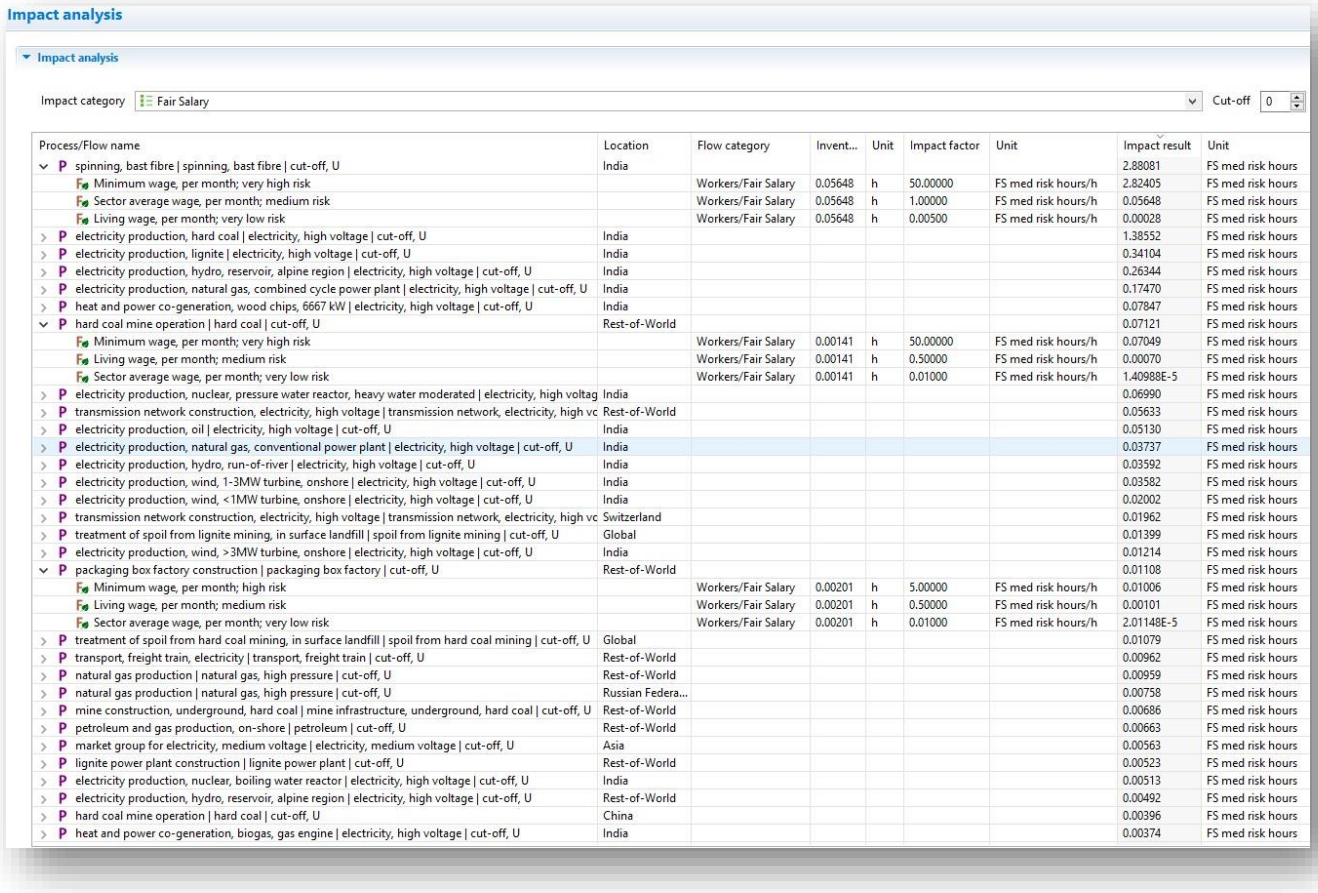


Figure 8: Graph of direct process contributions to impact category results (for Gender wage gap)



Contribution	Process	Amount	Unit
100.00%	spinning, bast fibre | spinning, bast fibre | cut-off, U - IN	0.64231	CL med risk hours
89.13%	market for electricity, high voltage | electricity, high voltage | cut-off, U - IN	0.57246	CL med risk hours
34.59%	electricity production, hard coal | electricity, high voltage | cut-off, U - IN	0.22220	CL med risk hours
32.32%	market for hard coal | hard coal | cut-off, U - RoW	0.20761	CL med risk hours
00.94%	market for hard coal ash | hard coal ash | cut-off, U - GLO	0.00605	CL med risk hours
00.41%	market for hard coal power plant | hard coal power plant | cut-off, U - GLO	0.00260	CL med risk hours
00.27%	market for SOx retained, in hard coal flue gas desulfurisation | SOx retained, in hard coal flue gas desulfurisation | cut-off, U - GLO	0.00170	CL med risk hours
00.15%	market for water, decarbonised, at user | water, decarbonised, at user | cut-off, U - GLO	0.00097	CL med risk hours
00.07%	market for light fuel oil | light fuel oil | cut-off, U - RoW	0.00044	CL med risk hours
00.01%	market for water, completely softened, from decarbonised water, at user | water, completely softened, from decarbonised water, at user | cut-off, U - GLO	6.13260E-5	CL med risk hours
00.00%	market for residue from cooling tower | residue from cooling tower | cut-off, U - GLO	6.27565E-6	CL med risk hours
25.54%	electricity production, lignite | electricity, high voltage | cut-off, U - IN	0.16405	CL med risk hours
15.47%	market for transmission network, electricity, high voltage | transmission network, electricity, high voltage | cut-off, U - GLO	0.09939	CL med risk hours
04.15%	electricity production, oil | electricity, high voltage | cut-off, U - IN	0.02665	CL med risk hours
02.02%	electricity production, natural gas, combined cycle power plant | electricity, high voltage | cut-off, U - IN	0.01300	CL med risk hours
01.43%	electricity, high voltage, import from BT | electricity, high voltage | cut-off, U - IN	0.00917	CL med risk hours
01.33%	treatment of coal gas, in power plant | electricity, high voltage | cut-off, U - IN	0.00855	CL med risk hours
01.18%	electricity production, hydro, reservoir, alpine region | electricity, high voltage | cut-off, U - IN	0.00757	CL med risk hours
00.97%	electricity production, natural gas, conventional power plant | electricity, high voltage | cut-off, U - IN	0.00626	CL med risk hours
00.66%	electricity production, wind, 1-3MW turbine, onshore | electricity, high voltage | cut-off, U - IN	0.00422	CL med risk hours
00.56%	heat and power co-generation, wood chips, 6667 kW | electricity, high voltage | cut-off, U - IN	0.00362	CL med risk hours
00.37%	electricity production, wind, <1MW turbine, onshore | electricity, high voltage | cut-off, U - IN	0.00237	CL med risk hours
00.25%	electricity production, wind, >3MW turbine, onshore | electricity, high voltage | cut-off, U - IN	0.00162	CL med risk hours
00.23%	electricity production, nuclear, pressure water reactor, heavy water moderated | electricity, high voltage | cut-off, U - IN	0.00148	CL med risk hours
00.22%	electricity production, hydro, run-of-river | electricity, high voltage | cut-off, U - IN	0.00140	CL med risk hours
00.06%	market for transmission network, long-distance | transmission network, long-distance | cut-off, U - GLO	0.00042	CL med risk hours
00.06%	heat and power co-generation, biogas, gas engine | electricity, high voltage | cut-off, U - IN	0.00039	CL med risk hours
00.01%	electricity production, nuclear, boiling water reactor | electricity, high voltage | cut-off, U - IN	8.10214E-5	CL med risk hours
05.06%	market for lubricating oil | lubricating oil | cut-off, U - GLO	0.03248	CL med risk hours
03.80%	market for packaging box factory | packaging box factory | cut-off, U - GLO	0.02439	CL med risk hours
03.57%	packaging box factory construction | packaging box factory | cut-off, U - RoW	0.02296	CL med risk hours
00.22%	packaging box factory construction | packaging box factory | cut-off, U - RER	0.00143	CL med risk hours
01.14%	market for soybean oil, crude | soybean oil, crude | cut-off, U - GLO	0.00733	CL med risk hours

Figure 9: Contribution tree (for Child Labour, total)



Process/Flow name	Location	Flow category	Invent...	Unit	Impact factor	Unit	Impact result	Unit
spinning, bast fibre | spinning, bast fibre | cut-off, U	India						2.88081	FS med risk hours
Minimum wage, per month; very high risk		Workers/Fair Salary	0.05648	h	50.00000	FS med risk hours/h	2.82405	FS med risk hours
Sector average wage, per month; medium risk		Workers/Fair Salary	0.05648	h	1.00000	FS med risk hours/h	0.05648	FS med risk hours
Living wage, per month; very low risk		Workers/Fair Salary	0.05648	h	0.00500	FS med risk hours/h	0.00028	FS med risk hours
electricity production, hard coal | electricity, high voltage | cut-off, U	India						1.38552	FS med risk hours
electricity production, lignite | electricity, high voltage | cut-off, U	India						0.34104	FS med risk hours
electricity production, hydro, reservoir, alpine region | electricity, high voltage | cut-off, U	India						0.26344	FS med risk hours
electricity production, natural gas, combined cycle power plant | electricity, high voltage | cut-off, U	India						0.17470	FS med risk hours
heat and power co-generation, wood chips, 6667 kW | electricity, high voltage | cut-off, U	India						0.07847	FS med risk hours
hard coal mine operation | hard coal | cut-off, U	Rest-of-World						0.07121	FS med risk hours
Minimum wage, per month; very high risk		Workers/Fair Salary	0.00141	h	50.00000	FS med risk hours/h	0.07049	FS med risk hours
Living wage, per month; medium risk		Workers/Fair Salary	0.00141	h	0.50000	FS med risk hours/h	0.00070	FS med risk hours
Sector average wage, per month; very low risk		Workers/Fair Salary	0.00141	h	0.01000	FS med risk hours/h	1.40988E-5	FS med risk hours
electricity production, nuclear, pressure water reactor, heavy water moderated | electricity, high voltag	India						0.06990	FS med risk hours
transmission network construction, electricity, high voltage | transmission network, electricity, high vc	Rest-of-World						0.05633	FS med risk hours
electricity production, oil | electricity, high voltage | cut-off, U	India						0.05130	FS med risk hours
electricity production, natural gas, conventional power plant | electricity, high voltage | cut-off, U	India						0.03737	FS med risk hours
electricity production, hydro, run-of-river | electricity, high voltage | cut-off, U	India						0.03592	FS med risk hours
electricity production, wind, 1-3MW turbine, onshore | electricity, high voltage | cut-off, U	India						0.03582	FS med risk hours
electricity production, wind, <1MW turbine, onshore | electricity, high voltage | cut-off, U	India						0.02002	FS med risk hours
transmission network construction, electricity, high voltage | transmission network, electricity, high vc	Switzerland						0.01962	FS med risk hours
treatment of spoil from lignite mining, in surface landfill | spoil from lignite mining | cut-off, U	Global						0.01399	FS med risk hours
electricity production, wind, >3MW turbine, onshore | electricity, high voltage | cut-off, U	India						0.01214	FS med risk hours
packaging box factory construction | packaging box factory | cut-off, U	Rest-of-World						0.01108	FS med risk hours
Minimum wage, per month; high risk		Workers/Fair Salary	0.00201	h	5.00000	FS med risk hours/h	0.01006	FS med risk hours
Living wage, per month; medium risk		Workers/Fair Salary	0.00201	h	0.50000	FS med risk hours/h	0.00101	FS med risk hours
Sector average wage, per month; very low risk		Workers/Fair Salary	0.00201	h	0.01000	FS med risk hours/h	2.01148E-5	FS med risk hours
treatment of spoil from hard coal mining, in surface landfill | spoil from hard coal mining | cut-off, U	Global						0.01079	FS med risk hours
transport, freight train, electricity | transport, freight train | cut-off, U	Rest-of-World						0.00962	FS med risk hours
natural gas production | natural gas, high pressure | cut-off, U	Rest-of-World						0.00959	FS med risk hours
natural gas production | natural gas, high pressure | cut-off, U	Russian Federa...						0.00758	FS med risk hours
mine construction, underground, hard coal | mine infrastructure, underground, hard coal | cut-off, U	Rest-of-World						0.00686	FS med risk hours
petroleum and gas production, on-shore | petroleum | cut-off, U	Rest-of-World						0.00663	FS med risk hours
market group for electricity, medium voltage | electricity, medium voltage | cut-off, U	Asia						0.00563	FS med risk hours
lignite power plant construction | lignite power plant | cut-off, U	Rest-of-World						0.00523	FS med risk hours
electricity production, nuclear, boiling water reactor | electricity, high voltage | cut-off, U	India						0.00513	FS med risk hours
electricity production, hydro, reservoir, alpine region | electricity, high voltage | cut-off, U	Rest-of-World						0.00492	FS med risk hours
hard coal mine operation | hard coal | cut-off, U	China						0.00396	FS med risk hours
heat and power co-generation, biogas, gas engine | electricity, high voltage | cut-off, U	India						0.00374	FS med risk hours

Figure 10: Impact analysis (for Fair Salary)

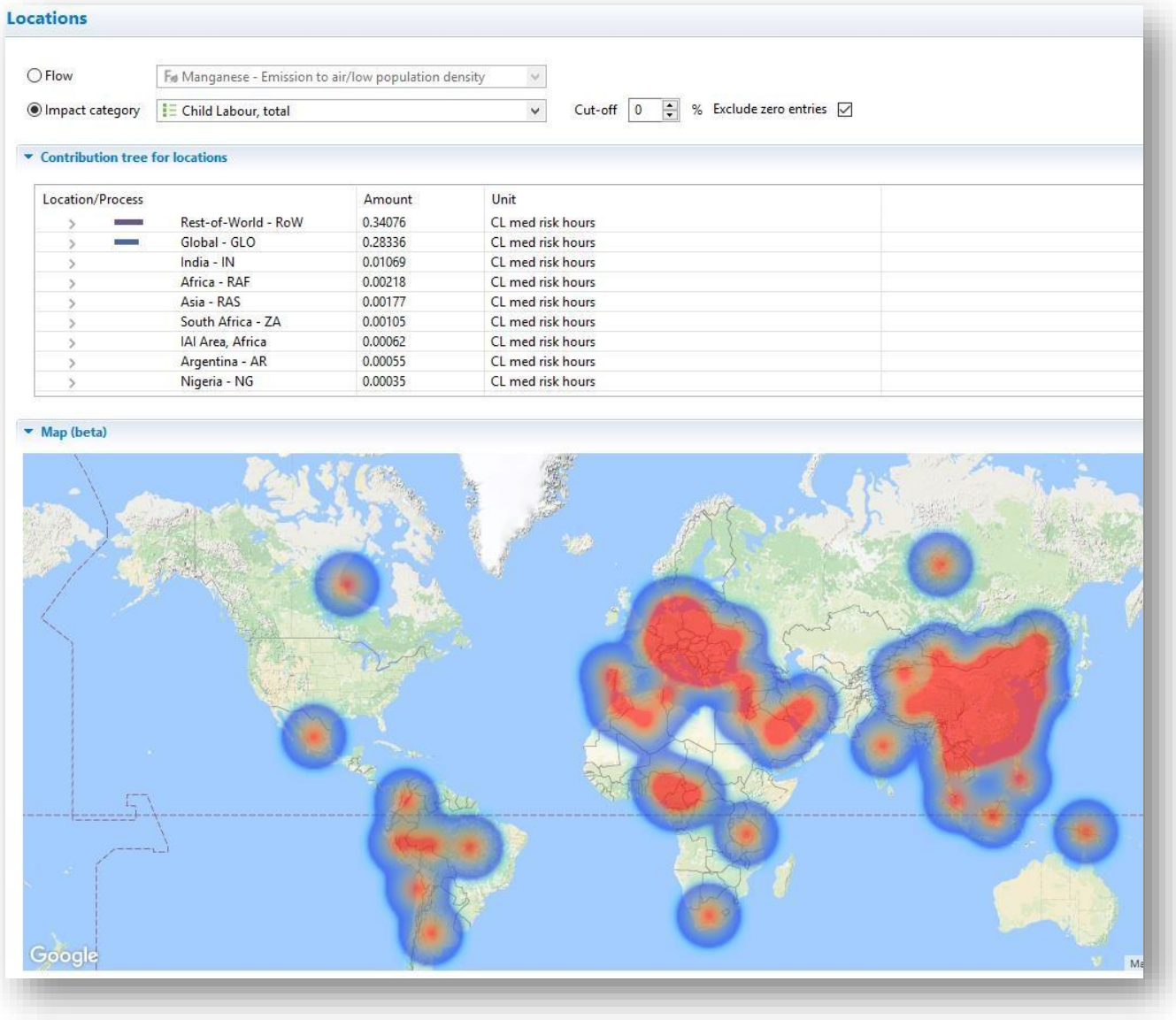


Figure 11: Heat map showing social hotspots (for Child Labour, total)

4 Discussion

Complemented by the inventory data on environmental impacts and the prices for all products, ecoinvent – soca is the first database that combines E-LCA, S-LCA, and LCC. Therefore, it is possible to carry out an entire Life Cycle Sustainability Assessment for a product system using only one database.

However, the applied method still holds inaccuracies and possible result distortions. For example, due to the mapping procedure described in chapter 2.1, all activities and products within a country or region belonging to the same category receive the same social information. This distortion could be refined in future versions. Further, the fact that the costs in ecoinvent are typically global averages, i.e., independent of the country and the specific technology, affects the working hours calculated for an activity on their basis.

Additionally, processes obtain social impacts now because of the mapping, and this mapping is country-specific due to the structure of eora. For example, "operation, computer, desktop, with liquid crystal display, off mode | operation, computer, desktop, with liquid crystal display, off mode | APOS, U". This process is part of the ecoinvent category “Photocopying, document preparation and other specialized office support act” which was

mapped with the PSILCA sector " Education, Health and Other services" for some countries, for example. Therefore, social indicators were also attributed to this process.

Furthermore, it can be interesting to compare social results of soca with other S-LCA databases (PSILCA and Social Hotspots Database (SHDB)), especially because location structures and process connections differ between the databases. For example, while PSILCA and SHDB use Input/Output databases as their bases with monetary connections between the processes, flow properties in ecoinvent are technical. To make a comparison, specific criteria have to be defined to evaluate the reliability and validity of results and comparability. Such a comparison of results is currently being carried out and can be provided soon.

Despite these points, soca is unique in combining environmental, social, and economic aspects in one single database. It is, therefore, a foundation for Life Cycle Sustainability Assessments.

5 References

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