XVII Convegno dell'Associazione Rete Italiana LCA

Milano
28-30 giugno 2023

30 anni di Life Cycle Assessment
sviluppi metodologici e applicativi

Con il Patrocinio di:

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Ocean acidification impacts application in LCA – Implication for negative emission technology in seawater

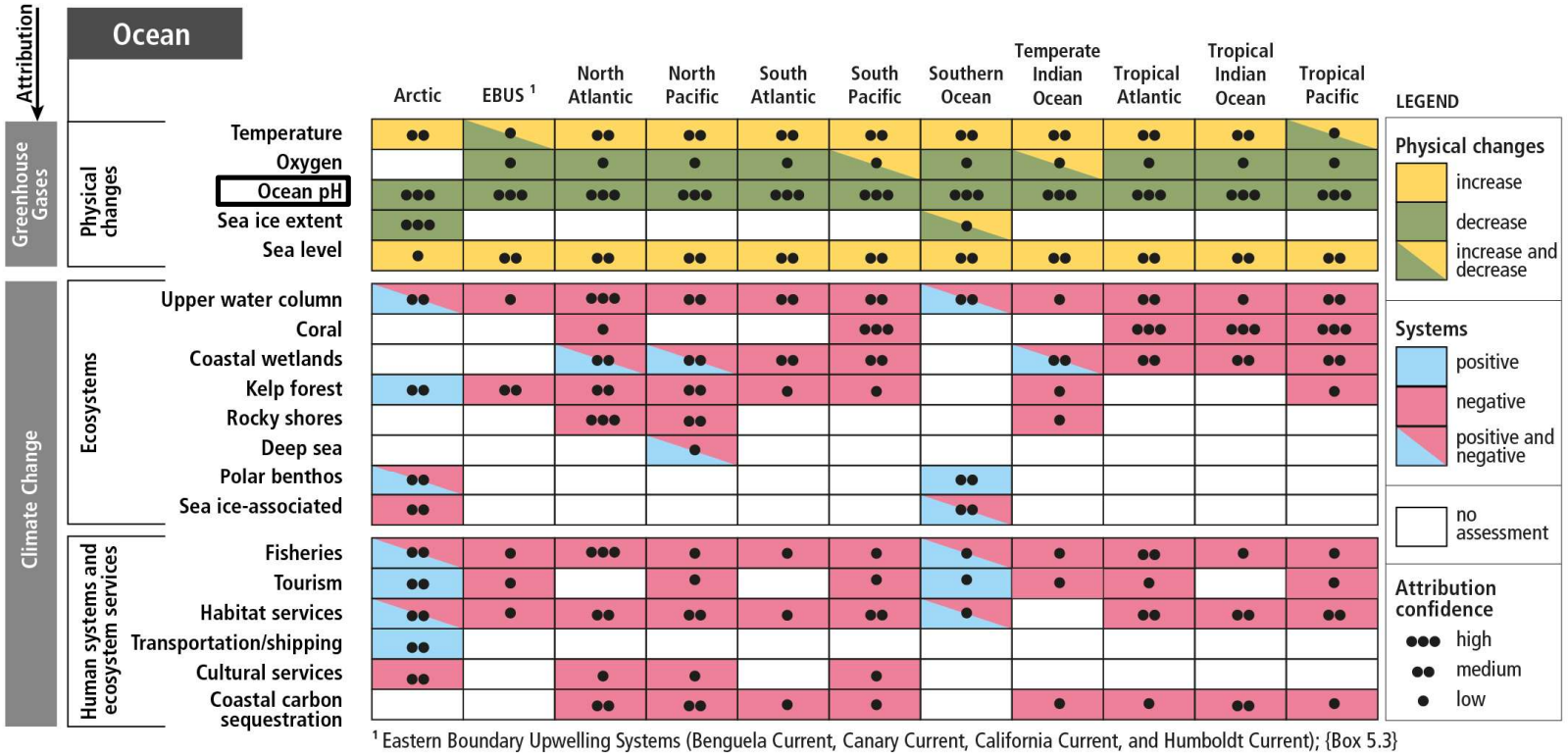
Selene Varliero[1], Francesco Pietro Campo[2]

[1] *Politecnico di Milano, Department of chemistry, materials, and chemical engineering*

[2] *Politecnico di Milano, Department of civil and environmental engineering*

Effect of climate change on ocean

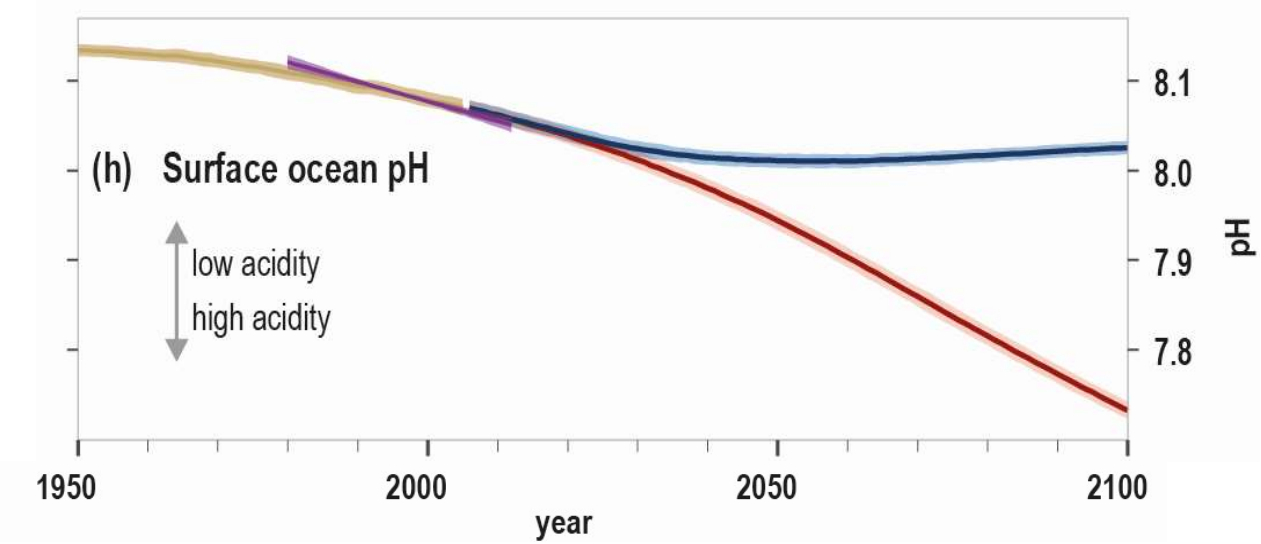
Observed regional impacts from changes in the ocean and the cryosphere



[1] Eastern Boundary Upwelling Systems (Benguela Current, Canary Current, California Current, and Humboldt Current); {Box 5.3}

IPCC, Special Report on the Ocean and Cryosphere in a Changing Climate

Effect of climate change on ocean acidification



$$CO_{2\,(g)} \rightleftharpoons CO_{2\,(aq)}$$

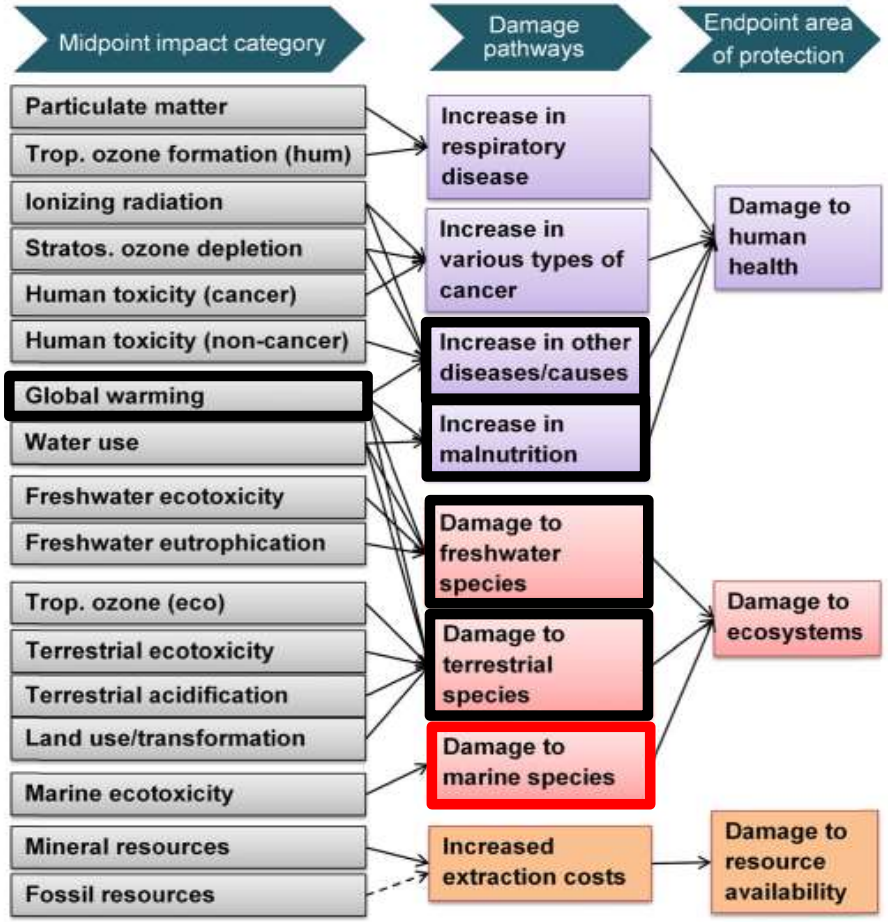
$$CO_{2\,(aq)} + H_2O \rightleftharpoons H_2CO_3$$

$$H_2CO_3 \rightleftharpoons H^+ + HCO_3^-$$

$$HCO_3^- \rightleftharpoons H^+ + CO_3^{2-}$$

IPCC, Special Report on the Ocean and Cryosphere in a Changing Climate

ReCiPe approach

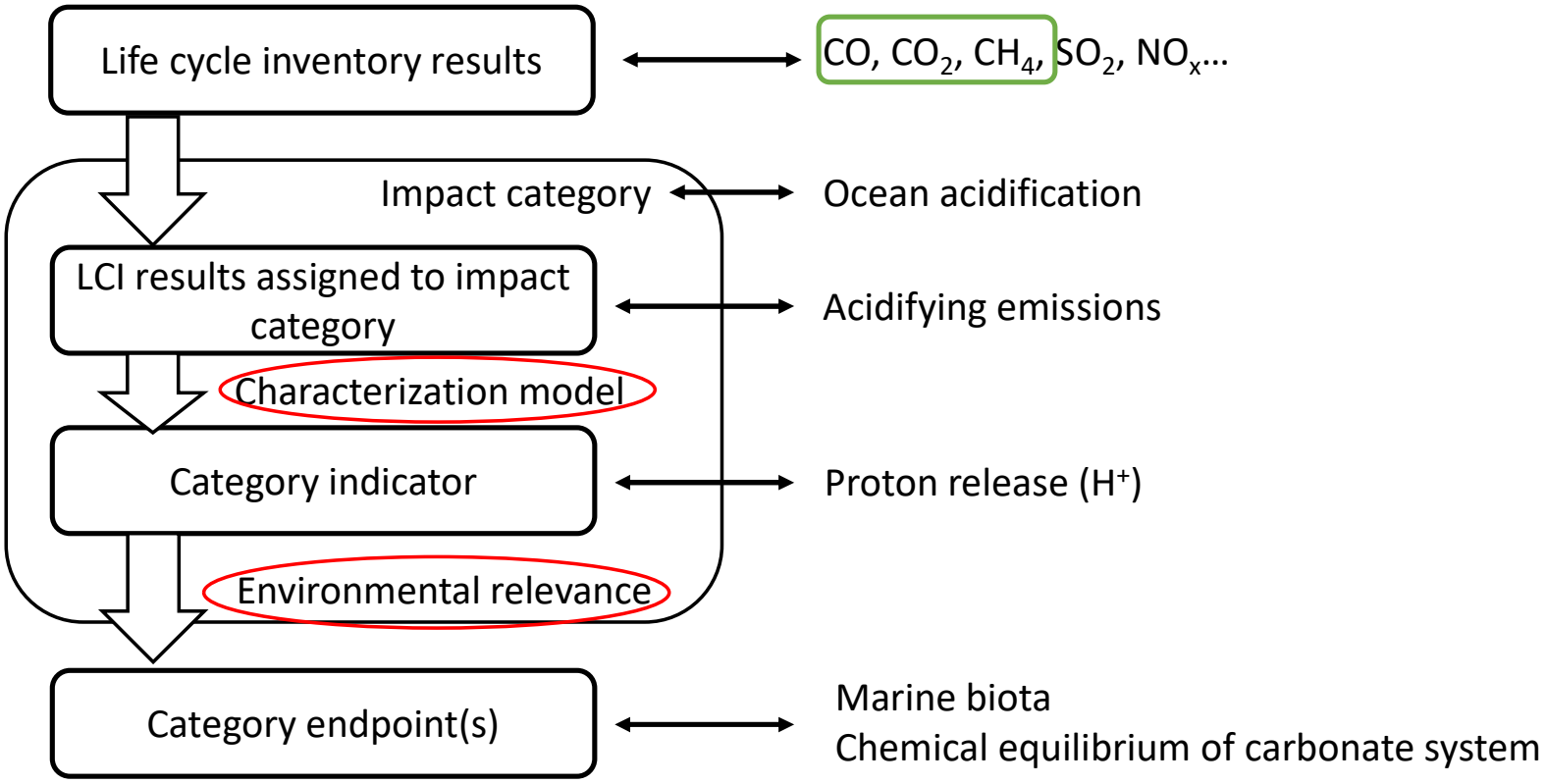


ReCiPe method (Huijbregts et al., 2016)

Even if in LCA approach is not yet considered, global warming has impacts on marine species due to variations in:

- Temperature
- Oxygen
- pH
- Sea level
- Ice extent

Category indicators, applied to ocean acidification



ISO 14044:2006

Characterization model for ocean acidification

→ From emissions to decrease of pH

Emissions of CO, CH_4 and CO_2

Fate factor

$$\text{Fate factor}_i = \text{conversion factor}_i \times \text{distribution factor}_i \times \text{dissolution factor}_i$$

Ocean Acidification Potential

$$OAP_i = \text{fate factor}_i \times \text{fate sensitivity factor}_i$$

Characterization factor

$$\text{Chacterization factor}_i = OAP_i / OAP_{CO2} \quad [\text{kg } CO_2\text{eq/kg of emission}]$$

Bach et al., 2016. Characterization model to assess ocean acidification within life cycle assessment. The International Journal of Life Cycle Assessment, 21, 1463-1472.

Endpoint approach

→ From pH decrease to effects on the marine biota

Characterization factor (Bach et al., 2016)

SSD: Species Sensitivity Distribution

Potentially Affected Fraction (PAF) of species with the decrease of pH

- 152 Species
- Climate area (polar, tropical…)
- Toxicity (chronic, acute…)

PDF: Potentially disappeared fraction

Fraction of species that can be damaged by ocean acidification, assumed as half of the affected species.

Scherer et al., 2022. Characterization factors for ocean acidification impacts on marine biodiversity. Journal of Industrial Ecology.

Further development

Many aspects require clarification

- Species → Calcifying/Not calcifying
- Timescale of the process → Residence time in atmosphere/in the ocean
- Portion of the ocean → Surface/Volume
- Area of the ocean → Coastal/All ocean

Application in climate change mitigation process

Buffered accelerated weathering of limestone for storing CO_2: Chemical background

Stefano Caserini [a,*], Giovanni Cappello [b], Davide Righi [a], Guido Raos [c], Francesco Campo [a], Serena De Marco [a], Phil Renforth [d], Selene Varliero [c], Mario Grosso [a]

[a] Dipartimento di Ingegneria Civile ed Ambientale, Politecnico di Milano, Milano, Italy
[b] CO2Apps, Galbiate (LC), Italy
[c] Dipartimento di Chimica, Materiali e Ingegneria Chimica "G. Natta", Politecnico di Milano, Milano, Italy
[d] The Research Centre for Carbon Solutions, Heriot-Watt University, Edinburgh, United Kingdom

Ocean alkalinity enhancement – avoiding runaway $CaCO_3$ precipitation during quick and hydrated lime dissolution

Charly A. Moras[1], Lennart T. Bach[2], Tyler Cyronak[3], Renaud Joannes-Boyau[1], and Kai G. Schulz[1]

[1]Faculty of Science and Engineering, Southern Cross University, Lismore, NSW, Australia
[2]Ecology & Biodiversity, Institute for Marine and Antarctic Studies, University of Tasmania, Hobart, TAS, Australia
[3]Department of Marine and Environmental Sciences, Nova Southeastern University, Fort Lauderdale, FL, USA

Olivine Dissolution in Seawater: Implications for CO_2 Sequestration through Enhanced Weathering in Coastal Environments

Francesc Montserrat,[*,†] Phil Renforth,[‡] Jens Hartmann,[§] Martine Leermakers,[†] Pol Knops,[∥] and Filip J. R. Meysman[†,⊥,#]

[†]Department of Analytical, Environmental and Geo-Chemistry, Free University of Brussels, Pleinlaan 2, 1050 Brussels, Belgium
[‡]School of Earth and Ocean Sciences, Cardiff University, Main Building, Park Place, Cardiff, CF10 3AT United Kingdom
[§]Institute for Geology, Center for Earth System research and sustainability (CEN), Universität Hamburg, Bundesstraße 55, 20146 Hamburg, Germany
[∥]Green Minerals B.V., Boulevard 17, 6127 AX Grevenbicht, The Netherlands
[⊥]Aarhus Institute of Advanced Studies (AIAS), Aarhus University, Hoegh-Guldbergs Gade 6B, DK-8000 Aarhus C, Denmark
[#]NIOZ Royal Netherlands Institute for Sea Research, Department of Estuarine and Delta Systems, and Utrecht University, Korringaweg 7, 4401 NT Yerseke, The Netherlands

How will the counteraction of ocean acidification be taken into account?

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Grazie per l'attenzione

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[2] *Politecnico di Milano, Department of civil and environmental engineering*

Contatti:

selene.varliero@polimi.it

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