flexby

FLEXIBLE AND ADVANCED BIOFUEL TECHNOLOGY THROUGH AN INNOVATIVE MICROWAVE PYROLYSIS & HYDROGEN-FREE HYDRODEOXYGENATION PROCESS

Regionalized Impact Calculation in openLCA: Case Study from the Flexby Project Preliminary Life Cycle Assessment

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(GreenDelta GmbH)

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Regionalized Impact Calculation in openLCA:
Case Study from the Flexby Project Preliminary Life Cycle Assessment

- Concept and Methodology of Flexby
- Case Study from the Flexby Preliminary LCA
- Regionalized LCIA with openLCA new Regionalization Tool
- Summary & Conclusions

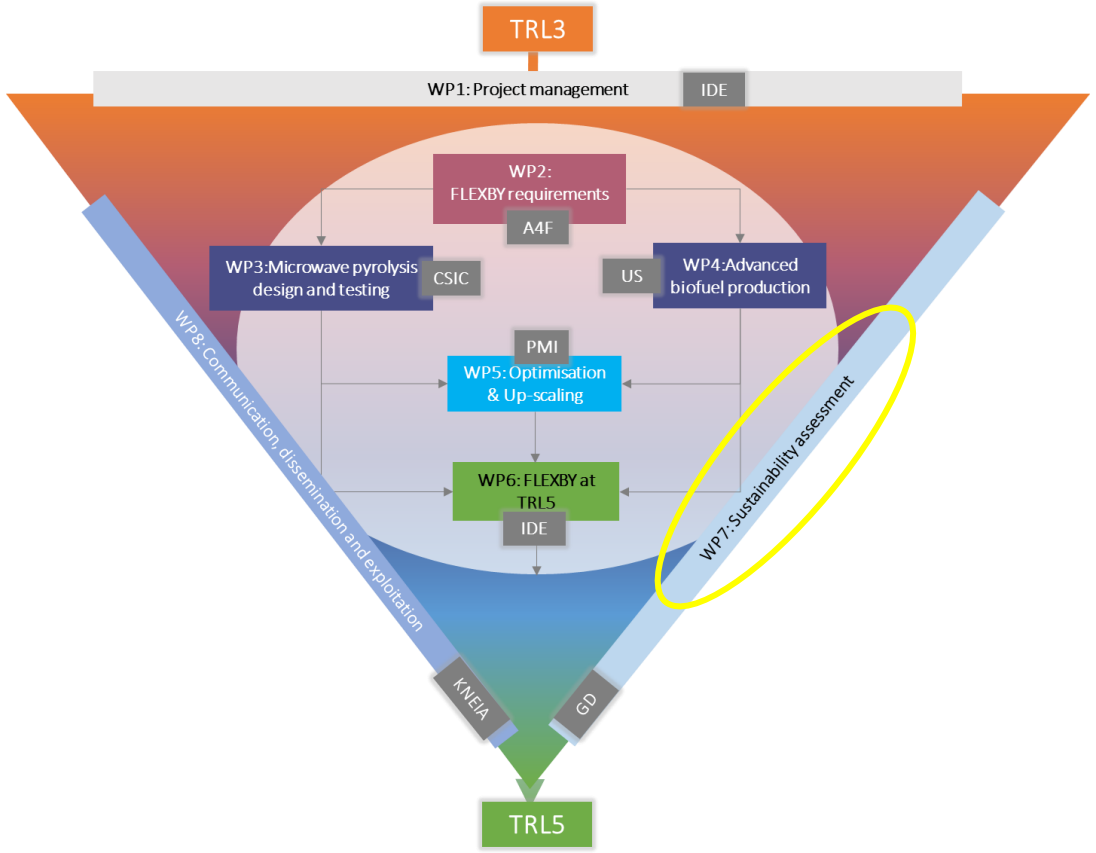
flexby - About

- Call topic: HORIZON-CL5-2023-D3-02-07 - Development of next generation advanced biofuel technologies
- Budget: € 3,993,682.50
- 48 month
- Project dates: 01-05-2024 to 30-04-2028

flexby - Objectives

- **Biofuels from algae:** Flexby aims to produce biofuels from microalgae grown in wastewater, and industrial sludge
- **Innovative tech:** microwave-assisted pyrolysis & hydrogen-free hydrodeoxygenation process
- **Sustainable & cost-effective:** minimise carbon waste, inhibit biogenic effluent gas emissions, while maintaining the product cost-effective

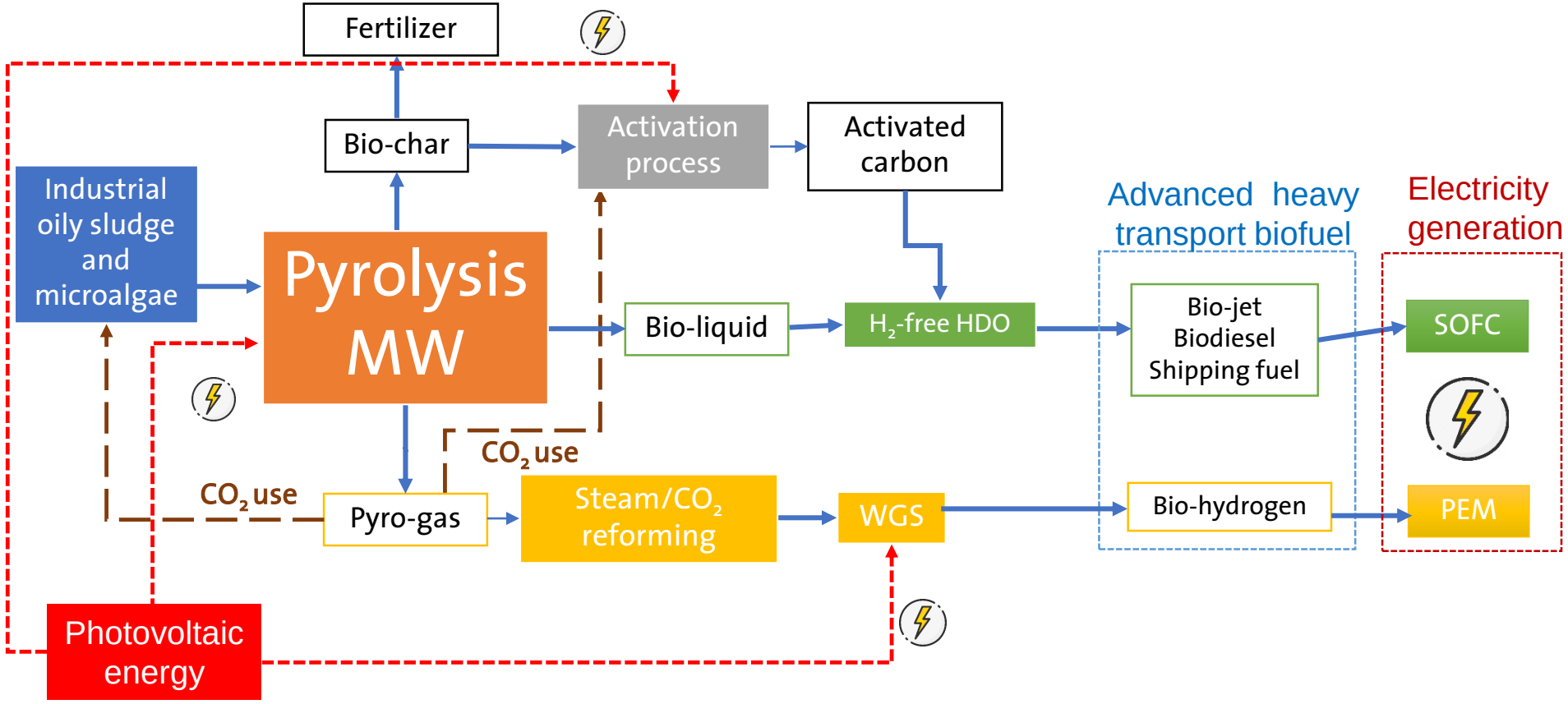
GreenDelta in flexby



GreenDelta role: as leader of WP7, GreenDelta conducts the **sustainability assessment** of Flexby using openLCA software.

During the whole length of the project a full Life Cycle Sustainability Assessment will be conduct

flexby - Concept and Methodology

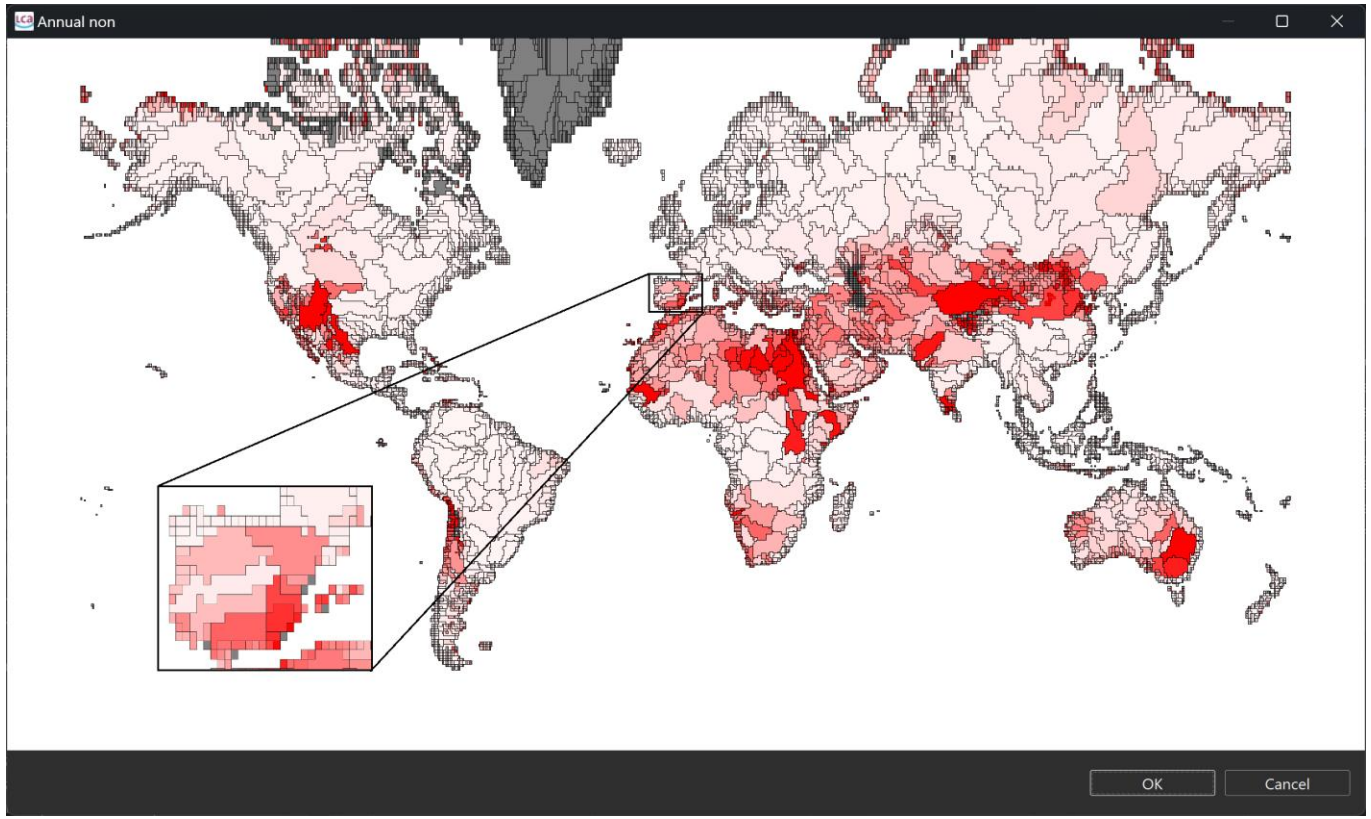


flexby - Concept and Methodology

- **Microwave-Assisted Pyrolysis**: Waste feedstock from microalgae and industrial sludge undergoes pyrolysis, producing three fractions: solid, liquid, and gas
- **Liquid Fraction Utilization**: The liquid fraction is converted into heavy transport biofuels using hydrogen-free hydrodeoxygenation (HDO), utilizing water from the feedstock
- **Gaseous Fraction Conversion**: The gaseous fraction is processed to produce bio-hydrogen, aligning with circular economy principles and promoting low-carbon emissions
- **Solid Fraction Applications**: The solid fraction is converted into biochar fertilizer, contributing to soil biogenic emission reduction, and used as activated carbon
- Overall sustainability evaluated through **Life Cycle Sustainability Assessment (LCSA):** considering environmental, economic and social aspects

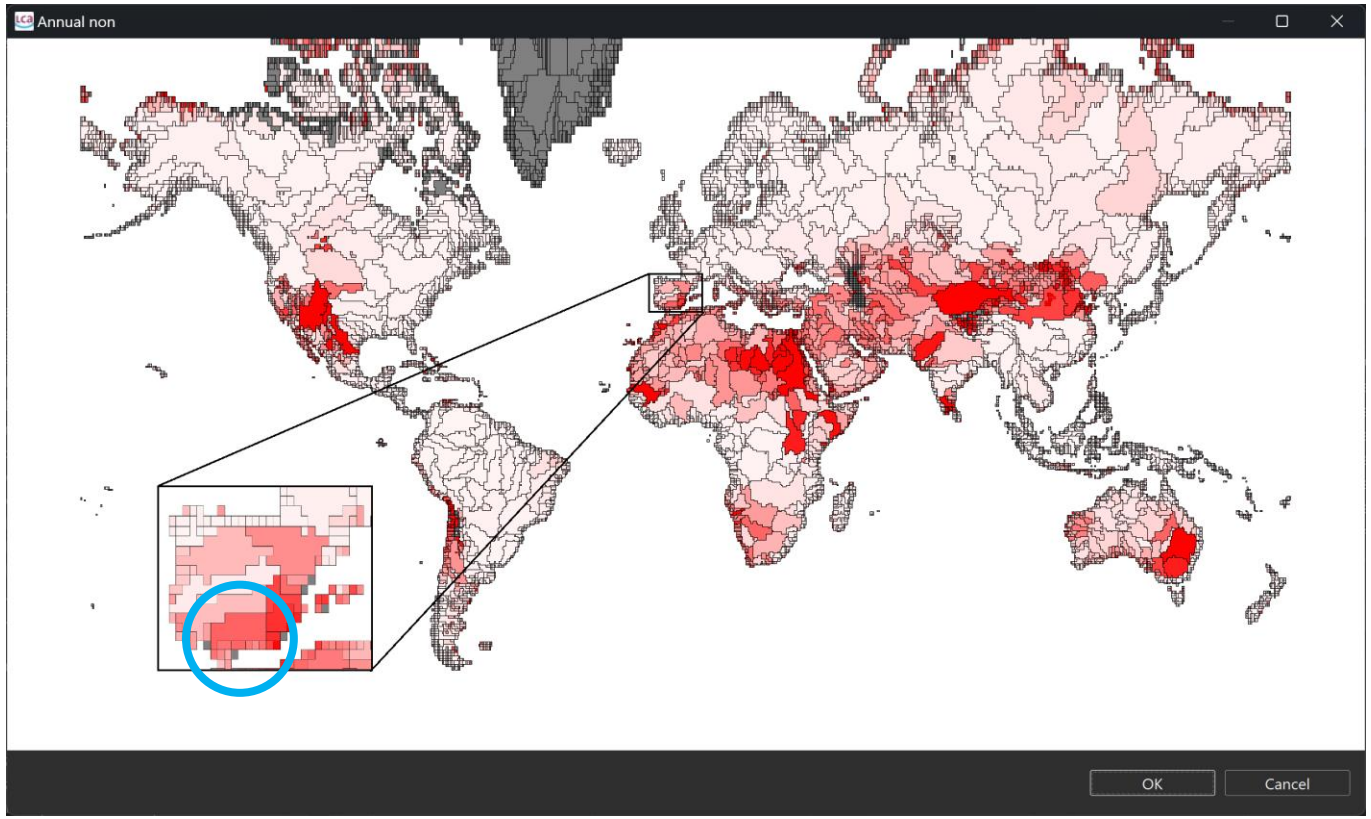
Regionalization in LCA

- **Challenge in LCA**: Accurately assessing localized impacts
- Certain impact categories particularly **need localized assessment** (e.g. water stress and land use)



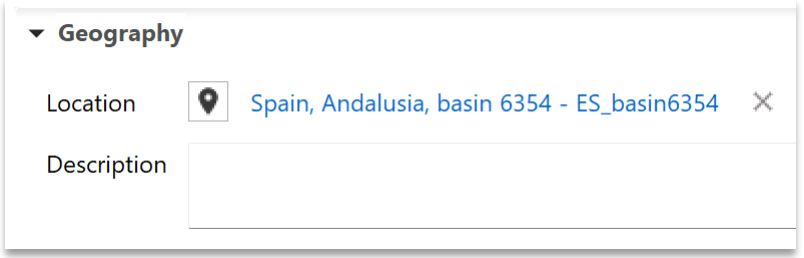
Case Study from the Flexby Preliminary LCA

- Most of Flexby key-processes take place between **Spain** and **Portugal**
- **Andalusia** faces higher water scarcity than the Spanish consumption-weighted average (as the country aggregation is computed in AWARE)



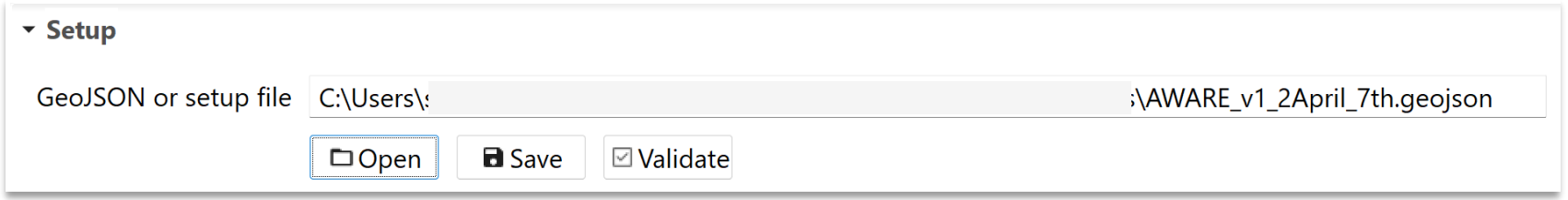
Focus: openLCA regionalized LCIA

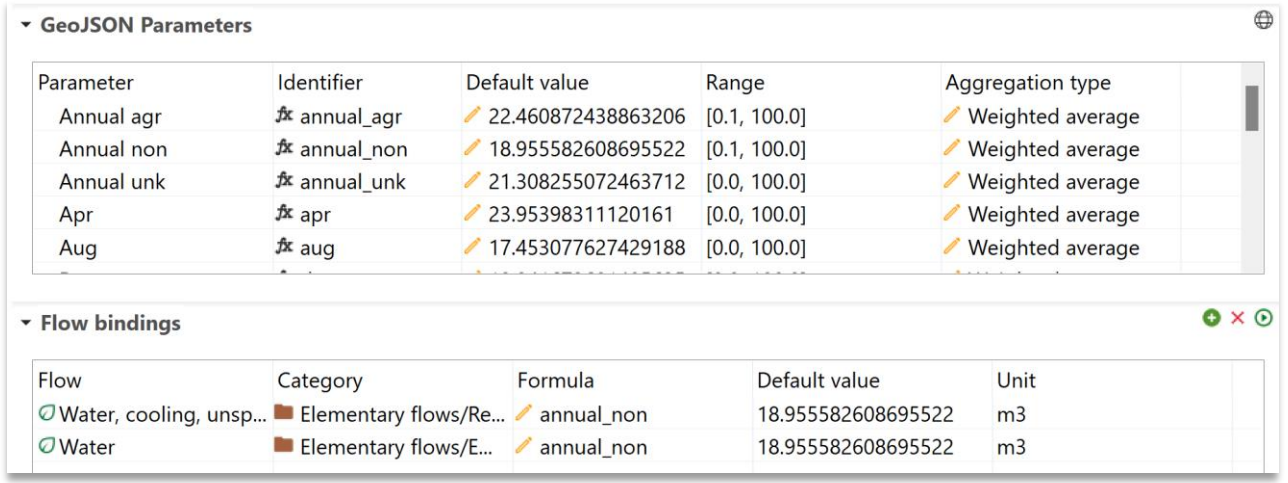
- Regionalized calculation is an **advanced** form of impact computation
- **Locations** are independent objects that interact with impact factors, processes, and exchanges to calculate region-specific impacts



Focus: openLCA regionalized LCIA

- GeoJSON files with regional characteristics can be loaded into the software to **access and/or calculate specific CFs**





Materials and Methods

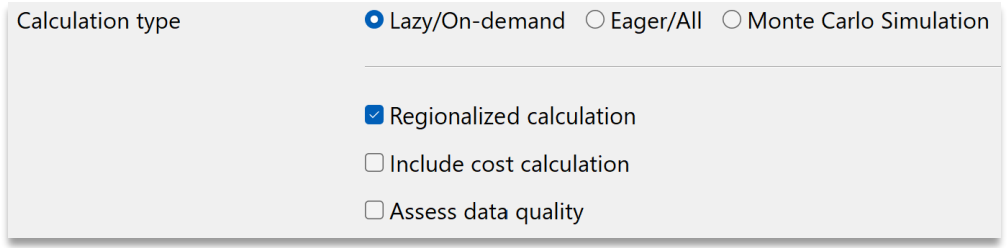
- Focused on the direct impact of a heat and power co-generation process within the preliminary LCA of Flexby (from ecoinvent)
- Evaluated the water scarcity footprint using **AWARE** and two different CFs:
  - Aggregated CF for Spain
  - Region-specific CF for Andalusia (basin 6354) using the the new regionalization tool of openLCA

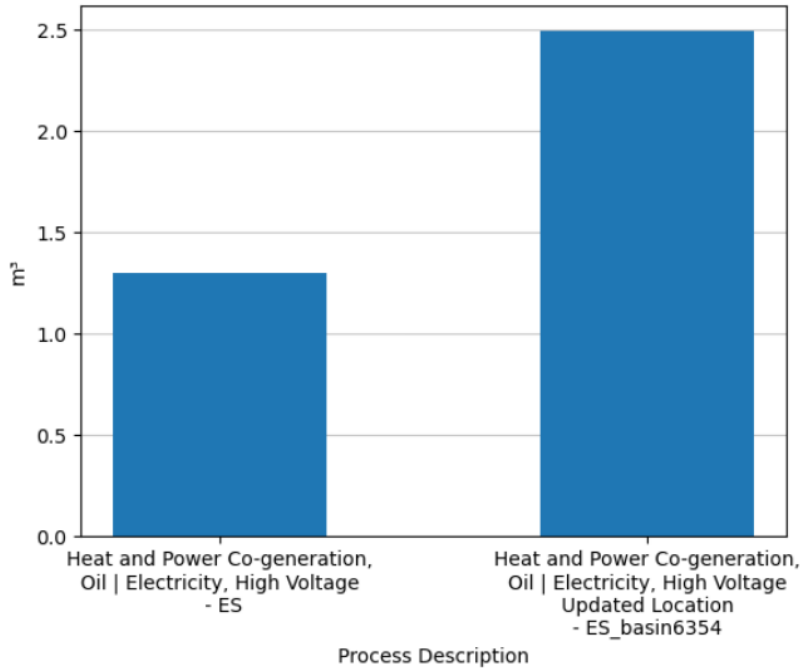
Characterization factors

Flow	Category	Factor	Unit	Uncertainty	Location
Water	Elementary flows/Emissio...	60.19999999999962	m3/m3	none	ES_basin6354
Water, cooling, unspecified natural origin	Elementary flows/Resourc...	60.19999999999962	m3/m3	none	ES_basin6354
Water	Elementary flows/Emissio...	31.411	m3/m3	none	ES
Water, cooling, unspecified natural origin	Elementary flows/Resourc...	31.411	m3/m3	none	ES

Comparison of impact results

- Impact result using the **CF for Spain**: 1.30139 m³ world-eq
- Impact result using region-specific **CF for Andalusia**: 2.49414 m³ world-eq





Data management perspective

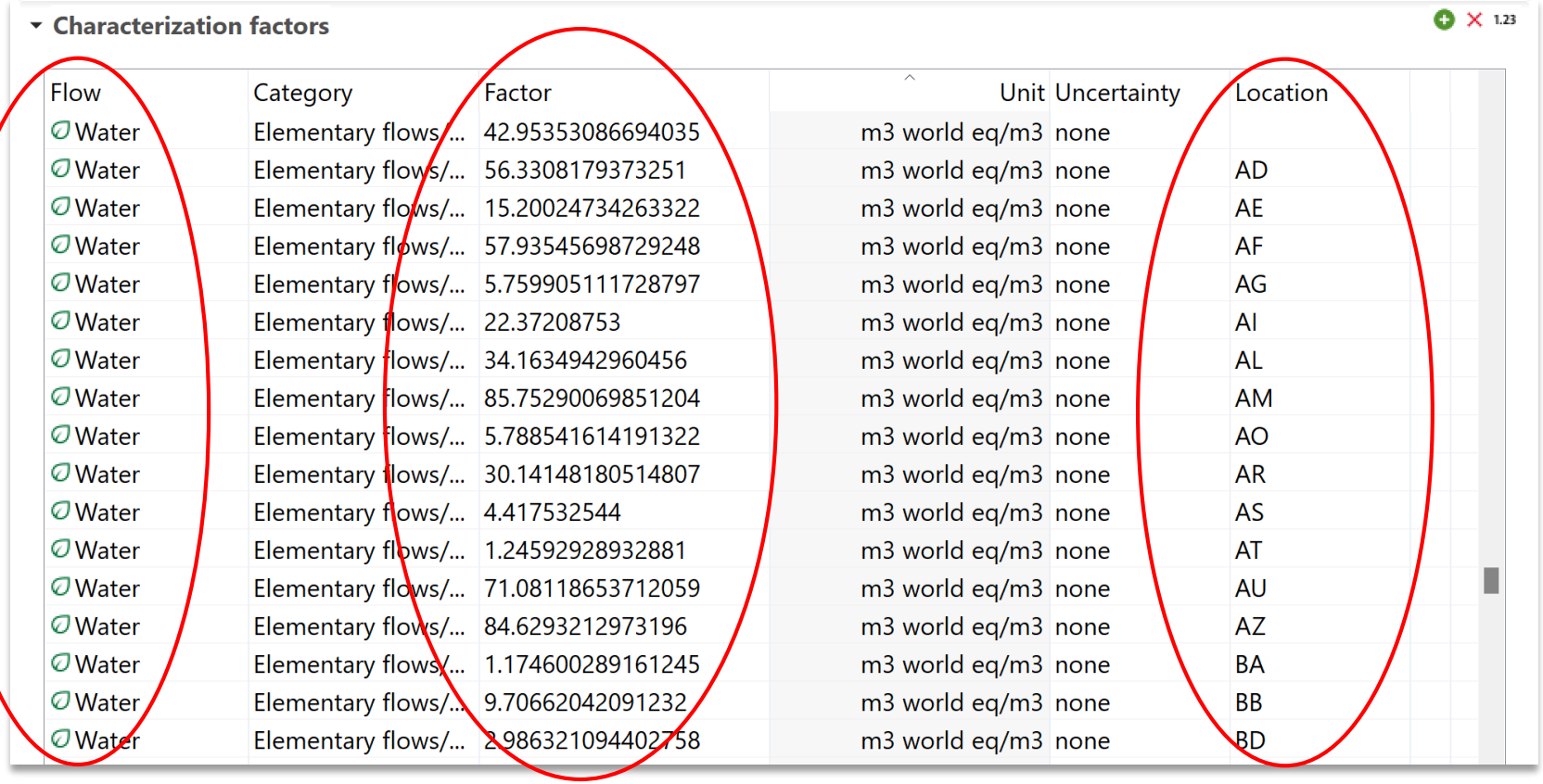
Location-based regionalization

Characterization factors

Flow	Category	Factor	Unit	Uncertainty	Location
Water	Elementary flows/...	42.95353086694035	m3 world eq/m3	none	
Water	Elementary flows/...	56.3308179373251	m3 world eq/m3	none	AD
Water	Elementary flows/...	15.20024734263322	m3 world eq/m3	none	AE
Water	Elementary flows/...	57.93545698729248	m3 world eq/m3	none	AF
Water	Elementary flows/...	5.759905111728797	m3 world eq/m3	none	AG
Water	Elementary flows/...	22.37208753	m3 world eq/m3	none	AI
Water	Elementary flows/...	34.1634942960456	m3 world eq/m3	none	AL
Water	Elementary flows/...	85.75290069851204	m3 world eq/m3	none	AM
Water	Elementary flows/...	5.788541614191322	m3 world eq/m3	none	AO
Water	Elementary flows/...	30.14148180514807	m3 world eq/m3	none	AR
Water	Elementary flows/...	4.417532544	m3 world eq/m3	none	AS
Water	Elementary flows/...	1.24592928932881	m3 world eq/m3	none	AT
Water	Elementary flows/...	71.08118653712059	m3 world eq/m3	none	AU
Water	Elementary flows/...	84.6293212973196	m3 world eq/m3	none	AZ
Water	Elementary flows/...	1.174600289161245	m3 world eq/m3	none	BA
Water	Elementary flows/...	9.70662042091232	m3 world eq/m3	none	BB
Water	Elementary flows/...	2.986321094402758	m3 world eq/m3	none	BD

Data management perspective

Location-based regionalization



Characterization factors

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Water	Elementary flows/...	42.95353086694035	m3 world eq/m3	none	
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Water	Elementary flows/...	9.70662042091232	m3 world eq/m3	none	BB
Water	Elementary flows/...	2.986321094402758	m3 world eq/m3	none	BD

Data management perspective

Flow-based regionalization

Characterization factors

Flow	Category	Factor	Unit	Uncertainty	Location
Water	Elementary flows/Emission to wa...	0.04295	m3/kg	none	
Water, AD	Elementary flows/Emission to wa...	74.67	m3/m3	none	
Water, AE	Elementary flows/Emission to wa...	18.56	m3/m3	none	
Water, AF	Elementary flows/Emission to wa...	57.2	m3/m3	none	
Water, AG	Elementary flows/Emission to wa...	13.66	m3/m3	none	
Water, AI	Elementary flows/Emission to wa...	22.37	m3/m3	none	
Water, AL	Elementary flows/Emission to wa...	23.12	m3/m3	none	
Water, AM	Elementary flows/Emission to wa...	85.45	m3/m3	none	
Water, AO	Elementary flows/Emission to wa...	7.986	m3/m3	none	
Water, AR	Elementary flows/Emission to wa...	47.1	m3/m3	none	
Water, AS	Elementary flows/Emission to wa...	4.418	m3/m3	none	
Water, AT	Elementary flows/Emission to wa...	1.267	m3/m3	none	
Water, AU	Elementary flows/Emission to wa...	72.11	m3/m3	none	
Water, AW	Elementary flows/Emission to wa...	100.0	m3/m3	none	
Water, AZ	Elementary flows/Emission to wa...	85.94	m3/m3	none	
Water, BA	Elementary flows/Emission to wa...	1.156	m3/m3	none	
Water, BB	Elementary flows/Emission to wa...	10.52	m3/m3	none	
Water, BD	Elementary flows/Emission to wa...	2.432	m3/m3	none	

Conclusions

- **Regionalized LCA** is essential for accurate evaluation of **localized impacts** like **water stress**
- Crucial for projects like **Flexby**, operating in regions with significant water scarcity, such as **Spain** and **Portugal**
- Results emphasize the value of **advanced LCA tools** for precise environmental evaluations
- Several **LCIA methods** (e.g., **AWARE**, **LC-IMPACT**, **TRACI**) are now regionalized and some use **geospatial data** to link CFs to local characteristics

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