Short Course on Modelling of Aquatic Eutrophication in LCIA

2013
Module I
Introduction

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Overview

Course plot

- Course context
- Structure
- Target group
- Learning objectives
- Reading material

- Introduction to freshwater eutrophication
- Fundamentals of marine eutrophication
Course context

- Task in the LC-IMPACT project
- Dissemination of the methodologies of the newly developed impact indicators, their results, and applicability

Structure

- 3 x 45 minutes
- Intro session + Freshwater eutrophication + Marine eutrophication
Target group

- Students (BSc, MSc, PhD) and professionals, either method developers or practitioners
- Those interested in characterisation and impact assessment (LCIA)

Learning objectives

At the end you should be able to:

- Understand the new methods developed in LC-IMPACT for freshwater and marine eutrophication
- Understand the indicators development and apply the methodology
Reading material (I)

Aquatic eutrophication:

Freshwater eutrophication:
Reading material (II)

**Marine eutrophication:**


**Additional referenced material:**

Introduction to Freshwater Eutrophication

Ligia B. Azevedo, Rosalie van Zelm, and Mark A. J. Huijbregts

Radboud University Nijmegen
Introduction to eutrophication

- Increase of nutrients leading to excessive primary productivity and biodiversity losses
- The two most common nutrients driving aquatic eutrophication are nitrogen (N) and phosphorus (P)
- In special cases, other nutrients may also trigger eutrophication, such as iron (especially in oceans) and silica. **Keep in mind** that increases in atmospheric carbon levels trigger eutrophication in terrestrial systems!
Introduction to aquatic eutrophication (I)

In LCIA, we assume that freshwater eutrophication is caused by P. However, keep in mind that this has been questioned recently.
Introduction to aquatic eutrophication (II)

- Recommended reading to understand the main drivers of freshwater eutrophication

**Technical Report**

*Nonpoint Pollution of Surface Waters with Phosphorus and Nitrogen*


1Center for Limnology, 680 North Park Street, University of Wisconsin, Madison, Wisconsin 53706 USA
2Institute of Ecosystem Studies, Box AB Route 44A, Millbrook, New York 12546 USA
3Smithsonian Environmental Research Center, P.O. Box 28, Edgewood Maryland 21037 USA
4Section of Ecology and Systematics, Cornell University, Ithaca, New York 14853 USA
5USDA-ARS, Pasture Systems and Watershed Management Research Laboratory, curtain Road, University Park, Pennsylvania 16802 USA

6Department of Systematics and Ecology, 6007 Haworth Hall, University of Kansas, Lawrence, Kansas 66045 USA
Freshwater eutrophication in the context of LCIA

- Sources of P to freshwater systems: sewage and agricultural (manure or synthetic) fertilizers

- Keep in mind that natural biogeochemical processes may also cause eutrophication if they are affected by human activities, e.g. atmospheric deposition (in the case of N) and erosion
Fundamentals of Marine Eutrophication

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Marine Eutrophication

*It is an ecosystem response to the availability of plant nutrients*

- Primary production is sustained by nutrients released as by-products of microbial and animal metabolism.
- This balance is **disrupted** by anthropogenic fertilization of the water masses.
- **Sources** may include run-off from agriculture activities (excess fertilizer and N-fixation), atmospheric deposition, and sewage waters emissions.
- Nutrients enrichment of marine waters promotes **excessive growth** of phytoplankton and macroalgae.
- The senescence and sink of this biomass to bottom sediments fuels bacterial metabolism for its degradation, **consuming dissolved oxygen**.
- In some conditions the oxygen depletion may originate hypoxic to anoxic bottom waters, or toxic chemicals released by some algal species may impair water quality.
- Sub-lethal and lethal effects on resident biota are expected.

*Audience: Apply the above concepts to the diagram in the next slide*
Definitions

- The European Environmental Agency (EEA) defines aquatic eutrophication as ‘*enhanced primary production due to excess supply of nutrients from human activities*’ (EEA, 2001)
- Nixon defines it as ‘*an increase in the rate of supply of organic matter to an ecosystem*’ (Nixon, 1995)
Life Cycle Assessment (LCA) is a methodology to evaluate the consumption of resources and the potential impacts of emissions associated with all the stages in a product’s life cycle (Pennington et al., 2004).

Life Cycle Impact Assessment (LCIA) is the phase where characterisation takes place, i.e. the calculation of impact category indicators (ISO 14040:2006).

The emitted quantities (Q, compiled in the Life Cycle Inventory, LCI) are converted into impact scores (Si) by application of Characterisation Factors (CF) per impact category (i):

\[ S_i = Q \cdot CF_i \]
This short course is part of the EU LC-Impact project: Development and application of environmental Life Cycle Impact assessment Methods for imProved sustAinability Characterisation of Technologies (Grant agreement No.: 243827 – LC-IMPACT), which is financially supported by the EU Commission within the Seventh Framework Programme Environment ENV.2009.3.3.2.1: Improved Life Cycle Impact Assessment methods (LCIA) for better sustainability assessment of technologies.