

Applying systems thinking to chemistry and agriculture for sustainability

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Chemists for Sustainability



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I O C D

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Systems Thinking

- One of the **key competencies** essential for achieving sustainability¹
= ability to analyse, understand and interpret complex systems²
- Sustainability is a property of the whole system
– it is not simply a property of individual elements of the system³
- Systems-Oriented Concept Map Extension **SOCME**⁴
= **visualization tool** to assist in teaching, learning and practicing ST in chemistry
* value in constructing a SOCME lies primarily in the fact that it **guides the analysis process**, encouraging thinking about where the materials and energy come from, where they go and what effects they may have; **indicates specially sensitive areas** where major sustainability challenges arise; and **supports questioning about and exploration of alternatives**.

¹ A. Wiek, L. Withycombe, C.L. Redman. *Sustainability Sci.* 2011, 6, 203–218, <https://doi.org/10.1007/s11625-011-0132-6>

² D. H. Meadows, . *Thinking in Systems: A Primer.* Earthscan, London 2009. <https://wtf.tw/ref/meadows.pdf>

³ F. Ceschin, I. Gaziulusoy. *Design Studies* 2016, 47, 118-163, <https://doi.org/10.1016/j.destud.2016.09.002>

⁴ P.G. Mahaffy, S.A. Matlin, T.A. Holme, J. MacKellar. *Nature Sustainability* 2019, 2, 362-370, <https://doi.org/10.1038/s41893-019-0285-3>

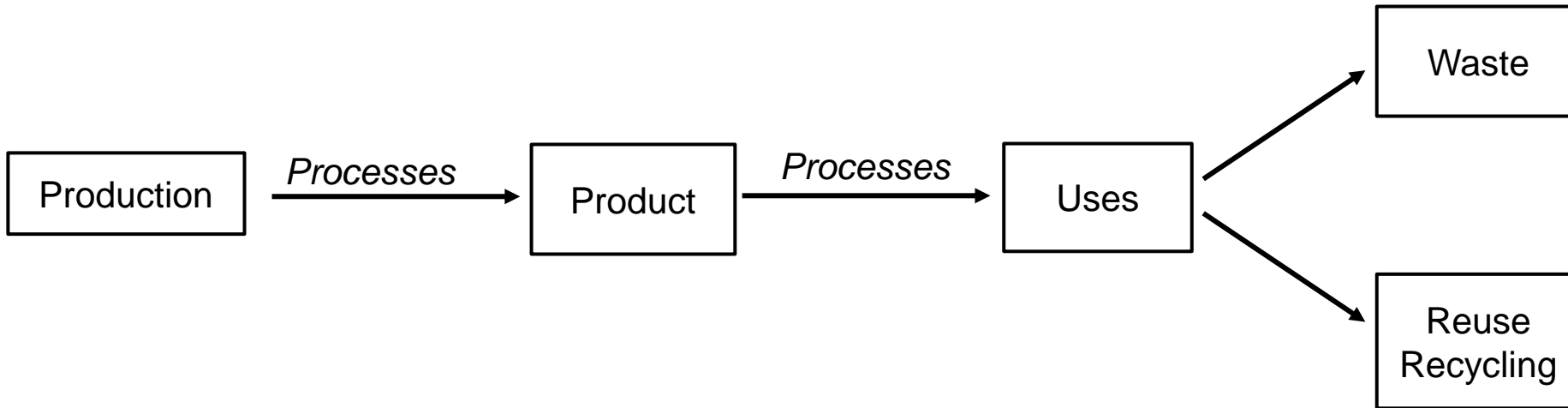
K.B. Aubrecht, Y.J. Dori, T.A. Holme, R. Lavi, S.A. Matlin, M. Orgill, H. Skaza-Acosta. *J Chem Educ* 2019, 96, 2888-2900, <https://doi.org/10.1021/acs.jchemed.9b00314>

ATMOSPHERIC SYSTEM

LAND SYSTEM

AQUATIC SYSTEM

**BIOLOGICAL &
ECOLOGICAL
SYSTEMS**



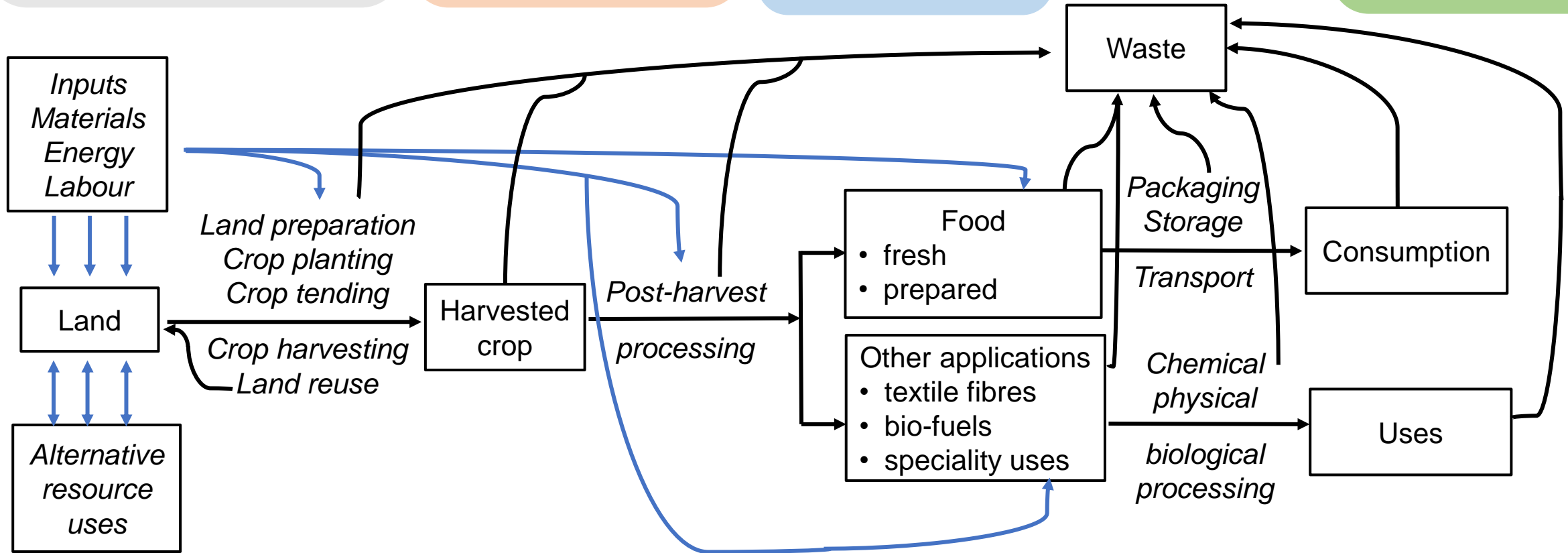
HUMAN SYSTEM

ATMOSPHERIC SYSTEM

LAND SYSTEM

AQUATIC SYSTEM

BIOLOGICAL & ECOLOGICAL SYSTEMS



HUMAN SYSTEM

Workshop

Select an agricultural material (input or output), or group of agricultural materials with similar uses/profiles

- Sketch a flow chart that begins with agricultural production and ends with post-use fate
- Develop the outlines of a SOCME for this sequence, considering at steps along the way:
 - what inputs are required and where they come from
 - what outputs are generated and their fate
 - possible types of impacts of the processes on Earth and societal systems
- Identify areas which are the major contributors to the [lack of] sustainability of the entire system for your chosen product(s).
 - What kinds of solutions might be most appropriate – e.g. which steps would benefit from new chemistry/technologies and which would be improved by changes in human attitudes or behaviours?
- What were the most important lessons from conducting the exercise?