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Decision supporting tool based on LCIA's marine eutrophication damage model

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Life Cycle Assessment (LCA) is an environmental assessment tool used to address and evaluate the environmental exchanges (inputs/outputs) and the potential environmental impacts of a product or service from 'cradle to grave'. It consists of a standardized iterative process that includes a Life Cycle Impact Assessment (LCIA) phase.

LCIA quantifies the potential for environmental impacts by evaluating impact scores resulting from the emission inventories and specific characterization factors (CF). The evaluation takes place either at the midpoint (MP) or endpoint level (EP) in the cause-effect chain. The midpoint might be the increase in the nutrient concentration in the water and the end-point the degree of reduction in species diversity.

Marine eutrophication is one of the impact categories in LCIA and is caused by nutrients enrichment and organic loading to marine coastal waters. The present study of damage (effects) estimation relies on the sequential correlation between nitrogen (N) inputs, the biomass production, the organic matter (OM) degradation, the resulting oxygen depletion, and the potential effects on biota. The latter can be assessed by a Species Sensitivity Distribution (SSD) method, where a Potentially Affected Fraction (PAF) of species is expected as a result of that N input. The same rationale is shared by Risk Assessment (predicting an effect from a stressor), or in establishing Environmental Quality Criteria (where a 'safe' concentration is defined bearing a known acceptable effect). Compiling the fate and effect factors into CFs at ecosystem's MP and EP level compartments help assessing the resulting impacts and shaping a damage model for marine eutrophication.

This ecosystem-based approach can bridge between a scientific tool (LCA) and management/regulatory frameworks, and may act as a Decision-Support System (DSS) by quantifying the impacts of emitting nutrients and OM into marine coastal ecosystems. Its results may be used in supporting an informed decision by managers and legislators, in preparing, adapting, or revising legislation on fertilizers composition, wastewater treatment, deciding about practices of application of inorganic/organic fertilizers, land use, agriculture carrying capacity, etc. – in short, estimations of the effects of their management and operational decisions.