February 18th, 2025

IMPACT World+ Webinar

Elliot Muller, Cécile Bulle

IMPACT World+

CIRAIG

DTU

Outline

Presentation (40 min)

- What is IMPACT World+?
- Strengths, specificities and novelties
- Overview of the indicators and possibilities for interpreting LCA results
- How to use IMPACT World+?

Discussion (20 min)

What is IMPACT World+?

Introduction

IMPACT World+

A globally regionalized method for life cycle impact assessment (LCIA)

Why IMPACT World+ has been created ?

- Joint effort to update IMPACT 2002+, EDIP and LUCAS Life Cycle Impact Assessment (LCIA) methods
- Integrating the most recent research in LCIA from CIRAIG, DTU and University of Michigan teams in a consistent way
- In the context of an emerging need to regionalize consistently at the global scale

Team

Board

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CIRAIG, Canada

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Lisa Duval
CIRAIG, Canada

IMPACT World+

Methodological framework

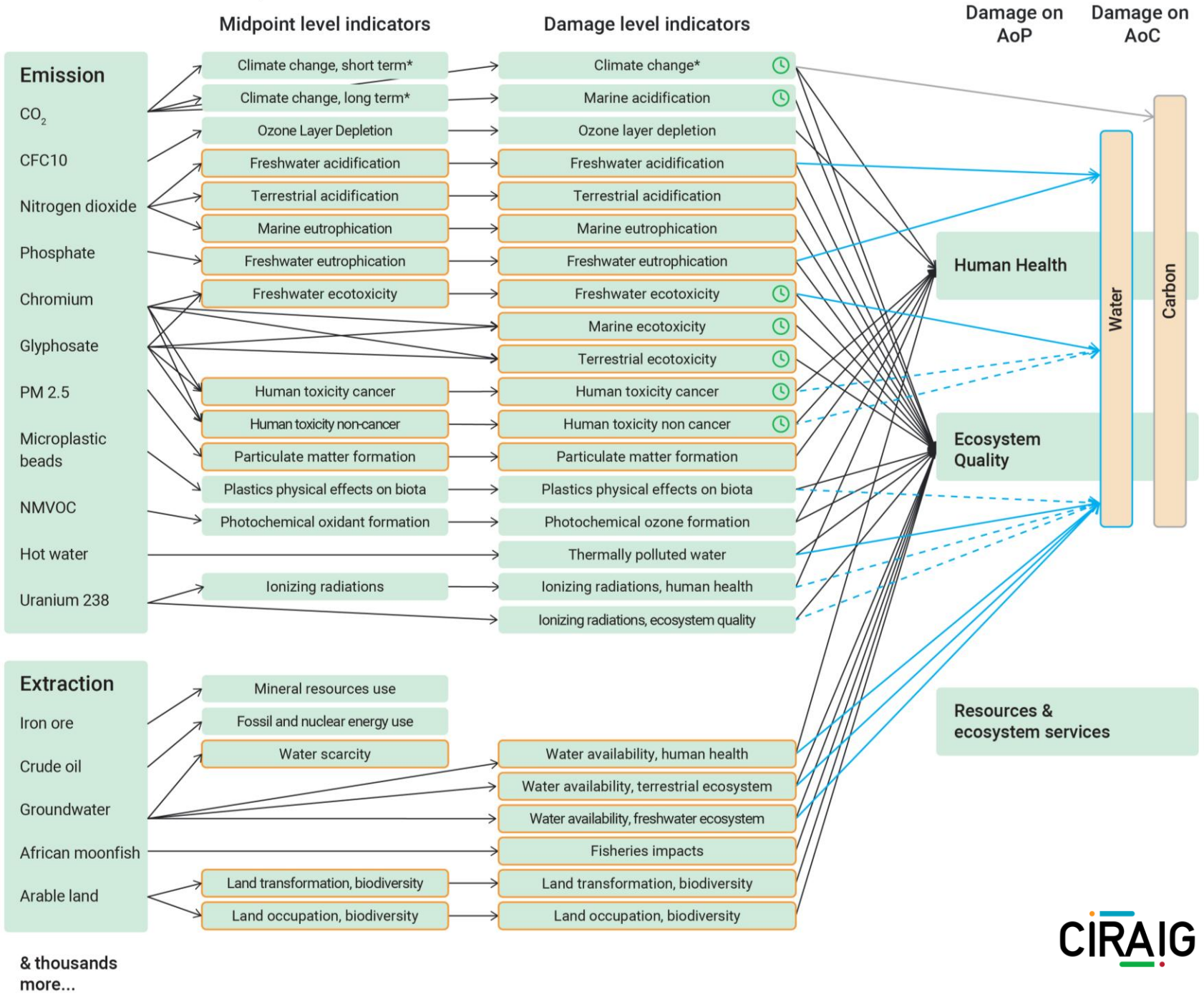
LEGEND

Temporally resolved indicators are identified by a small clock

Regionalized indicators are underlined in an orange box

Plain blue and grey arrows are linking the endpoint indicators to the area of concern to which they contribute (blue for water, grey for carbon)

Dotted blue arrows are used when only a fraction of the impact contributes to the damage on the water area of concern



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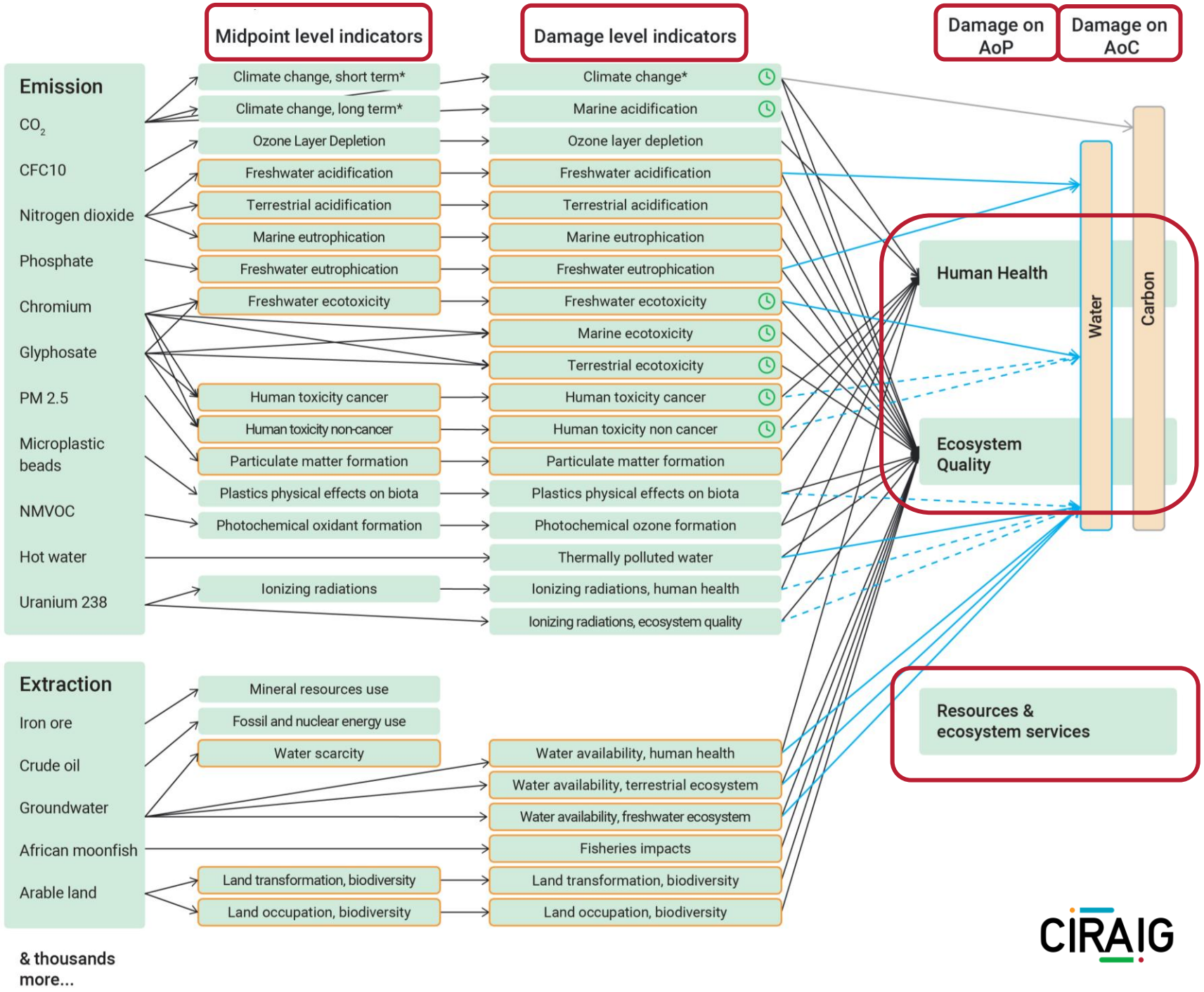
IMPACT World+

Methodological framework

- Two levels of interpretation: **Midpoint** (Problem) and **Damage**
- Damage indicators can be aggregated into **2 Areas of Protection** (Human Health and Ecosystem Quality)
- A **third Area of Protection** (Resources and ecosystem services) has been theorized but not operationalized yet
- Another level of interpretation (Damage on **Areas of Concern**) has also been theorized and partially operationalized in a specific version



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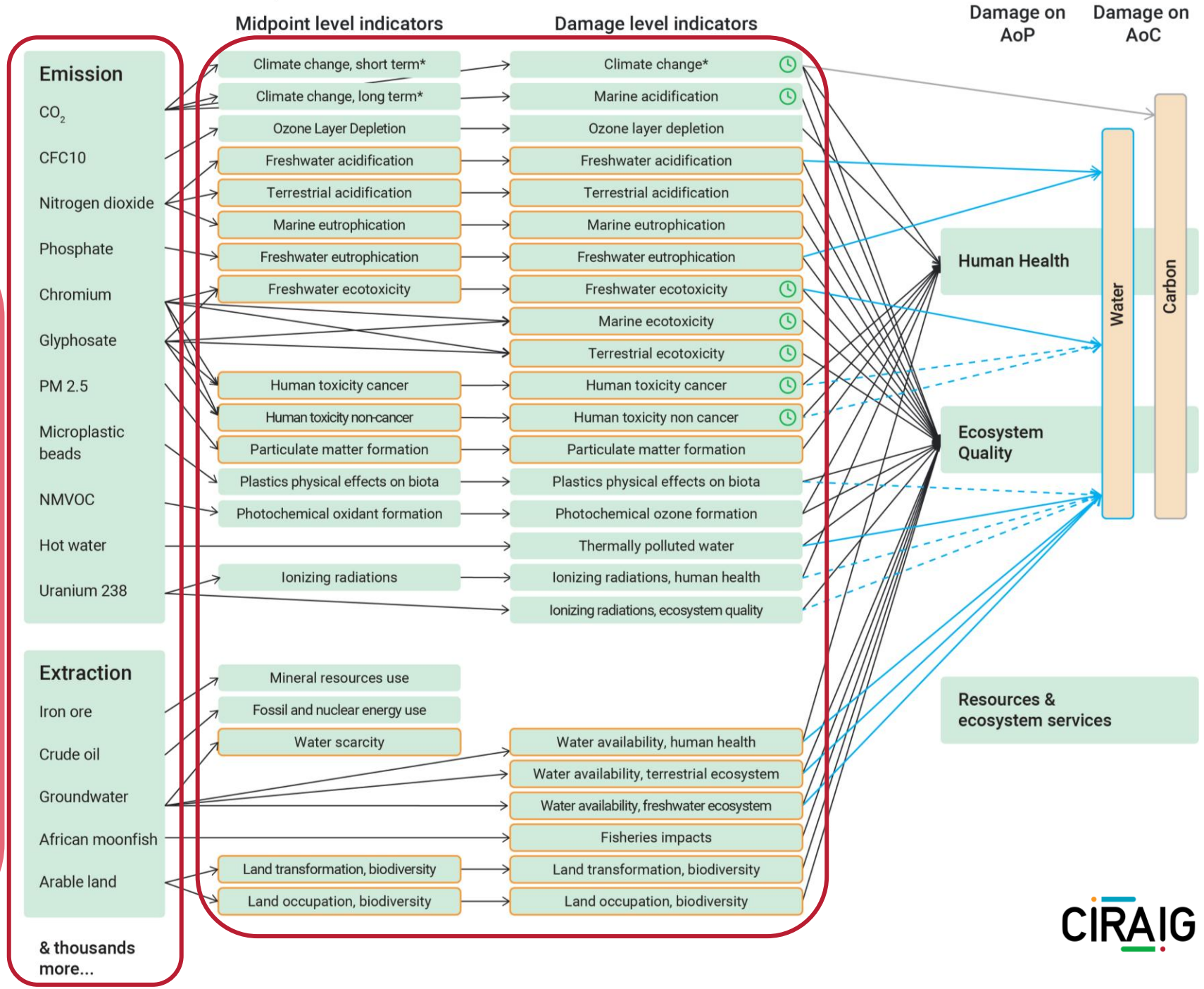
IMPACT World+

Methodological framework

- More than **3 400 elementary flows** covered (without accounting for emission compartment, spatialization or other contextualization)
- **72 impact indicators** (24 midpoint, 46 damage, 2 AoP) covering **15 environmental issues**.



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IMPACT World+

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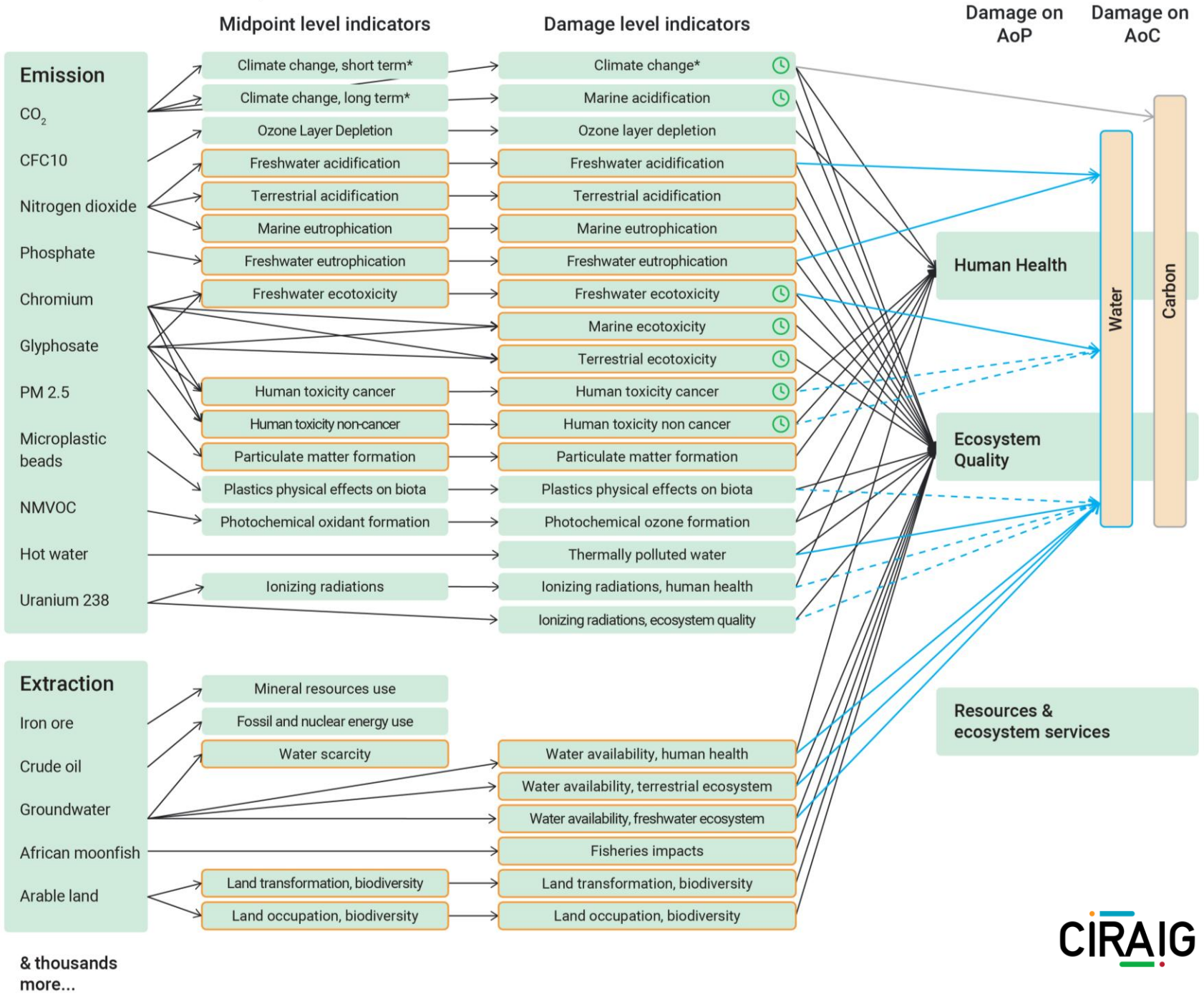

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Strengths, specificities and novelties

And why is it all you need?

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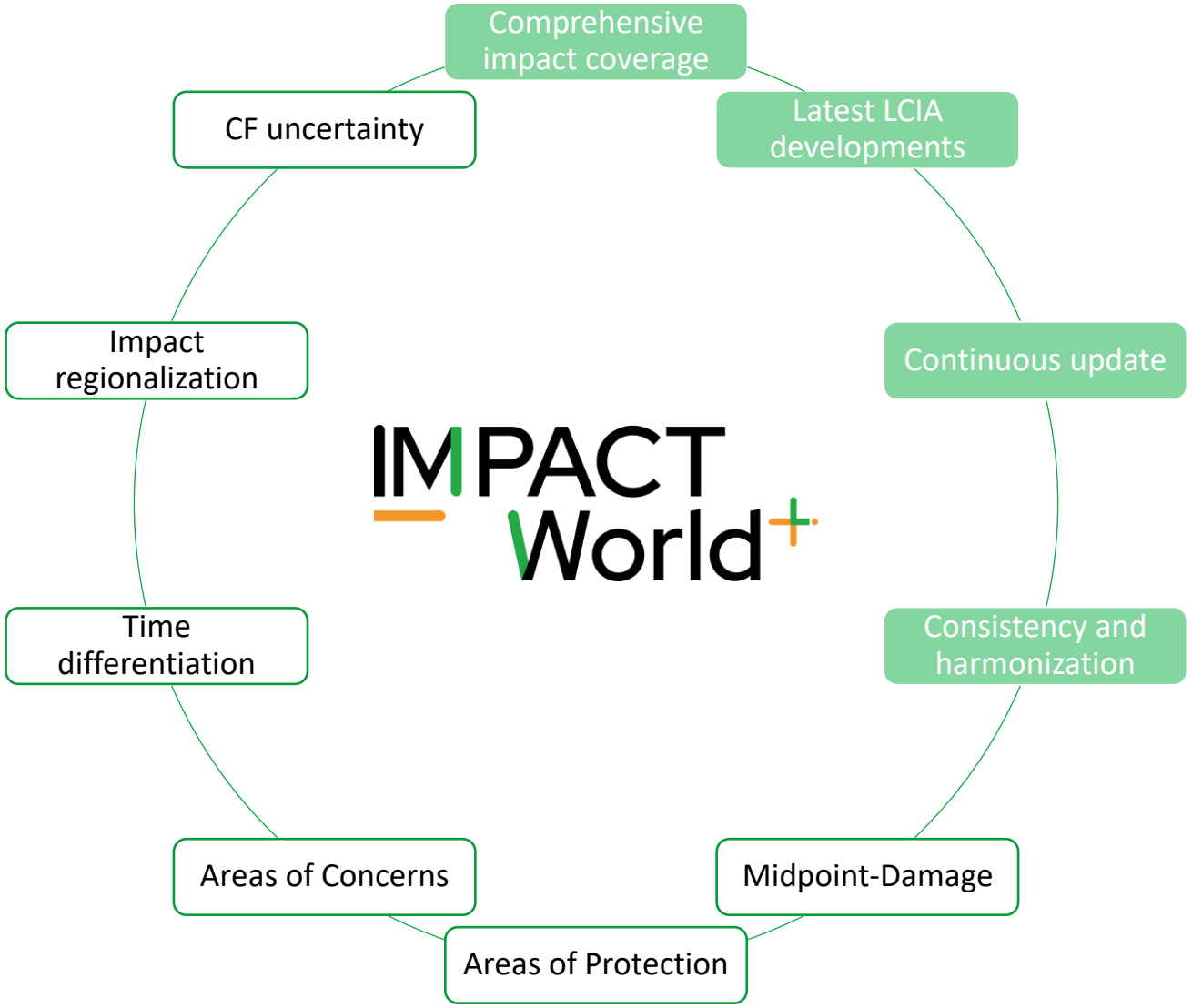
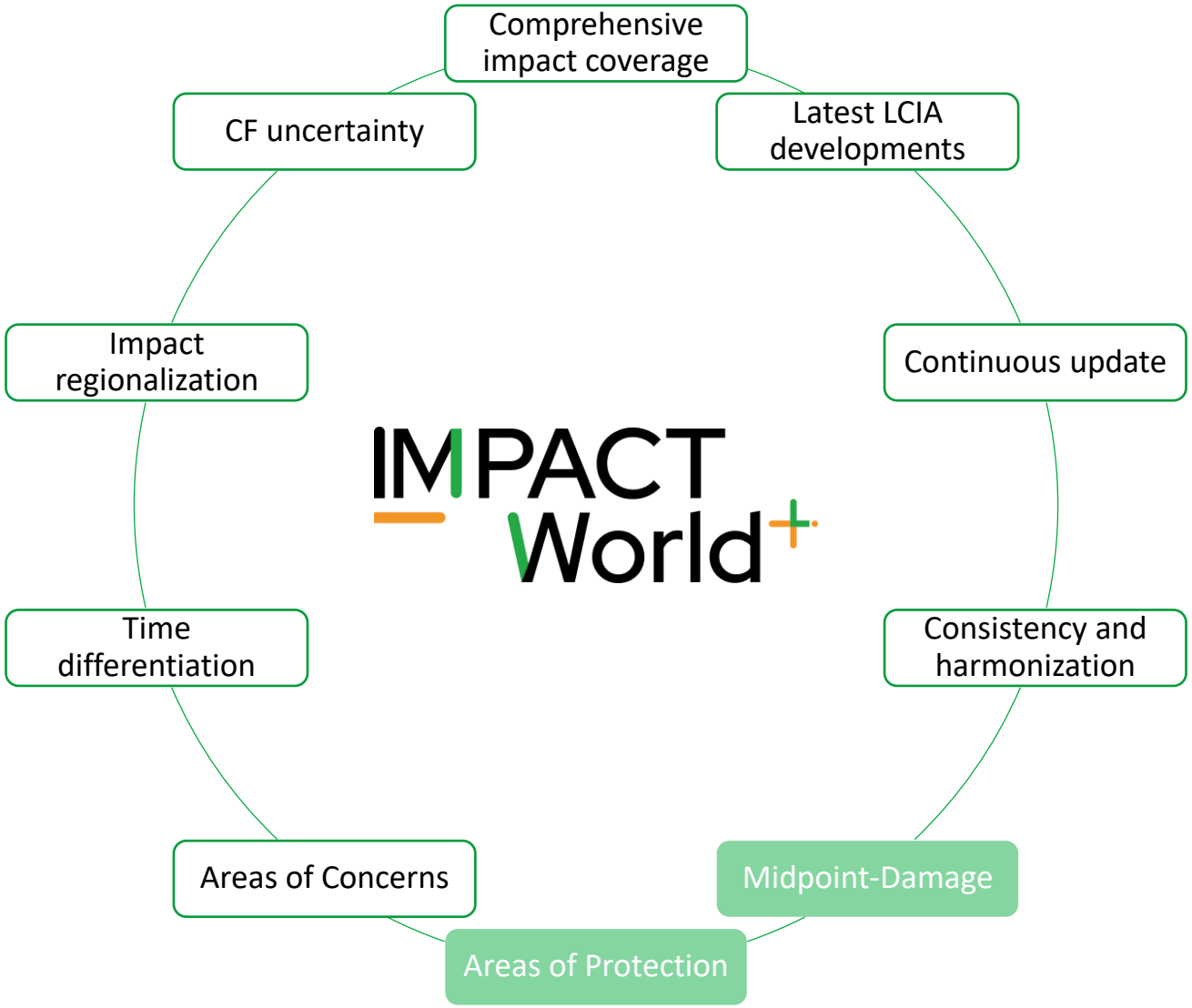
The main features of IMPACT World+



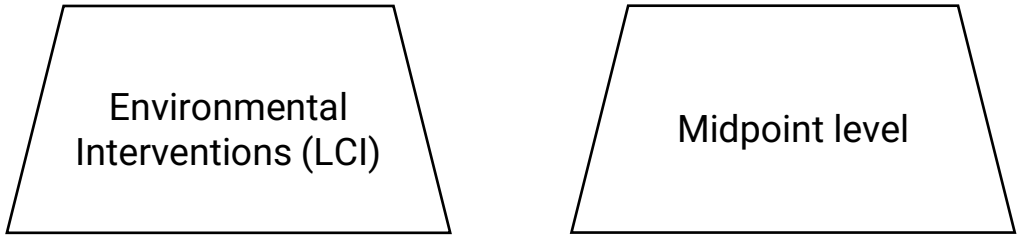
The set of impact indicators have been carefully selected and integrated in IW+

- One of the most **comprehensive coverage** of environmental issues
  - **15 environmental issues**, **72 impact indicators**
  - To **avoid impact transfer** from one impact category to another while conducting an LCA
- Impact methods selected from **latest developments** in the LCIA
  - Reflect most of the consensus reached in GLAM – Life Cycle Initiative
  - But also some of the most recent results available
- **Continuous update** of IW+ to
  - Use **up-to-date impact assessment methods** (IPCC, AWARE, particulate matter…)
  - Integrate **newly characterized environmental issue** (Fisheries impacts, Plastics physical effects on biota)
  - **Correct potential issues** detected by the community
- **Consistency and harmonization** across impact categories
  - **Coherent assumptions** in LCIA models and during implementation
  - **Meaning of units** (e.g. PDF.m^2.yr)

The main features of IMPACT World+



Characterization factors can be defined at midpoint or damage level



Elementary flows

- Climate change
- Stratospheric ozone depletion
- Particulate matter formation
- Photochemical ozone formation
- Ionizing radiation
- Human toxicity
- Ecotoxicity
- Acidification
- Eutrophication
- Land use
- Water use
- Resource use
- Seabed use
- Noise
- …

- Midpoint: indicator anywhere along the environmental mechanism before damage

LCIA conceptual framework from Verones et al. 2017 adapted for IW+ AoPs

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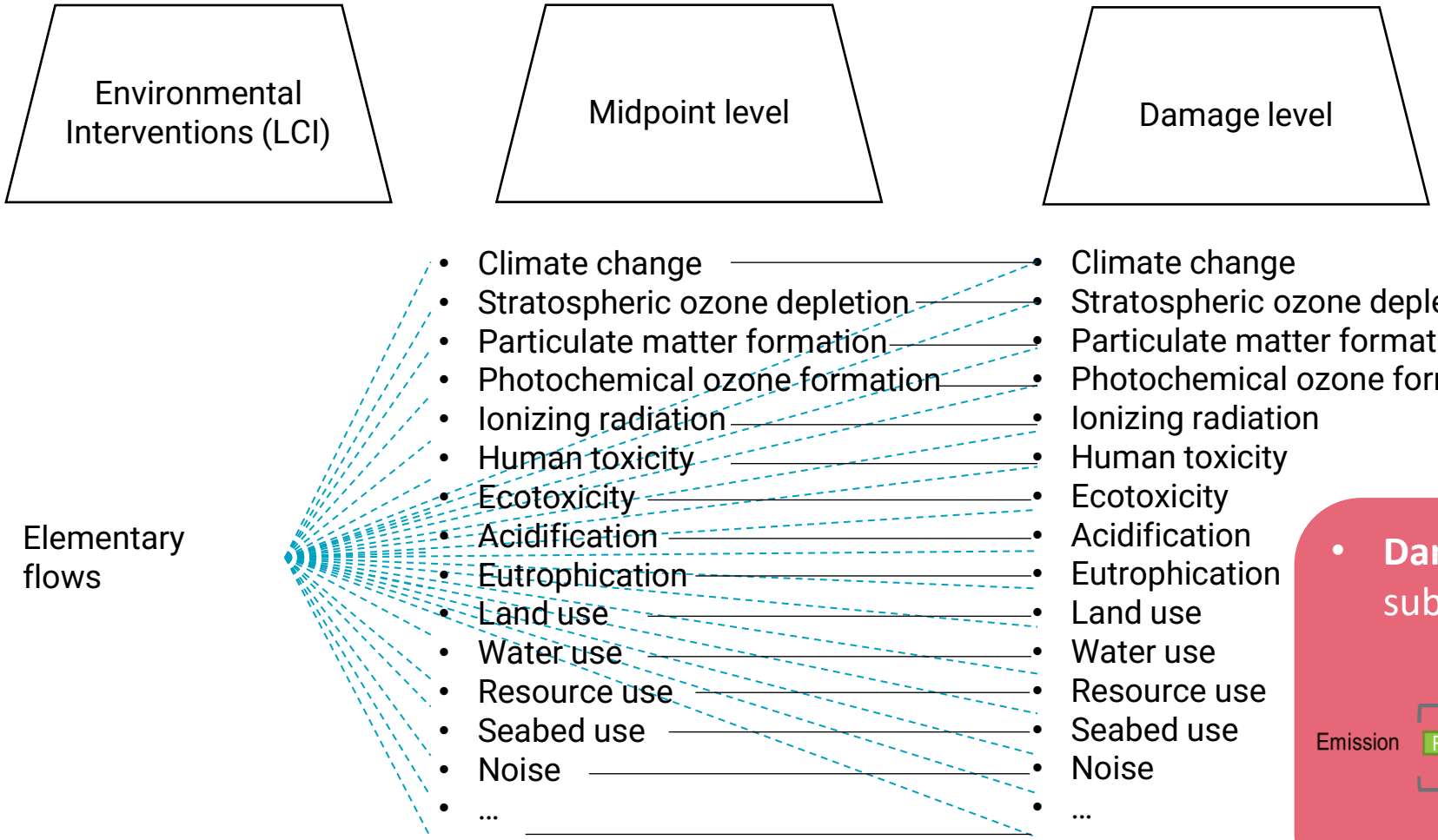
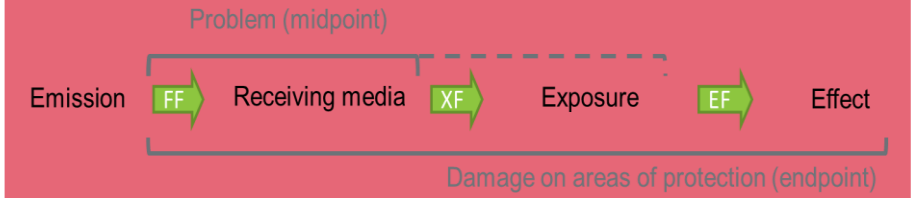


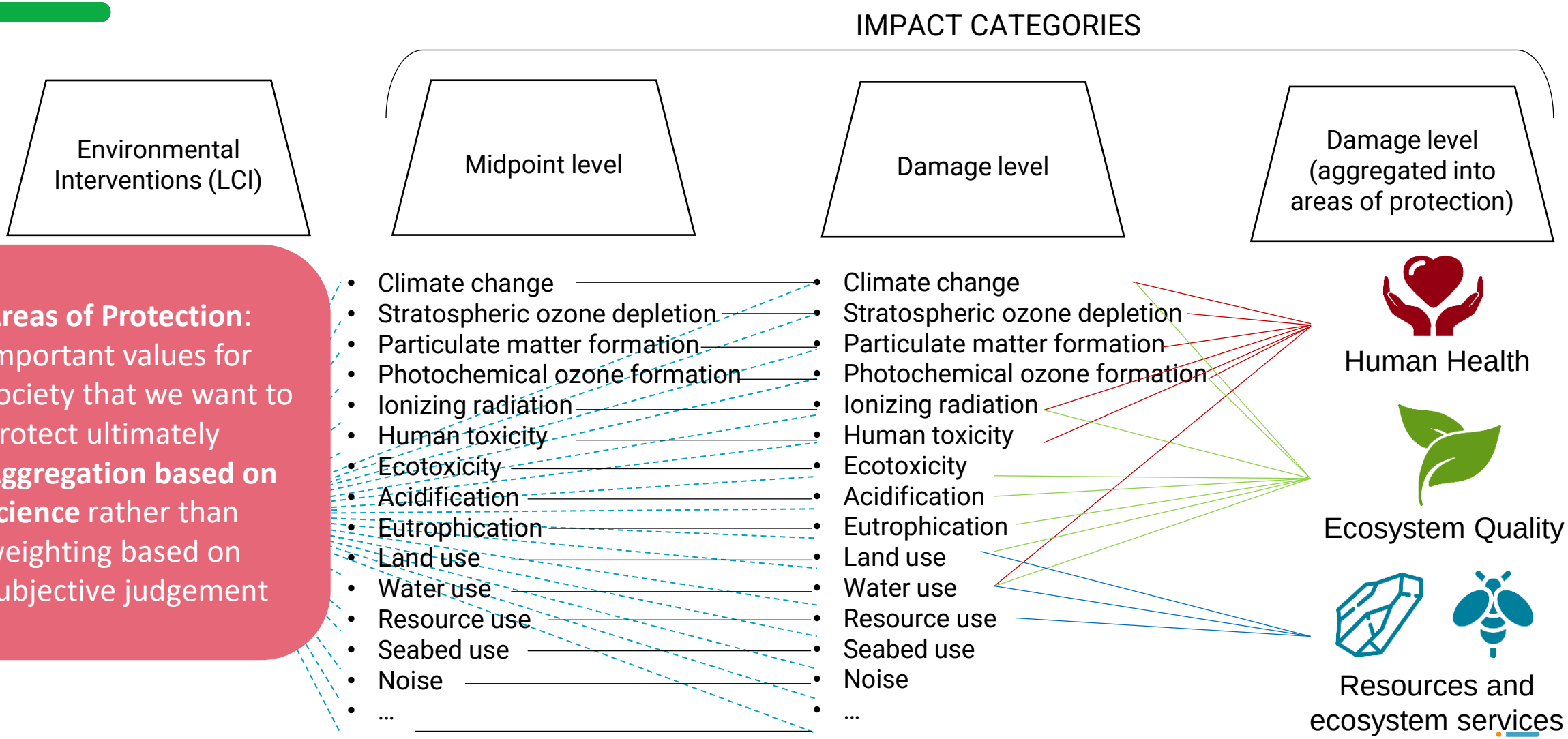
- **Damage**: indicator of the effect of the substance on the environmental issue



LCIA conceptual framework from Verones et al. 2017 adapted for IW+ AoPs

Impact categories at damage level can be aggregated into Areas of Protection

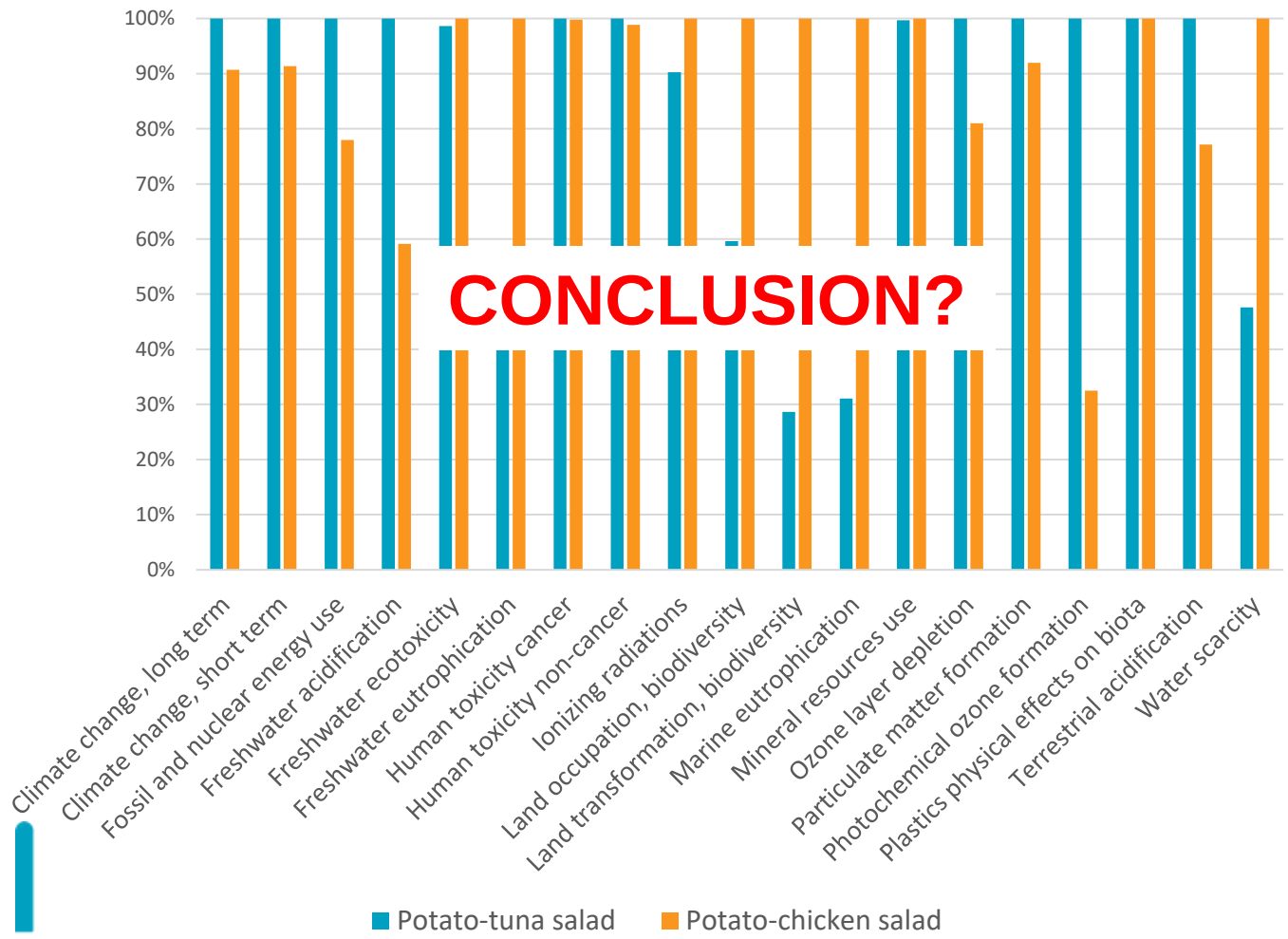
- **Areas of Protection**: important values for society that we want to protect ultimately
- **Aggregation based on science** rather than weighting based on subjective judgement



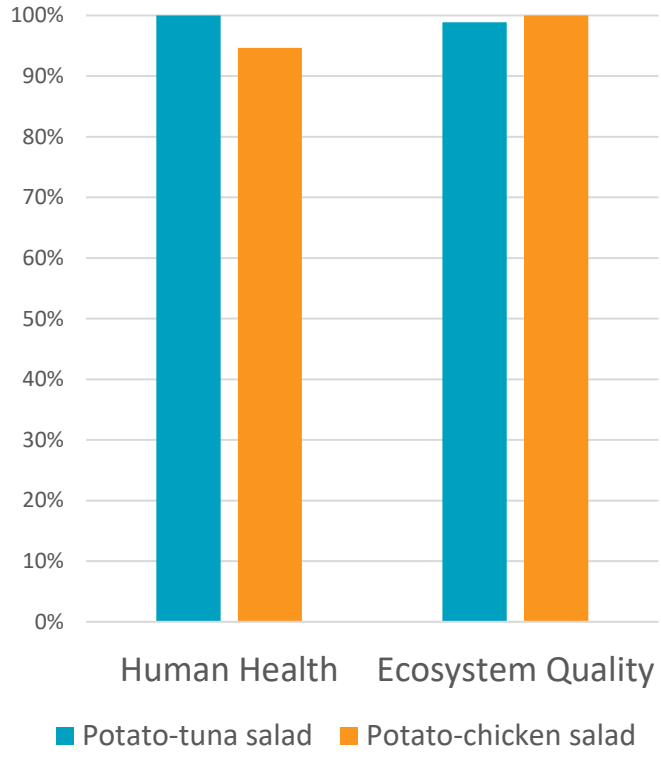
LCIA conceptual framework from Verones et al. 2017 adapted for IW+ AoPs

The power of a midpoint-damage framework to enhance interpretation

Midpoint level



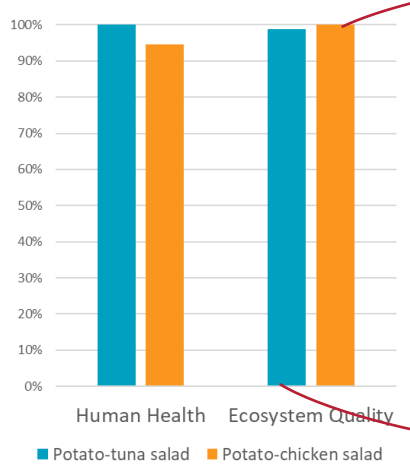
Damage level (aggregated into AoP)



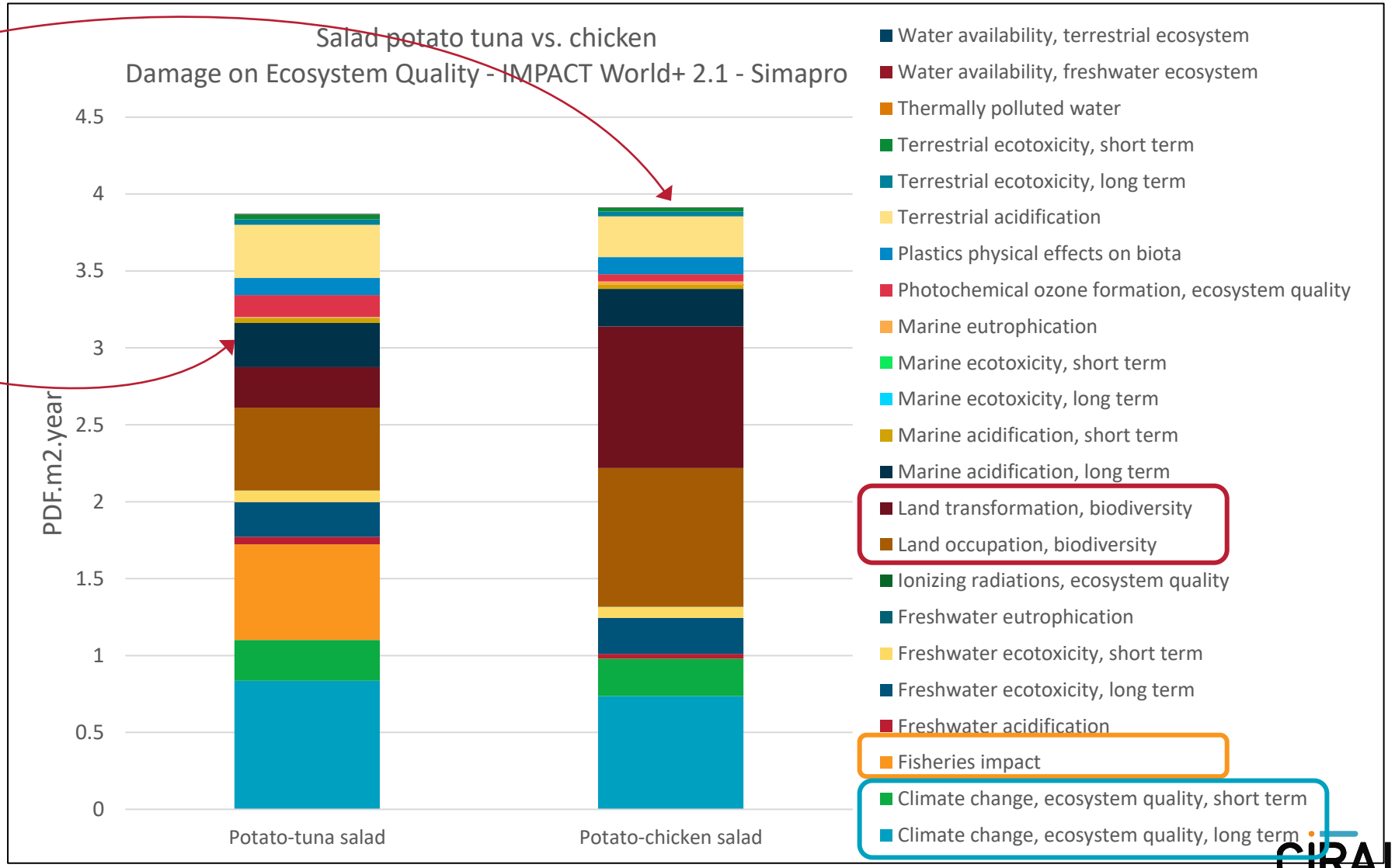
Facilitate decision making by reducing the number of criteria

IMPACTWorld+ v2.1; UF: 1kg of salad

The power of a midpoint-damage framework to enhance interpretation



Identify environmental issues which are the most harmful to the environment



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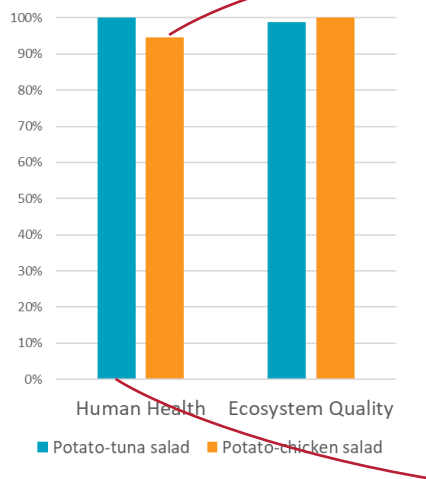

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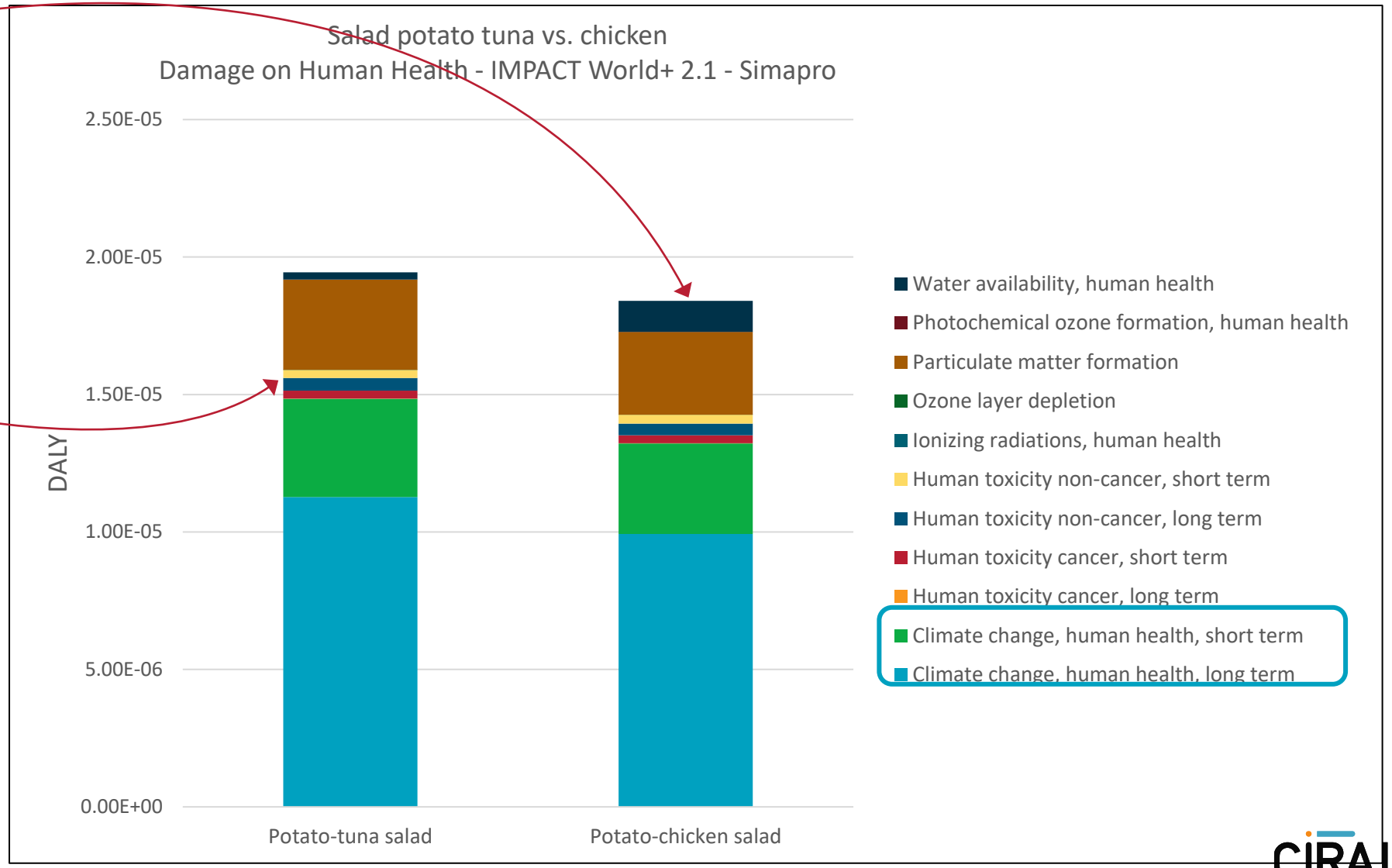

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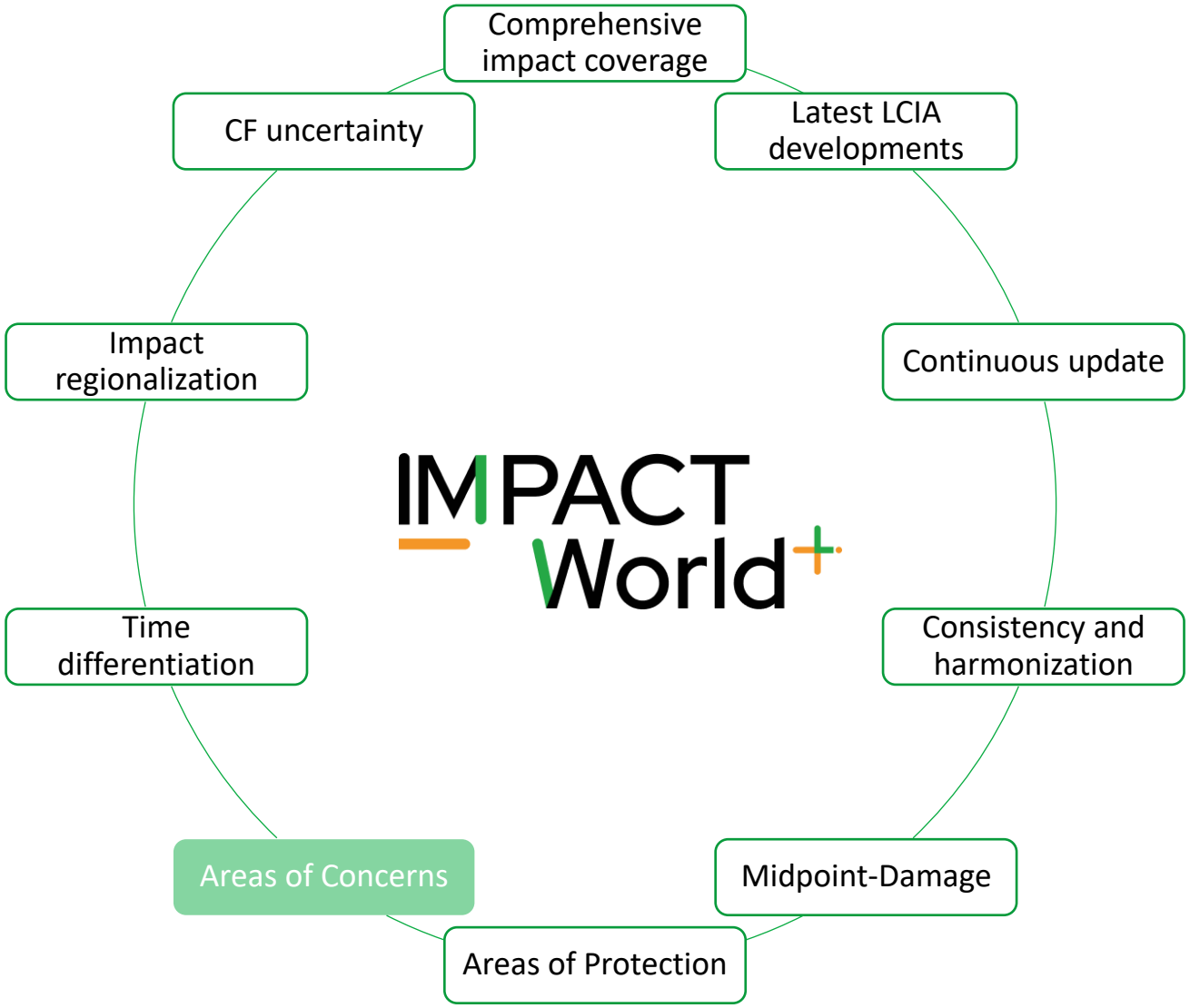
The main features of IMPACT World+



IMPACT World+

MIDPOINT - EXPERT

V2.1 – METHODOLOGICAL FRAMEWORK

LEGEND

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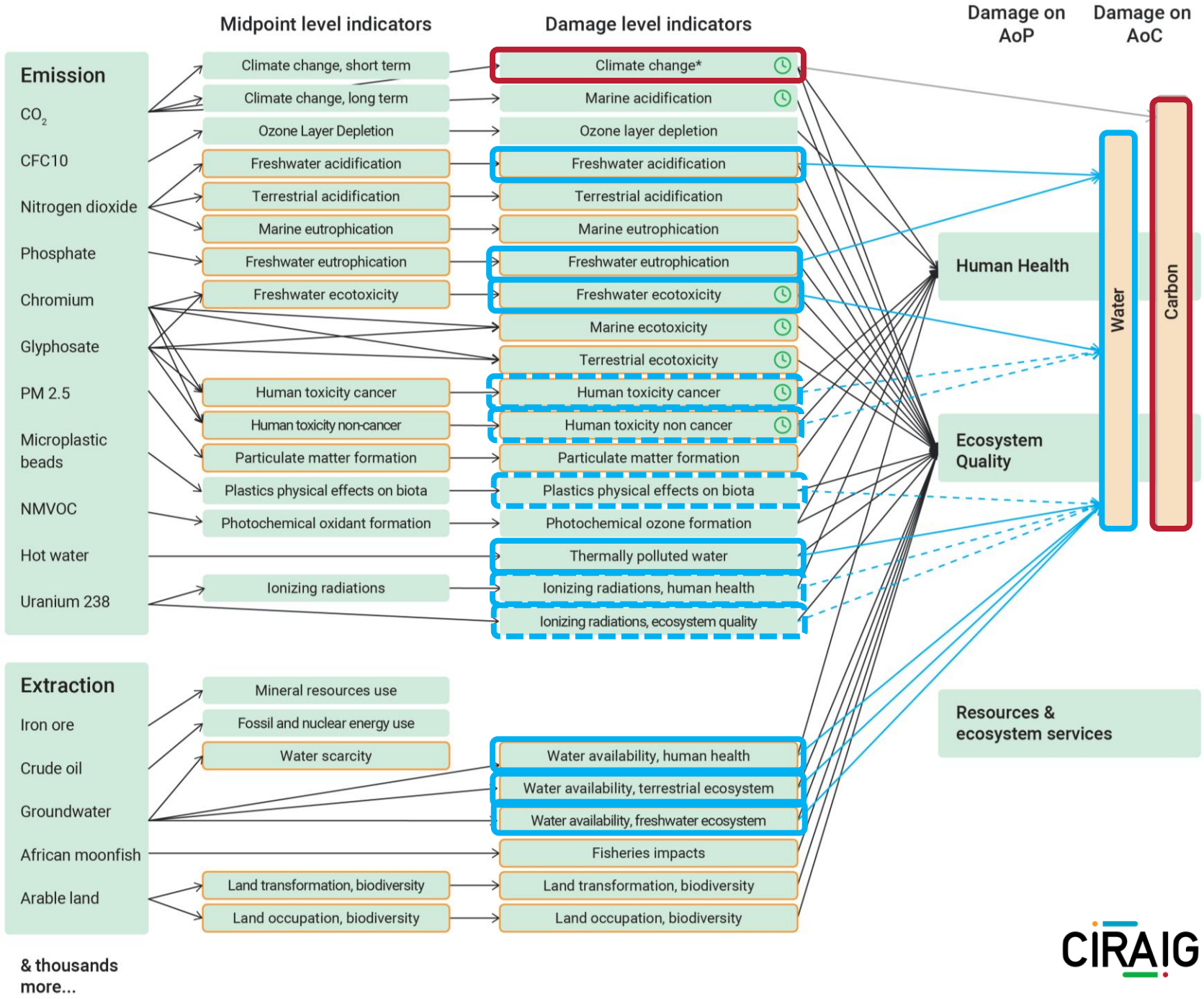

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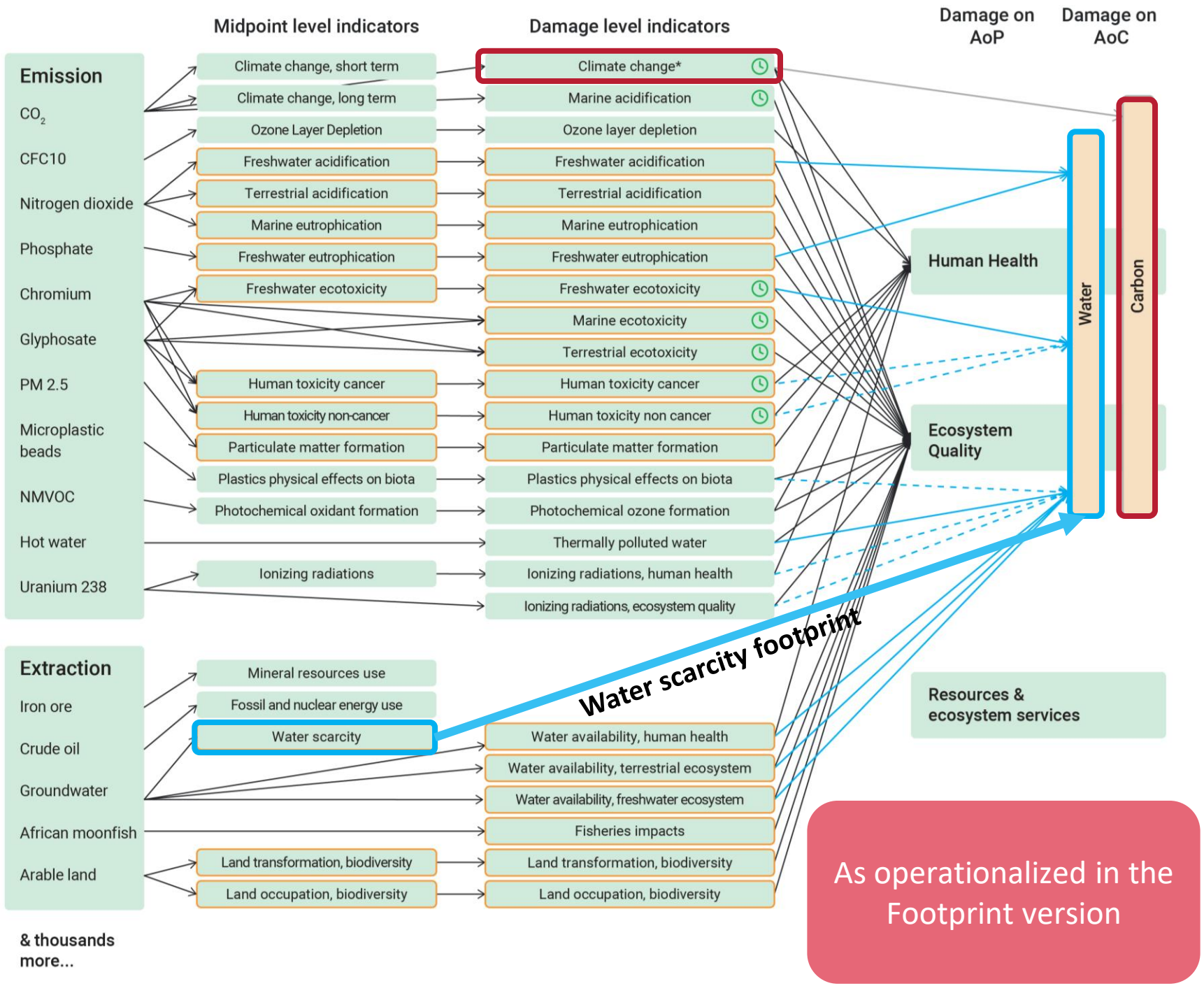
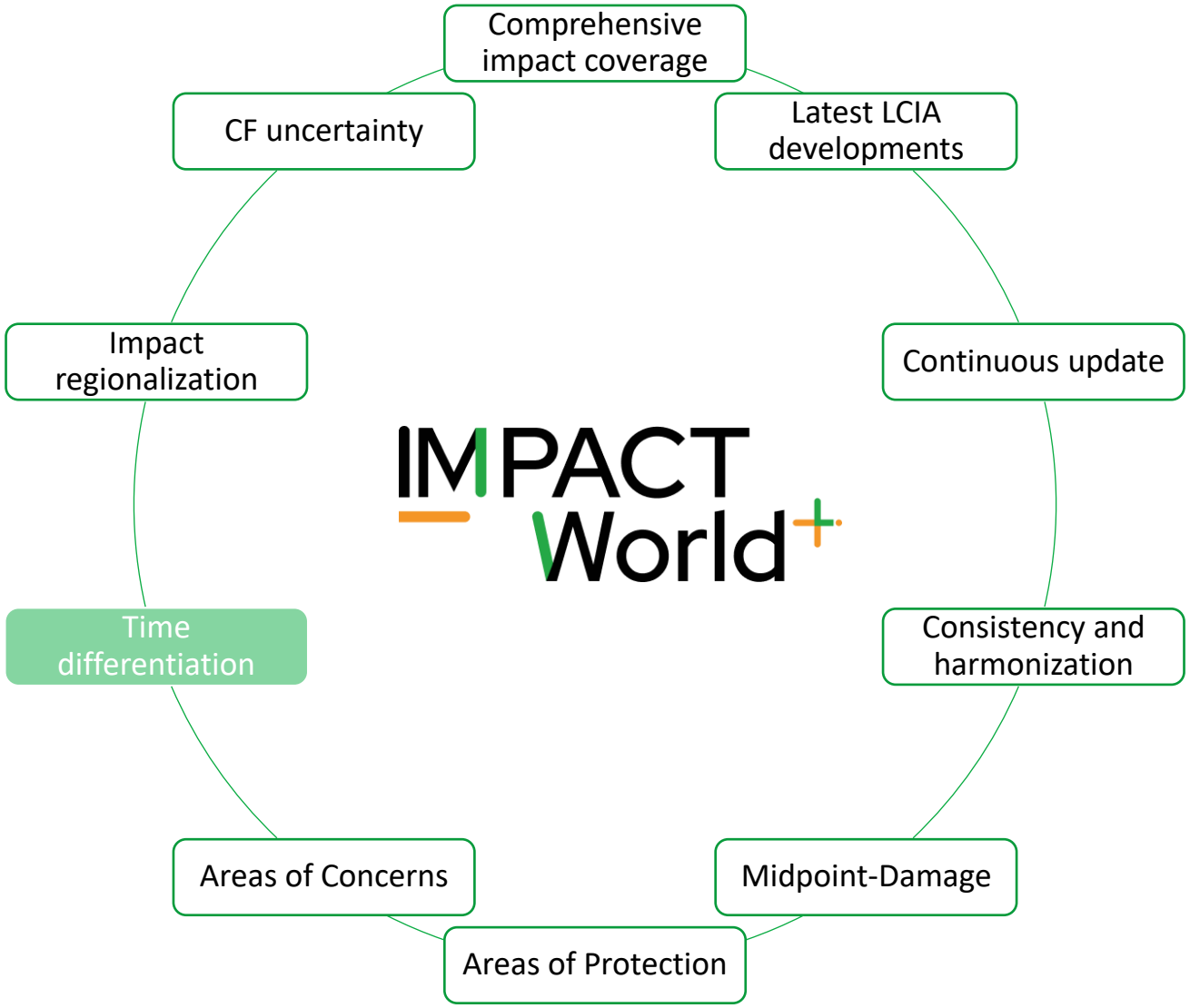


As operationalized in the Footprint version

The main features of IMPACT World+



Time-differentiation of CFs to enhance decision making

Shorter term:
Impacts on present generations

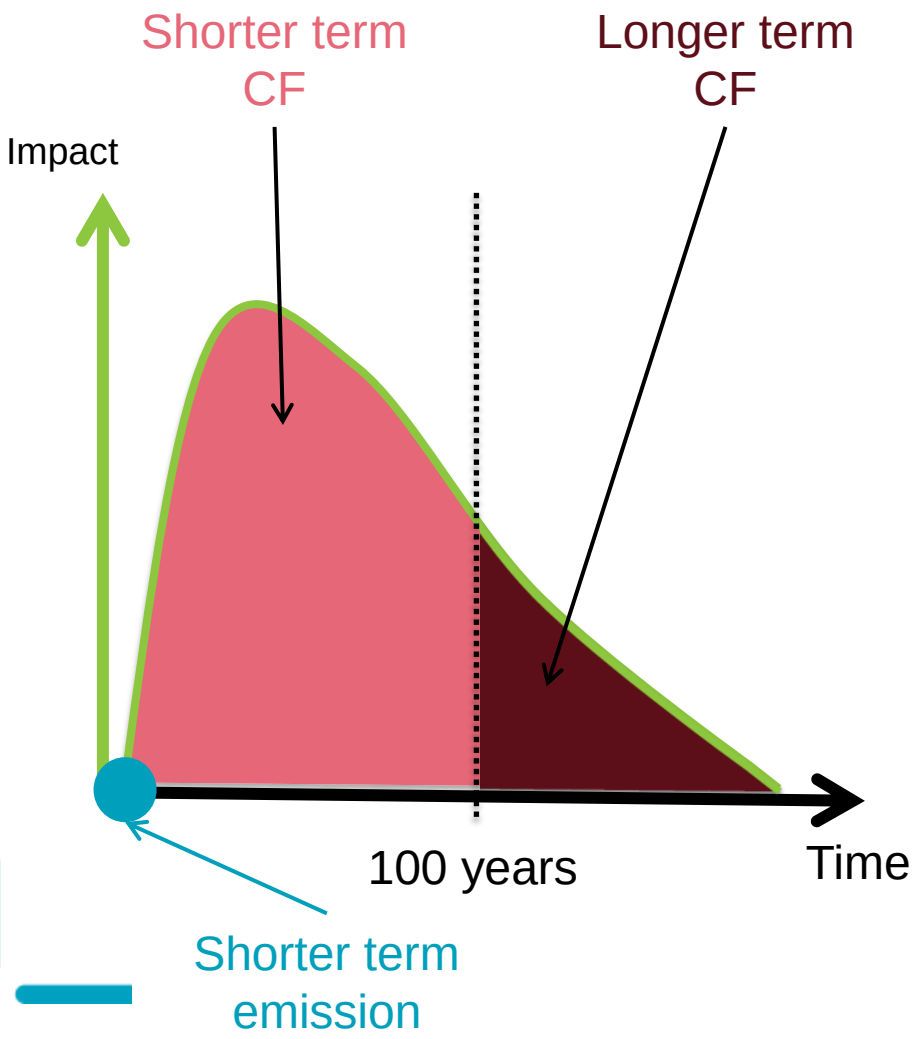
Longer term:
Impacts on future generations

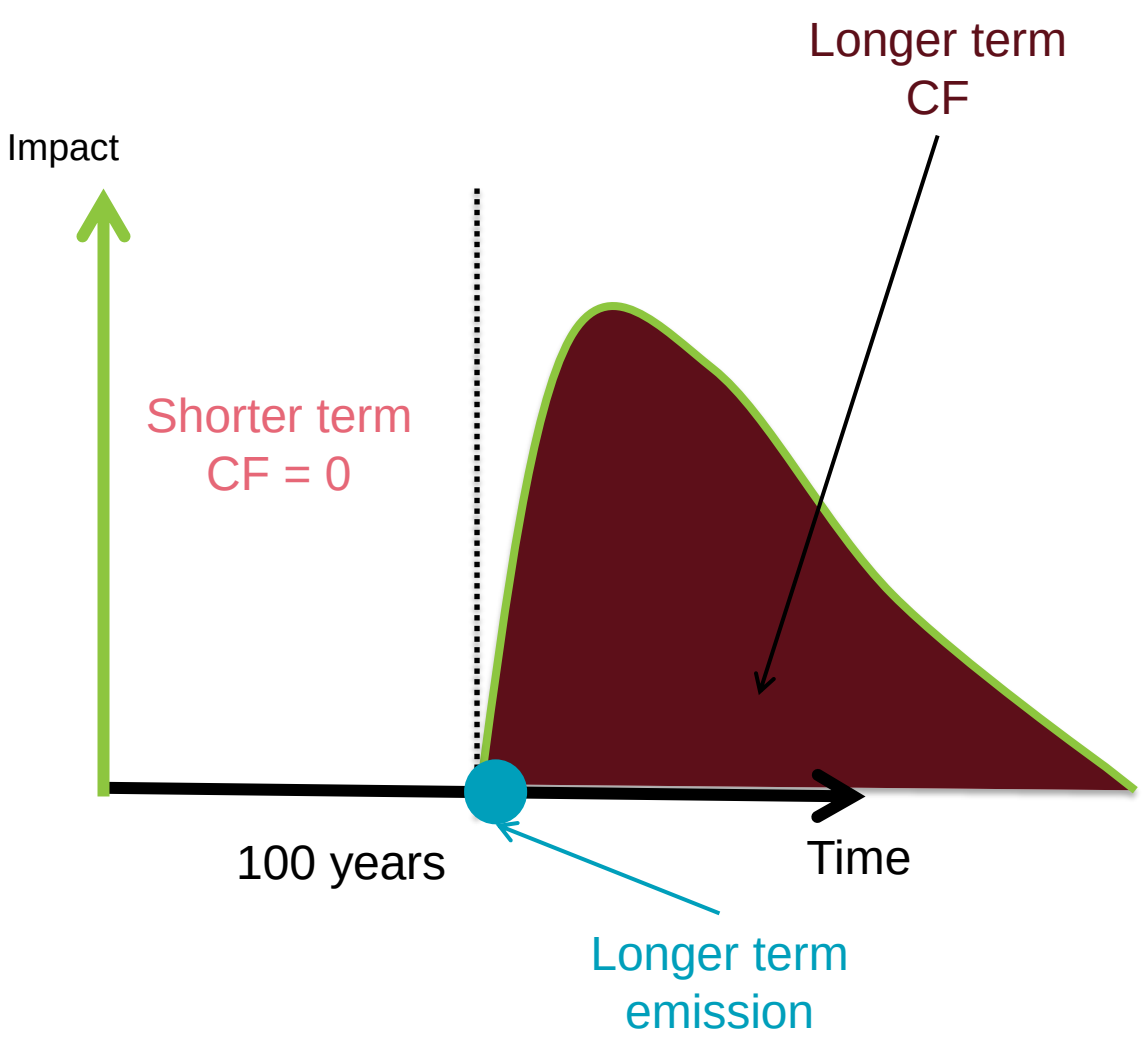
GWP100 only focuses on short term climate change impacts

The ecotoxicity of metals primarily manifests over an extended period.

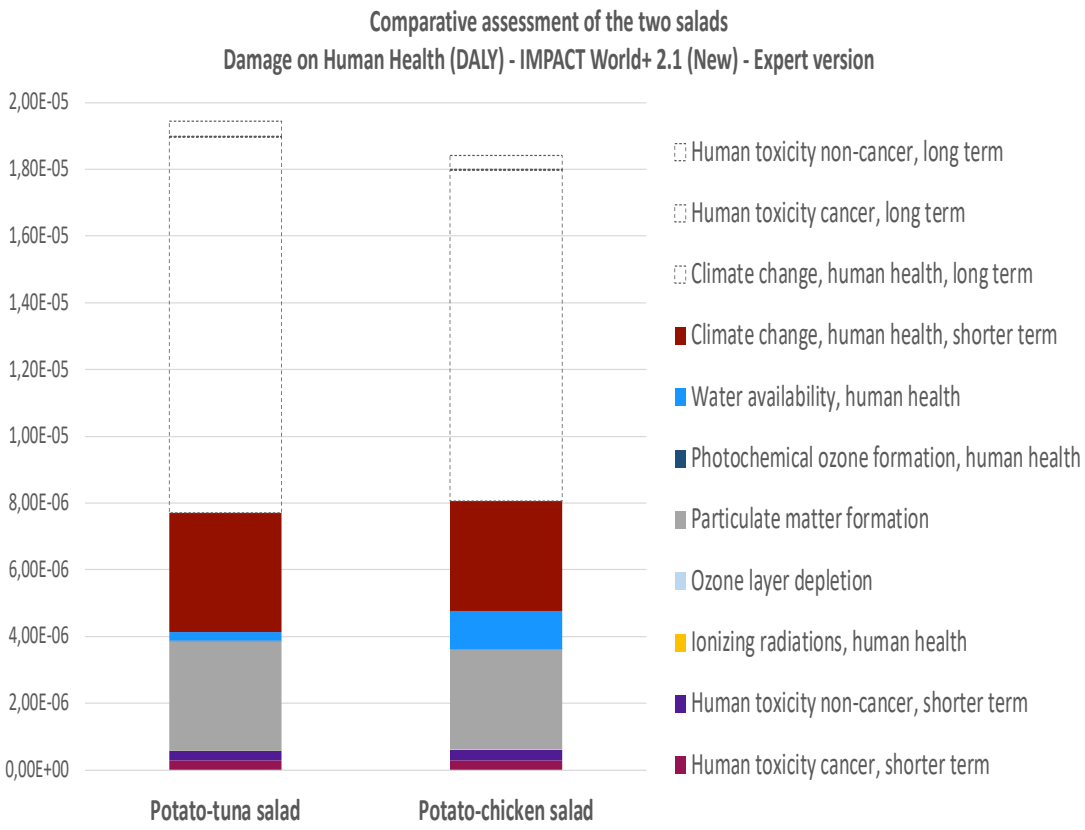
Temporal differentiation in IMPACT World+

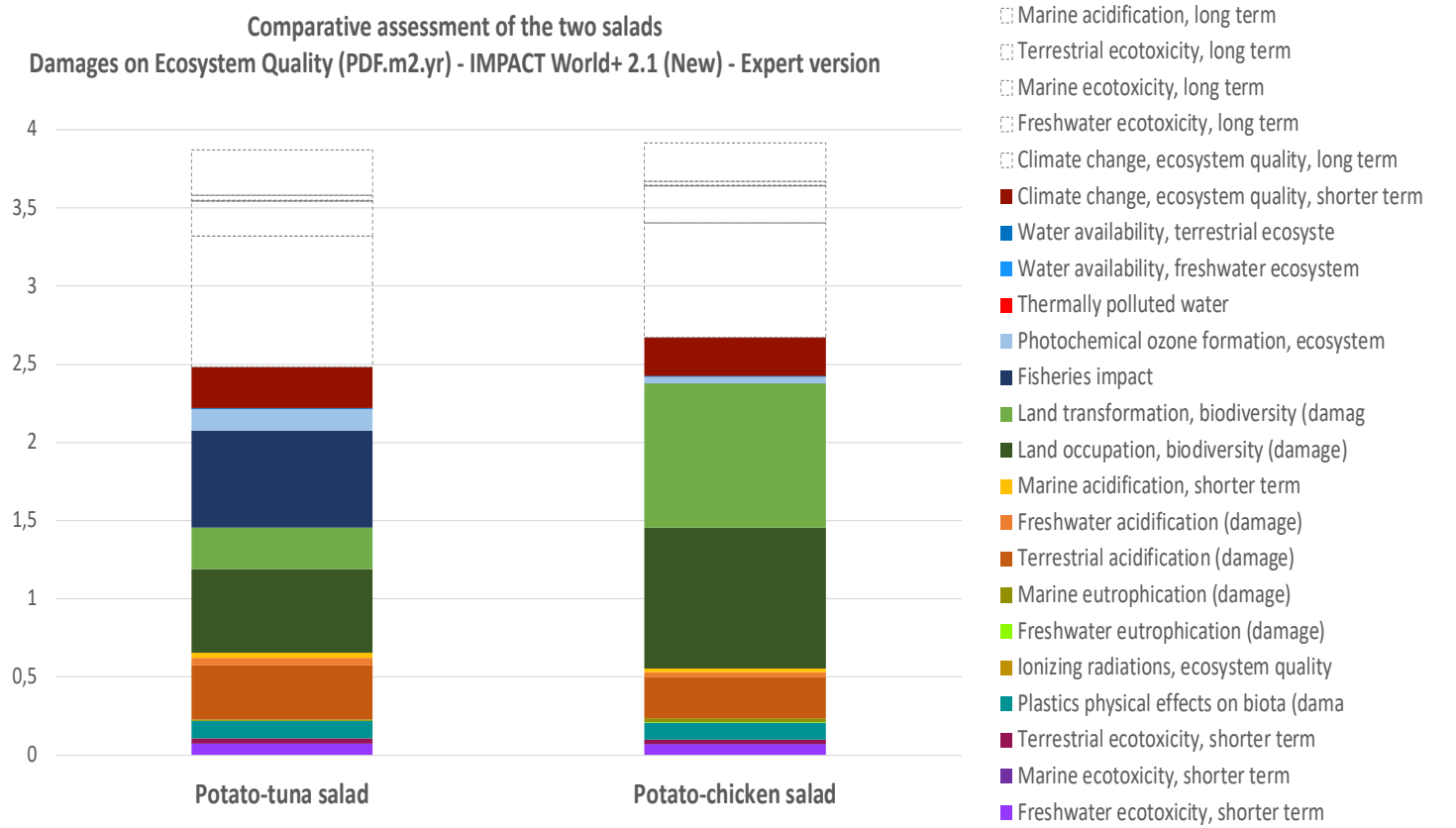
Only for climate change, marine acidification, human toxicity, ecotoxicity





How it may affect interpretation?





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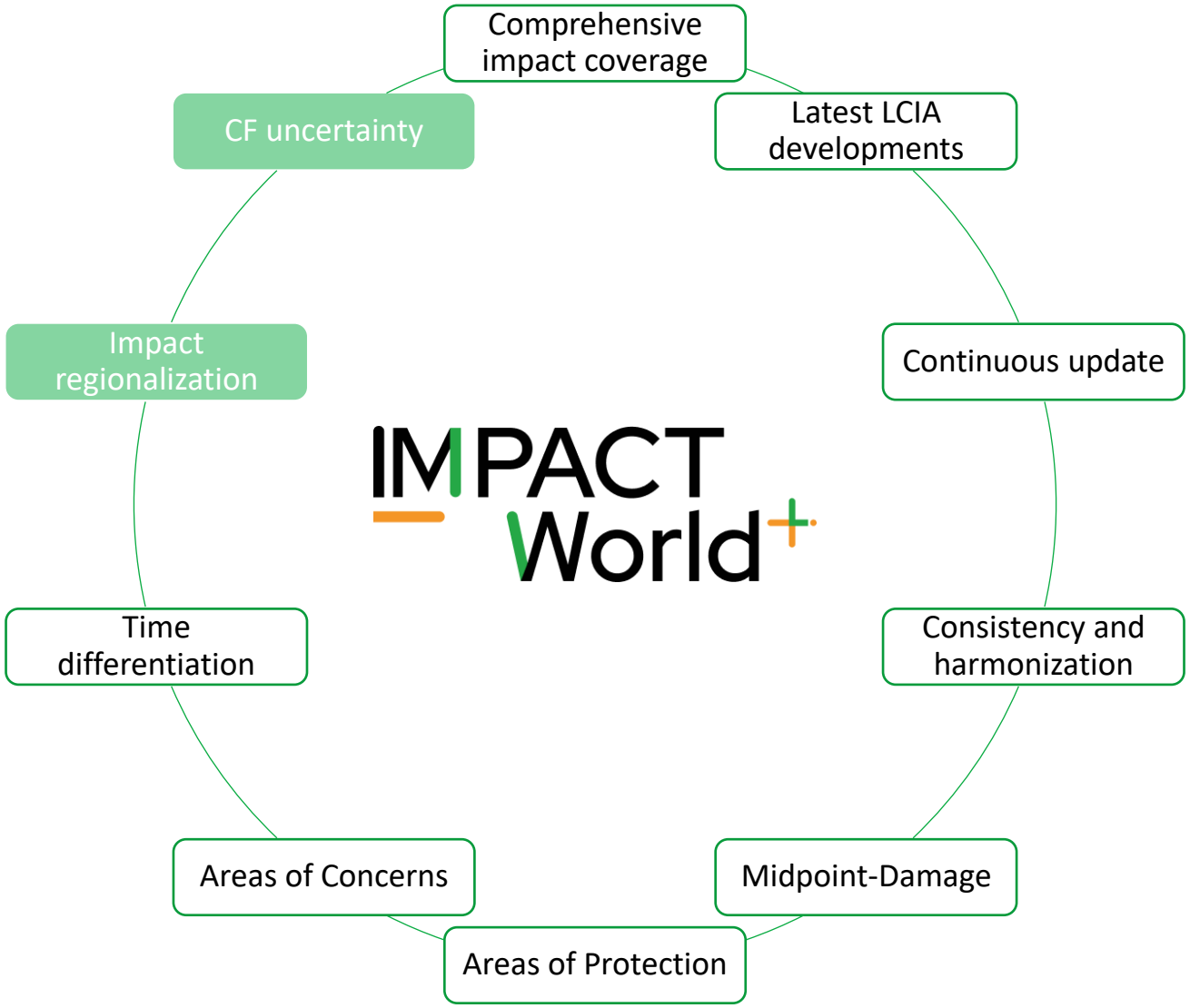


Some impacts vary a lot over space

Particule matter formation

VS

Land use

VS

Water use

VS

Acidification

VS

Impact regionalization in IW+

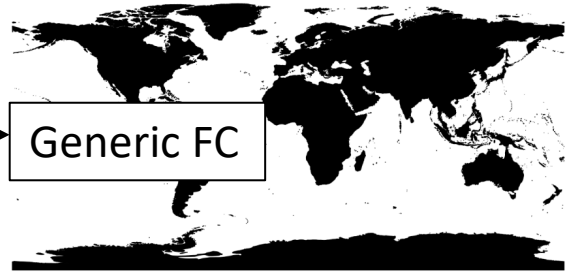
Spatial span = distance (emission location → impact location)

Native spatial resolution

Global

Climate change
Ozone layer depletion

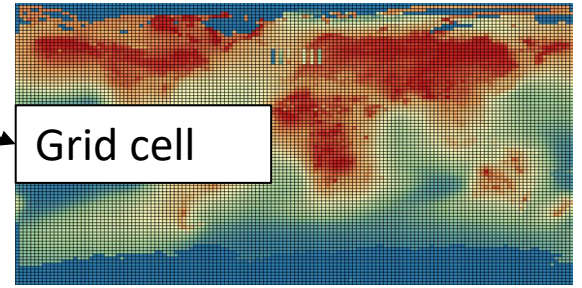
→ Generic FC



Continental/ country-specific

Acidification aquatic and terrestrial
Eutrophication aquatic and terrestrial

→ Grid cell

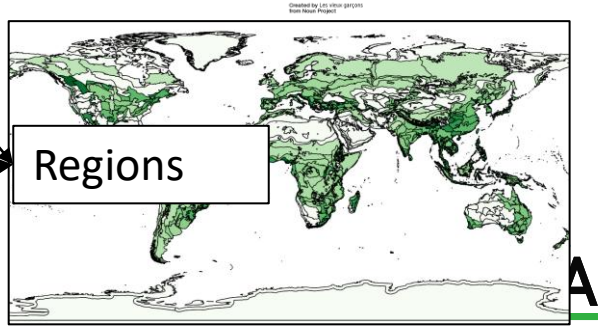


Regional

Human Toxicity
Ecotoxicity
Halieutic resource depletion

→ Archetypes

→ Regions



Local

Particulate matter formation
Land use
Water use

Impact regionalization in IW+

Spatial span = distance (emission location → impact location)

Global

Climate change
Ozone layer depletion

Continental/ country-specific

Acidification aquatic and terrestrial
Eutrophication aquatic and terrestrial

Regional

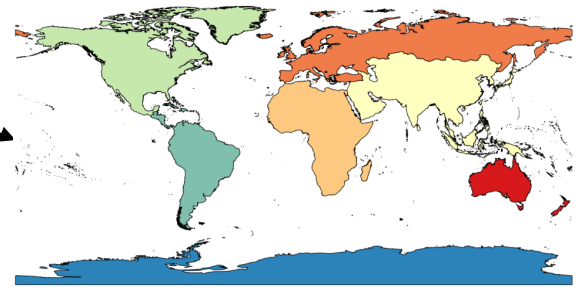
Human Toxicity
Ecotoxicity
Halieutic resource depletion

Local

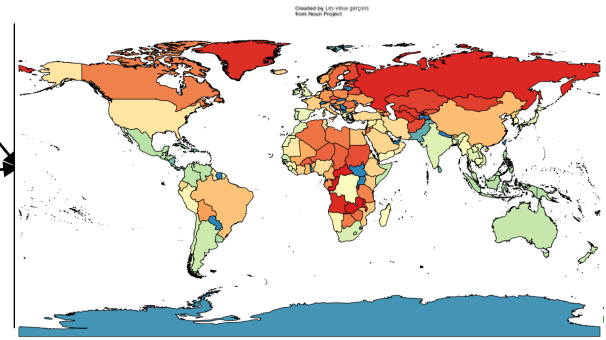
Particulate matter formation
Land use
Water use

Operationalized spatial resolution

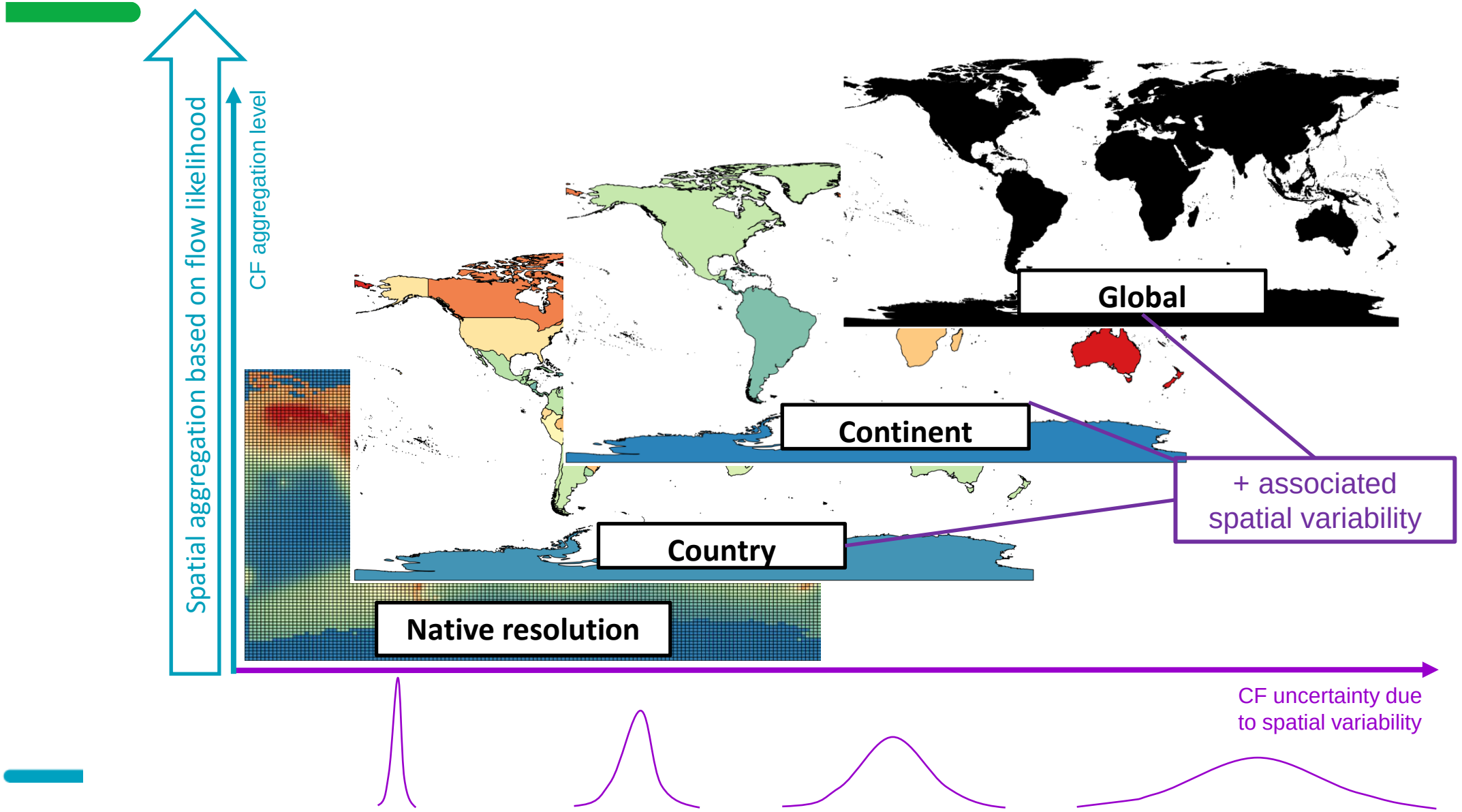
Generic FC



Archetypes



Uncertainty of aggregated CFs are provided



Overview of the indicators and possibilities for interpreting LCA results

IMPACT World+ versions

Three distinct complementary versions are available to present an LCIA profile and allow different levels of interpretation.

Expert version

For LCA experts who seek damage impacts and their contributions to the areas of protection Human health and Ecosystem quality.

The aggregation of damage indicators to only two areas of protection facilitate interpretation while keeping detailed and transparent results, but are more uncertain.

Midpoint version

For experts who want to stop at the midpoint of the cause-effect chain.

Midpoint indicators provide more precise, but less easy-to-interpret results.

Footprint version

For practitioners who need a simplified framework limited to indicators of general interest in decision making.

The selected indicators facilitate interpretation but is a simplification of the overall framework.

IMPACT World+

MIDPOINT - EXPERT

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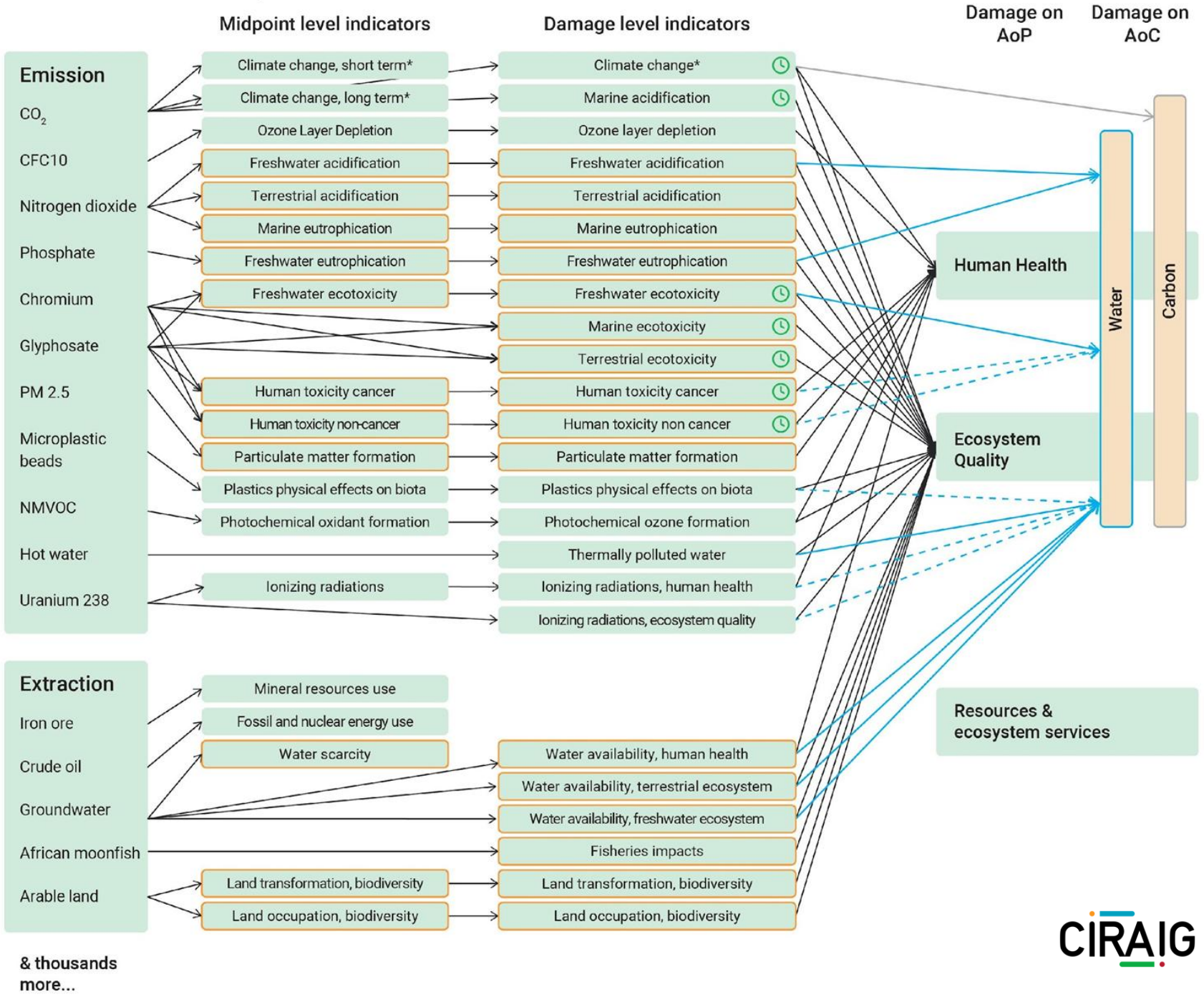

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FOOTPRINT

V2.1 – METHODOLOGICAL FRAMEWORK

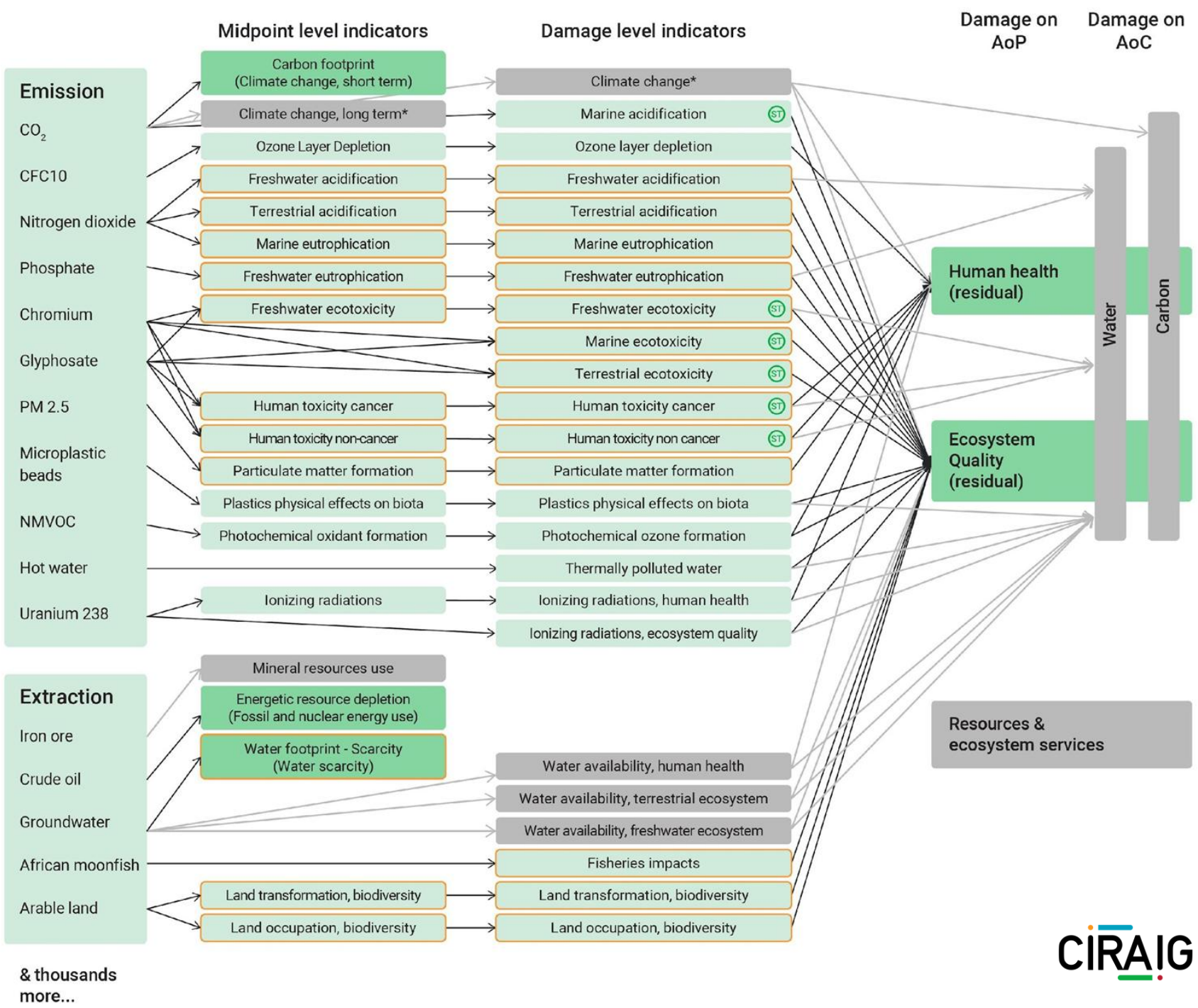
LEGEND

Only short-term temporally resolved indicators are included (ST)

Regionalized indicators are underlined in an orange box

Grey elements are excluded from the Footprint version

Footprint version indicators are bright green



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FOOTPRINT

V2.1 – OPERATIONAL FRAMEWORK

·LEGEND

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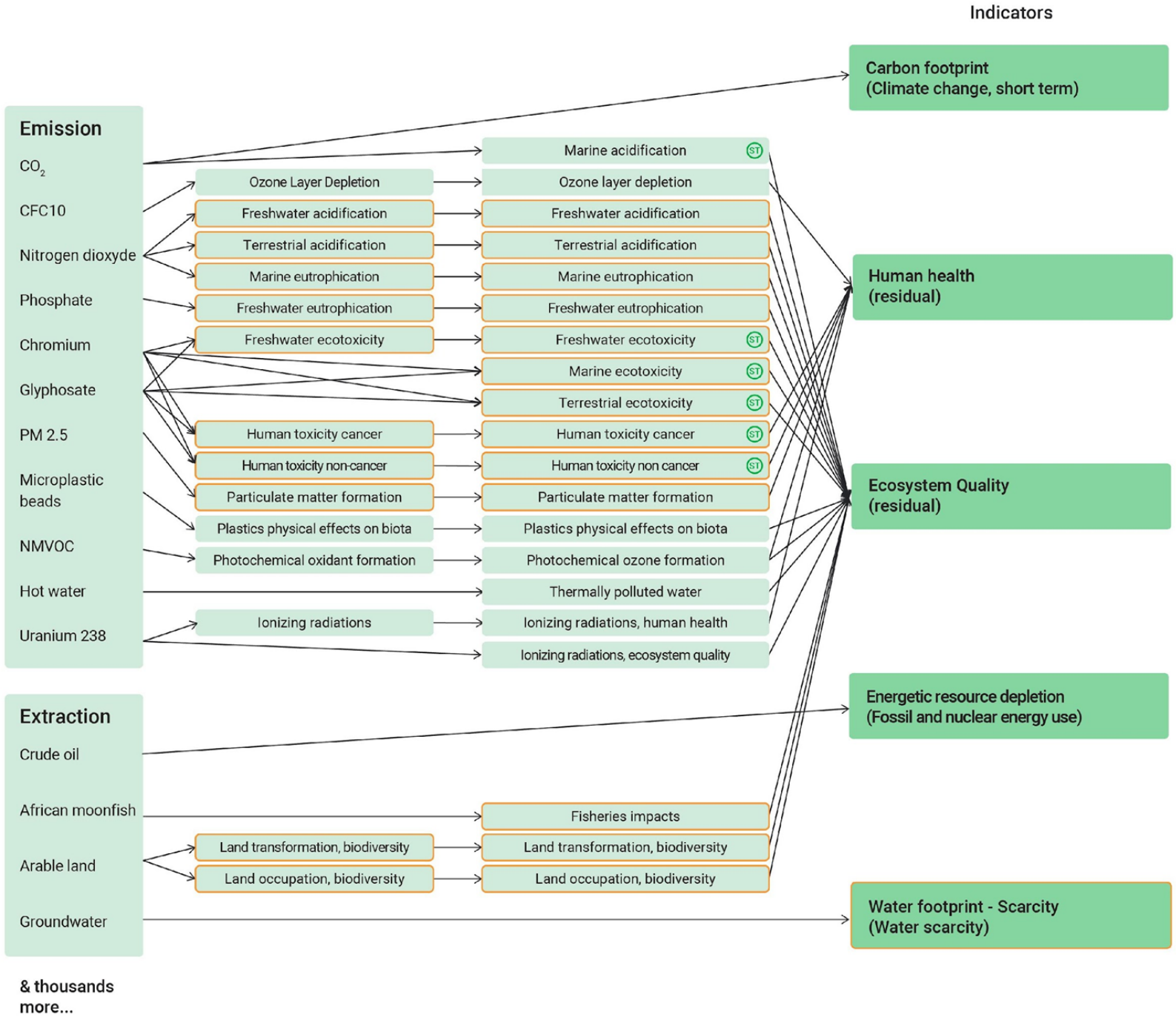
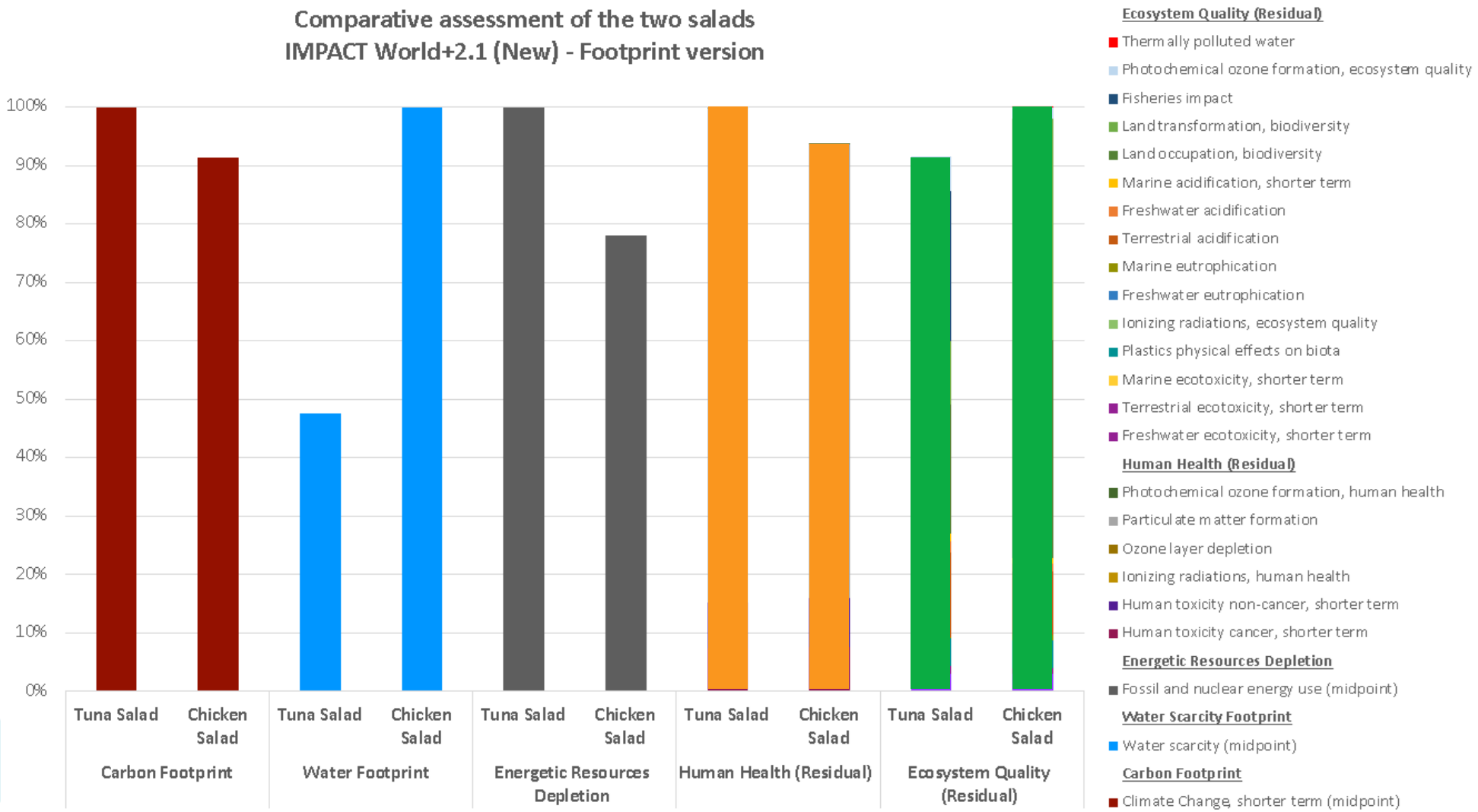
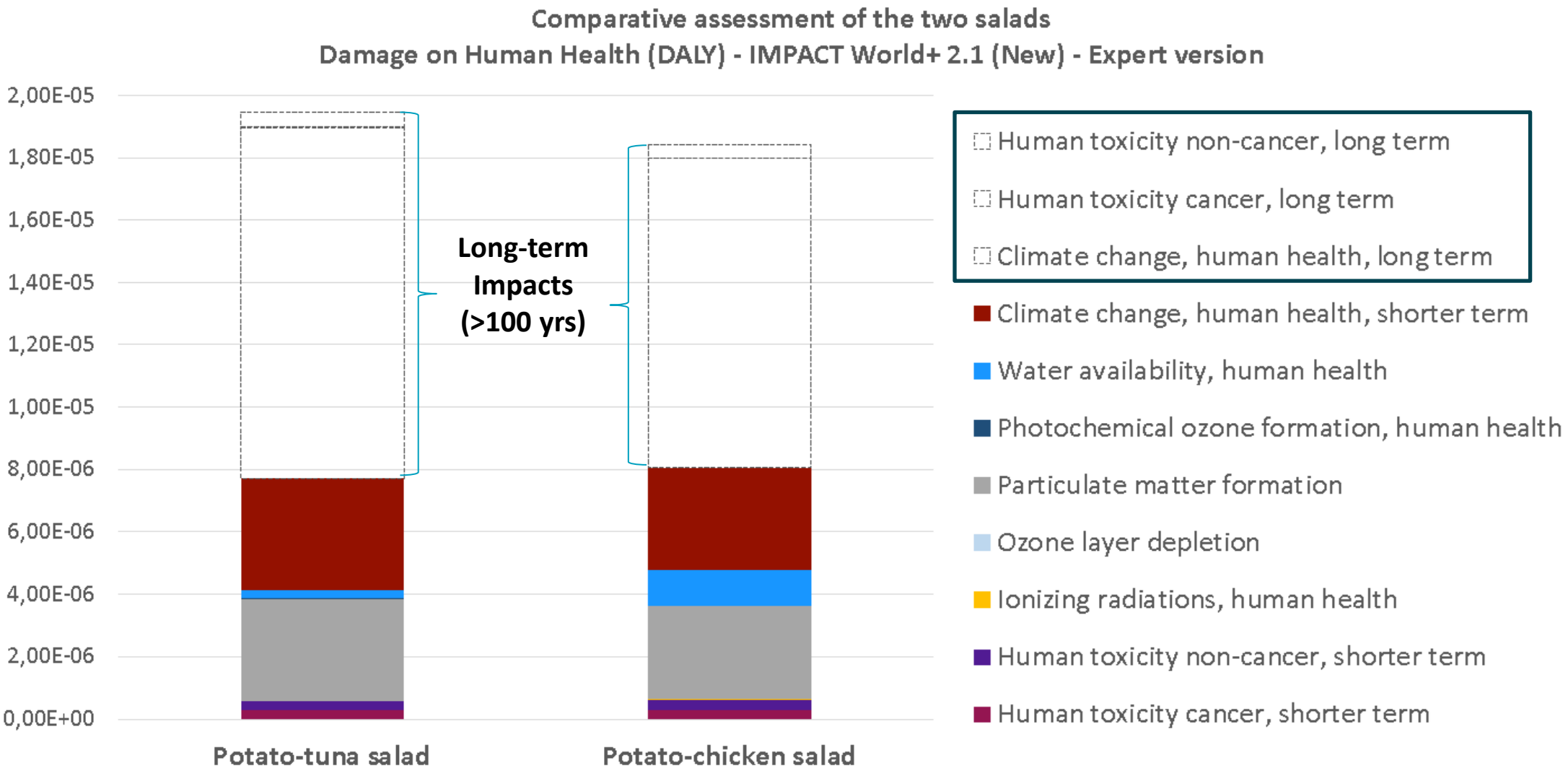


A closer look at the IMPACT World+ 2.1 Footprint version



What is the « Human Health (Residual) » Impact category ?



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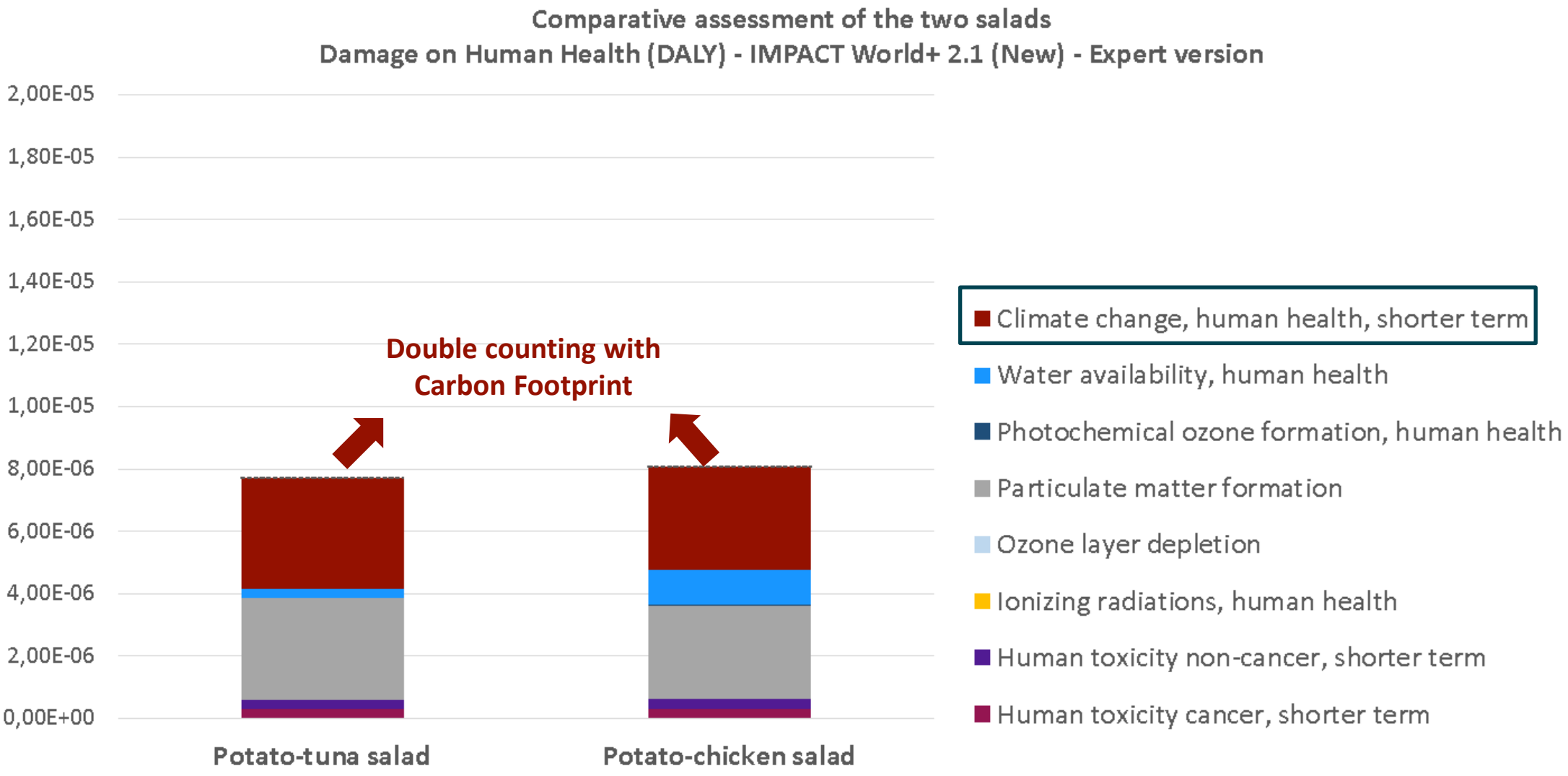

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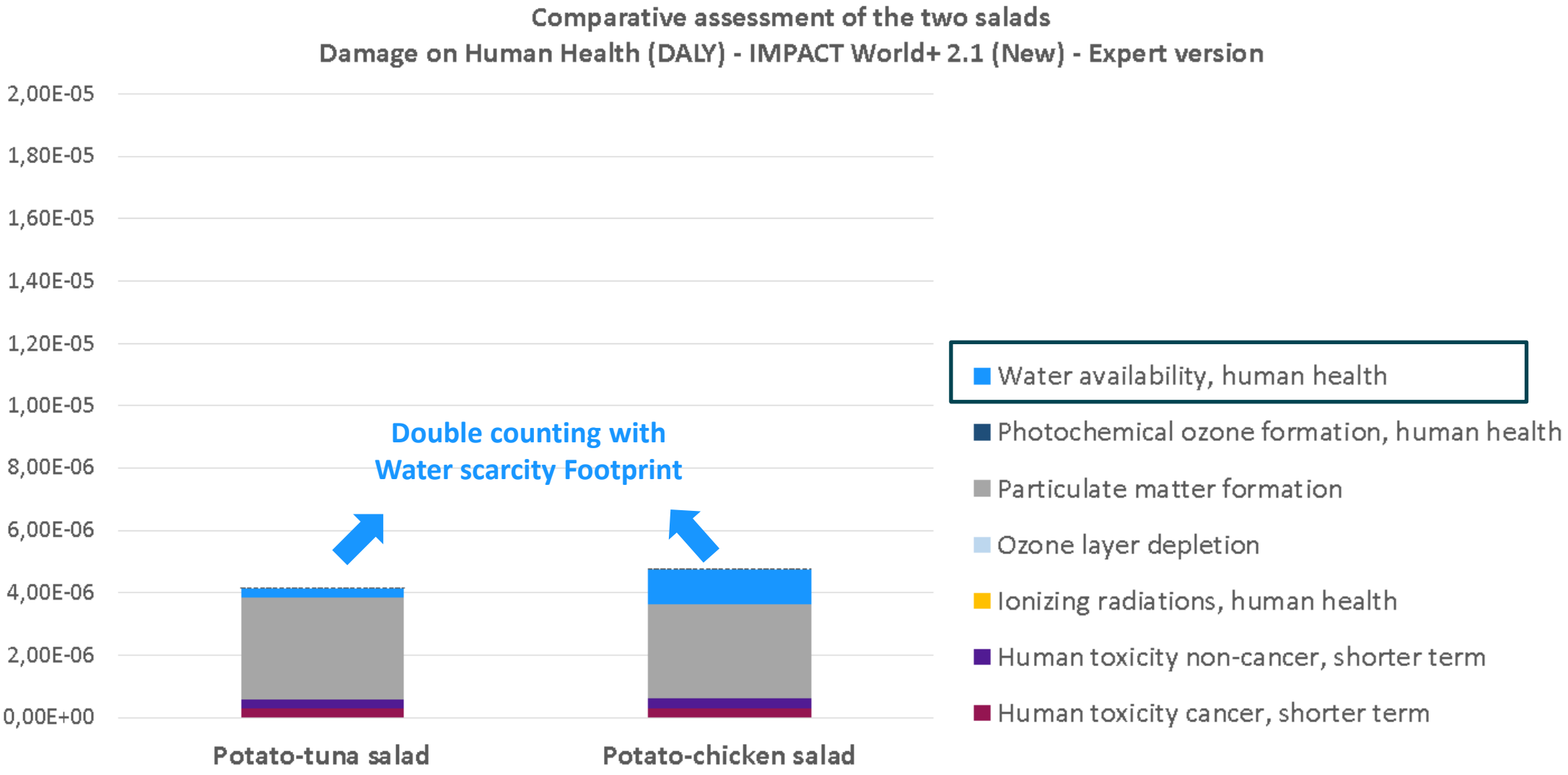

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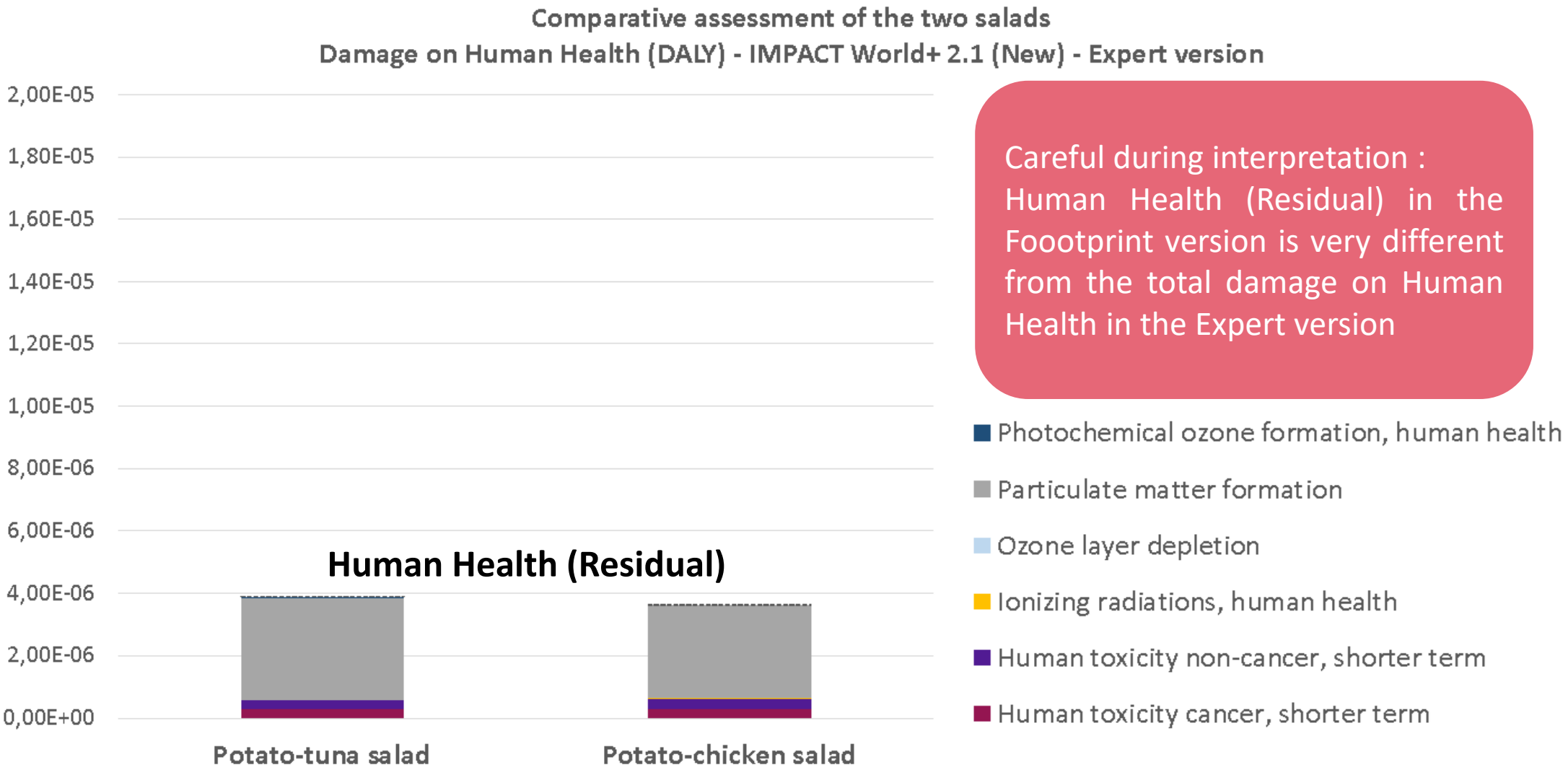
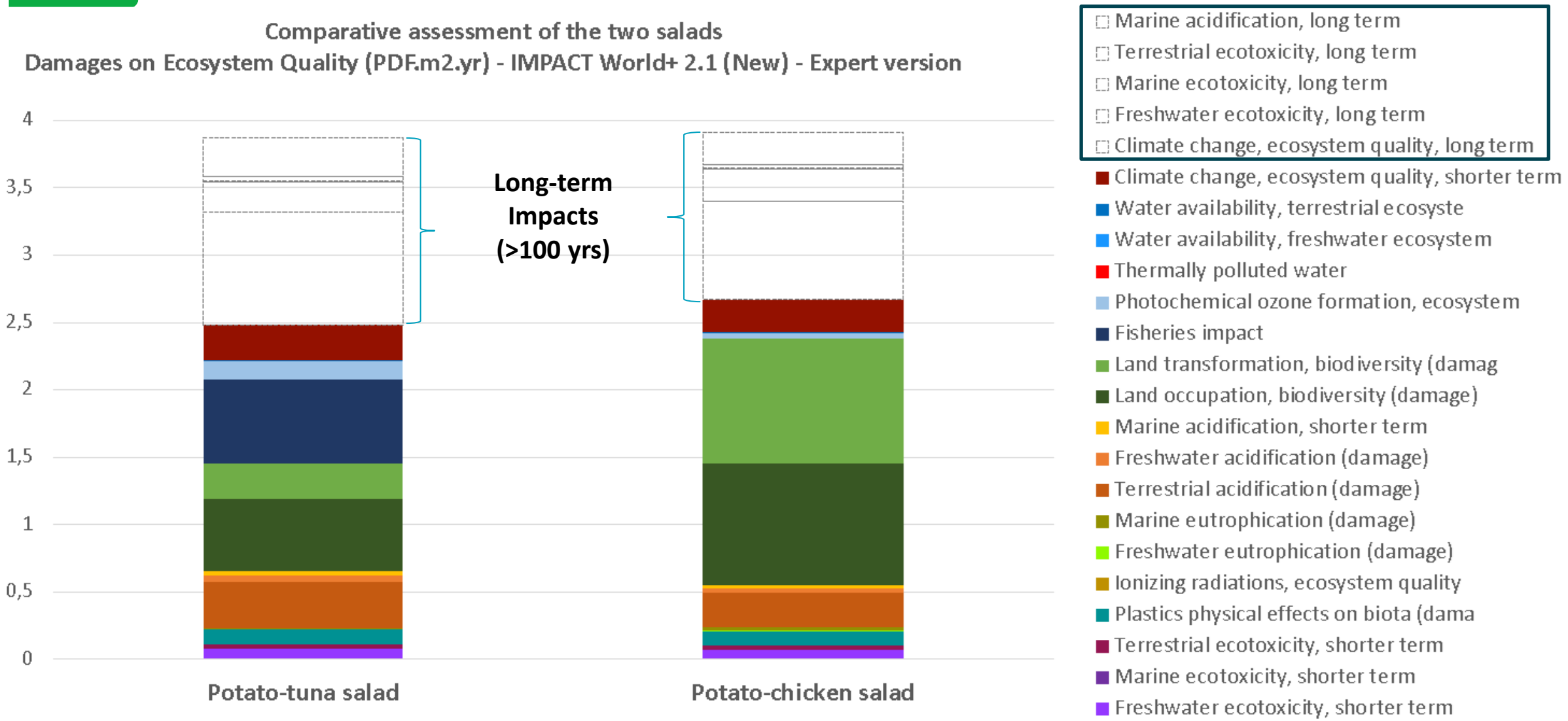


Careful during interpretation : Human Health (Residual) in the Foootprint version is very different from the total damage on Human Health in the Expert version

What is the « Ecosystem Quality (residual) » impact category ?



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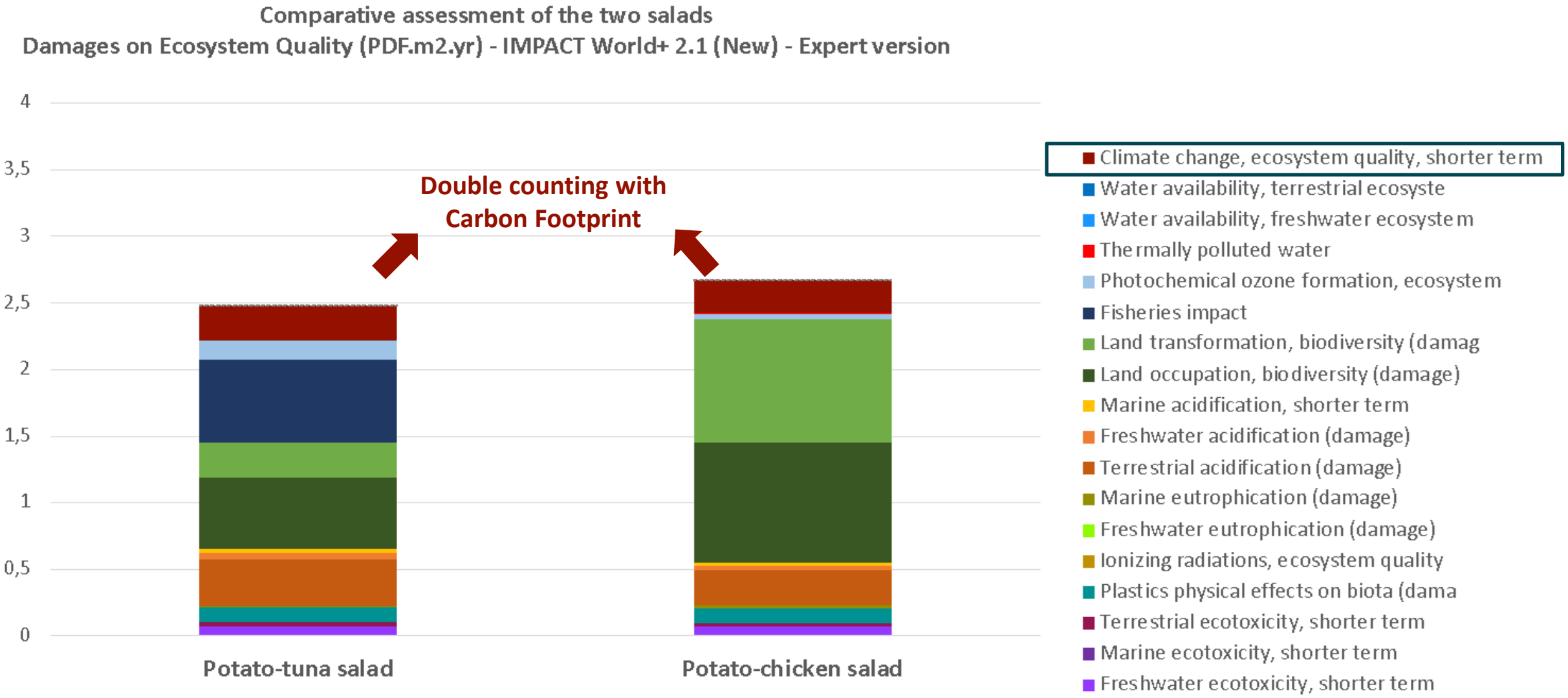

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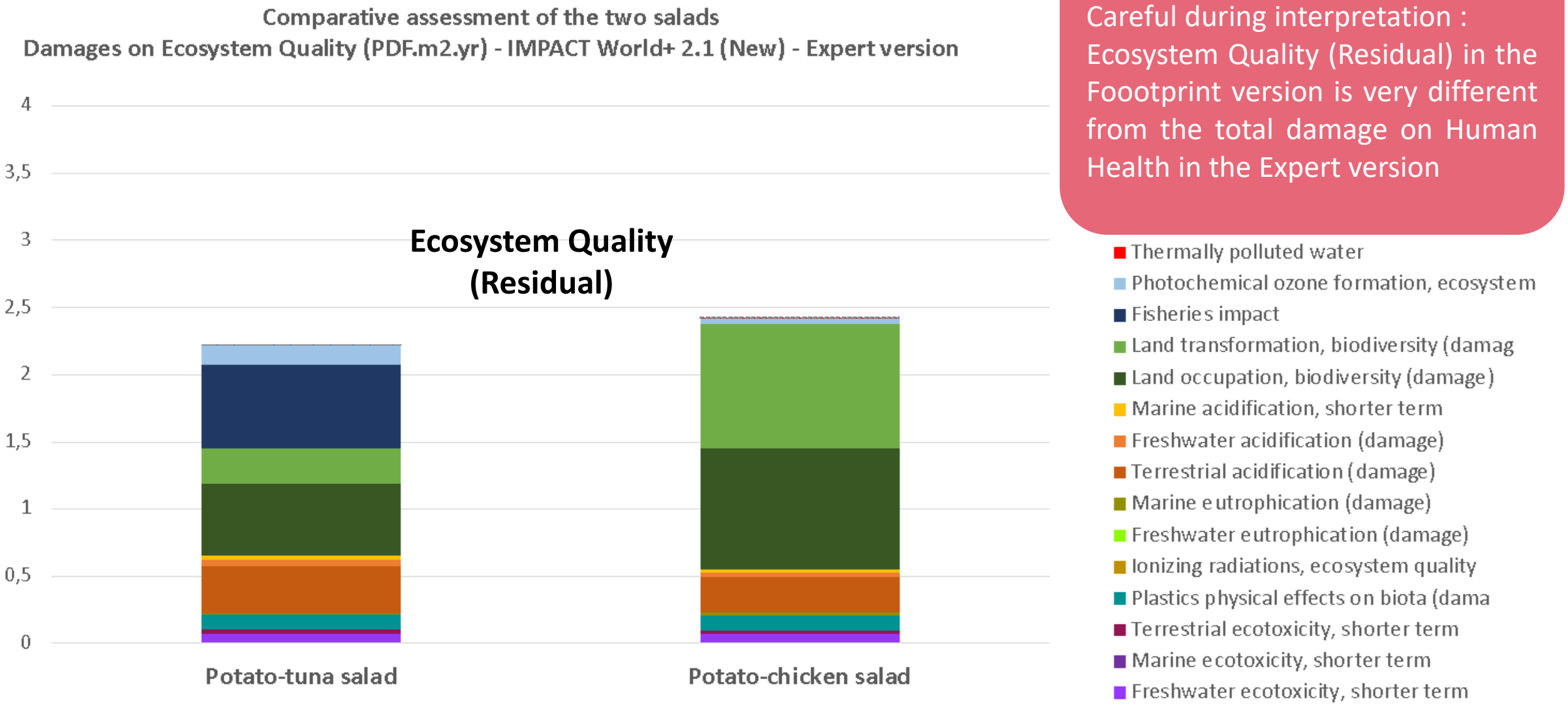


Careful during interpretation : Ecosystem Quality (Residual) in the Foootprint version is very different from the total damage on Human Health in the Expert version

Expert version key advantages

- IMPACT World+ 2.1 Expert version allows to keep track of the potential **long-term impacts**;
- Those long-term impacts are **very uncertain** and have to be interpreted with care
- But they also represent **a significant fraction of the damage :** taking a decision without them implies ignoring our environmental legacy to the next generations

Expert version key advantages

- IMPACT World+ 2.1 Expert version allows to **put in perspective** the contribution of Climate Change and Water use to the damages on Human Health and Ecosystem Quality;
- This is important to better **deal with trade-offs** between impact categories;
- Modeling Climate Change and Water use impacts to **the damage level is better than any normalization/weighting** as it is based on modelling a cause effect chain instead of a value choice.
- **Better interpretation possibilities for experts.**

Footprint version key advantages

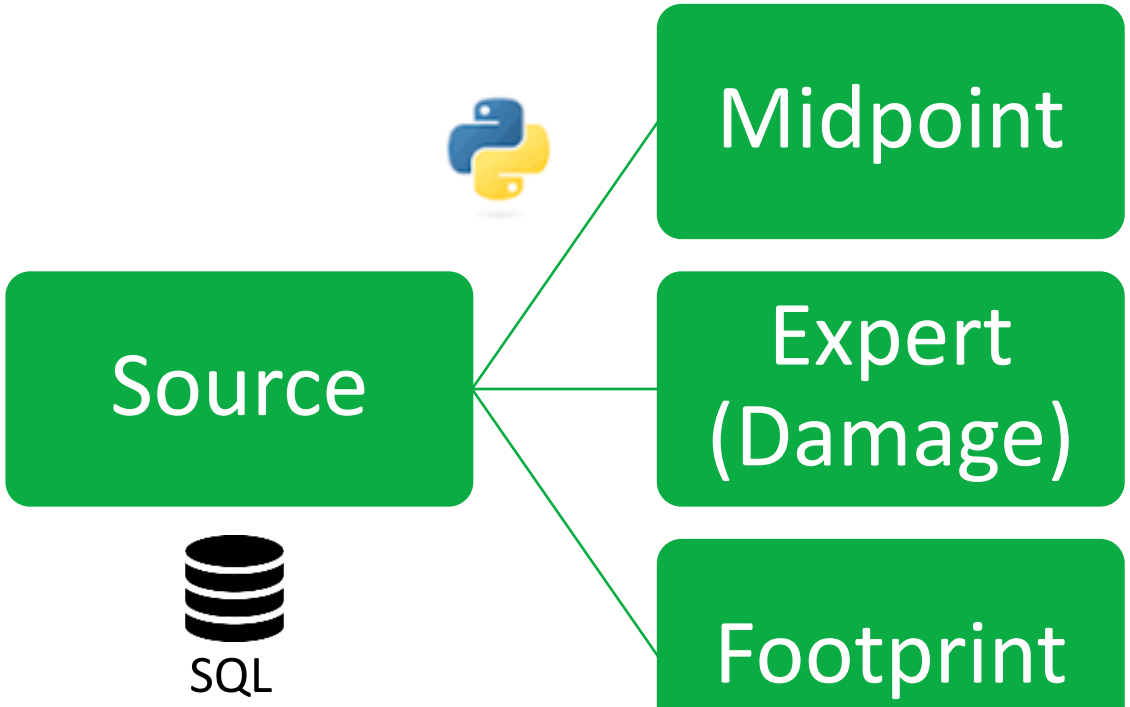
- The IMPACT World+ 2.1 Footprint version allows to obtain easily a **Carbon Footprint (based on GWP100)** and a **Water Scarcity Footprint (based on AWaRe),** giving access to the consensual footprinting models;
- It allows to keep track of the « residual damages » on Human Health and Ecosystem Quality in a **consistent** way while **avoiding any double counting**;
- It allows to have a complementaty indicator on **energy resources depletion;**
- **Easier to interpret** for non experts.

Summary

	Midpoint version	Expert Version	Footprint Version
Includes Long term impact ?	No (except for CC)	Yes	No
Allows to put in perspective the damages of water use on Human Health and Ecosystem Quality ?	No	Yes	No
Allows to put in perspective the damages of climate change on Human Health and Ecosystem Quality ?	No	Yes	No
Allows to obtain a GWP100 based carbon footprint and an AWARE based Water scarcity footprint?	Yes	No	Yes
Number of indicators to deal with once impact categories are agregated ?	19 (24)	2 (soon 3)	5
Number of impact categories considered ?	19 (24)	31 (72)	22
Ease of interpretation	Low	Medium	High
Depth of interpretation	Low	High	Medium

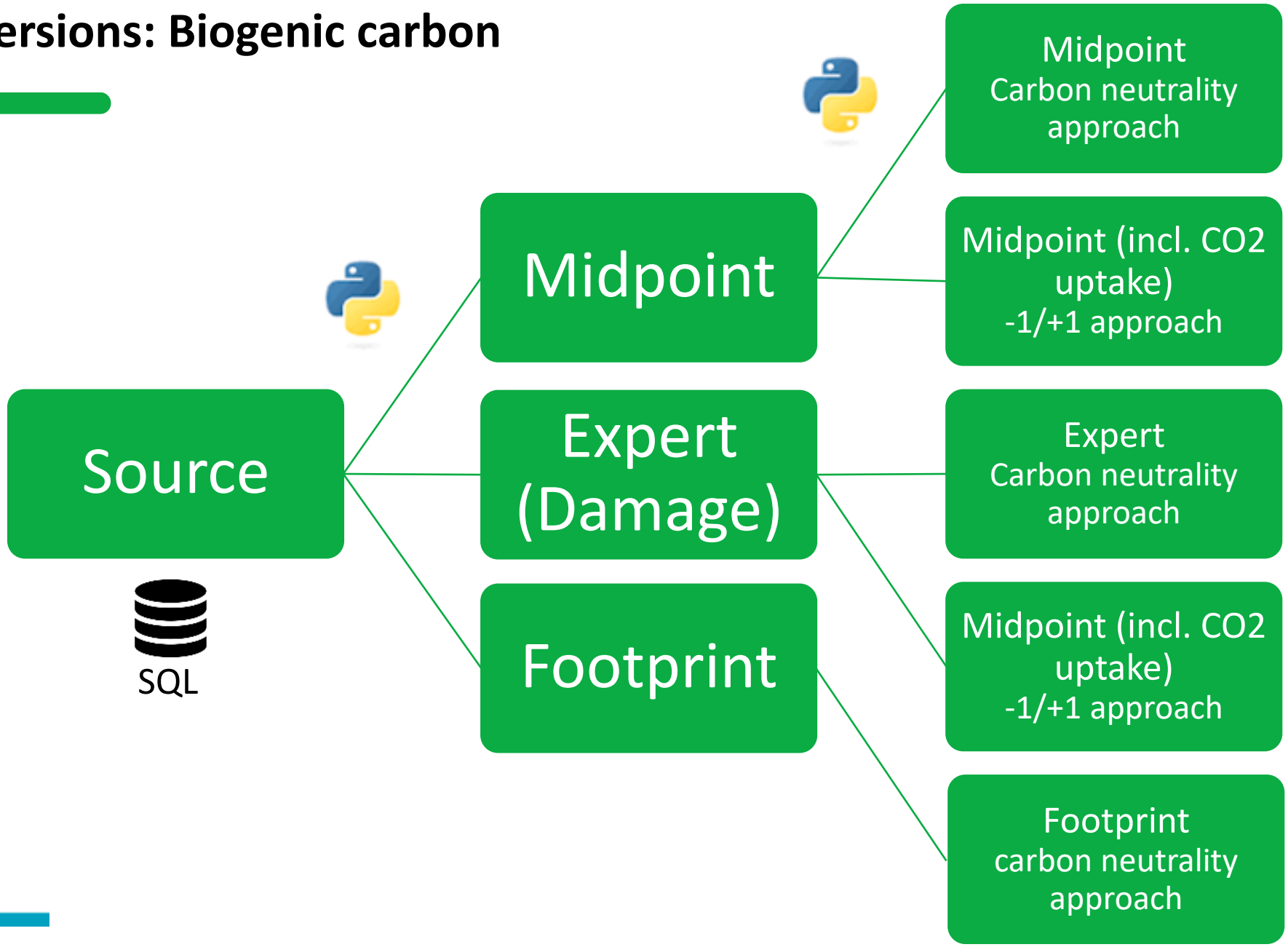
How to use IMPACT World+?

Versions: Indicator selection

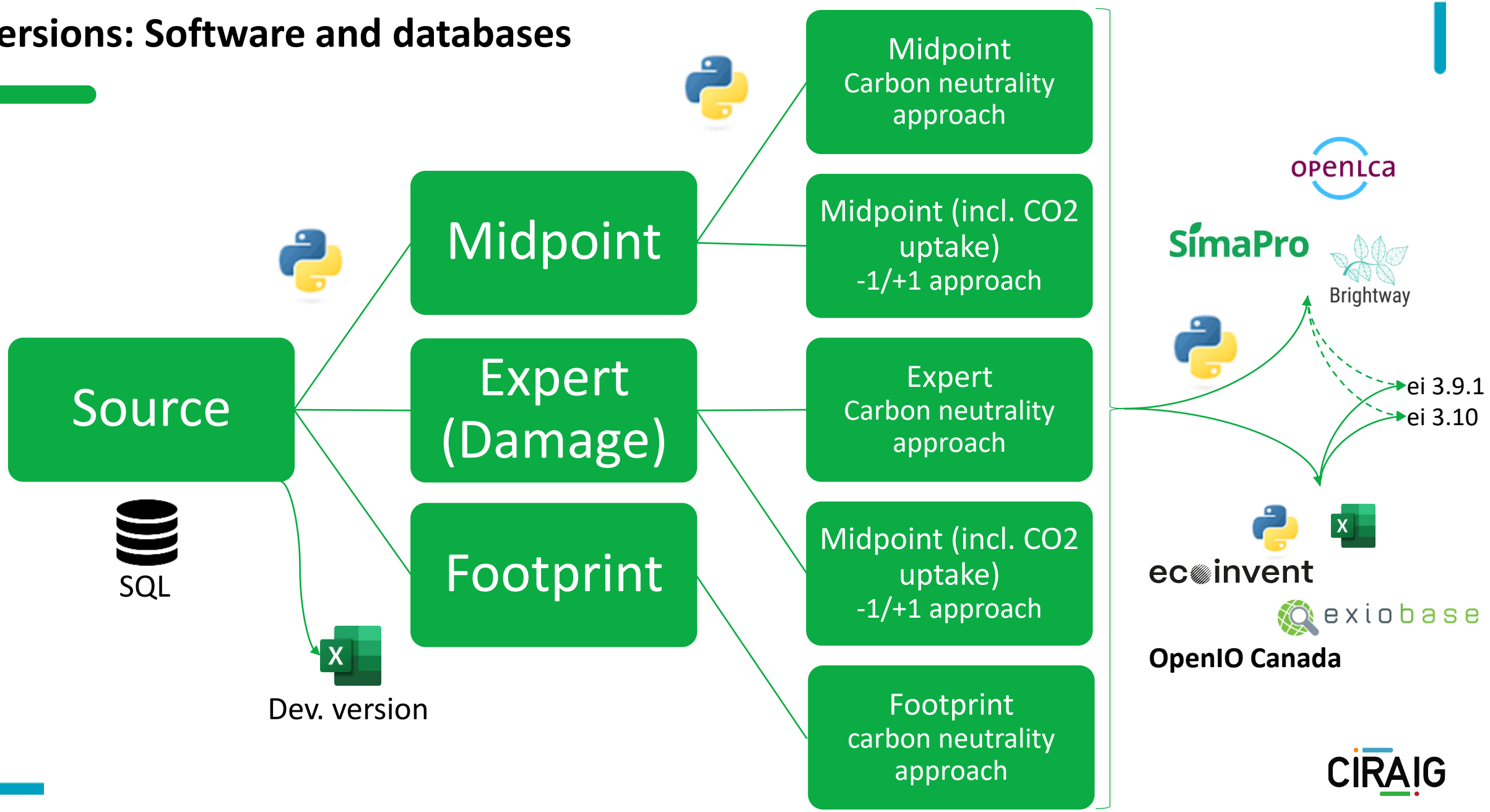


Since v2.0.1

Versions: Biogenic carbon



Versions: Software and databases



Where to find everything IMPACT World+ - related?

- Documentation: available through the published article, on the website and on GitHub/Zenodo
- Code: open-access and available on GitHub
- Native DB: available on Zenodo or on demand
- Operationalized files:
  - Our own versions are available on Zenodo
    - for software (SimaPro, openLCA and brightway)
    - for databases (ecoinvent and Exiobase)
  - Also directly available in:
    - ecoinvent package and on Ecoquery (v2.1, Footprint version, non-regionalized)
    - openLCA package and nexus (Midpoint and Expert version)
    - SimaPro package (Midpoint and Expert version, regionalized)
    - Directly included in the openIO Canada database (v2.1, Midpoint and Expert version, partially regionalized)

Thank you!
Questions?

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