



CIRCULANDIA

BUILDING CIRCULAR SOLUTIONS
FOR A SUSTAINABLE FUTURE.

Supporting Urban and Regional Decisions with System Dynamics Sustainability Assessment

A Framework and Toolset

Presented by Alexander Koch, GreenDelta

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Motivation: CIRCULANDIA



**Transform towards
regenerative
agriculture & local
circular nutrients**



**Transform
local food systems
for resilience and
equity**



**Scale reusable
takeaway packaging
systems**

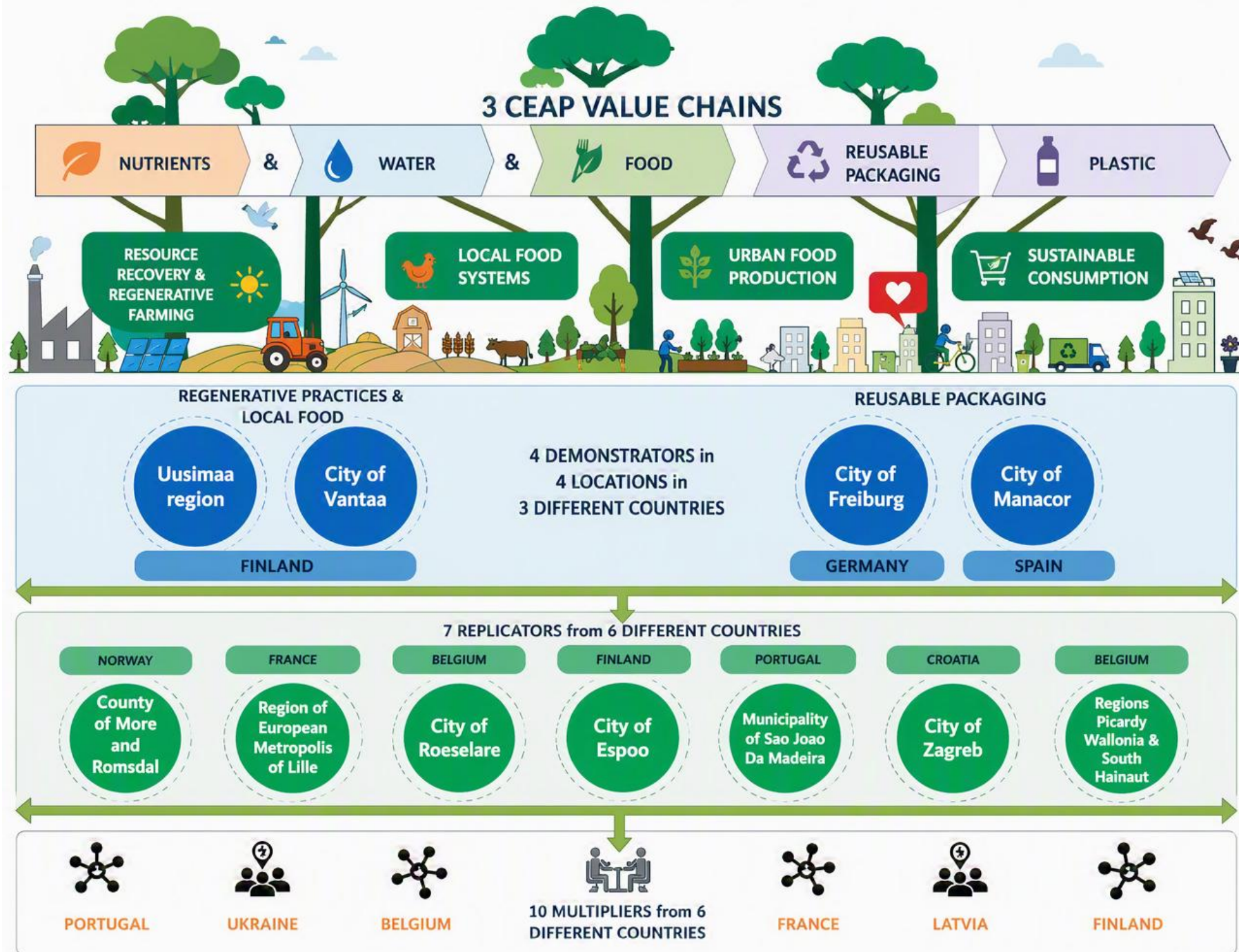


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From
demonstration
to wider
uptake



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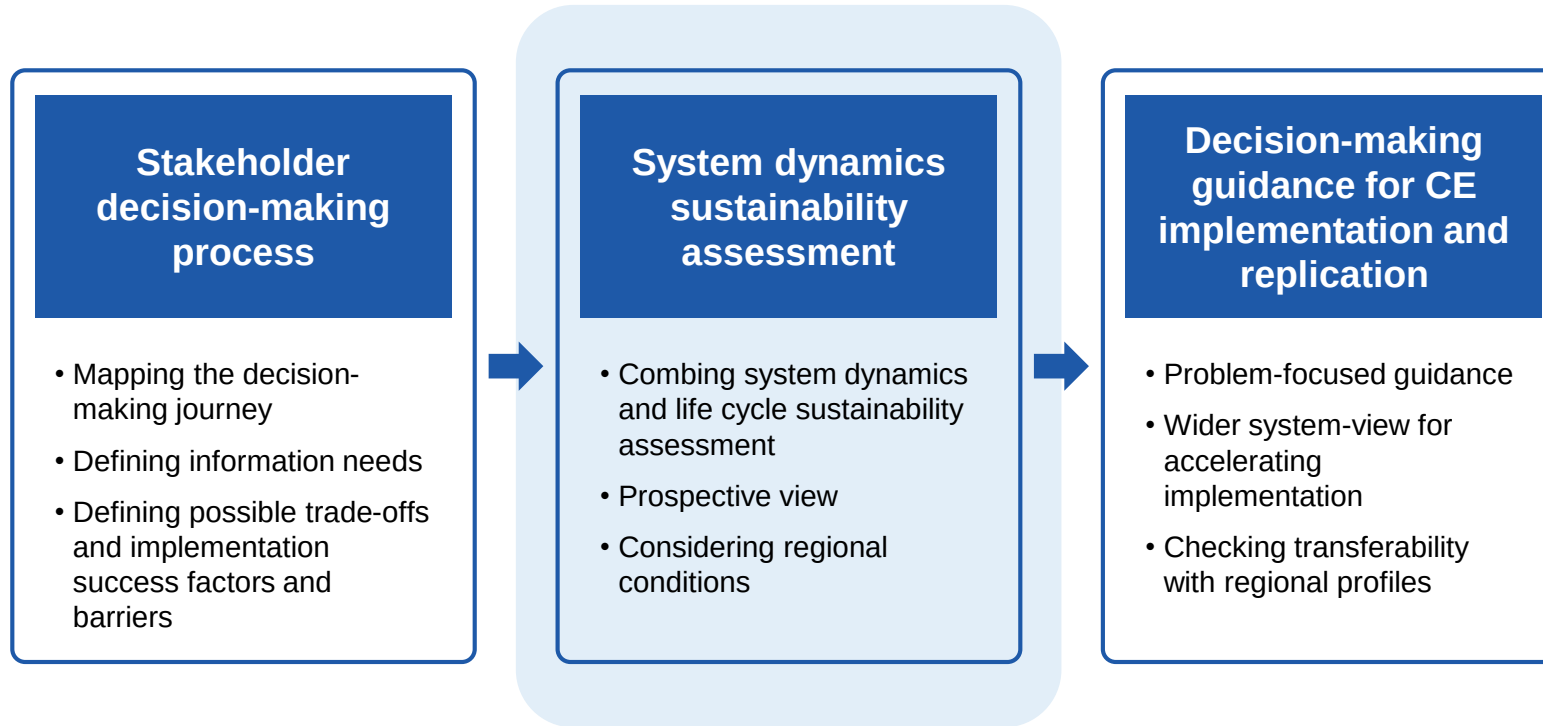
Decision-making support

Objective to quantify (potential) impact changes linked to (planned) circular economy (CE) solutions and thereby support decision-making during regional implementation and cross-regional replication of the CE solutions.

The **sustainability assessment** approach therefore needs:

- Prospective capabilities
- Consideration of regional conditions
- System-wide view (looking at e.g. socio-economic drivers and indirect effects)

Framework



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Why system dynamics?

Capability	Absolute sustainability assessment	Consequential LCA	Dynamic LCA	Prospective LCA	System dynamics + LCA
Time-dependant impacts	X	X	✓	✓	✓
Future transition scenarios	X	X	✓	✓	✓
Market effects and indirect consequences	X	✓	Limited	Limited	✓
Feedback loops	X	X	X	X	✓
Socio-economic drivers and barriers	X	X	X	X	✓
Resource constraints	✓	X	X	X	✓
Planetary boundaries / thresholds	✓	X	X	X	✓



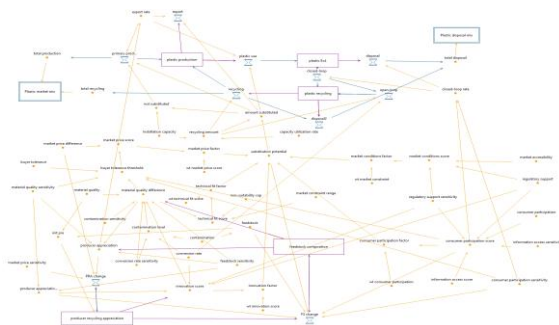
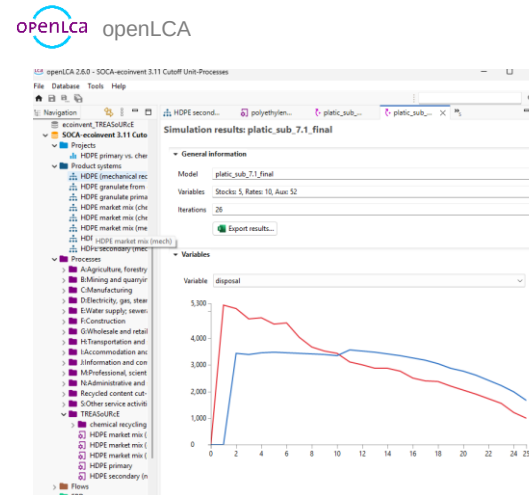
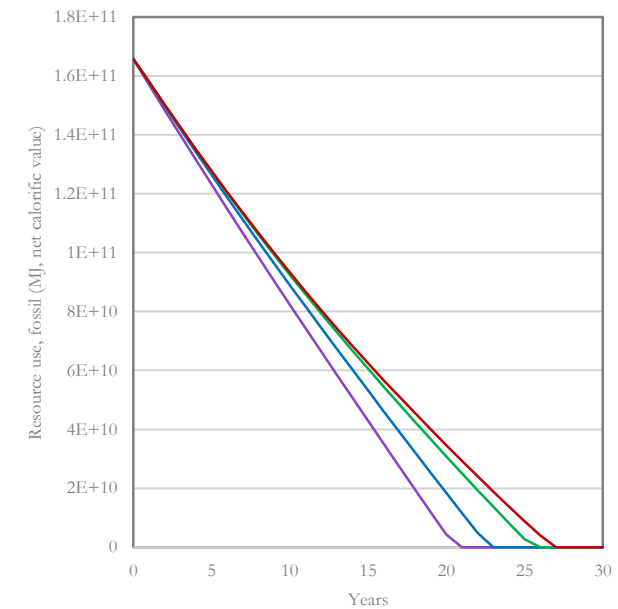
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System dynamics in openLCA



System dynamics
sustainability assessments

System dynamics model



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Example: Regenerative agriculture

Strategies

- Avoiding synthetic fertilizers
- Crop diversity
- Crop rotation
- Rotational grazing

Indicators

- Soil health
- Greenhouse gas emissions
- Biodiversity
- Water use
- Freshwater change
- Land system change

Modelling needs

- Dynamic context indicators
- Dynamic LCIA method
- Defined causal relationships



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Case study: Crop rotation

Case study assumptions

- Crop rotation over a 4-year cycle (wheat, barley, oats, rapeseed)
- On 20 ha of land in Vantaa, Finland
- Assess pressure on local environment (water, land, soil, ...)

Modelling needs

- Dynamic context indicators (local soil, climate and ecosystem characteristics)
- Dynamic LCIA method
- Simple system dynamics model

Prospective LCA with SD in openLCA

LCA Auxiliary

Name: p_AWARE

Unit: m3 world eq. / m3

Non-negative: ☐

Type: Lookup function

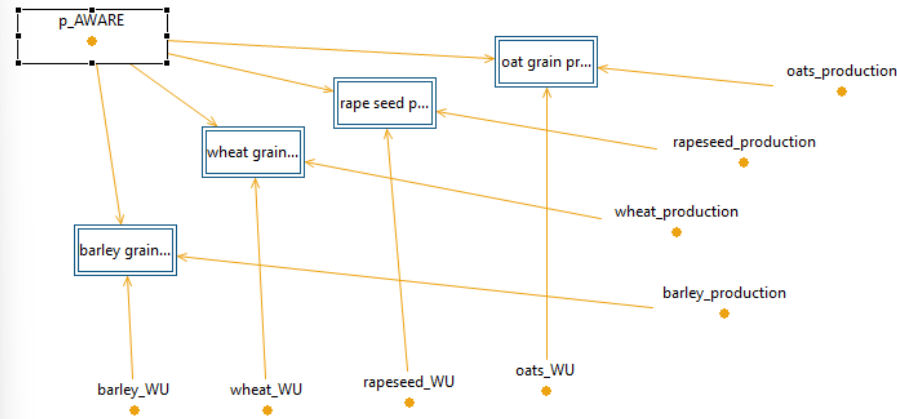
Equation for x:

TIME

Lookup values - linear interpolation

x	y
1.0	1.77
2.0	2.06
3.0	1.46
4.0	0.974
5.0	1.33
6.0	1.69
7.0	2.32
8.0	3.5
9.0	5.03
10.0	2.48

OK Cancel



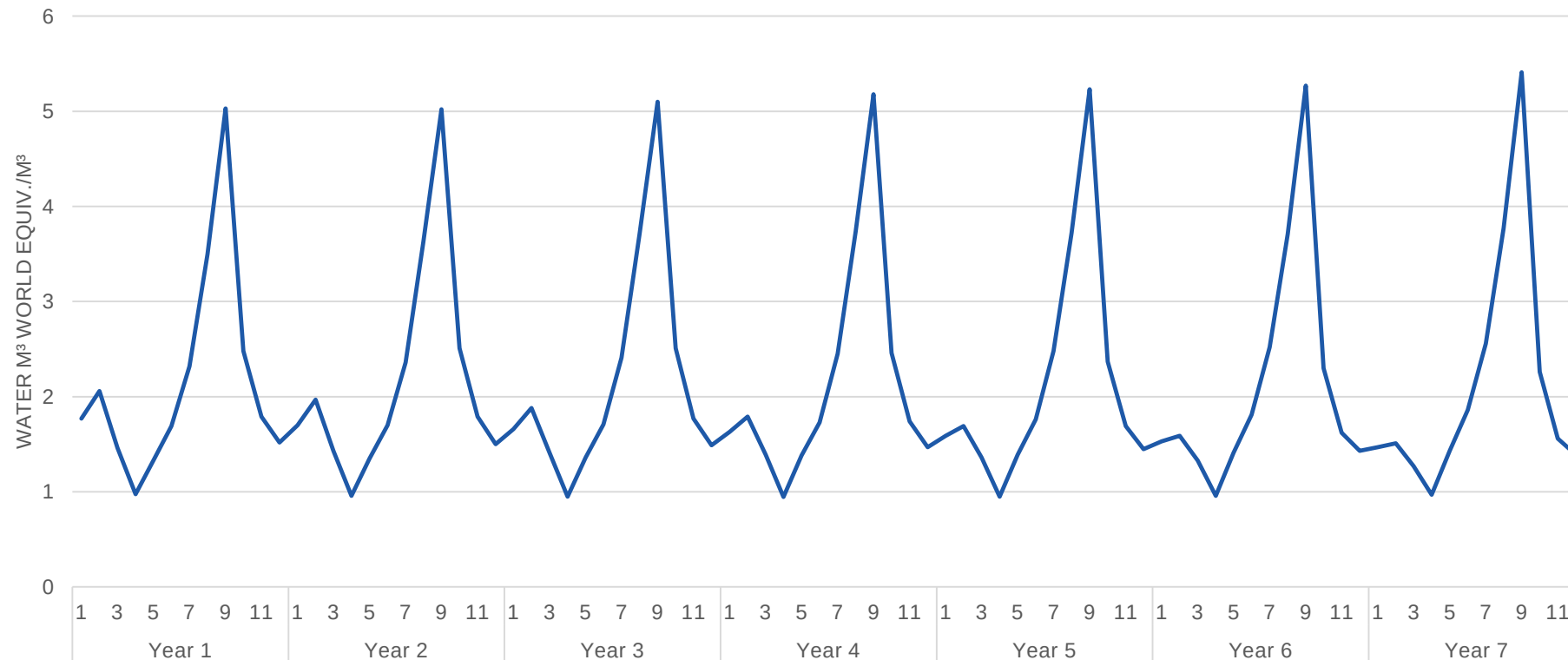
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Dynamic LCIA method

AWARE 2.0 characterisation factors for Finland



Seitfudem, G., Berger, M., & Boulay, A.-M. (2026). *Harnessing model ensembles to assess uncertainty and provide prospective characterization factors for AWARE2.0*; 10.1007/s11367-026-02648-7

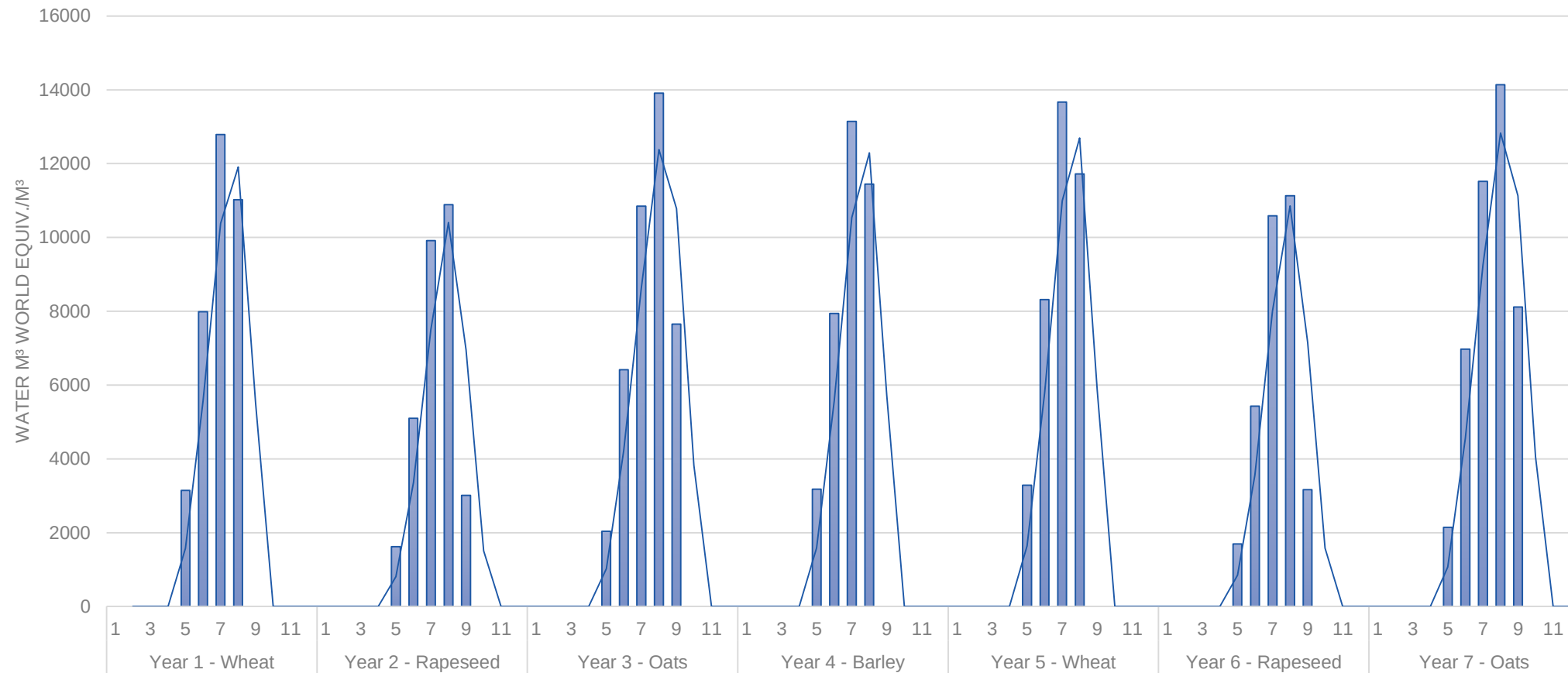


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Prospective LCA results

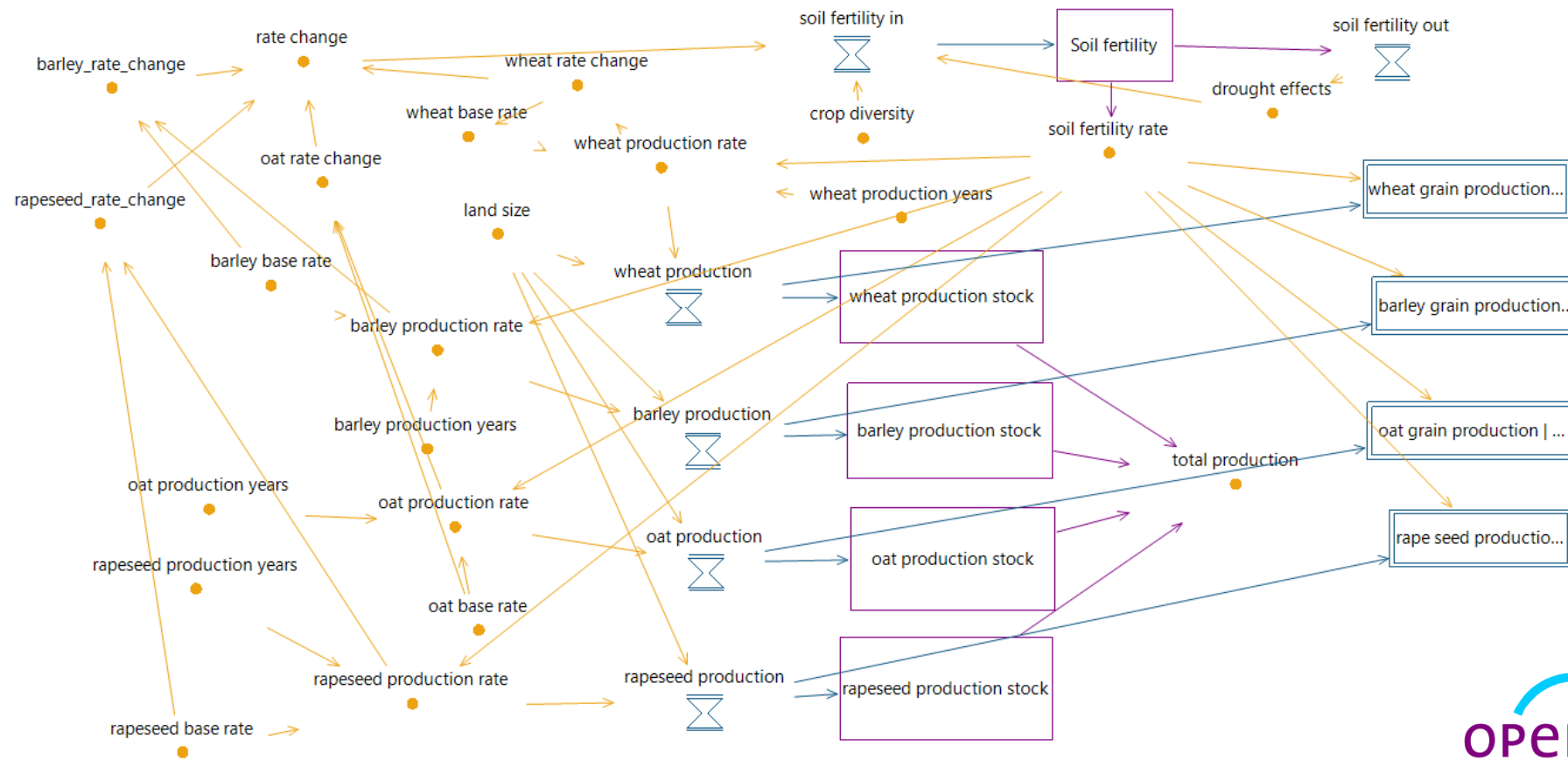


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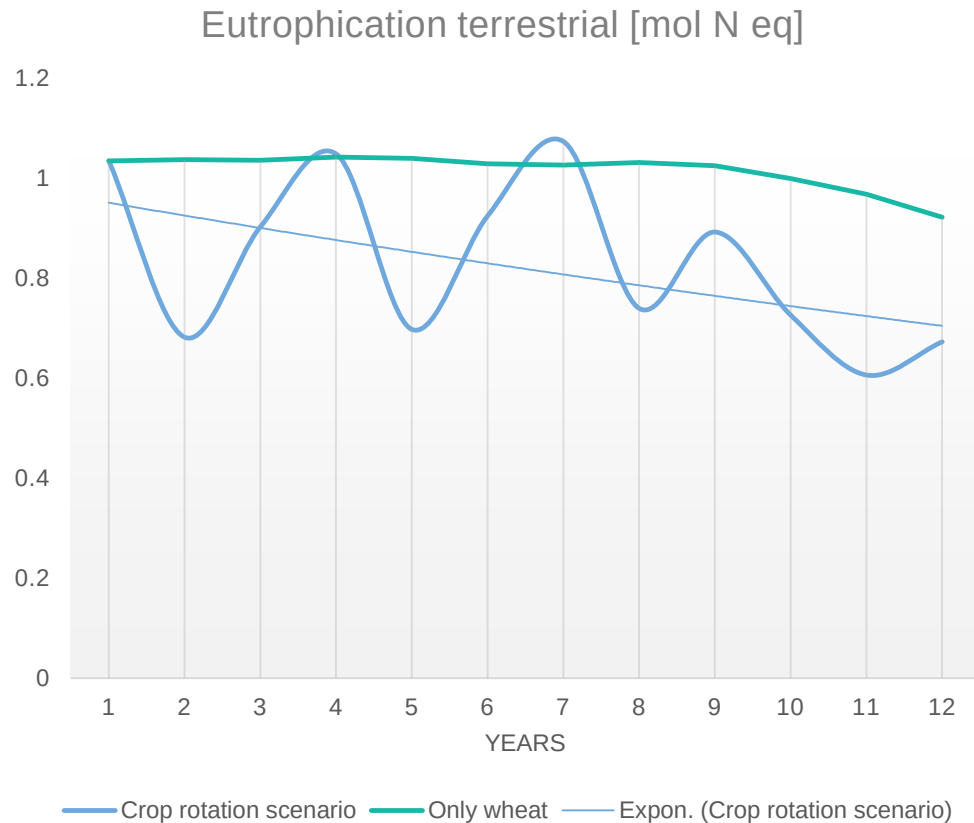
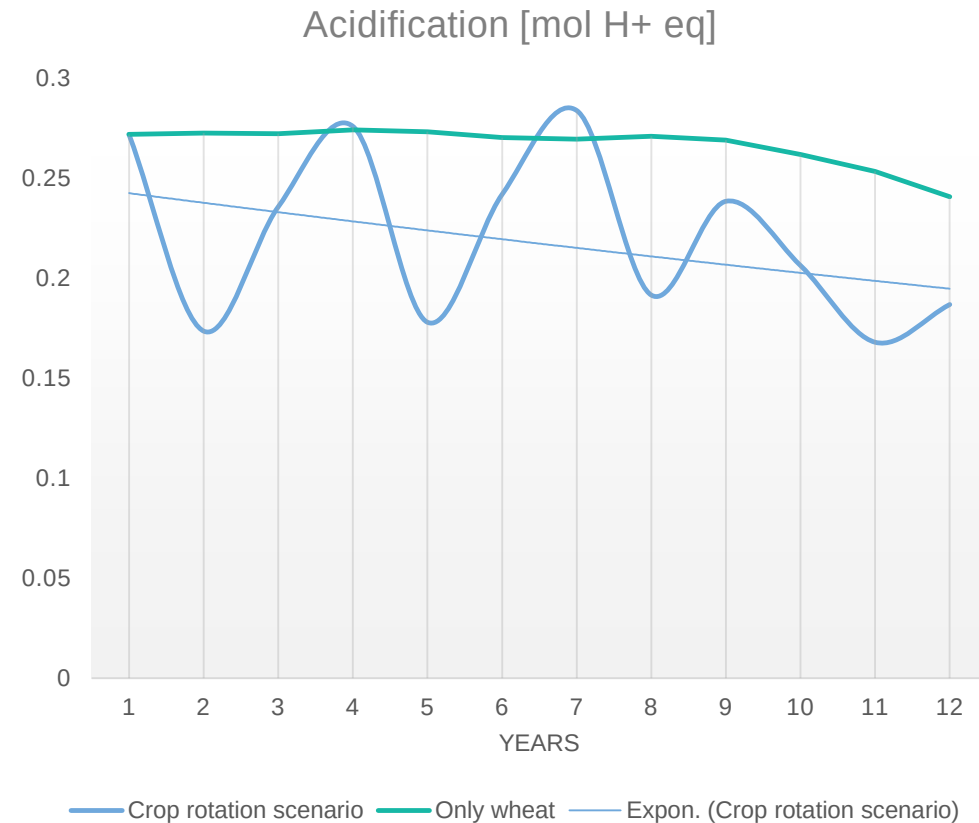


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Modelling with feedback loops



Dynamic LCA results



Conclusion

- Need a more extensive sustainability assessment framework for supporting decision-making
- openLCA now has a system dynamics modelling feature
- So, a toolset that allows temporalized and regionalized sustainability assessments
- Next steps: extend the framework, data collection, conduct full sustainability assessments



Thank you!

Alexander Koch

koch@greendelta.com