Assessing Eutrophication impacts in New Zealand

Sandra Payen
Outline

- The aquatic eutrophication impact pathway in LCA
- Comparison of eutrophication indicators on a NZ case study
- On-going methodological developments
The aquatic eutrophication impact pathway in LCA

Comparison of eutrophication indicators on a NZ case study

On-going methodological developments
Eutrophication in a nutshell

“covers all impacts of excessively high environmental levels of macronutrients, the most important of which are nitrogen (N) and phosphorus (P)”

(Guinee et al. 2002)

Algal growth can be limited by N and/or P
Aquatic eutrophication impact pathway

Inventory

Fate

Impact

Different LCIA methods available:

- ReCiPe 2016
  - Helmes et al. 2012
  - CML
  - Heijungs et al. 1992
- ReCiPe 2008
  - Struijs et al. 2009
  - Cosme et al. 2017

- P \rightarrow freshwater
- P \rightarrow marine water
- N \rightarrow freshwater
- N \rightarrow marine water

ON FARM

WASTE WATER

P emissions to freshwater

N emissions to freshwater to air
Outline

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Objective

Relevance of LCIA methods to estimate freshwater eutrophication impacts of NZ milk and meat?
Case study - Lake Taupo

Average dairy and sheep & beef farms

Lake Taupo catchment
Site-specific nutrient emissions modelling

Inventory

Fate

Impact

N & P inputs

P emissions to freshwater

N emissions to freshwater 
& to air

OVERSEER®

+ 50% N attenuation factor root zone → freshwater

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### Results: an impossible comparison

<table>
<thead>
<tr>
<th>Method</th>
<th>Impact indicator</th>
<th>Unit</th>
<th>Compartment</th>
<th>Sheep &amp; Beef</th>
<th>Dairy</th>
</tr>
</thead>
<tbody>
<tr>
<td>CML</td>
<td>Eutrophication potential</td>
<td>kg $\text{PO}_4^{3-}\text{eq}$</td>
<td>Terrestrial &amp; aquatic</td>
<td>14.4</td>
<td>40.0</td>
</tr>
<tr>
<td>ReCiPe 2008</td>
<td>Marine eutrophication potential</td>
<td>kg $\text{N}_{\text{eq}}$</td>
<td>Marine water</td>
<td>10.0</td>
<td>29.0</td>
</tr>
<tr>
<td>ReCiPe 2016</td>
<td>Freshwater eutrophication potential</td>
<td>kg $\text{P}_{\text{eq}}$</td>
<td>Freshwater</td>
<td>0.05</td>
<td>0.14</td>
</tr>
<tr>
<td>Cosme et al.</td>
<td>Marine eutrophication potential</td>
<td>kg $\text{N}_{\text{eq}}$</td>
<td>Marine water</td>
<td>8.53</td>
<td>24.56</td>
</tr>
</tbody>
</table>

**Different modelling rationale**

- Different indicators
- Different units
- Different compartments

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Geographical validity

Inventory

In Lake Taupo
growth
limited by
N and P

Fate

N:P ratio
CML

Impact

Freshwater eutrophication

P \rightarrow freshwater

N \rightarrow freshwater

P \rightarrow marine water

N \rightarrow marine water

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Water body sensitivity

Accounting for freshwater body sensitivity is paramount

Current assumption:
- Freshwater → P-limited only
- Marine water → N-limited only

BUT

Freshwater impact model focused on P is:
- only capturing part of the problem
- in contrast to water regulations in NZ
Outline

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We need **globally** valid model, but **site-specific** characterisation factors.
Combine N and P models

Inventory

N & P inputs

P emissions

N emissions

Fate

ReCiPe 2008
ReCiPe 2016
CML

Impact

Freshwater eutrophication

P ➔ freshwater

Combine the two

N ➔ freshwater

N ➔ marine water

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International guidelines

PEF recommendation not appropriate for NZ (and beyond):

valid for *Europe* & focus on *P* only

UNEP-SETAC task force “eutrophication and acidification” launched:

toward a consensual LCIA approach
Take home messages
- Eutrophication impact results varied considerably depending on the LCIA method
- Eutrophication indicators focusing on one nutrient may not be relevant
- Freshwaters can be limited by N and P as shown here for New Zealand
- On-going research toward more **NZ-specific** indicators, while using a **globally** valid model

**Payen S. and Ledgard S.** *Aquatic Eutrophication indicators in LCA: Methodological challenges illustrated using a case study in New Zealand.* Journal of Cleaner Production (under review)
Thank you for your attention

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