

**Data collection guideline for pressure indicators
for Life Cycle based Sustainability Assessment**

Bo P. Weidema
2.0 LCA consultants, Aalborg
2021-12-31

Preface

This is a data collection guideline for the pressure category indicators described in the report “An exhaustive quantitative indicator and impact pathway framework for sustainable development”. This guideline is prepared by Bo P. Weidema of 2.-0 LCA consultants, Denmark, for the 2.-0 SDG Club and the UNEP Life Cycle Initiative as part of the project “Linking the UN Sustainable Development Goals to life cycle impact pathway frameworks”.

Acknowledgements

We are grateful to UNEP Life Cycle Initiative and the following business members of the project for supporting the development:

- ArcelorMittal (corporate.arcelormittal.com)
- Corbion (Corbion.com)
- Janus (janus.co.jp)
- Novozymes (Novozymes.com)

© When referring to the publication, please use the following reference:

Weidema B P. (2021). Data collection guideline for pressure indicators for Life Cycle based Sustainability Assessment. Aalborg: 2.-0 LCA consultants.

Contents

1	Introduction	7
2	Pressure category indicators or impact category indicators	7
3	Population segmentation	8
4	Groups of pressure category indicators.....	8
5	Economic pressure category indicators.....	8
5.1	Value added.....	8
	Labour expenditures, including social security contributions	10
	Payments of entrepreneurs.....	10
	Tax expenditures minus subsidies on production and products	11
5.2	Interest paid on debt to private persons.....	11
5.3	Resource rents received or paid	11
5.4	Voluntary transfers.....	12
	Monetary value of transfers to research, innovation, and technology transfer	12
	Monetary value of subsidies, donations, or work hours targeted at poverty prevention and reduction activities	12
	Monetary value of transfers for anti-discriminatory advocacy and preventive or compensatory activities	13
	Monetary value of transfers for health care activities, including preventive activities, research, and advocacy	13
	Monetary value of transfers earmarked to education	13
	Monetary value of donations or work hours spent for advocacy activities for equity funding of education.....	14
	Monetary value of transfers for clean water supply, sanitation and related health care activities.....	14
	Monetary value of transfers for protection and maintenance of cultural heritage.....	14
	Monetary value of transfers for ecosystem protection, including preventive activities, research, and advocacy	15
	Monetary value of transfers not elsewhere classified, to intergovernmental organisations, charitable organisations or directly to private persons.....	15
5.5	Extreme underpayment of labour	15
5.6	Estimated value of transactional decisions made or foregone due to unfair commercial practices	16
5.7	Rent-seeking	16
5.8	Value of buildings and physical infrastructure	17
6	Resource pressure category indicators.....	17
6.1	Area-time of land occupied	17
6.2	Erosion-risk-equivalent area-time of land occupied with below 90% soil cover	18
6.3	Mass of extracted sub-soil resources and terrestrial wild fauna and flora	19
6.4	Live weight equivalent landings of aquatic wild fauna and flora	19
6.5	Person-days of recreational hunting sold.....	19
6.6	Harvest or commercialisation of individuals of threatened or CITES listed species.....	20

6.7	Net volume of freshwater transferred between environmental compartments.....	20
6.8	Inadequate procedural fairness in prioritisation of heritage conservation.....	21
6.9	Change in use of land or buildings without prior consultation of heritage conservation experts	22
7	Emission pressure category indicators	22
7.1	Emissions of ammonia, acid anhydrides, and particulates.....	22
7.2	Radiant and luminous energy of artificial light at night	23
7.3	Nitrogen and phosphorus emissions in their bioavailable forms	23
7.4	Noise.....	24
	Unweighted and A-weighted sound energy.....	24
	C-weighted sound energy for sound energy levels between 80 and 140 dB	24
	Incidences of peak sound pressure levels above 120 and 140 dB(C)	25
7.5	Odorant emissions.....	25
7.6	Emitted mass of ozone-depleting substances	25
7.7	Emitted radionuclides of clearly identifiable substance.....	26
7.8	Salinisation of surface or soil water.....	26
7.9	Emitted mass or toxicity-equivalent mass of clearly identifiable substance.....	26
7.10	Unintentional wildfire ignition	27
8	Occupational pressure category indicators	28
8.1	Forced labour and child labour.....	28
8.2	Persons without freedom of association and access to collective bargaining	29
8.3	Maternity benefits.....	29
	Female employees without guarantee of three daily paid breaks for breastfeeding for child below one year.....	29
	Female employees without guarantee of 26 weeks of continuous maternity leave, measured in weeks ...	29
8.4	Working conditions surveys and monitoring.....	30
	Work-years not in compliance to minimum requirements on working time arrangement.....	31
	Work days with shifts starting between 20 p.m. and 3:59 a.m.....	32
	Employee-years with self-reported low discretion over and predictability of working time arrangements	32
	Employee-years with self-reported high demands and low control at work	33
	Employee-years with self-reported inadequate conditions for workplace learning.....	34
	Person-years with skills in preventive practices with respect to infectious diseases.....	35
	Employee-years with self-reported psychosocial risk factors for musculoskeletal disorders.....	35
	Work-days with self-reported work-related severe discomfort.....	36
	Work-days involving ergonomic risk factors	36
	Hours of heat stress.....	37
	Occupational injuries, except road transport injuries.....	38
	Employment-years not covered by an occupational safety and health (OSH) management system	38
	Person-years of employees and their family members with basic skills in injury prevention and first aid... 38	
	Incidences of consumer injuries related to the analysed consumer products.....	39

Reductions in injury incidences from the application of specific safety-enhancing technologies	39
Employee-specific weekly metabolic energy expenditure	39
Ultraviolet radiation exposure	40
Consecutive work-days in locations without access to condoms.....	41
9 Additional pressure category indicators for specific types of organisations.....	41
9.1 For air transport	41
Change in effective dose of cosmic radiation relative to background level (social).....	41
9.2 For organisations supplying basic services	41
Access costs for provision of basic services, charged separately from the charge per unit of service supplied (economic)	41
Differential between overdraft and/or late payment fees and the losses on defaults and overdue payments (economic).....	42
9.3 For organisations that handle goods that can carry biological contamination	42
Deviations from hygienisation procedures at critical control points (ecosystem)	42
9.4 For activities handling foods and beverages	43
The nutrient density of qualifying and disqualifying nutrients in ingested or ingestible part of product.....	43
Glycaemic index for the carbohydrate content of the ingested or ingestible part of product	43
9.5 For government organisations	43
Monetary value of transfers to specified governments, to compensate for inability to raise sufficient funds through taxation (economic).....	43
9.6 For hospitals	44
Effective dose of directly generated ionising radiation (ecosystem)	44
9.7 For private or public investors.....	44
Funds for education provided with income-contingent payback (economic).....	44
9.8 For leisure activities.....	44
Person-hours of leisure with self-reported inadequate conditions for leisure time learning (social).....	44
9.9 For tourism	45
Proportion of income from tourism dedicated for heritage protection and maintenance (economic).....	46
Number of visitors and change in areal visitor density (social).....	46
Number of visitors and change in visitor density per local population (social).....	46
Tourism value added and change in tourism value added per total value added at tourist destination.....	46
9.10 For transport activities	47
Deviations from hygienisation procedures at critical control points (ecosystem)	47
Road transport injuries (social)	47
9.11 For activities located in urban core areas.....	48
Surface area-time weighted by the area's solar reflectance (ecosystem)	48
Evaporated water volume (ecosystem).....	48
Waste heat emission (ecosystem).....	48

References48

Annex to Section 6.2: Survey-questions on procedural fairness53

1 Introduction

Human activities contribute to sustainable development (and more specifically to the Sustainable Development Goals) through their pressures – in Life Cycle Assessment (LCA) parlance known as elementary flows. These pressures can be measured by quantitative pressure category indicators – or pressure indicators for short – in LCA parlance called inventory indicators. From the perspective of LCA, data for each relevant pressure category indicator is collected for each relevant human activity (in LCA parlance known as unit processes) as part of the Life Cycle Inventory Analysis. In general, all aspects of a Life Cycle Sustainability Assessment (LCSA) can be performed in accordance with the ISO 14000 series of LCA standards.

For many of the pressure category indicators, data are already available in existing LCA databases, and for others the statistical data available at the industry or country level will be sufficient to cover the data needs to perform an LCSA with the proposed pressure category indicators. However, for the foreground data system, that is under direct control of a decision maker, it may be relevant to collect more specific foreground data. This data collection guideline is intended for such foreground data collection.

The data collection guideline covers specific issues for each pressure category indicator in Weidema (2020), but does not cover the general issues of data collection, which are already adequately described in Weidema et al. (2003, 2013).

It should be noted that the current version of this guideline covers only pressure category indicators for 11 out of the 17 topics of Weidema (2020). The topics currently missing are:

- Human migration
- Physical infrastructure
- Global warming
- Marine ecosystems
- Safety and security
- Social infrastructure and participation

These topics will be included in future versions of this guideline.

2 Pressure category indicators or impact category indicators

Pressures are measured at the level of human activities, while all subsequent consequences of these pressures are called impacts, measured by impact category indicators. However, there is not a sharp boundary between human activities and their environment. In Weidema (2020), the impact pathways have in general been described from the perspective of a generic organisation that with its activities can exert a pressure that can lead to beneficial or detrimental impacts. Since many of the impacts are also directly related to human activities, there is not a sharp division between pressure category indicators and midpoint impact category indicators. This implies that specific organisations may have activities that can affect the level of a midpoint impact indicator directly, rather than via the pressure indicators that are listed as contributing to this midpoint impact indicator. For example, a hospital may through changes in its efficiency directly affect the midpoint impact indicator “Insufficient health care system”, while the generic organisation can only indirectly affect this midpoint impact indicator through the pressure category indicator “Underpayment of labour and taxes”. Thus, specific activities, like the hospital in the example, can have pressures that are described in Weidema (2020) by impact category indicators, but that from the perspective of the specific activity must be seen as pressure category indicators. Such indicators are not covered by this data collection guideline.

3 Population segmentation

The size of an impact can be highly dependent on the timing and location of the specific pressures, due to differences in background pressures or the sensitivity and resilience of the recipients. Ideally, this is reflected in a temporal and geographic differentiation in the available characterisation factors that express impacts per unit of pressure. Besides temporal and geographical differentiation, the characterisation factors can also vary between ecosystems, or taxa, down to individual species. When the recipient of an impact is the human population, further differentiation can be relevant, because of the multitude of causes for differences in vulnerability to the same impacts, especially annual income, wealth, and gender. Further relevant segmentations of human populations are on age, ethnic status, family relation, migratory status, occupation, and source of income; see Table 1. It should be noted that specific segmentations in some situations may place vulnerable groups at risk or otherwise be controversial. Questionnaires should therefore always contain a “prefer not to say” or similar opt-out option.

For the differentiation in characterisation models to be useful in practice, the pressure category indicators need to be segmented on the same dimensions as the characterisation models. The need for segmentation of the pressure categories indicators will thus vary depending on the impact categories and characterisation models that the pressures feed into. However, as a general rule, data that are available at a high level of segmentation should not be aggregated unnecessarily, and underlying raw data should to the extent possible be stored in their unaggregated form.

4 Groups of pressure category indicators

Based on their nature, the pressure category indicators have been divided in five groups:

- Economic pressure category indicators (Chapter 5)
- Resource pressure category indicators (Chapter 6)
- Emission pressure category indicators (Chapter 7)
- Occupational pressure category indicators (Chapter 8)
- Additional pressure category indicators for specific types of organisations (Chapter 9)

The division according to economic, ecosystem (resources and emissions), and social (mainly occupational) is relevant for structuring results according to the triple-bottom-line framework (Kraaijenbrink 2019). Therefore, the additional pressure indicators in Chapter 9 have also been labelled according to which of the three groups they belong.

5 Economic pressure category indicators

5.1 Value added

Value added is the differential between revenue and expenditures on intermediate inputs. From that differential, an organisation can make payments to labour, taxes, and entrepreneurs, or make savings, i.e. adding to its net wealth.

Measuring value added at the level of an organisation is relatively simple, since both revenue and expenditures on intermediate inputs are standard items on the annual financial accounts. Revenue data for a specific product can be calculated from its production volume and the sales price. The corresponding expenditures on intermediate inputs can be more difficult to obtain because it requires partitioning of the total intermediate inputs to each product. Bills of materials and costing calculations may be useful sources of information for such

partitioning. At the aggregate industry level, value added is available as part of the national supply-use tables, used for the national accounts. The sum of value added within the boundaries of a country is known as the Gross Domestic Product (GDP).

Table 1. Stakeholder segmentation by personal role

Criteria:	Examples of categories:
by age	Adults above 24 year Children (0-14 years) Teenage youth (15-18 years) Young adults (19-24 years)
by asset status	Asset poor (<50% of median asset level) Asset privileged Food insecure persons
by disease or disability	Disabled Healthy Sick
by ethnic status	Ethnic majority Ethnic minority
by family relation	Living in child-headed household Living in multiple-adult households with children Living in multiple-adult households without children Living in single-person household without children Living in single-person households with children Living in two-adult households with children Living in two-adult households without children
by gender	Females Males Non-cisgenders
by migratory status	Foreign born Foreign nationals Indigenous persons Internally displaced Native born
by occupation	Agriculturalists Non-agriculturalists
by source of income	Entrepreneurs (by industry) Household workers Informal sector workers (by industry) Labour market workers (by industry) Pension or social security recipients Rentiers

Value added is often used to proportionally distribute aggregate data to individual enterprises, when data are only available at more aggregate industry or administrative levels.

For many purposes, it is necessary to know who receives the value added, i.e. to split it up on different groups of employees, different groups of entrepreneurs, and different taxes and subsidies:

Labour expenditures, including social security contributions

Reference to Weidema (2020): **Chapter 10, Section 3.1;** Chapter 2, Section 3.3 (a); Chapter 3, Section 3.1 (a); Chapter 4, section 3.2 (a); Chapter 5, Section 3.1 (a); Chapter 6, Section 3.2 (a); Chapter 8, Section 3.5 (a); Chapter 11, Section 3.5 (a); Chapter 15, Section 3.12 (a).

Unit: Nominal currency units (with indication of base year), e.g. USD₂₀₁₁.

Minimum level of specification: By recipients' wage level (taxable income per time unit), as a minimum segmented per income taxation level (income bands with similar taxation percentage). For part time workers with other sources of income this may need to be estimated, since such information is usually not directly available to the individual employers. By direct wages and social security contributions, further specified by contributions to medical care, sickness, needs of workers with family responsibility, employment incapacity, maternity leave, unemployment, and old age pensions.

Guidance: Includes payments of wages and other payments related to the amount of labour, such as obligatory payments to pensions and other forms of social security. It also covers labour income of private entrepreneurs, as opposed to income from ownership of a business enterprise.

Sources: The bookkeeping of the organisation; general wage levels for specific types of work from local wage statistics.

Payments of entrepreneurs

Reference to Weidema (2020): Chapter 10, Section 3.2.

Unit: Nominal currency units (with indication of base year), e.g. USD₂₀₁₁.

Minimum level of specification: By recipient. When known, with the same specification by recipients' income level (annual taxable income) as for labour income.

Guidance: Entrepreneurs are the owners of a business enterprise. Payment of entrepreneurs is also known as profit, equity payment, or dividend. This is distinguished on the one hand from interest paid on borrowed capital and on the other hand from labour income of entrepreneurs that depends on the amount of labour. In a small company the latter may be difficult to separate from the payment of entrepreneurs, and care should be taken to avoid double-counting. Payment of entrepreneurs is fundamentally a payment for the risk of investing in the business plus any surplus profit from the difference between the marginal and actual production costs, also known as the producer surplus. Changes in enterprise equity are not included in "Payments to entrepreneurs" even though entrepreneurs may have substantial capital gains or losses when shares are sold or transferred or an enterprise goes bankrupt.

Sources: The bookkeeping and ownership book of the organisation; general income statistics.

Tax expenditures minus subsidies on production and products

Reference to Weidema (2020): Chapter 10, Section 3.4; Chapter 1, Section 3.3; Chapter 2, Section 3.3 (b); Chapter 3, Section 3.1 (b); Chapter 4, section 3.2 (b); Chapter 5, Section 3.1 (b) and 3.5 (e); Chapter 6, Section 3.2 (b); Chapter 8, Section 3.5 (b); Chapter 11, Section 3.5 (b); Chapter 15, Section 3.12 (b).

Unit: Nominal currency units (with indication of base year), e.g. USD₂₀₁₁.

Minimum level of specification: By type of tax and subsidy. By product, if related to a specific product, as for example import tariffs.

Guidance: Includes actually accrued corporate tax liabilities and negative taxes (subsidies). Includes both income and capital taxes, as well as taxes on specific activities or products. Taxes and subsidies on products should be included for the agent/activity to which the tax or subsidy accrues, which can be, e.g., producer, retailer, consumer, or waste handler. Both non-distortionary, distortionary, and externality-correcting payments should be included. Does not include taxes and subsidies that are not directly related to the production, such as taxes on the use of natural resources, subsidies received for research and innovation, and subsidies for transfer, dissemination, and diffusion of technology. Does not include social security payments that are labour related. Does not include user fees, to the extent that these are already correctly included as payments for received goods or services, in line with other intermediate costs. Does not include indirect subsidies like tax breaks and accelerated depreciation.

Sources: The bookkeeping of the organisation; published rates of taxes (Tax Foundation 2019) and tariffs (WTO et al. 2020). A general global database on subsidies does not exist, but studies exist for individual types of subsidies, such as for energy and fishery; see the Global Subsidies Initiative (<www.iisd.org/gsi/>).

5.2 Interest paid on debt to private persons

Reference to Weidema (2020): Chapter 10, Section 3.3 (b).

Unit: Nominal currency units (with indication of base year), e.g. USD₂₀₁₁.

Minimum level of specification: By recipient, with the purpose of estimating the ultimate recipients' income level (annual taxable income).

Guidance: Interests on debt are paid from borrowers (users) to lenders (owners). When payments are made via a financial institution, the interest payment that ultimately reach the lender may, from the perspective of the borrower, be indistinguishable from the financial charges. Care should be taken to avoid double-counting of financial services already recorded as intermediate inputs.

Sources: The bookkeeping of the organisation. At the aggregate level, private sector debt is part of the national financial statistics, and household- and person-level data are available from the Cross-National Data Center Luxembourg <www.lisdatacenter.org>.

5.3 Resource rents received or paid

Reference to Weidema (2020): Chapter 5, Section 3.5 (g); Chapter 10, Section 3.3 (a).

Unit: Nominal currency units (with indication of base year), e.g. USD₂₀₁₁.

Minimum level of specification: By resource and by income or expenditure. For intellectual property rights, by product. For expenditure paid to private resource owners, by recipient, with the purpose of estimating the ultimate recipients' income level (annual taxable income).

Guidance: Resource rents are paid to private resource owners for the use of a resource, such as unimproved land and sub-soil assets, freshwater, wild fauna and flora, intellectual property, etc. Double-counting should be avoided when the owner of the resource is the government and the rent payment has already been recorded as part of the value added, as a tax or a user fee. It is only payments to the ultimate private owners that are recorded, since the resource rents are included in the price of products traded between enterprises.

Sources: The bookkeeping of the organisation. In the bookkeeping, untaxed rent may not be distinguished from other revenue or expenditure, and may therefore have to be estimated from physical data. At the aggregate level, data for natural resource rents are available from the World Bank data series NY.GDP.TOTL.RT.ZS, while data on intellectual property are recorded in the national accounts (OECD 2010).

5.4 Voluntary transfers

A voluntary transfer provided by a government organisation is known as a subsidy. A voluntary transfer from a private organisation is known as a gift. If a gift is given to a charitable organisation, it is known as a donation. Note that sponsorships are not classified as gifts, but as advertising (an intermediate product), because some recognition or other benefit is received in return. Besides sponsorships, some gifts may already be recorded as intermediate flows, and should then not be included here, to avoid double-counting.

Monetary value of transfers to research, innovation, and technology transfer

Reference to Weidema (2020): Chapter 10, Section 3.5 (c).

Unit: Nominal currency units (with indication of base year), e.g. USD₂₀₁₁.

Minimum level of specification: None.

Guidance: Although spending on research, innovation, and technology transfer is often given with the expectation of something specific in return, this spending has a value for the general public beyond the value for the funding agency, i.e., as a beneficial externality of the funded activity. Does not include the spending of the activities performing the research but only the transfer of funding from the funding agency to the activity performing the research etc., also in the case that this occurs within the same legal entity.

Sources: The bookkeeping of the organisation.

Monetary value of subsidies, donations, or work hours targeted at poverty prevention and reduction activities

Reference to Weidema (2020): Chapter 1, Section 3.4.

Unit: Nominal currency units (with indication of base year), e.g. USD₂₀₁₁.

Minimum level of specification: None.

Guidance: Includes reduced tariffs for specific vulnerable population groups, or block tariff structures with a highly subsidized first block to cover basic needs. Claims for in-kind contributions, including work hours, need to be transparently documented and audited.

Sources: The bookkeeping of the organisation.

Monetary value of transfers for anti-discriminatory advocacy and preventive or compensatory activities

Reference to Weidema (2020): Chapter 2, Section 3.5; Chapter 5, Section 3.2.

Unit: Nominal currency units (with indication of base year), e.g. USD₂₀₁₁.

Minimum level of specification: By type of discrimination. By classification of the activity as advocacy, prevention, or compensation.

Guidance: Donations can be given to anti-discriminatory advocacy work or as counter-balancing payments to prevent or compensate for the damage caused by discriminatory practices or distortionary taxes or subsidies.

Sources: The bookkeeping of the organisation.

Monetary value of transfers for health care activities, including preventive activities, research, and advocacy

Reference to Weidema (2020): Chapter 3, Section 3.13.

Unit: Nominal currency units (with indication of base year), e.g. USD₂₀₁₁.

Minimum level of specification: By recipient and type of activity.

Guidance: Includes support to health care activities, including preventive activities, research, and advocacy, e.g. for removing unfair practices in health care.

Sources: The bookkeeping of the organisation.

Monetary value of transfers earmarked to education

Reference to Weidema (2020): Chapter 4, Section 3.3.

Unit: Nominal currency units (with indication of base year), e.g. USD₂₀₁₁.

Minimum level of specification: By recipient.

Guidance: Includes all transfers for education provided by governments, businesses, NGOs, and private persons, except transfers between family members (redistribution within households). Although voluntary transfers for education are less efficient than funding with income-contingent payback (see the following indicator), they still have a net positive influence on the level of education.

Sources: The bookkeeping of the organisation.

Monetary value of donations or work hours spent for advocacy activities for equity funding of education

Reference to Weidema (2020): Chapter 4, Section 3.1 (b).

Unit: Nominal currency units (with indication of base year), e.g. USD₂₀₁₁.

Minimum level of specification: By recipient and type of activity.

Guidance: Capital markets typically avoid investing directly in human capital due to legal limitations on the use of human capital as equity in financial contracts, so that financing of education is practically exclusively available through own family funds and/or public funds, and not through the capital markets. The legal limitations result from an inappropriate (over-)implementation of the slavery and bonded labour conventions (Jacobs & van Wijnbergen 2005). To correct the capital market failure, the challenge is thus to establish a clear distinction between detrimental situations of slavery and bonded labour on the one side, and beneficial situations of investment in education on the other. Interestingly, there are some forms of family or public funding that appear close to bonded labour (e.g., student loans with fixed payback irrespectively of post-education income, or free education against requirements to work for the government for a specified period after education) while a regular capital market funding of human equity would not meaningfully limit the free choice of employment and would only require payback with a percentage of future income when this income exceeds a well-defined lower limit. However, it is unlikely that regular capital market funding of human equity would become widespread without explicit government interaction to prevent that such funding be challenged as a breach of the slavery and bonded labour conventions. This is thus one of the areas where private actors can only contribute to reduce the capital market failure by lobbying for either government implementation of equity-based funding of education or more clear legal rules for private participation in such equity-based funding.

Sources: The bookkeeping of the organisation.

Monetary value of transfers for clean water supply, sanitation and related health care activities

Reference to Weidema (2020): Chapter 6, Section 3.3.

Unit: Nominal currency units (with indication of base year), e.g. USD₂₀₁₁.

Minimum level of specification: By recipient and type of activity.

Guidance: Water and sanitation service infrastructures can be influenced by voluntary donations supporting investments in and management of clean water supply, sanitation and related health care activities, including preventive activities, research, and advocacy, e.g. for removing unfair practices.

Sources: The bookkeeping of the organisation.

Monetary value of transfers for protection and maintenance of cultural heritage

Reference to Weidema (2020): Chapter 11, Section 3.6 and 3.7.

Unit: Nominal currency units (with indication of base year), e.g. USD₂₀₁₁.

Minimum level of specification: By recipient.

Guidance: Includes direct contributions to conservation and maintenance activities, but also to supporting activities, including research and advocacy, e.g., for removing illegitimate practices in heritage management. Includes also contributions to establish and maintain contingency plans for removal or in-situ protection of tangible cultural heritage during emergencies.

Sources: The bookkeeping of the organisation.

Monetary value of transfers for ecosystem protection, including preventive activities, research, and advocacy

Reference to Weidema (2020): Chapter 15, Section 3.13.

Unit: Nominal currency units (with indication of base year), e.g. USD₂₀₁₁.

Minimum level of specification: By recipient; by type of activity.

Guidance: Includes funding for forest and wildlife guards, research, and advocacy for ecosystem protection. Includes specific contributions from sustainable tourism to conservation of biodiversity and ecosystems.

Sources: The bookkeeping of the organisation.

Monetary value of transfers not elsewhere classified, to intergovernmental organisations, charitable organisations or directly to private persons

Reference to Weidema (2020): Chapter 10, Section 3.5 (b).

Unit: Nominal currency units (with indication of base year), e.g. USD₂₀₁₁.

Minimum level of specification: By recipient

Sources: The bookkeeping of the organisation.

5.5 Extreme underpayment of labour

Reference to Weidema (2020): Chapter 2, Section 3.4.

Unit: Purchasing-power-corrected currency units (with indication of base year), e.g. USD_{2011,PPP}.

Minimum level of specification: By difference to the two poverty lines of 1.55 and 1.03 USD_{2011,PPP}/work-hour.

Guidance: Extreme underpayment is defined as a wage below which the ability to purchase essential goods is affected, estimated here as the level below which malnutrition begins to occur, with the sharpest increase at wages between 1.55 and 1.03 USD_{2011,PPP}/work-hour. The pressure category indicator measures the difference between these two poverty lines and the actual payment. The actual wage levels are first purchasing power corrected. Then, the difference between the two poverty lines and the actual labour expenditures is calculated per worker (or group of workers) and summed over the work hours.

Sources: The bookkeeping of the organisation; general wage levels for specific types of work from local wage statistics.

5.6 Estimated value of transactional decisions made or foregone due to unfair commercial practices

Reference to Weidema (2020): Chapter 5, Section 3.3.

Unit: Nominal currency units (with indication of base year), e.g. USD₂₀₁₁.

Minimum level of specification: None. When possible, specified per income group and vulnerability of the discriminated trade partner.

Guidance: Commercial practices include promotion, marketing, sale, procurement, purchase, delivery, and after-sales services of a product, as well as subsequent collection of debts and any connected actions, representations, or omissions by a trader. A commercial practice is unfair if it is likely to impair the ability of a trade partner (supplier or customer) to make an informed decision regarding the offer, thereby causing the trade partner to make a transactional decision that he or she would not otherwise have made. Notable examples of unfair practices are: using false or misleading information, withholding relevant information, or exploiting a position of power. Furthermore, commercial practices are unfair if they discriminate potential or actual trade partners based on irrelevant characteristics.

Sources: Numbers of complaints, number of complaints settled to the satisfaction of the complainant, and more general surveys on market fairness and satisfaction with trading partners may provide information that can be used to estimate this value. One of the more thorough studies on quantitative measurement of consumer detriment is the report by Civic Consulting (2017) for the EU Consumer Programme.

5.7 Rent-seeking

Rent-seeking is an activity that seeks to obtain income from economic rent, i.e. income that exclusively comes from the control of a resource, as opposed to income from productive work. Some forms of rent-seeking are illegal, such as collusion, bribery, corruption, fraud, tax evasion, arrears, theft, and handling of stolen goods. Other forms of rent-seeking may be legal, such as tax avoidance or lobbying for distortionary subsidies or taxes. Whether successful or not, rent-seeking implies a social cost, since the efforts spent on redistributing wealth could instead have been spent on productive activities that increase wealth. While it is possible to estimate the aggregate amount of resources spent on rent-seeking at the level of administrative units, it is very difficult to trace these expenditures to the level of individual activities. Therefore, instead of indicators of the actual rent-seeking, the relevant pressure category indicators are rather management indicators, expressing the efforts to reduce the risk of rent-seeking. Thereby, pressure category indicators for rent-seeking can be seen as an alternative specification for value added or revenue, as described below.

Reference to Weidema (2020): Chapter 5, Section 3.4 and 3.5; Chapter 8, Section 3.4; Chapter 11, Section 3.3.

Unit: Nominal currency units (with indication of base year), e.g. USD₂₀₁₁.

Minimum level of specification: a) Value added of the activities for which there are no transparent documentation, reporting, and auditing procedures for financial and product flows and stocks, including

accrued closure and post-closure costs and the timely payment of creditors; b) Value added of activities not covered by an explicit anti-rent-seeking policy, including an employee educational programme, a no-sanction policy for not paying bribes, a whistleblower protection policy with specified reporting mechanisms and follow-up procedures, and a register for conflicts of interest; c) Revenue of products for which the producer holds more than a 50% market share of all products within the product group; d) Value added of activities not covered by a publicly announced renouncement of net advantages obtained from differential treatment or distortionary taxes or subsidies; e) Value added of activities not covered by a publicly announced fair wage policy, requiring universal access to social protection, and equal wages for equal work, comparable to the wage that could be obtained from the same work if the collective of workers hired the other factors of production and hired the management to organise the production; f) Revenue from access, occupation, extraction, or sale of natural assets or archaeological sites or artefacts, without documented approval from the affected indigenous population.

Guidance: The different specifications above relate to different efforts to reduce the risk of rent-seeking: a) By transparent documentation, reporting, and auditing procedures for all product and financial flows, in all countries where the organisation has legal presence; b) By an organisational policy that foster a culture of non-acceptance, by having an explicit anti-rent-seeking policy, including an employee educational programme, a no-sanction policy for not paying bribes, a whistleblower protection policy with specified reporting mechanisms and follow-up procedures, and a register for conflicts of interest (parts of this are covered by the ISO standard 37001 on anti-bribery management systems); c) The risk of collusion can be further reduced by splitting up commercial enterprises when their market shares exceed 50%; d) The risk of legal forms of rent-seeking can best be avoided by removing the incentive through a publicly announced policy of not accepting (or providing) any net advantage from differential or distortionary taxes or subsidies, irrespective of whether this advantage is obtained from own rent-seeking or that of others; e) Similarly, a publicly announced fair wage policy can remove the incentive for rent-seeking on the labour market; f) The risk of violation of the rights of indigenous people can be reduced by requiring documentation that the affected indigenous people have approved any required access to or occupation, extraction, or sale of natural assets or archaeological sites or artefacts.

Sources: The bookkeeping, documentation, and policy documents of the organisation.

5.8 Value of buildings and physical infrastructure

Reference to Weidema (2020): Chapter 5, Section 3.5 (f).

Unit: Nominal currency units (with indication of base year), e.g. USD₂₀₁₁.

Minimum level of specification: None.

Guidance: For use in estimating land rents for urban lands and tourist destinations.

Sources: Balance sheet specifications of organisation; Local published data on property values.

6 Resource pressure category indicators

6.1 Area-time of land occupied

Reference to Weidema (2020): Chapter 5, Section 3.5 (j), Chapter 15, Section 3.1.

Unit: Area-time units, e.g. hectare-years.

Minimum level of specification: By geographical coordinates (at least allowing identification of agro-ecological zone, WFF ecoregion, and estimation of appropriated net primary production capacity); by isolation extent (share of area within 100 metres that does not contain similar habitat); by core habitat area status, including the NPP capacity of any adjacent core habitat area (within 100 metres).

Guidance: Geographical coordinates allow the use of maps to identify the agro-ecological zone (IIASA/FAO 2012; relevant for estimation of land rents), the WFF ecoregion (Dinerstein et al. 2017, for estimating biodiversity impact), and the appropriated net primary production (NPP) capacity (Del Grosso et al. 2008; for estimating biomass resource impacts). If the specific geographical coordinates are not known, at least these three measures (agro-ecological zone, ecoregion, and appropriated NPP) must be provided. Some older LCA databases that are still in use, do not include the upstream (indirect) land use change that provides the biomass production capacity required for a specific activity. This (indirect) land use therefore first has to be calculated as the area-time of the land occupied, and then weighted by the ratio of potential NPP of the occupied land to the average land within that potential land use class (arable land, intensive forest land, extensive forest land, grassland). The impact of a change in vegetation cover or habitat does not only depend on the size of the area affected by the change, but also on the surrounding land use. Fragmented ecosystems provide fewer options for migration and provide less habitat area for species that require large habitat areas for survival. Populations in small, isolated habitats are more at risk for extinction and loss of genetic diversity. Thus, the size of habitats and the connectivity of the landscape, i.e. the existence of adequate corridors for migration, are important for ecosystem functions. A good measure of continuous habitat area is “core habitat area”, typically defined as area further than 100 metres from nearest edge, constructed road, or other barrier, and a good isolation measure is the amount of available habitat within a given radius around the occupied patch. A specific type of land use is setting aside the area for ecosystem conservation. This shifts land use change from the set aside area to the marginal land within that land class. The net effect of the set aside can thus be calculated as the difference between the primary production and biodiversity of the set aside area and the area of marginal indirect land use change induced by the occupation of the set aside area.

Sources: The bookkeeping and tenure documents of the organisation. At the aggregate level, data from local land registers.

6.2 Erosion-risk-equivalent area-time of land occupied with below 90% soil cover

Reference to Weidema (2020): Chapter 15, Section 3.3.

Unit: Erosion-risk-equivalent hectare-years, or similar units of erosion-risk-equivalent area-time.

Minimum level of specification: Separately reported with and without additional reduction factors for soil conservation management.

Guidance: Erosion-risk-equivalence is expressed as in the RUSLE equation (Renard et al. 1991) by a severity-factor between 0 and 1, where 0 is no risk and 1 is the erosion risk on bare land with 9% uniform slope tilled perpendicular to the contour lines. The direct management factors that can be influence soil erosion are the soil cover by vegetation or vegetation residues, conservation tillage or zero tillage, contour farming, and field borders in the form of e.g. stone walls or grass margins. Panagos et al. (2015a, b) provide default factors for

European conditions. For example, a wheat field has a severity factor of 0.2 related to its vegetation cover. These vegetation-specific severity factors can be further reduced by multiplying by different factors accounting for different soil conservation practices, such as zero-tillage (factor 0.25), conservation tillage, where at least 30% of plant residues are left on the soil surface (multiply by 0.35), growing cover crops (factor 0.8), and leaving crop residues on the field (factor 0.88). For water erosion in hilly areas (slope >9%) additional reduction factors are applicable for contour farming of $0.6+0.025*s$, where s is each additional % slope between 9% and 25%, for stone walls of more than 20 metres length (factor $0.7-0.1w$, where w is each additional wall with a maximum of 3 on a 250 metre transect), and for grass margins of more than 20 metres length and a width of 1-3 metres (factor $0.85-0.05g$, where g is each additional grass margin with a maximum of 3 on a 250 metre transect).

Sources: Documentation of the organisation for the monitoring of soil cover and soil conservation management. At aggregate level, satellite monitoring.

6.3 Mass of extracted sub-soil resources and terrestrial wild fauna and flora

Reference to Weidema (2020): Chapter 5, Section 3.5 (l).

Unit: Mass units, e.g. metric tonnes.

Minimum level of specification: By sold products.

Sources: The bookkeeping of the organisation. At the aggregate level, data from USGS Mineral Commodities Summaries.

6.4 Live weight equivalent landings of aquatic wild fauna and flora

Reference to Weidema (2020): Chapter 5, Section 3.5 (m).

Unit: Mass units, e.g. metric tonnes. Note that aquatic flora is not usually measured in live weight equivalents, but more reasonably in dry mass.

Minimum level of specification: By species, fishing area, fishing vessel type and nationality, fishing gear, and fishing effort, all according to CWP (2017), as well as type of fishing rights according to national accounting rules for catch sharing.

Sources: The bookkeeping of the organisation. At the aggregate level, data from FAO Yearbook of Fishery and Aquaculture Statistics.

6.5 Person-days of recreational hunting sold

Reference to Weidema (2020): Chapter 5, Section 3.5 (n).

Unit: Person-days.

Minimum level of specification: None.

Guidance: This pressure category indicator is intended for recreational hunting, where the harvest output is not the main purpose, but rather the hunting experience. The rent – as well as the disturbance – is then rather related to the person-time than to the extracted mass.

Sources: The bookkeeping of the organisation. At the aggregate level, estimates may be based on direct or indirect entries in the national accounts and the quinquennial US National Surveys of Fishing, Hunting, and Wildlife-Associated Recreation.

6.6 Harvest or commercialisation of individuals of threatened or CITES listed species

Reference to Weidema (2020): Chapter 15, Section 3.15.

Unit: Unitless (Individuals).

Minimum level of specification: by species; by age of the individuals.

Guidance: Includes any species listed on the IUCN Red List or any of the three CITES appendices without national exceptions, as well as individuals of species that can be confounded with listed species, unless accompanied by official trade permits and forgery-secured means of traceability.

Sources: Audits of the organisation. At the aggregated level, estimates based on contraband seizure data.

6.7 Net volume of freshwater transferred between environmental compartments

Reference to Weidema (2020): Chapter 5, Section 3.5 (k); Chapter 15, Section 3.3 (b).

Unit: Volume units, e.g. cubic metres.

Minimum level of specification: by supplying and receiving environmental compartment (air, soil water, groundwater, surface water), by watershed, by ecosystem, by time period.

Guidance: When freshwater is withdrawn from groundwater or surface water and applied for human activities, the abstracted water will often be used in a way that increases evapotranspiration and thus lowers the availability of freshwater for natural ecosystems. Even when evapotranspiration is not increased, the abstracted freshwater may be released in a different location than where it was abstracted, thus also changing the amount of freshwater available to the affected natural ecosystems. Artificial drainage has the same effect. Abstraction of groundwater in coastal areas can lead to intrusion of saltwater. Artificial barriers to lateral surface and subsurface water flows decrease freshwater downstream of the barrier and increase it upstream or sideways of the barrier, thus affecting different ecosystems. Artificial barriers may also be constructed with the aim of protecting existing ecosystems against excess abstraction or the intrusion of saltwater. Human activities that change the properties of soil and vegetation can influence the distribution of precipitation between evapotranspiration, infiltration and percolation to soil and groundwater, and runoff and lateral flow to surface water bodies. In general, reduction in vegetation leaves the soil surface open for non-productive evaporation loss. When crops are grown, evaporation decreases somewhat due to the local influence of the crops on air temperature, wind speed, and how much solar radiation reaches the soil surface. Anything that increases crop yields will thus reduce evaporation while linearly increasing transpiration. Evaporation may also be reduced by mulching. Guidance on calculating evapotranspiration can be found in Steduto et al. (2012). Precipitation in excess of that required for evapotranspiration will either infiltrate the soil and percolate to groundwater or

flow to surface water bodies through surface runoff or subsurface lateral flow (drainage), and will therefore remain available as a freshwater resource. However, excess surface runoff may cause waterlogged soils and flooding elsewhere. Waterlogged soils are detrimental to agricultural production, although they may be beneficial as natural habitat and act to even out fluctuations in river flow. Runoff may be increased if infiltration and percolation capacity is reduced by agricultural practices that leave the soil surface uncovered and the soil compacted from tilling and use of heavy machinery, especially when operating on wet soil. The runoff from fully vegetated, aerated (i.e., not waterlogged) soils will typically be less than 10% of the precipitation, and will increase linearly with any decrease in vegetation cover and soil organic matter content, mainly operating through changes in surface inception and soil bulk density. Soil organic matter can hold up to its own weight in available water, or 1.5-1.7 volume-% water relative to soil organic matter weight-%. Typical runoff from agricultural fields can be reduced by 30-40% through Controlled Traffic Farming, where the use of navigation aids and autosteering allows the field traffic to be reduced to permanently separated, dedicated lanes, so as to affect only 10-20% of the field area.

Sources: Water metering for freshwater withdrawal from groundwater or surface water. At the aggregate level, data from Aquastat (FAO 2016). Water balances for emissions of water to different environmental compartments, taking into account drainage, artificial barriers, points of emission, evapotranspiration, infiltration and percolation to soil and groundwater, and runoff and lateral flow to surface water bodies.

6.8 Inadequate procedural fairness in prioritisation of heritage conservation

Reference to Weidema (2020): Chapter 11, Section 3.4.

Unit: Likert-scale scores.

Minimum level of specification: By stakeholder group.

Guidance: Not all heritage has sufficient value to warrant its conservation costs. It is the values of current social groups that determine what parts of the total heritage should be conserved for enjoyment by current and future generations. While uniqueness and distinctiveness can be used to identify some parts of total heritage as worthy of conservation, it is in the end a subjective valuation whether other concerns are more important. Prioritisation of heritage protection and maintenance is therefore dependent on broad participation by both laypersons and experts from the local stakeholder groups and the international heritage conservation community. Decisions should be made in a fair procedure between equal and autonomous representatives of different stakeholder interests and not depend solely on the values of specific cultural groups, local interest groups, commercial interests, or international institutions and experts. Besides *fair representation*, Murphy (2017) characterises procedural fairness as *respect* for the rights and dignity of the participants, *neutrality* (consistent, accurate, fact-based, transparent, unbiased reasoning and behaviour) and *trustworthiness* (justified and correctable outcomes with a legitimate, benevolent objective, and due consideration of participants' needs and views). The pressure category indicator assesses this procedural fairness through self-assessment by the stakeholder groups. Proposed survey-questions can be found in the annex. For such a self-assessment to be valid, it must include and give equal voice to any self-defined group that expresses an interest in the topic following an open and transparent process of stakeholder identification.

Sources: Documentation of the self-assessment procedure and outcome.

6.9 Change in use of land or buildings without prior consultation of heritage conservation experts

Reference to Weidema (2020): Chapter 11, Section 3.1.

Units: Volume of affected soil; Area of affected building.

Minimum level of specification: By floor, roof, interior wall, exterior façade.

Guidance: Alterations in the use of land or buildings can destroy valuable tangible cultural heritage. Although the land and buildings may be privately or publicly owned, the heritage value includes the appreciation of non-owners. For this reason, the International Convention Concerning the Protection of the World Cultural and Natural Heritage (UNESCO 1972) mandate countries to identify land that have potential archaeological interest and buildings with heritage value, “for whose protection it is the duty of the international community as a whole to co-operate” (UNESCO 1972, Article 6), while respecting territorial sovereignty and property rights. Land that has occupied by previous generations will contain sub-soil traces of that occupation, which may be of archaeological interest. These sub-soil traces may be damaged by changes in land use practices that imply increased disturbance of deeper soil layers, e.g. through deep-rooted plants, erosion, deep soil cultivation, or drainage. Likewise, buildings may contain heritage value that can be damaged by both interior and exterior alterations. To avoid unintentional damage to tangible cultural heritage, those responsible for activities that involve changes in use land or buildings should consult independent experts or local authorities on cultural heritage conservation for advice on possible impacts and options for mitigation or alternative actions.

Sources: Documentation of the result of the consultations.

7 Emission pressure category indicators

7.1 Emissions of ammonia, acid anhydrides, and particulates

Reference to Weidema (2020): Chapter 3, Section 3.2; Chapter 11, Section 3.2; Chapter 15, Section 3.6.

Unit: Mass units, such as kg.

Minimum level of specification: By substance; Particulates as PM2.5 and PM10, if available.

Guidance: Acidifying substances are those that can release hydrogen ions when deposited on soil, vegetation or surface waters. The main emissions that create acidification are ammonia, that release a hydrogen ion when oxidised to nitrate by soil bacteria, and acid anhydrides, such as sulfur oxides, nitrogen oxides, formates, and acetates, when they in a wet atmosphere are hydrolysed to acids that subsequently release hydrogen ions when deposited, and therefore also have corrosive effects on materials of building and engineering surfaces. As a general oxidant, ozone has a synergistic effect with the acid anhydrides. Primary particles, typically measured as PM2.5 or PM10, is one of the most important air pollutants from a human health perspective and also contribute to soiling of materials of building and engineering surfaces, such as solar panels.

Sources: Emission meters or estimates of the organisation. If unavailable, emission factors per activity level, from EEA (2019), AP-42 <www.epa.gov/air-emissions-factors-and-quantification>, or similar national or regional emission factor guidance.

7.2 Radiant and luminous energy of artificial light at night

Reference to Weidema (2020): Chapter 15, Section 3.14 (a).

Units: Joule, or similar energy units (for radiant energy); lumen-seconds (for luminous energy).

Minimum level of specification: None.

Guidance: The impact of artificial light often results from the combined effect of all light sources in an area (sky glow) and therefore each individual light source matters, although artificial light management must necessarily also be undertaken on a regional, collaborative basis. Biologically relevant light is expressed as the radiant energy, which is the radiant flux integrated over time. Luminous energy is the luminous flux integrated over time, and is an adjusted measure that considers that the human eye is less sensitive to blue and ultra-violet wavelengths. Guidelines for Best Practice Lighting Design (Pendoley et al. 2020) consists of:

- Only adding externally visible artificial light for specific and well-defined purposes;
- Managing duration, intensity and colour with adaptive light controls;
- Shielding against light spill outside of the object or area to be lighted;
- Combining the least-reflective surfaces and the lowest intensity lighting appropriate for the task;
- Using the least amount of light at wavelengths below 500 nm that are particularly disturbing for nocturnal wildlife.

It is relevant to apply these guidelines for any artificial lighting that is externally visible, although they are particularly important to observe for lighting in locations that are not already disturbed.

Sources: Monitoring by the organisation. Both radiant and luminous flux can be measured with a calibrated digital camera and a relevant software for pixel analysis (Hiscocks 2014, Jechow et al. 2019). A worst-case estimate of radiant flux can be obtained by summing the installed lighting capacity in Watt multiplied by the radiant efficiency, which in the most efficient LED sources can reach 40-50%.

7.3 Nitrogen and phosphorus emissions in their bioavailable forms

Reference to Weidema (2020): Chapter 15, Section 3.4.

Unit: Mass units, such as kg.

Minimum level of specification: By substance.

Guidance: Reactive and bioavailable nitrogen corresponds to reduced nitrogen (ammonia and its reaction product ammonium), oxidized nitrogen (nitrogen oxides) and organic nitrogen compounds. For leachate and runoff from agricultural areas to groundwater or surface waters, as well industrial water emissions, the so-called “Total nitrogen” is therefore a reasonable measure of bioavailable nitrogen. Organic nitrogen emissions to air can come from many diverse sources, with biomass combustion and urea among the most important. In water emissions, the readily bioavailable fraction of phosphorus corresponds to the fully dissociated orthophosphate ions (H_2PO_4^- , HPO_4^{2-} , PO_4^{3-}) that are measured by the molybdenum-blue method of Murphy & Riley (1962). This method does not include biological phosphorus and is therefore not adequate for measurements in surface waters. Total phosphorous is not a good indicator for bioavailable fraction of

phosphorus, because it also includes particulate phosphorus that is only scarcely or conditionally bioavailable. Phosphorus emissions to air are mainly from biomass combustion and fertiliser spreading.

Sources: Emission sampling or metering of the organisation. Emission factors per activity level and/or nitrogen and phosphorous balances using EEA (2019), MITERRA-EUROPE (Velthof et al. 2009), or similar national or regional emission factor guidance.

7.4 Noise

Noise, as well as sound in general, is usually measured in decibel (dB_{SWL}), which is a logarithmic scale for the sound power level (L_W) relative to the lowest human-audible level of 1 pico-watt ($1\text{pW} = 10^{-12}\text{ W}$). However, the unit of dB is not additive, and the impact of noise also depends on the duration. Thus, to obtain an expression that is additive and also considers the duration of the noise, the sound power level in the logarithmic decibel ratio must be converted to the linearly additive units of energy per time and multiplied by the duration (t) in seconds, thus obtaining the sound energy $W(A)$ in joule:

$$W[J] = 1[\text{pW}] * 10^{\frac{L_W[\text{dB}]}{10}} * t[\text{s}]$$

Furthermore, the sound power level (L_W) is usually frequency-weighted to the A-scale, as defined in IEC (2013), giving the sound power level L_{WA} in the unit dB(A), which accounts for the frequency selective response of the human ear at low sound pressure levels, and/or to the C-scale (L_{WC} in the unit dB(C)) that eliminates very low frequency sounds and therefore is more relevant for specifically measuring the high-frequency sounds that cause hearing impairment. Wildlife have many different ranges of sound perception which often exceed the frequency range of the human ear, and an equal weighting of frequencies is therefore more appropriate than applying the frequency-weighting to the A-scale. If specific species are concerned, species-specific frequency-weighting should be applied.

Unweighted and A-weighted sound energy

Reference to Weidema (2020): Chapter 15, Section 3.14 (b); Chapter 3, Section 3.6 (a).

Unit: Energy units, such as J.

Minimum level of specification: By source and time of day (daytime, evening, night-time); when possible specified by frequency.

Guidance: The human impact of noise depends on the time of day, and noise measurements are therefore typically specified over a day-time of 12 hours, an evening of 4-hours, and an 8-hour night-time. Providing the unweighted sound energy by frequency allows the application of different frequency-weight on the same measurements, e.g. for application to different species-sensitivity.

Sources: Monitoring records or estimates of the organisation or equipment producers.

C-weighted sound energy for sound energy levels between 80 and 140 dB

Reference to Weidema (2020): Chapter 3, Section 3.6 (b).

Minimum level of specification: Per 8-hour work-day.

Unit: Energy units, such as J.

Guidance: Damage thresholds and occupational exposure limits for high-frequency sounds are typically based on noise levels integrated over an 8-hour work-day.

Sources: Monitoring records of the organisation.

Incidences of peak sound pressure levels above 120 and 140 dB(C)

Reference to Weidema (2020): Chapter 3, Section 3.6 (c).

Minimum level of specification: None.

Unit: Unitless (incidences).

Guidance: Peak sound pressure levels above 120 and 140 dB(C) should be monitored to indicate the need for protective equipment.

Sources: Monitoring records of the organisation.

7.5 Odorant emissions

Reference to Weidema (2020): Chapter 15, Section 3.15.

Unit: European odour units (ou_E).

Minimum level of specification: None.

Guidance: Measurement of odour is notably difficult due to the many substances involved and the typical measurement is still the assessment of diluted samples by a trained odour panel, as described by the European standard EN 13725:2003, in which the European odour unit ou_E is defined as the mass of odorant that when evaporated into 1 m³ of odour-free air or nitrogen is just detectable to 50% of a panel of trained observers, with 123 mg n-butanol (40 ppb) as a calibration reference. Such odour measurements are costly and therefore often substituted or complemented by dispersion modelling based on measured emission concentrations of specific odorous substances for which a conversion between chemical concentrations and odour units is available (Kim & Park 2008, Abraham et al. 2012).

Sources: Measurements of the organisation on emission samples, either assessed following EN 13725:2003 or for the concentration of specific odorous substances.

7.6 Emitted mass of ozone-depleting substances

Reference to Weidema (2020): Chapter 3, Section 3.3; Chapter 15, Section 3.7.

Unit: Mass unit, such as gram.

Minimum level of specification: By substance.

Guidance: Ozone-depleting substances react with ozone in the stratosphere causing depletion of the ozone layer that protects the biosphere against harmful UV-radiation. Many substances have this stratospheric ozone depleting effect, the most important one in terms of quantity and effect being N₂O, with a time-integrated Ozone Depletion Potential (ODP) of 0.015 kg-equivalents of trichlorofluoromethane (CFC-11) per kg, while the more potent ozone depleting substances, such as the CFCs with ODPs between 0.26 and 1, are regulated under the Montreal protocol, for which reason they are also slowly disappearing from the atmosphere (WMO 2018). Note that several ozone-depleting substances are also included as greenhouse gases. Double-counting of the emissions inventory should be avoided.

Sources: Mass balances, emission factors, data submitted to the UNEP ozone secretariat <<https://ozone.unep.org/>>.

7.7 Emitted radionuclides of clearly identifiable substance

Reference to Weidema (2020): Chapter 3, Section 3.5 (a); Chapter 15, Section 3.9.

Unit: Ionising radiation units, such as Bq.

Minimum level of specification: By substance.

Guidance: Different radionuclides (radioactive isotopes) emit different types of radiation and have different half-lives and is therefore typically measured in units of ionising radiation rather than in mass (although each type of radionuclide has a fixed ratio between its mass and its ionising radiation). The unit of ionising radiation is Bq (becquerel), which is an SI derived unit equal to 1/s, i.e. the decay of 1 nucleus per second.

Sources: Emission meters or estimates of the organisation. If unavailable, Annex B of UNSCEAR (2000) provides estimates of typical concentrations of radionuclides in food and drinking water, raw and produced materials, and in wastes of the mineral processing industry.

7.8 Salinisation of surface or soil water

Reference to Weidema (2020): Chapter 15, Section 3.3.

Unit: Unit of electrical conductivity, such as mS/cm.

Minimum level of specification: None.

Guidance: Salinisation occurs when evapotranspiration exceeds the inflow of freshwater from precipitation and lateral inflows, and dissolved salts (Na⁺, K⁺, Ca²⁺, Mg²⁺ and Cl⁻) accumulate at or near the soil surface as the water evaporates. This is exacerbated when additional salts are added with irrigation water or from industrial brine emissions.

Sources: Changes in salinity of surface or soil water can be measured directly by its electrical conductivity or calculated from the estimated salinity of inflows and outflows in a water balance approach.

7.9 Emitted mass or toxicity-equivalent mass of clearly identifiable substance

Reference to Weidema (2020): Chapter 3, Section 3.2; Chapter 15, Section 3.8.

Unit: Mass unit, such as gram.

Minimum level of specification: By substance.

Guidance: A large number of substances are identified as harmful to human health, and even more substances are harmful to ecosystems, since ecosystems have many more different organisms that are sensitive to different substances. Individual substance emissions are typically recorded in mass units. Due to the large amount of different substances, some of which have low toxicity but appear in large quantities, others appearing in small amounts but with high toxicity, it is a serious problem to obtain measures for all harmful substances. It may therefore be relevant to also measure the toxicity of the exhaust and effluent, without necessarily identifying each individual contributing substance. The result of such measurements will not be expressed in mass of substance emissions, but rather in toxicity-equivalent mass. An example of this is that dioxins and dioxin-like chemicals are often expressed in mass-equivalents of 2,3,7,8-TCDD, which is the most toxic dioxin. However, for such aggregation to be fully valid, the substances should be similar in terms of fate, exposure and type of toxic effect. When direct monitoring or sample measurements are not available, estimates can be obtained from mass balances, indirect calculations, modelling, engineering judgement, or from published emission factors.

Sources: Emission meters or estimates of the organisation; toxicity-tests of exhaust or effluent. If unavailable, estimates based on similar activities. Guidance for release estimation for specific chemicals and activities can be found as part of the Pollutant Release and Transfer Registers documentation (see OECD <www.oecd.org/chemicalsafety/pollutant-release-transfer-register/> for an overview, and particularly TRI <www.epa.gov/toxics-release-inventory-tri-program> that covers the largest number of substances) and as a secondary source the OECD Series of Emission Scenario Documents (OECD 2019).

7.10 Unintentional wildfire ignition

Reference to Weidema (2020): Chapter 15, Section 3.11.

Unit: Unitless (Incidences).

Minimum level of specification: By cause.

Guidance: Unintentional wildfires can be caused by, e.g.:

- Powerlines clashing, arcing, or breaking.
- Sparks from equipment or machinery use or malfunction.
- Accidental escapes from intentional burning, fire-fighting training activities, campfires, or cooking fires.
- Accidental ignition by lit cigarette butts or other material or matches used for smoking.
- Fireworks.
- Railroad or other vehicle sparks.

Drained peatlands are especially prone to smouldering underground fires that are very difficult to extinguish. In ecosystems that depend on fire, controlled fires can be way to avoid unintentional fire. Emissions from fires are covered in the relevant emission pressure categories. Human health impacts from fires are covered as injuries under the Occupational pressure category indicators in Chapter 8.

Sources: Wildfire statistics.

8 Occupational pressure category indicators

While this category is mainly concerned with occupational issues from an enterprise perspective, some indicators are equally relevant for household or leisure activities, e.g. injuries, and some even specifically for such, like injuries related to consumer products.

8.1 Forced labour and child labour

Reference to Weidema (2020): Chapter 8, Section 3.1.

Unit: Person-years.

Minimum level of specification: By gender and age, and for child labour by number of hours of child work per week.

Guidance: Forced labour is defined 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”, which implies involuntary work performed under some form of coercion. The coercion may involve violence or threats of violence, also against family members, debt bondage, withholding of wages, retaining identity documents, being kept in isolation, or threats of dismissal or denunciation of illegal immigration to authorities.

Child labour is defined (ICLS 2008) as:

- Any paid work performed by children below 12 years of age
- Paid work exceeding 14 hours per week performed by children aged 12-14 years
- Unpaid household work exceeding 21 hours per week performed by children below 15 years of age
- Paid work exceeding 43 hours per week performed by persons aged 15-17 years of age
- Work in designated hazardous industries performed by persons below 18 years of age, even when not covered by the above

For a specific enterprise to claim a better performance than the average, an active involvement in preventive measures is required, such as participation in local initiatives for funding of free schooling and independent monitoring schemes for forced labour and/or child labour (ILO 2005), using an area- and community-based (rather than industry-specific) approach with a focus on coordinated protection efforts for forced labour and/or child labour, e.g. following up on previous reports on forced labour, verifying workplace compliance, and tracking that children are attending school or provided with other satisfactory alternatives. Thus, the data for the pressure category indicator are estimated at the lowest possible administrative level and attributed to economic activities in proportion to share of total value added, excluding activities participating in a local forced labour and/or child labour monitoring scheme.

Sources: Documentation of active participation of the organisation in a local forced labour and/or child labour monitoring scheme. Local estimates of forced labour and child labour derived from national household surveys, which sometimes include information on which industry the forced labour or child labour was performed in. For the latest global estimates for forced labour (ILO et al. 2017), the household survey data are supplemented with data from the International Organization for Migration (IOM) and secondary sources. The latest ILO estimates of child labour (ILO 2017) include reports from 105 countries or 70% of the world population aged 5-17 years. Of the child workers below 12 years of age, 61% worked less than 14 hours a week, while 6% worked more than 43 hours per week. For those aged 12-14, the same percentages were 10% and 15%.

8.2 Persons without freedom of association and access to collective bargaining

Reference to Weidema (2020): Chapter 8, Section 3.3.

Unit: Person-years.

Minimum level of specification: By gender, migrant status, and type of contract (full-time/part-time, indefinite/temporary (<1 year), and self-employed workers).

Guidance: Freedom of association and collective bargaining refer to the right of self-determining individuals to form and join workers' or employers' organisations and to negotiate and conclude collective agreements to determine terms and conditions of employment (cf. ILO conventions 87 and 98). Universal coverage is an important aspect, to avoid that the freedom of association and the right to collective bargaining are circumvented through the use of part-time, temporary, or self-employed workers. For a specific enterprise to claim a better performance than the average, documentation must be available to demonstrate that these rights are fulfilled in practice. Thus, the data for the pressure category indicator are estimated at the lowest possible administrative level and attributed to economic activities in proportion to share of total value added, excluding activities excluding activities that can demonstrate that these rights are fulfilled in practice.

Sources: Documentation that workers of the organisation have freedom of association and access to collective bargaining in practice. Local estimates of persons without freedom of association and access to collective bargaining can be based on local surveys and the "Global Rights Index" of the International Trade Union Confederation that reports violations of fundamental rights at work, largely corresponding to the reporting of ILO for the SDG indicator 8.8.2 "Level of national compliance with labour rights (freedom of association and collective bargaining) based on International Labour Organization (ILO) textual sources and national legislation, by sex and migrant status".

8.3 Maternity benefits

Female employees without guarantee of three daily paid breaks for breastfeeding for child below one year

Reference to Weidema (2020): Chapter 2, Section 3.1.

Unit: Fulltime-equivalent female employee-years.

Minimum level of specification: None.

Guidance: Premature cessation of exclusive breastfeeding is an important cause of undernutrition. Employers can reduce cessation of breastfeeding by guaranteeing paid breastfeeding breaks providing sufficient time to express and deliver the breast milk to the child. In some jurisdictions, this may be a legal requirement.

Sources: Employment contracts of the organisation. Local regulation on maternity benefits.

Female employees without guarantee of 26 weeks of continuous maternity leave, measured in weeks

Reference to Weidema (2020): Chapter 2, Section 3.2.

Unit: Person-weeks (Calculated as the number of fulltime-equivalent female employee-years multiplied by the differential between 26 weeks and the number of weeks of continuous maternity leave ensured by legal or contractual guarantee).

Minimum level of specification: None.

Guidance: Cessation of breastfeeding is correlated to first return to work, rather than to length of maternity leave (which does not need to be taken consecutively). The indicator therefore reflects requirements for early return to work, rather than the length of the maternity leave.

Sources: Employment contracts of the organisation. Local regulation on maternity benefits.

8.4 Working conditions surveys and monitoring

A number of the pressure category indicators in this section rely on working conditions surveys, where especially the COPSQ questionnaire (COPSQ 2019, Llorens et al. 2019) stands out as a comprehensive, widely used, standardised, reliable, and validated survey instrument, available in 25 languages. In Table 2, the topics of the different pressure category indicators are matched with the dimensions of the COPSQ 3 questionnaire. Another widely used survey instrument is the Job Content Questionnaire (Karasek et al. 1998, Karasek & Theorell 1990), originally developed to estimate stressful work conditions.

Table 2. Relationship between the dimensions of the COPSQ 3 questionnaire and the pressure category indicators

COPSQ 3 dimension:	Relevant for pressure category indicator:
Quantitative Demands (QD)	High demands at work; (negative for) Variable challenges (conditions for workplace learning)
Work Pace (WP)	High demands at work; High perceived work pace (psychosocial risk factor for musculoskeletal disorders)
Cognitive Demands (CD)	High demands at work Distractions and multi-tasking (insufficient conditions for workplace learning) (CD1) Generation of new ideas (conditions for workplace learning) (CD3)
Emotional Demands (ED)	High demands at work; (negative for) Variable challenges (conditions for workplace learning)
Demands for Hiding Emotions (HE)	High demands at work; (negative for) Variable challenges (conditions for workplace learning)
Influence at Work (IN)	Low control at work (reversed) Variable challenges (conditions for workplace learning) Self-control (conditions for workplace learning)
Possibility for Development (PD)	Low control at work (reversed) Variable challenges (conditions for workplace learning)
Variation at Work (VA)	Low control at work (reversed); Variable challenges (conditions for workplace learning) Monotonous work (reversed) (psychosocial risk factor for musculoskeletal disorders)
Control over Working time (CT)	Low discretion over and predictability of working time arrangements (reversed); High demands at work (CT5 on overtime)
Meaning of Work (MW)	
Predictability (PR)	

Recognition (RE)	Low control at work (reversed)
Role Clarity (CL)	High demands at work (reversed)
Role Conflicts (CO)	High demands at work
Illegitimate Tasks (IT)	
Quality of Leadership (QL)	Low control at work (reversed)
Social Support from Supervisor (SS)	Low control at work (reversed); Social support (conditions for workplace learning) Poor social support at work (reversed) (risk factor for musculoskeletal disorders)
Social Support from Colleagues (SC)	Low control at work (reversed); Social support (conditions for workplace learning) Poor social support at work (reversed) (risk factor for musculoskeletal disorders)
Sense of Community at Work (SW)	Low control at work (reversed) Social support (conditions for workplace learning)
Commitment to the Workplace (CW)	
Work Engagement (WE)	
Job Insecurity (JI)	Low control at work
Insecurity over Working Conditions (IW)	Low control at work; Low discretion over and predictability of working time arrangements (IW3)
Quality of Work (QW)	Conscious reflection (conditions for workplace learning)
Job Satisfaction (JS)	Low job satisfaction (reversed) (psychosocial risk factor for musculoskeletal disorders)
Work Life Conflict (WF)	Low control at work
(Negative Acts)	
Self Rated Health (GH)	
Sleeping Troubles (SL)	
Burnout (BO)	
Stress (ST)	High perceived stress (psychosocial risk factor for musculoskeletal disorders)
Somatic stress (SO)	High perceived stress (psychosocial risk factor for musculoskeletal disorders)
Cognitive Stress (CS)	High perceived stress (psychosocial risk factor for musculoskeletal disorders)
Depressive Symptoms (DS)	
Self-Efficacy (SE)	Self-confidence (conditions for workplace learning) Generation of new ideas (conditions for workplace learning)

Work-years not in compliance to minimum requirements on working time arrangement

Reference to Weidema (2020): Chapter 8, Section 3.2 (a).

Unit: Fulltime-equivalent work-years.

Minimum level of specification: None.

Guidance: The minimum requirements of the ILO conventions on working time arrangements are:

- the maximum 8-hour work-day,
- the weekly minimum 24 consecutive hours of rest, and
- the annual three weeks holiday with normal pay of which two weeks uninterrupted.

National regulation may include stricter minimum requirements.

Sources: Working conditions surveys performed at the organisation. When unavailable, similar surveys at industry level. The standard working conditions survey instruments do not have details on these issues.

Recommended questions are:

- Within the last 12 months, have you worked more than 10 hours a day?
- Within the last 12 months, have you worked more than 48 hours a week?
- Within the last 12 months, have you had weeks without 24 hours of time off from work?
- Within the last 12 months, have you had at least two weeks uninterrupted holiday with normal pay?
- Within the last 12 months, have you had more than three weeks of holiday with normal pay?

Response options for the first three: 'Always; Often; Sometimes; Seldom; Never/hardly ever' and for the last two: 'Yes/No'. At the aggregate level, time use surveys are the most reliable source. The Doing Business database of the World Bank (<www.doingbusiness.org>) has data on national legislation for the three bulleted points above.

Work days with shifts starting between 20 p.m. and 3:59 a.m.

Reference to Weidema (2020): Chapter 3, Section 3.4 (a).

Unit: Person-days.

Minimum level of specification: By age and gender.

Guidance: Work shifts during the night (starting between 20 p.m. and 3:59 a.m.) can have severe health effects, which is suspected to be caused by the exposure to artificial visible light, causing disruption of the circadian rhythm and reductions in melatonin secretion. Possible preventive measures, e.g. selectively shielding from blue light or stimulation of alternative non-harmful circadian rhythms, have not yet been sufficiently researched to provide definitive guidance on the sufficiency of such measures.

In the ILO convention 171 on night work, the term night work is defined as work performed during a period of not less than seven consecutive hours, including the interval from midnight to 5 a.m. For this reason, we do not use the term night work in this connection.

Sources: The roster of the organisation. At the aggregate level, industry and national statistics on night work (no global statistics currently available).

Employee-years with self-reported low discretion over and predictability of working time arrangements

Reference to Weidema (2020): Chapter 8, Section 3.2 (b).

Unit: Fulltime-equivalent employee-years.

Minimum level of specification: None.

Guidance: Besides the issues covered by the above ILO conventions, working time arrangements include issues of fixed scheduling, such as:

- the fixed timing of breaks during a working day, typically minimum 30 minutes meal break after maximum 6 hours, and minimum 10 minutes refreshment breaks within each half working day,

- the typical 11-hour recovery period between two working days, but also the degree of flexibility required of the workers and allowed to be negotiated and influenced by them, with respect to:
 - the taking of additional breaks during the workday for handling private matters,
 - the overall weekly working time,
 - the scheduling of work-shifts,
 - the scheduling of holidays and paid days off, and
 - the taking of unpaid leave,
- as well as the predictability of changes to the working time arrangement, as measured by frequency and the length of advance notice.

Sources: Working conditions surveys performed at the organisation. When unavailable, similar surveys at industry level. In the European Working Conditions Survey (Ardito et al. 2012), working time arrangements are limited to four questions on “work-life balance” (Questions 39-41): on the choice of working time arrangement, on how well working hours fit in with family commitments, on the extent of work during free time, and on the difficulty in taking a couple of hours off. In the widely used COPSOQ questionnaire (COPSOQ 2019, Llorens et al. 2019, see also Table 2) the corresponding 5 questions have the heading “Control over working time” (CT), covering overtime and flexibility of breaks and holidays, while an additional question (IW3) is on predictability of schedule: “Are you worried about the timetable being changed (shift, weekdays, time to enter and leave ...) against your will?”.

Employee-years with self-reported high demands and low control at work

Reference to Weidema (2020): Chapter 8, Section 3.6.

Unit: Fulltime-equivalent employee-years.

Minimum level of specification: By gender and level-1 occupation according to the International Standard Classification of Occupations (ILO 2012).

Guidance: The most well-known model for work-related stress is Karasek’s demand-control model supported by the Job Content Questionnaire (Karasek et al. 1998, Karasek & Theorell 1990). The model relates stress to situations of high demands and low levels of control, which can also be measured by the more comprehensive Copenhagen Psychosocial Questionnaire (COPSOQ 2019, Llorens et al. 2019). Ardito et al. (2012, Table 1) describes a construct where 48 of the COPSOQ questions (see Table 2 for explanation of the following abbreviations) are used to inform four dimensions of “demand” (psychological (QD, WP, CO and CT5), cognitive (CD), emotional (ED), and demands for hiding emotions (HE) and eight dimensions of “control” (skill discretion (PD and VA), decision authority/Influence (IN), support from colleagues (SC), support from supervisors QL and SS), social community (SW), job rewards/recognition (RE), work-life balance (WF), and job security (JI and IW)), supported by 28 questions of the European Working Conditions Survey. Each dimension was given equal weight when collapsed on their respective axis of the two-dimensional demand-control chart, where high demand and low control were defined as the extreme tertiles of the distributions. The resulting average scores for job demand (intensity of work) and control (autonomy) are provided by type of occupation.

Sources: Working conditions surveys performed at the organisation, preferably using the COPSOQ questionnaire and structuring the output as described by Ardito et al. (2012). When unavailable, similar surveys at industry level.

Employee-years with self-reported inadequate conditions for workplace learning

Reference to Weidema (2020): Chapter 4, Section 3.4.

Unit: Fulltime-equivalent employee-years.

Minimum level of specification: None.

Guidance: Workplaces can stimulate efficient learning. The Job Content Questionnaire (Karasek et al. 1998, Karasek & Theorell 1990) and especially the Copenhagen Psychosocial Questionnaire (COPSOQ 2019; Llorens et al. 2019) include items relevant for evaluating the workplace learning environment. In the following, codes in brackets refer to the COPSOQ dimensions in Table 2 and the suggested supplementary questions are intended for scoring on 5-point Likert-scales. Here, a workplace learning environment is evaluated as enhancing efficiency of learning if it:

- Provides **variable challenges**, matching the changing abilities of the learner, avoiding the demotivating extremes of too easy, directed, and boring on the one side, and too difficult, demanding, and scary on the other side, thus finding a middle road. Challenges should be genuine, as far as possible with options for direct, as opposed to second-hand, experience. However, this should not be seen as replacement for learning abstract principles that allow the application of the learning in new contexts. Repeated challenges with varying context can be a means of facilitating the learning of abstract principles. An adequate level of breaks and repetitions ensures durability of the obtained knowledge and skills. Periods of rest in between repeated periods of intensive learning has been shown to increase learning retention. Knowledge and skills that are not used will deteriorate over time. Relevant dimensions in the COPSOQ questionnaire are Quantitative Demands (QD), Emotional Demands (ED), and Demands for Hiding Emotions (HE), all three detrimental to learning, and Influence (IN), Possibilities for Development (PD), and Variation of work (VA), all three beneficial for learning. The matching dimension in the Job Content Questionnaire is on Skill discretion and utilisation.
- Provides appropriate levels of **social support**. The relevant COPSOQ dimensions are Social Support (SS and SC) and Sense of Community (SW). The matching scores in the Job Content Questionnaire are on Social support. These questions may be supplemented by: “I learn from others and help others to learn”.
- Enhances the learner’s **self-confidence** through experiences of achievement or success at a rate that motivates further effort to improve. The relevant COPSOQ dimension is Self-Efficacy (SE); May be supplemented by “I know what I need to know to perform my tasks” and “I am confident that I can learn to perform new tasks well”.
- Encourages **learning from mistakes**, understanding mistakes as a necessary and beneficial part of effective learning and that self-detection and self-correction of errors can be superior to immediate external support and feedback. This issue is not adequately covered in the Job Content or Copenhagen Psychosocial questionnaires and should therefore be captured by the following additional statement for self-reported agreement on 5-point Likert scale: “Making mistakes is necessary to learn”.
- Has a low level of **distractions and multi-tasking**. Especially noise have been in focus as a distractor, but other sensory distractors, irrelevant information, and any other stressor, can distract focus from task attention and reduce efficiency of learning. Relevant questions are Question CD1 in COPSOQ: “Do you have to keep your eyes on lots of things while you work?”, Job Content Questionnaire scores on ‘Psychological Job Demands’, and more generally scores for high perceived stress, cf. the health section

of COPSOQ. Alternative questions are: “There are often things happening that distract my attention” and “I often have to do more than one task at a time”.

- Facilitates the autonomous **generation of new ideas**, broadening the application area of acquired knowledge, and intentional combinations with other knowledge or skills. Relevant questions are Question CD3 in COPSOQ: “Does your work demand that you are good at coming up with new ideas?”, Job Content Questionnaire score on: ‘requires creativity’, and the COPSOQ score for Self-efficacy.
- Stimulates **conscious reflection** and theoretical understanding, helping the learners to value their existing funds of knowledge and skills, and to recognise mental models and sources of cognitive bias, such as overconfidence and confirmation bias. The closest fitting COPSOQ dimension is Quality of Work (QW), which may be supplemented or replaced by “I often think about how to perform my tasks correctly”; “I often think about what is required to obtain good quality from my tasks”.
- Supports the **motivation** of the learner by explicit learning objectives, consciously formulated or accepted by the learner, that makes the value of the potential achievement explicit and adds an expectation of success. This issue is not adequately covered in the Job Content or Copenhagen Psychosocial questionnaires and should therefore be captured by the following additional statement for self-reported agreement on 5-point Likert scale: “I often think about new things I would like to learn”
- Supports the learner’s **self-control** and **understanding of the learning process** by providing a structured and organised learning environment that allows efficient interaction with other learners and sources of knowledge, and conscious combination and adaption of different learning strategies. The relevant COPSOQ dimension is Influence at Work (IN) and the matching scores in the Job Content Questionnaire are on Decision authority. To cover the understanding of the learning process, the following additional statement should be used for self-reported agreement on 5-point Likert scale: “I am aware what I need to do to learn new tasks well”.

Sources: Working conditions surveys performed at the organisation, preferably using the COPSOQ questionnaire with the supplementary questions suggested above. When unavailable, similar surveys at industry level.

Person-years with skills in preventive practices with respect to infectious diseases

Reference to Weidema (2020): Chapter 6, Section 3.1.

Unit: Person-years.

Minimum level of specification: Employees/family members; Time since last documented test of skills.

Guidance: Documentation of skills should not be more than three years old and should cover hygienic practices, reporting on incidences of diseased family-members and animals, self-monitoring for signs of infection, reducing interpersonal contact upon suspicion of infection, and following the advice of medical personnel. For part-time employees, the person-years recorded should be reduced proportionally, also for their family members.

Sources: Documentation of the organisation.

Employee-years with self-reported psychosocial risk factors for musculoskeletal disorders

Reference to Weidema (2020): Chapter 3, Section 3.11 (c).

Unit: Fulltime-equivalent employee-years.

Minimum level of specification: None.

Guidance: In epidemiological studies, musculoskeletal disorders have also been related to psychosocial factors in the workplace, notably (codes in brackets refer to the COPSOQ dimensions in Table 2): Low job satisfaction (JS), monotonous work (VA), poor social support at work (SS and SC), high perceived stress (ST, SO and CS), and/or high perceived work pace (WP). low job satisfaction, monotonous work, poor social support at work, high perceived stress, and/or high perceived work pace. Indicators for these factors can be found in the most widely used, standardised, reliable, and validated psychosocial survey instruments, such as the Job Content Questionnaire (Karasek et al. 1998, Karasek & Theorell 1990) and the Copenhagen Psychosocial Questionnaire (COPSOQ 2019, Llorens et al. 2019, see also Table 2).

Sources: Working conditions surveys performed at the organisation, preferably using the COPSOQ questionnaire. When unavailable, similar surveys at industry level.

Work-days with self-reported work-related severe discomfort

Reference to Weidema (2020): Chapter 3, Section 3.11 (a).

Unit: Person-work-days.

Minimum level of specification: By type of discomfort, notably severe low back pain, severe neck pain, severe shoulder pain, severe elbow pain, swelling/stiffness/pain in hand or forearm, tingling/numbness/burning/pain in fingers, Raynaud's phenomenon, and knee pain.

Guidance: Self-assessment of workers can identify occurrence of musculoskeletal disorders, supplemented by clinical examination when necessary. If the self-assessment shows absence of musculoskeletal disorders, this may make more specific identification of ergonomic risk factors (see the following pressure category indicator) superfluous. However, separate measurement of indicators for ergonomic risk factors may still be relevant for prevention of musculoskeletal disorders.

Sources: Workplace assessments of the organisation. When unavailable, statistics at industry level.

Work-days involving ergonomic risk factors

Reference to Weidema (2020): Chapter 3, Section 3.11 (b).

Unit: Person-work-days.

Minimum level of specification: By type of risk, notably standing more than 6 hours a day or continuously for more than 2 hours, sitting continuously for more than 2 hours, unassisted lifting from low positions more than 50 times a day or lifting of burdens exceeding the NIOSH (1994) recommended weight limit (note specific assessment methods in ISO TR 12296:2012 for handling of people in the healthcare sector), pushing, pulling, kneeling, or squatting for more than 2 hours a day or continuously or repetitively (more than 5 times per minute) for more than 30 minutes, neck flexing in excess of 45 or 20 degrees during more than 5% and 40%, respectively, neck rotation in excess of 45 degrees during more than 25% of work time, bending or twisting

trunk more than 30 degrees sideways, 60 degrees forward, or 20 degrees backwards, or reaching above shoulder level or below knee level, either more than 10 times per hour or continuously for more than 15 minutes.

Guidance: Ergonomic risk factors are the aspects of a task that can cause or contribute to the development of a musculoskeletal disorder as a result of a biomechanical stress on the body, notably: Awkward postures, cold temperatures, contact stress, force, repetitive movements, static postures, and vibration. A large number of standards developed under ISO/TC 159 are specifically addressing the measurement of ergonomic risk factors. A good overview of the topic can be found at https://oshwiki.eu/wiki/Category:Musculoskeletal_disorders and simple screening tools are available from <https://www.hse.gov.uk/> and the U.S. Department of Defense (DOD s.a.). If a preceding self-assessment of workers has shown absence of musculoskeletal disorders, more specific identification of ergonomic risk factors may be unnecessary, but may on the other hand be relevant for prevention of potential damages.

Sources: Workplace assessments of the organisation. When unavailable, statistics at industry level.

Hours of heat stress

Reference to Weidema (2020): Chapter 3, Section 3.7 (a).

Unit: Person-hours.

Minimum level of specification: None.

Guidance: The autonomous heat regulation of the human body occurs through surface evaporation. Under conditions of high air temperature, high humidity, and/or low ventilation rates, the internal metabolic heat generation and/or external sources of heat can exceed the ability of the human body to cool itself through surface evaporation, causing heat stress. This can be aggravated by dehydration. In unacclimatised persons, heat stress can occur already at effective wet bulb globe temperatures (WBGT_{eff}) of 22°C if performing strenuous work (at 500 watt metabolic rate, see Figure 1). Acclimatisation is the physiological adaptation occurring during 7 days of repeated exposure to a hot environment. WBGT is a measure of temperature as perceived by humans that considers air temperature, humidity, ventilation, and irradiation. Effective WBGT adds a correction factor for the effect of clothing. Details on calculation can be found in ISO 7243 (ISO 2017) and OSHA (2017). Occupational heat stress is avoided by ensuring access to water and ventilation, and limiting irradiation exposure and physical activity to stay below the TLV and Action Limits indicated in Figure 1. Thus, hours of heat stress are measured as hours with insufficient access to water and ventilation, or with irradiation exposure and physical activity above the ACGIH (2017) TLV and Action Limits.

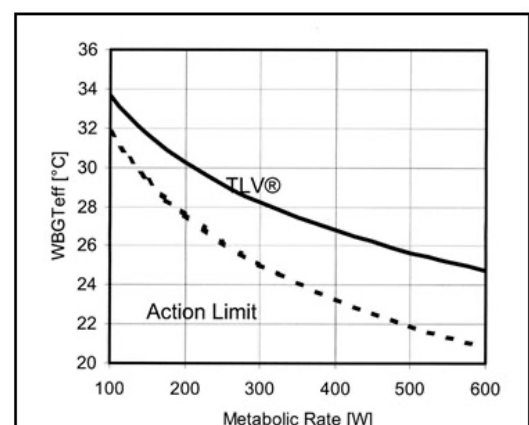


Figure 1. Threshold Limit Values (TLV) and Action Limits for metabolic rates of work load, expressed in watt, that can cause heat stress in acclimatized and non-acclimatized workers, respectively, at different effective wet bulb globe temperatures (WBGT_{eff}). From ACGIH (2017), reproduced from OSHA (2017). [permission from ACGIH pending]

Sources: Daily records of the organisation for personnel identified as having potential of being affected.

Occupational injuries, except road transport injuries

Reference to Weidema (2020): Chapter 3, Section 3.12 (a).

Unit: Unitless (incidences)

Minimum level of specification: By fatal (within one year of accident), permanent incapacity (inability to resume the same job within one year of accident), and temporary incapacity (calendar days between the day of the accident and the day when the employee can again perform the normal duties of the job occupied at the time of the accident, not including the day of the accident), further specified by gender, age, and migrant status, as well as accident and injury detail as further specified by ILO (1998).

Guidance: Non-transport injuries include falls, drowning, suffocation, firearms, exposure to mechanical forces, poisonings, animal contact, as well as fire, and hot substances. Heat stress, musculoskeletal disorders, and drug-related injuries are treated by separate pressure category indicators.

Sources: ILO statistics cover occupational injuries, divided on fatal or non-fatal, with the latter divided on permanent or temporary incapacity to perform the normal duties of the job occupied at the time of the accident (ILO 1998).

Employment-years not covered by an occupational safety and health (OSH) management system

Reference to Weidema (2020): Chapter 3, Section 3.12 (d).

Unit: Fulltime-equivalent employment-years.

Minimum level of specification: None.

Guidance: At a general level, occupational injuries are sought prevented through occupational safety and health (OSH) management systems that include appropriate training and monitoring, as described in the ILO (2001) guideline.

Sources: Documentation of the organisation.

Person-years of employees and their family members with basic skills in injury prevention and first aid

Reference to Weidema (2020): Chapter 3, Section 3.12 (d).

Unit: Person-years (number of persons tested for skills within the last three years)

Minimum level of specification: None.

Guidance: Training sessions in basic injury prevention and first aid are equally relevant for non-work situations and it is therefore relevant to offer such training session also to employee family members.

Sources: Documentation of the organisation. At aggregate level, data from national statistics.

Incidences of consumer injuries related to the analysed consumer products

Reference to Weidema (2020): Chapter 3, Section 3.12 (e).

Unit: Unitless (incidences)

Minimum level of specification: By fatal (within one year of accident), permanent incapacity (inability to resume the same job within one year of accident), and temporary incapacity, further specified by gender and age, as well as accident and injury detail.

Guidance: The U.S. Consumer Product Safety Commission provides statistics on injuries related to consumer, sports and recreational products in their National Electronic Injury Surveillance System (NEISS) available at <<https://www.cpsc.gov/Research--Statistics/NEISS-Injury-Data>>. The National Safety Council, an American non-profit organization, provides their own analysis of these data at <<https://injuryfacts.nsc.org/home-and-community/safety-topics/consumer-product-injuries/>> and <<https://injuryfacts.nsc.org/home-and-community/safety-topics/sports-and-recreational-injuries/>>. Producers that maintain statistics on consumer injuries for their own products can use these data to provide a product group benchmark. The difference to the benchmark can then be used as a pressure category indicator.

Sources: Benchmark values can be calculated from NEISS or similar data sources. Producer's statistics. Documentation of the organisation.

Reductions in injury incidences from the application of specific safety-enhancing technologies

Reference to Weidema (2020): Chapter 3, Section 3.12 (f).

Unit: Unitless (incidences).

Minimum level of specification: By fatal (within one year of accident), permanent incapacity (inability to resume the same job within one year of accident), and temporary incapacity, further specified by gender and age, as well as accident and injury detail.

Guidance: Organisations that apply specific safety-enhancing technologies, such as:

- Remote monitoring technology,
- Vision enhancement, such as lighting, mirrors, and television equipment,
- For falls: Handrails and non-slip, non-skid surfaces,
- For hazardous products: Safe storage, impediments to access and use, and equipment that reduce exposure during use, cleaning and disposal,
- Stability control technologies for moving equipment and their loads,
- Devices that secure objects that can fall or tip over,
- Flame retardants, smoke and fire alarms and containment systems, and fire suppression systems,
- Personal protective equipment,

and can provide documentation for related lower than average injury levels, can use the reduction in injury incidences as a pressure category indicator.

Sources: Documentation of the organisation.

Employee-specific weekly metabolic energy expenditure

Reference to Weidema (2020): Chapter 3, Section 3.9.

Units: MET or MET-minutes/work hour; Work-hours/week.

Minimum level of specification: By employee. The pressure category indicator records the employee-specific average metabolic energy expenditure during working hours and the weekly work-hours separately, allowing combination of these data across different jobs and leisure activities.

Guidance: Physical exercise is most easily recorded in MET-minutes, which is a relative measure of the metabolic energy expenditure of the human body during an activity relative to the resting energy expenditure. By definition, the resting expenditure is thus 1 MET or 10080 MET-minutes/week. The contribution of each individual activity can be expressed in MET-minutes. For example, sitting has a MET of 1 and thus 60 MET-minutes per hour of sitting, while bicycling at 15 km/h has a MET of 5.8, thus contributing $5.8 \times 60 = 348$ MET-minutes per hour of bicycling. Summing over the two hours, the average metabolic energy expenditure is $(60+348)/(2 \times 60) = 3.4$ MET or $(60+348)/2 = 204$ MET-minutes/hour. The measurement of the metabolic rate is described in ISO 8996 (ISO 2004).

Sources: Workplace assessments of the organisation. MET-levels for many activities are included in Ainsworth et al. (2000). Data on sedentary work per industry, occupation, and skill level are available from Australia (Kyaw-Myint & de Crespigny 2011).

Ultraviolet radiation exposure

Reference to Weidema (2020): Chapter 3, Section 3.4 (b) and (c).

Unit: Person-days.

Minimum level of specification: Days of occupational exposures of unprotected skin above 1.3 SED. During the summer months at latitude 30 and above: Days where occupation restricts access to lunch breaks with sunlight exposure.

Guidance: For ultraviolet radiation, there is a disease burden associated both with excessive and with insufficient ultraviolet radiation exposure. Ultraviolet radiation exposure is beneficial by stimulating the body to generate sufficient vitamin D. At latitude 30 and above, adequate exposure is hampered by the low level of ultraviolet radiation and the temperatures during winter, which implies that more exposure is required during summer months to build up the serum vitamin D to a level that can supply the monthly requirement during the winter months. Webb et al. (2018) suggest that at higher latitudes the annual requirement of 39 SED can best be obtained by solar exposure of 35% of the skin during lunchtime in 3 summer months and 10% of the skin (face and hands) during another four months. Lunchtime exposure of less than 30 minutes per day would be sufficient for light-skinned individuals. Webb et al. (2018) suggest that single exposure doses should be kept below 1 SED, since higher doses of ultraviolet radiation - whether from the sun or from phototherapy, tanning lamps, or germicidal lamps - is an important risk factor for skin cancer. While squamous cell carcinoma is found to be related to lifetime accumulated exposure, the most lethal forms of skin cancer - melanoma - are rather related to intense exposure (sunburn), i.e. single events where exposure exceeds a threshold, which varies with skin sensitivity, the lowest of which is 1.3 SED (Webb et al. 2011). In both cases, protection consists in avoiding outdoor occupations during the peak periods of radiation and otherwise covering the body with clothing and using UV-protecting sunglasses. See also Vecchia et al. (2007) and ICNIRP (2004).

Sources: Daily records of the organisation for personnel identified as having potential of being affected.

Consecutive work-days in locations without access to condoms

Reference to Weidema (2020): Chapter 3, Section 3.10.

Unit: Person-work-days.

Minimum level of specification: None.

Guidance: While the majority of sex occurs as a household (leisure) activity, it is obviously highly relevant in relation to employees in the sex industry and may also be relevant for employers that out-station employees in remote locations for longer periods of time, where the employer may be seen as having some co-responsibility for harmful off-duty conduct. In practice, it is difficult to monitor the occurrence of unsafe sexual practices, and the only practicable indicator is therefore the provision of access to condoms. For a period of n consecutive work-days, the indicator measures $n-1$ person-work-days.

Source: Workplace assessments of the organisation.

9 Additional pressure category indicators for specific types of organisations

9.1 For air transport

Change in effective dose of cosmic radiation relative to background level (social)

Reference to Weidema (2020): Chapter 3, Section 3.4 (d).

Unit: Sievert (biological effectiveness equivalent of a joule of beta-particle radiation in a kilogram of human tissue).

Minimum level of specification: None.

Guidance: Cosmic radiation is a form of ionising radiation to which aircrews (and aircraft passengers) are exposed at higher levels than ground-based personnel. According to Annex B of UNSCEAR (2000), the effective dose for altitudes of 9-12 km is 5-8 $\mu\text{Sv}/\text{hour}$ at temperate latitudes and 2-4 $\mu\text{Sv}/\text{hour}$ at equatorial latitudes. This should be compared to the cosmic radiation at sea level of 0.03-0.4 $\mu\text{Sv}/\text{hour}$.

Sources: In-flight data from e.g. <http://jag.cami.jccbi.gov/cariprofile.asp> linked to employee roster.

9.2 For organisations supplying basic services

Basic services are here defined as clean water supply, sanitation, solid waste disposal, electricity, housing, internet access, and banking.

Access costs for provision of basic services, charged separately from the charge per unit of service supplied (economic)

Reference to Weidema (2020): Chapter 1, Section 3.2 (a).

Unit: Purchasing-power corrected currency units, e.g. $\text{USD}_{2011,\text{PPP}}$.

Minimum level of specification: None

Guidance: The cost of services may be divided in access costs, typically per household or individual, to cover the infrastructure establishment and maintenance, and unit costs for the actual amount of service supplied (cubic metres of water or solid waste, kWh of electricity, square-metre-years of housing, GB of data, time-integrated account balance in currency units). For poor households with low consumption, the total cost will be larger if access costs are charged separately compared to when the access charges are distributed evenly over the unit costs of all consumers of the service. While separate access charges and fees thus create unnecessary access barriers for poor households, they may be justified from an activity costing perspective, especially when the cost of providing access is location dependent, e.g. when supplying remote areas having low population density. In such situations, it is fair to charge the location-dependent part of the access costs separately, while providing payment plans with low-cost credit for poor households. Therefore, the pressure category indicator does not include separate access charges that are justified by the supply location.

Sources: The bookkeeping of the organisation. Published fees.

Differential between overdraft and/or late payment fees and the losses on defaults and overdue payments (economic)

Reference to Weidema (2020): Chapter 1, Section 3.2 (a).

Unit: Purchasing-power corrected currency units, e.g. USD_{2011,PPP}.

Minimum level of specification: None

Guidance: Poor households are particularly vulnerable to overdraft or late payment fees, especially when charged in excess of what is required to cover the average losses on defaults or overdue payments. For example, relative to a 2% risk-free real annual interest rate, a 20% real annual rate on overdrafts and late payments is sufficient to cover the income loss of a 15% average default rate of such overdraft or late payments. The pressure category indicator measures any excess revenue from overdraft or late payment fees.

Sources: The bookkeeping of the organisation.

9.3 For organisations that handle goods that can carry biological contamination Deviations from hygienisation procedures at critical control points (ecosystem)

Reference to Weidema (2020): Chapter 6, Section 3.4.

Unit: Unitless (Incidences).

Minimum level of specification: None.

Guidance: Sufficient hygienisation is particularly important when moving persons, goods or wastes between locations. The definition of critical control points and monitoring are specific to different processes and are described in specific industry guidelines and requirements. When no industry standard exists, the IFH guidelines for everyday situations (IFH 2001, 2002, 2004) may be applied.

Sources: Documentation from the monitoring system of the organisation.

9.4 For activities handling foods and beverages

The nutrient density of qualifying and disqualifying nutrients in ingested or ingestible part of product

Reference to Weidema (2020): Chapter 3, Section 3.8 (a).

Units: Mass per energy unit, e.g. gram/kJ (for nutrient density); Energy units, such as kJ (for metabolisable energy)

Minimum level of specification: By unit of metabolisable energy measured according to the recommendations of FAO (2003), and whenever possible relative to daily recommended intake and prior diet balance of the ingesting population group.

Guidance: Qualifying nutrients include vitamins, minerals, choline, polyunsaturated fatty acids, omega-3 fatty acids or precursors, dietary fibre according to the AOAC official method 985.29 or similar, protein, and water. Disqualifying nutrients shall include saturated and trans fatty acids, cholesterol, sodium, and total sugars and ethanol.

Sources: Measurement, as for nutrient labelling.

Glycaemic index for the carbohydrate content of the ingested or ingestible part of product

Reference to Weidema (2020): Chapter 3, Section 3.8 (b).

Units: Unitless (index).

Minimum level of specification: None.

Guidance: The glycaemic index should be determined in accordance with ISO 26642 (ISO 2010).

Sources: Measurement, as for nutrient labelling.

9.5 For government organisations

Monetary value of transfers to specified governments, to compensate for inability to raise sufficient funds through taxation (economic)

Reference to Weidema (2020): Chapter 10, Section 3.5 (a).

Unit: Nominal currency units (with indication of base year), e.g. USD₂₀₁₁.

Minimum level of specification: None

Guidance: Such transfers are normally only between governments.

Sources: The bookkeeping of the organisation.

9.6 For hospitals

Effective dose of directly generated ionising radiation (ecosystem)

Reference to Weidema (2020): Chapter 3, Section 3.5 (b).

Unit: Sievert.

Minimum level of specification: None

Guidance: Acceleration of charged particles in electromagnetic fields generates ionising radiation that is especially important in medical contexts (diagnostic radiology and radiation therapy). The human exposure is estimated directly from the kinetic energy of the charged particles and expressed in units of effective dose (Sievert, the biological effectiveness equivalent of a joule of beta-particle radiation in a kilogram of human tissue).

Sources: Exposure for patients and personnel, estimated by the hospital.

9.7 For private or public investors

Funds for education provided with income-contingent payback (economic)

Reference to Weidema (2020): Chapter 4, Section 3.1 (a).

Unit: Nominal currency units (with indication of base year), e.g. USD₂₀₁₁.

Minimum level of specification: None

Guidance: In a well-functioning capital market, investments will be made with priority to the activities that are expected to give the largest returns. Considering that education is one of the best investments that a person can make in a life-time, with a return of several orders of magnitude, it is conspicuous that financing of this is practically exclusively available through own family funds and/or public funds, and not through the capital markets. The reason why capital markets typically avoid investing directly in human capital is the legal limitations on the use of human capital as equity in financial contracts. Equity-based funding (as opposed to debt-based funding) is the most socially efficient way of funding education and the legal limitations result from an inappropriate (over-)implementation of the slavery and bonded labour conventions (Jacobs & van Wijnbergen 2005). Equity-based funding can also be provided by governments as loans with income-contingent payback, as already implemented in a few countries, or as free education combined with a graduate tax on post-education income. Regular capital market funding of human equity does not limit the free choice of employment and shall only require payback with a percentage of future income when this income exceeds a well-defined lower limit.

Sources: Bookkeeping of the organisation.

9.8 For leisure activities

Person-hours of leisure with self-reported inadequate conditions for leisure time learning (social)

Reference to Weidema (2020): Chapter 4, Section 3.5.

Unit: Person-hours.

Minimum level of specification: None

Guidance: Both non-formal and informal learning can occur during leisure time, and the environmental factors influencing learning are largely the same as in the workplace. However, measurement instruments for leisure time learning are even more rare than for workplace learning. To provide comparable scores to those obtained for workplace learning, the following statements are proposed for self-reported agreement on 5-point Likert scale, for each relevant leisure activity for which the time spent is registered:

- Variable challenges: “I have opportunity to apply all aspects of my knowledge and skills”; “I have opportunity to learn new things”; “I have opportunity to develop my skills”; “I combine new things I learn with what I already know”.
- Social support: “I learn from others and help others to learn”.
- Self-confidence: “I know what I need to know to perform my activities”; “I am confident that I can learn to perform new tasks well” (may complement the COPSOQ Self-Efficacy questions; see the following bullet point).
- Generation of new ideas: The Self-Efficacy questions of COPSOQ (2019): “I am always able to solve difficult problems, if I try hard enough”; “If people work against me, I find a way of achieving what I want”; “It is easy for me to stick to my plans and reach my objectives”; “I feel confident that I can handle unexpected events”; “When I have a problem, I can usually find several ways of solving it”; “Regardless of what happens, I usually manage”.
- Learning from mistakes: “Making mistakes is necessary to learn”.
- Distraction and multi-tasking: “There are often things happening that distract my attention”; “I often have to do more than one task at a time”; “I have to keep my eyes on lots of things at the same time”.
- Conscious reflection: “I often think about how to do things the right way”; “I often think about how to spend my time the best way”.
- Motivation: “I often think about new things I would like to learn”.
- Self-control: “It is my own responsibility to improve my knowledge and skills”.
- Understanding of the learning process: “I am aware what I need to do to learn new tasks well”.

It should be noted that these questions have not been assessed for reliability.

Sources: Household surveys.

9.9 For tourism

The pressure category indicators below are intended to capture these specific pressures from tourism on heritage. On the upside, tourism can play a beneficial role in the prioritisation of heritage conservation and in ensuring international sharing of costs and supervision according to the common heritage principle, and tourism can itself contribute financially or in-kind to the local activities for heritage protection and maintenance. To avoid double-counting with the indicator for voluntary contributions, the pressure category indicator here measures the *share* of the income from tourism that is dedicated for heritage protection and maintenance, rather than the absolute contributions that are measured by the indicator for voluntary contributions.

On the downside, tourism activities can contribute to the degradation and depletion of the local heritage. This can occur as a result of:

- An excess number of visitors per area, to the extent that this reduces the enjoyment of the assets for the local population or for other current or future visitors, either by their sheer presence or by the direct wear on the asset itself. This is mainly an issue for natural and tangible cultural heritage.

- An excess number of visitors relative to the local population, to the extent that this reduces the ability to enjoy traditional local social practices, i.e., mainly an issue for intangible cultural heritage.
- A too high share of tourism in the local economy, to the extent that this increases the vulnerability of the local economy to fluctuations in the number of visitors.

A separate pressure indicator is included for each of these issues, accounting for the additional contribution of the specific tourism activity to the prior level of tourism. This allows to account for the marginal or incremental change in tourism pressure.

Proportion of income from tourism dedicated for heritage protection and maintenance (economic)

Reference to Weidema (2020): Chapter 11, Section 3.8 (a).

Unit: Unitless (proportion)

Minimum level of specification: None.

Sources: The bookkeeping of the organisation.

Number of visitors and change in areal visitor density (social)

Reference to Weidema (2020): Chapter 11, Section 3.8 (b).

Unit: Unitless (visitors)

Minimum level of specification: By area and time, especially for peak season.

Sources: The bookkeeping of the organisation, local visitor statistics.

Number of visitors and change in visitor density per local population (social)

Reference to Weidema (2020): Chapter 11, Section 3.8 (c).

Unit: Unitless (visitors)

Minimum level of specification: By area and time, especially for peak season.

Sources: The bookkeeping of the organisation, local population census.

Tourism value added and change in tourism value added per total value added at tourist destination

Reference to Weidema (2020): Chapter 11, Section 3.8 (d).

Unit: Unitless (proportion)

Minimum level of specification: None.

Sources: The bookkeeping of the organisation, local tourism statistics, local economic accounts.

9.10 For transport activities

Deviations from hygienisation procedures at critical control points (ecosystem)

Reference to Weidema (2020): Chapter 15, Section 3.2.

Unit: Unitless (Incidences).

Minimum level of specification: by applied standard or guideline.

Guidance: Dispersal of invasive species, alien to the local ecosystems, may happen as a result of intentional introductions (mainly in relation to agriculture, forestry and aquaculture), or as an unintentional side-effect of transport, where the organisms are contaminants of biological commodities and packaging materials or contaminants of the vehicles or passengers (such as contaminated ballast water of freighters, fouling on ship hulls, and soil sticking to trucks or machinery). In parallel to the control of infectious diseases, dispersal of invasive species can be controlled by introducing hygienisation procedures at critical control points. Critical control points can be limited to consider transports originating in environments with high probability of being a source of invasive species for the receiving environment, which allow to eliminate consideration of local transports (within the same biogeographical region) and transports between areas with very different biogeographical characteristics (which are less likely to result in species invasion). For critical control points, hygienisation procedures can be directed towards minimising the amount of contamination on or in the biological material transported (the commodities and their packaging materials) or the vehicles (ballast water, fouling on ship hulls, soil/dirt clinging to vehicles), reducing survival probability during transport by managing water availability or applying preservation methods, possibly combined with quarantine, and towards minimising the probability of escape for intentionally introduced species.

Sources: Documentation from the monitoring system of the organisation. The relevant international standards and guidelines are listed in the annex of the Secretariat of the Convention on Biological Diversity document (SCBD 2011).

Road transport injuries (social)

Reference to Weidema (2020): Chapter 3, Section 3.12 (b).

Unit: Unitless (incidences); expressed per vehicle-km of the accident-causing vehicle type.

Minimum level of specification: By vehicle type; by fatal (within one year of accident), permanent incapacity (inability to resume the same job within one year of accident), and temporary incapacity (calendar days between the day of the accident and the day when the employee can again perform the normal duties of the job occupied at the time of the accident, not including the day of the accident), further specified by gender, age, and migrant status, as well as accident and injury detail as further specified by ILO (1998), and, when possible, specified by type of roads and applied vehicle technologies (crash-preventing speed and stability control technologies, and impact-mitigating technologies, such as seat-belts, airbags, and helmets).

Guidance: The EU countries have begun recording road injury data by severity, using the proprietary Abbreviated Injury Scale that relate to the probability of fatal outcomes (IFT 2019).

Sources: National injury statistics. Some countries have statistics per brand of vehicle, e.g. the US National Highway Traffic Safety Administration Fatality Analysis Reporting System.

9.11 For activities located in urban core areas

Human activities located in densely populated urban core areas with limited vegetation and a large building volume can influence the natural background temperatures, and thus indirectly the occurrence of heat stress in the local environment, particularly in the afternoon. The most relevant indicators are changes relative to the reference situation of surface reflection (albedo), evaporated water volume, and to a lesser extent direct heat emission. Urban core areas are defined following Dijkstra & Poelman (2014) as being contiguous 1 km² grid cells with a density of at least 1500 persons per km² and a minimum population of 50000 persons.

Surface area-time weighted by the area's solar reflectance (ecosystem)

Reference to Weidema (2020): Chapter 3, Section 3.7 (b).

Unit: Area-time units, such as m²-years, with solar-reflectance-weighting according to Levinson et al. (2010).

Minimum level of specification: None.

Sources: Area from the bookkeeping and tenure documents of the organisation

Evaporated water volume (ecosystem)

Reference to Weidema (2020): Chapter 3, Section 3.7 (c).

Unit: Volume units, such as m³.

Minimum level of specification: None.

Guidance: Evaporated water can be estimated as the residual of a volume balance: Evaporated = Purchased water + water in purchased products + rainwater – wastewater – water in products.

Sources: Water metering and water balance of the organisation.

Waste heat emission (ecosystem)

Reference to Weidema (2020): Chapter 3, Section 3.7 (d).

Unit: Energy units, such as J, for heat emission.

Minimum level of specification: None.

Guidance: Direct emission of waste heat can be calculated from the higher heating value of fuels combusted plus electricity consumed plus purchased heat minus any heat sold as product. Heat release or capture by chemical and biological processes are usually insignificant in comparison and may therefore be ignored.

Sources: Calculations based on the bookkeeping of the organisation.

References

Abraham M H, Sánchez-Moreno R, Cometto-Muñiz J E, Cain W S. (2012). An Algorithm for 353 Odor Detection Thresholds in Humans. *Chemical Senses* 37(3):207-18.

- ACGIH. (2017).** Heat Stress and Strain. TLV® Physical Agents 7th Edition Documentation. Cincinnati: American Conference of Governmental Industrial Hygienists (ACGIH).
- AOAC. (2000).** Official Methods of Analysis. 17th ed. Gaithersburg: AOAC International.
- Ardito C, d’Errici A, Leombruni R, Pacelli L. (2012).** Health and well-being at work: A report based on the fifth European Working Conditions Survey, Dublin: Eurofound.
- COPSOQ. (2019).** The Third Version of the Copenhagen Psychosocial Questionnaire. Safety and Health at Work 10(4):482-503.
- CWP. (2017).** CWP Handbook of Fishery Statistical Standards. Rome: Coordinating Working Party on Fishery Statistics, Food and Agriculture Organization of the United Nations. Available at <www.fao.org/cwp-on-fishery-statistics/handbook/en/> (accessed 2020-03-25)
- Del Grosso S, Parton W, Stohlgren T, Zheng D, Bachelet D, Prince S, Hibbard K, Olson R. (2008).** Global potential net primary production predicted from vegetation class, precipitation, and temperature. Ecology, 89(8):2117-2126.
- Dinerstein E, Olson D, Joshi A, Vynne C, Burgess N D, Wikramanayake E, Hahn N, Palminteri S, Hedao P, Noss R, Hansen M, Locke H, Ellis E C, Jones B, Barber C V, Hayes R, Kormos C, Martin V, Crist E, Sechrest W, Price L, Baillie J E M, Weeden D, Suckling K, Davis C, Sizer N, Moore R, Thau D, Birch T, Potapov P, Turubanova S, Tyukavina A, De Souza N, Pintea L, Brito J C, Llewellyn O A, Miller A G, Patzelt A, Ghazanfar S A, Timberlake J, Klöser H, Shennan-Farpón Y, Kindt R, Lillesø J -P B, van Breugel P, Graudal L, Voge M, Al-Shammari K F, Saleem M. (2017).** An Ecoregion-Based Approach to Protecting Half the Terrestrial Realm. BioScience 67(6):534-545.
- DOD. (s.a.).** Ergonomics in Action. Tech Guide 220. Edgewood Arsenal: U.S. Army Center for Health Promotion and Preventive Medicine (Now: U.S. Army Public Health Center). Available from <https://www.denix.osd.mil/ergoworkinggroup/assessmenttools/>
- EEA (2019).** EMEP/EEA air pollutant emission inventory guidebook 2019. Copenhagen: European Environmental Agency. (EEA Report No 13/2019)
- FAO. (2003).** Food Energy - Methods of Analysis and Conversion Factors. Report of a Technical Workshop, Rome, 3-6 December 2002. (FAO Food and Nutrition Paper 77).
- FAO. (2016).** AQUASTAT Main Database. Rome: Food and Agriculture Organization of the United Nations. Website accessed on 2020-08-16.
- Hiscocks P D. (2014).** Measuring Luminance with a Digital Camera. Richmond Hill: Syscomp Electronic Design Limited. Available from <www.ee.ryerson.ca/~phiscock/astronomy/light-pollution/luminance-notes-2.pdf> (accessed 2020-03-08)
- IIASA/FAO. (2012).** Global Agro-ecological Zones (GAEZ v3.0). Laxenburg/Rome: International Institute for Applied Systems Analysis/Food and Agriculture Organization of the United Nations.
- ICLS. (2008).** Resolution II. Resolution concerning statistics of child labour. Geneva: International Conference of Labour Statisticians.
- ICNIRP. (2004).** Guidelines on limits of exposure to ultraviolet radiation of wavelengths between 180 nm and 400 nm (Incoherent optical radiation). Health Physics 87(2):171-186.

- IEC. (2013).** IEC 61672-1 Electroacoustics - Sound level meters - Part 1: Specifications. Geneva: International Electrotechnical Commission.
- IFH. (2001).** Recommendations for selection of suitable hygiene procedures for use in the domestic environment. Geneva/Milano: International Scientific Forum on Home Hygiene/Intermed Communications.
- IFH. (2002).** Guidelines for the prevention of infection and cross-infection in the domestic environment: focus on home hygiene issues in developing countries. Geneva/Milano: International Scientific Forum on Home Hygiene/Intermed Communications.
- IFH. (2004).** Guidelines for the prevention of infection and cross-infection in the domestic environment. 2nd Edition. Geneva/Milano: International Scientific Forum on Home Hygiene/Intermed Communications.
- IFT. (2019).** Road safety annual report 2019. Paris: OECD International Transport Forum.
- ILO. (1998).** Resolution concerning statistics of occupational injuries (resulting from occupational accidents), adopted by the 16th International Conference of Labour Statisticians. Geneva: International Labour Office.
- ILO (2001).** Guidelines on occupational safety and health management systems, ILO-OSH 2001. Geneva: International Labour Office.
- ILO. (2005).** Guidelines for Developing Child Labour Monitoring Processes. Geneva: International Labour Office.
- ILO. (2012).** International Standard Classification of Occupations: ISCO-08. Geneva: International Labour Office.
- ILO. (2017).** Methodology of the global estimates of child labour, 2012-2016. Geneva: International Labour Office.
- ILO, Walk Free Foundation, International Organization for Migration. (2017).** Methodology of the global estimates of modern slavery: Forced labour and forced marriage. Geneva: International Labour Office.
- ISO. (2010).** ISO 26642:2010 Food products — Determination of the glycaemic index (GI) and recommendation for food classification. Geneva: International Organization for Standardization (ISO).
- ISO. (2012).** ISO/TR 12296 Ergonomics - Manual handling of people in the healthcare sector. Geneva: International Organization for Standardization (ISO).
- ISO. (2017).** ISO 7243:2017 Ergonomics of the thermal environment — Assessment of heat stress using the WBGT (wet bulb globe temperature) index. Geneva: International Organization for Standardization (ISO).
- Jacobs B, van Wijnbergen SJG (2005).** Capital Market Failure, Adverse Selection and Equity Financing of Higher Education. Amsterdam: Tinbergen Institute Discussion Paper TI 2005-037/3.
- Jechow A, Kyba C C M, Hölker F. (2019).** Beyond All-Sky: Assessing Ecological Light Pollution Using Multi-Spectral Full-Sphere Fisheye Lens. Imaging Journal of Imaging 5(4:46).
- Karasek R, Brisson C, Kawakami N, Houtman I, Bongers P, Amick, B. (1998).** The job content questionnaire (JCQ): an instrument for internationally comparative assessments of psychosocial job characteristics. Journal of Occupational Health Psychology 3(4):322-355.
- Karasek R, Theorell T. (1990).** Healthy work: stress, productivity, and the reconstruction of working life. New York: Basic Books.

- Kim K-H, Park S-Y. (2008).** A comparative analysis of malodor samples between direct (olfactometry) and indirect (instrumental) methods. *Atmospheric Environment* 42(20):5061–5070.
- Kraaijenbrink J. (2019).** What the 3Ps of the triple bottom line really mean. *Forbes*. Accessible at <https://www.forbes.com/sites/jeroenkraaijenbrink/2019/12/10/what-the-3ps-of-the-triple-bottom-line-really-mean/>
- Levinson R, Akbari H, Berdahl P. (2010).** Measuring solar reflectance - Part II: Review of practical methods. *Solar Energy* 84(9): 1745-1759.
- Llorens C, Pérez-Franco J, Oudyk J, Berthelsen H, Dupret E, Nübling M, Burr H, Moncada S. (2019).** COPSQ III. Guidelines and questionnaire. Freiburg im Breisgau: COPSQ International Network.
- Murphy J, Riley J P. (1962).** A modified single-solution method for the determination of phosphate in natural waters. *Analytica Chimica Acta* 27:31-36.
- Murphy K. (2017).** Procedural justice and its role in promoting voluntary compliance. Pp. 43-58 in Drahos P. (Ed.): *Regulatory Theory: Foundations and Applications*. Canberra: Australian National University Press.
- NIOSH. (1994).** Applications Manual for the Revised NIOSH Lifting Equation. Cincinnati: National Institute for Occupational Safety and Health.
- OECD. (2010).** Handbook on Deriving Capital Measures of Intellectual Property Products. Paris: Organisation for Economic Co-operation and Development.
- OECD. (2019).** Emission Scenario Documents. Website: www.oecd.org/chemicalsafety/emissionscenariodocuments.htm (Accessed 2020-08-17)
- OSHA. (2017).** Heat Stress. Section III: Chapter 4 of the OSHA Technical Manual. Washington DC: Occupational Safety and Health Administration.
- Panagos P, Borrelli P, Meusburger C, Alewell C, Lugato E, Montanarella L. (2015a).** Estimating the soil erosion cover-management factor at European scale. *Land Use Policy* 48:38-50.
- Panagos P, Borrelli P, Meusburger K, van der Zanden E H, Poesen J, Alewell C. (2015b).** Modelling the effect of support practices (P-factor) on the reduction of soil erosion by water at European scale. *Environmental Science & Policy* 51:23–24.
- Pendoley K, Bell C, Surman C, Choi J. (2020).** National Light Pollution Guidelines for Wildlife Including Marine Turtles, Seabirds and Migratory Shorebirds. Canberra: Department of the Environment and Energy, Commonwealth of Australia.
- Renard K G, Foster G R, Weesies G A, Porter J P. (1991).** RUSLE: revised universal soil loss equation. *Journal of Soil Water Conservation* 46(1):30–33.
- Tyler T, Dienhart J, Thomas T. (2008).** The Ethical Commitment to Compliance: Building Value-Based Cultures. *California Management Review* 50(2):31-51.
- UNSCEAR. (2000).** Sources and effects of ionizing radiation. Report to the General Assembly, with Scientific Annexes. Volume I: Sources. New York: United Nations Scientific Committee on the Effects of Atomic Radiation.
- UNSCEAR (2016).** Sources, effects and risks of ionizing radiation. Report to the General Assembly, with Scientific Annexes. New York: United Nations Scientific Committee on the Effects of Atomic Radiation.

- UNESCO. (1972).** International Convention Concerning the Protection of the World Cultural and Natural Heritage. Paris: United Nations Educational, Scientific and Cultural Organization.
- Vecchia P, Hietanen M, Stuck B E, van Deventer E, Niu S. (Eds.)(2007).** Protecting Workers from Ultraviolet Radiation. Oberschleißheim: International Commission on Non-Ionizing Radiation Protection.
- Velthof G L, Oudendag D, Witzke H P, Asman WAH, Klimont Z, Oenema O. (2009).** Integrated Assessment of Nitrogen Losses from Agriculture in EU-27 using MITERRA-EUROPE. *Journal of Environmental Quality* 38:402-417.
- Webb A R, Kift R, Berry J L, Rhodes L E. (2011).** The Vitamin D Debate: Translating Controlled Experiments into Reality for Human Sun Exposure Times. *Photochemistry and Photobiology* 87:741–745.
- Webb A R, Kazantzidis A, Kift R C, Farrar M D, Wilkinson J, Rhodes L E. (2018).** Meeting vitamin D requirements at UK latitudes: Providing a choice. *Nutrients* 10(4):E497.
- Weidema B P. (2020).** An exhaustive quantitative indicator and impact pathway framework for sustainable development. Draft manuscript. Aalborg: 2.-0 LCA consultants.
- Weidema B P, Cappellaro F, Carlson R, Notten P, Pålsson A-C, Patyk A, Regalini E, Sacchetto F, Scalbi S (2003).** Procedural guideline for collection, treatment, and quality documentation of LCA data. Document LC-TG-23-001 of the CASCADE project. Available at <<https://lca-net.com/p/1106>>.
- Weidema B P, Bauer C, Hischer R, Mutel C, Nemecek T, Reinhard J, Vadenbo C O, Wernet G (2013).** Overview and methodology. Data quality guideline for the ecoinvent database version 3. *Ecoinvent Report 1(v3)*. St. Gallen: The ecoinvent Centre. Available at <<https://lca-net.com/p/234>>.
- WMO. (2018).** Scientific Assessment of Ozone Depletion: 2018. Geneva: World Meteorological Organization. (Global Ozone Research and Monitoring Project Report No. 58).

Annex to Section 6.2: Survey-questions on procedural fairness

The following generic survey-questions on procedural fairness have been adapted for relevance to the stakeholders' self-assessment of the decision-making process on prioritisation of heritage protection and maintenance. For such an assessment to be valid, it must include any self-defined group that expresses an interest in the topic following an open and transparent process of stakeholder identification, and must give equal voice and weight to these groups.

Collective understanding and reflection, voice and participation:

- "In your opinion, is the prioritisation based on the best available information?" (Likert-scale)
- "Have you shared with other participants your opinion on the prioritisation?" (ability to share reflection; Likert-scale)
- "Have you shared with other participants your opinion on the way the heritage protection is enforced?" (ability to share reflection; Likert-scale)
- "Do you feel that you are allowed to question the prioritisation and/or the way the heritage protection is enforced?" (ability to voice opinion; Likert-scale)
- "Have you been encouraged to question the prioritisation and/or the way the heritage protection is enforced?" (encouraged to voice opinion; Likert-scale)
- "If you or someone else would like to change the prioritisation and/or the way the heritage protection is enforced, would you have any influence on the decision to change or not to change?" (participation in decision-making; Likert-scale)

Procedural fairness (Respect):

- "In decisions about the prioritisation, are the relevant rights of participants respected?" (Likert-scale)
- "In decisions about the prioritisation, are affected participants treated with dignity?" (Likert-scale)
- "In decisions about the prioritisation, do affected participants receive polite and respectful treatment?" (Likert-scale)

Procedural fairness (Neutrality):

- "Is the prioritisation applied consistently in different situations?" (Likert-scale)
- "Are enforcement decisions based on accurate information?" (Likert-scale)
- "Are enforcement decisions based on the best available information?" (Likert-scale)
- "Are enforcement decisions made in a transparent way?" (Likert-scale)
- "Is the heritage protection enforced in the same way for all participants in the activity?" (Likert-scale)
- "Are enforcement decisions influenced by personal opinions and relationships?" (Likert-scale)

Procedural fairness (Trustworthiness):

- "Are enforcement decisions explained and justified?" (Likert-scale)
- "Is it possible to appeal a decision if you disagree with it?" (Yes/No)
- "Do decisions about the prioritisation reflect a desire to do what is best for the group?" (Likert-scale)
- "In decisions about the prioritisation, are the needs of relevant participants considered?" (Likert-scale)
- "In decisions about the prioritisation, are the views of relevant participants considered?" (Likert-scale)

The questions on procedural fairness are largely consistent with those used by Tyler et al. (2008).