Carbon footprintof aquaculture –what circularity can change in the context of tropical aquaculture?

Joël Aubin

Carbon footprint of aquaculture – what circularity can change in the context of tropical aquaculture

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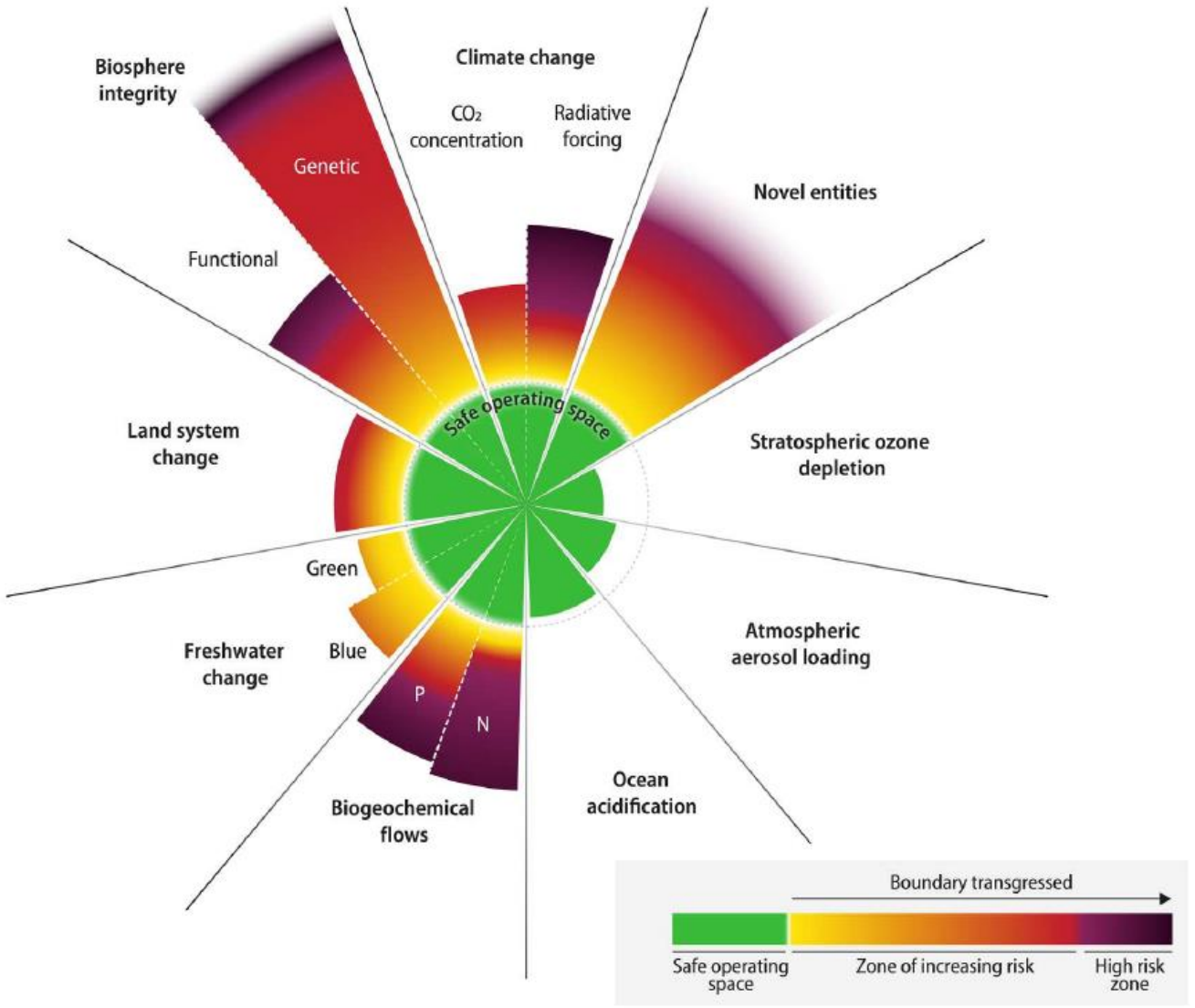
Content

- What is carbon footprint?
- Stake for aquaculture?
- What is circularity in aquaculture?
- What does it change in C footprint?

Planetary Boundarie



Richardson *et al.*, *Sci. Adv.* **9**, eadh2458 (2023) 13 September 2023

What is carbon footprint?

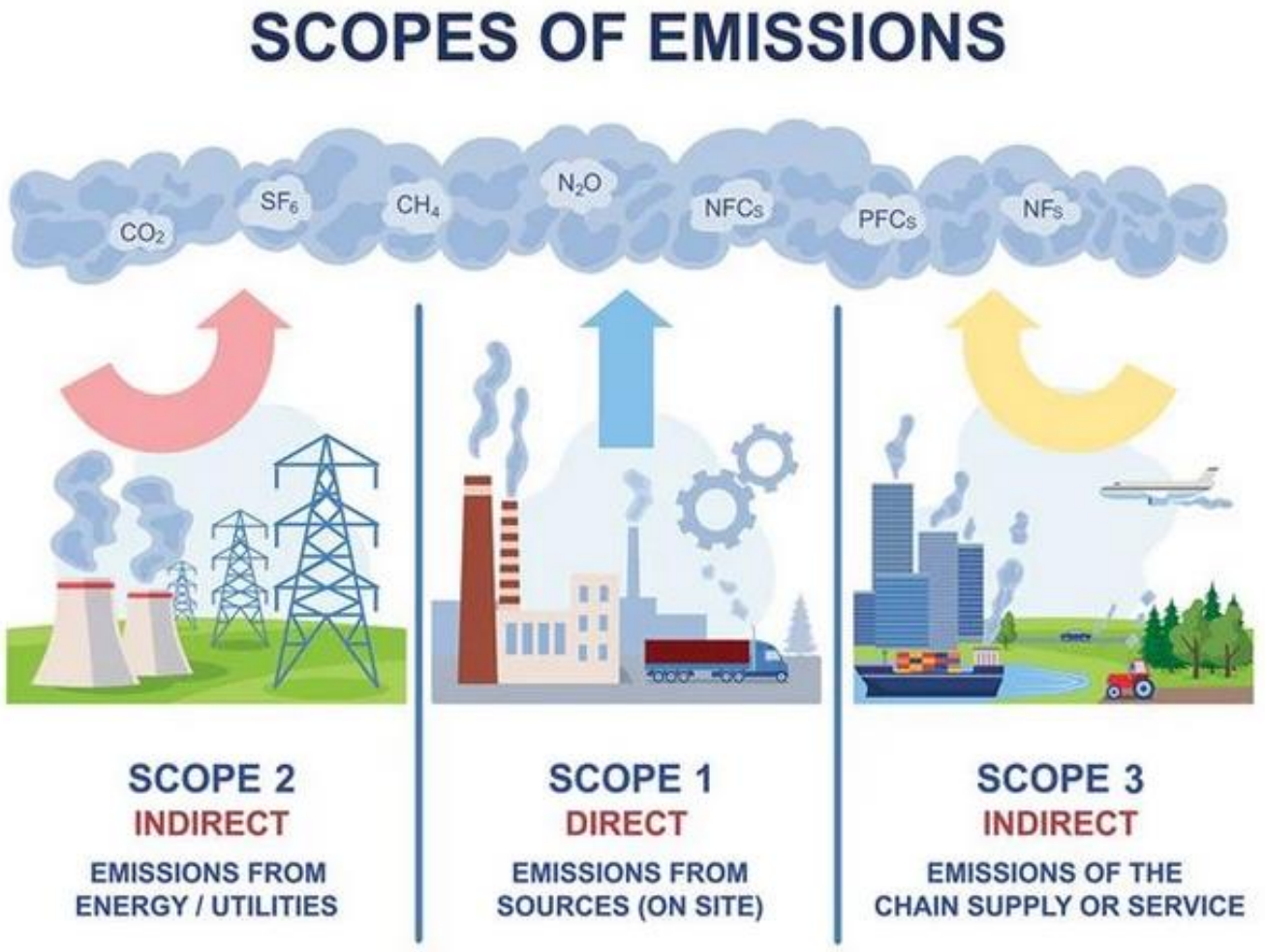
Carbon footprint

- A calculated value
- To compare the total amount of greenhouse gases
- Of an activity, product, company or country emits to the atmosphere
- Reported in tonnes of emissions of CO_2 equivalent per unit of comparison (ex : year, kg of product, km travelled, $, inhabitant...).
- Includes the emissions for the entire life cycle, from the raw material extraction (energy production) along the supply chain, up to its final consumption and disposal.
- Organization's carbon footprint includes the direct as well as the indirect emissions that it causes (Scope 1, 2 and 3 emissions*)*
- Several methodologies and online tools to calculate the carbon footprint.

=> Life Cycle Assessment

Scope 1, 2 & 3 carbon emissions

The 3 scopes are a way of categorising the different types og greenhouse gas emissions created by company, its suppliers and customers

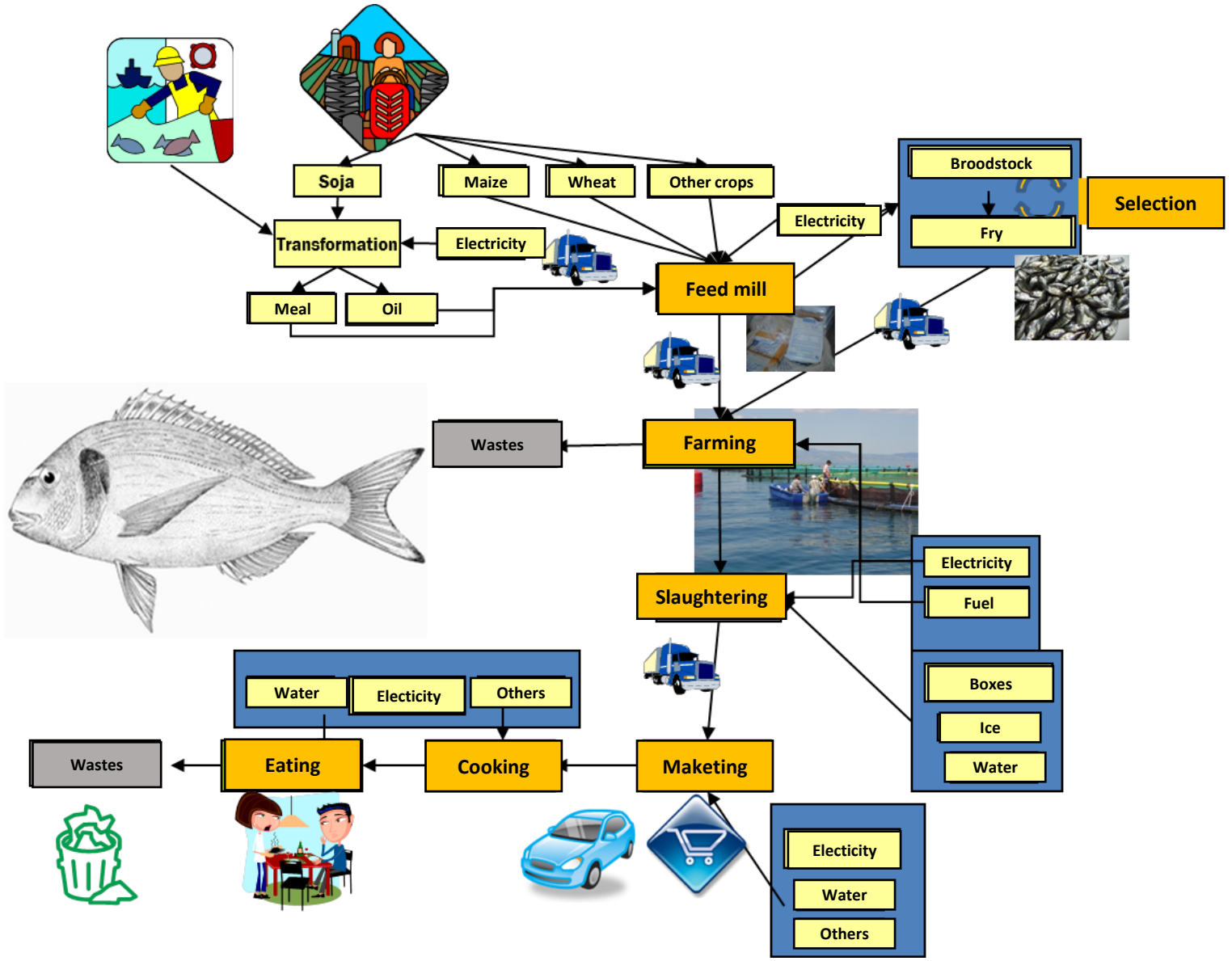


From GHG Protocol

Goal and scope

System boundaries

Fild'Or Project
(Acosta-Alba et al. 2014)



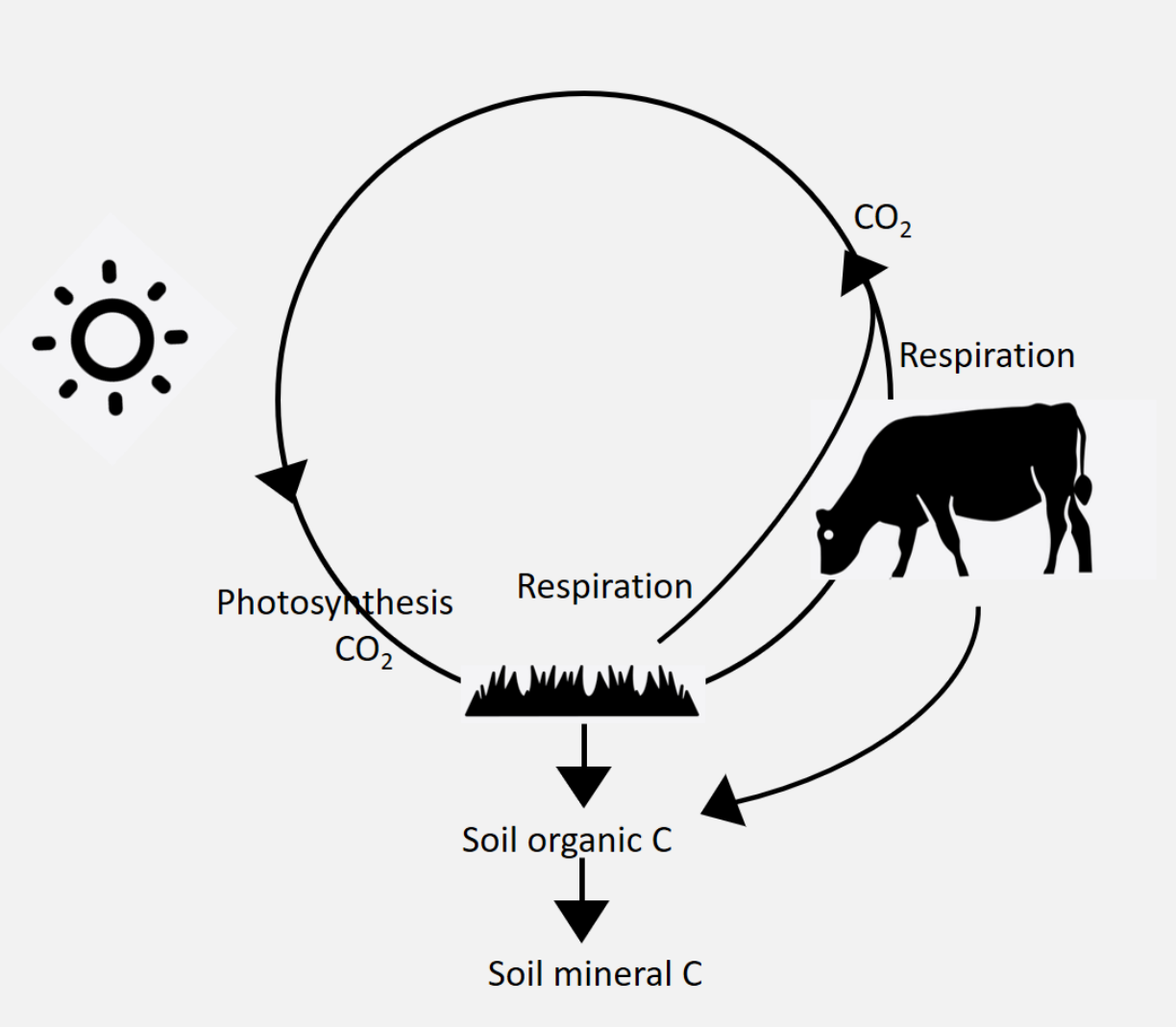
Global Warming Potential

Molecule	Global Warming Potential
CO_2	1 $kgCO_2eq$
CH_4	27 $kgCO_2eq$
N_20	298 $kgCO_2eq$
SF_6	23,900 $kgCO_2eq$

Calculated for a 100-year horizon

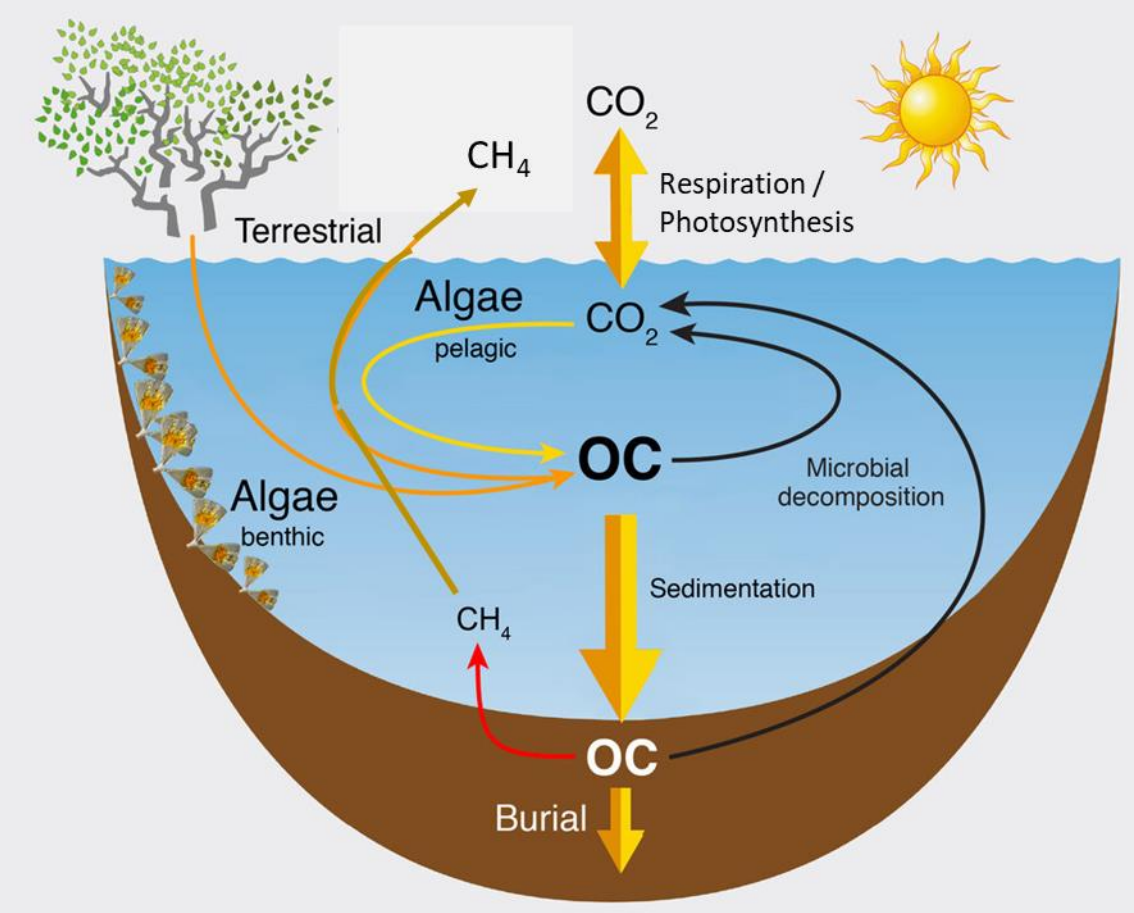
Source: Intergovernmental Panel on Climate Change.

Biogenic carbon cycle



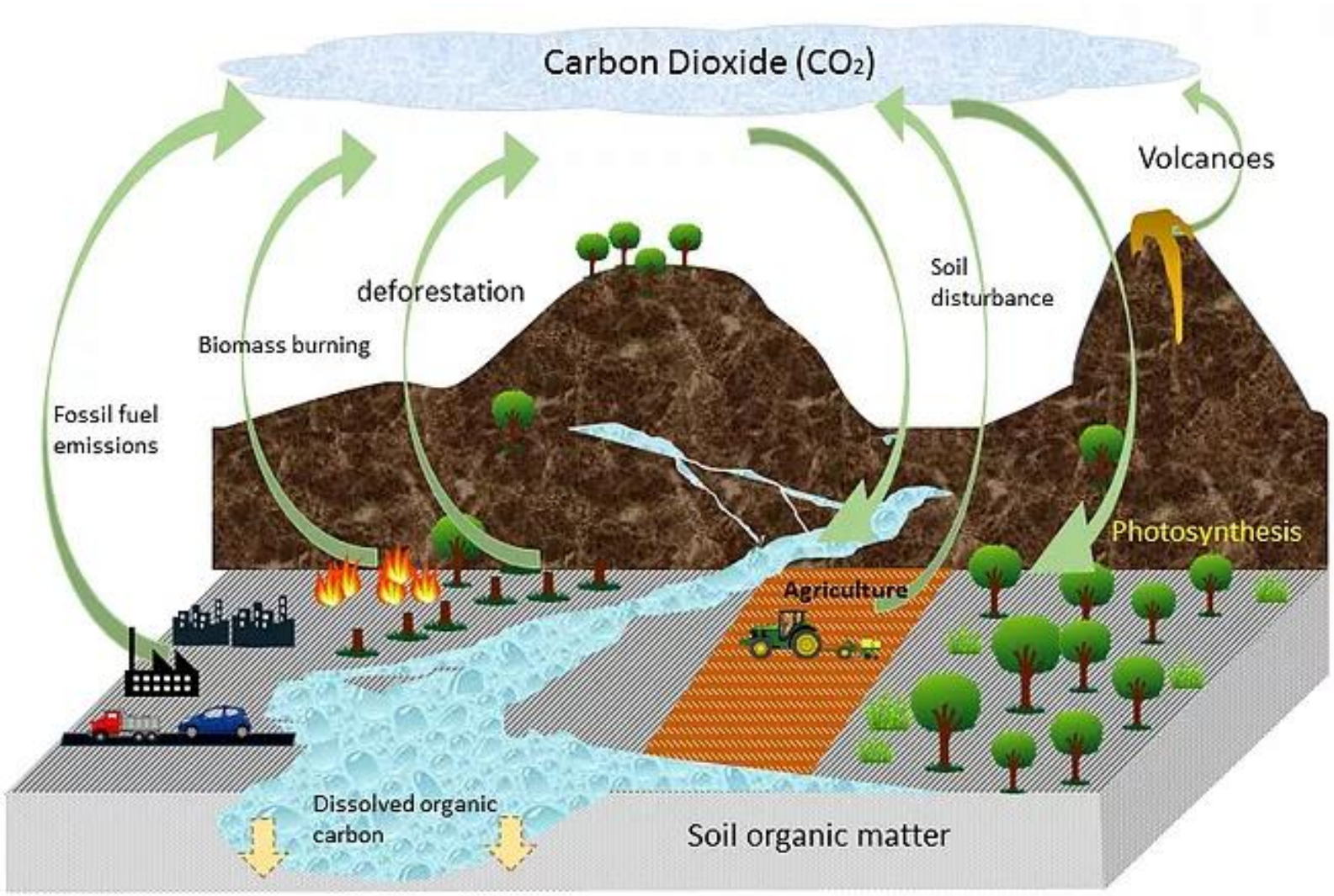
Icons: @ the Noun Project

Carbon cycle in aquatic systems



Adapted from
Climate Impact Research Centre

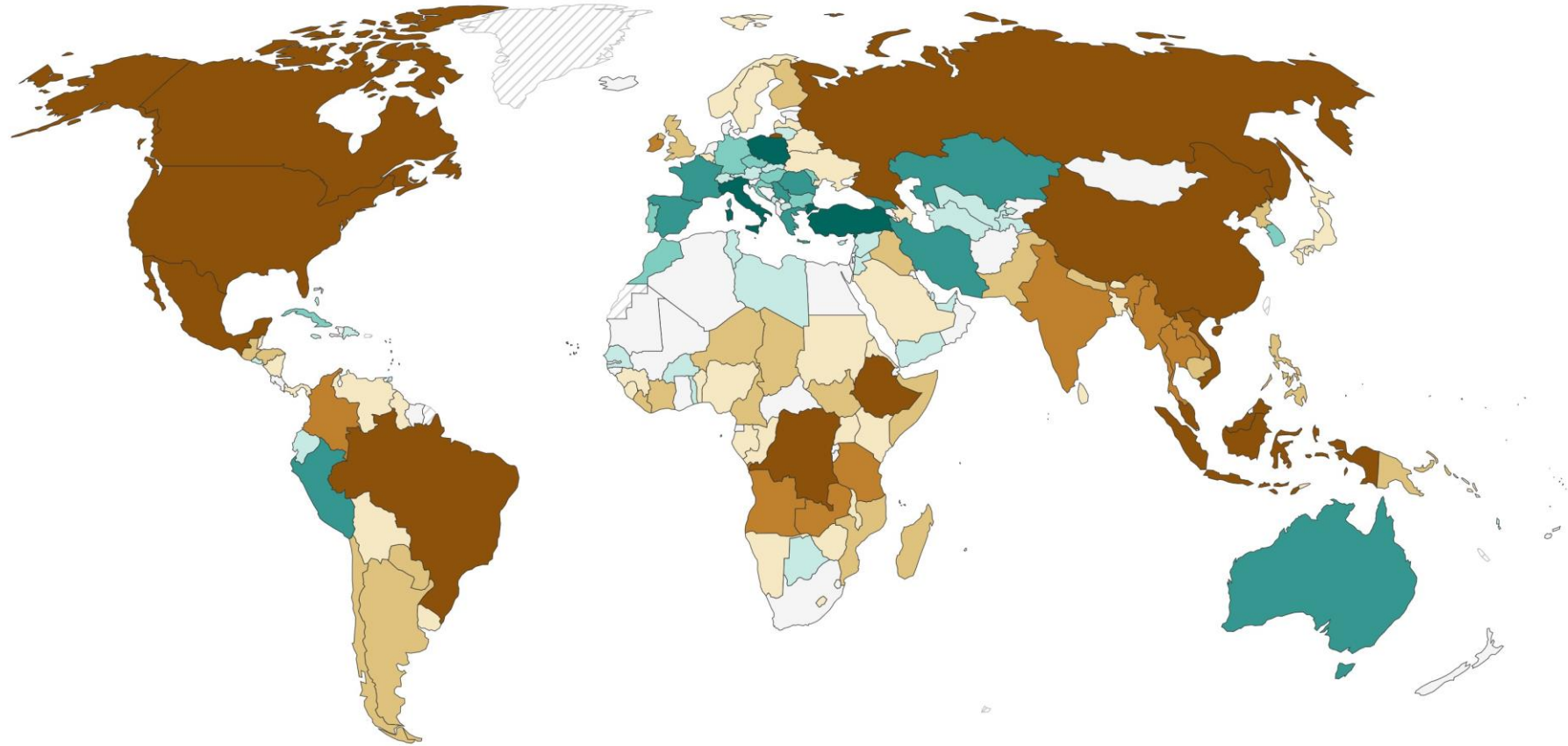
Carbon Cycle in land use and land use change



Annual CO_2 emissions from land-use change, 2022

Our World in Data

Emissions from land-use change can be positive or negative depending on whether these changes emit (positive) or sequester (negative) carbon.

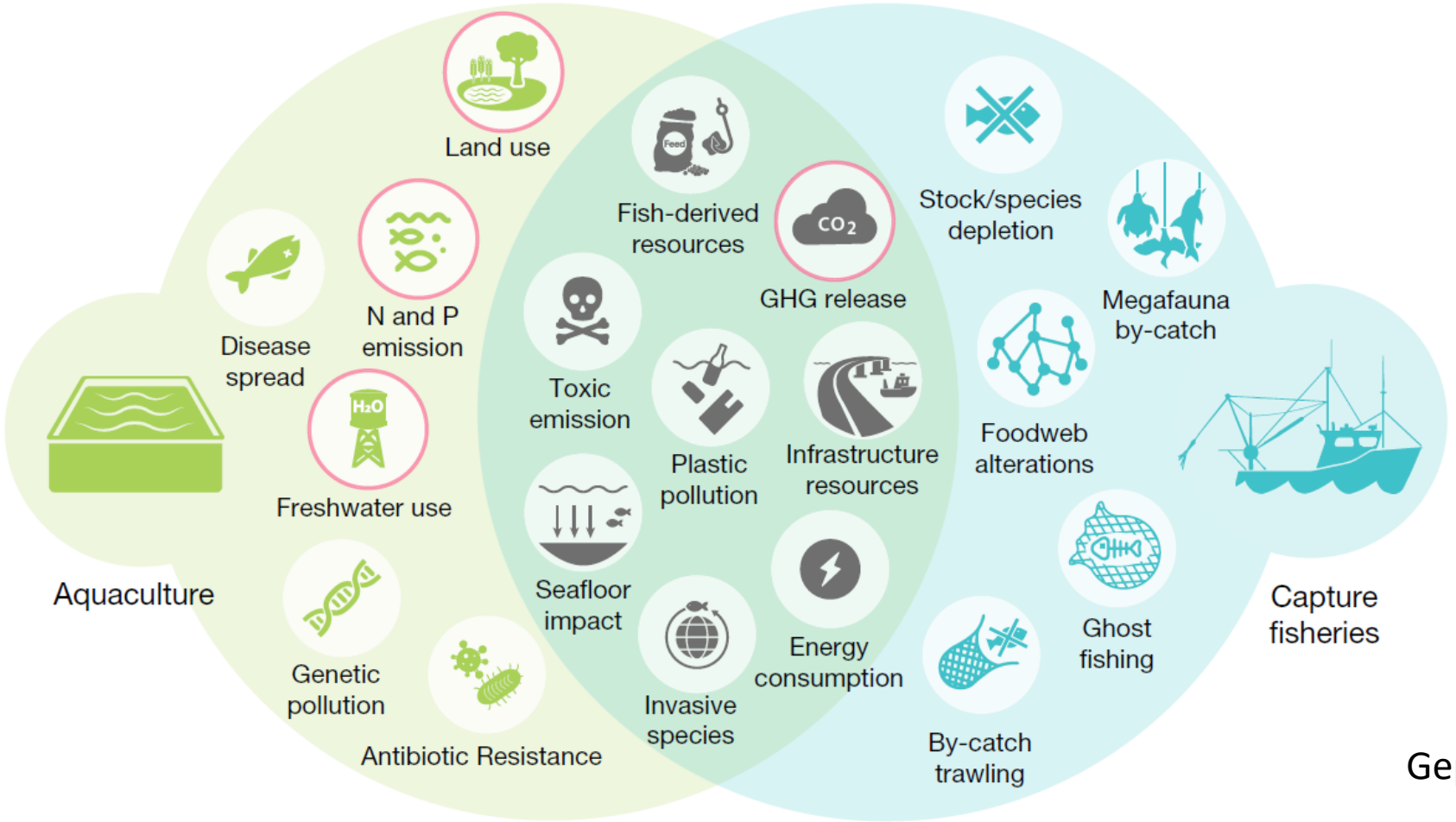


Data source: Global Carbon Budget (2023)

OurWorldInData.org/co2-and-greenhouse-gas-emissions | CC BY

Challenges for aquaculture

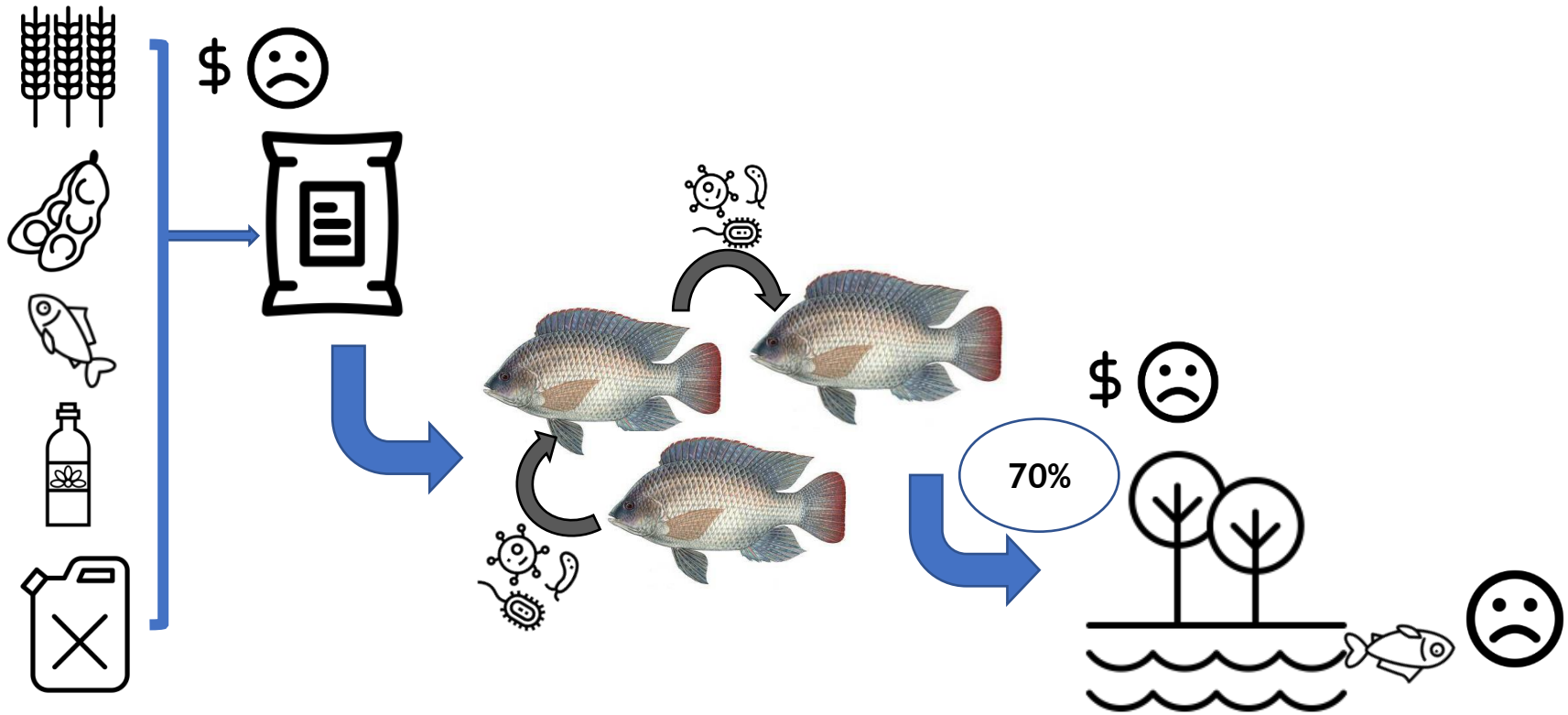
Environmental challenges



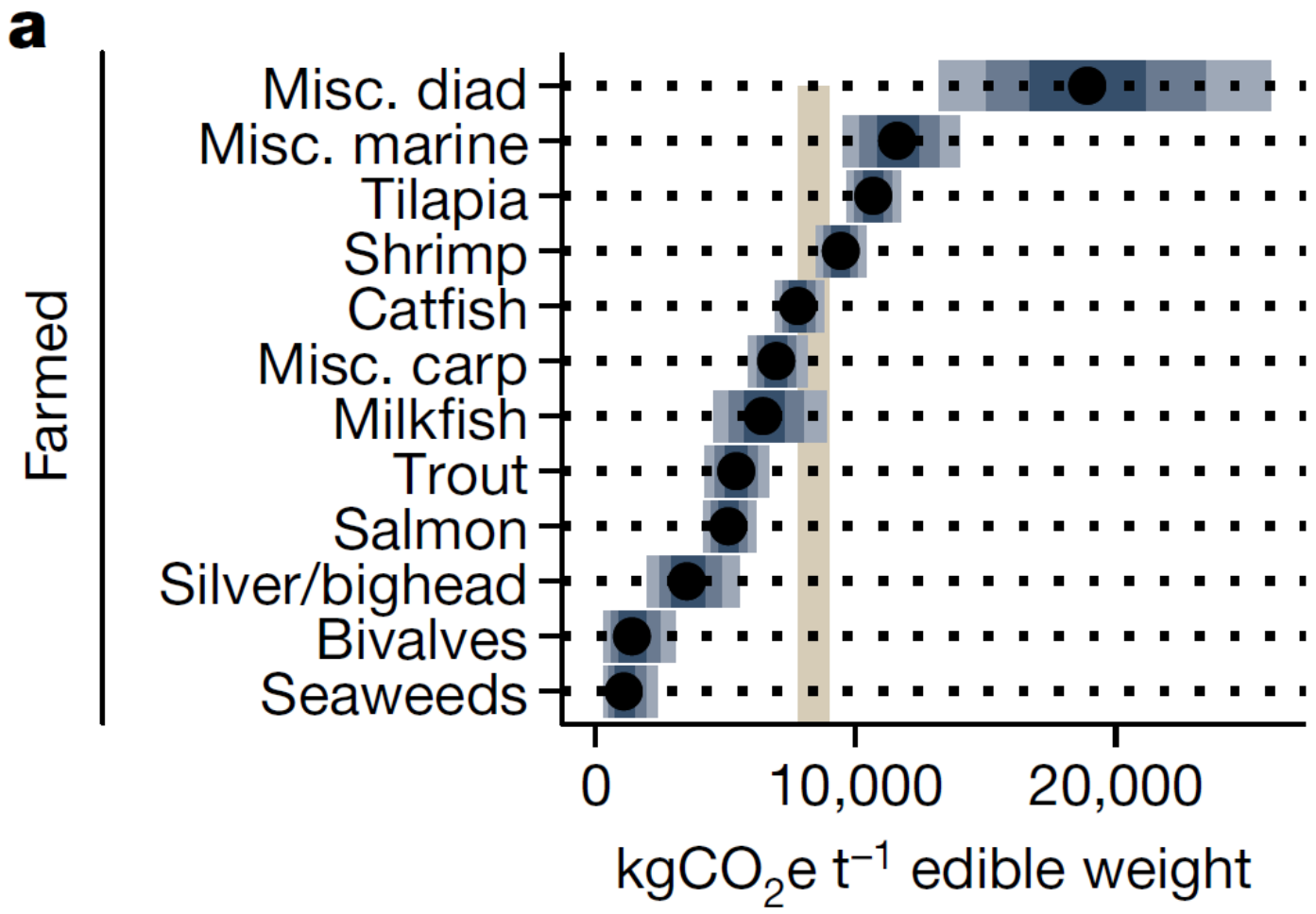
Gephart et al. 2021

Major stressors stemming from aquaculture and capture fisheries

Intensive fish monoculture farming drawbacks

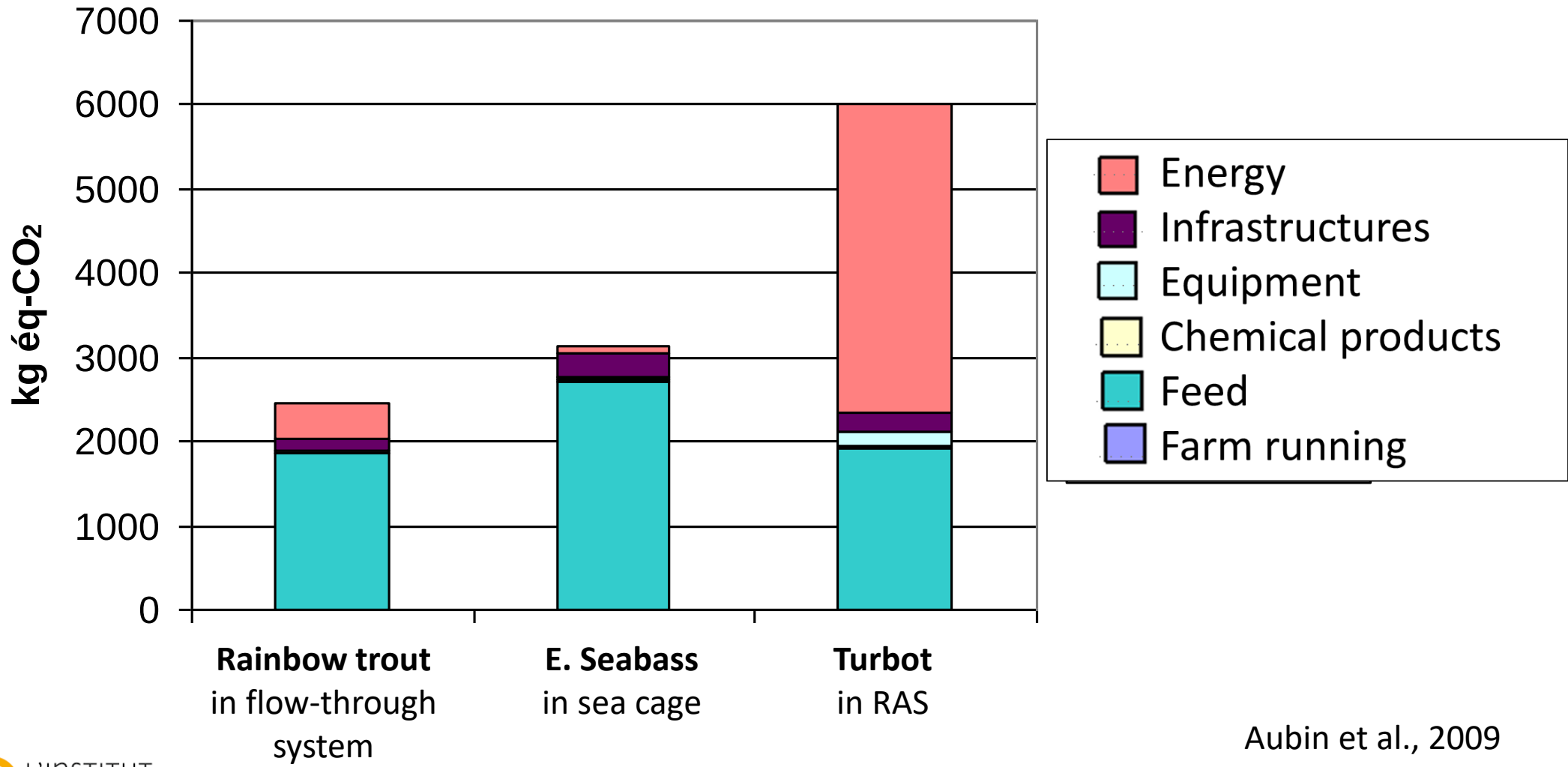


Climate change potential of aquaculture, compared to poultry production



Gephart et al. 2021

Climate change potential for 1 ton of fish



Aubin et al., 2009

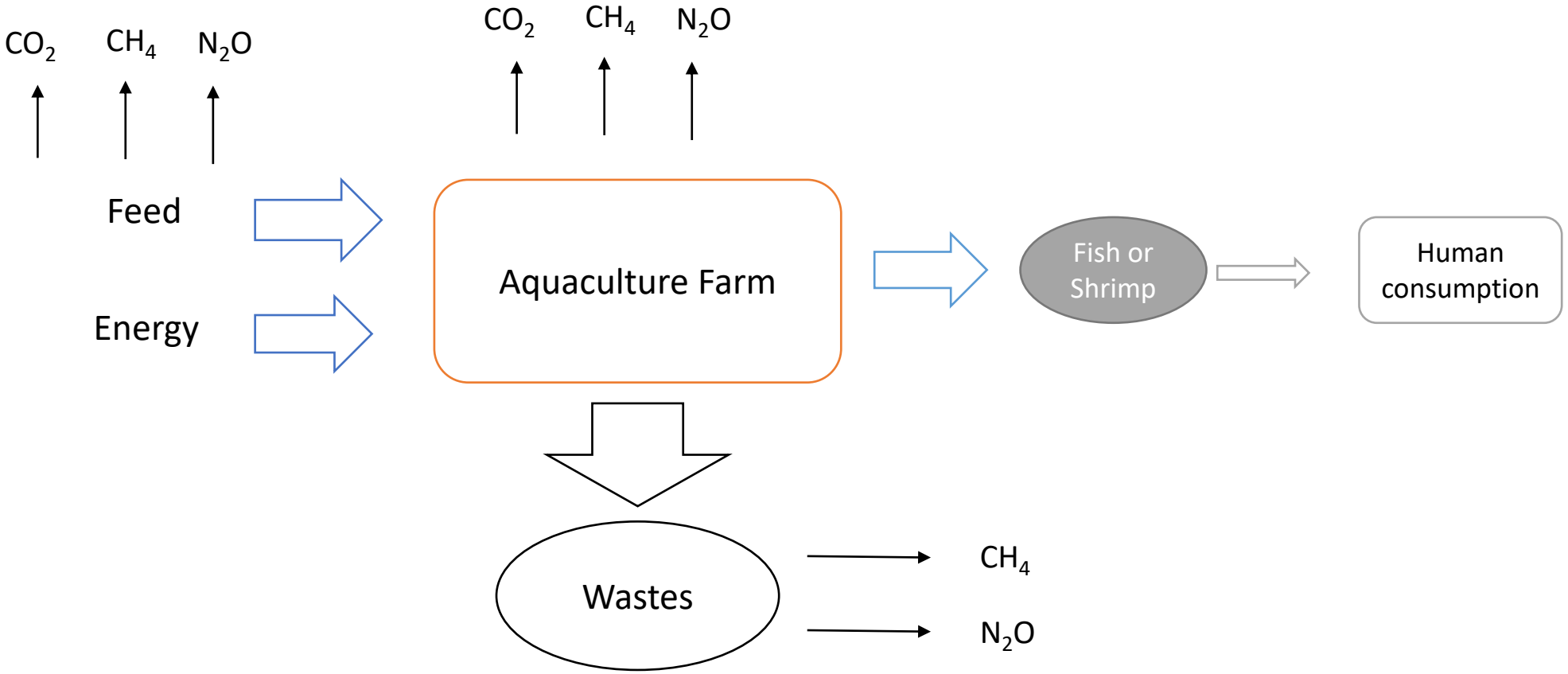
Circularity in aquaculture

Circular economy

- Economic system
- human society is interrelated with nature
- aiming to prevent the depletion of resources,
- closing energy and materials loops
- facilitating sustainable development
- implementation at the micro, meso and macro levels’

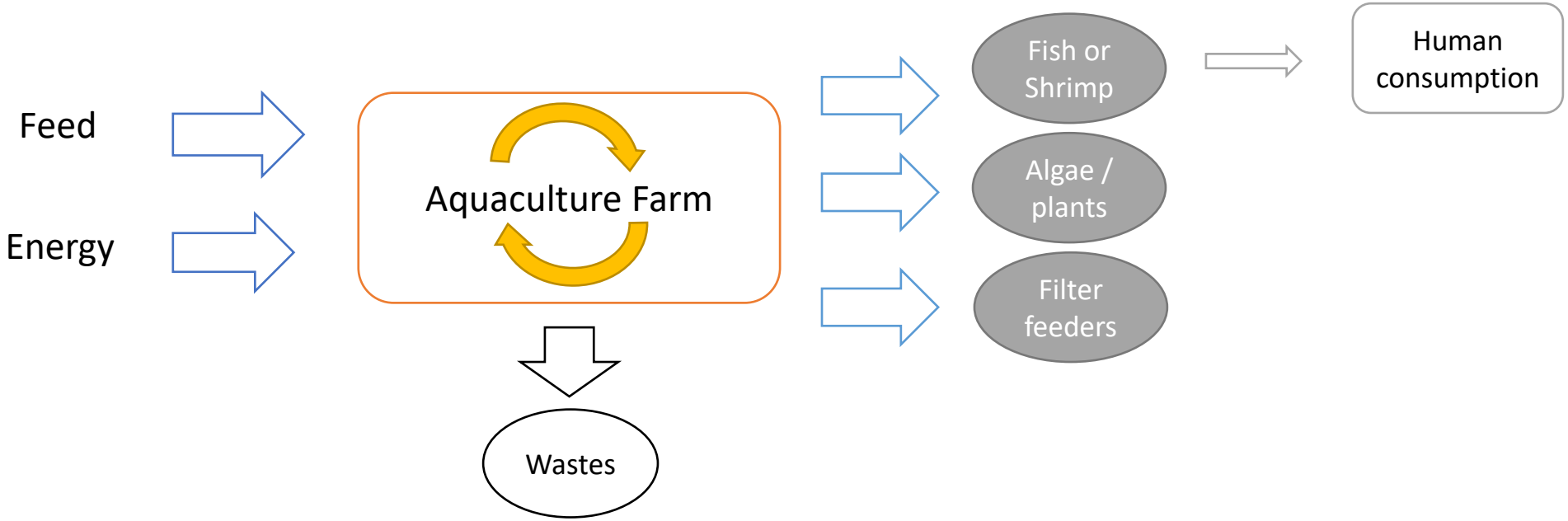
Prieto-Sandoval et al. (2018)

What can we expect from circularity in a C-footprint perspective?



What can we expect from circularity in a C-footprint perspective?

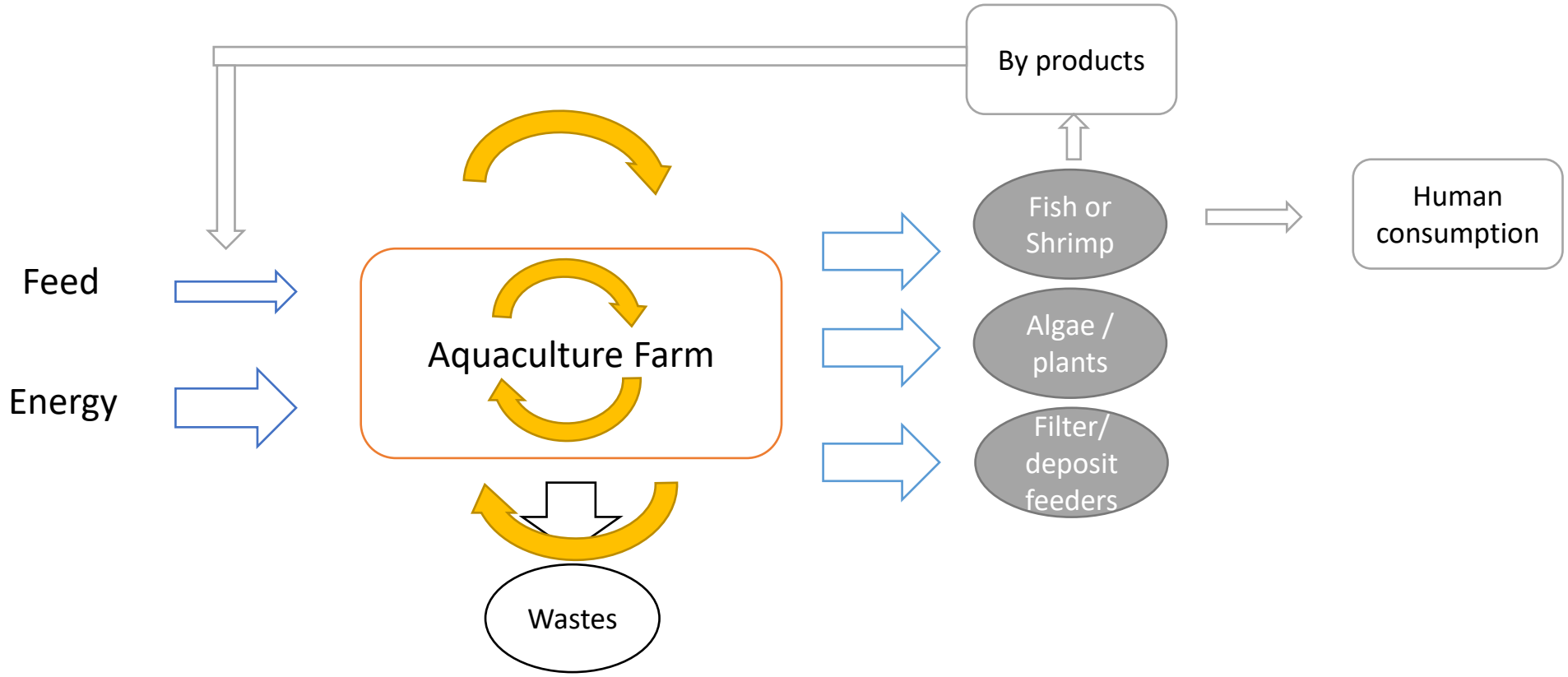
At farm level



- Increase the production with the same quantity of inputs
- Decreasing organic wastes and potential GHG emissions

What can we expect from circularity in a C-footprint perspective?

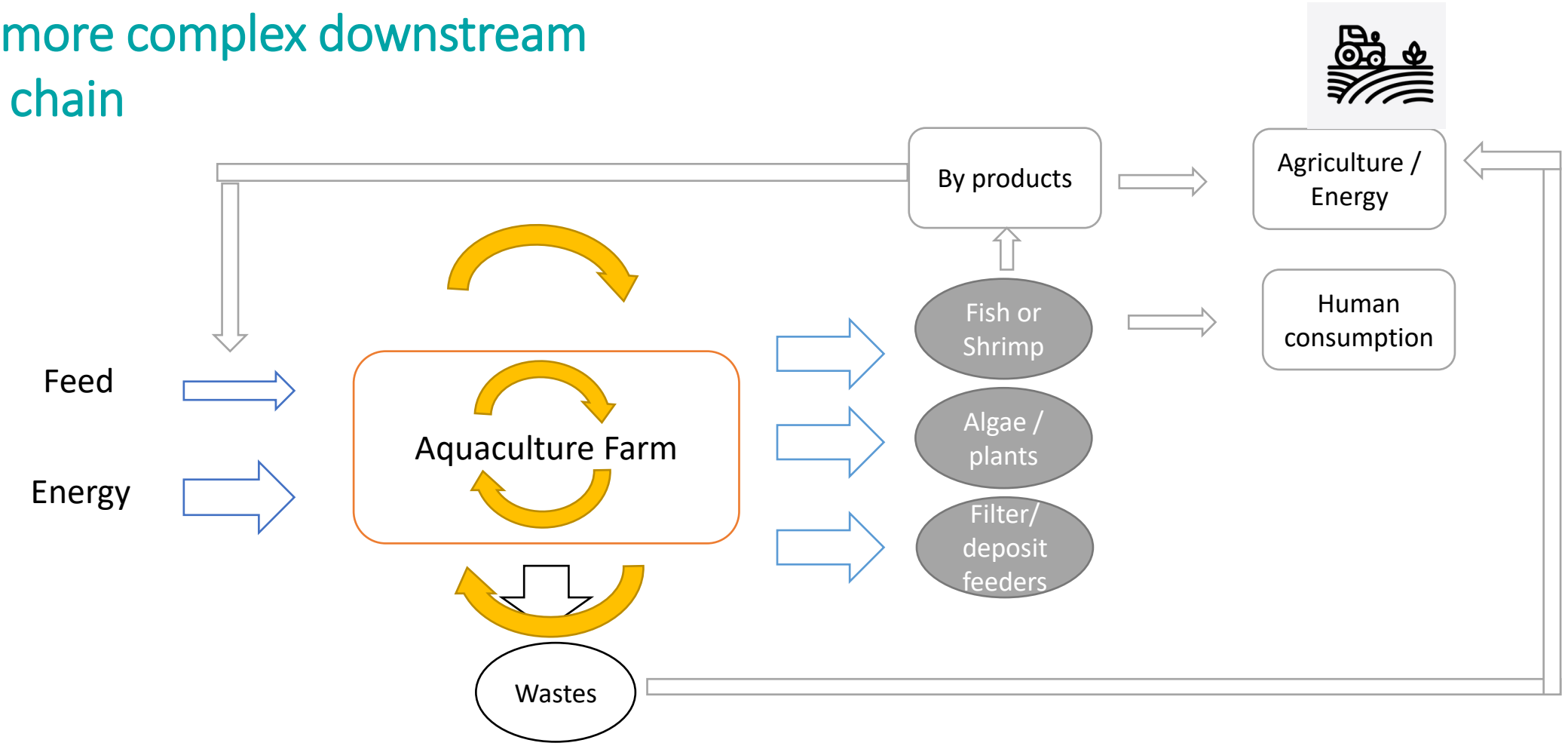
At value chain level



- Reuse of by-products to feed aquaculture systems
- Decreasing the use of traditional feeds

What can we expect from circularity in a C-footprint perspective?

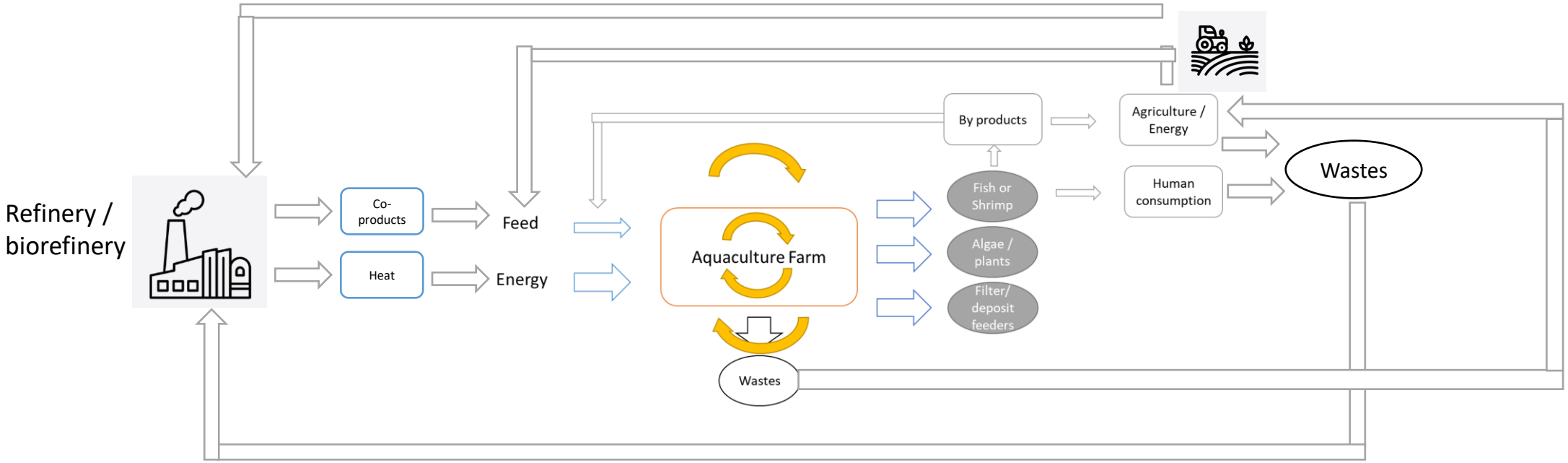
With more complex downstream value chain



- Reuse of by-products for agriculture, industrial or energetic purposes

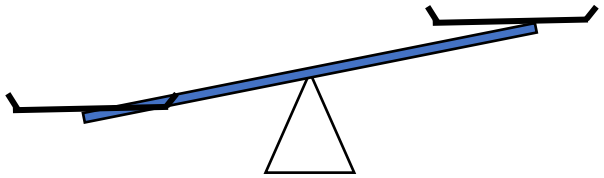
What can we expect from circularity in a C-footprint perspective?

A complex ecosystem of recycling



- More integration with agriculture
- Reuse more diversified sources of by products
- Biorefinery for new ingredient sources

Drawbacks, Risks



- Carbon cost of setting the flows in motion:
  - Energy cost of pumping, on farm
  - Energy for collecting and transporting, wastes and co-products
  - Energy for processing and making nutrients available

⇒ Key point : Origin of the energy source, fossil or not fossil?

- Potential competition with existing value chains

⇒ Attention to feed to food competition, to energy production competition

- Potential environemental social and economic impact transferts

⇒ Necessity to assess precisely the environmental balance (LCA?), and stakeholders perceptions

Muscat et al. 2021 → Chary et al. 2023

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REVIEW

Reviews in Aquaculture

Transforming sustainable aquaculture by applying circularity principles

Killian Chary[1] | Anne-Jo van Riel[1,2] | Abigail Muscat[3] | Aurélie Wilfart[4] | Souhil Harchaoui[4] | Marc Verdegem[1] | Ramón Filgueira[5,6] | Max Troell[7,8] | Patrik J. G. Henriksson[7,8,9] | Imke J. M. de Boer[2] | Geert F. Wiegertjes[1]

1. Safeguarding and regenerating the health of aquatic ecosystems (and associated ones),
2. Avoiding producing non-essential products and avoiding wasting those that are essential,
3. Prioritising biomass streams for basic human needs (e.g., food before feed or energy)
4. Using and recycling byproducts of agro-aqua ecosystems,
5. Using renewable energy while minimising overall energy use

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What can we expect from circularity in a C-footprint perspective? Take-home messages

- Produce more with the same flow of inputs (energy, nutrients)
- Develop internal recycling to decrease the need for feed (ex: biofloc)
- Decrease the flows of formulated feed (carrying high impacts), and replace high impact with low impact ingredients
- Decrease organic wastes, avoiding emissions of related GHG (CH_4, N_2O)
- Participate to a more vertuous industrial ecosystem, decreasing the overall need of inputs
- Don’t forget feed to food competition
- Take care of energy use level and the source of energy
- Multicriteria assessment (not only C Footprint) is a necessity to avoid impact transfers

Thank you for your attention

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