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Applying Regenerative Sustainability Principles in Manufacturing

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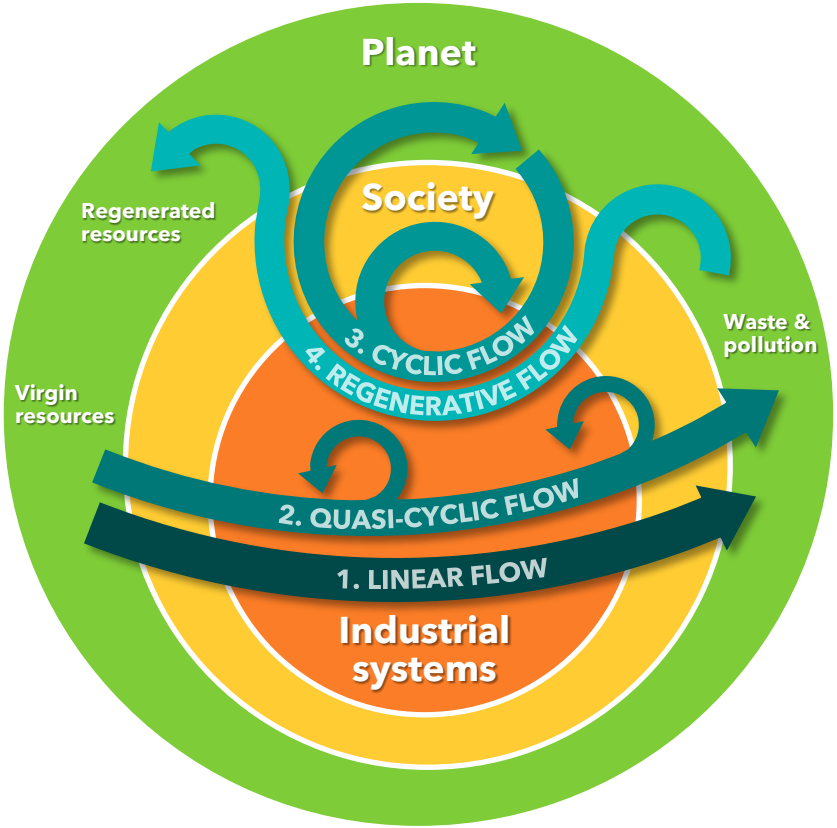
Mélanie Despeisse

Associate Professor in Sustainable Digitalized Production, Division of Production Systems, Department of Industrial and Materials Science, Chalmers University of Technology

From less bad to more good

Principle 1:
Sourcing materials, energy and water to promote conservation

Principle 2:
Respecting regeneration rate



Principle 3:
Preventing and mitigating harmful effects to promote preservation

Principle 4:
Respecting assimilation capacity

Proposed 12 principles for regenerative sustainability in manufacturing

Principle 1. Source materials, energy and water to promote conservation
➡ use renewable, non-toxic, and locally abundant resources

Principle 2. Respect resource regeneration rate
➡ use industrial processes that do not exceed ecosystems' renewal capacity

Principle 3. Prevent and mitigate harmful effects to promote preservation
➡ eliminate, minimise and treat waste/emissions

Principle 4. Respect the assimilative capacity
➡ use industrial processes that do not exceed ecosystems' absorption capacity

Principle 5. Restore natural resource flows locally
➡ use industrial processes that restore local ecosystems' health through decontamination and purification

Principle 6. Regenerate damaged resources in products
➡ use processes, and systems that reverse harm/recapture harmful substances

Principle 7. Enable eco-efficient and circular resource flows locally
➡ design and operate processes and systems that increase efficiency/reduce energy-matter throughput and increase circularity

Principle 8. Maximise value creation through eco-efficient processes
➡ design and operate processes and systems that efficiently create value to meet minimum requirements

Principle 9. Retain and maintain value embedded in products
➡ design and operate processes and systems for durability and repairability

Principle 10. Recapture value embedded in products
➡ design and operate processes and systems that capture end-of-life products, components, and materials to give them a new life

Principle 11. Develop circular processes
➡ develop materials, processes and systems for minimum material heterogeneity and contamination to enable value recovery

Principle 12. Maximise value delivery through eco-efficient products
➡ design and operate processes and systems for maximum value to society per unit of resource consumed; dematerialisation, miniaturisation, multi-functionality, modularisation, upgradability, repairability, durability, servitization, etc.

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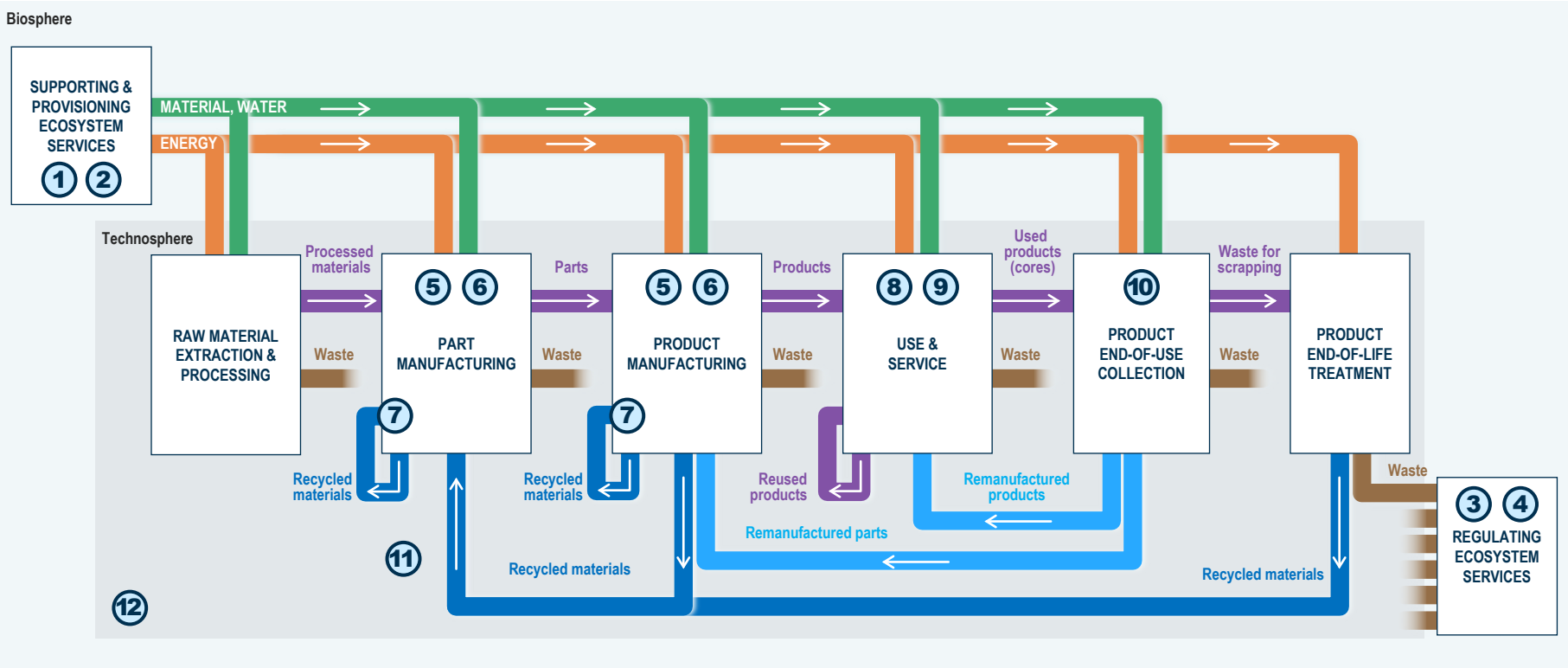
Mapping the regenerative principles



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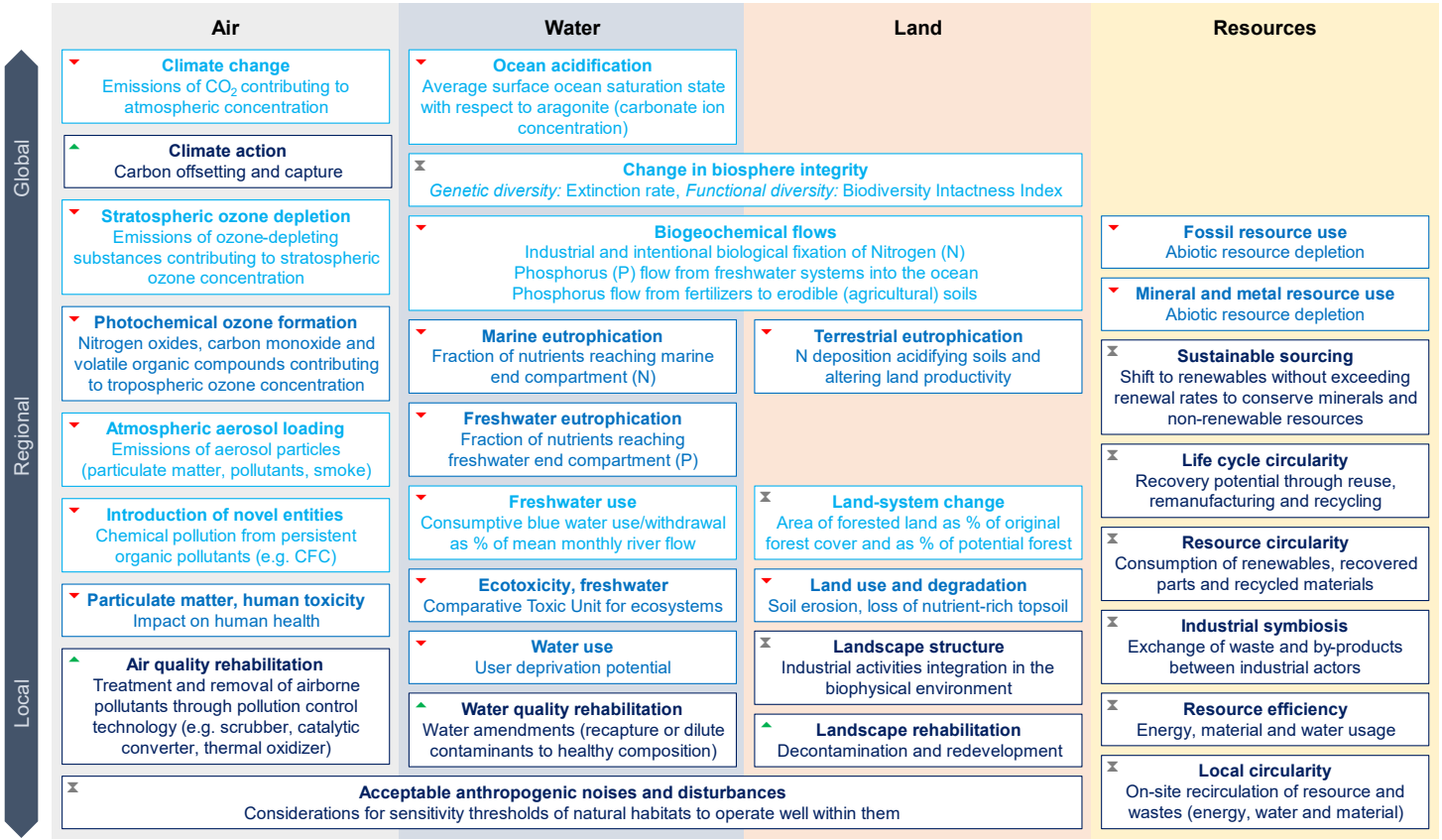
Measuring regenerative sustainability



Annotations

- Reduce negative impact
- Create positive impact
- Both/potential for positive impact

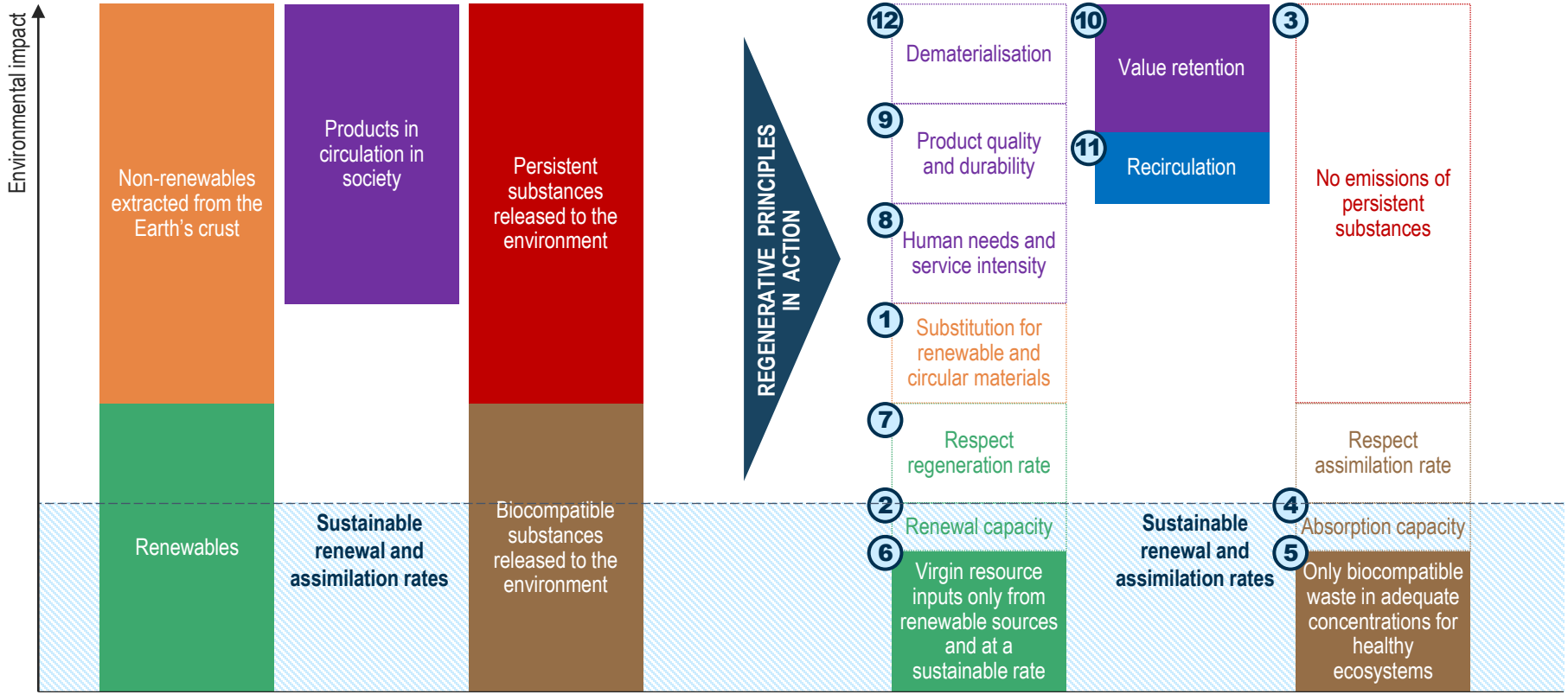
Earth-system process – Global and regional control variables from the Planetary Boundaries [26]

Environmental footprint monitoring – Impacts and indicators from the European Commission [27]

Environmental performance betterment – Actions for eco-efficiency, circularity and regenerative sustainability

[see *Reference list* in the paper]

Reducing environmental impacts below the regenerative threshold



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