PSILCA v.3

Database documentation

PSILCA

A Product Social Impact Life Cycle Assessment database

Database version 3

Documentation

Version 1.0

June 2020

Kirill Maister, Claudia Di Noi, Andreas Ciroth, Michael Srocka (all GreenDelta)

The documentation is based on the documentation for PSILCA v.2 by F. Eisfeldt and A. Ciroth.

Cover photo by C. Di Noi

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1 Foreword to the 3rd version

This third version of the documentation refers to the third version of PSILCA which comes with some updates and innovations.

Most indicators in PSILCA v3 were updated, i.e. current or better suiting sources and data were used for the assessment. This resulted in more current values and, in some cases, a broader country or sector coverage. For some indicators, data was calculated differently from previous versions, e.g. normalised. Also, the evaluation of risks or the risk levels were adapted for some indicators where considered necessary. All updates and changes regarding version 2 are highlighted after the indicator descriptions.

Further, 14 new indicators were added to the database and are marked as such in Table 1:

- Risk of conflicts
- Violations of mandatory health and safety standards
- Asylum Seekers
- Immigration rate
- Emigration rate
- Domestic and external health expenditure
- Domestic general government health expenditure
- Human rights issues faced by migrants
- Embodied CO2 footprint
- Embodied CO2-eq footprint
- Embodied agricultural area footprint
- Embodied forest area footprint
- Embodied water footprint
- Number of threatened species
- Embodied total value added

The database contains an indicator related to positive impacts: “Contribution of the sector to economic development”, which is assessed by different opportunity levels.

An innovation in PSILCA 3 is the direct impact assessment method which allows to calculate social risks based on the initial values of the indicator without the intermediate layer of working hours. Further explanation is provided in Section 3.7.2.

2 Background and motivation

In a globalized world it is becoming more and more difficult to track products and all their components, and to find out under which conditions they are produced. More and more customers care about all of the impacts the products they purchase leave behind over the entire life cycle of the goods, from production to use to disposal. Hence, growing demand for more transparency along supply chains can be observed, in order to have a choice between more or less sustainable products.

In response to this, a rising number of companies and policy actors are considering extending more traditional footprint or Life Cycle Assessment approaches to cover also social impacts for products, in order to address sustainability more completely. Social impacts over the life cycle are relatively new, with fewer data sources available. Nonetheless, the research field is highly interesting since investigation of social aspects allows to detect potential social risks in product life cycles, but can also reveal positive social impacts “hidden” in product supply chains.

However, a database which contains non-valuated, transparent and comprehensive information about the social impacts of products over their life cycle does not exist yet. It is to some extent more demanding since social data is often of qualitative nature and, therefore, difficult to access, organize and evaluate, and also inherently subjective which calls for more stringent transparency.

This was the motivation to create PSILCA as a new global, consistent database, hopefully useful to assess social impacts of products, along product life cycles.

This text serves to document the structure of the database and the indicators it supports. One important aspect are methodological choices and their implications for using the database.

As is somehow logical from the scope of social data (but not always easy to achieve), emphasis is laid on transparency of the database modelling and data collection efforts.

3 Methods used for creating the database

3.1 A multi-regional input/output database as basis

In order to provide insights into global supply chains, PSILCA uses a multi-regional input/output (MRIO) database, called Eora. For version 3 of PSILCA; the Eora release from 2019 is used[1]. Eora can claim to cover the entire world economy, on an industrial sector basis.

The Eora database is initially developed and maintained by Manfred Lenzen and colleagues (Lenzen et al. 2012, Lenzen et al. 2013, Wiedmann et al. 2013; Eora 2015).

Key features of the Eora database include (Eora 2015):

- 189 individual countries are represented by a total of 14,838 sectors distinguished by so-called entities: industries, commodities, value added/ final demand
- Various environmental indicators covering air pollution, energy use, green-house gas

[1] See https://worldmrio.com/eora/

emissions, water use, Ecological Footprint, and Human Appropriation of Net Primary Productivity

- High-resolution heterogeneous classification, or 26-sector harmonized classification
- Raw data drawn from the UN's System of National Accounts and COMTRADE databases, Eurostat, IDE/JETRO, and numerous national agencies
- Distinction between basic prices and purchasers' prices through 5 mark-ups, and
- Reliability statistics (estimates of standard deviation) for all results

As a consequence, data for around 15,000 sectors and 189 countries is available in PSILCA. For the time being, the time series from Eora are not considered in PSILCA; rather, Eora's latest available year in the 2019 release, namely 2015, is used as reference year for Eora in PSILCA, while 2017 is used as reference year for the social indicators in the database.

The "heterogeneous classification" was selected by Eora developers in order to stick to national sectoral classifications from I-O or supply-use tables, where available. It has the effect that for some countries hundreds of sectors (industries or commodities) are listed, e.g. UK is represented by a total of 1022 industries and commodities, USA by 858 industries and commodities and China by 123 commodities. On the other hand, for almost a third of the countries in Eora, I-O tables were not available or "national sectoral classifications were less detailed than a common ISIC [International Standard Industrial Classification, *remark of author*]-type classification spanning 25 sectors" (Lenzen et al. 2013, p. 25). In these cases, a harmonized 26-sector classification was introduced (see Figure 1). For other countries, sectors can become really detailed; in the UK, e.g., bookbinding is a separate sector (Figure 2).

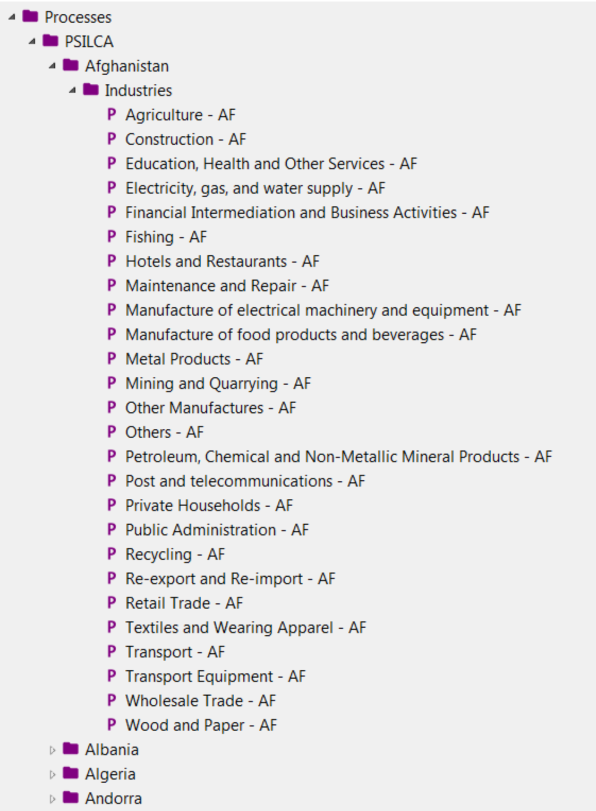

Figure 1: Example of a 26-sector classification in Eora and PSILCA, for Afghanistan, screenshot from openLCA

Figure 2: Example of a classification in Eora and PSILCA, for UK (showing only some of the sectors), screenshot from openLCA

This heterogeneous classification makes sense as it avoids to a large extent to complete sectors where little information is available, which makes the overall information basis more stable. However, this leads to different denominations for the same sectors, Spanish names for sectors in some countries, and typos in the names, in the original Eora database.

For the PSILCA database, these sector names were harmonized across the different countries, translating them to English where necessary, and using common ISIC names where possible. Hence, for example, the sectors “Horeca”, “Lodging; food and beverage serving services” and “Horeca services” are all renamed to “Accommodation and food service activities”.

As an I-O database, Eora uses money flows to link processes.

3.2 Indicators in PSILCA, and their structure

Selecting indicators for a social LCA database is a delicate task for several reasons. Social LCA is still an emerging field and social impacts are not defined by natural laws but depend largely on human perception. Also, the assessment of the indicators is not broadly established but so far, to our knowledge, rather done following a case-by-case approach.

Many larger, recent projects on social LCA literally spent years on selecting and describing a suitable set of indicators, including the ProSuite EU 7FP project (ProSuite 2013), and the PRé roundtable (Fontes, J. et al. 2014); and, of course, also in the UNEP/SETAC working group (UNEP/SETAC 2009) the indicators proposed were a major point of discussion. Nevertheless, the „Guidelines for social life cycle assessment of products” and “The Methodological Sheets for Subcategories in Social Life Cycle Assessment (S-LCA)” (2013) are often taken as basis for these projects, and also the PSILCA database indicators benefit from these ground-breaking publications.

Another important basis for the stakeholders and indicators in PSILCA is the notebook computer study (Ciroth, Franze 2011), which is still one of the most comprehensive studies for social LCA that are published worldwide, and basis for other case studies at GreenDelta. Information collected for these case studies has been used in the database as well.

Since there is not a broadly accepted standard or reference for social indicators, however, a broad set of indicators is collected for and made available in the PSILCA database, to be able to cover many different viewpoints and applications.

Altogether, 69 qualitative and quantitative indicators are provided in the PSILCA database. They are measured in different units such as single values or percentages; some are also qualitative. For several of the latter, also a text is used to describe a situation. The indicators (and sometimes also sub-indicators) are organized in clusters describing 25 social and socio-economic subcategories (topics) inspired by UNEP/SETAC (2009, pp. 48).

The subcategories address four stakeholder categories: workers, local community, society, and value chain actors.

Table 1 shows stakeholders, subcategories and indicators assessed in PSILCA. The definitions, units of measurement, measurement procedure and data sources of each indicator are provided in more detail in chapter 3.

Table 1: Existing (white) and new (green) stakeholders, subcategories and indicators with units of measurement in the PSILCA database

WORKERS	Child labour	Children in employment, male	% of male children ages 7-14
		Children in employment, female	% of female children ages 7-14
		Children in employment, total	% of all children ages 7-14
	Forced labour	Goods produced by forced labour	Number of goods in the sector
		Frequency of forced labour	Cases per 1,000 inhabitants in the country
		Tier placement referring to trafficking in persons	Tier placement
	Fair salary	Living wage, per month	USD
		Minimum wage, per month	USD
		Sector average wage, per month	USD
	Working time	Hours of work per employee, per week	h
	Discrimination	Women in the labour force (total)	% of economically active population
		Women in the sectoral labour force	ratio
		Gender wage gap	%
	Health and Safety	Accident rate at workplace	Cases per 100,000 employees and year
		Fatal accidents at workplace	Cases per 100,000 employees and year
		DALYs due to indoor and outdoor air and water pollution	DALYs per 1,000 inhabitant in the country
		Presence of sufficient safety measures	OSHA cases per 100,000 employees in the sector
		Workers affected by natural disasters	%
	Social benefits, legal issues	Social security expenditures	% of GDP
		Evidence of violations of laws and employment regulations	Violation cases
	Workers´ rights	Trade union density	% of employees organised in trade unions
		Right of Association	score of ordinal 0-3 scale
		Right of Collective bargaining	score of ordinal 0-3 scale
		Right to strike	score of ordinal 0-3 scale
VALUE CHAIN ACTORS	Fair competition	Presence of anti-competitive behaviour or violation of anti-trustand monopoly legislation	Cases per 10,000 employees in the sector
	Corruption	Public sector corruption	Score (Corruption Perceptions Index score of the country)
		Active involvement of enterprises in corruption and bribery	%
	Promoting social responsibility	Membership in an initiative that promotes social responsibility along the supply chain	Number of companies
SOCIETY	Contribution to economic development	Public expenditure on education	% of GDP
		Adult illiteracy rate (15+ years), male	% of male population
		Adult illiteracy rate (15+ years), female	% of female population
		Adult illiteracy rate (15+ years), total	% of total population
		Youth illiteracy rate, male	% of male population, 15-24
		Youth illiteracy rate, female	% of female population, 15-24
		Youth illiteracy rate, total	% of total population, 15-24
	Health and Safety	Health expenditure, total	% of GDP
		Health expenditure, public	% of total health expenditure
		Health expenditure, out-of-pocket	% of total health expenditure
		Health expenditure, external resources	% of total health expenditure
		Domestic and External Health Expenditure	% of total health expenditure
		Domestic General Government Health Expenditure	% of total health expenditure
		Life expectancy at birth	Years
	Prevention and mitigation of conflicts	Risk of conflicts	Score

SOCIETY	Health and Safety	Violations of mandatory health and safety standards	Cases of Violation
		Presence of commissions or institutions to detect violations of standards and protect consumers from health and safety risks	Y/N
		Presence of management measures to assess consumer health and safety	Y/N or #
LOCAL COMMUNITY	Access to material resources	Level of industrial water use (related to total withdrawal)	% of total water withdrawal
		Level of industrial water use (related to renewable water resources)	% of renewable water resources
		Extraction of biomass (related to area)	t/km∞
		Extraction of biomass (related to population)	t/cap
		Extraction of fossil fuels	t/cap
		Extraction of industrial and construction minerals	t/cap
		Extraction of ores	t/cap
		Certified environmental management systems (CMEs)	# CEMs (ISO 14001) in sector per 10,000 employees
	Respect of indigenous rights	Presence of indigenous population	Y/N
		Indigenous People Rights Protection Index	Score
	Safe and healthy living conditions	Pollution level of the country	Index
		Drinking water coverage	% of the population
		Sanitation coverage	% of the population
	Local employment	Unemployment rate in the country	% of the population
	Migration	International migrant workers in the sector	% (of total workers in the sector)
		International Migrant Stock	% (of total population)
		Net migration rate	‰ (= per 1,000 persons)
		Asylum Seekers Rate	% (Asylum Seekers/Total Population)
		Emigration rate	% (of total population)
		Immigration rate	% (of total population)
		Human rights issues faced by migrants	yes/no
	GHG Footprints	Embodied CO_2 footprint	t per $
		Embodied CO_2-eq footprint	
	Environmental Footprints	Embodied agricultural area footprint	ha/$1
		Embodied forest area footprint	ha/$1
		Embodied water footprint	Mm3/$
		Number of threatened species	# species/$1
	Labor Footprints	Embodied value added total	$/$

3.3 Sources, data collection and -refactoring

For the initial version of the database, more than three years of effort were spent on data collection considering a variety of sources. Main sources are statistical agencies such as World Bank (World Bank 2015a), the International Labour Organisation (ILO 2019), World Health Organization (WHO 2017), and United Nations (UN 2017). Also private or governmental databases were taken into account, e.g. the Database on Institutional Characteristics of Trade Unions, Wage Setting, State Intervention and Social Pacts (ICTWSS 2013 by the Amsterdam Institute for Advanced Labour Studies (AIAS)), public records on Environmental Health and Safety (EHS) violations, by company or industry (United States Department of Labor (USDOL) 2014a; EHSToday 2015) etc.. Apart from this, case studies and own investigations were carried out, initially by GreenDelta, to obtain site-specific information. All the sources used are documented in the database.

While some of the indicators can be measured and collected directly, for others, only proxies are available. For example, the indicator “Anti-competitive behaviour or violation of anti-trust and monopoly legislation” is measured by the number of competitions, merger, price fixing cases etc. in the sector. This is, of course, documented.

3.4 Normalisation, extrapolation and attribution of indicator values

3.4.1 Normalisation

Some of the indicator values depend on the size of the sector or economy, some are independent of the size. In analogy to thermodynamics, one could speak of extensive and intensive properties, respectively: for extensive indicators, the value depends on the size of the system (mass, or volume), for intensive indicators, the value is independent of the system size (density for example). In order to make indicator results better comparable across countries and across different sectors, the PSILCA database provides all indicator values as “intensive” values. To achieve this, “extensive” properties are normalized, e.g. by the number of employees in the sector, by its total output, or by the population in the country or region. For example, the indicator “Presence of sufficient safety measures” is measured by the number of accidents, safety and health incidents per 10,000 employees in the sector. This normalisation is, of course, also documented.

3.4.2 Attribution and extrapolation

The need for extrapolation and attribution of indicator values comes from a different level of detail in the data sources. Quite often, the Eora database is more detailed than data in the data source; sometimes, there is more detailed information in the data source available.

Further, for those cases where the Eora database is more detailed, two situations can occur: Raw data is available for only a few sectors of an “Eora country” (i.e. a country existing in the Eora database) or raw data is not available for an Eora country or any of its sectors.

In the following, different approaches and steps to generate data for every country and sector regarding a specific indicator are described. Which approach is finally chosen depends e.g. on the amount of raw data available for each indicator, country, and sector. The selected approach is documented individually per indicator in chapter 3 and also in the data quality assessment (see chapter 2.6).

The cases need to be considered for each indicator separately.

Case 1: for a specific indicator, raw data is available for an “Eora country” and all its sectors

This is the ideal case, no attribution is necessary. Information is entered for the Eora country, directly, without extrapolation or attribution.

Case 2: for a specific indicator, raw data is available for an “Eora country” and for some if its sectors

In this second case, data needs to be “attributed” to the various sectors where no raw data is directly available. This is done in several steps.

Step 1, sector-mapping: First, all country-sector-combinations of Eora are mapped to those from the raw data. All Eora sectors that have a counterpart in the raw data obtain the indicator value from the raw data.

Step 2, inference: Here, again several different situations need to be distinguished.

a) From step 1, indicator values are available for a sector, indicator values for sectors hierarchically below this sector are missing. In short, data for a parent sector is available, data for child sectors is missing. In this case, the child sectors get the value available for the parent sector. Figure 3 shows an example.

Country	Sector	Indicator value	
USA	MANUFACTURE OF DAIRY PRODUCTS	3,25	Original value
USA	Fluid milk and butter manufacturing	3,25	Extrapolated values
USA	Ice cream and frozen dessert manufacturing	3,25	Extrapolated values
USA	Cheese manufacturing	3,25	Extrapolated values

Figure 3: Attribution of the original value from a parent sector to child sectors

b) From step 1, indicator values are available for a sector, indicator values for sectors hierarchically above this sector are missing. In short, data for one or several child sectors is available, data for a parent sector is missing. In this case, in principle the parent sector gets the value available for one specific or more child sectors. The first option is selected if one of the child sectors fits perfectly to the parent sector (Figure 4). However, typically, in this situation several equally relevant child sectors are available, with different values. Therefore, in this case, the average (arithmetical mean) of the child data sets of the next hierarchy level is taken as value for the parent sector (Figure 5).

Country	Sector	Indicator value	
Cyprus	EDUCATION; HEALTH AND OTHER SERVICES	8,62	Extrapolated value
Cyprus	Education	8,62	Original value
Cyprus	Health care		
Cyprus	Nursing homes	7,43	Original value

Figure 4: Attribution of the original value from a child sector to parent sector

c) From step 1, indicator values are available for a sector, indicator values for sectors hierarchically at the same level of this sector are missing. In this case, the average (arithmetical mean) of the sectors on the same hierarchy level is taken (Figure 5).

Country	Sector	Indicator value	Mean value	
Cyprus	EDUCATION; HEALTH AND OTHER SERVICES	8.025		Extrapolated values
Cyprus	Education	8.62		Original values
Cyprus	Health care	8.025	8.025	
Cyprus	Nursing homes	7.43		

Figure 5: Assigning mean value of different sectors to other sectors on the same and higher level

b) and c) have not yet occurred in combination (i.e. sector data is missing for sectors of more than two hierarchy levels). Therefore, a prioritisation was so far not necessary. In principle, b) seems better able to represent results than c). For sectors still remaining without data in a specific country, the average of all other sectors of the same country is taken.

Case 3: for a specific indicator, raw data is not available for an "Eora country"

Also here, several approaches are applied:

a) Values are extrapolated from a similar country (because of geographical proximity or similarity, a similar economic structure or the like).

b) All countries are assigned to groups based on geographical and economical similarities (e.g. South America, Mediterranean region, high income countries, OPEC countries etc.). Mean values are calculated across all countries within each group. Then, a country without an original value gets the mean value of one group where it belongs to (either the one that fits best to the indicator or where the mean value is most reliable).

c) Extending option b, the mean value is calculated over the average of the indicator value of all groups where the country belongs to.

The application of these rules is depending on the indicator and on the data availability; it is documented in each case and is reflected in the data quality assessment.

3.5 Indicator assessment

The indicator assessment in PSILCA assigns an ordinal level to the observed indicator values. These levels and the assessment are indicator dependent. Typically, 6 different levels are distinguished on a negative scale: no risk, very low risk, low risk, medium risk, high risk, and very high risk. For some indicators (e.g. *Respect of indigenous rights*, *Social benefits and legal issues*), additionally or only an opportunity scale is used and planned as the indicator result may reflect a positive social impact. The levels used are high, medium and low opportunity. The first indicator associated with positive impacts, *Contribution of the sector to economic development,* was inserted in PSILCA v2.

In the current version of PSILCA, all indicators are risk-assessed; this makes their values better comparable between different processes, and it accelerates result calculation in software. This follows the idea of indicator assessment for social LCA already used in e.g. Ciroth and Franze 2011, ProSuite 2013, and Fontes, J. et al. 2014[2].

The assignment of risk levels to the indicator values is based on international conventions and standards, labour laws, expert opinions but also own experience and evaluation. Of course, as it is inherent in the nature of social LCA, this risk assessment is to some extent subjective and dependent on cultural and even individual evaluations and conventions. It is, therefore, useful to be able to modify these assignments in case studies. In order to meet this need, the PSILCA database provides the unassessed indicator values as a "control value" as well as the assigned risk levels and the ordinal risk scales of the indicators, as default, proposed assessment. The risk levels can be modified individually to better reflect e.g. specific goal and scope of a study.

Performance reference points and rules are provided for the PSILCA database for each indicator separately, to document the default indicator assessments available in the database. The risk assessment for each indicator is illustrated in chapter 4.

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[2] However, in future versions result calculations will be possible also with the unassessed values, at least for quantitative indicators, in order to assure more accuracy and to leave space for more individual interpretation.

3.6 Data documentation and quality assessment

Transparent data documentation and quality assessment is essential for a comprehensive, very large database with quickly changing, social information, which has the aim to cover the entire world economy. As a consequence, all information about data collection and attribution methods, sources, original and default values such as risk assessment are documented in this manual and/or in the datasets of the database, as available in LCA software[3]. Documentation is provided both on indicator and on process/sector level.

The PSILCA database uses a pedigree matrix for the quality assessment of each indicator (see Table 2). It is based on the pedigree matrix that was introduced to LCA by Weidema and Wesnæs (1996) for quality assurance. The matrix used in the PSILCA database is adapted to social LCA. One indicator is addressing the reliability of the sources; four indicators address the conformance of the data set related to completeness, time, geography, and technology (as far as it has not been covered by time and geography). The indicators are assessed in five scores, from 1 (meaning very good performance) to 5 (meaning very bad performance). This pedigree matrix is based on an initial version proposed in Ciroth et al. 2013A statistical study is understood as a study where a random sampling is used to obtain data for the analysis, and where the sampled data is treated with measures of statistics to retrieve representative values.

Technical and geographical conformance are often related, which was already recognised in the “original” pedigree matrix. Their difference can be explained by the following example. Information is needed for mango production in Vietnam. This information can either be obtained from an aggregation of several different data sets available for Vietnam for slightly similar products (coconut, banana, mango, citrus production), or from aggregating mango production information from several countries (India, Indonesia, Thailand, Brazil). The first aggregation leads to a difference in technical conformance (the different products); the second to a difference in geographical conformance.

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[3] Currently in openLCA, www.openlca.org

Table 2: The pedigree matrix for data quality assessment of social data, used in PSILCA

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

3.7 Activity variable

Activity variables (Norris 2006) are used to describe the relevance of impacts caused by a process in a life cycle. They "*reflect the share of a given activity associated with each unit process*" (UNEP/SETAC 2009, p. 98) and, therefore, quantify the respective social indicators related to the product system.

Currently, the most common activity variable is worker hours, i.e. the time workers spend to produce a certain amount of product in the given process or sector. Strictly speaking, worker hours are only related to the stakeholder workers. Nevertheless, initially, they are applied to all indicators, also those not concerning labour conditions. Other activity variables that better suit the indicators concerning local community, society, value chain actors or consumers are currently being assessed.

3.7.1 Worker hours

In the PSILCA database, worker hours are the basic activity variable. They are related to 1 USD of process (or sector) output. The worker hours were not directly available from an external source, but calculated for the database, as follows:

$$\textbf{Worker hours} = \frac{\textbf{Unit labour costs}}{\textbf{Mean hourly labour cost (per employee)}} \qquad \text{Equation 1}$$

$$\text{Unit labour costs} = \frac{\text{Compensation of employees (in USD per country–specific sector and year)}}{\text{Gross output (in USD per country–sector and year)}}$$

Data for *compensation of employees* was taken from the Eora satellite accounts (Eora 2015). According to the developers of Eora (Moran 2015) this category follows the definitions of United Nations´ System of National Accounts (UN et al. 2009):

"[...] compensation of employees is defined as the total remuneration, in cash or in kind, payable by an enterprise to an employee in return for work done by the latter during the accounting period."

From this definition, it becomes clear that *compensation of employees* consists of two main components:

"a. Wages and salaries payable in cash or in kind;

b. Social insurance contributions payable by employers, which include contributions to social security schemes; actual social contributions to other employment-related social insurance schemes and imputed social contributions to other employment-related social insurance schemes." (ibid.)

These two components, basically the net and the gross salary and related expenditures, are both taken into account in the calculation of the worker hours.

According to UN SNA, *gross output* is equal to the intermediate consumption plus value added of each group of producing unit (industry) (ibid., p. 273). The gross output for all sectors and countries was calculated from Eora, where it can be obtained for all countries and for almost 10,000 sectors. It is available per year; for the calculation, 2011 was taken, the most recent year available in Eora at time of calculation.

Although gross output is available for 10,000 sectors, it is lacking for one third of the country-specific sectors in Eora. In order to obtain data for the remaining sectors, the mean value of unit labour costs over all sectors within the same country was taken.

With these two components, unit labour costs could be obtained. Data on *mean nominal hourly labour cost per employee* are available from the International Labour Organization (ILO 2015a)

"disaggregated by economic activity according to the latest version of the International Standard Industrial Classification of All Economic Activities (ISIC) available for that year, and presented for a selection of categories at the 2-digit level of the classification".

According to ILO´s definition, labour cost

> "*comprises remuneration for work performed, payments in respect of time paid for but not worked, bonuses and gratuities, the cost of food, drink and other payments in kind, cost of workers' housing borne by employers, employers' social security expenditures, cost to the employer for vocational training, welfare services and miscellaneous items, such as transport of workers, work clothes and recruitment, together with taxes regarded as labour cost.*" (ILO 2015a)

This fits to the activity variable and was therefore taken for the calculation. However, data for mean hourly labour cost per employee was not available, from ILO or other sources, uniformly for every country, sector and year. In some cases, and e.g. in contrast to the title of the ILO source[4], cost values were provided per day, week, month or year. This required a calculation of the hourly labour costs using actual daily, monthly, weekly or yearly hours of work per employee mainly taken from ILOstat (ILO 2015a). In some cases, data for the mean labour costs was only available for years before 2011; in these cases, the most recent value available was chosen and extrapolated to 2011 assuming a wage increase of 3% per year.

After that, all given values were converted to USD, using a currency converter (Oanda 2015), usually with the currency exchange rate from 31.12.2011. In cases where values were quite old and countries witnessed high inflation rates, currency exchange rates from the respective year were chosen, e.g. in the case of Venezuela.

In a last step, mean hourly labour cost per employee, by country and sector, were mapped to Eora sectors. Eora sectors without an equivalent in the “Mean hourly labour cost per employee”-table were assigned a mean value (arithmetic mean) of hourly labour cost over all the other sectors within the country. For countries without any data on hourly labour cost, values from a similar country were used. The similarity was based on the regional classification of ILO (ILO 2012). Furthermore, information on mean monthly salaries, the gross domestic product per inhabitant, and also the number of sectors in Eora were taken into account to identify similar countries and sectors as realistically as possible.

After this procedure, worker hours are available for every country and every sector of Eora. Figure 6 shows the results, for all the 15,000 sectors in PSILCA, ordered by amount.

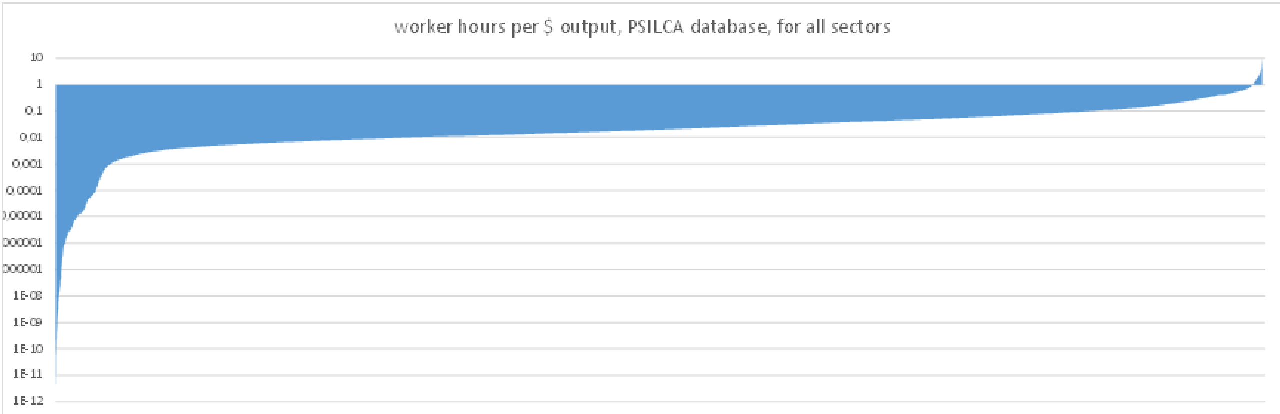


Figure 6: Calculated worker hours per USD output, for all country-specific sectors in Eora, ordered by amount; logarithmic scale

The figure shows that some of the values are extremely small; they belong typically to sectors related to export or import; some values are rather high, but not completely unrealistic; for the vast majority of the sectors, values between 0.001 and 1 hours per USD output are calculated. Figure 7 shows the top and lowest calculated working times.

[4] “Mean hourly labour cost” (ILO 2015a)

Country	sector	working_time_h_per$output
USA	Owner-occupied dwellings	4,33735E-12
Japan	House rent (imputed house rent)	1,1318E-11
Germany	Reexport	5,40891E-11
Netherlands	Re-export	5,94739E-11
Belgium	Re-export	7,42249E-11
Australia	Ownership of dwellings	1,05445E-10
France	Re-export	2,02097E-10
Taiwan	House Services	2,12274E-10
UK	Re-export	2,41377E-10
UK	Re-import	2,41377E-10
South Korea	Business consumption expenditure	2,4138E-10
Israel	Imputed bank services and general expenses	3,94426E-10
Country	sector	working_time_h_per$output
Argentina	Hosting Services	3,337685951
Zimbabwe	Wood and Paper	3,462536466
Zimbabwe	Private Households	3,514877142
Argentina	Domestic Services	3,531174992
Argentina	Housekeeping	3,531174992
Zimbabwe	Maintenance and Repair	3,707173827
Zimbabwe	Transport	3,910826902
Zimbabwe	Hotels and Restraurants	4,31413564
Zimbabwe	Post and Telecommunications	4,540594893
Zimbabwe	Public Administration	5,589076512
Zimbabwe	Financial Intermediation and Business Activitie	6,080253051
Zimbabwe	Wholesale Trade	6,39911571
Zimbabwe	Retail Trade	7,493041122
Zimbabwe	Education; Health and Other Services	7,895964597
Zimbabwe	Construction	9,374066113

Figure 7: Calculated worker hours per USD output, for all country-specific sectors in Eora, ordered by amount, top and lowest values

Calculation and extrapolation methods of worker hours for specific country sectors are provided upon demand.

3.7.2 New: A direct quantification of indicators in PSILCA's life cycle calculation

The 3rd edition of the PSILCA database is also available in a version that allows a calculation of social risks based on the initial values of each indicator. Results are not quantified with working hours as activity variable, but instead the original amount of the indicators is taken "directly" (for example % of child labour). Some few of the indicators needed to be refactors to allow this quantification: a Boolean value (yes / no) was transformed into a 1 / 0, ordinal indicators were transformed to impact scales from e.g. 1 to 5 for five classes of order. More details are available in a presentation[5].

This method applies a normalization of overall results for the different social indicators by the total amount of products in the life cycle. The idea behind is that every process contributes with a certain amount of its product to the overall result, and therefore to final impacts. To do so in practice, all results are divided by the scaled diagonal of the technology matrix, following this formula:

[5] Ciroth, A, De Bellis, A, a direct quantification of indicators in social LCA – beyond worker hours, SLCA2020, https://youtu.be/ChdeMfRsr8M

$$r_k = \frac{g_k}{\sum_{i=1}^{n} a_{ii} \cdot s_i};$$

where r_k is a normalized result, a_{ii} is a process outputs in the technology matrix and s_i is a scaling factor;

The scaling factor can be calculated according to the following expression:

$s_i = (A^{-1} \cdot f)_i$ for each individual process i, and

$s = (A^{-1} \cdot f)$ for the entire vector s

where A^{-1} is the inverted technical matrix and f is a demand vector which is the amount of product supplied by the product system;

Note again that this is not just some arbitrary normalization but a weighted average of the indicator raw values using the economic outputs of the sectors in the supply chain as weights.

To perform the direct calculation, a user must run a Python script in openLCA based on an existing product system, the script and its used is explained and provided in section 5.4.

3.8 Life Cycle Impact Assessment

For each impact category, overall social impacts are calculated by aggregating the social risks of all involved processes along the life cycle. Social risks are scaled by price (inputs), working hours and characterization factors.

The PSILCA database contains an impact assessment method named "Social Impacts Weighting method" which describes exponential relations between impact factors, see Table 3. A characterization factor of 1 is assigned to medium risk levels, thus results are expressed in medium risk hours.

Table 3: Characterization factors for the impact assessment method in PSILCA

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

In PSILCA, characterization factors are reported for each social risk level within each impact category, see for instance Figure 8 about impact factors for the category "Illiteracy, female".

Impact factors: Social Impacts Weighting Method

Impact factors

Impact category: Illiteracy, female

Flow	Category	Flow property	Factor	Unit	Uncertainty
Illiteracy rate, female; very high risk	Society/Contribution to economic development	Duration	100.0	I med risk hours/h	none
Illiteracy rate, female; high risk	Society/Contribution to economic development	Duration	10.0	I med risk hours/h	none
Illiteracy rate, female; medium risk	Society/Contribution to economic development	Duration	1.0	I med risk hours/h	none
Illiteracy rate, female; low risk	Society/Contribution to economic development	Duration	0.1	I med risk hours/h	none
Illiteracy rate, female; no data	Society/Contribution to economic development	Duration	0.1	I med risk hours/h	none
Illiteracy rate, female; very low risk	Society/Contribution to economic development	Duration	0.01	I med risk hours/h	none

Figure 8: Impact assessment method in PSILCA

4 Individual indicators: definition, data collection, refactoring, and risk assessment

In the following chapter, data collection and risk assessment rules for indicators that have been prepared so far for the PSILCA database in openLCA are outlined. The list will be expanded with the progress of the database. The discussion is organised by stakeholders and subcategories.

4.1 Stakeholder Workers

4.1.1 Subcategory Child labour

Overview

The subcategory child labour includes the indicators "Children in employment, male", "Children in employment, female" and "Children in employment, total". Data for all indicators was mainly taken from World Bank, where child labour is defined as follows:

"Children in employment refer to children involved in economic activity for at least one hour in the reference week of the survey [...] The data here have been recalculated to present statistics for children ages 7-14." (World Bank 2017)

Of course, this is a very broad definition that neither considers the severity or danger of the work nor if children are deprived of the opportunity to attend school. Also living conditions that might require the additional income of a child, or cultural convictions or local laws that allow a certain amount and kind of child labour are not taken into account. It is planned to consider these facts in future versions of the database.

Data collection and attribution

Data for child labour should be collected on a sector level. Due to a lack of quantitative data on a sector level for these three indicators, data was initially collected only on country level, based on World Bank statistics (World Bank 2017).

Data for 132 countries was available. Always, the most current values available were selected. However, for some countries values are much older than 5 years. For those countries without specific values, an average across countries from similar country groups was calculated.

Risk assessment: Risk of child labour in the sector

Due to the very general definition of child labour, risk assessment is not straightforward and very subjective. Different degrees of severity or duration of child labour cannot directly be considered in the risk assessment. Additionally, some users might not accept any kind of child labour at all and, therefore, evaluate already low percentages as very high risk. Bearing this in mind, the following risk scale is only a proposal. It compares the given values among each other and is oriented roughly towards the mean value. The ranges for each risk level might appear quite high, e.g. a relatively high percentage of child labour is "accepted"; this is to smooth the fact that – by definition – already one hour of work per week is considered as child labour.

Child labour risk assessment, applied as default for the indicators "Children in employment, male", "Children in employment, female" and "Children in employment, total":

Indicator value y, %	Risk level
0	no risk
0 < y < 2.5	very low risk
2.5 ≤ y < 5	low risk
5 ≤ y < 10	medium risk
10 ≤ y < 20	high risk
20 ≤ y	very high risk
-	no data

4.1.2 Subcategory Forced Labour

<u>Overview</u>

Forced labour was already defined by the ILO Forced Labour Convention, 1930 (No. 29), Article 2.1 (ILO 2012, p.19) as

"all work or service which is exacted from any person under the menace of any penalty and for which the said person has not offered himself voluntarily".

Thus, according to ILO (ibid.), the definition contains three main elements:

"first, some form of work or service must be provided by the individual concerned to a third party; second, the work is performed under the threat of a penalty, which can take various forms, whether physical, psychological, financial or other; and third, the work is undertaken involuntarily, meaning that the person either became engaged in the activity against their free will or, once engaged, finds that he or she cannot leave the job with a reasonable period of notice, and without forgoing payment or other entitlements."

Forced labour is thus predominantly defined by

> *"the nature of the relationship between the person performing the work and the person exacting the work."*

Further, ILO also considers trafficking in persons for the purpose of exploitation as a form of forced labour (ibid., pp.19).

According to ILO, forced labour is still very difficult to detect due to a "lack of reliable national estimates based on specialized data collection instruments" (ibid., p. 21). As a consequence, quantitative data for the frequency of forced labour in different sectors and countries is hard to receive. On the one hand, ILO provides numbers of "reported cases" (ibid.) of forced labour per 1,000 persons in macro regions and, on the other hand, qualitative reports about labour conditions in selected sectors and countries are available.

However, on its website, ILO states that:

> *"A future priority of the ILO will be to study the economics of modern forced labour in greater depth. This will include an analysis of certain industries or economic sectors that seem to be more vulnerable to forced labour practices than others. It will also include research into the prevalence of forced labour in global supply chains. By the end of this year [2012, remark of author], we aim to produce a new study on the profits generated by forced labour. Based on an initial assessment of the data, we can already say that the sectors most frequently cited are agriculture, domestic work, construction and manufacturing."* (ILO 2015b)

It was decided to assess the subcategory forced labour by three different indicators:

1. the regional values for frequency of forced labour complemented by
2. numbers of goods produced by forced labour in the sector and
3. national data on trafficking in persons.

They will be explained in more detail in the following.

4.1.2.1 Frequency of forced labour

The indicator is measured by the estimated proportion of a country´s population in modern slavery by the Walk Free Foundation (WFF). Here, the term is defined as:

> *"[...] modern slavery refers to situations of exploitation that a person cannot refuse or leave because of threats, violence, coercion, abuse of power or deception, with treatment akin to a farm animal."* (WFF 2016a, p. 12)

The approach includes "concepts such as human trafficking, forced labour, debt bondage, forced or servile marriage, and the sale or exploitation of children" (ibid.). Hence, data comprises broader concepts than only forced labour.

Data collection and attribution

Values are used from data on modern slavery derived from the Global Slavery Index 2018 (WFF 2018a). Data is based on face-to-face or telephone surveys carried out in 25 countries[6] by the Walk Free Foundation together with the research agency Gallup (2016). The values are provided in absolute numbers of persons having faced forced labour and in percent of the population. The outcomes were extrapolated by the Foundation "to countries with an equivalent risk profile" (WFF 2016b, p. 13). For PSILCA, values are shown in permille – number of cases per 1000 inhabitants – and are available for 150 countries. The other countries remain without data.

Risk assessment: Risk of forced labour in the country

The counted cases of persons in modern slavery per 1,000 inhabitants range between 0.3 (in industrialized western countries) and 90 (in Eritrea). The risk scale is based on the equal distribution

[6] Brazil, Ethiopia, Indonesia, Nepal, Nigeria, Russia, Pakistan, Bangladesh, Bolivia, Cambodia, Chile, Dominican Republic, Ghana, Guatemala, Hungary, India, Mauritania, Mexico, Myanmar, Philippines, Poland, South Africa, Sri Lanka, Tunisia and Vietnam

of values.

Indicator value y, per mille	Risk level
0	no risk
0 < y < 4	very low risk
4 ⩽ y < 8	low risk
8 ⩽ y < 12	medium risk
12 ⩽ y < 16	high risk
y ⩾ 16	very high risk
-	no data

[Changes to PSILCA version 2:

- More current values]

4.1.2.2 Goods produced by forced labour

The United States Department of Labor's (DOL) Bureau of International Labor Affairs (ILAB) provides a list of goods and specific products produced by forced labour (and child labour) per country (USDOL 2018a). Based on a wide range of publicly available sources, as surveys carried out by foreign governments and ILO, site visits, studies by governmental and non-governmental institutions, information by civil society organizations etc. (ibid., pp.19), ILAB collected data on forced labour according to ILO´s definition (see above). The authors state that the list

> *"includes only those goods for which ILAB is able to document that there is reason to believe that child or forced labor is used in their production." (ibid.)*

Therefore,

> *"it is likely that many more goods are produced through these forms of labor abuse." (ibid., p. 3).*

Yet still, the list is considered as a good auxiliary indicator in order to assess forced labour on a sector level.

Data collection and attribution

Goods and products produced by forced labour in a country were mapped to the sectors of the respective country in Eora. This way, some products were mapped to different Eora sectors (e.g. garments in Argentina fit to "Finishing of textiles", "Manufacture of textiles", "Yarns and threads for textile fibres", "Clothing, except fur" etc.) that are in potential risk of forced labour. The indicator is only measured by yes or no. According to the statement of ILAB claiming that the institution is not able to record all cases of forced labour (see above), countries and sectors that are not listed in the data sources are assigned a "no data" (and not a "no risk").

Risk assessment: Risk of forced labour in the sector

Due to the new measurement of this indicator, the risk assessment is updated. Risk levels basically refer to the match between the products and the sectors which is described by the data quality indicator "Technical conformance" (see chapter 3.6). Additionally, sectors that could also be affected by forced labour, e.g. because they are part of the supply chain, are considered by a lower risk level. For example, cattle in Brazil is affected by forced labour; while cattle breeding/ animal husbandry would be assessed by a "very high risk", the sectors "Milk from cows and other animals" and "Milk products" would be assessed by "high risk" and "medium risk" respectively.

The risk is assessed by the following scale:

Technical conformance value y, score	*Risk level*
1	*very high or high risk*
2	*medium or high risk*
3	*low risk*
5	*no data*

[Changes to PSILCA version 2:

- More current values]

4.1.2.3 Trafficking in persons

"The Palermo Protocol defines trafficking in persons as the recruitment, transportation, harbouring or receipt of persons, by means of coercion, abduction, deception or abuse of power or of vulnerability, for the purpose of exploitation. It goes on to specify that exploitation shall, at a minimum, include sexual exploitation, forced labour, slavery and slavery-like practices." (ILO 2012, p. 20).

Hence, there is a clear link to forced labour which is why trafficking in persons is selected as an indicator for the subcategory.

<u>Data collection and attribution</u>

Data is based on the Tier Placements of countries provided by the Office to Monitor and Combat Trafficking in Persons in the "Trafficking in Persons Report 2018" (U.S. Department of State 2018). The tiers are available for almost every country in Eora, except for the miniature states. They are assigned a "no data" value. Tiers are defined as follows (ibid.):

> *"Tier 1*
>
> *Countries whose governments fully meet the Trafficking Victims Protection Act's (TVPA) minimum standards.*
>
> *Tier 2*
>
> *Countries whose governments do not fully meet the TVPA's minimum standards, but are making significant efforts to meet those standards.*
>
> *Tier 2 Watch List*
>
> *Countries whose governments do not fully meet the TVPA's minimum standards, but are making significant efforts to meet those standards AND:*
>
> *a) The absolute number of victims of severe forms of trafficking is very significant or is significantly increasing;*
>
> *b) There is a failure to provide evidence of increasing efforts to combat severe forms of trafficking in persons from the previous year, including increased investigations, prosecutions, and convictions of trafficking crimes, increased assistance to victims, and decreasing evidence of complicity in severe forms of trafficking by government officials; or*
>
> *c) The determination that a country is making significant efforts to meet the minimum standards was based on commitments by the country to take additional future steps over the next year.*

Tier 3

Countries whose governments do not fully meet the minimum standards and are not making significant efforts to do so."

Risk assessment: Risk that there are cases of trafficking in persons in the country

According to the definitions of the Tier placements referring to trafficking in persons, risk levels are assessed as follows:

Indicator value y, tier # and text	*Risk level*
1	*very low risk*
2	*medium risk*
2.1 (watch list)	*high risk*
3 and 3.1 (Special case)	*very high risk*
-	*no data*

[Changes to PSILCA version 2:

- More current values]

4.1.3 Subcategory Fair Salary

Overview

"Fair wage means a wage fairly and reasonably commensurate with the value of a particular service or class of service rendered, and, in establishing a minimum fair wage for such service or class of service.

Codes of conduct which deal with wages and benefits have focused on three standards when assessing level of wages:

- *the minimum wage required by law;*
- *the local 'prevailing industry wage';*
- *The 'living wage' (also sometimes designated as a 'floor wage' or 'non-poverty wage')."* (UNEP/ SETAC 2013, p. 98)

Following this definition of UNEP, the three following indicators are taken into account in this subcategory: "Living wage, per month", "Minimum wage, per month", and "Sector average wage, per month".

4.1.3.1 Living wage, per month

Following WageIndicator (2019), this indicator is defined as follows:

"Living Wage per month is defined as the income needed for a decent living, i. e. the monthly wage needed to cover the necessary living costs of an individual or family."

These needs include "*nutritious food, water, shelter, clothing, education, healthcare and transport*" (UNEP/ SETAC 2013, p. 98).

Data collection and attribution

Data was taken from WageIndicator.org (2019), where values are calculated based on living cost prices collected in a survey. To consider the different indications of prices made by the respondents, data is provided as an interval of two figures: lower bound and upper bound living wages showing the 25th and 75th percentile of all reported prices. The values were converted in USD.

Values for the minimum living wages for individuals were selected in order to illustrate the cost required for the lowest level of a decent living standard that has to be met by minimum and sector average wages. The data was available for only 70 countries. For these countries, values were converted to USD with the respective exchange rates and provided on a country level. Averages across countries belonging to given economical regions (e.g. Middle-income counties, non-OECD countries) were calculated and assigned to the remaining countries.

Risk assessment: Risk that cost of living is high

Living wage values are a proxy to evaluate the subcategory fair salary and the other two indicators minimum and sector average wages. Independently, values for living wages are of only limited informative value. However, to stick to the structure of the indicators in PSILCA, also living wages are risk assessed.

To define the risk levels, values are compared with each other. They are evaluated considering that the higher the living wage, the higher minimum and sector average wages have to be – triggering risks especially for workers in low-paid sectors.

Indicator value y, USD	*Risk level*
y < 100	*very low risk*
100 ⩽ y < 200	*low risk*
200 ⩽ y < 500	*medium risk*
500 ⩽ y < 1000	*high risk*
1000 ⩽ y	*very high risk*
-	*no data*

[Changes to PSILCA version 2:

- More current values]

4.1.3.2 Minimum wage, per month

In principle, defining the minimum wage is rather straightforward. A specific definition is given by WageIndicator (2014):

> *"A national minimum wage is the lowest gross wage a full-time worker can be remunerated in a specific country, defined by national law and legally binding."*

However, in practice not every country defines a minimum wage, for every sector, by law. Sometimes, also several minimum wages are defined for different categories of workers based on skill level, age, region or other criteria (ibid.).

Minimum wages can be used to evaluate the sector average or actually paid wage in a company. Together with the living wage it is an important indicator to assess if salary is fair and allows the worker a dignified life. Although, in some countries there are agreed sector-specific wages by collective bargaining, data is usually available on a country level.

Data collection and attribution

Data for minimum wage was used mainly from WageIndicator.org (2019). The source provides data for lowest and highest minimum wages, on country level in the national currency. Values of lowest national minimum wages in local currency were selected and converted to USD (with the respective current exchange rates) (ER, 2019). For countries without data, values were attributed with the average values among economic groups. Here, minimum wages are provided in USD per year (calculated with exchange rates the respective years). Hence, values per month were calculated.

When data was only available for one specific sector, typically the public sector, it was assumed to be valid for the entire country.

Risk assessment: Risk that minimum wage is too low to permit a dignified life

Risk levels are defined in comparison to the living wage of the country, by calculating the ratio of living wage to minimum wage. Basically, the higher the ratio, the higher the risk of a too-low minimum wage, meaning that living wage exceeds the minimum wage. Furthermore, the raw value of the minimum wage is considered based on the assumption that a very low minimum wage aggravates living conditions in general (e.g. for purchasing foreign products).

Indicator value y, USD	*Logical connection*	*Indicator value x, ratio*	*Risk level*
y > 300	*And*	*x < 0.5*	*very low risk*
y ⩽ 300	*And*	*x < 0.5*	*low risk*
y > 300	*And*	*0.5 ⩽ x < 0.9*	
y ⩽ 300	*And*	*0.5 ⩽ x < 0.9*	*medium risk*
y > 300	*And*	*0.9 ⩽ x < 1.3*	
y ⩽ 300	*And*	*0.9 ⩽ x < 1.3*	*high risk*
y > 300	*And*	*1.3 ⩽ x < 1.8*	
y ⩽ 300	*And*	*1.3 ⩽ x < 1.8*	*very high risk*
		x ⩾ 1.8	
-		*-*	*no data*

[Changes to PSILCA version 2:

- More current values
- Additional new source used]

4.1.3.3 Sector average wage, per month

Sector average wage provides information about the mean monthly salaries in different industry sectors and countries and assesses if the salary is enough to afford a decent standard of living. The indicator is given as the mean of monthly earnings of all employees in the sector. These data are defined as follows:

“The earnings of employees relate to the gross remuneration in cash and in kind paid to employees, as a rule at regular intervals, for time worked or work done together with remuneration for time not worked, such as annual vacation, other type of paid leave or holidays. Earnings exclude employers' contributions in respect of their employees paid to social security and pension schemes and also the benefits received by employees under these schemes. Earnings also exclude severance and termination pay.” (ILO 2017, “Mean nominal monthly earnings”)

Values are provided in nominal terms and, therefore, are no indication for the purchasing power of employees. The unit of measurement is USD.

Data collection and attribution

Data is based on the indicator "Mean nominal monthly earnings of employees by sex and economic activity (Local currency)" from ILOSTAT database (ILO 2019). Depending on the country, information is provided for different years and industry sectors according to ISIC and is disaggregated by sex.

Despite of the title ("Mean nominal *monthly* earnings") values are not always given per month but often per hour, day, week or year. This is sometimes indicated but in other cases not. It is even not consistent within one and the same country. If no other time unit was noted than per month, questionable values were compared to information about average salaries in the country according to other sources (e.g. Numbeo.com 2015b). Based on such data it was then assumed whether a raw value was referring to an hour, day, week or year.

After that, values were converted into USD usually with current exchange rates (ER 2019). Only when salaries where provided in old currencies (e.g. for years before the EUR was introduced) corresponding exchange rates were used.

After refactoring the data, the country-specific sectors from Eora were mapped to the ISIC sectors from the raw data as described in chapter 3.4.2. So, first, all Eora sectors with a counterpart in the ILOSTAT data obtained the respective value. Second, sectors related to a more general (or detailed) sector were assigned the corresponding value. The remaining country-specific sectors received the "total" value provided by ILOSTAT. If this was not available, an average across all sectors from the same country was calculated.

In order to designate a value to the 60 countries without any raw data in ILOSTAT these countries were assigned to different country groups. For each country group, an average was calculated over all sectors of the countries belonging to it. Then again, an average across all the country groups the country under study belongs to was calculated and assigned to every of its sectors (; see chapter 3.4.2, case 3c).

Risk assessment: Risk that salary is too low to permit a dignified life

The mean earnings were put into relation with living wages in the country (see chapter 4.1.3.1). If living wages were not available, prevailing minimum wages were taken as a reference (see chapter 4.1.3.2). For the remaining countries a mean living wage was calculated across all the corresponding country groups. In every case it is quoted which value was taken as a reference.

Ratios were calculated dividing the sector average wage by the (mean) living or minimum wage in the same country. To simplify risk assessment, it is assumed that minimum wages are equal or higher than living wages (which is true for more than half of the cases).

Since the selected living wages refer to the cost of living for an individual in the cheapest part of the country (see chapter 4.1.3.1) it is assumed that employees earning merely the living wage (i.e. a ratio lower than 1) face a very high risk of not being able to live a decent life. Only salaries that are at least twice as high as the living wage are supposed to permit a decent standard of living also for other family members and allow to cover increased or unexpected costs.

The following risk scale is used to assess the average monthly salaries.

Indicator value y, ratio Salary/Liv. wage or Salary/Minim. wage	*Risk level*
0 < y <1	*very high risk*
1 ⩽ y < 1.5	*high risk*
1.5 ⩽ y < 2	*medium risk*
2 ⩽ y < 2.5	*low risk*
2.5 ⩽ y	*very low risk*

[Changes to PSILCA version 2:

- More current values
- Adjusted calculation approach]

4.1.4 Subcategory Working time

<u>Overview</u>

This subcategory aims to assess if the number of hours that employees really work in different sectors and countries comply with the ILO standards, but also with national standards of working time. It addresses excessive working time that prohibits a sustainable work-life-balance as well as too little working hours limiting a satisfying professional life. Hence, the indicators chosen within this subcategory are “*Daily hours of work per employee*”, “*Weekly hours of work per employee*”, “*Standard weekly hours*” and “*Standard daily hours*”.

4.1.4.1 Weekly hours of work per employee

Data on weekly hours of work per employee and sector is provided, “*whenever possible, on the basis of the mean number of hours of work per week, and with reference to hours worked in all jobs of employed persons and in all types of working time arrangements (e.g. full-time and part-time).*” (ILO 2019). According to ibid. “Hours actually worked include

(a) ‘direct hours’ or the time spent carrying out the tasks and duties of a job,

(b) ‘related hours’, or the time spent maintaining, facilitating or enhancing productive activities

(c) ‘down time’, or time when a person in a job cannot work due to machinery or process breakdown, accident, lack of supplies or power or Internet access and

(d) ‘resting time’, or time spent in short periods of rest, relief or refreshment, including tea, coffee or prayer breaks, generally practised by custom or contract according to established norms and/or national circumstances.”

<u>Data collection and attribution</u>

Data for weekly hours of work per employee is based on the statistics for “Mean weekly hours actually worked per employed person, by sex and economic activity” by the ILOSTAT database (ILO 2019). Data is provided by sex and ISIC sector for different years since 1969. However, in order to use rather current data, only values in the range of 2008-2018 were selected. Furthermore, it was not distinguished between men and women.

The Eora country-specific sectors were mapped to the available sectors of the data source (see chapter 2.4.2). First, all Eora sectors that had a counterpart in the raw data obtained the original value. Second, data from more general sectors was assigned to subordinate sectors, where available. In a third step, Eora sectors still without data got the value of one more detailed sector. By this extrapolation and interpolation procedure, more than 10,000 of all Eora country-sector-combinations got a value.

For the remaining sectors without a counterpart in the raw data the average across all sectors within the respective country was used (if available, from the sector "Total", otherwise the calculated mean value).

All the sectors of countries without any raw data were assigned by the mean over the average values of all groups the country belongs to (see chapter 2.4.2, case 3c).

Risk assessment: Risk of improper working hours

The risk assessment of this indicator is based on the ILO conventions No. 1 "Hours of work (industries) Convention" (ILO 1919) and No. 47 "Forty-Hour Week Convention" (ILO 1935). The first one limits working time especially in the mining, construction, manufacturing and transportation sectors to 8 hours a day and 48 hours a week. It is ratified by 52 countries. Convention No. 47 defines the standard working week by 40 hours but is ratified by only 15 countries. Hence, both conventions were taken into account by setting the "normal" amount of weekly working hours between 40 and 48. However, apparently this is not accepted by every nation as the standard working time, and, therefore, this range is already assessed by "low risk" of improper working hours. The higher the amount of weekly working hours are, the higher is the risk level for the sector.

Furthermore, also very low numbers of working time are considered as improper because they might not permit the employee to realize his professional objectives or have enough professional social relations. Hence, also low values of weekly working hours are assessed by higher risk levels of improper working time.

Therefore, the risk is assessed by the following scale:

Indicator value y, hours of work per employee and week	*or*	*Indicator value y, hours of work per employee and week*	*Risk level*
40 ⩽ y <48			*low risk*
30 ⩽ y < 40		*48 ⩽ y < 55*	*medium risk*
20 ⩽ y < 30		*55 ⩽ y < 60*	*high risk*
20 ⩾ y		*60 ⩽ y*	*very high risk*

[Changes to PSILCA version 2:

- More current values
- Updated country mapping]

4.1.5 Subcategory Discrimination

Overview

Worker discrimination is a very multifaceted subcategory. The authors of UNEP/SETAC (2013, p.111) describe it as follows:

> *"Equal opportunity or the principle of non-discrimination emphasizes that opportunities in education, employment, advancement, benefits and resource distribution, and other areas should be freely available to all citizens irrespective of their age, race, sex, religion, political association, ethnic origin, or any other individual or group characteristic unrelated to ability,*

performance, and qualification."

Due to the variety of aspects and their mostly qualitative character, it becomes clear that it is difficult to fully cover this subcategory in the database. Therefore, six indicators were chosen to assess the worker discrimination. The indicators "Women in the sectoral/ total labour force" and "Men in the sectoral/ total labour force" are supposed to verify whether there are gender discrimination issues related to equal employment opportunities. "Gender wage gap" assesses wage disparities between men and women. As these indicators only take into account gender discrimination, the indicator "Occurrence of discrimination" serves to address all the other discrimination types, e.g. racism, or discrimination due to political or religious orientation, by a qualitative description.

4.1.5.1 Women in the sectoral labour force

The distribution of women and men in the labour force of different sectors is often quite unequal. In general, women are mostly engaged in service sectors such as human health activities, social work, education, or household services. In countries with high poverty levels they are employed mostly in agriculture or manufacturing sectors. Most of these sectors do not require high professional skills, and especially social service activities, household services and agriculture, are typically low-paid (see chapter 4.1.5.2). Since women are as intelligent and capable of learning as men, "Women in the sectoral labour force" serves as an indication for structural discrimination of women, i.e. the systemic and institutionalized disadvantage faced by women regarding their participation in economic life.

"Structural discrimination refers to rules, norms, routines, patterns of attitudes and behaviour in institutions and other societal structures that represent obstacles to groups or individuals in achieving the same rights and opportunities that are available to the majority of the population." (Najcevska 2010)

<u>Data collection and attribution</u>

Raw values for the share of women in the labour force are provided by the Key Indicators of the Labour Market (KILM) database (2015) from ILO's Yearbook of Labour Statistics. Here, data is provided for sectors defined by the latest revision of ISIC, Revision 4 (2008) tabulation category, as the percentage of women employed in a specific sector out of the total active female population in the country. Hence, this value defines how women are distributed across economic sectors in a country. However, this share is no sufficient basis to evaluate if women and men are equally involved in all sectors. Therefore, it is compared with the overall economic structure in a country by dividing it by the percentage of all employees in the same sector related to the total active population:

Women in the sectoral labour force =

$$\frac{Women\ employed\ in\ sector\ x\ (\%\ of\ active\ female\ population\ in\ the\ country)}{Men\ and\ women\ employed\ in\ sector\ x\ (\%\ of\ total\ active\ population\ in\ the\ country)}$$

Being a ratio between two percentages, this index is dimensionless. The ratio is used to define the risk evaluation scheme of this indicator and is provided as the "raw values" in PSILCA. The values of the shares of women employed in a sector out of the active female population is provided as a comparative value in the comments of each process in PSILCA.

Due to the different sector classification in the original source and Eora, the majority of the sectors had to be mapped the same way as for other indicators. Original data were provided by the most general classification of ISIC tabulation, hence in most cases data was assigned to subordinate sectors. When data for some sectors was missing, mean values were calculated across sectors for a specific country. Additionally, there were some countries without any data. In these cases, an average among similar countries was calculated and attributed to all the belonging sectors.

In the comments of some data points a reference is made to statistics from World Bank (2017). This serves as a quality index for the reliability of the value. Additionally, the share of women employed in a specific sector out of the total active female population in the country is provided in the comments.

Risk assessment: Risk of women being underrepresented in specific sectors

The index is used to assess structural discrimination of women in a country´s economy by evaluating the gap between female and male employment in the country-specific sectors. For the risk assessment, it is assumed that an equal share of women working in a sector related to the active female population in the country and female and male workers in a sector related to all employees in the country, i.e. a ratio of 1, is ideal. The lower these ratios are, the higher the risk of female discrimination to be employed in a sector.

However, discrimination can also be represented by very high ratios, occurring especially in low-paid activities such as household or cleaning services. This additional qualitative fact cannot be entirely accounted for by the general risk scale below. Additionally, an "overrepresentation" of women in some sectors is not necessarily negative. However, the potential risk that sectors with very high shares of women employed are low-paid (service) sectors, is still considered by low risk levels (instead of no risk).

Indicator value y, ratio	*Risk level*
1.5 < y	*low risk*
1 < y ⩽ 1.5	*very low risk*
y = 1	*no risk*
0.8 ⩽ y < 1	*very low risk*
0.6 ⩽ y < 0.8	*low risk*
0.4 ⩽ y < 0.6	*medium risk*
0.2 ⩽ y < 0.4	*high risk*
0.2 > y	*very high risk*

4.1.5.2 Men in the sectoral labour force

This indicator is added in order to complete the assessment of gender discrimination. Unequal employment opportunities (with negative effects) can also be faced by men, e.g. in the health or education sectors. So, a more comprehensive picture of gender inequality can be drawn by comparing ratios of women and men in the sectoral labour force. Further, the sector coverage between the two indicators slightly differ so that this indicator can bring new insights.

Of course, the consideration of wage data, i.e. assessing wage gaps especially in those sectors with high shares of male or female workers, would complete the assessment. This can be realized by an adequate characterization factors in this subcategory.

Data collection and attribution

Indicator assessment and data collection are analogous to those of "Women in the sectoral labor force". Hence, provided values are the ratios of men in the sectoral labour force calculated with the following equation:

Women in the sectoral labour force =

$$\frac{Men\ employed\ in\ sector\ x\ (\%\ of\ active\ male\ population\ in\ the\ country)}{Men\ and\ women\ employed\ in\ sector\ x\ (\%\ of\ total\ active\ population\ in\ the\ country)}$$

Risk assessment: Risk of men being underrepresented in specific sectors

Also, the risk assessment follows the same logic as mentioned above. Again, high ratios equate less discrimination in terms of employment but do not say anything about the type of work, qualification or wages of the employees. Hence, lower ratios are basically associated with higher risks of employment discrimination.

Indicator value y, ratio	*Risk level*
1.5 < y	*low risk*
1 < y ⩽ 1.5	*very low risk*
y = 1	*no risk*
0.8 ⩽ y < 1	*very low risk*
0.6 ⩽ y < 0.8	*low risk*
0.4 ⩽ y < 0.6	*medium risk*
0.2 ⩽ y < 0.4	*high risk*
0.2 > y	*very high risk*

A quick comparison of both indicators reveals that in 10,788 sectors men are – proportionally to their sectoral distribution – more represented than women. Only in 3,333 sectors, this is the case for women.

4.1.5.3 Gender wage gap

Gender wage (or pay) gap can be calculated in different ways. Data in PSILCA follows the definition of OECD (2015) describing it as the “difference between median earnings of men and women relative to median earnings of men” referring to full-time employees. However, this definition implies that wages of men are higher than wages of women which is not always the case. Therefore, the definition is extended as follows:

“Gender wage gap describes the difference between median earnings of men and women relative to median earnings of men if wages of men are higher. Otherwise, it is the difference between median earnings of men and women relative to median earnings of women.”

Data collection and attribution

Values for gender wage gaps in different countries and sectors are based on the data for “Mean nominal monthly earnings of employees by sex and economic activity (Local currency)” by the ILOSTAT database (ILO 2019).

If wages of men are higher than wages of women, values are calculated by:

$$\frac{Male\ wages - female\ wages}{Male\ wages} * 100$$

If wages of women are higher, values are calculated by:

$$\frac{Male\ wages - female\ wages}{Female\ wages} * (-100)$$

The negative factor is used to indicate that wages of women are higher than wages of men.

Due to the different sector classification of the raw data and Eora, sectors had to be mapped. This was done the same way as for indicator "Weekly hours of work per employee" (chapter 3.1.4.1): First, all Eora sectors with a counterpart in the raw data obtained the original value. Second, where available, data from more general sectors was assigned to subordinate sectors, and third, Eora sectors still without data got the value of one more detailed sector.

For those sectors without a matching economic activity, the value of the "Total" sector of the respective country was used.

Risk assessment: Risk of unequal wages

For the risk assessment, it should be considered that data is unadjusted, i.e. factors as qualification, job position or working time are not considered. Hence, values do not necessarily reflect if women or men are paid less only because of gender reasons or also due to lower job positions or shorter working times etc. However, for some industries it can be discussed if missing qualifications, lower job positions or less working hours are already triggered by other forms of discrimination, e.g. unequal access to education, insufficient childcare institutions etc.

Within the assessment of this indicator, these considerations cannot be completely considered. Nevertheless, a certain percentage of wage gap is "accepted" in order to consider the fact that values are unadjusted.

Furthermore, higher wages of men or women are equally risk assessed and considered as discrimination. If the value of earnings of one sex is 0, and hence the gender wage gap ratio is 100, it can be assumed that there are no male or female employees in this economic activity. For these sectors (only 6) the indicator is not applicable.

The following scale shows the assessment basis:

Indicator value y, %	*Risk level*
y = |0|	*no risk*
0 < y < |5|	*very low risk*
|5| ≤ y < |10|	*low risk*
|10| ≤ y < |20|	*medium risk*
|20| ≤ y < |30|	*high risk*
|30| ≤ y	*very high risk*
-	*no data*
y = |100|	*not applicable*

[Changes to PSILCA version 2:

More current values]

4.1.6 Subcategory Health and Safety (Workers)

Overview

This subcategory is another essential and "traditional" one contributing to the S-LCA of a product or industry. Here, occupational health and safety conditions in different sectors are assessed. Since 1950, ILO and WHO (Agius 2010) define occupational health as follows:

> *"Occupational Health is the promotion and maintenance of the highest degree of physical, mental and social well-being of workers in all occupations by preventing departures from health, controlling risks and the adaptation of work to people, and people to their jobs."*

Furthermore:

> *"The term health, in relation to work, indicates not merely the absence of disease or infirmity;it also includes the physical and mental elements affecting health, which are directly related to safety and hygiene at work." (ILO 1981)*

Occupational health and safety and the risk of specific diseases and accidents depend on different factors that are to be assessed by the indicators of this subcategory. Two indicators assess the actual risk of accidents at workplace depending on their severity: "Rate of non-fatal accidents" and "Rate of fatal accidents". The indicator "DALYs due to indoor and outdoor air and water pollution" describes the risk of insidious health damages only notable after years of working in a specific working environment. The indicator "Workers affected by natural disasters" provides information on risks independently from the employer. To limit these industry-specific risks and protect workers companies should take prevention measures evaluated by the indicator and "Presence of sufficient safety measures". By the indicator "Occupational risks" specific hazards and their severity are described qualitatively. By all these indicators an overall picture of the level of occupational health and safety risks in general can be drawn.

4.1.6.1 Accident rates at workplace (non-fatal and fatal accidents)

Accident rates are the main indicator to reflect the state of safety conditions at a specific workplace or in a specific industry. While occupational non-fatal accidents cause injuries not leading to death, fatal accidents refer to those incidents "where death occurred within one year of the day of the accident" (ILO 2017).

Apart from the fact that it is every employee´s right to work in a safe and healthy environment (see chapter 0), it should be in the interests of employers to keep accident and injury rates as low as possible to avoid absence and a loss of efficiency and working time.

<u>Data collection and attribution</u>

Accident rates are taken from the indicators "Non-fatal occupational injuries per 100'000 workers by economic activity" and "Fatal occupational injuries per 100'000 workers by economic activity" from ILOstat database (ILO 2019). They are expressed as the number of new cases of [fatal/] non-fatal occupational injuries during the reference period divided by the number of workers in the reference group and multiplied with 100,000(ibid.). Values are given for different years. Always the most current value per sector is selected.

Numbers may vary a little due to their reference base. Normally they refer to 100,000 employees, but in some cases, they relate to 100,000 persons insured or full-time workers etc.

As it is the case for most indicators, data had to be assigned to the "right" Eora sectors. Hence, mapping was done as described in chapter 3.4.2 and already for other indicators: First, mapping of identical sectors and countries was done. Second, where available, mapping of more general sectors to subordinate sectors, and third, Eora sectors still without data were mapped to a more detailed sector. All Eora sectors mapped this way were assigned the respective values. This extrapolation and interpolation procedure could be implemented for half of all the sectors in Eora.

For the remaining sectors of the countries with any raw data available, the value of "Total" of the appropriate country (or the calculated mean value) was used. The remaining countries and their sectors were assigned a "no data".

Especially regarding the indicator "Non-fatal accidents", some raw values, e.g. of Colombia, Sri Lanka, Azerbaijan, Turkey etc., seemed quite low. This may be due to the fact that for most countries only accidents of insured employees are recorded. Apparently, in developing countries many accidents are not covered as carefully as in developed countries.

Risk assessment: Risk that workers suffer non-fatal accidents

The risk assessment scale is based on the mean value of non-fatal accidents per 100,000 employees worldwide (calculated out of the data available).

Indicator value y, # per 100,000 employees	*Risk level*
0 ≤ y < 750	*very low risk*
750 ≤ y < 1500	*low risk*
1500 ≤ y < 2250	*medium risk*
2250 ≤ y < 3000	*high risk*
3000 ≤ y	*very high risk*
-	*no data*

Risk assessment: Risk that workers suffer fatal accidents

The risk assessment scale is based on the mean value of fatal accidents per 100,000 employees worldwide (calculated out of the data available).

Indicator value y, # per 100,000 employees	*Risk level*
0 ≤ y < 7.5	*very low risk*
7.5 ≤ y < 15	*low risk*
15 ≤ y < 25	*medium risk*
25 ≤ y < 40	*high risk*
40 ≤ y	*very high risk*
-	*no data*

[Changes to PSILCA version 2:

- More current values]

4.1.6.2 DALYs due to indoor and outdoor air and water pollution

High air and water pollution levels are a main health risk for workers at the workplace. As workplace related health effects are often insidious and time-delayed, disability adjusted life years (DALYs), attributable to indoor and outdoor air and water pollution, seem to be a suitable indicator for the assessment of the health risks from pollution.

WHO (2009) defines the concept of DALYS as follows:

> *"One DALY can be thought of as one lost year of 'healthy' life. The sum of these DALYs across the population, or the burden of disease, can be thought of as a measurement of the gap between current health status and an ideal health situation where the entire population lives to an advanced age, free of disease and disability."*

The Japanese life expectancy of 80 years for men and 82.5 years for women is considered as reference or "ideal health situation". DALYs can be provided per 100,000 inhabitants, per 1,000 inhabitant years or per 1,000 inhabitants per year.

Data collection and attribution

Data for this indicator is taken from WHO (2009) statistics for DALYs due to water, sanitation & hygiene, indoor and outdoor air pollution. The unit is DALY per 1000 capita and year.

Unfortunately, data is only provided on a country-by-country basis for the whole population, not for workers or specific industry sectors. Therefore, the values can only be seen as a proxy for occupational health risks assuming that levels of air and water pollution at workplaces are similar as (or higher than) in a whole country. This data can also be used to assess the health and safety situation of societies.

Raw data for DALYs was not updated since 2004 which is why at the moment it has to be referred to these rather old values. Data could be attributed to 172 countries of Eora, the rest were assigned a "no data".

Risk assessment: Risk to lose (healthy) life years due to indoor and outdoor air and water pollution

The risk assessment is oriented towards the mean value of DALYs due to indoor and outdoor air and water pollution over all available countries.

Indicator value y, DALYs	*Risk level*
0 = y	*no risk*
0 < y < 5	*very low risk*
5 ⩽ y < 15	*low risk*
15 ⩽ y < 30	*medium risk*
30 ⩽ y < 50	*high risk*
50 ⩽ y	*very high risk*
-	*no data*

4.1.6.3 Presence of sufficient safety measures

As described by former indicators, occupational health and safety depends, on the one hand, on the hazards and risks that workers are directly exposed to in their working environment. On the other hand, these occupational health risks can be limited by appropriate measures taken by the employer. This is assessed by the indicator "Presence of sufficient safety measures".

Data collection and attribution

"To promote and to assure workplace safety and health, and to reduce workplace fatalities, injuries and illnesses" is the declared goal of the Occupational Safety and Health Administration (OSHA) by the US Department of Labor (USDOL 2014a). Conducting programmed and un-programmed workplace inspections in the U.S., OSHA detects violations of safety and health standards and takes enforcement actions.

Proxy data for this indicator is taken from the OSHA Violation Statistics (USDOL 2019a). Statistics are provided for U.S. companies and their NAICS (North American Industry Classification Systems) classification for over four decades. All "severe violation cases" between 2015 and 2019 (USDOL 2019a), and "severe work-related injuries" between January 2015 and February 2019 were selected. While the first accident types are defined as "serious, willful, repeat and other-than-serious violation" cases referring to violations leading to deaths or hospitalizations of employees (USDOL 2014b), *"severe work-related injuries [are] defined as an amputation, inpatient hospitalization, or loss of an eye"*, i.e. do not include injuries leading to deaths (USDOL 2017).

All cases were aggregated per 3-digit NAICS code and related to the number of employees in the respective sectors derived from USDOL (2019a). Final values for "*Presence of sufficient safety measures*" are provided as number of OSHA violations per year and 100,000 employees.

Due to a lack of international data, it is assumed that safety risks are similar in the same industries in different countries. Therefore, provided values are extrapolated to suitable industry sectors worldwide. This is, of course, reflected in the data quality matrix.

To assign values to matching Eora sectors, these were mapped to the NAICS 3-digit-code sectors. All the sectors were mapped in a multi-stage process (see chapter 3.4.2 and 4.1.4.1) to Eora sectors. Remaining sectors were left without data.

<u>Risk assessment: Risk of insufficient safety measures at workplace</u>

The risk assessment scheme is based on the distribution of the OSHA violations per 100,000 employees. Some of the sectors indicate relatively high number of violations, these sectors are monetary activities and retail trade. Such data peaks indicate hot spots and most exposed sectors which characterized with high number of accidents in compare to other sectors within a country. The following figure 9 illustrates accident rates per sector in logarithmic scale.

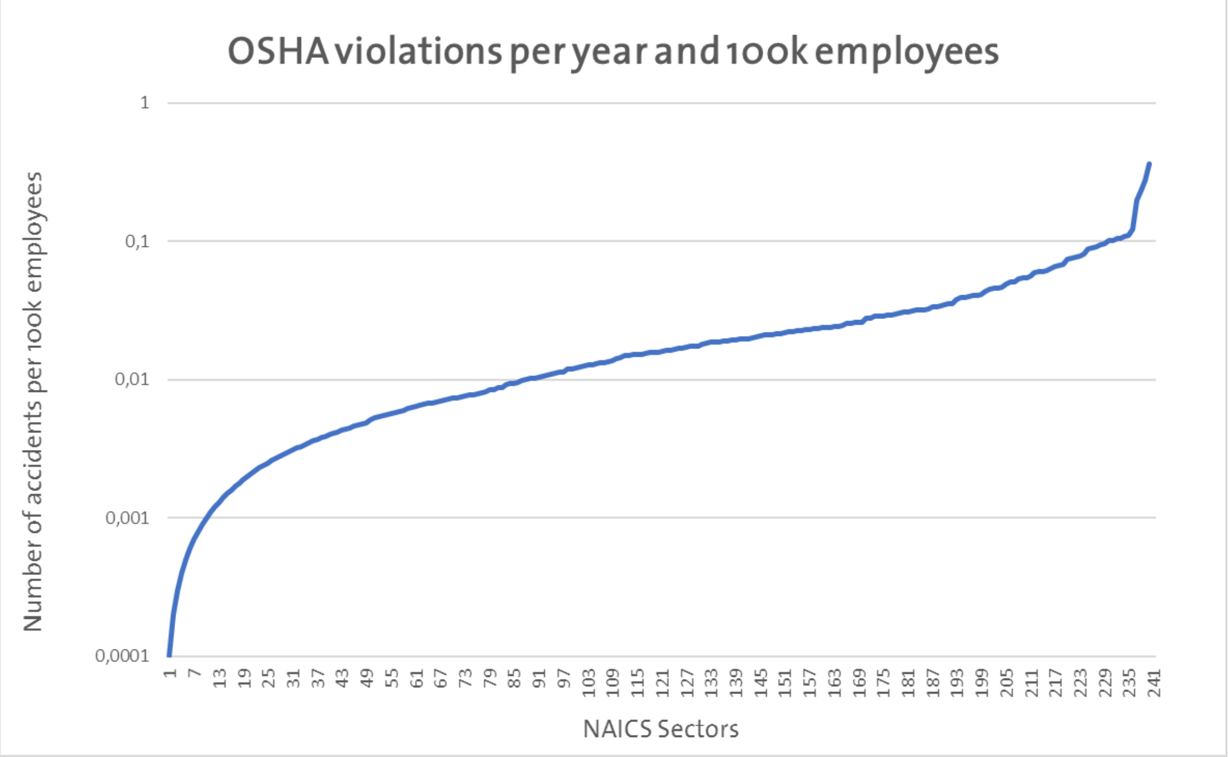


Figure 9: Number of severe violation cases and severe work-related injuries between 2015 and 2019, provided per year and 100,000 employees in 3-Digit NAICS sectors

Indicator value y, DALYs	*Risk level*
y < 0.0005	*very low risk*
0.0005 ≤ y < 0,0015	*low risk*
0.0015 ≤ y < 0,01	*medium risk*
0.01 ≤ y < 0.06	*high risk*
y ≤0.06	*very high risk*
-	*no data*

[Changes to PSILCA version 2:

- More current values
- Larger sector coverage
- Updated risk scale]

4.1.6.4 Workers affected by natural disasters

The idea of this indicator is to verify whether workers in specific countries or industries are at higher risk to fall victim to natural disasters than others. Natural disasters can be classified as hazards of the atmosphere and hydrosphere (as storms, floods, droughts), of the lithosphere (as volcanic eruptions, earthquakes) and of the biosphere (as forest fires or epidemics) (GeoDZ 2015). All these types are considered by this indicator.

Data collection and attribution

The International Disaster Database EM-DAT provides comprehensive "information on the human impact of disasters, such as the number of people killed, injured or affected" but also "disaster-related economic damage estimates and disaster-specific international aid contributions" (CRED 2015).

As for the DALY values (chapter 0), data for natural disasters is provided for countries and populations as a whole, not disaggregated by industry sectors. Due to a lack of better suiting data, these values are applied as a proxy for this indicator. Of course, employees working outside in specific industries are exposed to a higher risk of some natural hazards (as tornados, floods, droughts) than others.

For this indicator, the number of all affected persons (injured, homeless, otherwise affected) between 2012 and 2014 in a country was divided by its population in 2014, multiplied by 100. These normalized values (given in %) were attributed to all sectors of the respective country. Countries without affected persons by natural disaster between 2012 and 2014, but with affected persons in former years, were assumed to have a very low risk of natural hazards. Countries not listed at all in the database were assigned a "no data".

Risk assessment: Risk for workers to be affected by natural disasters

The risk assessment is oriented towards the mean value of the percentage of affected population within three years (between 2012 and 2014). Countries with 0 affected persons during this time frame were assigned a "very low risk" because harmful natural hazards can have happened in former years.

Indicator value y, %	*Risk level*
0 ⩽ y < 1	*very low risk*
1 ⩽ y < 3	*low risk*
3 ⩽ y < 5	*medium risk*
5 ⩽ y < 10	*high risk*
10 ⩽ y	*very high risk*
-	*no data*

4.1.7 Subcategory Social benefits, legal issues

Overview

This subcategory assesses the legal status and social security of workers which is considered as a basic human right in the Universal Declaration of Human Rights, Art. 22 (UN 1948). Social benefits are understood as non-monetary employment compensations paid in addition to wages. They basically refer to retirement, disability, dependents`, and survivors` benefits but can also include medical insurance, paid parental leave, education and training etc. (UNEP/SETAC 2013, p. 121). Hence, this subcategory can be assessed on its own but can also be used to relativize wages or working time.

The indicators within this subcategory are "*Social security expenditures*", "*Evidence of violations of laws and employment regulations*" and "*Workers with a contract*".

4.1.7.1 Social security expenditures

The ILO convention No. 102 identifies nine main social security branches, which are Medical Care, Sickness Benefit, Maternity Benefit, Old-age Benefit, Invalidity Benefit, Survivors' Benefit, Family Benefit, Employment Injury Benefit and Unemployment Benefit (ILO 1952). The extent of (public) social security expenditures depends on political decisions and tax regulations. Data is therefore collected on a country basis and given as a percentage of GDP.

Data collection and attribution

Data is taken from the Social Security Expenditure Database by ILO (2015c). The sub-indicator "Public social protection expenditure (excluding health benefit in kind) as a percentage of GDP" was selected as basis for data collection. It includes all the above-mentioned branches except health care which is covered by the indicators regarding health expenditures in PSILCA.

The country-specific data in the Social Security Expenditure Database (ILO 2015c) was collected from regional or international databases by different institutions as OECD, International Monetary fund, World Bank or EUROSTAT.

For all countries except Aruba values not older than 2005 were used. Since data can vary between several years due to economic situations and changing GDPs average values over several years were calculated (if available). This is documented for every country in the data quality. For 23 countries there was no data available. For now, no mean value was calculated for these cases.

Risk assessment: Risk that workers are not socially protected if they are unable to work

The following risk scale is based on average social security expenditures related to GDP worldwide. For interpreting the indicator values, it should be mentioned that countries with the same value can face totally different situations of social security. For example, if GDP of a country is quite high, lower percentages can already be sufficient to provide a sound social security system (e.g., Switzerland and New Zealand). Especially in developing countries, GDP is rather low, but medical or living costs can be very high, which in turn would require higher social security expenditures. However, these issues are not considered in the current version of PSILCA.

Indicator value y, %	*Risk level*
20 < y	*very low risk*
15 < y ⩽ 20	*low risk*
7,5 < y ⩽ 15	*medium risk*
2,5 < y ⩽ 7,5	*high risk*
2,5 > y	*very high risk*
-	*no data*

4.1.7.2 Evidence of violations of laws and employment regulations

Violations of employment regulations, by the employer, are one threat to employees' well-being and therefore a potential social impact. Information about these violations is taken from a public source in the United States – U.S. Department of Labor (USDOL 2015b).

Data collection and attribution

These data sets report violations for specific enterprises in the U.S., from early cases in the 2015 until end of 2019. From the source, OSHA violation cases were removed since these are considered already in another indicator in the database (see chapter 4.1.6.3 Presence of sufficient safety measures). The remaining cases were aggregated to NAICS 3-tier sections, and afterwards, cases per 1,000 employees were calculated. Missing sectors were imported from the previous version of the database and contains cases from 2007 to 2014. Finally, these cases were mapped to the Eora sectors, and "extrapolated" to other countries worldwide. The difference in country and regarding the sector was considered in the data quality assessment.

The results show that most sectors report very few cases per 1,000 employees, with some sectors having a high probability of law violation. These extremes are represented by monetary services and retail trade (see

Figure 10).

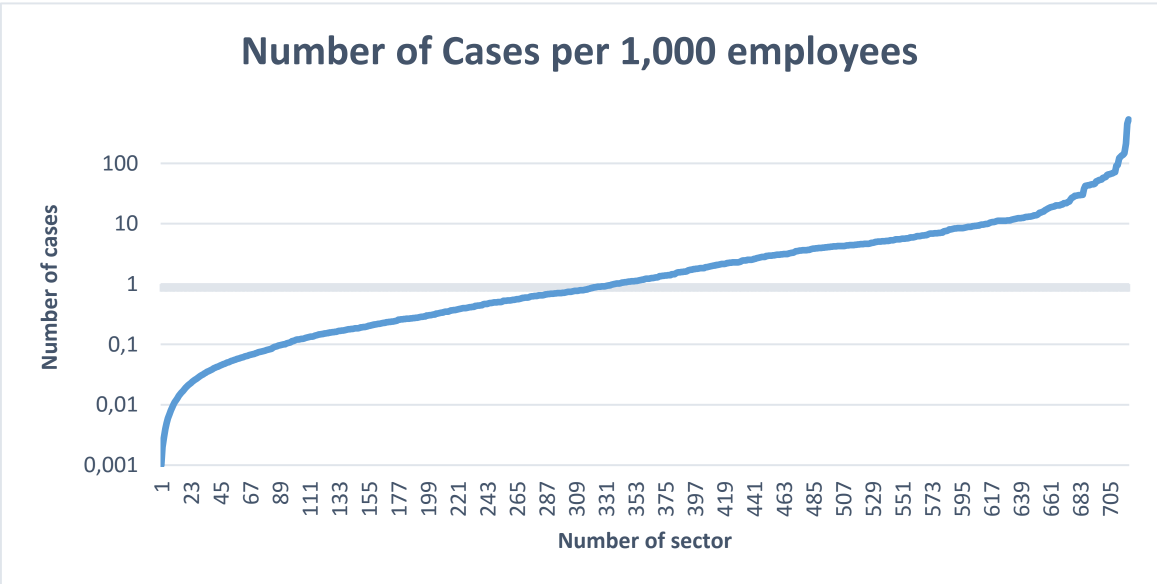


Figure 10: Number of cases regarding violations of laws and employment regulation, per 1,000 employees, for NAICS 3-tier sectors, OSHA violations are excluded from the figure

Indicator value y, cases per 1,000 employees	Risk level
0.1 > y	very low risk
0.1 ≤ y < 1	low risk
1 ≤ y < 10	medium risk
10 ≤ y < 100	high risk
100 < y	very high risk
-	no data

Risk assessment: Risk that worker-related laws and employment regulations are violated

4.1.8 Freedom of association and collective bargaining

Overview

According to the Universal Declaration of Human Rights, Art. 20 (UN 1948) every individual has the right to assembly peacefully and to form and join organizations of their choice without being compelled to belong to any association.

By several conventions and principles this right is explicitly applied to workers. ILO (1998) names "*freedom of association and the effective recognition of the right to collective bargaining*" as one of the four principles concerning the fundamental rights at work. Also, UN Global Compact (2017) lists freedom of association in its "Ten Principles of the UN Global Compact" to promote corporate sustainability.

Apart from being a fundamental right, freedom of association is a "*prerequisite for sound collective bargaining and social dialogue*" and, hence, essential for a pleasant and progressive working environment which assures a sustainable and efficient economic development (see ILO 2016).

In concrete, employers and workers must have the right to strike, the right to draw up their constitutions and rules within an organization, to elect their representatives in full freedom, to organize their activity freely and to formulate their programmes (see UNEP/SETAC 2013, p. 88). This subcategory aims to verify to what extend these conditions are met within different industries and countries. This is measured by the indicators "*Trade union density*", "*Right of Association*", "*Right of Collective bargaining*" and the "*Right to Strike*".

4.1.8.1 Trade union density

This indicator serves to assess how liberal and vivid trade union culture is, and, in the end, to what degree the right to organize freely is assured in different sectors. It is defined by ILO (2017[7]) as follows:

> *"A trade union is defined as a workers' organization constituted for the purpose of furthering and defending the interests of workers. This trade union density rate conveys the number of union members who are employees as a percentage of the total number of employees. "*

Hence, the indicator can be used to evaluate the degree of workers´ organization. Nevertheless, Hayter and Stoevska (2009, p. 2) state:

[7] Indicator „Trade union density rate"

> *"union density only measures the extent of unionisation and tells us very little about the influence or bargaining power of unions [...] In some countries, such as France, trade union density rates may be considered comparatively low, however collective bargaining plays a significant role in regulating terms and conditions of employment and the coverage of workers by collective agreements is high. On the other hand, in countries such as those of the former Soviet Union and in regimes where a single union system prevails, trade union density rates may be comparatively high, but this is neither a reflection of the strength of the union nor a measure of freedom of association."*

Trade union density, therefore, can only be seen as a proxy to get an overall impression of association culture in different industries and countries. To evaluate the actual freedom of association in countries "trade union density rates should always be interpreted within their particular political and social context" (Hayter, Stoevska 2009, p. 2). For a more comprehensive picture of the freedom of association and collective bargaining, the latter – considered as significant to regulate working conditions (see ibid.) – is measured by separate indicators (see chapter 0).

Data collection and attribution

Data is collected from the indicator "*Trade union density rate*" from ILOstat database (ILO 2019). In contrast to the previous version, the data is provided for years 2013-2016. ILO´s measurement procedure is specified as follows:

"For the purpose of this indicator in particular, trade union membership excludes union members who are not in paid employment (self-employed, unemployed, retired, etc.), unless otherwise stated in the notes. The statistics presented in this table result from a collaboration between the ILO and J. Visser, ICTWSS Database, version 5, AIAS. (ILO 2019)

Always the most current data points per country were selected. Updated values are available for 79 countries. The remaining countries were assigned an average across all countries within adequate country groups (see chapter 3.4.2, case 3c). In these cases, mean values were also calculated for years. All mapping procedures and the temporal conformance are reflected in data quality assessment.

Risk assessment: Risk that employees are not allowed to organise in trade unions

Since the right to organise in trade unions is fundamental to defend workers´ interests and rights collectively, higher density rates are basically considered as an indication for better or more liberal association conditions. Of course, this assumption is restricted by the claims made in the introductory part of this chapter.

The risk levels are based on an equal distribution of values between 0 and 100%.

Indicator value y, %	*Risk level*
20 ⩾ y	*very high risk*
20 < y ⩽ 40	*high risk*
40 < y ⩽ 60	*medium risk*
60 < y ⩽ 80	*low risk*
80 < y	*very low risk*

4.1.8.2 Right of Association, Right of Collective bargaining, Right to Strike

These three indicators shall verify to what degree rights of association, collective bargaining and to strike are assured in different industries and countries, regardless of the number or density of trade unions.

Data collection and attribution

Data is derived from the *Database on Institutional Characteristics of Trade Unions, Wage Setting, State Intervention and Social Pacts* (ICTWSS) that compiles datasets regarding workers´ rights, Wage Setting; Social Pacts and Agreements, Works Councils and employee representation in the enterprise (5); Employer organization; Union density and bargaining and others for 51 OECD, EU and emerging countries since 1960 (Visser 2015, p. 5). When updating these indicators for PSILCA v.3, version 460 of the database was available with most current data for 2017. The indicators *Right of Association, Right of Collective bargaining* and *Right to Strike* were selected as reference.

To collect information for her database, Visser (2015, p. 5ff) refers to relevant literature, own studies and to the ILO Natlex legal database (NATLEX – Database of national labour, social security and related human rights legislation).

These indicators are measured semi-quantitatively by a 4-point-scale "with separate entries for the private or market sector and the government sector, defined as the general government, including public administration, defence, compulsory social insurance, education, health and social work" (Visser 2015, p. 8). Consequently, all Eora sectors were mapped either to market or to government sector if data for the according country was available. All other countries remain without data.

The rating scales for each indicator and sector are defined in Table 4.

Table 4: Rating scales for different indicators in ICTWSS
(adapted from Visser 2015, p. 13f.)

Score	*Right of association*		*Right of collective bargaining*		*Right to strike*	
	Market	*Government*	*Market*	*Government*	*Market*	*Government*
3	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
2	*Yes, with minor restrictions (e.g. recognition procedures, workplace elections, thresholds)*	*Yes, with minor restrictions (e.g., recognition procedures, thresholds, only military, judiciary or police excluded – as per ILO convention)*	*Yes, with minor restrictions (e.g. registration, thresholds)*	*Yes, with minor restrictions (e.g. registration, thresholds, only military, judiciary or police excluded – as per ILO convention)*	*Yes, with minor restrictions (e.g. recognized union, balloting, proportionality, respect of peace obligation)*	*Yes, with minor restrictions (e.g. recognized union, balloting, proportionality, respect of peace obligation, only military, judiciary or police excluded – as per ILO convention)*

1	*Yes, with major restrictions (e.g. monopoly union, prior authorization, major groups excluded)*	*Yes, with major restrictions (e.g., monopoly union, government authorization, major groups excluded)*	*Yes, with major restrictions (e.g. monopoly union, government authorization, limitations on content, major groups excluded)*	*Yes, with major restrictions (e.g. monopoly union, government authorization, limitations on content, major groups excluded)*	*Yes, with major restrictions (e.g. monopoly union, compulsory arbitration or conciliation, restrictions on issues or content, major groups excluded)*	*yes, with major restrictions (e.g. monopoly union, compulsory arbitration or conciliation, restrictions on issues or content, major groups excluded)*
0	*No*	*No*	*No*	*No*	*No*	*No*

<u>Risk assessment: Risk that association rights of workers are restricted</u>

Right of Association, Right of Collective bargaining and Right to Strike are fundamental to assess the subcategory "Freedom of association and collective bargaining". Measured by a 4-point-scale these indicators provide valuable qualitative information about the extent of organization and associations rights within different industries and countries. Of course, being statistics data does not apply to every single company or every specific sector directly. However, information goes beyond a simple Yes/No analysis of overall situations in a country.

<u>Risk levels for each indicator are assigned to the four scores as indicated in the following table.</u>

Indicator value y, score	*Risk level*
y = 3	*no risk*
y = 2	*low risk*
y = 1	*high risk*
y = 0	*very high risk*
-	*no data*

4.2 Stakeholder Local Communities

4.2.1 Subcategory Access to material resources

<u>Overview</u>

The idea behind this subcategory is to assess whether the access of local communities to material resources is restricted because of commercial or industrial activities in their regions. Reason is that "expanding operations carry the potential for depletion of and conflict over natural material resources (e.g. water, forest land, homelands), especially in emerging or unstable countries." (UNEP/SETAC 2013, p. 38). Therefore, organizations and industries should, on the one hand, respect and protect community access to local material resources (i.e. water, land, mineral and biological resources) by preventing, mitigating and controlling environmental damage. On the other hand, they should work to facilitate access for communities, e.g. by building new infrastructure (see ibid.).

To describe this subcategory the level of industrial water use, the extraction of other material resources, the presence of certified environmental management systems and the potential of material resource conflicts are assessed.

4.2.1.1 Level of industrial water use

The level of industrial water use is the quantity of freshwater, desalinated water and treated wastewater withdrawn for industrial purposes related to *total water withdrawal* (for agricultural, industrial and municipal use) and to *total actual renewable water resources* (see Food and Agriculture Organization (FAO) 2017).

While the first sub-indicator describes the importance of industrial water use compared to other water uses, the second "parameter is an indication of the pressure on the renewable water resources." (ibid.). Furthermore, it can be assumed that high levels of water withdrawal are accompanied by high levels of water pollution. Therefore, high values of industrial water use are associated with different risks for local communities, e.g. health risks, destruction of local economic structures (e.g. agricultural practices) and an overall deterioration of quality of life.

Values are provided in percentages per year.

Data collection and attribution

The AQUASTAT database from FAO (2017) provides comprehensive water statistics for 200 countries. The two sub-indicators are calculated according to the following formulas:

$$level\ of\ industrial\ water\ use, \%\ of\ total\ withdrawal\ = \frac{Total\ Industial\ Water\ Withdrawal}{Total\ Water\ Withdrawal} \cdot 100\% ;$$

$$level\ of\ industrial\ water\ use, \%\ of\ total\ actual\ renewable = \frac{Total\ Industial\ Water\ Withdrawal}{Total\ Renewable\ Water\ Resources} \cdot 100\% ;$$

This way, data could be gathered for 135 and 86 countries. For the remaining countries old data was taken to fill the information gap in compare with previous version of the database. The rest of the data was attributed based on the combination of best fitting economic-geographical groups.

Some values demonstrate data anomaly. It is valid for two countries namely Singapore and Kuwait. It might be related with the external processes within these two countries for the given years.

Risk assessment: Risk that industry accounts for a large share of water withdrawal

The following risk scale is used for the indicator "Level of industrial water use (related to total withdrawal)". It is oriented towards the mean value across all countries.

Indicator value y, %	*Risk level*
0 ⩽ y < 10	*very low risk*
10 ⩽ y < 20	*low risk*
20 ⩽ y < 30	*medium risk*
30 ⩽ y < 40	*high risk*
40 ⩽ y	*very high risk*
-	*no data*

Risk assessment: Risk of a high pressure on renewable water resources

The following risk scale is used for the indicator "Level of industrial water use (related to renewable water resources)". According to the definition of water stress, extreme water stress occurs when total withdrawal exceeds 40% of the total renewable water resources (Climate Service Center 2015). Assuming that industrial water withdrawal makes up around one third of total withdrawal on an average (see "Level of industrial water use (related to total withdrawal)") the proportion of industrial water withdrawal of total resources should not exceed 13%.

Based on these findings, the following risk scale is created.

Indicator value y, %	*Risk level*
0 ⩽ y < 1	*very low risk*
1 ⩽ y < 3	*low risk*
3 ⩽ y < 7	*medium risk*
7 ⩽ y < 13	*high risk*
13 ⩽ y	*very high risk*
-	*no data*

[Changes to PSILCA version 2:

- More recent values from 2017
- Updated data quality assessment for the old datasets]

4.2.1.2 Extraction of material resources (other than water)

Besides water, there are other material resources directly or indirectly important for local communities and organizations, mainly fossil fuels, biomass, ores and minerals. They play a vital role because they can be communities' base of life and economy. Consequently, the exploitation and destruction of natural resources can cause resettlements, poverty, cultural uprooting and, in the end, conflicts with local people.

For this indicator, the total extraction of fossil fuels, biomass, ores and minerals on a country level was chosen. Values are given in tons per capita, and for biomass, additionally, in tons per km^2.

Data collection and attribution

Data was taken from www.materialflows.net (SERI 2017), an online portal that provides comprehensive data about material flows and human´s material consumption. Data for the total extraction of the above-mentioned resources in 2015 was used. The exception is extraction of total biomass with the data from 2017. It is provided for several countries between 120 and 182 depending on the indicators. Countries without any data did not get a value.

Risk assessment: Risk of conflicts due to a restricted access of local communities to material resources

The risk assessment for the individual indicators is not straightforward. To really assess the exhaustion of raw materials information about the criticality of the resources is missing, i.e. extraction levels should be related to available reserves. Furthermore, it is not always clear how to evaluate high values of resource extraction per capita. They can either result from relatively small populations dispersed on huge areas or from elevated resource extractions.

The following examples illustrate this discrepancy: Australia and China have similar normalized levels of extraction of minerals in 2015 (8.35 t/cap and 12.73 t/cap respectively) while the population of China is almost 60 times higher than the population of Australia (on nearly the same area).

For Australia, the risk for communities to be affected by resource extraction is rather low because people not necessarily live close to deposits of raw materials. On the contrary, in China, many more persons are – at least potentially – affected. Hence, normalization with the population density might make more sense.

In addition to this, it can be discussed whether high levels of resource extraction only harm local communities because of environmental destruction, or if they considerably contribute to local economic development through infrastructure such as schools, or roads.

As these reflections cannot be answered with the currently available data, it was decided, for the risk assessment, that the higher the extraction levels the higher the risk for local communities to be negatively affected. In the following, the risk scales for each sub-indicator are presented. All are related to the average values across all countries.

Risk assessment: Extraction of fossil fuels

Indicator value y, t/cap	*Risk level*
0 ⩽ y < 10	*very low risk*
10 ⩽ y < 20	*low risk*
20 ⩽ y < 30	*medium risk*
30 ⩽ y < 50	*high risk*
50 ⩽ y	*very high risk*
-	*no data*

Risk assessment: Extraction of ores

Indicator value y, t/cap	*Risk level*
0 ⩽ y < 5	*very low risk*
5 ⩽ y < 10	*low risk*
10 ⩽ y < 15	*medium risk*
15 ⩽ y < 20	*high risk*
20 ⩽ y	*very high risk*
-	*no data*

Risk assessment: Extraction of industrial and construction minerals

Indicator value y, t/cap	*Risk level*
0 ⩽ y < 2,5	*very low risk*
2,5 ⩽ y < 5	*low risk*
5 ⩽ y < 10	*medium risk*
10 ⩽ y < 15	*high risk*
15 ⩽ y	*very high risk*
-	*no data*

Risk assessment: Extraction of biomass (related to population)

Indicator value y, t/cap	Risk level
0 ≤ y < 2,5	very low risk
2,5 ≤ y < 5	low risk
5 ≤ y < 10	medium risk
10 ≤ y < 15	high risk
15 ≤ y	very high risk
-	no data

Risk assessment: Extraction of biomass (related to area)

Indicator value y, t/km²	Risk level
0 ≤ y < 200	very low risk
200 ≤ y < 400	low risk
400 ≤ y < 600	medium risk
600 ≤ y < 800	high risk
800 ≤ y	very high risk
-	no data

[Changes to PSILCA version 2:

- More recent values from 2015 and 2017
- Updated data quality assessment for the old datasets
- Larger country coverage]

4.2.1.3 New: GHG, Labour, and other Environmental Footprints by sector.

The newest version of the PSILCA database contains several new indicators which reflect various footprints in respect to a production sector in 189 countries. The footprints describe inputs in different economic sectors based on the initial indicators.

Embodied agricultural area footprint

The embodied agricultural area footprint indicates the ratio between hectares of affected agricultural land in relation to 1 dollar of product output.

Embodied forest area footprint

The embodied forest area footprint indicates the ratio between hectares of affected forest land in relation to 1 dollar of product output.

Embodied water footprint

The embodied water footprint indicates the ratio between cubic meters of affected blue water in relation to 1 dollar of product output.

Embodied CO2 footprint and Embodied CO2-eq footprint

The embodied CO2 and Embodied CO2-eq footprint as a ratio of tons CO2 and CO2-eq of total greenhouse gases per 1 dollar of output respectively.

Embodied value-added total per 1 dollar of output

The embodied value-added total reflects an average value of the difference between the sale price and the production cost in relation to 1 dollar of the output product within various sectors.

Number of threatened species

The indicator reflects number of threatened species as a ratio of affected animals per 1 dollar of output in respect to different production sectors.

Data collection and attribution

The data is reported for scope 1 coefficients, for everyone unit ($1) of a good or service sold, the direct intensity of how much of various nonmonetary factors were used to produce that output. For example, influence of a chemical production sector on the blue water per one dollar of output.

The following risk scales are used to assess the risk levels. It is based on the range of the values.

Risk assessment: Embodied agricultural area footprint

Indicator value y, ha/$1	*Risk level*
y ⩽1e-7	*very low risk*
1e-7⩽y < 1e-5	*low risk*
1e-5⩽y <1e-4	*medium risk*
1e-4⩽y < 1e-2	*high risk*
1e-2< y	*very high risk*
0	*no risk*
-	*no data*

Risk assessment: Embodied forest area footprint

Indicator value y, ha/$1	*Risk level*
y ⩽1e-5	*very low risk*
1e-5⩽y < 0.0004	*low risk*
0.0004 ⩽y <0.002	*medium risk*
0.002⩽y <	*high risk*
0.2< y	*very high risk*
0	*no risk*
-	*no data*

Risk assessment: Embodied water footprint

Indicator value y, Mm3/$	*Risk level*
y ⩽1e-7	*very low risk*
1e-7⩽y < 1e-6	*low risk*
1e-6⩽y <1e-5	*medium risk*
1e-5⩽y <	*high risk*
1e-4<y	*very high risk*
0	*no risk*
-	*no data*

Risk assessment: Embodied CO2 footprint

Indicator value y, t per $	Risk level
y≤ 2e-18	very low risk
2e-18 ≤y < 1e-10	low risk
1e-10≤y <1e-10-6	medium risk
1e-10-6≤y < 0.00035	high risk
0.00035< y	very high risk
0	no risk
-	no data

Risk assessment: Embodied CO2-eq footprint

Indicator value y, t per $	Risk level
y≤ 1e-47	very low risk
1e-47≤y < 1e-27	low risk
1e-27≤y <1e-10-3	medium risk
1e-10-3≤y <0.1	high risk
0.1< y	very high risk
0	no risk
-	no data

Risk assessment: Embodied value-added total

Indicator value y, $/$	Risk level
y≤0.1	very high risk
0.1≤y < 0.25	high risk
0.25≤y <0.45	medium risk
0.45≤y < 0.6	low risk
0.6< y	very low risk
0	no risk
-	no data

Risk assessment: Number of threatened species

Indicator value y, # species/$1	Risk level
y≤1e-9	very low risk
1e-9≤y < 1e-8	low risk
1e-8≤y <1e-7	medium risk
1e-7≤y < 1e-9-6	high risk
1e-9-6< y	very high risk
0	no risk
-	no data

4.2.1.4 Certified environmental management systems

This indicator assesses the number of certified environmental management systems (EMS) per sector, in relation to the number of employees in the same sector. Idea is to take the existence of certified EMS as a proxy for the commitment of companies in a sector to environmental protection. ISO 14001 certifications are considered as certified EMS. Values are given in numbers of ISO certifications per 10,000 employees.

Data collection and attribution

Data was taken from the ISO Survey of Management System Standard Certifications (2013-2017) and the ISO Survey of Management System Standard Certifications 2018 – Industrial Sectors (ISO 2017). The documents provide the numbers of different ISO certifications for 185 countries (relevant for PSILCA) and 40 industry sectors. Only the number of ISO 14001 certifications were selected and divided by the number of employees in the respective sector and country. Data on employment is provided by ILOSTAT (ILO 2017), "Employees by sex and economic activity (Thousands)"). In case no information about the number of employees was available for a specific sector, the number of certified EMS was divided by the mean number of employees over all sectors in the country. For 19 of the countries with data regarding ISO certifications, no information was available for the number of employees to normalize. Hence, the information on risk levels were taken from the previous version of the database.

After normalising the values, sector-specific data was mapped to matching sectors and countries in Eora (as described in chapter 3.4.2.). Countries without any value were assigned a "*no data*".

Risk assessment: Risk of environmental damage

Risk levels are based on the normalised values (except for those countries without values for employees). These values are not adjusted, i.e. facts like the potential of the sector to pollute the environment and, therefore, the need for environmental management systems, are not considered. The risk scale was adjusted as the new time range (2013-2017) is shorter and contains smaller values in compare with the previous scale.

The following risk scale is used to assess the risk levels. It is based on the range of the values.

Indicator value y, # per 10,000 employees	*Risk level*
0.1 ⩽ y	*very low risk*
0.01 ⩽ y < 0.1	*low risk*
0.005 ⩽ y <0.01	*medium risk*
0.0005 ⩽ y < 0.005	*high risk*
y < 0.005	*very high risk*
-	*no data*

[Changes to PSILCA version 2:

- More recent values
- Updated data quality assessment for the old datasets
- Larger country coverage
- Updated risk assessment scale]

4.2.2 Subcategory Respect of indigenous rights

Indigenous peoples have been living in many territories of the world long before colonialization and "civilization". Contrary to common practices in past and present, their human rights must be respected in order to ensure peaceful coexistence and conserve important cultural heritage. Regarding indigenous rights UNEP/SETAC (2013, p. 26) state the following:

> *"Respect of indigenous rights includes the right to lands, resources, cultural integrity, self-determination and self-government. Historically, states have denied many indigenous populations these rights."*

Therefore, "*organizations [companies and governments] should engage with indigenous peoples to obtain consent for actions that may affect their rights.*" (ibid.).

This subcategory assesses the risk of undermining indigenous rights by specific sectors and countries. First it is verified if indigenous peoples exist in the country and based on that the general situation of their human rights and companies' respect of indigenous rights are assessed.

4.2.2.1 Presence of indigenous population

This indicator serves to verify if the subcategory is relevant for the country and its industry sectors. It is measured on a country level by yes or no.

Data collection and attribution

Information was gotten from the list of indigenous peoples (Wikipedia 2015a). It lists all indigenous peoples as officially defined by international organizations by regions and countries. Countries with at least one indigenous tribe are assigned a yes. Countries not appearing in this list but that have ratified the "Indigenous and Tribal Peoples Convention" (ILO 1989) are also assumed to have indigenous population. Furthermore, if there is a report available about the rights of native peoples in a specific country (Office of the United Nations High Commissioner for Human Rights (OHCHR) 2015) it also got a "*yes*".

The indicator was not updated as presence of indigenous people is a quite stable parameter, thus the sub-indicator was not updated in the version 3.0.

Risk assessment: Relevance of subcategory

As mentioned before, "risk levels" for this indicator are rather a basis for decision-making if the subcategory is relevant for a country.

Indicator value y, yes/no	*Risk level*
no	*No risk*
yes	*Medium risk*

4.2.2.2 Indigenous People Rights Protection Index

This indicator is supposed to describe and assess the legal situation of indigenous peoples. In fact, this is a qualitative indicator that is difficult to assess, which calls for a careful investigation not yet carried out. For the time being, the indicator is assessed by three proxies: ratification of the "*Indigenous and Tribal Peoples Convention, 1989 (No. 169)*" (ILO 1989), availability of a UN report on the rights of indigenous peoples (OHCHR 2018), and adoption of the UN "*Declaration on the rights of indigenous peoples*" (UN Department of Economic and Social Affairs DESA 2007). Based on these proxies a score was calculated in order to define risk levels.

Data collection and attribution

First of all, only the countries with indigenous population were considered (see chapter 4.2.2.1). For the remaining ones the indicator is not applicable. Countries that ratified ILO convention No. 169 (ILO 1989) got one point, countries that didn´t 0 points. If a UN report was available (OHCHR 2018), for a country it also got 1 point, otherwise 0 points. Regarding the adoption of the Declaration on the rights of indigenous peoples (UN-DESA 2007), there were several options: countries that voted for the adoption received 3 points, countries abstaining from voting and those that are not members of the UN General Assembly received 2 points, absent countries got 1 point, and countries voting against the adoption received 0 points.

The final score for each country was calculated by summing up the individual points scaling the legal situation of indigenous peoples between all the countries.

Risk assessment: Risk of a precarious legal situation regarding human rights of indigenous peoples

According to the score the following risk scale is developed.

Indicator value y, score	*Risk level*
y ⩾ 6	*very low risk*
y = 4	*low risk*
y = 3	*medium risk*
y = 2	*high risk*
y = 1 or 0	*very high risk*
–	*no data*
	not applicable

[Changes to PSILCA version 2:

- More recent data on the final score of countries
- Updated risk assessment scale]

4.2.3 Subcategory Safe and healthy living conditions

This subcategory assesses the state of safety and health for communities, and it evaluates the influence of industries and organizations on living conditions. In PSILCA, the focus of this category is on contributions to healthy living conditions. So, companies or whole industry sectors may increase the risk of diseases such as cancer for surrounding communities, by the release of hazardous material, by emissions, or due to poor water drainage. Consequently, companies and organizations should control health damage from their operations and reduce health impacts to a minimum. "*Organizations culpable for negative health effects should engage in remediation or compensation efforts*" (UNEP/SETAC 2013, p. 43), e.g. by building hospitals or extending water supply and sanitation coverage.

In this subcategory, the indicator "Contribution of the sector to environmental load" expresses the risk of negative health effects by specific industries due to the emission of different components. The other indicators describe the related context within that emissions occur, influencing their impacts. These are "*Pollution level of the country*", "*Drinking water coverage*" and "*Sanitation coverage*". It makes sense to assess the subcategory as a whole because communities living in countries or regions with high pollution levels and/or low water supply are much more vulnerable to health risks caused by the emissions than people in regions with clean air and water.

The indicator "*Certified environmental management systems*", already described within the subcategory "*Access to material resources*" (see chapter 4.2.1) is an indication for the engagement of companies to mitigate environmental, and therefore, health impacts.

4.2.3.1 Contribution of the sector to environmental load

This indicator measures the emissions of different gases and chemical compounds into air per sector and, therefore, a sector´s contribution to environmental pollution, global warming and, finally, health risks. It is evaluated for 6 emissions: Carbon monoxide (CO), Non-methane volatile organic compounds (NMVOCs), Nitrogen oxides (NOx), Atmospheric particulate matter (PM_{10}), Sulfur dioxide (SO_2), and Carbon dioxide equivalents (CO_2-equiv.).

These emissions have negative impacts on the environment, e.g. by acid rain, and increase the greenhouse gas effect. Health risks associated with these compounds are mainly respiratory symptoms and diseases, but also lung cancer, cardiovascular disease, premature delivery, birth defects, low birth weight, and premature death (Wikipedia 2017).

Data collection and attribution

The values for the different emissions are provided sector-wise in the Eora database (2015). Hence, they could be mapped directly to the respective sectors. For industries related to re-export and re-import and many financial intermediation services sectors, no values were available. For nine countries (Gaza Strip, Serbia, Montenegro, Andorra, South Sudan, Monaco, San Marino, Liechtenstein, Sudan) there is no information.

Data is mainly from 2013, only single values are older.

For a better comparison, the values were divided by the sector´s gross domestic product. The unit is kg per USD.

Risk assessment: Risk of health and environmental risks due to different compounds

The risk scales reflect the exponential distributions of the data points.

Risks related to CO, NMVOCs, NOx, PM10, SO2

Indicator value y, index	*Risk level*
0	*no risk*
0 < y ≤ 1e-7	*very low risk*
1e-7 < y ≤ 1e-6	*low risk*
1e-6 < y ≤ 1e-5	*medium risk*
1e-5 < y ≤ 5e-4	*high risk*
y > 5e-4	*very high risk*
-	*no data*

Risks related to CO_2-equiv.

Indicator value y, index	*Risk level*
0	*no risk*
0 < y ⩽ 1e-5	*very low risk*
1e-5 < y ⩽ 1e-4	*low risk*
1e-4 < y ⩽ 1e-3	*medium risk*
1e-3 < y ⩽ 1e-2	*high risk*
y > 1e-2	*very high risk*
-	*no data*

4.2.3.2 Pollution level of the country

This indicator assesses the overall level of pollution in a country in order to describe the situation in that a company or industry is operating. Hence, it provides information about the importance of clean economic activities and compensation efforts.

Data is based on the pollution index by Numbeo (Numbeo.com 2019a). The index refers to different types of contamination in cities.

"The biggest weight is given to air pollution, than [sic!] to water pollution/accessibility, two main pollution factors. Small weight is given to other pollution types." (ibid.)

Some other pollution types are:

- Garbage disposal
- Cleanliness and tidiness of the city
- Noise pollution and light during the night in the city
- Green and parks in the city (see ibid.)

This index is based on a survey carried out among visitors of the website, and official data from WHO and other institutions (ibid.). This makes it possible to include the actually perceived pollution by inhabitants and its impacts on their living conditions.

It makes sense to extrapolate the pollution levels of cities to the whole country because cities usually record highest contamination, many people live there and suffer from pollution and, furthermore, most industries are located in or close to urban areas that contribute but can also reduce emissions. Pollution index is therefore a suitable indicator to assess safe and healthy living conditions of local communities.

<u>Data collection and attribution</u>

As already mentioned, data refers to the pollution index gathered from Numbeo (Numbeo.com 2019a). The survey data is based on visitors' perceptions not older than 3 years (from the publication date). The indices basically range between 0 and 100 and are calculated by scoring and weighting the survey entries and data from renowned institutions.

Data in PSILCA v3 refers mainly to 2019. Only for 21 countries no updated values were provided, hence, data from 2014 and 2017 was used. Values are provided for 109 countries. The other countries remained without value.

Risk assessment: Risk of high pollution levels

The risk levels are equal intervals of 20 index points with indices below 20 considered as very low risk, and indices over 80 meaning very high risk of pollution. This coincides with the evaluation scale of the survey results (see Numbeo.com 2019a).

Indicator value y, index	*Risk level*
y < 20	*very low risk*
20 ⩽ y < 40	*low risk*
40 ⩽ y < 60	*medium risk*
60 ⩽ y < 80	*high risk*
y > 80	*very high risk*
-	*no data*

[Changes to PSILCA version 2:

- More recent values from 2019
- Updated data quality assessment for the old datasets
- Larger country coverage]

4.2.3.3 Drinking water coverage

This indicator serves to assess the availability and accessibility of uncontaminated water for domestic use. Data for drinking water coverage is based on information about the share of population with access to a safely managed improved water source:

"'Improved' sources are those that are potentially capable of delivering safe water by nature of their design and construction. These include piped water, boreholes or tube wells, protected dug wells, protected springs, and rainwater." (WHO 2017, p. 13)

Now, to meet the threshold for a "safely managed" service, the improved water source must comply with the three following conditions:

"• source should be located on premises (within the dwelling, yard or plot),

• water should be available when needed, and

• water supplied should be free from faecal and priority chemical contamination." (ibid.)

If any of the three criteria is not fulfilled and a roundtrip to the next available improved water source is less than 30 minutes roundtrip away from home, the service is classified as "basic access" (see ibid.). Although data coverage for the basic service is much broader, it was decided to use values for "safely managed" because it refers to a water supply free from faecal and priority chemical contamination. According to the above cited definition, "basic access" is no indication for uncontaminated water.

As the indicator also indirectly shows the share of the population without access to an improved drinking water source, it serves to assess the vulnerability of populations and local communities to water pollution and water shortages. Hence, people's exposure to diseases can be derived. Vice versa, the indicator provides information about the potential for companies to engage in improving water treatment and water supply.

Data collection and attribution

The indicator consists of 3 sub-indicators namely Urban, Rural and the total percentage of drinking water coverage. If one of the sub-indicators does not fit into the range of 85-100%, then the indicator does not comply with the overall threshold for the drinking water coverage and was marked as a failed one. That is why some of countries with relatively high level of the drinking water coverage were given a high risk of possible social impacts.

Data was gathered from WHO/UNICEF Joint Monitoring Programme for Water Supply, Sanitation and Hygiene (WHO/UNICEF 2017) which provides comprehensive data about water infrastructure for several years in urban, rural and national areas worldwide. The most current values, from 2015 were selected.

Due to the new and more specific definition, values for "safely managed" drinking water cover only 88 countries. Countries without this specific information received data from "at least basic" drinking water provision. Since this coverage is usually better for basic water supply, i.e. the values are higher, the risk assessment was adapted. Hence, risk levels given in the table below are valid for the next lower range of values. Only Former USSR and Taiwan remained without data.

Risk that people do not have access to safely managed drinking water

According to the definition of "safely managed", the given values theoretically only refer to a water supply free from any contamination located on premises. This means that the share of people with basic access to an improved water source, or even limited or no access, are either potentially in danger of using contaminated water, or safe drinking water is not always available or accessible. The latter implies that water might be stored for several hours or days because of convenience which in turn can hold the risk of diseases. Therefore, only very high percentages of drinking water coverages are considered as very low risk.

These risk scales are adapted if data for "at least basic" drinking water coverage was used (see above).

Indicator value y, %	*Risk level*
100 = y	*no risk*
95 < y < 100	*very low risk*
90 < y ⩽ 95	*low risk*
85 < y ⩽ 90	*medium risk*
80 < y ⩽ 85	*high risk*
y ⩽ 80	*very high risk*
-	*no data*

4.2.3.4 Sanitation coverage

For this indicator, values for the proportion of the population using improved and safely managed sanitation facilities were selected. This indicator also follows a definition by the World Health Organization where "safely managed" means:

> "*Use of improved facilities which are not shared with other households and where excreta are safely disposed in situ or transported and treated off-site [...] Improved facilities include: flush/pour flush to piped sewer system, septic tanks or pit latrines [sic!]; ventilated improved pit latrines, composting toilets or pit latrines with slabs*" (WHO/UNICEF 2017)

Populations with lower sanitation coverage are exposed to a higher risk of infectious diseases and epidemics. Assuming that low access to improved and safely managed sanitation facilities is accompanied by lower water treatment rates, the indicator also provides information about general water quality (e.g. because wastewater might be piped directly into rivers). This should motivate companies to improve sanitation facilities.

Data collection and attribution

As for "Drinking water coverage" data was also gathered from WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation (WHO/UNICEF 2017). Values are generally from 2015. Countries without raw values got an average over similar countries.

Risk assessment: Risk that population does not have access to facility safely managed sanitation service

Indicator value y, %	*Risk level*
100 = y	*no risk*
95 < y < 100	*very low risk*
90 < y ⩽ 95	*low risk*
85 < y ⩽ 90	*medium risk*
80 < y ⩽ 85	*high risk*
y ⩽ 80	*very high risk*
-	*no data*

Considering that the percentage values also include pit latrines and composting toilets the remaining population indeed has no access to an appropriate sanitation facility. Therefore, only very high percentages of sanitation coverage are considered as very low risk of insufficient sanitation facilities.

4.2.4 Subcategory Local employment

Local employment improves the living conditions of communities, limits the risk of poverty and keeps people from emigrating. Cooperation with local suppliers further strengthens local economies, expands supply and promotes regional development. Besides advantages for local communities all these facts prevent the development of trans-regional or global problems, e.g. resulting from migration, high unemployment rates or poverty.

Within this subcategory, the unemployment rate of a country is taken as a basis for the evaluation of the share of work force hired locally, and for the percentage of spending on locally based suppliers.

4.2.4.1 Unemployment rate

"The unemployment rate is the number of persons who are unemployed as a percent of the total number of employed and unemployed persons (i.e., the labour force)." (ILO 2017, "Unemployment rate by sex, age and rural / urban areas")

The indicator serves to describe the employment situation in a country and to derive assumptions about the importance of local employment.

Data collection and attribution

Data was taken from the parameter "Unemployment rate by sex, age and rural / urban areas" provided for national, rural and urban areas per countries by ILOSTAT (ILO 2017). The most current values for the total population (not distinguished between men and women), between 15 and 64 years, national coverage, were selected. In total, values are available for 71 countries. The remaining were not assigned any value.

Risk assessment: Risk of unemployment in the country

Full employment is the aim of every economy. However, due to always existing frictional and structural unemployment, full employment does not mean an unemployment rate of 0% but lies somewhere above. Recognised economists argue about the acceptable level of unemployment setting it between 2% and 7% or even 13% depending on the country (see Investopedia 2015, Wikipedia 2015b). For the risk assessment, the theory of the British economist William Beveridge is followed considering 3% unemployment as full employment (and therefore very low risk) (see ibid). The other risk levels are developed on this basis, also regarding the range of unemployment rates within the different countries.

Indicator value y, %	*Risk level*
0 ⩽ y < 3	*very low risk*
3 ⩽ y < 8	*low risk*
8 ⩽ y < 13	*medium risk*
13 ⩽ y < 18	*high risk*
18 ⩽ y	*very high risk*
-	*no data*

[Changes to PSILCA version 2:

- More current values for most countries]

4.2.5 Subcategory Migration

Migration is a multi-facetted phenomenon. Reasons for emigration range from economic crises to political unrests or wars to climate hazards. Additionally, *"involuntary resettlement may occur if organizations directly or indirectly dispossess individuals or groups of individuals of their land or resources*." (UNEP/SETAC 2013, p. 14). The selection of countries for immigration depends on the economic and political situation, geography, legislation but also on cultural similarities with the country of origin.

Apart from the reasons for migration, consequences for countries and economies can vary at large, e.g. due to the demographic structure. Hence, migration involves challenges for governments and local companies, e.g.: Shall a government promote immigration, specifically labour migration? How can migrants be integrated well in the labour market? How is the health and legal situation of migrants? If operations require human relocation, concerns have to make sure that affected groups do not suffer (too much) from it. This is ensured by appropriate compensation, adequate relocation and the provision of legal remedied (see UNEP/SEATC 2013, p. 14).

Based on these reflections, for the moment this subcategory assesses the overall situation of migrants per country in order to derive potential risks of conflicts or challenges for organizations. The indicators "International migrant workers in the sector", "International Migrant Stock" and "Net migration rate" are selected to this end. Issues concerning discrimination of migrant workers are considered in subcategory discrimination.

4.2.5.1 International migrant workers in the sector

The indicator provides information on the share of international migrant workers of the total employed population. It can be seen as an indication for potential conflicts (e.g. religious, racial, or discrimination related).

Data collection and attribution

Data is based on ILOstat (ILO 2019) which provides international labour migration statistics disaggregated by economic activity according to the latest version of the International Standard Industrial Classification of All Economic Activities (ISIC Rev.4). "*Employed migrants refer to individuals who changed their country of usual residence and were also employed during a specified brief period [...]*" (ILO 2019). Values are provided as absolute numbers for the year 2017.

The used values are calculated by dividing the number of employed migrants by the total number of employees in the sector (also from ILOstat 2017). Only for 17 countries current data was provided. The other countries remain without data.

The initial data source of the indicator was replaced, as the former source was migrated to the ILOstat database. Some of the countries have almost 100% of migrants in the sector. Most of them are Arabic countries like Qatar, UEA, Kuwait and other countries of Arabic World which initially have large share of the migrants in the migrants as they employ large number of foreign labour force.

Risk assessment: Risk of conflicts, discrimination etc. due to high share of migrant workers in the sector and large difference to international migrant stock

Due to the multiple reasons and effects of high shares of migrant workers in some countries and sectors, the risk assessment is not straightforward. So, there are countries with traditionally high rates of international migrant workers that are required and more or less well-integrated, as Luxembourg or Brazil. In other countries with similar shares of migrant workers, their working conditions might look very different, as in Qatar, Kuwait or Bahrain. Values also should be relativized with regards to the total amount of immigrants in a country. If the international migrant stock in a country (see chapter 4.2.5.2) is very high, the share of international migrant employees in the labour force should also be rather high.

For the risk assessment, it is basically assumed that a high share of migrant workers holds a higher risk of discrimination, unfair working conditions and conflicts with local communities than lower shares. Additionally, it is supposed that a big difference to the migrant stock of a country can also trigger problems. This is considered by calculating the ratio between the migrant stock and the share of international migrant workers in the sector. For sectors without migrant workers (110 cases), the absolute difference to the migrant stock was considered, using the following risk scale:

Difference x ffi |2.5| = very low risk, |2.5| < x ffi |5| = low risk; |5| < x ffi |10| = medium risk, |10| < x ffi |20| = high risk, x > |20| = very high risk.

The following table shows the risk levels for all sectors with international migration rates higher than zero:

Indicator value y, %	*Logical connection*	*Ratio x (Int. migrants in sector / Int. migrants in country)*	*Risk level*
y = 0			*no risk*
		0.8 < x ⩽ 1.25	*very low risk*
0 < y ⩽ 2.5	*and*	*0.5 < x ⩽ 0.8 or 1.25 < x ⩽ 2*	*low risk*
		x ⩽ 0.5 or x > 2	*medium risk*
		0.8 < x ⩽ 1.25	*low risk*
2.5 < y ⩽ 5	*and*	*0.5 < x ⩽ 0.8 or 1.25 < x ⩽ 2*	*medium risk*
		x ⩽ 0.5 or x > 2	*high risk*
5 < y ⩽ 10	*and*	*0.8 < x ⩽ 1.25*	*medium risk*

Indicator value y, %	Logical connection	Ratio x (Int. migrants in sector / Int. migrants in country)	Risk level
		$0.5 < x \leqslant 0.8$ or $1.25 < x \leqslant 2$	high risk
		$x \leqslant 0.5$ or $x > 2$	very high risk
$10 < y \leqslant 20$	and	$0.8 < x \leqslant 1.25$	high risk
		$x \leqslant 0.8$ or $x > 1.25$	very high risk
$y > 20$			very high risk
-		-	no data

4.2.5.2 International migrant stock

"International migrant stock is the number of people born in a country other than that in which they live in relation to the population. It also includes refugees [...]" (World Bank 2017)

On the one hand, this indicator serves to put into perspective the shares of migrant workers in the labour force (see chapter 4.2.5.1). On the other hand, it can be an indication for the risk potential of discrimination, racism or social conflicts within a society.

Data collection and attribution

Data was taken from the World Development Indicators by World Bank (2017). The sub-indicator "International migrant stock (% of population)" was used selecting the most current value for 183 countries which was 2015. Only for the "Eora countries" Former USSR and Taiwan no data was available.

Risk assessment: Risk of discrimination, racism and social conflicts due to high immigration

It is assumed that the risk of racial discrimination and related social conflicts rises with the share of immigrants in a society. Therefore, the following risk scale is created according to the distribution of values.

Indicator value y, %	Risk level
$y = 0$	no risk
$0 < y < 2.5$	very low risk
$2.5 \leqslant y < 5$	low risk
$5 \leqslant y < 10$	medium risk
$10 \leqslant y < 20$	high risk
$20 \leqslant y$	very high risk
-	no data

4.2.5.3 Net migration rate

"Net migration rate compares the difference between the number of persons entering and leaving a country during the year per 1,000 persons (based on midyear population)" (CIA 2017)

Further, "*high levels of migration, whether in or out of a country, can cause problems relating to unemployment and, in some areas, a reduction or glut in a particular labor force.*" (BusinessDictionary 2015). Therefore, net migration should be close to 0‰ implying that this maintains labour markets stable. This, of course, might not be true for countries with an ageing population that need immigrants to fill vacancies. However, for the moment, this fact is not considered here.

Data collection and attribution

Data comes from the World Factbook (CIA 2017) where values are available for the year 2017 (except for the Netherlands Antilles with a value for 2014). The source did not provide data for the countries Former USSR and Montenegro.

Risk assessment: Risk of unemployment or excess of vacant positions

As mentioned above, high net migration rates can lead to unemployment or understaffing. Both situations limit economic development. Based on this assumption, the following risk scale is developed taking into account the dispersion of the values.

Indicator value y, 0‰	*Risk level*
y = 0	*no risk*
0 < y < |2.5|	*very low risk*
|2.5| ≤ y < |5|	*low risk*
|5| ≤ y < |10|	*medium risk*
|10| ≤ y < |15|	*high risk*
|15| ≤ y	*very high risk*
-	*no data*

[Changes to PSILCA version 2:

- More current values

4.2.5.4 New sub-indicator: Immigration rate

The immigration rate indicates social risks linked with a migrant inflow. The more migrants are in a certain country the more they influence on the job market. Therefore, it might lead to increase of social risks through the changes of salaries for certain positions as migrants are often take jobs with a salary lower than it is usually paid to other candidates. The high migrant inflow could also be a reason for the job shortage as the job market could offer only a limited number of positions for the residents of the country.

Data collection and attribution

Data comes from the OECD.Stat (OECD 2017a) where values are available for the year 2016 (except for Turkey with a value for 2010). The data is available for 34 countries, other countries remained with no data.

Risk assessment: Possible preconditions to social conflicts due to high immigration inflow

It is assumed that the risk of racial discrimination and related social conflicts might be preconditioned by the rise of immigrant's share in a society. Therefore, the following risk scale is created according to the distribution of values.

Indicator value y, %	*Risk level*
y < 0,004	*very low risk*
0,004 ≤ y < 0,008	*low risk*
0,008 ≤ y < 0,015	*medium risk*
0,015 ≤ y < 0,022	*high risk*
0,022 ≤ y	*very high risk*
-	*no data*

4.2.5.5 New sub-indicator: Emigration rate

The emigration rate indicates social risks linked with a migrant outflow. The more migrants leave a certain country the more they influence on the external job market. It might lead to brain drain and lack of specialist in high end sectors. It might lead to social risks through the underemployment and slow economy development. The high migrant inflow could also be a reason for the job shortage as the job market could offer only a limited number of positions for the residents of the country.

Data collection and attribution

Data comes from the OECD.Stat (OECD 2017a) where values are available for the time range 2006- 2016 (except for Turkey with a value for 2010). The data is available for 45 countries, other countries remained with no data.

Risk assessment: Possible preconditions to social risks due to high immigration outflow

Indicator value y, %	*Risk level*
y < 0,000851	*very low risk*
0,0008510 ⩽ y < 002751	*low risk*
002751 ⩽ y < 0,006151	*medium risk*
0,006151 ⩽ y < 0,01111	*high risk*
0,01111 ⩽ y	*very high risk*
-	*no data*

It is assumed that the risk of underemployment and related social risks might be preconditioned by the rise of migrant outflow in a society. Therefore, the following risk scale is created according to the distribution of values.

4.2.5.6 New sub-indicator: Asylum seekers rate

The asylum seekers rate indicates social risks linked with a high presence of people who yet have not underwent migration procedures. The high number of those people might bring additional risks related with radicalization among themselves due to social pressure and activity increase among anti-immigration movements (UNHCR, 2018). Both could lead to the increased number of social conflicts and economic risks.

Data collection and attribution

Data comes from the OECD.Stat (OECD 2017a) where values are available for the time range 2016- 2017. The data is available for 35 countries, other countries remained with no data.

Risk assessment: Possible preconditions to social risks and economic risks due to high number of asylum seekers.

It is assumed that the risk of radicalization in society and related risks might be preconditioned by the increase of the asylum seekers presence at the border and within a certain country. Thus, the following risk scale is created according to the distribution of values.

Indicator value y, %	*Risk level*
y < 0,0002	*very low risk*
0,00055 ≤ y < 0,0002	*low risk*
0,00055 ≤ y < 0,0011	*medium risk*
0,0111 ≤ y < 0,0211	*high risk*
0,0211 ≤ y	*very high risk*
-	*no data*

4.3 Stakeholder Society

4.3.1 Subcategory Contribution to economic development

Overview

This subcategory strives to draw a picture of the overall economic (and educational) situation in a country, assess organizations' and industries' contribution to it, and to provide ways for companies to foster economic development. The latter can be realized by creating jobs, providing education and training, making local investments, or forwarding research (see UNEP/SETAC 2013: 134).

The subcategory is evaluated by the indicators "Economic situation of the country", "Contribution of the sector to economic development", "Public expenditure on education" and illiteracy rates disaggregated by age and sex.

4.3.1.1 Contribution of the sector to economic development

The indicator assesses to what extend the sectors contribute to the economic development of the country. It is measured as the monetary contribution to a country´s Gross Domestic Product (GDP). This metric can be understood as an indication for other types of contributions to economic development, e.g. the creation of jobs, specific education and training, investments in businesses/ infrastructure etc.

Values are expressed as a sector´s share of the GDP or Value added at current prices in percent.

Data collection and attribution

Data is mainly derived from the United Nations Statistics Division (UNSTAT 2017) that provides the shares of different sectors classified by ISIC of the total GDP. Values were added to the equivalent sectors in PSILCA. For some mining-related industries, specific data was available in the Mining contribution index published by the International Council on Mining & Metals (ICMM) (2016). The values express the metallic mineral and coal production value from 2014 (as % of GDP). For 249 CSS no data was available or too broad to be considered reliable.

Opportunity assessment: Extend of a sector´s contribution to the national economic – hence social – development

This is the first indicator determined to measure positive impacts on a society. The extend of a sectors contribution to economic development is expressed by opportunity levels. It is assumed that very low values basically do not provide any significant contribution to economic development (compared to other sectors). The remaining opportunity evaluation is based on the exponential distribution of the values considering that most values are lower than 50, with identifiable levels at 10 and 25.

Indicator value y, %	Opportunity level
0 ⩽ y < 1	No opportunity
1 ⩽ y ⩽ 10	Low opportunity
10 < y ⩽ 25	Medium opportunity
25 < y	High opportunity

4.3.1.2 Public expenditure on education

This indicator is expressed as percentage of GDP. It is defined as follows:

> „*Total general (local, regional and central) government expenditure on education (current, capital, and transfers), expressed as a percentage of GDP. It includes expenditure funded by transfers from international sources to government.*" (UNESCO Institute for Statistics (UIS) 2017)

The level of public expenditure on education is an indication for fair and equal access to education for all social strata. Values show the government priority given for education. If public expenditure is low, good and higher education might mainly be provided by private institutions reserved for wealthier groups of the society. Hence, government expenditure on education can be an indication for the overall educational level of societies. This in turn might prevent companies to settle or invest because of a possible lack of qualified and skilled labour force. To help the countries out of this vicious circle and foster economic development, organizations already established in these regions should promote education.

Data collection and attribution

Data comes from the UNESCO Institute for Statistics (UIS 2019) providing statistics partly until 2018. Most current data for each country was selected. For Former USSR an average across all countries was calculated.

Risk assessment: Risk of restricted access to education

The following risk scale is roughly oriented towards the mean of public expenditure on education over different countries.

Indicator value y, %	Risk level
0 ⩽ y < 2.5	very high risk
2.5 ⩽ y < 5	high risk
5 ⩽ y < 7.5	medium risk
7.5 ⩽ y < 10	low risk
10 ⩽ y	very low risk

[Changes to PSILCA version 2:

- More recent data]

4.3.1.3 Illiteracy rate

Generally speaking, illiteracy is the incapacity of a person to read or write properly. It is mainly distinguished between (primary) illiteracy – meaning that a person has never learned to read and write – and functional illiteracy occurring when a person´s reading and writing skills are insufficient to use them naturally and appropriately in daily social life (see Zeit online 2011 and Blumenfeld 2012).

For PSILCA, data is taken from the UIS that follows the concept of functional illiteracy, defined as:

> *„Adult illiteracy is defined as the percentage of the population aged 15 years and over who [cannot] both read and write with understanding a short simple statement on his/her everyday life.*" (UIS 2017)

Further, also the inability to make simple arithmetic calculations ("numeracy") is encompassed by illiteracy (ibid.).

Despite this internationally accepted definition, some countries follow slightly different concepts of illiteracy which distorts statistics. Therefore, UIS (ibid.) states:

> "*It has been observed that some countries apply definitions and criteria for literacy which are different from the international standards defined above, or equate persons with no schooling to illiterates, or change definitions between censuses. Practices for identifying literates and illiterates during actual census enumeration may also vary, as well as errors in literacy self-declaration can affect the reliability of literacy statistics.*" (ibid.)

However, low illiteracy rates are an indication for an effective primary education system which is the basis for further education and profession. On the other hand, high illiteracy rates mean that more workers are not qualified for white collar jobs or higher positions which obstructs economic development of a region or a whole country.

Illiteracy rates are provided for female, male, and total population.

<u>Data collection and attribution</u>

Data is derived from UIS that provides information about literacy in different countries and macro regions (like Central and Eastern Europe, Lower Income countries, Western Asia...). For "Illiteracy rate" the indicators "Adult literacy rate, population 15+ years, both sexes (%)", "Adult literacy rate, population 15+ years, female (%)" and "Adult literacy rate, population 15+ years, male (%)" were selected. Values for the illiteracy rate were calculated by subtracting the literacy values from 100, and then assigned to the respective countries. Countries without data (around 40) were attributed the value of a matching macro region. After this procedure, only Former USSR was left that got the average over all countries.

<u>Risk assessment: Risk of illiteracy</u>

The risk assessment is roughly oriented at the average rate of illiteracy across all countries. Considering the fact that values show functional illiteracy, the scale shifts a little further to higher rates. The following table shows the default risk levels.

Indicator value y, %	*Risk level*
0 ≤ y < 1	*very low risk*
1 ≤ y < 4	*low risk*
4 ≤ y < 8	*medium risk*
8 ≤ y < 15	*high risk*
15 ≤ y	*very high risk*

[Changes to PSILCA version 2:

- More current values]

4.3.1.4 Youth illiteracy rate

Youth illiteracy rate follows the same definition as illiteracy rate (see chapter 0) but refers only to people aged 15 to 24 years (see UIS 2015).

Youth illiteracy rates are even a stronger indication for the effectiveness of the current primary education system as they look only at the population that has just left (primary) school and should be able to read and write properly. This indicator can also provide information about potential young, qualified workers on the labour market.

Data is also provided for female, male and total population, between 15 and 24 years.

Data collection and attribution

Information is again derived from the UIS. The indicators "Youth literacy rate, population 15-24 years, both sexes (%)", "Youth literacy rate, population 15-24 years, female (%)" and "Youth literacy rate, population 15-24 years, male (%)" were selected. Values for the illiteracy rate were calculated by subtracting the literacy values from 91 and assigned to the respective countries. The roughly 100 countries without data were attributed the value of a matching macro region.

Risk assessment: Risk of youth illiteracy

The risk assessment follows the same logic as the one of adult illiteracy rates. The following table shows the default risk levels.

Indicator value y, %	*Risk level*
0 ⩽ y < 1	*very low risk*
1 ⩽ y < 4	*low risk*
4 ⩽ y < 8	*medium risk*
8 ⩽ y < 15	*high risk*
15 ⩽ y	*very high risk*

[Changes to PSILCA version 2:

- More current values]

4.3.2 Subcategory Health and Safety (Society)

Overview

This subcategory examines the overall health status of a society measured by the "Health expenditures" and the "Life expectancy at birth". It assesses the overall health conditions under that a company or sector is operating and points out the potential of improving the health system. The latter can be done by investments in health facilities, better health information systems, or better trained human resources (see World Bank 2017d).

4.3.2.1 Health expenditure

Health expenditure is one of the key indicators to assess the health systems of countries which in turn are essential to combat disease and improve the health of populations (see World Bank 2014d). Health systems are defined as "*the combined arrangements of institutions and actions whose primary purpose is to promote, restore, or maintain health*" (WHO 2000 cited in World Bank 2014d). Effective health systems are considered as important for human and economic development.

This indicator is divided into four sub-indicators defined in the following.

Health expenditure, total

> *„Total health expenditure is the sum of public and private health expenditure. It covers the provision of health services (preventive and curative), family planning activities, nutrition activities, and emergency aid designated for health but does not include provision of water and sanitation."* (World Bank 2014d)

It is an indication for the overall health status of a society. Total health expenditure is provided in % out of the national GDP in 2016.

Health expenditure, public

„Public health expenditure consists of recurrent and capital spending from government (central and local) budgets, external borrowings and grants (including donations from international agencies and nongovernmental organizations), and social (or compulsory) health insurance funds." (World Bank 2014d)

In general, high- and middle-income countries have higher shares of public health expenditures than low-income countries (see ibid.). High shares of public health expenditures are an indication for a rather fair health system that many people have access to. The indicator is provided in % of the total health expenditure.

The updated version of the sub-indicator is not presented in the third version of the database as it is not supported by the World Bank Database anymore, thus, it was replaced by two sub indicators: domestic and external health expenditure as a percentage of the current health expenditure). However, it can still be used for calculations.

Out-of-pocket health expenditure

„Out-of-pocket expenditure is any direct outlay by households, including gratuities and in-kind payments, to health practitioners and suppliers of pharmaceuticals, therapeutic appliances, and other goods and services whose primary intent is to contribute to the restoration or enhancement of the health status of individuals or population groups. It is a part of private health expenditure." (World Bank 2014d)

Generally, in low-income countries "out-of-pocket expenditure makes up the largest proportion of private expenditures" (ibid.) showing that public health expenditures are not sufficient to cover health issues. Therefore, impoverished households are greatly put at a disadvantage because they are discouraged to access needed preventive or curative care (see ibid.). The indicator is provided in % of the total health expenditure.

External resources for health

„External resources for health are funds or services in kind that are provided by entities not part of the country in question. The resources may come from international organizations, other countries through bilateral arrangements, or foreign nongovernmental organizations. These resources are part of total health expenditure." (World Bank 2014d)

High external resources for health are normally an indication of very poor health systems. The indicator is measured in % of the total health expenditure.

New sub indicator: Domestic and external health expenditure (% of current health expenditure)

The sub-indicator indicates both direct foreign transfers and all internal transfers distributed by a government as a percentage of the total health expenditure. The foreign transfers which are distributed by government encompass all financial inflows into the national health system from outside the country (World Bank 2019a). This sub-indicator was used to derive an external level of the health expenditures.

New sub indicator: Domestic health expenditure (% of current health expenditure)

Share of current health expenditures funded from domestic private sources. Domestic private sources include funds from households, corporations and non-profit organizations. Such expenditures can be either prepaid to voluntary health insurance or paid directly to healthcare providers..” (World Bank 2019a)

The sub-indicator indicates all internal transfers distributed by a government as a percentage of the total health expenditure (World Bank 2019a).

Data collection and attribution

Data was drawn from the World Development Indicators about health systems (World Bank 2017) which in turn are based on the Global Health Expenditure Database by the WHO[8] where the respective percentage values were provided for 2016. The data is available for 214 countries; values for health expenditure from external resources were provided for 163 EORA countries. For the remaining countries, values from one adequate country group were used.

Risk assessment: Risk of unfair health systems and a poor health status of the population

The basic idea behind the risk assessment for health expenditure indicators is that a relatively high share of public expenditure and relatively low shares of private expenditures indicate strong and fair health systems being “key to combating disease and improving the health status of populations” (World Bank 2017) (of course, there are exceptions like “civilization diseases” in industrialized countries, e.g. obesity). There is no need to say that healthy people are one condition for a strong workforce, better economic development and less emigration.

In the following, risk scales for each sub-indicator are presented. They are all oriented roughly at the respective mean values.

Health expenditure, total

By this indicator, rather the overall health status of the population can be assumed. Since it combines public and private expenditures, it does not say anything about the fairness of the health system. Given as the percentage of the GDP it is not a straightforward indication for the effectiveness of health systems neither because the need for health investments does not grow with a growing GDP. This is illustrated by the fact that among the 10 countries with the highest shares there are Germany, Switzerland and the Netherlands as well as Lesotho, Sierra Leone and Liberia.

Therefore, this indicator might only provide an orientation for the risk of a poor health status.

[8] http://apps.who.int/nha/database

Indicator value y, % of GDP	Risk level
$0 \leqslant y < 2.5$	very high risk
$2.5 \leqslant y < 5$	high risk
$5 \leqslant y < 10$	medium risk
$10 \leqslant y < 15$	low risk
$15 \leqslant y$	very low risk
-	no data

Health expenditure, public

As mentioned above, high shares of public health expenditures are generally an indication for a rather fair health system. Considering that they are accompanied by low shares of private health expenditures, also a rather effective health system can be assumed.

It is thus assumed that higher shares imply a lower risk of poor health states.

Indicator value y, % of total	Risk level
$0 \leqslant y < 20$	very high risk
$20 \leqslant y < 40$	high risk
$40 \leqslant y < 60$	medium risk
$60 \leqslant y < 80$	low risk
$80 \leqslant y$	very low risk
-	no data

Out-of-pocket health expenditure

As mentioned above, high shares of out-of-pocket health expenditures indicate that the public health system is not enough to cover needed health care and, hence, discriminates poor population groups.

Therefore, the following risk scale is selected:

Indicator value y, % of total	Risk level
$0 \leqslant y < 10$	very low risk
$10 \leqslant y < 20$	low risk
$20 \leqslant y < 35$	medium risk
$35 \leqslant y < 50$	high risk
$50 \leqslant y$	very high risk
-	no data

External resources for health

High shares of external resources for health usually imply a very poor local health system. Therefore, high shares are considered as an urgent need for health expenditure indicating a high risk of a bad health status of the population.

Indicator value y, % of total	Risk level
0 ⩽ y < 2.5	very low risk
2.5 ⩽ y < 5	low risk
5 ⩽ y < 10	medium risk
10 ⩽ y < 15	high risk
15 ⩽ y	very high risk
-	no data

4.3.2.2 Life expectancy at birth

This indicator is useful to reveal critical living conditions in different countries. It can further be an indication of a good/ bad national health system.

A definition of "Life expectancy at birth" is provided by World Bank (2017):

"*Life expectancy at birth indicates the number of years a newborn infant would live if prevailing patterns of mortality at the time of its birth were to stay the same throughout its life.*"

Measured in years, the values of life expectancy at birth can be easily compared between several countries.

Data collection and attribution

Data was drawn from the World Bank database and values are provided for years between 2011 and 2014. For each country, most recent data was taken. For six countries, averages over countries with similar conditions were calculated and assigned all their sectors.

Risk assessment: Risk of bad living conditions (and poor healthcare)

The risk evaluation scale is based, on the one hand, on the "Programme of Action" for the world´s population and development (UN 2014, p. 81):

"Countries should aim to achieve by 2005 a life expectancy at birth greater than 70 years and by 2015 a life expectancy at birth greater than 75 years. Countries with the highest levels of mortality should aim to achieve by 2005 a life expectancy at birth greater than 65 years and by 2015 a life expectancy at birth greater than 70 years."

A life expectancy of at least 70 or 75 years (for developed countries and those with still high mortality rates, respectively) is recommended. Therefore, life expectancies between 70 and 75 years are considered as a low risk of bad living conditions.

The final risk evaluation scale, on the other hand, is built after checking the distribution of the data. This is shown in Figure 11.

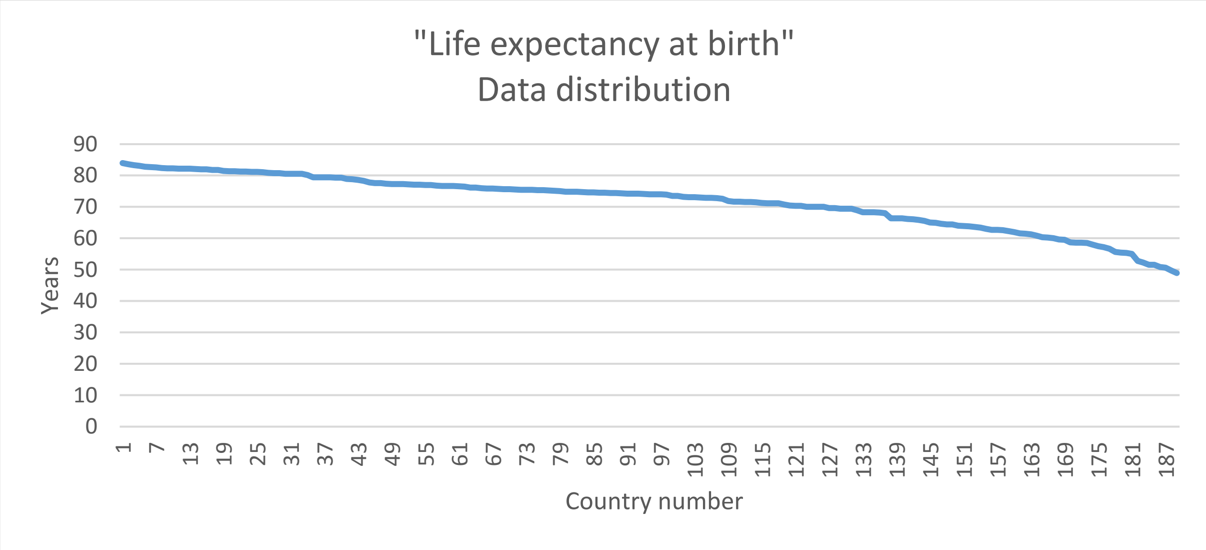


Figure 11: Life expectancy at birth in years for all the 189 countries in PSILCA

Indicator value y, years	*Risk level*
80 ⩽ y	*No risk*
75 ⩽ y < 80	*very low risk*
70 ⩽ y < 75	*low risk*
65 ⩽ y < 70	*medium risk*
60 ⩽ y < 65	*high risk*
60 ⩾ y	*very high risk*

4.3.2.3 New Indicator: Violations of mandatory health and safety standards

The indicator could be used to measure an overall country's compliance with mandatory health and safety standards. It indicates occupational safety and health conditions which may reflect poor/good health protection of the workers in a country.

Data collection and attribution

The datasets have been obtained from the United States Consumer Product Safety Commission and contain information about violations in 57 countries (USCPSC, 2019). The datasets were not mapped to the EORA sectors as majority of violations were reported in children toys and Apparel sectors. Thus, only country related information was used for this indicator.

In order to establish a qualitative reference among different lands, the total number of violations were divided by the labor force in a country. It allowed to compare the available country level results and perform risk assessment. The labor force data was taken and adapted from "The World Factbook" (CIA, 2017).

Risk assessment: High risk of injury on the production site and poor safety standards

The risk assessment was done based on the number of cases per country in relation to the available labor force, the more cases of violations per total number of workers are the most probable risk of getting injury. It might also indicate insufficient precaution measures in the production sector (USCPSC, 2019). The risks were evaluated according to the following scale based on the initial range of raw values:

Indicator value y, %	*Risk level*
0,000000055 ⩽ y 0,00000025	*very low risk*
0,00000025 ⩽ y < 0,0000008	*low risk*
0,0000008 ⩽ y <0,0000015	*medium risk*
0,0000015 ⩽ y < 0,000005	*high risk*
0,000005 ⩽y	*very high risk*

4.4 Stakeholder Value Chain actors

4.4.1 Subcategory Fair competition

Sustainable conditions along the life cycle of a product also concern, of course, suppliers, competitors and other value chain actors.

It is important to keep competition on the market fair and transparent in order to allow supply and demand to regulate freely, to maintain prices moderate, to facilitate innovative product and service developments and keep quality and choice of goods and services high. At the end, this favours local economies, suppliers and customers.

Any form of collusion or anti-trust between market actors hinders fair competition and is, therefore, in most countries considered a crime. Hence, local and multinational companies and organizations must behave and act in a way that allows fair competition. In order to control and ensure this, appropriate policies and laws should exist in every country.

Overall,

> *"this subcategory assesses if the organization's competitive activities are conducted in a fair way and in compliance with legislations preventing anti-competitive behaviour, anti-trust, or monopoly practices."* (UNEP/SETAC 2013, p. 52)

For this purpose, the following two indicators are selected: "Presence of anti-competitive behaviour or violation of anti-trust and monopoly legislation" and "Presence of policies to prevent anti-competitive behaviour".

4.4.1.1 Presence of anti-competitive behaviour or violation of anti-trust and monopoly legislation

This indicator refers to any kind of anti-competitive behaviour. This includes all forms of collusion, abuse of monopoly or other market positions, and other unfair business practices. The most common forms of collusion or antitrust violations are:

- *price fixing, i.e. an "agreement among competitors to raise, fix, or otherwise maintain the price at which their goods or services are sold" (U.S. Department of Justice (USDOJ) 2015),*
- *bid rigging, i.e. market actors manipulate a public bid by submitting false bids or ones not complying with the conditions, or suppressing competitor´s bids (see ibid.), or*
- *market division or allocation schemes, i.e. "agreements in which competitors divide markets among themselves. In such schemes, competing firms allocate specific customers or types of customers, products, or territories among themselves." (ibid.)*

Other unfair business practices are, e.g. creating market or output restrictions or anti-competitive mergers.

The indicator measures the risk of anti-competitive business practices and violation of anti-trust legislation in different industry sectors.

Data collection and attribution

Basis for this indicator are the enforcement cases recorded by the U.S. Federal Trade Commission (FTC 2015) for U.S. firms. Among others, the commission "monitor[s] business practices, review[s] potential mergers, and challenge[s] them when appropriate to ensure that the market works according to consumer preferences, not illegal practices." (ibid.). All cases and proceedings are listed and publicly available. They are basically sorted by the "mission" of FTC, i.e. competition or consumer protection, and the competition topic, i.e. merger or nonmerger (price fixing, bid rigging, market allocation etc.).

To measure the indicator, all competition-related cases for the USA (i.e. all merger and nonmerger topics) between January 2000 and February 2015 were selected. They were sorted by industry classification and counted per industry sector. These absolute numbers were normalised by dividing them by the number of employees in the respective industries (data taken from USDOL 2015a) and multiplied by 10,000.

It is assumed that occurrence and frequency of anti-competitive behaviour and unfair business practices are similar for the same industry sectors worldwide. Therefore, data from the U.S. is extrapolated to all countries by mapping the original industry sectors from the FTC to the country-specific sectors in PSILCA. The normalised values, i.e. number of enforcement cases per 10,000 employees, were then assigned to the matching sectors in every country. Sectors without a matching sector from the raw data remained without a value and risk assessment.

Risk assessment: Risk of anti-competitive behaviour or unfair business practices in the sector

The higher the number of cases per 10,000 employees the higher the risk of unfair business practices in the sector. The risk assessment is roughly oriented at the mean of the normalised values.

Indicator value y, number per 10,000 employees	*Risk level*
0	*no risk*
0 < y < 0.05	*very low risk*
0.05 ≤ y < 0.1	*low risk*
0.1 ≤ y < 0.2	*medium risk*
0.2 ≤ y < 0.4	*high risk*
0.4 ≤ y	*very high risk*
-	*no data*

4.4.2 Subcategory Corruption

In general, corruption is "the abuse of entrusted power for private gain" (Transparency International 2015). Three main types of corruption can be distinguished "depending on the amounts of money lost and the sector where it occurs" (ibid.).

"**Grand corruption** consists of acts committed at a high level of government that distort policies or the central functioning of the state, enabling leaders to benefit at the expense of the public good.

Petty corruption refers to everyday abuse of entrusted power by low- and mid-level public officials in their interactions with ordinary citizens, who often are trying to access basic goods or services in places like hospitals, schools, police departments and other agencies.

Political corruption is a manipulation of policies, institutions and rules of procedure in the allocation of resources and financing by political decision makers, who abuse their position to sustain their power, status and wealth." (ibid.)

It becomes clear that corruption normally refers to public institutions or governments and can affect daily life. This is also highlighted by Transparency International (2012):

"Corruption translates into human suffering, with poor families being extorted for bribes to see doctors or to get access to clean drinking water. It leads to failure in the delivery of basic services like education or healthcare. It derails the building of essential infrastructure, as corrupt leaders skim funds."

Therefore, it could also be attributed to the stakeholder Society. However, at this point the subcategory shall rather assess whether an organization or industry sector is engaged in corruption, e.g. by taking advantage from public institutions, by fraud or bribery affecting supply chain actors, or by clientelism and nepotism within the company.

To this aim, the overall state of corruption in a country is assessed by the indicator "Public sector corruption". The indicator "Active involvement of enterprises in corruption and bribery" evaluates to what degree an organization has been engaged in corruptive behaviour, or whether it has implemented appropriate measures to prevent corruption.

4.4.2.1 Public sector corruption

Public sector corruption, i.e. corruption as defined above, is measured by the Corruption Perceptions Index (Transparency International 2012):

"A country [sic!] or territory's score indicates the perceived level of public sector corruption on a scale of 0-100, where 0 means that a country is perceived as highly corrupt and 100 means it is perceived as very clean." (Transparency International 2012)

The index is based on expert opinions.

Since "the poor and most vulnerable are [corruption´s] primary victims" (Transparency International 2012) it is important that governments take anti-corruption actions and combat this behaviour.

Data collection and attribution

The index is created by Transparency International (2019). Data from 2018 was taken. Scores for different countries and territories are provided in a ranking list that makes it possible to compare easily the degree of corruption between different countries. Information is available for 176 countries (assigned to regional country groups) that correspond to 167 PSILCA countries. For the remaining countries, averages across the given regions were calculated.

Risk assessment: Risk of corruption in the country

The risk assessment is based on the distribution of the scores and on the evaluation given by Transparency International (2012): "While no country has a perfect score, two-thirds of countries score below 50, indicating a serious corruption problem.". The following risk scale is applied:

Indicator value y, number per 10,000 employees	*Risk level*
100 ⩾ y ⩾ 85	*very low risk*
84 ⩾ y ⩾ 75	*low risk*
74 ⩾ y ⩾ 65	*medium risk*
64 ⩾ y ⩾ 55	*high risk*
55 ⩾ y	*very high risk*
-	*no data*

[Changes to PSILCA version 2:

- More current values
- Averages from given country groups used for countries without specific values]

4.4.2.2 Active involvement of enterprises in corruption and bribery

Corruption does not only affect daily life of mainly most vulnerable people, it also hinders economic growth and therefore human development.

"Corruption also undermines growth and development. On the one hand, businesses forego innovation and competitiveness for bribery. On the other hand, individuals within governments divert funds for their own personal use that should be used to promote the well-being of people." (OECD 2014, p. 3)

Hence, OECD considers corruption and bribery a serious problem that has to be criminalised and combated (see ibid.). To this end, this indicator shall assess the degree of an active involvement of companies in corruption and bribery along their supply chains.

Data collection and attribution

Corruption is a very "complex and convert crime" (OECD 2014, p. 3) difficult to detect and fight. To tackle the problem, OECD adopted the *Convention on Combating Bribery of Foreign Public Officials in International Business Transactions* (OECD 2011), short the OECD Anti-Bribery Convention, in 1999. To measure and document transnational corruption, a *Foreign Bribery Report* was first published in 2014 (OECD 2014). Due to the scarce amount of data available for the time being, this indicator refers to foreign bribery. The OECD Anti-Bribery Convention, Art. 1, defines foreign bribery as:

"to offer, promise or give any undue pecuniary or other advantage, whether directly or through intermediaries, to a foreign public official, for that official or for a third party, in order that the official act (sic!) or refrain (sic!) from acting in relation to the performance of official duties, in order to obtain or retain business or other improper advantage in the conduct of international business". (OECD 2011, p. 7)

In the report, different analyses and statistics are presented for 427 foreign bribery enforcement actions concluded between 15 February 1999 and 1 June 2014. To measure this indicator, statistics about the spread of foreign bribery cases across industry sectors were taken as reference (see Figure 12).

Percentages refer to the share of all foreign bribery cases reported in the survey period (see above) attributable to specific activity sectors. It becomes clear that almost two thirds of all cases occurred in only four industry sectors.

Since the OECD Anti-Bribery Convention was adopted by 41 countries (all OECD member states as well as Argentina, Brazil, Bulgaria, Colombia, Latvia, Russia, and South Africa) (see OECD 2011), data was assumed for all these countries. Hence, percentage values were assigned to their according Eora sectors (see method described in chapter 3.4.2).

A mean value (7.14%) was calculated and assigned to the remaining sectors of the signatories because it is probable that companies of other sectors are also involved in bribery without being revealed so far. This value corresponds to medium risk of involvement in foreign bribery (see next section).

The other countries in PSILCA and their respective sectors (7038 in total) remain without data.

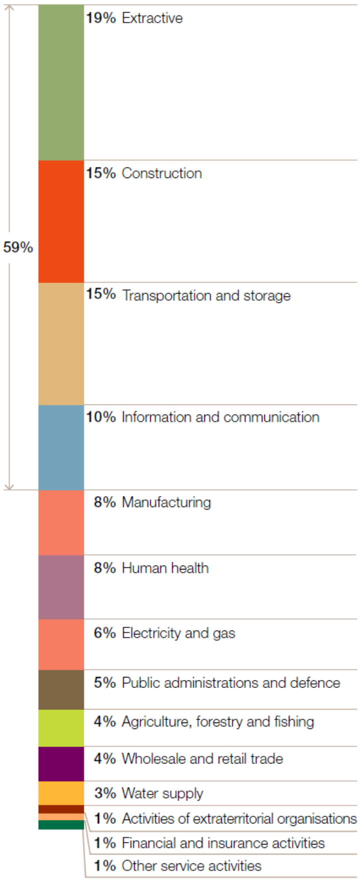


Figure 12: Foreign bribery cases according to their occurrence in activity sectors (OECD 2014, p. 22)

Risk assessment: Risk of involvement in foreign bribery

The risk scale is oriented towards the maximum percentage of bribery cases detected in one sector. All risk levels are distributed within this range.

Indicator value y, %	*Risk level*
$0 < y \leq 3$	*very low risk*
$3 < y \leq 7$	*low risk*
$7 < y \leq 11$	*medium risk*
$11 < y \leq 14$	*high risk*
$14 < y$	*very high risk*
-	*no data*

4.4.3 Subcategory Promoting social responsibility

Social responsibility is understood as a company´s obligation to perform in a way that considers the interests and needs of all its stakeholders, i.e. employees, customers, communities, society etc. Main areas in question are human rights, labour, environment and anti-corruption.

By integrating social responsibility into own business processes and relations, and promoting it along supply chains, an organization can create real social value. The actions implemented by a company to ensure social responsibility can differ widely from one organization to another and are thus difficult to structure and quantify. Thus, for the purpose of PSILCA, this subcategory should rather be measured by memberships in initiatives and foundations with a related focus, the and the existence and number of codes of conducts and contractual agreements with suppliers concerning social responsibility (see UNEP/SETAC 2013).

4.4.3.1 Social responsibility along the supply chain

The indicator examines, to what extend social responsibility is taken seriously and assured by companies within specific sectors. The approach follows the idea mentioned above to recur to initiatives and agreements with a focus on social sustainability. The UN Global Compact Initiative (2017) is considered to be an adequate association. It supports and binds participating companies to align their strategies with the initiative´s Ten Principles referring to human rights, labour, environment and anti-corruption. Seven of these principles directly address workers, local communities or value chain actors, hence, the initiative has a strong social focus.

Data collection and attribution

UN Global Compact provides a list of participants classified by sector and country. For the assessment, all entries (companies and non-businesses) within a country and sector were counted, normalized with the number of employees and mapped to the Eora sectors. No mean values were calculated because it is assumed that all members are documented. Therefore, country-specific-sectors that are not covered by any entry – a number of 3315 – are assessed by "very high risk".

Risk assessment: Risk of unsustainable business practices

The risk scale follows the exponential distribution of the values.

Indicator value y, %	*Risk level*
110 ≤ y	*very low risk*
70 ≤ y < 100	*low risk*
5 ≤ y < 70	*medium risk*
1 ≤ y < 5	*high risk*
y < 1	*very high risk*
-	*no data*

[Changes to PSILCA version 2:

- Updated risk assessment scale
- New approach to the indicator's evaluation]

4.4.4 Subcategory Prevention and mitigation of conflicts

This subcategory indicates risks of conflicts and overall level of peacefulness in a certain country. The indicators in the group mostly refer to political stability within a certain state as well as character of foreign policy, namely insolvency in local conflicts. The other side of the sub-category is social security which might be influenced by the overall trend of militarization within a certain country.

4.4.4.1 Risk of conflicts

The indicator represents overall level of three thematic groups, namely the level of Societal Safety and Security; the extent of Ongoing Domestic and International Conflict; and the degree of Militarisation (IEP, 2018). All the groups are combined in a single Global Peace Index (GPI). The higher the GPI the more likely social risks would increase.

Data collection and attribution

The GPI was developed by The Institute for Economics & Peace (IEP), the overall index covers 99.7 per cent of the world's population, using 23 qualitative and quantitative indicators (IEP 2018). The data was extracted from Global Peace Index Report 2018 and contains information on 163 countries in 2018.

The missing data was attributed as an average value among the mix of best fitting economic and geographical country groups. It gives a rough estimation of the GPI within the countries which were not listed in the initial report.

Risk assessment: Risk of involvement in foreign bribery

The risk scale was adapted from GPP color code indication based on the overall rates within different risk groups. All risk levels are distributed within the following range.

Indicator value y, %	*Risk level*
1 ⩽y< 1.45	*very low risk*
1.45 ⩽y < 2	*low risk*
2 ⩽y <2.3	*medium risk*
2.3⩽y < 2.8	*high risk*
2.8⩽y	*very high risk*

5 PSILCA in openLCA

5.1 General comments on PSILCA in openLCA

The PSILCA database is available first in the open source LCA software openLCA (www.openlca.org), a high-performance and feature-rich LCA software. A version for SimaPro is in preparation.

In the database, sectors (industries and/ or commodities) per country are modelled as processes based on the Eora Input-Output database. Eora provides data on money flows between country-specific sectors. Each country-specific sector (CSS) generates output (i.e. a product), evaluated in USD, and receives materials and products from other sectors, also in USD. In PSILCA, the sectors are scaled so that each sector produces an output of exactly 1 USD that is used to calculate the product system (see Figure 14).

Without cut-off, a PSILCA system which follows all the links from one selected CSS to other sectors gets really large, with roughly 15,000 sectors and millions of connections, and sectors with more than 1,000 other sectors delivering products to the sector (Figure 13).

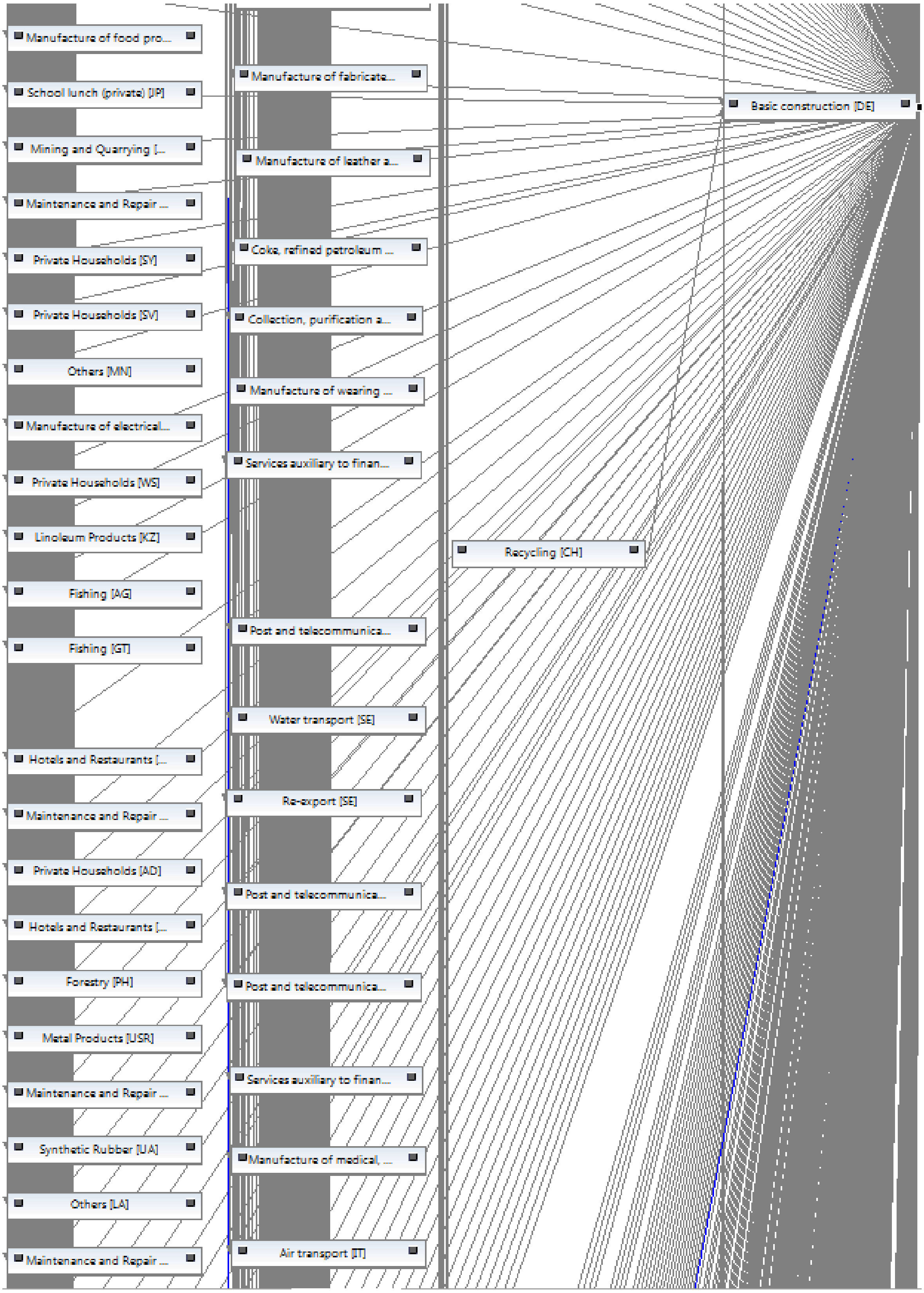


Figure 13: Model graph (part) of a product system in openLCA for the sector "Basic construction" in Germany in PSILCA, with 3 tiers of sector inputs (for some selected sectors visible)

For each process, the risk-assessed indicators are represented as elementary flows, "characterised" with the activity variable. For the time being, all indicators use worker hours as activity variable. As described in chapter 3.7 the amount of worker hours is calculated in relation to 1 USD output for each process and has, therefore, the same amount for every risk assessed indicator within a process (see Figure 14).

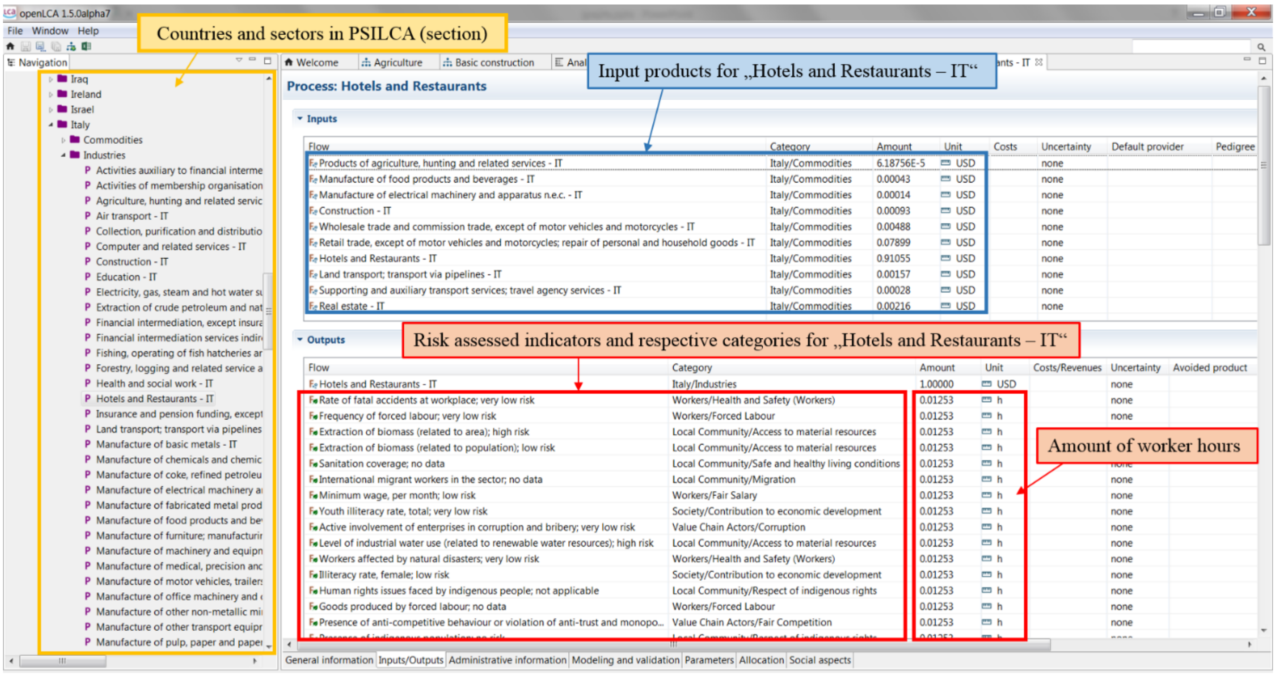


Figure 14: Inputs and outputs of the process "Hotels and Restaurants – IT" in openLCA

Indicator information in openLCA is provided in two levels, for each indicator separately, and for each process exchange. General indicator information is provided individually for each indicator, independently of processes (see Figure 15). This information includes the risk assessment procedure ("evaluation scheme") and the activity variable used for the indicator.

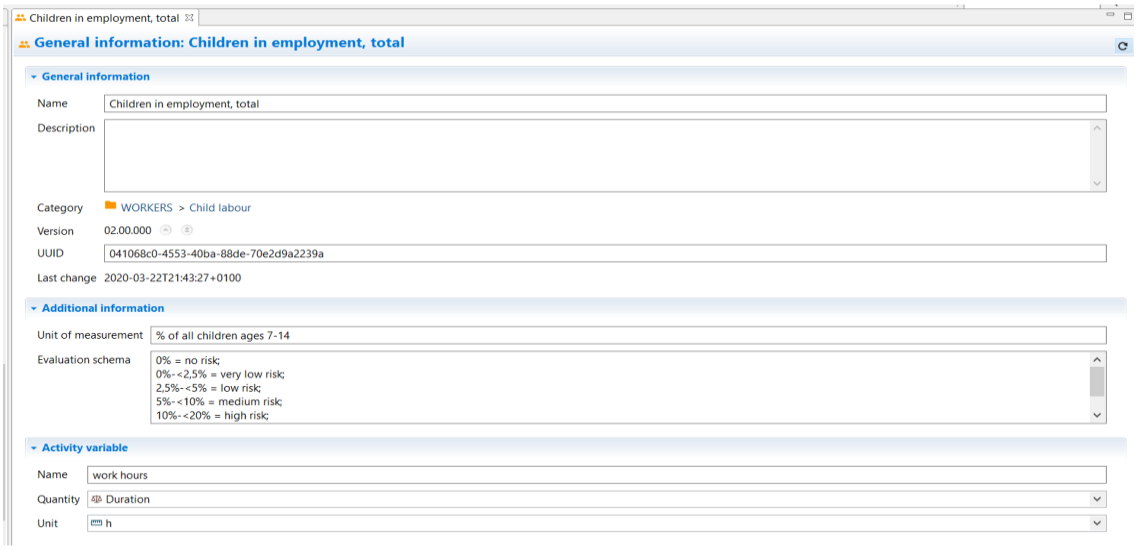


Figure 15: Social indicator information in the PSILCA database as provided in openLCA

Then, indicator results are provided for each process, in a level of detail depending on the PSILCA database type (*Starter, Professional* or *Developer*) – for the *Developer* database, data quality, unassessed indicator values, indicator risk levels and sources are provided (see Figure 16).

Social aspects: Agriculture

Social assessment

Name	Raw value	Risk level	Activity variable	Data quality	Comment	Source
WORKERS						
Health and Safety						
Violations of mandatory health and safety standards		No data	0.107182416210069 [h, work ...			
Rate of non-fatal accidents at workplace	0 [#/yr and 100,000 employe...	No data	0.107182416210069 [h, work ...			
Rate of fatal accidents at workplace	0 [#/yr and 100,000 employe...	No data	0.107182416210069 [h, work ...			
Presence of sufficient safety measures	0.012444802 [Cases per 100,...	High risk	0.107182416210069 [h, work ...	(1;2;1;5;1)	Compensated Dat...	OSHA: Severe I...
Child labour						
Children in employment, female	60.68917175 [% of female ch...	Very high risk	0.107182416210069 [h, work ...	(1;1;5;1;0)	Year: 2011	WB: Children in ...
Children in employment, total	9.3 [% of all children ages 7-...	Medium risk	0.107182416210069 [h, work ...	(1;2;5;2;0)	Year: 2011	WB: Children in ...
Forced Labour						
Goods produced by forced labour	1 [#]	No risk	0.107182416210069 [h, work ...	(1;1;1;1;1)	Year: 2018	ILAB: Forced La...
Frequency of forced labour		No data	0.107182416210069 [h, work ...			
Trafficking in persons	2 [Tier]	Medium risk	0.107182416210069 [h, work ...	(1;1;1;1;0)	Year: 2018	US: Trafficking i...

Figure 16: Social aspects in the PSILCA database (Developer) as provided in openLCA for each process (i.e. sector) separately

In the developer database, information on data quality can also be modified by the user, for each indicator and process. The pedigree data quality matrix is shown; colours emphasize the assessment, from green for a score of 1, to red for a score of 5 (see Figure 17).

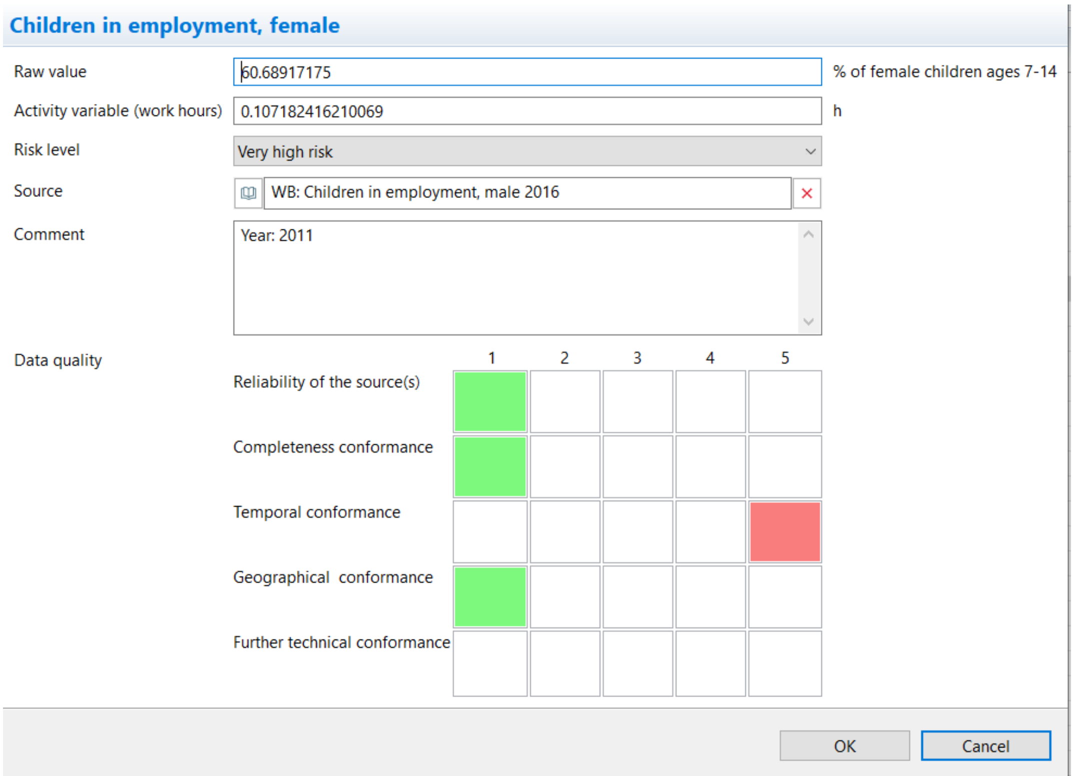


Figure 17: Data quality pedigree matrix in the PSILCA database as provided in openLCA for each process (i.e. sector) and indicator separately

The direct calculation approach (see section 3.7.2) is provided for the professional and developer version.

5.2 Quick guide on using PSILCA in openLCA

openLCA is an LCA software and the implementation of PSILCA in openLCA reflects this, with CSS modelled as processes, typically product flows on the input and elementary flows (here the social effects) on the output side. However, in order to use PSILCA properly in openLCA it is, of course, very useful to know the basics of the software. This text has not the intention to fully explain openLCA; more information about how to use openLCA, including e.g. video tutorials and manuals, are available under http://www.openlca.org/learnmore (GreenDelta GmbH 2020).

5.2.1 Memory and time for the creation and calculation of a product system

The current PSILCA version provided in June 2020 is based on an Eora database where a cut-off of 1E-5 (*Starter* type), 1E-7 (*Professional* type) or no cut-off for the *Developer* type has been applied. This means that in the *Starter* and *Professional* types all flows with a contribution below 1E-5/ 1E-7 USD to the final product have been deleted from the database. Nevertheless, data volume is quite big. In order to perform calculations, it is recommended to use a PC with rather high amount of RAM[9] and a modern processor. openLCA can be downloaded for free under http://www.openlca.org/download_page (GreenDelta GmbH 2020a).

Some plausibility checks were carried out with a PSILCA version, cut-off 1E-6, in order to show the reduction of required time and memory for calculations. It shows that creating and calculating product systems without an additional cut-off criterion requires considerable time (47 min) and working memory (up to 30 GB). Consequently, full calculations are only possible on very powerful computers. In order to use less memory it is advised to enter a cut-off criterion to create a product system.

Figure 18 and Figure 19 show the memory and time required for the creation and calculation of product systems of “Basic construction” in Germany entering different cut-offs. These calculations were done on a very powerful computer with a 64 bit operating system, 96 GB random access memory (RAM) and two Intel(R) Xeon(R) CPU X5690 processors with 12 cores and 3.46 GHz respectively. By applying a cut-off of 1E-11, the necessary working memory for openLCA reduces from 30 GB to 17 GB and the overall calculation time from 47 min to only 16 min. By using a cut-off of 1E-7, memory has already reduced to 3.5 GB and the system was calculated in less than three minutes etc.

[9] and allocate the RAM to openLCA under preferences in openLCA, see next page

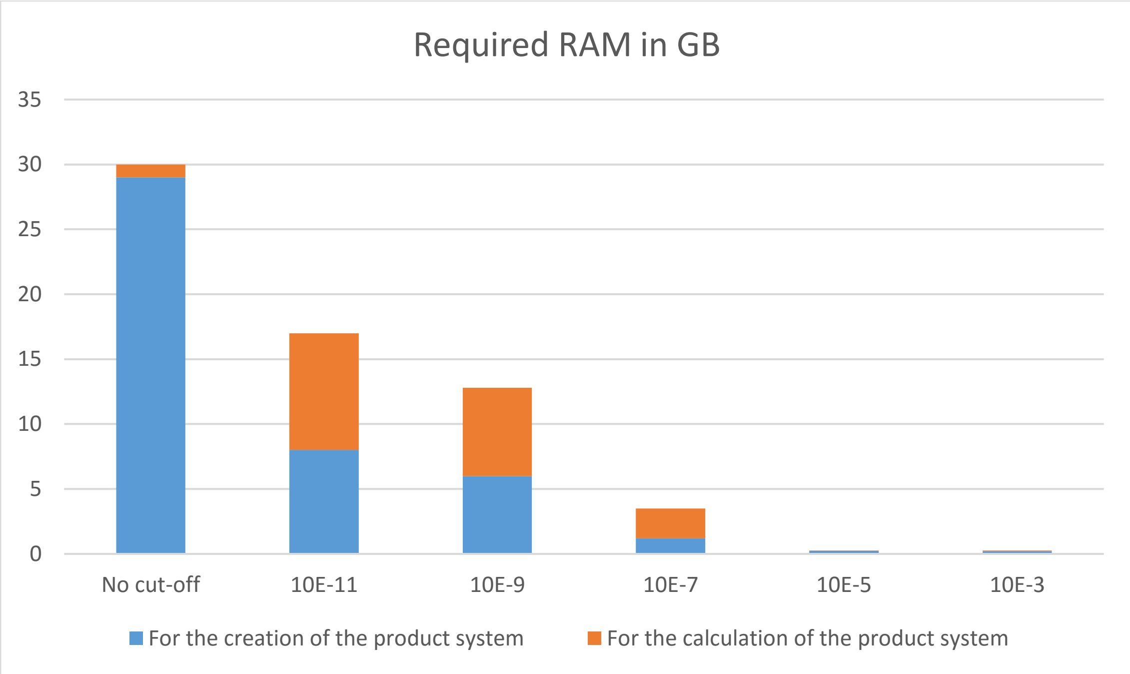


Figure 18: Required RAM for the creation of the product system "Basic construction" in Germany with different cut-off criteria[10]

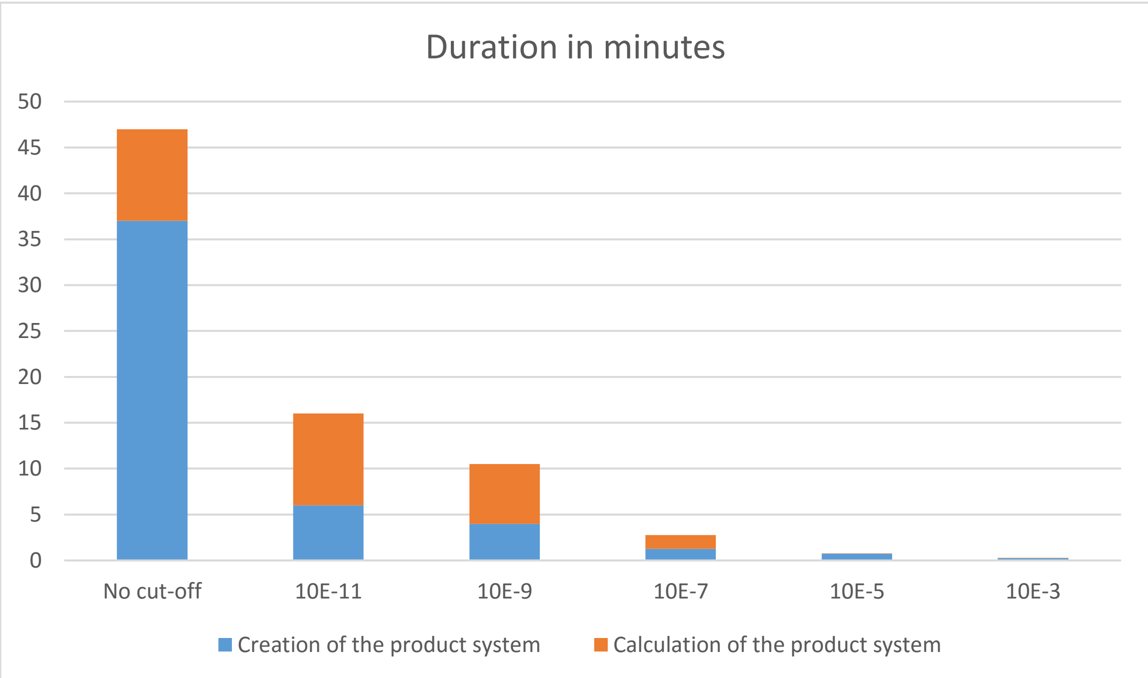


Figure 19: Duration of the creation of the product system "Basic Construction" in Germany with different cut-off criteria[10]

Therefore, after installing openLCA, it is recommended to increase the maximum memory usage of

[10] With a PSILCA/Eora database with a cut-off of 1E-6.

openLCA, considering the RAM of the computer. For PCs with 32 GB memory the maximum memory usage of openLCA should be around 27 GB. For computers with smaller RAM sizes the maximum memory usage of openLCA has to be lower; it can never be higher than the RAM available as hardware (and some parts of the RAM are always required for the operation system etc.). You can experiment with the maximum allocated memory. If your computer is not able to provide sufficient memory, openLCA will not start.

To increase the maximum memory usage go to *File → Settings→ Configuration and then specify the maximum memory usage* (see Figure 20).

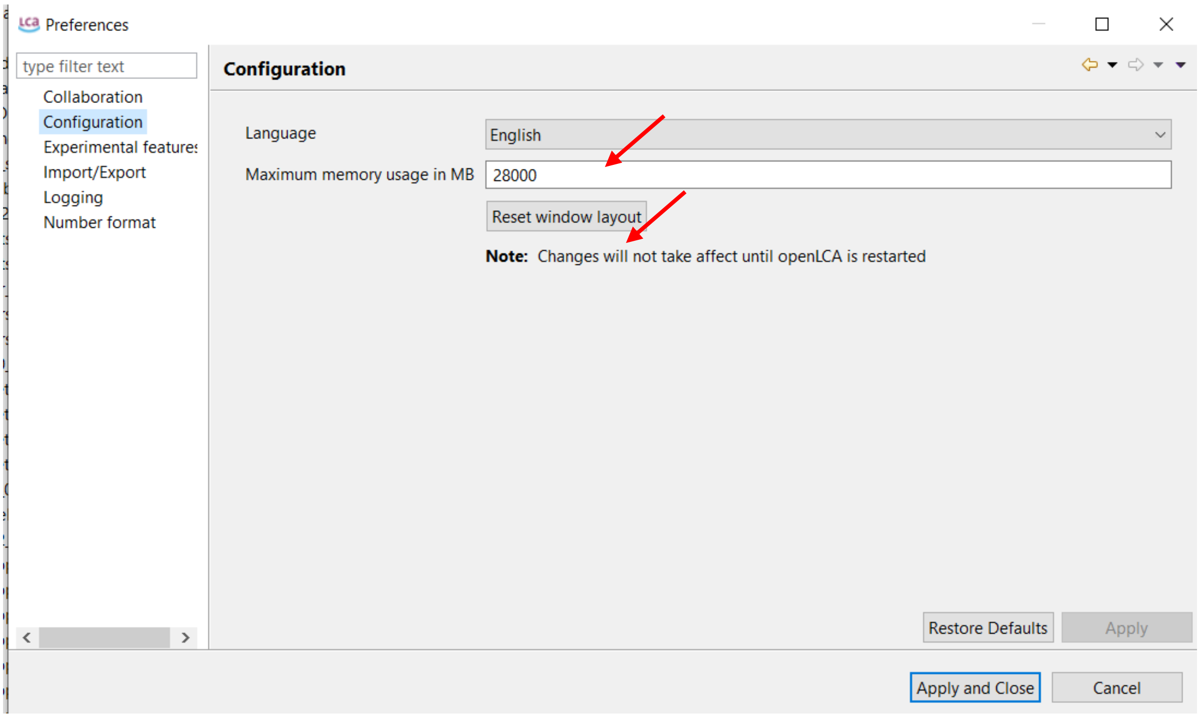
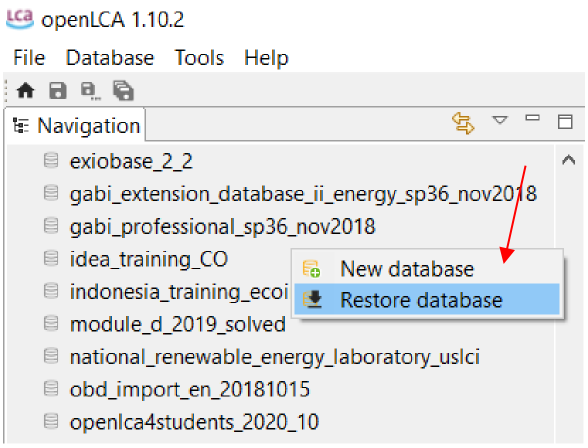


Figure 20: Increase of maximum memory usage in openLCA

5.2.2 How to use PSILCA in openLCA?

Importing PSILCA

PSILCA is provided as a zolca-file. After downloading and saving the file, the database can be imported into openLCA. Just right-click on the white area on the left side and select *Restore database*. A new window pops up where you select the folder where you saved the file. Then open it (see Figure 21).



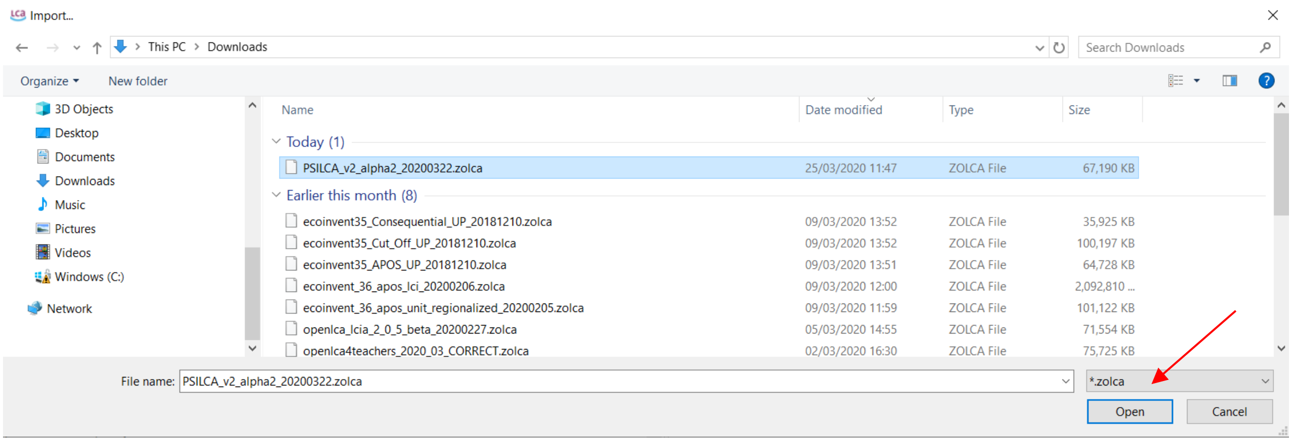


Figure 21: Restore PSILCA in openLCA

The database will be imported into the software. Due to its size this can take some minutes.

Opening the database, flows and processes

The database can be opened by double-clicking on it or right-clicking and selecting *Open database.*

To open a category (i.e. Processes, Flows, Products systems etc.) navigate through the navigation tree on the left side of the openLCA application by clicking on the small triangles. Flows have the icons with a large, brown “F”, and processes the icons with a large, violet “P”. They are opened by double-clicking on them (see Figure 22).

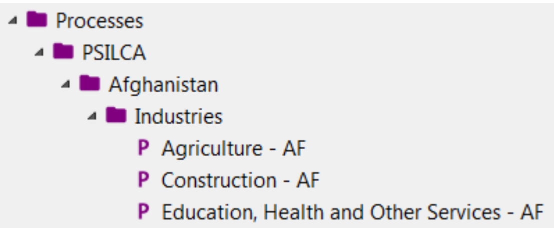


Figure 22: Part of navigation tree of PSILCA in openLCA

The flow or process will be opened in the editor window on the right side. For detailed information about the category switch through the different tabs on the bottom (see Figure 23).

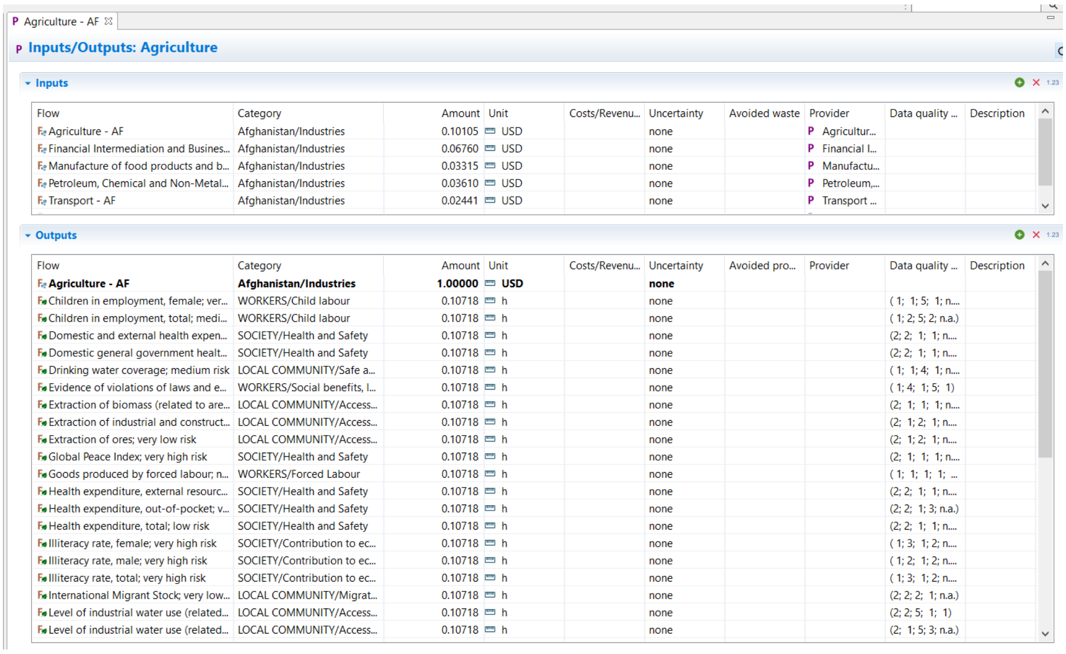


Figure 23: View of inputs and outputs of a process with its tabs

Creating a product system

To create a product system of a CSS select *Create product system* in the *General information* tab of the respective process (see Figure 24).

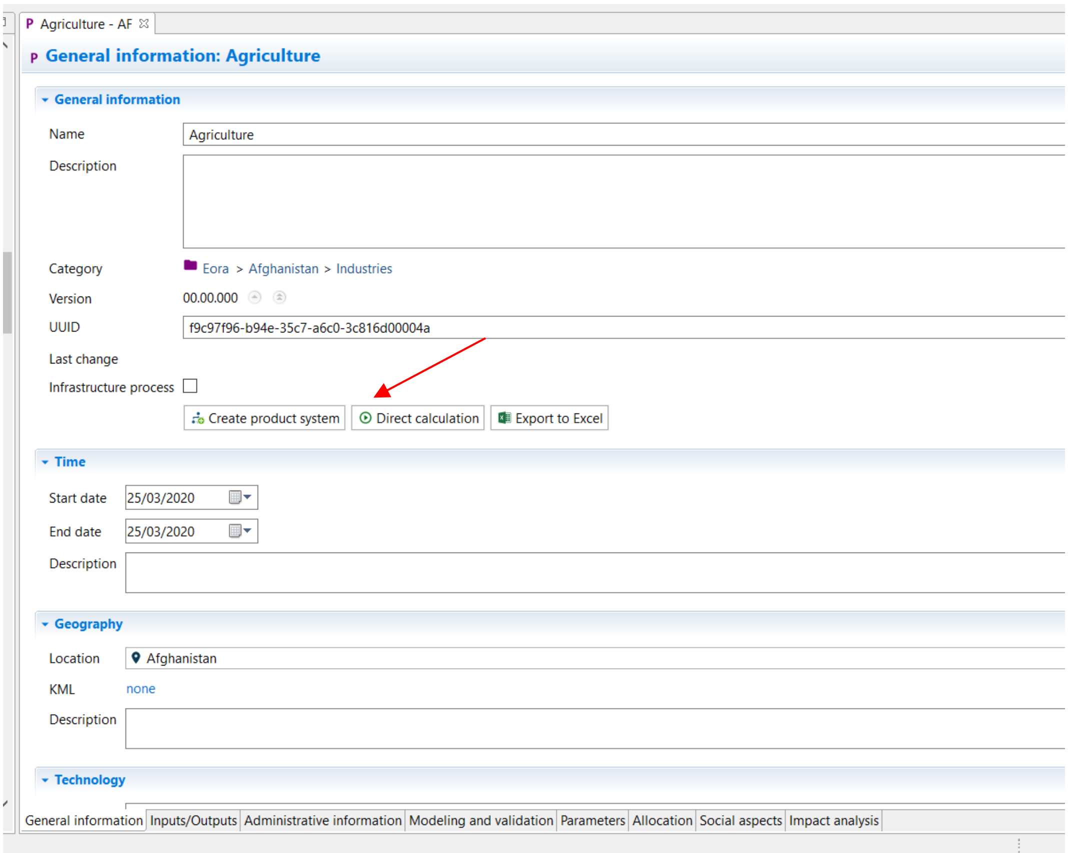


Figure 24: Creation of a product system

Remember that the calculation of a product system without a cut-off can take a lot of time (or not be possible on PCs with small memories) due to the huge amount of data. Therefore, it is highly recommended to enter a cut-off criterion (e.g. 1E-5) to reduce the memory usage of openLCA and avoid problems. This can be done in the window that opens after selecting *Create product system. Enable Cut-off* and insert the desired cut-off in the respective field (see Figure 25).

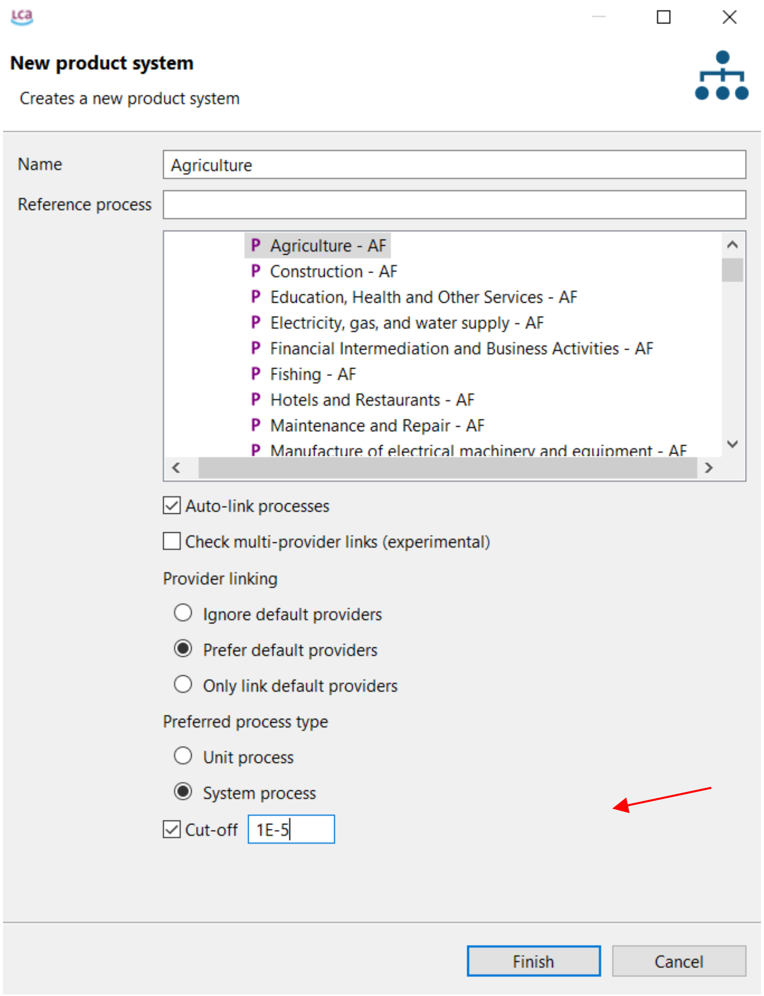


Figure 25: Inserting a cut-off criterion

Click *finish* to create the product system.

Calculating results

After creating the product system, results (e.g. social impacts) can be calculated for it (either quick or analysis results). To do so, click on *Calculate,* select an impact assessment method and the calculation type in the window "Calculation properties" opening up, and finish the calculation (see Figure 26).

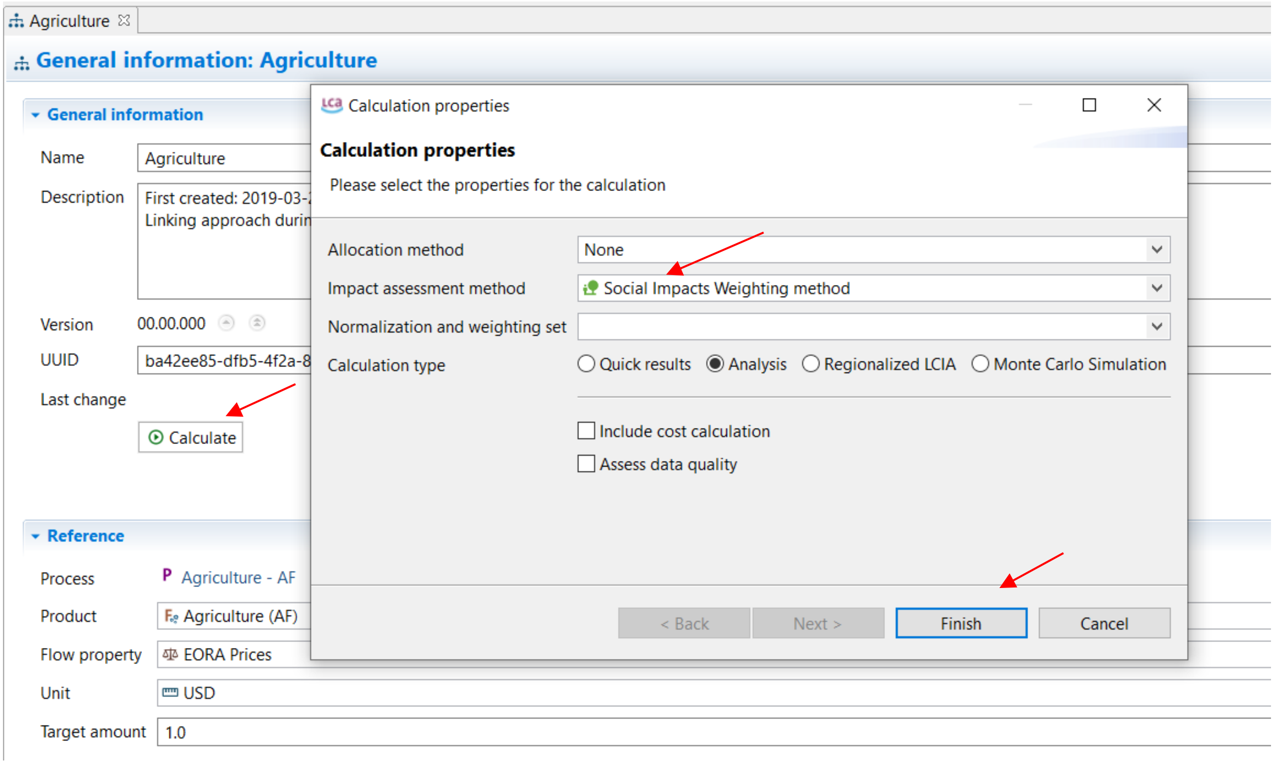


Figure 26: Calculation of results for a product system in openLCA

Analysing results of a product system

The calculation results (quick and analysis results) provide different charts and tables showing the inventory results, life cycle impact assessment results, process and flow contributions to impact categories and information about locations.

The following figures show some examples of result presentation for the process "Basic construction" in Germany (as screenshots from openLCA):

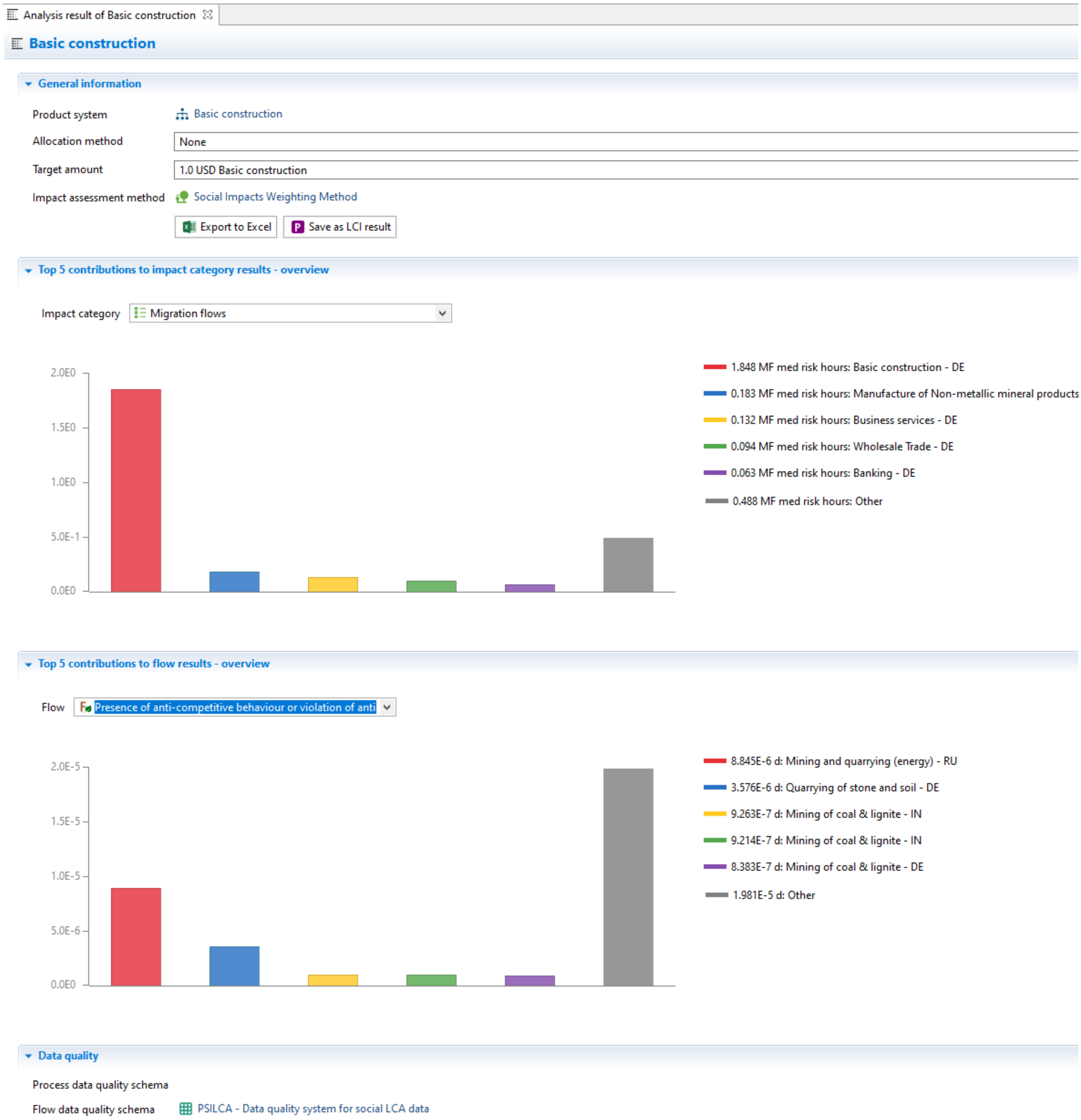
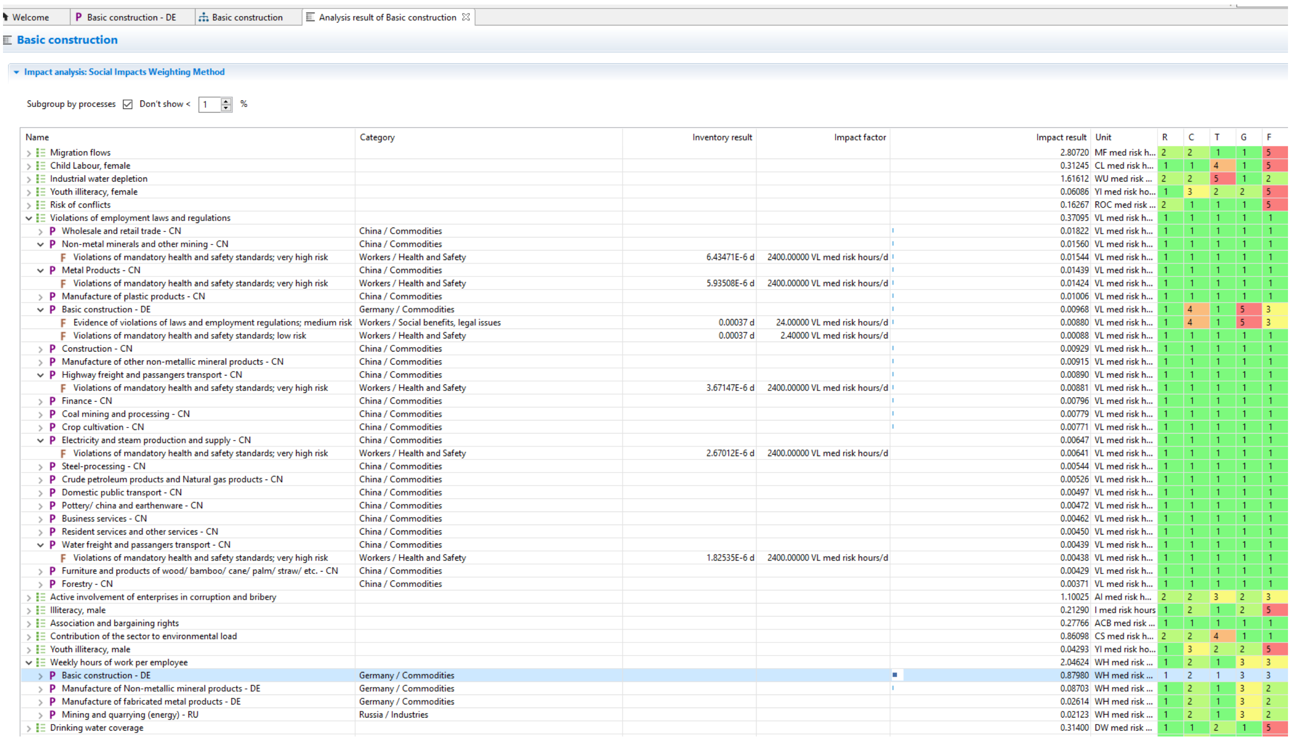


Figure 27: General information and selected flow and impact contributions



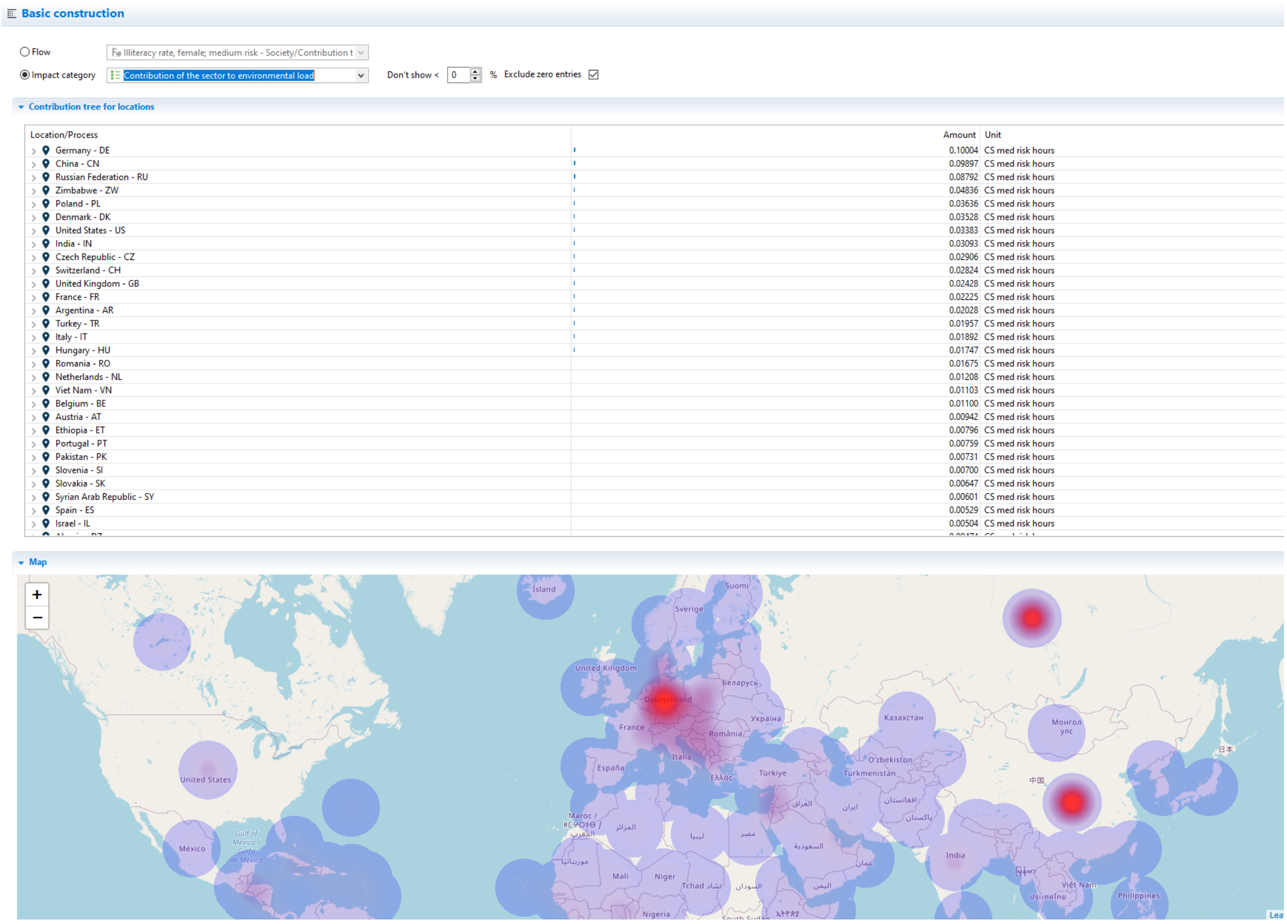
Basic construction

Impact analysis: Social Impacts Weighting Method

Subgroup by processes ☑ Don't show < 1 %

Name	Category	Inventory result	Impact factor	Impact result	Unit	R	C	T	G	F
Migration flows				2.80720	MF med risk h...	2	2	1	1	5
Child Labour, female				0.31245	CL med risk h...	1	1	4	1	5
Industrial water depletion				1.61612	WU med risk ...	2	2	5	1	2
Youth illiteracy, female				0.06086	YI med risk ho...	1	3	2	2	5
Risk of conflicts				0.16267	ROC med risk ...	2	1	1	1	5
Violations of employment laws and regulations				0.37095	VL med risk h...	1	1	1	1	1
P Wholesale and retail trade - CN	China / Commodities			0.01822	VL med risk h...	1	1	1	1	1
P Non-metal minerals and other mining - CN	China / Commodities			0.01560	VL med risk h...	1	1	1	1	1
F Violations of mandatory health and safety standards; very high risk	Workers / Health and Safety	6.43471E-6 d	2400.00000 VL med risk hours/d	0.01544	VL med risk h...	1	1	1	1	1
P Metal Products - CN	China / Commodities			0.01439	VL med risk h...	1	1	1	1	1
F Violations of mandatory health and safety standards; very high risk	Workers / Health and Safety	5.93508E-6 d	2400.00000 VL med risk hours/d	0.01424	VL med risk h...	1	1	1	1	1
P Manufacture of plastic products - CN	China / Commodities			0.01006	VL med risk h...	1	1	1	1	1
P Basic construction - DE	Germany / Commodities			0.00968	VL med risk h...	1	4	1	5	3
F Evidence of violations of laws and employment regulations; medium risk	Workers / Social benefits, legal issues	0.00037 d	24.00000 VL med risk hours/d	0.00880	VL med risk h...	1	4	1	5	3
F Violations of mandatory health and safety standards; low risk	Workers / Health and Safety	0.00037 d	2.40000 VL med risk hours/d	0.00088	VL med risk h...	1	1	1	1	1
P Construction - CN	China / Commodities			0.00929	VL med risk h...	1	1	1	1	1
P Manufacture of other non-metallic mineral products - CN	China / Commodities			0.00915	VL med risk h...	1	1	1	1	1
P Highway freight and passangers transport - CN	China / Commodities			0.00890	VL med risk h...	1	1	1	1	1
F Violations of mandatory health and safety standards; very high risk	Workers / Health and Safety	3.67147E-6 d	2400.00000 VL med risk hours/d	0.00881	VL med risk h...	1	1	1	1	1
P Finance - CN	China / Commodities			0.00796	VL med risk h...	1	1	1	1	1
P Coal mining and processing - CN	China / Commodities			0.00779	VL med risk h...	1	1	1	1	1
P Crop cultivation - CN	China / Commodities			0.00771	VL med risk h...	1	1	1	1	1
P Electricity and steam production and supply - CN	China / Commodities			0.00647	VL med risk h...	1	1	1	1	1
F Violations of mandatory health and safety standards; very high risk	Workers / Health and Safety	2.67012E-6 d	2400.00000 VL med risk hours/d	0.00641	VL med risk h...	1	1	1	1	1
P Steel-processing - CN	China / Commodities			0.00544	VL med risk h...	1	1	1	1	1
P Crude petroleum products and Natural gas products - CN	China / Commodities			0.00526	VL med risk h...	1	1	1	1	1
P Domestic public transport - CN	China / Commodities			0.00497	VL med risk h...	1	1	1	1	1
P Pottery/ china and earthenware - CN	China / Commodities			0.00472	VL med risk h...	1	1	1	1	1
P Business services - CN	China / Commodities			0.00462	VL med risk h...	1	1	1	1	1
P Resident services and other services - CN	China / Commodities			0.00450	VL med risk h...	1	1	1	1	1
P Water freight and passangers transport - CN	China / Commodities			0.00439	VL med risk h...	1	1	1	1	1
F Violations of mandatory health and safety standards; very high risk	Workers / Health and Safety	1.82535E-6 d	2400.00000 VL med risk hours/d	0.00438	VL med risk h...	1	1	1	1	1
P Furniture and products of wood/ bamboo/ cane/ palm/ straw/ etc. - CN	China / Commodities			0.00429	VL med risk h...	1	1	1	1	1
P Forestry - CN	China / Commodities			0.00371	VL med risk h...	1	1	1	1	1
Active involvement of enterprises in corruption and bribery				1.10025	AI med risk h...	2	2	3	2	3
Illiteracy, male				0.21290	I med risk hours	1	2	1	2	5
Association and bargaining rights				0.27766	ACB med risk ...	1	1	1	1	1
Contribution of the sector to environmental load				0.86098	CS med risk h...	2	2	4	1	1
Youth illiteracy, male				0.04293	YI med risk ho...	1	3	2	2	5
Weekly hours of work per employee				2.04624	WH med risk ...	1	2	1	3	3
P Basic construction - DE	Germany / Commodities			0.87980	WH med risk ...	1	2	1	3	3
P Manufacture of Non-metallic mineral products - DE	Germany / Commodities			0.08703	WH med risk ...	1	2	1	3	2
P Manufacture of fabricated metal products - DE	Germany / Commodities			0.02614	WH med risk ...	1	2	1	3	2
P Mining and quarrying (energy) - RU	Russia / Industries			0.02123	WH med risk ...	1	2	1	3	2
Drinking water coverage				0.31400	DW med risk ...	1	1	2	1	5

Figure 28: Impact analysis result (part)



Basic construction

Flow: Illiteracy rate, female; medium risk - Society/Contribution t

Impact category: Contribution of the sector to environmental load — Don't show < 0 % — Exclude zero entries ☑

Contribution tree for locations

Location/Process	Amount	Unit
Germany - DE	0.10004	CS med risk hours
China - CN	0.09897	CS med risk hours
Russian Federation - RU	0.08792	CS med risk hours
Zimbabwe - ZW	0.04836	CS med risk hours
Poland - PL	0.03636	CS med risk hours
Denmark - DK	0.03528	CS med risk hours
United States - US	0.03383	CS med risk hours
India - IN	0.03093	CS med risk hours
Czech Republic - CZ	0.02906	CS med risk hours
Switzerland - CH	0.02824	CS med risk hours
United Kingdom - GB	0.02428	CS med risk hours
France - FR	0.02225	CS med risk hours
Argentina - AR	0.02028	CS med risk hours
Turkey - TR	0.01957	CS med risk hours
Italy - IT	0.01892	CS med risk hours
Hungary - HU	0.01747	CS med risk hours
Romania - RO	0.01675	CS med risk hours
Netherlands - NL	0.01208	CS med risk hours
Viet Nam - VN	0.01103	CS med risk hours
Belgium - BE	0.01100	CS med risk hours
Austria - AT	0.00942	CS med risk hours
Ethiopia - ET	0.00796	CS med risk hours
Portugal - PT	0.00759	CS med risk hours
Pakistan - PK	0.00731	CS med risk hours
Slovenia - SI	0.00700	CS med risk hours
Slovakia - SK	0.00647	CS med risk hours
Syrian Arab Republic - SY	0.00601	CS med risk hours
Spain - ES	0.00529	CS med risk hours
Israel - IL	0.00504	CS med risk hours

Figure 29: Geographical hot spots, expenditure on education

By clicking on *Export to Excel* (in the *General information* tab) results can also be converted into an excel file and saved independently from openLCA (see Figure 30).

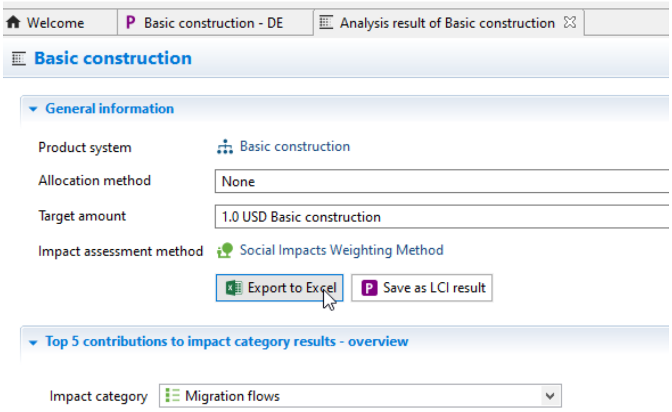


Figure 30: Export of results to an excel file

This calculation works with a cut-off, and also without a cut-off. As explained above, the calculation without a cut-off requires a powerful computer, depending on the database. As an example, for calculating basic construction, Germany, setting up the product system takes 53 minutes and requires 101.685 GB RAM, performing the calculation afterwards takes additional 18.5 minutes and altogether 118.640 GB RAM[11].

New: Alternative to product system creation, the direct network calculation feature

OpenLCA in version 1.10 and higher allows a network calculation without making a product system first, via the Direct calculation button in the General information tab of each process, see Figure 31.

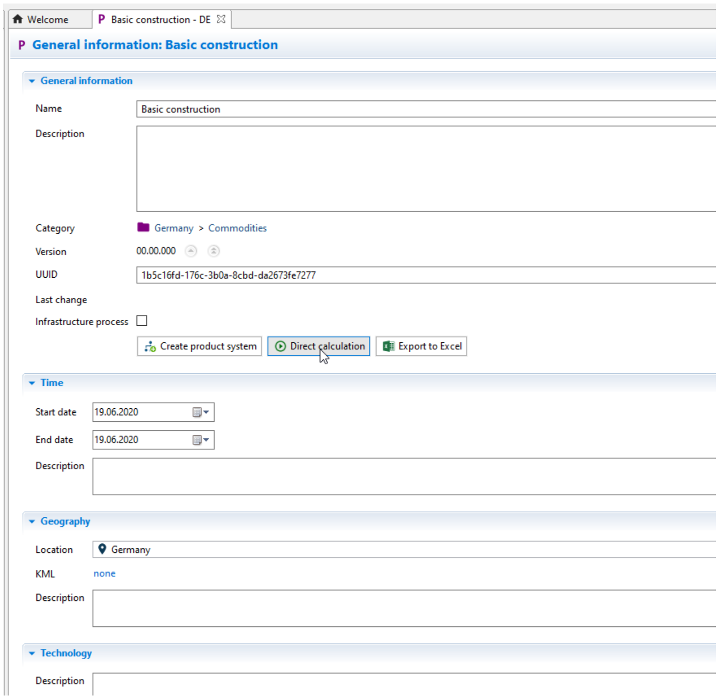


Figure 31: Direct calculation feature

This saves time and memory for densely populated databases with many connections, typically I/O databases, and makes e.g. the PSILCA developer database fully calculable also on an average computer.

[11] Computer: Threadripper 3970X, 256 GB RAM

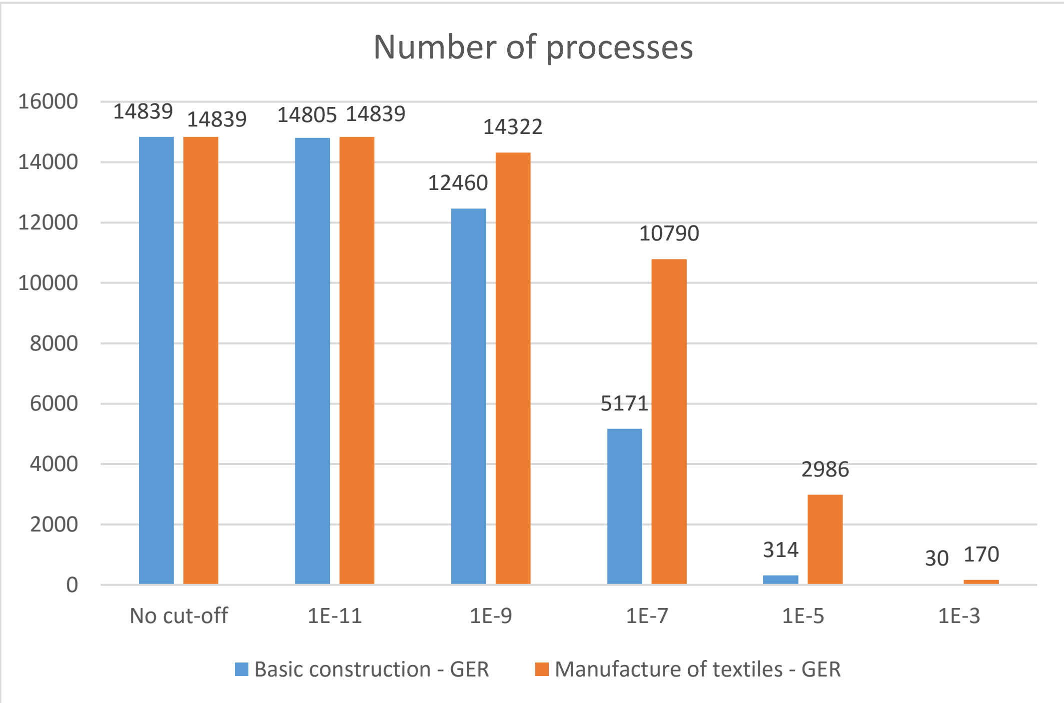
For example, for the “Basic Construction” DE process, where the life cycle calculation took more than one hour in the normal mode (see above), the direct calculation on the same computer took less than 4 minutes, requiring < 16 GB of RAM, for the same system, i.e. the complete developer database without any cut-offs.

Note that this works only if the database contains unambiguous, simple links, which can be checked before using this feature. More information is available in the openLCA 1.10 user manual (GreenDelta GmbH 2020b) or at the following link https://www.openlca.org/fast-network-calculation-in-openlca-1-10-2-what-is-it-and-what-is-it-good-for/.

5.3 Variation of results due to different cut-off criteria

As demonstrated above (see chapter 5.2.1) the use of cut-off criteria reduces the maximum memory usage of openLCA and the calculation time. Unfortunately, of course, this also leads to a loss of detail in the results[12].

Figure 32 shows the general effects on the system using different cut-offs for the product systems “Manufacture of textiles” and “Basic construction” in Germany. It becomes clear that the effects are not equally high for the two systems. The product systems with a cut-off of 1E-11 both contain (almost) all processes, but the one for “Basic construction” with 1E-9 has already reduced by roughly 2,400 processes while the system of “Manufacture of textiles” still contains 14,322 5 processes. For the system of “Basic construction” with 1E-7 the amount of connected processes has reduced significantly while the one of “Manufacture of textiles” still counts almost 11,000 (see Figure 32).



[12] This chapter is taken from the previous database version. Since the structure of the database remains exactly the same, with identical number of processes (country / sector combinations), also the conclusions drawn are valid for the version 3 of the database.

Figure 32: Number of processes depending on different cut-off criteria, for two product systems[10]

Of course, with the reduction of the amount of processes, also the number of process links is reduced a lot, from almost 40 million in the versions without cut-off to 177 and 38 with a cut-off of 1E-03 for the two product systems respectively (see Figure 33).

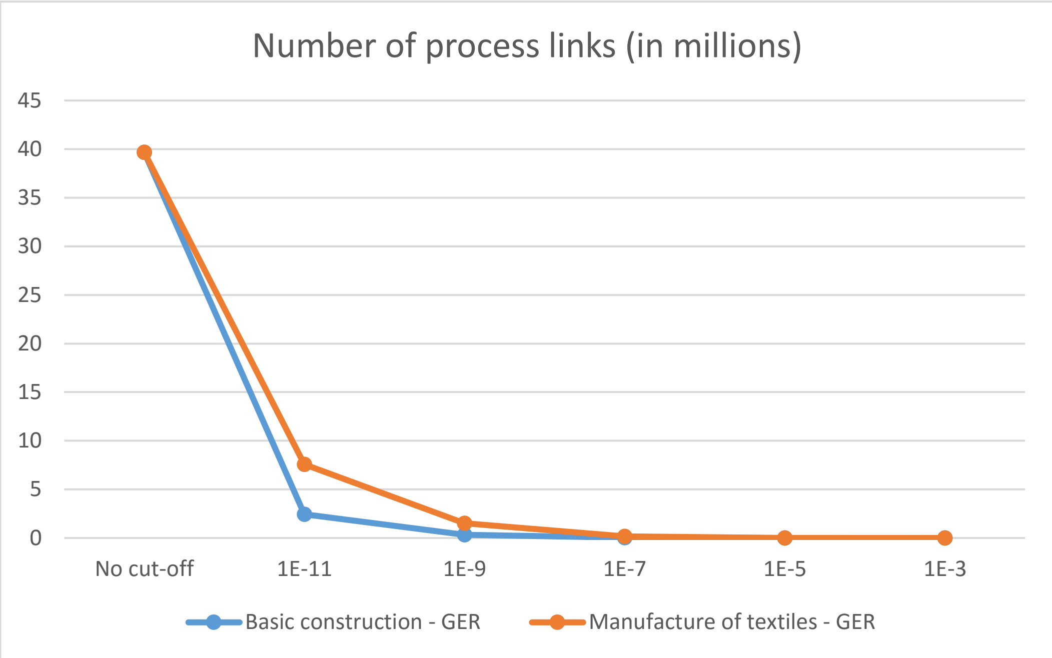


Figure 33: Number of process links depending on different cut-off criteria, for two product systems[10]

This short analysis shows that the effects on the system can vary greatly between different product systems. However, the strong reduction of the number of processes especially with cut-offs of 1E-7 and below already indicates that it is not recommendable to apply very high cut-offs.

In the following, some analysis results are presented for the product system “Manufacture of textiles” in Germany calculated with different cut-offs.

Figure 34 illustrates the overall impact of child labour for “Manufacture of textiles” in Germany. Similarly, to the reduction of the number of processes the amount of medium risk hours of child labour starts to reduce stronger with a cut-off of 1E-7. However, it still makes up more than 80% of the total impact (without a cut-off). Only with a cut-off of 1E-5 the overall impact decrements significantly representing roughly half of the overall impact the system has without a cut-off.

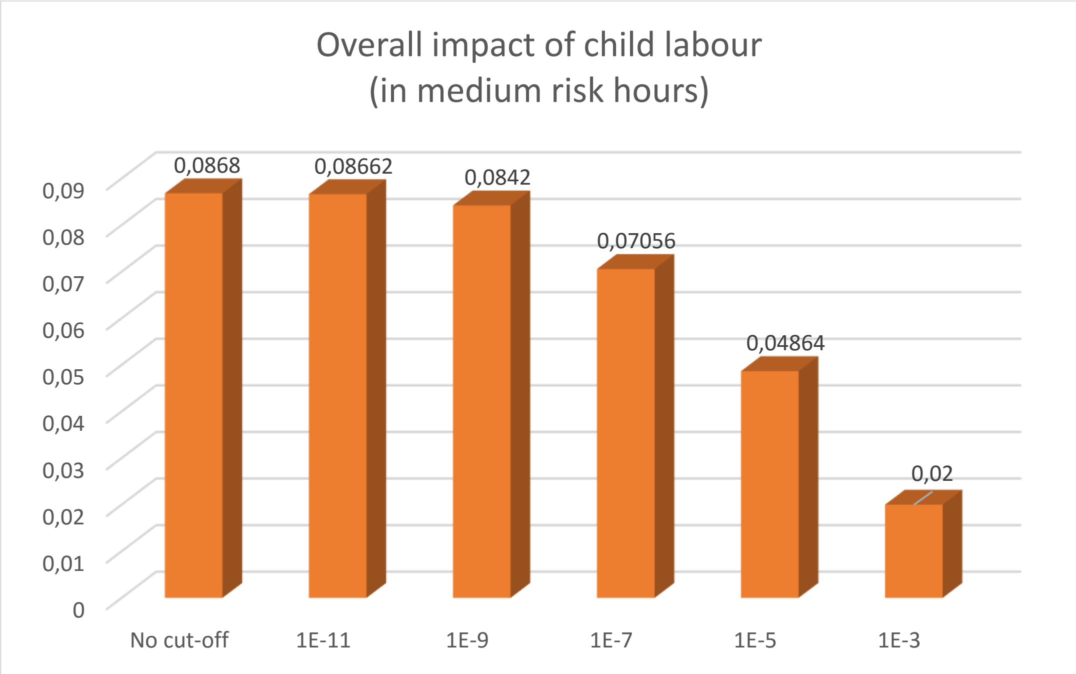


Figure 34: Overall impact of child labour for "Manufacture of textiles" in Germany[10]

In the following figures, the highest impact contributions for child labour of "Manufacture of textiles" in Germany are illustrated disaggregated by processes and locations. Only results for the systems without a cut-off, with a cut-off of 1E-7 and 1E-5 are shown because results for 1E-11 and 1E-9 do not vary much from the ones without a cut-off.

Figure 35 shows that the shares of the most contributing processes to child labour – "Manufacture of wearing apparel, dressing and dyeing of fur (Turkey)" (Industry and Commodity) and "Sewn Goods (Ukraine)" – become bigger with a growing cut-off because less important processes from the upstream chain are cut off.

Figure 35: Pie chart of highest contributions to child labour for product systems of "Manufacture of textiles" in Germany without a cut-off (above), with a cut-off of 1E-7 (middle) and 1E-5 (below)

The maps in Figure 36 illustrate that with increasing cut-off criteria less countries seam to contribute to child labour at all while others gain more importance (e.g. Turkey). Of course, this is due to the fact, that processes from some countries are cut off the product system and, hence, do not contribute anymore (or much less) to the final result (e.g. Argentina).

Locations

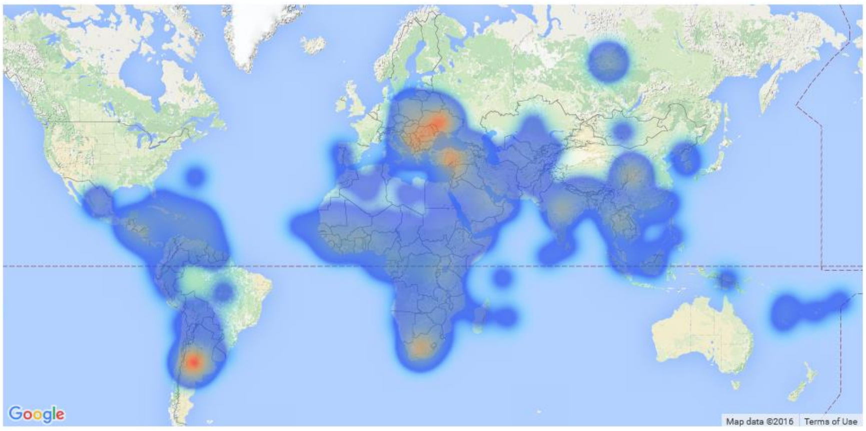
Flow: Extraction of industrial and construction minerals; medium

Impact category: Child Labour

▾ Result contributions

Location	Process	Amount	Unit
Argentina		0.01147	CL med risk hours
Ukraine		0.00893	CL med risk hours
Turkey		0.00784	CL med risk hours
South Africa		0.00749	CL med risk hours
China		0.00523	CL med risk hours
Romania		0.00517	CL med risk hours
India		0.00439	CL med risk hours
Poland		0.00420	CL med risk hours

▾ Map (beta)

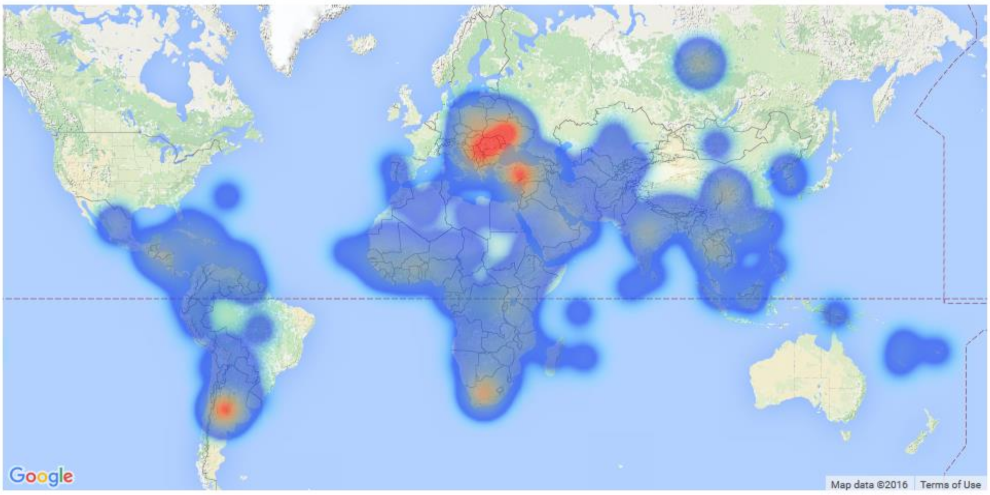


No cut-off

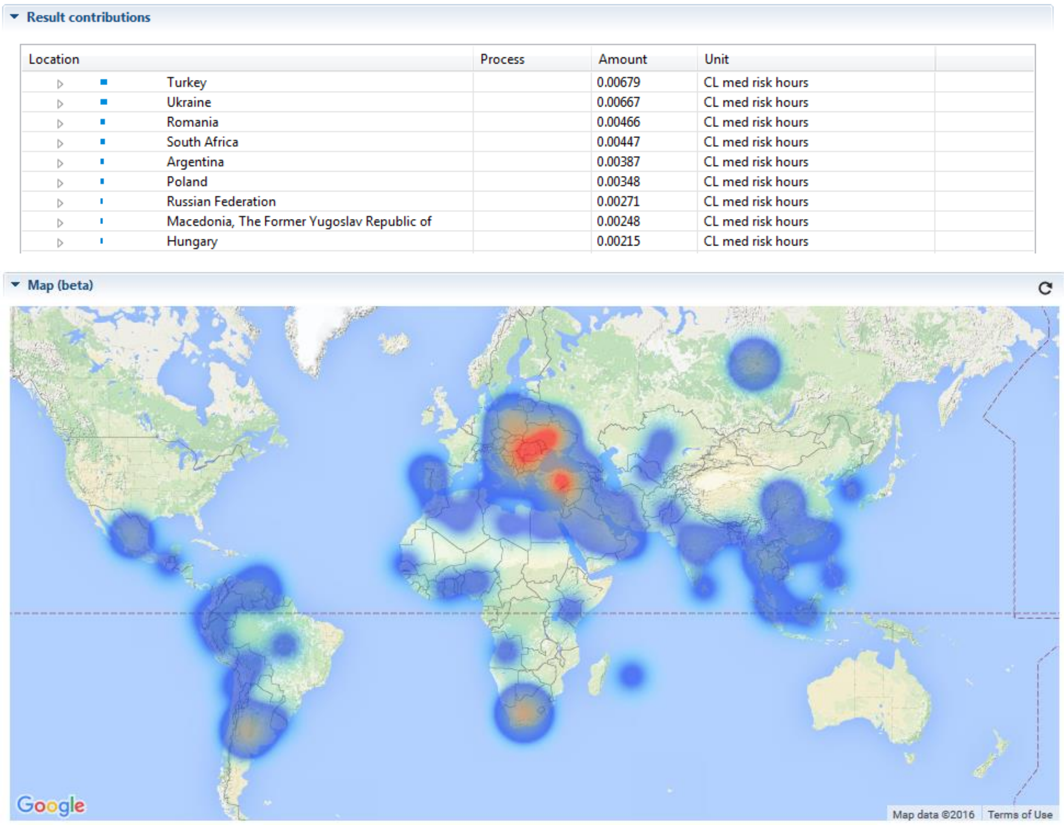
▾ Result contributions

Location	Process	Amount	Unit
Ukraine		0.00846	CL med risk hours
Argentina		0.00797	CL med risk hours
Turkey		0.00758	CL med risk hours
South Africa		0.00628	CL med risk hours
Romania		0.00510	CL med risk hours
Poland		0.00405	CL med risk hours
Russian Federation		0.00370	CL med risk hours
China		0.00357	CL med risk hours

▾ Map (beta)



1E-7



Result contributions

Location	Process	Amount	Unit
Turkey		0.00679	CL med risk hours
Ukraine		0.00667	CL med risk hours
Romania		0.00466	CL med risk hours
South Africa		0.00447	CL med risk hours
Argentina		0.00387	CL med risk hours
Poland		0.00348	CL med risk hours
Russian Federation		0.00271	CL med risk hours
Macedonia, The Former Yugoslav Republic of		0.00248	CL med risk hours
Hungary		0.00215	CL med risk hours

1E-5

Figure 36: Most contributing locations (countries) to child labour for product systems of "Manufacture of textiles" in Germany without a cut-off (above), with a cut-off of 1E-7 (middle) and 1E-5 (below)

Out of these findings, an interim conclusion can already be drawn. For the examined product systems, all the analyses indicate that results only start to change significantly from a cut-off of 1E-7. The comparison of general results show that – including the cut-off of 1E-5 – the four most contributing processes remain the same (see Figure 35). Regarding locations only one country loses significantly importance as a social hot spot while the other three would be detected even applying a cut-off of 1E-5 (see Figure 36).

Of course, the level of detail, e.g. the total amount of medium risk hours of an impact or the exact contribution of locations to an impact category, becomes more imprecise with increasing cut-offs. Additionally, since cut-off criteria refer to the monetary contribution to the final product (or sector) there is a growing risk of “cutting off” social hotspots (e.g. processes with high or very high risks of an impact) when applying higher cut-offs.

Consequently, in order to receive most detailed and exact results cut-off criteria should be as small as possible. Nonetheless, calculations with cut-offs until around 1E-7 or even 1E-5 still deliver reliable results for comparing most relevant impacts and detecting social hotspots (processes as well as countries).

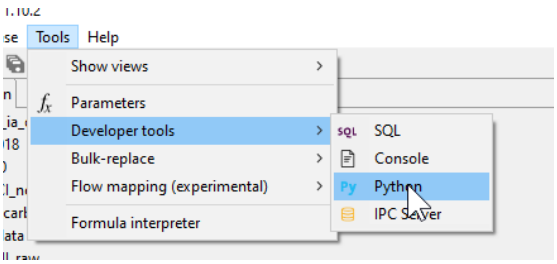
5.4 New: A direct quantification of indicators in PSILCA's life cycle calculation, practicalities

The 3rd edition of the PSILCA database allows a new "direct" calculation of indicators from their raw values, without using worker hours. This is motivated and explained in section 3.7.2.

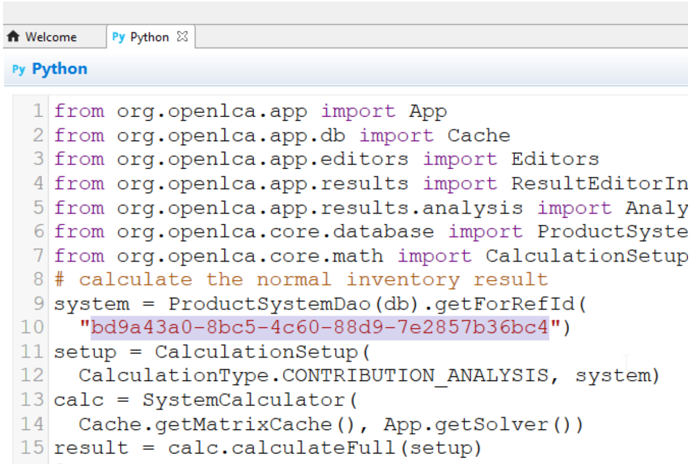
To apply this approach, a Python script needs to be executed in openLCA, which calculates an existing product system. The script is as follows:

```
from org.openlca.app import App
from org.openlca.app.db import Cache
from org.openlca.app.editors import Editors
from org.openlca.app.results import ResultEditorInput
from org.openlca.app.results.analysis import AnalyzeEditor
from org.openlca.core.database import ProductSystemDao
from org.openlca.core.math import CalculationSetup, CalculationType, SystemCalculator
# calculate the normal inventory result
system = ProductSystemDao(db).getForRefId(
  "bd9a43a0-8bc5-4c60-88d9-7e2857b36bc4")
setup = CalculationSetup(
  CalculationType.CONTRIBUTION_ANALYSIS, system)
calc = SystemCalculator(
  Cache.getMatrixCache(), App.getSolver())
result = calc.calculateFull(setup)
# calculate the total product amount (assuming
# the products can be summed up (e.g. are monitary))
# note, that A is already scaled in the result!
A = result.techMatrix
n = A.rows()
total = 0.0
for j in range(0, n):
  total += A.get(j, j)
log.info("total = {}", total)
# normalize the results
D = result.directFlowResults
U = result.upstreamFlowResults
g = result.totalFlowResults
m = D.rows()
for j in range(0, n):
  for i in range(0, m):
    D.set(i, j, D.get(i, j) / total)
    U.set(i, j, U.get(i, j) / total)
for i in range(0, m):
  g[i] /= total
# open the result
inp = ResultEditorInput.create(setup, result)
Editors.open(inp, AnalyzeEditor.ID)
```

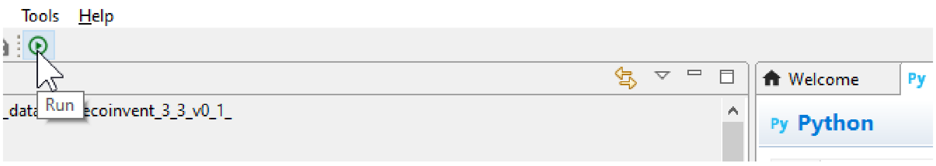
To use it, paste the code into the openLCA Python window..



..and edit the reference ID of your product system to match the one of the product system you want to calculate. You find the reference ID on the general information tab of the product system..



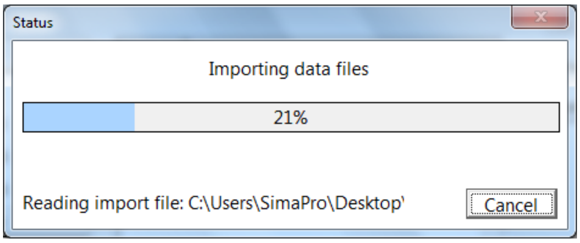
.. and then press the ‘run’ button:



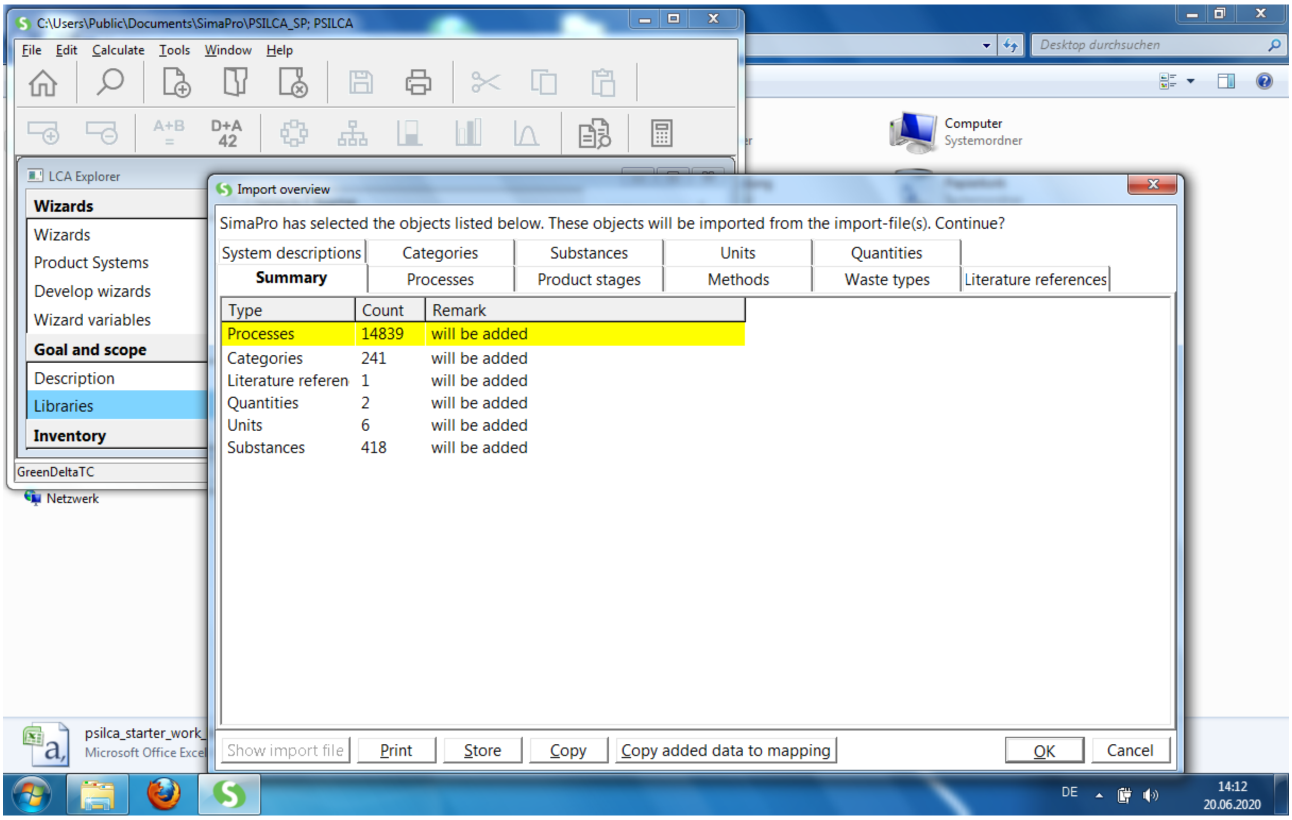
This starts the calculation.

6 PSILCA in SimaPro

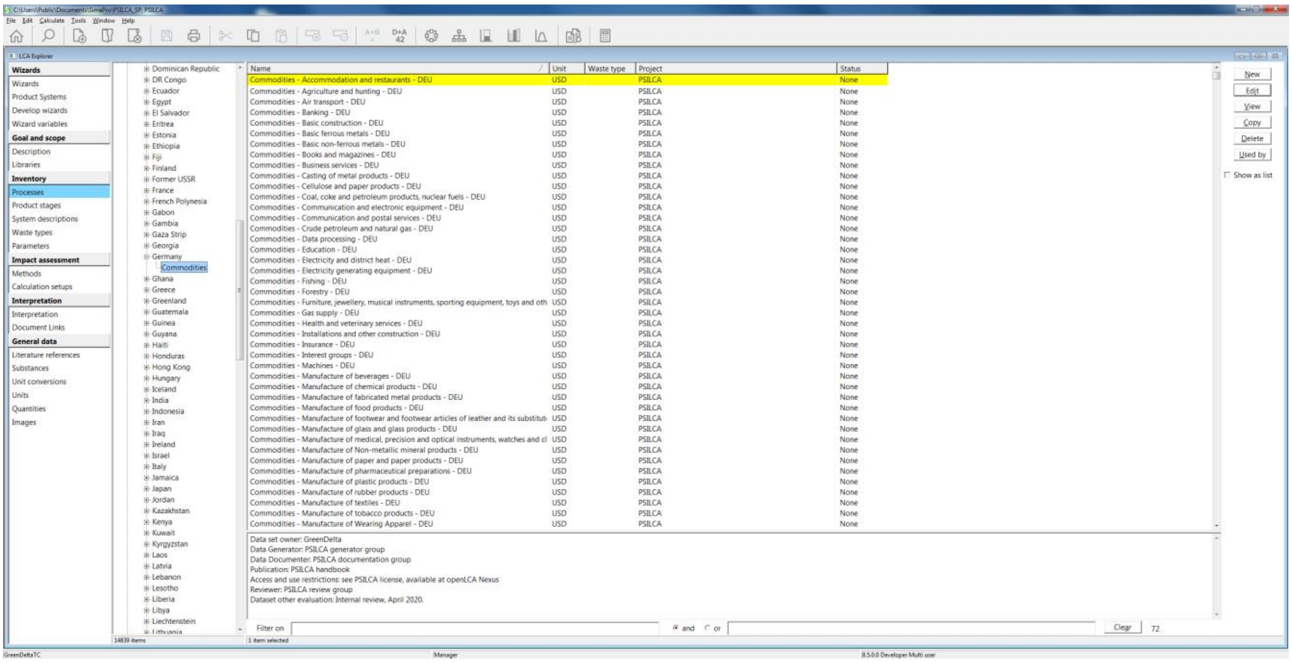
PSILCA is also available for the SimaPro LCA software, as a SimaPro csv file. In order to use it, simply import the csv, which can take a while, into a new database in SimaPro.



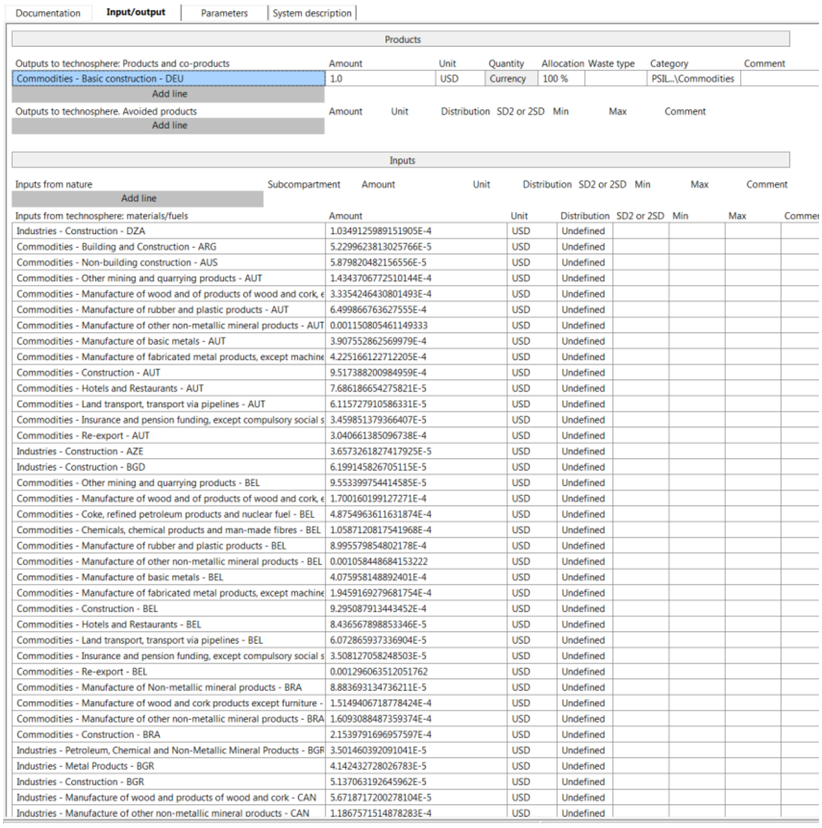
Since SimaPro does not allow the modification of the calculation algorithm and does not understand the product system concept, only the “usual”, worker hour databases are available.



The database contains the same country-specific sectors as the openLCA databases.



The processes are more truncated, though; in the distributed version, all product flows < 3*1e-5 were deleted, since otherwise, SimaPro is not able to calculate them due to memory restrictions (Figure 38).



Documentation | Input/output | Parameters | System description

Products

Outputs to technosphere: Products and co-products	Amount	Unit	Quantity	Allocation	Waste type	Category	Comment
Commodities - Basic construction - DEU	1.0	USD	Currency	100 %		PSIL...\Commodities	
Add line							

Outputs to technosphere. Avoided products	Amount	Unit	Distribution	SD2 or 2SD	Min	Max	Comment
Add line							

Inputs

Inputs from nature	Subcompartment	Amount	Unit	Distribution	SD2 or 2SD	Min	Max	Comment
Add line								

Inputs from technosphere: materials/fuels	Amount	Unit	Distribution	SD2 or 2SD	Min	Max	Commei
Industries - Construction - DZA	1.0349125989151905E-4	USD	Undefined				
Commodities - Building and Construction - ARG	5.2299623813025766E-5	USD	Undefined				
Commodities - Non-building construction - AUS	5.879820482156556E-5	USD	Undefined				
Commodities - Other mining and quarrying products - AUT	1.4343706772510144E-4	USD	Undefined				
Commodities - Manufacture of wood and of products of wood and cork, e	3.3354246430801493E-4	USD	Undefined				
Commodities - Manufacture of rubber and plastic products - AUT	6.499866763627555E-4	USD	Undefined				
Commodities - Manufacture of other non-metallic mineral products - AUT	0.001150805461149333	USD	Undefined				
Commodities - Manufacture of basic metals - AUT	3.907552862569979E-4	USD	Undefined				
Commodities - Manufacture of fabricated metal products, except machine	4.225166122712205E-4	USD	Undefined				
Commodities - Construction - AUT	9.517388200984959E-4	USD	Undefined				
Commodities - Hotels and Restaurants - AUT	7.686186654275821E-5	USD	Undefined				
Commodities - Land transport, transport via pipelines - AUT	6.115727910586331E-5	USD	Undefined				
Commodities - Insurance and pension funding, except compulsory social s	3.459851379366407E-5	USD	Undefined				
Commodities - Re-export - AUT	3.040661385096738E-4	USD	Undefined				
Industries - Construction - AZE	3.6573261827417925E-5	USD	Undefined				
Industries - Construction - BGD	6.199145826705115E-5	USD	Undefined				
Commodities - Other mining and quarrying products - BEL	9.553399754414585E-5	USD	Undefined				
Commodities - Manufacture of wood and of products of wood and cork, e	1.700160199127271E-4	USD	Undefined				
Commodities - Coke, refined petroleum products and nuclear fuel - BEL	4.8754963611631874E-4	USD	Undefined				
Commodities - Chemicals, chemical products and man-made fibres - BEL	1.0587120817541968E-4	USD	Undefined				
Commodities - Manufacture of rubber and plastic products - BEL	8.995579854802178E-4	USD	Undefined				
Commodities - Manufacture of other non-metallic mineral products - BEL	0.001058448684153222	USD	Undefined				
Commodities - Manufacture of basic metals - BEL	4.075958148892401E-4	USD	Undefined				
Commodities - Manufacture of fabricated metal products, except machine	1.9459169279681754E-4	USD	Undefined				
Commodities - Construction - BEL	9.295087913443452E-4	USD	Undefined				
Commodities - Hotels and Restaurants - BEL	8.436567898853346E-5	USD	Undefined				
Commodities - Land transport, transport via pipelines - BEL	6.072865937336904E-5	USD	Undefined				
Commodities - Insurance and pension funding, except compulsory social s	3.508127058248503E-5	USD	Undefined				
Commodities - Re-export - BEL	0.001296063512051762	USD	Undefined				
Commodities - Manufacture of Non-metallic mineral products - BRA	8.883693134736211E-5	USD	Undefined				
Commodities - Manufacture of wood and cork products except furniture -	1.5149406718778424E-4	USD	Undefined				
Commodities - Manufacture of other non-metallic mineral products - BRA	1.6093088487359374E-4	USD	Undefined				
Commodities - Construction - BRA	2.1539791696957597E-4	USD	Undefined				
Industries - Petroleum, Chemical and Non-Metallic Mineral Products - BGR	3.501460392091041E-5	USD	Undefined				
Industries - Metal Products - BGR	4.142432728026783E-5	USD	Undefined				
Industries - Construction - BGR	5.137063192645962E-5	USD	Undefined				
Industries - Manufacture of wood and products of wood and cork - CAN	5.6718717200278104E-5	USD	Undefined				
Industries - Manufacture of other non-metallic mineral products - CAN	1.1867571514878283E-4	USD	Undefined				

Figure 37: Process Basic Construction, DE, in SimaPro (excerpt)

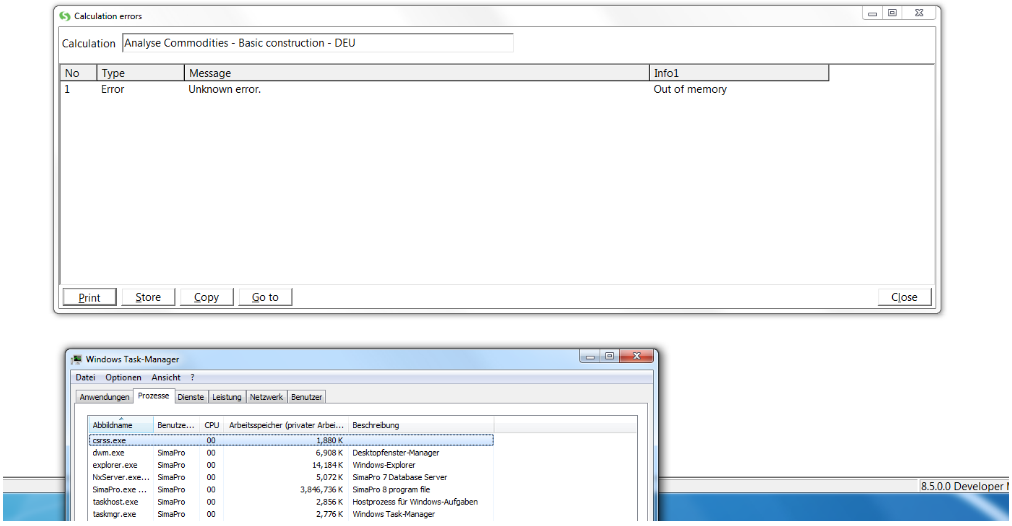


Figure 38: Calculating the PSICA starter database in SimaPro, 8.5.5 Developer version, with a cut-off of 1e-5 (i.e. the PSILCA Starter setting)

With the distributed version, the calculation works (Figure 39); evidently, values are somewhat lower than with the openLCA versions of the database since more data was truncated. Figure 41 and Figure 40 show a comparison of results for the process basic construction, Germany, for the openLCA PSILCA v3 developer, professional and starter version and for the SimaPro version as well.

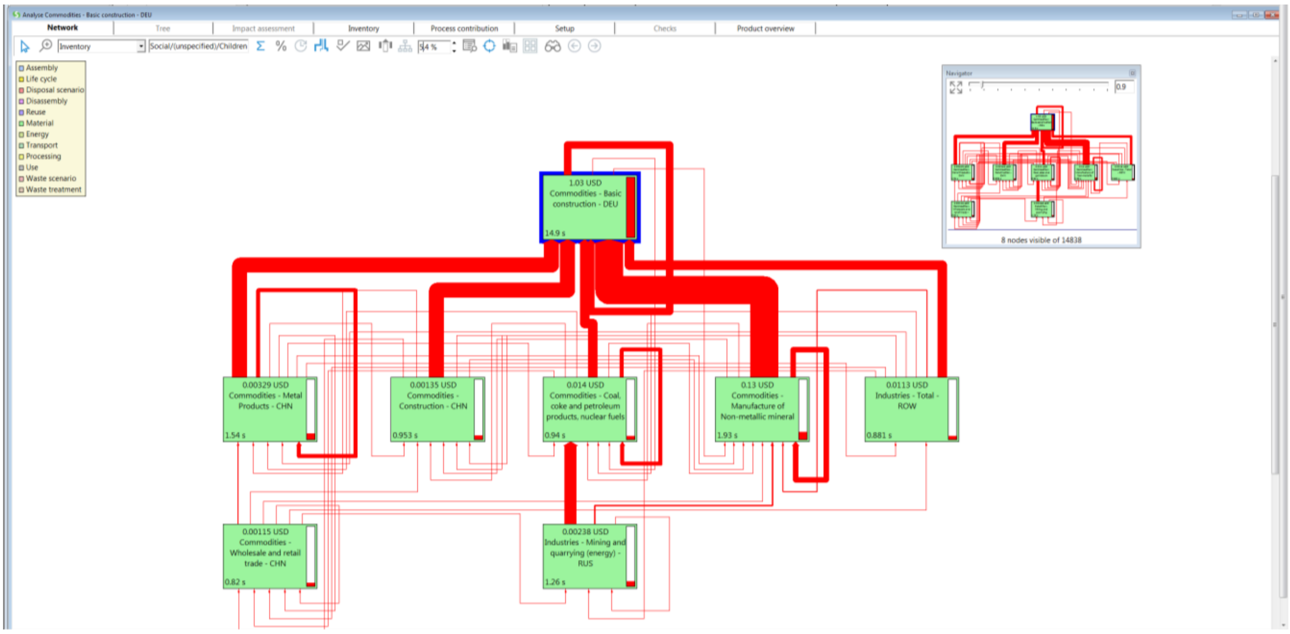


Figure 39: Network result view for the SimaPro version, process basic construction, Germany, female child work

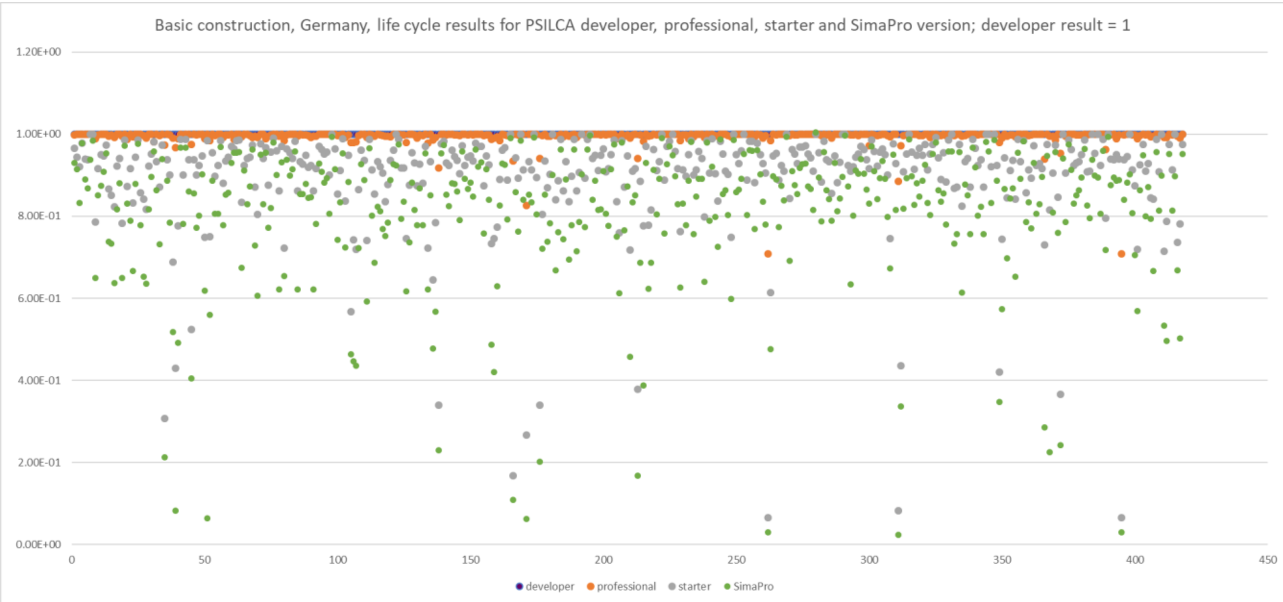


Figure 40: Comparison of PSILCA results for different database versions, Developer, professional, starter, and SimaPro, for the network calculation result for basic construction, Germany; developer result = 1

Result variation in PSILCA v3 software versions; developer result = 1	developer	professional	starter	SimaPro
Active involvement of enterprises in corruption and bribery; low risk	1.00E+00	9.99E-01	9.66E-01	9.30E-01
Active involvement of enterprises in corruption and bribery; medium risk	1.00E+00	1.00E+00	9.44E-01	9.15E-01
Active involvement of enterprises in corruption and bribery; no data	1.00E+00	1.00E+00	9.20E-01	8.32E-01
Active involvement of enterprises in corruption and bribery; very high risk	1.00E+00	1.00E+00	9.78E-01	9.79E-01
Active involvement of enterprises in corruption and bribery; very low risk	1.00E+00	9.99E-01	9.40E-01	8.89E-01
Certified environmental management systems; high risk	1.00E+00	1.00E+00	9.38E-01	8.68E-01
Certified environmental management systems; low risk	1.00E+00	1.00E+00	1.00E+00	9.38E-01
Certified environmental management systems; medium risk	1.00E+00	1.00E+00	1.00E+00	9.84E-01
Certified environmental management systems; no data	1.00E+00	9.89E-01	7.85E-01	6.49E-01
Certified environmental management systems; very high risk	1.00E+00	9.99E-01	9.16E-01	8.51E-01
Certified environmental management systems; very low risk	1.00E+00	1.00E+00	9.50E-01	8.74E-01
Children in employment, female; high risk	1.00E+00	1.00E+00	9.47E-01	9.09E-01
Children in employment, female; low risk	1.00E+00	1.00E+00	9.73E-01	9.53E-01
Children in employment, female; medium risk	1.00E+00	9.95E-01	8.66E-01	7.38E-01
Children in employment, female; no data	1.00E+00	9.98E-01	8.50E-01	7.33E-01
Children in employment, female; very high risk	1.00E+00	9.91E-01	8.23E-01	6.37E-01
Children in employment, female; very low risk	1.00E+00	9.99E-01	9.23E-01	8.17E-01
Children in employment, male; high risk	1.00E+00	1.00E+00	9.41E-01	8.81E-01
Children in employment, male; low risk	1.00E+00	9.94E-01	7.83E-01	6.49E-01
Children in employment, male; medium risk	1.00E+00	1.00E+00	9.86E-01	9.72E-01
Children in employment, male; no data	1.00E+00	9.88E-01	8.73E-01	8.32E-01
Children in employment, male; very high risk	1.00E+00	1.00E+00	9.17E-01	7.89E-01
Children in employment, male; very low risk	1.00E+00	9.93E-01	8.32E-01	6.67E-01
Children in employment, total; high risk	1.00E+00	1.00E+00	9.44E-01	8.79E-01
Children in employment, total; low risk	1.00E+00	1.00E+00	9.85E-01	9.77E-01
Children in employment, total; medium risk	1.00E+00	1.00E+00	8.58E-01	7.78E-01
Children in employment, total; no data	1.00E+00	9.97E-01	8.42E-01	6.52E-01
Children in employment, total; very high risk	1.00E+00	9.90E-01	8.16E-01	6.36E-01
Children in employment, total; very low risk	1.00E+00	9.99E-01	9.22E-01	8.17E-01
Contribution of the sector to economic development; high opportunity	1.00E+00	1.00E+00	9.52E-01	8.96E-01
Contribution of the sector to economic development; low opportunity	1.00E+00	9.81E-01	9.81E-01	9.57E-01
Contribution of the sector to economic development; medium opportunity	1.00E+00	1.00E+00	9.33E-01	8.63E-01
Contribution of the sector to economic development; no data	1.00E+00	9.96E-01	8.71E-01	7.31E-01
Contribution of the sector to economic development; no opportunity	1.00E+00	9.99E-01	9.73E-01	9.39E-01
DALYs due to indoor and outdoor air and water pollution; high risk	1.00E+00	9.73E-01	3.07E-01	2.13E-01
DALYs due to indoor and outdoor air and water pollution; low risk	1.00E+00	1.00E+00	9.38E-01	8.87E-01
DALYs due to indoor and outdoor air and water pollution; medium risk	1.00E+00	9.97E-01	9.01E-01	7.84E-01
DALYs due to indoor and outdoor air and water pollution; no data	1.00E+00	9.91E-01	6.89E-01	5.18E-01
DALYs due to indoor and outdoor air and water pollution; no risk	1.00E+00	9.68E-01	4.29E-01	8.22E-02
DALYs due to indoor and outdoor air and water pollution; very high risk	1.00E+00	9.89E-01	7.76E-01	4.92E-01
DALYs due to indoor and outdoor air and water pollution; very low risk	1.00E+00	1.00E+00	9.87E-01	9.67E-01

Figure 41: Comparison of PSILCA results for different database versions, Developer, professional, starter, and SimaPro, for the network calculation result for basic construction, Germany (excerpt)

7 Outlook

The current PSILCA database is the third public version released in June 2020. It contains 74 social indicators addressing 20 subcategories and 4 stakeholders. More indicators, also for the stakeholder consumers, are currently being processed and assessed. A specific download directory will be established so that clients with licenses including maintenance can access data, indicator or methodological updates.

8 Contact

Feedback about the practical use, bugs, implementation in openLCA etc. is very welcome. There is also the possibility to contribute data on specific indicators, countries or sectors.

If you have any comments or questions, please contact us:

Kirill Maister, Claudia Di Noi, Andreas Ciroth

GreenDelta GmbH

Kaiserdamm 13, 14057 Berlin, Germany

psilca@greendelta.com

www.greendelta.com

9 Annex A: Python Script for changing risk levels

```
# ****USER INPUT****

# Write the name of the social indicator for which the risk level ranges apply. If it is for all,
write "ALL"
# Enclose the indicators within [] and use "," as separator:
# Example 1: indicator = [["Children in employment, total"],["Trafficking in persons"]]
# Exampel 2: indicator = [["ALL"]]
indicator = [["Children in employment, total"]]

# Numeric ranges, single numeric values or text variables can be used to define the risk levels.
# Format for defining risk levels using ranges: ["Risk_Level", "VALUE_TYPE1", "Minimum_Value1",
"Maximum_Value1", "VALUE_TYPE2", "Minimum_Value2","Maximum_Value2",...]
# Format for defining risk levels using specific text/numeric values:
["Risk_Level","VALUE_TYPE1", "Value1","VALUE_TYPE2","Value2","VALUE_TYPE3","Value3",...]
# These are the codes for each type of value available:
# R1 = Numeric range type 1: minimum value <= Raw amount < maximum value
# R2 = Numeric range type 2: minimum value < Raw amount <= maximum value
# R3 = Numeric range type 3: minimum value < Raw amount < maximum value
# R4 = Numeric range type 4: minimum value <= Raw amount <= maximum value
# EV = Value (either text or number): Raw amount = value
# N1 = Numeric value 1: Raw amount >= value
# N2 = Numeric value 2: Raw amount <= value
# Several ranges, values can be used for defining a risk level e.g.
["NO_DATA","EV","n.a","EV","no data","EV","null"], ["HIGH_RISK","R1","5","10","R2","-10","-
5"],...
# If the values refer to float numbers use "." as decimal separator
# Enclose the risk levels and their values within [] and use "," as separator. e.g risk_level =
[["NO_DATA","EV","n.a."],["NO_RISK","EV","0"]]
# Risk levels are fixed in openLCA. Levels available:
# HIGH_OPPORTUNITY, MEDIUM_OPPORTUNITY, LOW_OPPORTUNITY, NO_RISK, VERY_LOW_RISK, LOW_RISK,
MEDIUM_RISK, HIGH_RISK, VERY_HIGH_RISK, NO_DATA, NOT_APPLICABLE
eval_scheme = [["NO_DATA","EV","n.a."],
             ["NO_RISK","EV","0"],
             ["VERY_LOW_RISK","R3","0","5","R3","-5","0"],
             ["LOW_RISK","R1","5","10","R2","-10","-5"],
             ["MEDIUM_RISK","R1","10","20","R2","-20","-10"],
             ["HIGH_RISK","R1","20","30","R2","-30","-10"],
             ["VERY_HIGH_RISK","N1","30","N2","-30"]]

# Define the path of the change log file (a list of the changes done in the Evaluation Schemes
and Social Aspects will be recorded)
change_log = 'C:/Users/Username/Documents/log_psilca_indicators.csv'

# ****SCRIPT (DO NOT MODIFY)****
import codecs
import csv
out = codecs.open(change_log, 'w', 'cp1252')
f = open(change_log, 'wb')
writer = csv.writer(f, quoting=csv.QUOTE_NONNUMERIC)
def main():
    global olca, log
    section_title = ['CHANGES IN EVALUATION SCHEMES PER INDICATOR']
    columns = ['Social Indicator Reference ID', 'Social Indicator Name', 'Old Evaluation scheme',
'New evaluation scheme']
    writer.writerow(section_title)
    writer.writerow(columns)
    olca.eachSocialIndicator(rewrite_scheme)
    writer.writerow('')
    section_title = ['CHANGES IN RISK LEVELS PER PROCESS AND SOCIAL INDICATOR']
    columns = ['Process Reference ID', 'Process Name', 'Social Indicator Reference ID','Social
Indicator Name', 'Raw amount','Old Risk Level', 'New Risk Level','Exchange updated']
    writer.writerow(section_title)
    writer.writerow(columns)
```

```
    olca.eachProcess(update_risk_levels)
    out.close()
# Updates the evaluation scheme of the selected social indicator with the new evaluation scheme
set by the user
def rewrite_scheme(socialIndicator):
    for ind in indicator:
        if socialIndicator.name == ind[0] or ind[0] == "ALL":
            new_evaluation_scheme = ''
            for risk in eval_scheme:
                if risk[0] == "HIGH_OPPORTUNITY":
                  risk_name = "High opportunity"
                if risk[0] == "MEDIUM_OPPORTUNITY":
                  risk_name = "Medium opportunity"
                if risk[0] == "LOW_OPPORTUNITY":
                  risk_name = "Low opportunity"
                if risk[0] == "NO_RISK":
                  risk_name = "No risk"
                if risk[0] == "VERY_LOW_RISK":
                  risk_name = "Very low risk"
                if risk[0] == "LOW_RISK":
                  risk_name = "Low risk"
                if risk[0] == "MEDIUM_RISK":
                  risk_name = "Medium risk"
                if risk[0] == "HIGH_RISK":
                  risk_name = "High risk"
                if risk[0] == "VERY_HIGH_RISK":
                  risk_name = "Very high risk"
                if risk[0] == "NO_DATA":
                  risk_name = "No data"
                if risk[0] == "NOT_APPLICABLE":
                  risk_name = "Not applicable"
                size_risk = len(risk)
                i = 1
                while i < size_risk-1:
                    j = i
                    if risk[i] == "R1":
                        new_evaluation_scheme = '%s%s <= %s < %s%s' %(new_evalua-
tion_scheme,risk[i+1],risk_name,risk[i+2],'; ')
                        i += 3
                    elif risk[i] == "R2":
                        new_evaluation_scheme = '%s%s < %s <= %s%s' %(new_evalua-
tion_scheme,risk[i+1],risk_name,risk[i+2],'; ')
                        i += 3
                    elif risk[i] == "R3":
                        new_evaluation_scheme = '%s%s < %s < %s%s' %(new_evalua-
tion_scheme,risk[i+1],risk_name,risk[i+2],'; ')
                        i += 3
                        break
                    elif risk[i] == "R4":
                        new_evaluation_scheme = '%s%s <= %s <= %s%s' %(new_evalua-
tion_scheme,risk[i+1],risk_name,risk[i+2],'; ')
                        i += 3
                    elif risk[i] == "EV":
                        new_evaluation_scheme = '%s%s = %s%s' %(new_evalua-
tion_scheme,risk[i+1],risk_name,'; ')
                        i += 2
                    elif risk[i] == "N1":
                        new_evaluation_scheme = '%s%s >= %s%s' %(new_evalua-
tion_scheme,risk[i+1],risk_name,'; ')
                        i += 2
                    elif risk[i] == "N2":
                        new_evaluation_scheme = '%s%s <= %s%s' %(new_evalua-
tion_scheme,risk[i+1],risk_name,'; ')
                        i += 2
                    elif i == j:
                        error_msg = 'Code of value type not found: ' + risk[0] + ' ' + risk[i]
                        log.error(error_msg)
```

```
                    break
                new_evaluation_scheme = new_evaluation_scheme + '\n'
            row = [socialIndicator.refId,socialIndicator.name,socialIndicator.evalua-
tionScheme,new_evaluation_scheme]
            writer.writerow(row)
            socialIndicator.evaluationScheme = new_evaluation_scheme
            olca.updateSocialIndicator(socialIndicator)

# Updates the risk level for the selected social indicator per process applying the new evalua-
tion scheme (changes in elementary flow used and social aspect risk level)
def update_risk_levels(process):
    global new_flow_name
    if process.location is None:
      location = ''
    else:
      location = process.location.code
    for s in process.socialAspects:
        for ind in indicator:
            if s.indicator.name == ind[0] or ind[0] == "ALL":
                if (s.rawAmount is not None and s.rawAmount !=''):
                    old_flow_name = ''
                    if str(s.riskLevel) == "HIGH_OPPORTUNITY":
                      old_flow_name = ind[0] + '; ' + 'high opportunity'
                    elif str(s.riskLevel) == "MEDIUM_OPPORTUNITY":
                      old_flow_name = ind[0] + '; ' + 'medium opportunity'
                    elif str(s.riskLevel) == "LOW_OPPORTUNITY":
                      old_flow_name = ind[0] + '; ' + 'low opportunity'
                    elif str(s.riskLevel) == "NO_RISK":
                      old_flow_name = ind[0] + '; ' + 'no risk'
                    elif str(s.riskLevel) == "VERY_LOW_RISK":
                      old_flow_name = ind[0] + '; ' + 'very low risk'
                    elif str(s.riskLevel) == "LOW_RISK":
                      old_flow_name = ind[0] + '; ' + 'low risk'
                    elif str(s.riskLevel) == "MEDIUM_RISK":
                      old_flow_name = ind[0] + '; ' + 'medium risk'
                    elif str(s.riskLevel) == "HIGH_RISK":
                      old_flow_name = ind[0] + '; ' + 'high risk'
                    elif str(s.riskLevel) == "VERY_HIGH_RISK":
                      old_flow_name = ind[0] + '; ' + 'very high risk'
                    elif str(s.riskLevel) == "NO_DATA":
                      old_flow_name = ind[0] + '; ' + 'no data'
                    elif str(s.riskLevel) == "NOT_APPLICABLE":
                      old_flow_name = ind[0] + '; ' + 'not applicable'
                    update = 0
                    for risk in eval_scheme:
                        new_risk_level = ''
                        size_risk = len(risk)
                        i = 1
                        while i < size_risk-1:
                            j = i
                            if risk[i] == "EV":
                                try:
                                    if int(float(s.rawAmount)) == int(float(risk[i+1])):
                                        new_risk_level = risk[0]
                                except ValueError:
                                    if s.rawAmount == risk[i+1]:
                                        new_risk_level = risk[0]
                                i += 2
                            else:
                                try:
                                    if risk[i] == "R1":
                                        i += 3
                                        if float(s.rawAmount) >= float(risk[i-2]) and
float(s.rawAmount) < float(risk[i-1]):
                                            new_risk_level = risk[0]
                                    elif risk[i] == "R2":
                                        i += 3
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                                        if float(s.rawAmount) > float(risk[i-2]) and
float(s.rawAmount) <= float(risk[i-1]):
                                            new_risk_level = risk[0]
                                    elif risk[i] == "R3":
                                        i += 3
                                        if float(s.rawAmount) > float(risk[i-2]) and
float(s.rawAmount) < float(risk[i-1]):
                                            new_risk_level = risk[0]
                                    elif risk[i] == "R4":
                                        i += 3
                                        if float(s.rawAmount) >= float(risk[i-2]) and
float(s.rawAmount) <= float(risk[i-1]):
                                            new_risk_level = risk[0]
                                    elif risk[i] == "N1":
                                        i += 2
                                        if float(s.rawAmount) >= float(risk[i-1]):
                                            new_risk_level = risk[0]
                                    elif risk[i] == "N2":
                                        i += 2
                                        if float(s.rawAmount) <= float(risk[i-1]):
                                            new_risk_level = risk[0]
                                except ValueError:
                                    i = size_risk
                            if i == j:
                                error_msg = 'Code of value type not found: ' + risk[0] + ' ' +
risk[i]
                                log.error(error_msg)
                                break
                        if new_risk_level != '':
                            update = 1
                            new_flow_name = old_flow_name
                            old_risk_level = s.riskLevel
                            if new_risk_level == "HIGH_OPPORTUNITY":
                                s.riskLevel = RiskLevel.HIGH_OPPORTUNITY
                                new_flow_name = ind[0] + '; ' + 'high opportunity'
                            if new_risk_level == "MEDIUM_OPPORTUNITY":
                                s.riskLevel = RiskLevel.MEDIUM_OPPORTUNITY
                                new_flow_name = ind[0] + '; ' + 'medium opportunity'
                            if risk[0] == "LOW_OPPORTUNITY":
                                s.riskLevel = RiskLevel.LOW_OPPORTUNITY
                                new_flow_name = ind[0] + '; ' + 'low opportunity'
                            if risk[0] == "NO_RISK":
                                s.riskLevel = RiskLevel.NO_RISK
                            if risk[0] == "VERY_LOW_RISK":
                                s.riskLevel = RiskLevel.VERY_LOW_RISK
                                new_flow_name = ind[0] + '; ' + 'very low risk'
                            if risk[0] == "LOW_RISK":
                                s.riskLevel = RiskLevel.LOW_RISK
                                new_flow_name = ind[0] + '; ' + 'low risk'
                            if risk[0] == "MEDIUM_RISK":
                                s.riskLevel = RiskLevel.MEDIUM_RISK
                                new_flow_name = ind[0] + '; ' + 'medium risk'
                            if risk[0] == "HIGH_RISK":
                                s.riskLevel = RiskLevel.HIGH_RISK
                                new_flow_name = ind[0] + '; ' + 'high risk'
                            if risk[0] == "VERY_HIGH_RISK":
                                s.riskLevel = RiskLevel.VERY_HIGH_RISK
                                new_flow_name = ind[0] + '; ' + 'very high risk'
                            if risk[0] == "NO_DATA":
                                s.riskLevel = RiskLevel.NO_DATA
                                new_flow_name = ind[0] + '; ' + 'no data'
                            if risk[0] == "NOT_APPLICABLE":
                                s.riskLevel = RiskLevel.NOT_APPLICABLE
                                new_flow_name = ind[0] + '; ' + 'not applicable'
                            try:
                                new_flow = olca.getFlow(new_flow_name)
                                for e in process.exchanges:
```

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                                    if e.flow.name == old_flow_name:
                                        if old_flow_name != new_flow_name:
                                            e.flow = new_flow
                                            e.flowPropertyFactor = new_flow.referenceFactor
                                            row = [process.refId,process.name,s.indica-
tor.refId,s.indicator.name,s.rawAmount,old_risk_level,new_risk_level,'TRUE']
                                            writer.writerow(row)
                                        else:
                                            row = [process.refId,process.name,s.indica-
tor.refId,s.indicator.name,s.rawAmount,old_risk_level,new_risk_level,'NO UPDATE NEEDED']
                                            writer.writerow(row)
                                except:
                                    error_msg = 'Flow ' + new_flow_name + ' does not exist in the da-
tabase. Exchange could not be updated'
                                    row = [process.refId,process.name,s.indicator.refId,s.indica-
tor.name,s.rawAmount,old_risk_level,new_risk_level, 'ERROR: ' + error_msg]
                                    log.error(error_msg)
                                    writer.writerow(row)
                    if update != 1:
                        error_msg = 'Risk level for indicator ' + ind[0] + ' in process ' + pro-
cess.name + ' - ' + location + ' could not be updated. Check Raw Amount and new evaluation
scheme'
                        log.error(error_msg)
                        row = [process.refId,process.name,s.indicator.refId,s.indica-
tor.name,s.rawAmount,s.riskLevel,'Risk level not updated', 'ERROR: New risk level could not be
identified. Check Raw Amount and new evaluation scheme']
                        writer.writerow(row)
                else:
                    error_msg = 'Risk level for indicator ' + s.indicator.name + ' in process ' +
process.name + ' - ' + location + ' could not be updated. No Raw Amount included in the process'
                    log.error(error_msg)
                    row = [process.refId,process.name,s.indicator.refId,s.indica-
tor.name,'',s.riskLevel,'Risk level not updated', 'ERROR: No Raw Amount specified']
                    writer.writerow(row)

    olca.updateProcess(process)

if __name__ == '__main__':
    main()
```

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