



IMPACT World+

version 2.0.1

CIRAIG





1 Introducing the 2.0.1 version

The update of IMPACT World+ to version 2.0.1 was driven by several key objectives. The main one was the segmentation of the methodology into three distinct versions. One version exclusively contains midpoint indicators, another, called the *Expert version*, exclusively features damage indicators, catering to experts in the field. The third version, designed for practitioners with a more limited expertise in LCA and impact assessment, offers a simplified approach. The separation of the *Midpoint* and *Expert versions* was necessary to accommodate certain LCA software that does not allow for the distinction between the midpoint and damage levels during result calculations, thereby mitigating the risk of double counting. Furthermore, the introduction of the third version, referred to as the *Footprint version*, fulfills the need for straightforward results that do not demand an advanced level of expertise for interpretation. This approach reduces the risk of misinterpreting results and aligns with the areas of interest typically examined in the sustainability field.

Another key objective of the 2.0.1 version update is the incorporation of the most up-to-date climate change indicators from the IPCC's AR6 report.

Additionally, this update provided an opportunity to rectify inconsistencies in the indicators related to land use.

2 Three versions developed for different levels of interpretation

The IW+ 2.0.1 explicitly distinguishes three versions of IW+, namely: the *Footprint* version, the *Expert* version and the *Midpoint* version. The first one is proposed as a default for practitioners with a lower degree of expertise in LCA and impact assessment, the second one as the expert version for experienced users and the third one is destined to practitioners wanting to stay at the Midpoint level.

2.1 Why this distinction?

This explicit versioning builds on the recommendations of the original publication of IW+ by de Bulle et al (2019) to propose a simplified version that (i) offers stakeholders an impact profile closer to the environmental issues of concern, namely carbon footprint, water and resources in addition to indicators addressing potential impacts on human health and ecosystem quality and (ii) allows for some simplifications in methodological aspects that are still not mature enough to be readily understood during the interpretation phase by less experienced practitioners.

2.2 The Footprint version

The Footprint version aims at displaying indicators of general interest in decision making, along with indicators ensuring comprehensiveness in respect to all the environmental issues considered in the Expert version. The Footprint version is compliant with the optional ISO LCIA elements *grouping*. Displayed categories, indicators and their units in the Footprint version are summarized in Table 1.

For the “Carbon footprint”, only the short-term impact categories for *Climate change* (i.e. GWP100) are included, as this time horizon is the one of interest to stakeholders. The *Climate change, short term* indicator is taken from the midpoint profile of the Expert version.

For the “Water scarcity footprint”, in the ideal case we would have to include the water footprint concept as proposed by ISO, including issues related to water quality and water consumption (as well as all other impacts related to the water compartment such as (eco)toxicity, acidification, or eutrophication). However, due to implementation issues with the life cycle inventory, the impact scores of this impact category can be flawed if the inventories are not corrected. The main issue lies in the incapacity to compute water consumption at a regional level consistently for all elementary processes due to an inconsistent identification of regional locations of water flows entering and leaving some unit processes in *ecoinvent*. Despite this severe limitation and because the Water scarcity indicator (AWARE) is the recommended indicator supported by a global consensus to assess water related issues despite covering water consumption only, we integrated the Water scarcity indicator in the Footprint version. However, users need to keep in mind that the Water scarcity indicator needs regionalized water flows to provide meaningful results. The current implementation of AWARE without regionalized water flows is simply calculating the water consumption inventory multiplied by a constant characterization factor of 42.95 m³ eq/m³ consumed, meaning that the potential impact of consuming water is the same all around the world.

The category indicators *Rest of human health* and *Rest of ecosystem quality* are presented excluding the contributions of Climate change indicators and Water availability indicators and excluding all long-term indicators, as this time horizon is of lesser interest to stakeholders.

The “Resources and ecosystem services” has not been included in the footprint version because the

framework to aggregate midpoint impact categories contributing to this area of protection still needs to be developed. The sole “Fossil and nuclear energy use” impact category is included so far. The “Mineral resources use” impact category that aims to assess the loss of functional value of the mineral resource has not been retained so far in the footprint version, because it is still under development and the interpretation of the resulting impact scores requires a certain level of expertise. Moreover, this indicator mostly represents long-term impacts.

Table 1: Impact categories, indicators, and indicators’ unit of the *Footprint version*

| Impact categories | Indicators displayed and units |
|---|---|
| Carbon footprint | - Climate change, short term (in kg CO ₂ eq) |
| Water scarcity footprint | - Water scarcity (in m ³ world-eq) |
| Resource depletion | - Fossil and nuclear energy use (in MJ deprived) |
| Rest of human health AoP (minus the contribution of climate change and water related issues) | - Rest of human health (in DALY) |
| Rest of ecosystem quality AoP (minus the contribution of climate change and water related issues) | - Rest of ecosystem quality (in PDF.m ² .yr) |

2.3 The *Expert* and *Midpoint* versions

The expert and midpoint versions are the same version that were made available to users up until now, i.e., versions with all recommended indicators, one at midpoint level and another at damage levels, these latter aggregated into Areas of Protection (AoP), namely *Human health* and *Ecosystem quality*. Displayed categories, indicators and their units in the AoP version are summarized in Table 2.

The two versions are separated because of the way impact assessment methods are operationalized in LCA software that do not allow the user to display separately midpoint and endpoint indicators, thus leading to potential misinterpretation of the results.

It must be noted that some indicators such as the *Fossil and nuclear energy use* and the *Mineral resources use* are only available at the Midpoint level. Thus, if these indicators are considered of interest for a given study along with the AoP indicators, both versions of the method should be used.



3 Updates of CF

3.1 Climate change

The *Climate change, long term* and *Climate change, short term* midpoint categories were updated to the IPCC2021 AR6 values in the *Footprint* and *Midpoint* versions of IMPACT World+ 2.0.1. Note that damage categories for these categories are still based on AR5 values and will be updated in later versions of IW+.

3.2 Land occupation and land transformation

The land type "unspecified" (e.g., Land occupation, unspecified) were previously not characterized, which means these flows had no impact in software that included them in their elementary flows database. Now an average CF was calculated based on the land type used globally.

Moreover, artificial water bodies are now associated to this newly created unspecified CF, rather than being associated to the urban CF, which significantly reduces the impact on biodiversity of hydroelectricity for example. The reasoning behind associating them with the urban CF before was that the method upon which these indicators are based considers terrestrial biodiversity and not aquatic biodiversity. The construction of an artificial water body leads to a drastic diminution of the terrestrial biodiversity, similar to that of building urban infrastructure but also to a newly created aquatic biodiversity. The replacement of the terrestrial biodiversity by an aquatic biodiversity cannot be assessed directly with this method. In the 2.0.1 version we decided to use the unspecified land type as a proxy rather than the urban one in order to take this effect into account.

3.3 Precise report of changes

The precise reports of changes (flow by flow), for all software and database for which we provide an IW+ version, can be found here: https://github.com/CIRAIG/IWP_Reborn/tree/master/Report_changes.

Note that those reports depend on the database/software combination as software typically do not cover the same elementary flows and use different names.

Appendix 1 Indicators of the *Expert version*

Table 2: Impact categories, indicators, and indicators' unit of the *Expert version*

| Impact categories | Indicators displayed and units |
|---------------------------------|--|
| Acidification | <ul style="list-style-type: none"> - Marine acidification, long term (in PDF.m².yr) - Marine acidification, short term (in PDF.m².yr) - Freshwater acidification (in PDF.m².yr) - Terrestrial acidification (in PDF.m².yr) |
| Climate change | <ul style="list-style-type: none"> - Climate change, human health, long term (in DALY) - Climate change, human health, short term (in DALY) - Climate change, ecosystem quality, long term (in PDF.m².yr) - Climate change, ecosystem quality, short term (in PDF.m².yr) |
| Ecotoxicity | <ul style="list-style-type: none"> - Freshwater ecotoxicity, long term (in PDF.m².yr) - Freshwater ecotoxicity, short term (in PDF.m².yr) |
| Eutrophication | <ul style="list-style-type: none"> - Freshwater eutrophication (in PDF.m².yr) - Marine eutrophication (in PDF.m².yr) |
| Human toxicity | <ul style="list-style-type: none"> - Human toxicity cancer, long term (in DALY) - Human toxicity cancer, short term (in DALY) - Human toxicity non-cancer, long term (in DALY) - Human toxicity non-cancer, short term (in DALY) |
| Ionizing radiations | <ul style="list-style-type: none"> - Ionizing radiations, human health (in DALY) - Ionizing radiation, ecosystem quality (in PDF.m².yr) |
| Land related issues | <ul style="list-style-type: none"> - Land occupation, biodiversity (in PDF.m².yr) - Land transformation, biodiversity (in PDF.m².yr) |
| Ozone layer depletion | <ul style="list-style-type: none"> - Ozone layer depletion (in PDF.m².yr) |
| Particulate matter formation | <ul style="list-style-type: none"> - Particulate matter formation (in DALY) |
| Photochemical oxidant formation | <ul style="list-style-type: none"> - Photochemical oxidant formation (in DALY) |
| Water related issues | <ul style="list-style-type: none"> - Thermally polluted water (in PDF.m².yr) - Water availability, human health (in DALY) - Water availability, freshwater ecosystem (in PDF.m².yr) - Water availability, terrestrial ecosystem (in PDF.m².yr) |

Appendix 2 Indicators of the *Midpoint version*

Table 3: Impact categories, indicators, and indicators' unit of the *Midpoint version*

| Impact categories | Indicators displayed and units |
|---------------------------------|---|
| Acidification | - Freshwater acidification (in kg SO ₂ eq) - Terrestrial acidification (in SO ₂ eq) |
| Climate change | - Climate change, long term (in kg CO ₂ eq (long)) - Climate change, short term (in kg CO ₂ eq (short)) |
| Ecotoxicity | - Freshwater ecotoxicity (in CTUe) |
| Eutrophication | - Freshwater eutrophication (in kg PO ₄ P-lim eq) - Marine eutrophication (in kg N N-lim eq) |
| Human toxicity | - Human toxicity cancer (in CTUh) - Human toxicity non-cancer (in CTUh) |
| Ionizing radiations | - Ionizing radiations (in Bq C-14 eq) |
| Land related issues | - Land occupation, biodiversity (in m ² arable land eq.yr) - Land transformation, biodiversity (in m ² arable land eq) |
| Ozone layer depletion | - Ozone layer depletion (in kg CFC-11 eq) |
| Particulate matter formation | - Particulate matter formation (in kg PM2.5 eq) |
| Photochemical oxidant formation | - Photochemical oxidant formation (in kg NMVOC eq) |
| Resources | - Fossil and nuclear energy use (in MJ deprived) - Mineral resources use (in kg deprived) |
| Water related issues | - Water scarcity (in m ³ world-eq) |