Memorandum of Understanding (MoU) on the establishment of an AWARE working group

Effective Date: June 1st, 2026
Duration: 10 years, until May 31st, 2036

Annexes:

- **Annex 1: Core Concepts of AWARE**
- **Annex 2: AWARE update approval policy**
- **Annex 3: Classification of AWARE-related CF datasets**

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1. Purpose

This Memorandum of Understanding (MoU) formalizes the establishment of the AWARE working group for the ongoing maintenance, development, and update of the AWARE method, ensuring that updates are transparent, scientifically rigorous, and align with the broader LCA community consensus. It establishes an agreement on the core concepts of the AWARE method, and on essential procedures for managing future requests and efforts for maintaining and updating AWARE.

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2. Background

The AWARE method was initially developed through a collaborative process under WULCA, and its maintenance has since been entrusted to a core group of researchers. This MoU formalizes roles and responsibilities of the researchers historically involved in the development and maintenance of AWARE by establishing the AWARE working group consisting of the AWARE Team and the Extended AWARE Community. AWARE Team and Extended AWARE Community collaborate in maintaining the legacy of the AWARE method.

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3. Definitions

- **AWARE Team**: The core group of researchers responsible for maintaining the AWARE method as defined in Annex 1. The chairs of the AWARE Team are part of the AWARE Team. By signing this MoU in the section “AWARE Team”, the respective signatories become members of the AWARE Team. New members can join the AWARE Team on invitation by the chairs of the AWARE Team.
- **Extended AWARE Community:** Additional stakeholders who provide input and feedback on updates to the AWARE method. By signing this MoU in the section “Extended AWARE Community”, the respective signatories become members of the Extended AWARE

Community. New members can join the Extended AWARE Community on invitation by the AWARE Team.

- **AWARE working group:** All members of the AWARE Team and the Extended AWARE Community.
- **Signatory**: Any person who has signed this MoU, regardless of their current membership status in the AWARE working group.
- **Global (spatial) coverage:** Spatial coverage sufficient for most LCIA applications of the international LCA community
- **Regional recalculation:** A recalculation of AWARE with different, potentially higher-resolution input data and with limited spatial coverage, e.g., covering a single country. Spatial aggregations (averages of existing AWARE CFs to obtain factors in resolutions other than watershed resolution) are not regional recalculations. For an illustration of the differences, see Annex 3.

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4. Roles and Responsibilities

4.1. Main contact and chairs of the AWARE Team (2 persons, currently Anne-Marie Boulay & Montse Núñez)

4.1.1. **Lead the AWARE Team**

4.1.1.1. Receive suggestions for updates and forward them to the AWARE Team

4.1.1.2. Guide the AWARE Team in the update approval process

4.1.1.3. Act as connection between AWARE Team and other stakeholders such as GLAM

4.1.2. **Maintain the communication around the AWARE method.** This includes

4.1.2.1. The maintenance of the WULCA website (currently hosted at CIRAIG)

4.1.2.2. Providing clear guidance for practitioners on how to apply AWARE

4.1.2.3. Communication and documentation of developments around AWARE (e.g., regarding updates, case studies, extensions)

4.1.2.4. Support for AWARE via the website contact form

4.2. AWARE Team

4.2.1. **Conduct AWARE update reviews** according to the procedures outlined in the AWARE update approval policy document (annex 2), ensuring transparency.

4.2.2. **Serve as stewards,** not owners, of the methodology.

4.2.3. **Invite new members** to the Extended AWARE Community. Most important, the AWARE Team should consider inviting authors of approved AWARE updates to the Extended AWARE Community or to suggest them as new members for the AWARE Team. This is

essential for ensuring methodological consistency in subsequent maintenance and updates.

4.3. Extended AWARE Community

4.3.1. **Provide scientific input** and feedback on proposed updates.

4.3.2. **Participate in reviews** of significant updates to the AWARE method when requested by the AWARE Team.

4.3.3. **Attend workshops** or meetings as necessary to discuss updates.

4.3.4. **Offer suggestions** for corrections, improvements, or other AWARE development based on their expertise and experience.

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5. Alignment with the AWARE consensus approach

5.1. No member of the AWARE working group shall publish or contribute to publications of characterization factors with global spatial coverage claiming to be an update of AWARE without following the AWARE update approval policy appended to this MoU (Annex 2).

5.2. If one or several members of the AWARE working group nevertheless publish updates or recalculations with global coverage where they use the name “AWARE method” to describe all or part of their methodology for calculating the characterization factors, they shall explicitly state that

5.2.1. The characterization factors are **not in line with the consensus-based AWARE** update procedures.

5.2.2. The characterization factors **cannot be used** for impact assessment claiming use of a consensus-based AWARE method.

5.3. Regional (i.e., spatially limited) recalculations of Characterization Factors based wholly or partly on AWARE's equations and concept are not part of the consensus on AWARE and therefore not addressed with an update or approval process under this MoU. This is independent of the degree to which the recalculations are aligned with the core concepts of AWARE or with implementation details of the current official version. The AWARE Team will communicate its stance on regional recalculations on the website. The AWARE Team might set up approval or recommendation processes for regional recalculations in the future. As long as no such process is set up:

5.3.1. No member of the AWARE working group shall publish or contribute to publications of regional recalculations claiming to be in line with the AWARE consensus.

5.3.2. If a member of the AWARE working group publishes or contributes to a regional recalculation of AWARE, they ensure that corresponding publications mention that the obtained characterization factors **cannot be used** for impact assessment claiming alignment with the consensus-based AWARE method.

5.4. As stewards of the AWARE method, signatories of this MoU should communicate the essence of paragraphs 5.1 to 5.3 also when acting in an advisory capacity, e.g. peer review activities.

5.5. All signatories commit to upholding the principles in Section 5, regardless of their AWARE working group membership status.

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6. Communication

6.1. Informal reports summarizing updates, community input, and decisions will be provided by the AWARE Team after completed update approval processes.
6.2. The AWARE Team aims to organize annual calls with the Extended AWARE Community.
6.3. Core aspects of this MoU and its annexes will be communicated to the general public via the WULCA website.

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7. Termination and Revisions

This MoU and its annexes may be:

7.1. amended by agreement of 2/3 of the AWARE team and half of the Extended AWARE Community.
7.2. temporally extended or terminated by agreement of 2/3 of the AWARE team and half of the Extended AWARE Community.
7.3. Any member of the AWARE working group who does not agree to an approved amendment of the MoU or its annexes may withdraw from the AWARE working group by providing written notice to the chairs of the AWARE Team.

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8. Binding Effect on Future Members

Any person invited to join the AWARE Team or the Extended AWARE Community in future must, as a condition for their membership, formally acknowledge to be bound as if they were signatories by this MoU and its annexes in their version valid at the time of entering membership.

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9. Signatures

(see following page)

9. Signatures

AWARE Team		Extended AWARE Community
Markus Berger	Amandine Pastor	Lorenzo Benini
Anne-Marie Boulay	Stephan Pfister	Michael Lathuillière
Masaharu Motoshita	Bradley Ridoutt	Alessandro Manzardo
Montse Núñez	Georg Seitfudem	Manuele Margni
Taikan Oki		

Annex 1: Core Concepts of AWARE

This document describes the core concepts of the AWARE method as emerged from the work on AWARE under the auspices of the UNEP-SETAC Life Cycle Initiative. For any update or correction of AWARE, these concepts must be followed. Changes to the concepts mean that the proposed update or correction is not true to the original AWARE consensus. This document also provides aspects to consider when evaluating potential updates.

Core concepts of AWARE – concept of the AMD

C1 AWARE is based on 1/AMD, the inverse of the Availability Minus Demand.

C2 The AMD represents the amount of water hypothetically remaining available in a watershed after human and ecosystem water requirements have been met, divided by the area of the watershed.

C3 The environmental water requirements to be satisfied include at least the aquatic ecosystem's water requirement for habitat quality.

C4 Human water requirements take into account actual water consumption and water infrastructure impacts, such as alteration of flows and increased evaporation by dams.

C5 The amount of water remaining available includes but is not restricted to the renewably available freshwater.

C6 The AMD does not include green water.

Core concepts of AWARE – concept of the CF

C7 The AWARE characterization factor represents a comparison between the individual AMD of a watershed and month and the $AMD_{world\ average}$.

C8 The $AMD_{world\ average}$ represents the AMD that would apply to randomly selected m^3 of the global water consumption inventory (GWCI).[1]

C9 GWCI is taken from a recent year.[2]

C10 Due to its hyperbolic nature, the AWARE characterization factor is restricted to a value range.

C11 The range of the characterization factors is selected so that outliers in characterization factors do not distort LCA results.[3]

C12 The characterization factors are set to the maximum possible value where no available water remains after human and ecosystem demand have been met.

[1] This is not the same as the AMD that would apply to a randomly selected watershed: In a random selection of watersheds, the expected value for the AMD equals the arithmetic average of all AMDs. In contrast, the expected value for the AMD that applies to a randomly selected m^3 of the global water consumption equals a consumption-weighted average of all AMDs.

[2] This implies that the weighting depends on the overall weather of that specific year, since (agricultural) water consumption depends on weather (dry years vs. wet years).

[3] „...both the choice of geographical location (i.e., the water scarcity) and the improvement in water efficiency (i.e., the inventory) [should] play a significant role in the impact score" (Boulay et al., 2019)

Core concepts of AWARE – technical specificities

C13 AWARE's native spatial resolution is defined by watershed boundaries.[4]
C14 Large watersheds can be subdivided into sub-watersheds to improve spatial specificity of the native resolution.
C15 The native resolution determines the spatial units for which AMDs and CFs are calculated.
C16 AWARE's native temporal resolution is monthly.
C17 The characterization factors are provided in the unit m^3 world-equivalent/m^3.

Relevant aspects in evaluating potential updates of AWARE

- Comparability between watersheds should be ensured.
- The use of mathematical transformations[5] in calculating the characterization factor from AMD and $AMD_{world\ average}$ should be avoided.
- The spatiotemporal fate of the water consumption should be covered as well as possible.
- The cutoffs should be set in a way that prevents affecting a large share of global water consumption [6]
- The environmental water requirements should be defined in a way that finds a reasonable balance between aiming for pristine environmental conditions and acknowledging that some changes made in the past are irreversible.
- Reductions in input data quality should be avoided
- The input data should be publicly available
- The documentation of the update shall refer to the original AWARE publication Boulay et al. (2018) and explain how it differs from the original and its updates.
- The methodology of the update should be sufficiently documented to allow others to reproduce the CFs from the publicly available data.

[4] In line with literature on regionalized LCIA (https://doi.org/10.1007/s11367-018-1539-4, https://doi.org/10.1016/j.jclepro.2017.12.192), the "native spatial resolution" is a resolution by which AWARE best represents the key mechanisms shaping water deprivation impacts and preserves their spatial variability. There also is a technical aspect to AWARE's native spatial resolution since the watersheds can be defined on varying grid resolutions (currently 0.5°x0.5°). These grid resolutions are not essential to the AWARE concept but are an implementation aspect of the native resolution that could be changed in progress-based AWARE updates.
[5] E.g., a mathematical transformation could be the transformation of the CF function from a hyperbolic to an S-curve function.
[6] In AWARE2.0, one third of the global water consumption have a CF of 100 m^3 world-eq./m^3, but **less than 3%** would obtain a different CF if the cut-off was set at e.g. 1000 m^3 world-eq./m^3 instead of 100 m^3 world-eq./m^3.

Annex 2: AWARE update approval policy

This document outlines the different kinds of updates possible in the context of AWARE and the process to follow to obtain approval for updates by the AWARE working group. The document concerns AWARE characterization factor (CF) datasets with global spatial coverage (as opposed to regional recalculations).

Definitions

AWARE Team & Extended AWARE Community:
As defined in the Memorandum of Understanding
AWARE core dataset:
native level CFs (watershed resolution, monthly) with global coverage
GLAM:
The Global Guidance for Life Cycle Impact Assessment Indicators and Methods, an initiative under the UNEP Life Cycle Initiative aimed at developing globally harmonized, scientifically robust guidance for LCIA

AWARE updates – Quality assurance, transparency, and peer review process

The AWARE working group intends to publish updated versions of the AWARE core dataset as often as necessary, attempting at the same time to minimize the number of updates. Additions to AWARE that do not change existing and published Characterization Factors (CFs) (e.g., country aggregations, future projections, …) can be done anytime. Updates affecting existing/published CFs should not occur more frequently than every five years, but in case of error corrections, this interval might be shorter. To address these issues, the AWARE working group has adopted an updating procedure that aims to provide an optimal mix of transparency, stability and scientific quality of the model and the characterization factors calculated. This document identifies and illustrates the process for assuring the quality, transparency, and credibility of the AWARE method, its input data, and respective LCIA results.

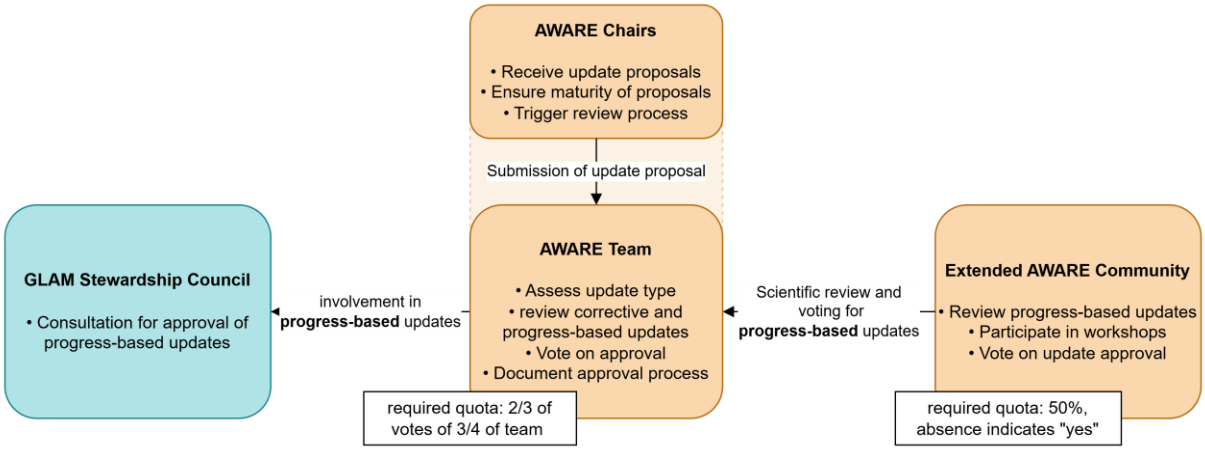

Figure 1 General framework for approving updates

Involvement of GLAM

The final deliverables of the GLAM project are expected to be published in 2026. The Life Cycle Initiative recommends impact characterization methods exclusively via GLAM. To maintain GLAM and potentially update recommendations, a stewardship council is being established in 2026. The workings and structure of this council are not detailed yet. The AWARE Team aims for involvement of the GLAM stewardship council in update processes of AWARE for updates listed in point 2 below (this excludes “corrective updates”).

Funding of update processes

Update proposals can come from within or outside the AWARE working group (AWARE Team & Extended AWARE Community). Since there is no funding provided by the AWARE working group, update projects will require their own funding. This is independent of whether the update will become an official AWARE update or not. There is no prospect of dedicated funding for the operations of the AWARE working group. The work related to the AWARE update approval process is therefore performed on a pro bono basis.

Update procedure:

The AWARE Team distinguishes two kinds of model updates, each with its own updating protocol. Mere ideas for updates are not fit for approval; the resulting CFs and their documentation have to be provided to start an update process. Before an update approval process is started, it should be verified that the proposed update is mature enough to be reviewed. Nonetheless, ideas for updates should be shared with the AWARE Team early on to judge the likelihood of them being approved and to avoid unnecessary or redundant work. Consequentially, the AWARE team should be contacted in two stages of the development of new CFs:

i. When conceptualizing the idea for the new CFs, to obtain informal feedback about the likelihood of them being approved as an update.

ii. When preliminary results and documentation are available and sufficiently mature to enter the approval process.

New CF datasets published and claiming to be or implying to be an AWARE update without having been approved according to this approval policy will only be able to enter the approval process "after the fact" under exceptional circumstances.

1. Corrective updates (of models and data):

Corrections affecting existing CFs that are found to be potentially erroneous, e.g. corrections to AWARE CF calculation procedures (which are not affecting the core principles of AWARE outlined in annex 1), or correction of erroneous input data and parameters. Suggestions for corrections may arise from work with the CFs but also with the intermediate data and the input data of AWARE. They may as well arise from published bug fixes in the input data. The suggestions for corrections may find their way to the AWARE Team directly (person-to-person), via the WULCA website or via other channels that may be created in the future. **Generally, proposals for correction will be discussed, decided on, carried out and published by the AWARE Team without consultation of the Extended AWARE Community.** Corrective updates should only be implemented if **more than 50%** of the AWARE Team agree to it. The AWARE Team aims to group corrections in collective updates to reduce the number of publication iterations (maximum 1 per year). If the impact of an individual correction on the CFs is substantial, the corrections should be made as soon as possible.

2. Updates based on conceptual, scientific and technical progress (progress-based updates):

a. input data focused updates: Updates of the AWARE input data, affecting existing characterization factors in native resolution, e.g. alternative (improved) river discharge or water consumption data. Such updates affecting the existing AWARE core dataset but changing nothing except the input data will be approved only if the input data quality is **measurably improved.** If improving the CF quality, input data updates can also be approved for data fitting the **purpose of AWARE** better by design[1].

b. AWARE input variable definitions, equations, and resolution: Updates affecting the existing CFs by changing the **way AWARE is calculated**, e.g. alternative (improved) calculations for the EWR; additional fate mechanisms (water transfer, reservoirs); adjusting the technical implementation of the native spatial resolution (e.g., watershed delineation or grid resolution) of AWARE[2]; distinguishing groundwater from surface water consumption. The interval between the publication of these updates should at least equal 5 years.

[1] E.g., in inland sinks without river discharge leaving the terminal grid cell, the definition of "Availability-HWC" is not easily implementable. If data is available **better** representing this edge case than the data already used, it could be considered as an update.

[2] In original AWARE, the native spatial resolution is "watershed, defined by 0.5°x0.5° grid cells". A new spatial resolution could be "watershed, defined by 5'x5' grid cells" or other resolutions. However, since this update policy only concerns the AWARE dataset with global coverage, spatially limited regional recalculations with finer resolution (e.g. for the watersheds of a single country) do not fall under this update approval policy. A

c. Peripheral updates: Updates extending the conceptual scope of AWARE or replacing information that is not part of the AWARE core dataset. Possible examples: Adding spatiotemporal aggregations, adding or changing uncertainty information. These updates are not covered by this update policy. They can be made anytime. However, their compliance with existing AWARE-related datasets should be ensured[3] (no new "parallel" CFs) and they cannot claim to be part of the AWARE consensus.

Documented suggestions for progress-based updating, made by any party, will be considered by the AWARE Team. If the suggestion is considered a potential candidate for an update, the AWARE Team will consult with GLAM. The decision tree for these consultations and the subsequent processes is detailed in Figure 2.

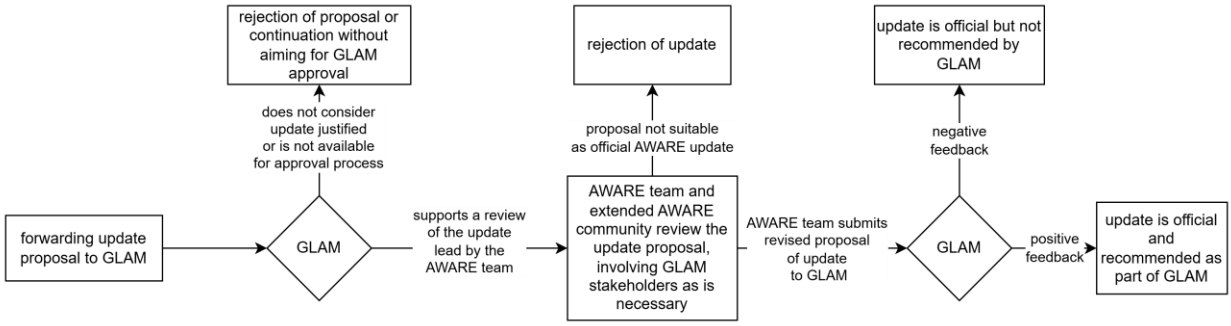

Figure 2 Decision tree for involvement of GLAM in update process of progress-based updates

During the review, the AWARE Team and the Extended AWARE Community review the update proposal and decide about the implementation of the update. The review of the proposed update will be carried out with respect to the following criteria, aligned with the core concepts of AWARE:

- Scientific quality/viability (Is the method/data published in peer-reviewed literature?)
- Level of parsimony (What is the added complexity and is it justified?)
- Thoroughness of the evaluation regarding the update's effects on the CFs and LCIA
- Level of transparency (documentation)
- Level of scientific acceptance/consensus in the community (Is the method/data already used in published methods?)
- Feasibility/influence in application (Do the changes maintain the applicability of AWARE in LCA practice?)
- Meaningfulness/added value (Is this meaningful to consider in practice? What is the improvement from a practical point of view? Does it entail an additional effort and is it worth it?)

global CF dataset replacing existing AWARE CFs of selected regions with regional recalculations and then claiming to be an updated version of the AWARE core dataset would however need undergo the update approval process.

[3] E.g., an overabundance of national level CFs for the country of France (with overseas territories, without overseas territories, with updated irrigation water consumption weights…) should be avoided.

The review can also take on the format of a workshop, organized by the AWARE Team. The AWARE Team will consider the recommendations made by the Extended AWARE Community, forward this feedback to the update developers and organize a voting on the approval of the final version of the update.

To approve an update, a vote needs to be held. Progress-based updates should be approved as official AWARE updates when 2/3 of the AWARE Team vote "yes" to the update. Members of the AWARE Team who do not participate in the voting are not considered when calculating the agreement rate for the AWARE Team. However, if less than 3/4 of the AWARE Team participate in the voting, approval of the update cannot be achieved[4]. In addition to the AWARE Team, the Extended AWARE Community holds a vote – but without a minimum participation threshold. 50% of the Extended AWARE Community need to vote "yes" for an update to be approved. The agreement rate for the Extended AWARE Community is calculated by assuming that non-participating members agree to the update[5].

If the process leads to the rejection of an update proposal, the reasoning shall be published (e.g. on the AWARE website). In all cases, the AWARE Team shall document the entire updating process, from update suggestions, acceptance/rejection decisions, review reports, decisions on implementation, implementation actions, to eventually updated model and its input and output data, making relevant documents publicly accessible.

Naming of AWARE updates:

AWARE versions have version numbers with two numbers separated by a period (e.g., 1.3). The first number is reserved for progress-based updates. The second number is reserved for corrective updates and is reset to zero after a progress-based update. If, for example, the current AWARE version were 1.7, a corrective update would lead to version 1.8, while a progress-based update would lead to version 2.0.

Replicability of AWARE:

Files and potential program code required to replicate AWARE updates need to be made accessible to the AWARE team with the updated CFs. This is important to ensure that the AWARE team can implement corrections of the CFs as required after the publication of the update. The documentation of AWARE CFs should allow a reproduction of the results.

Additional remarks:

Uncertainty sources of AWARE should be transparently communicated. Uncertainty assessment of the CFs is important. To maintain the transparency of the method and allow detailed uncertainty assessment, the input data used for the AWARE core dataset must be publicly available.

[4] This ensures that approved updates have the support of at least 50% of the AWARE Team members while being flexible enough to withstand situations where a team member cannot participate in the vote.
[5] This keeps effort for the Extended AWARE Community low but still allows the community members to block an update if there is sufficient support for preventing it.

Annex 3: Classification tree for AWARE-related CF datasets