Identification of best practice

Development of basis for a recommended LCIA methodology for the European Commission

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Outline

- Background and aims
- Identification of candidate characterisation models
- Development of criteria
- Analysis of characterisation models
- Results
- What are the deliverables?
- Where are we now?

Background

Increased LC-focus in policy and business in Europe as well as globally

- Sustainable Consumption and Production Action Plan
  - IPP
  - Thematic strategies for resource use and for waste
- International Life Cycle Data System

LCIA recommendations beyond ISO 14044

Basis is international consensus and method development work under

- SETAC in the 1990'ies
- UNEP-SETAC since 2002

Aims and principles

- Basis of recommended LCIA framework
- Global validity preferred (life cycle is global)
- Both midpoint and endpoint
- Characterisation, not normalisation or weighting
- Recommendations among existing methods and factors – only very limited new developments
- Best attainable consensus among existing practices
- Extensive hearings of domain experts and stakeholders

Identification of candidates

Selected among existing methodologies

- CML2002
- Eco-indicator 99
- EDIP 2003/EDIP97
- EPS 2000
- IMPACT 2002+
- LIME
- LUCAS
- MEEuP
- ReCiPe
- Swiss Ecoscarcity 07
- TRACI

… and other approaches for

- Respiratory inorganics
- Human and ecotoxicity
- Ionizing radiation
- Photochemical Ozone
- Acidification
- Land use
- Resource depletion
- Noise
- Climate change

1. Originality of approach
2. Only most recent version or update considered, as far as available to us
3. Midpoint and endpoint methods

…. Among 157 characterisation methods, 92 were pre-selected

Criteria for analysis

Developed in advance to prevent bias

Scientific criteria

- Completeness of scope (8 sub criteria)
- Environmental relevance (4-12 sub criteria)
- Scientific robustness and certainty (8-15 sub criteria)
- Documentation, transparency and reproducibility (6 sub criteria)
- Applicability (4 sub criteria)

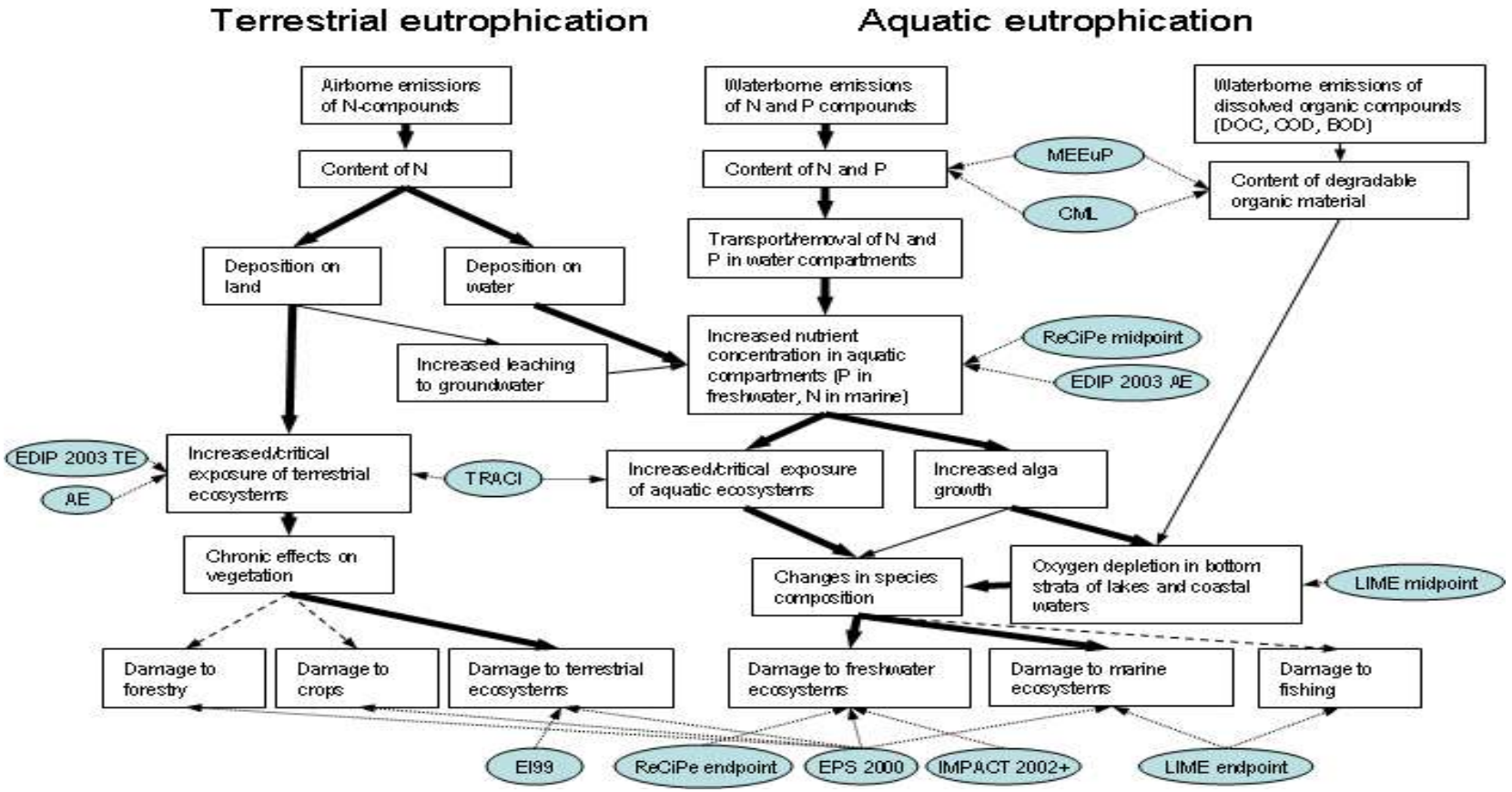
Stakeholder acceptance (5 sub criteria)

Sub criteria are weighted according to importance (high-low)

Hurdles are introduced on fundamental sub criteria

Specific criteria

Impact pathway helps identify sensitive parts and discriminate between methods



Specific criteria for aquatic eutrophication

Environmental relevance

Midpoint

- Fate and transport is considered and advection out of a region is not considered a final loss
- Influential fate processes are considered (denitrification, precipitation and sedimentation of P)
- The factors allow distinction between individual N- and P-compounds

Endpoint

- For damages on ecosystems, the method discriminates exposed systems according to their sensitivity to eutrophication and oxygen depletion and limiting nutrient (N for marine, P for freshwater)
- Potency or dose-response is included

Analysis of characterisation models

Each model is scored against each sub criterion

- A: full compliance to E: no compliance

… for all five main Scientific criteria and the Stakeholder criteria (35-50 in total)

Each model is scored against each sub criterion

Aquatic eutrophication		Check the following:	Threshold (Minimum score)	Importance (N-N)	CML 2002 Score	CML 2002 Comments	EDIP2003 aquatic Score	EDIP2003 aquatic Comments	LIME midpoint Score	LIME midpoint Comments	ReCiPe mipoint Score	ReCiPe mipoint Comments	TRACI Norris, 2003 Score	TRACI Norris, 2003 Comments
Environmental relevance		• Fate and transport is considered	B	H	D	Mineralisation with full release of nutrients in biologically available form assumed, Redfield ratio assumed for ration between N and P (not relevant for terrestrial systems)	A	Removal of nutrients in hydrological cycle	B	No leaching of N from land, estuarine circulation modelled	A	Both for atmospheric and waterborne emissions	A	As well atmospheric as waterborne transport
		• Advection out of a region is not considered a final loss			n.r.	no fate model	A	No advection out of the modelled region	??	Not clear f rom documentation, but only impacts in coastal waters considered	A	No advection out of the modelled region	A	No advection out of the modelled region
		• Influential fate processes are considered For aquatic systems: denitrification, precipitation and sedenentation of P For terrestrial systems: oxidation, deposition			E	Influential fate processes governing availability of nutrients not considered	B	Modelled by CARMEN model as fixed removal ratio for N- and P-compounds in different emission scenarios	C	no consideration of removal of N or P, no consideration of terrestrial impacts	B	Modelled by CARMEN model as fixed removal ratio	C	Transport processes modelled but no removal of N or P
		• For damages on ecosystems, a fate sensitivity factor discriminating between sensitive and insensitive recipients is included For aquatic systems according to their sensitivity to eutrophication and oxygen depletion and limiting nutrient (N for marine, P for freshwater) For terrestrial systems according to the sensitivity to eutrophication (critical load, N)		H	E	No distinction between sensitive and insensitive recipients	C	No distinction between freshwaters and marine waters	C	Dose response relationship for N and P based on empirical observations	B	Distinction according to limiting nutrient	B	Transport factor, distinction between sensitive and insensitive recipients
		• Magnitude of exceedance for exposure above critical level is considered			n.r.	midpoint model	n.r.	critical level not considered	n.r.	Linear dose-response relationship assumed	n.r.	midpoint model	n.r.	midpoint model
		• Potency or dose-response is included			n.r.	midpoint model	n.r.	midpoint model	n.r.	Midpoint model	n.r.	midpoint model	n.r.	midpoint model
		• Distinction of individual N- and P-compounds	C	H	A	8 N-compounds, 4 P compounds, COD	A	9 N-compounds, 3 P compounds	B	To air: NOx and NH3, to water: N, P, COD (?)	B	To air: NOx and NH3, to water: N-total, P-total, but differentiation of N-total and P-total according to source	A	To air: NO, NO2, NOx, NH3 To water: NH4+, N, NO3-, PO43-, P, COD
	Overall evaluation				D-E	Environmental relevance is low, most important fate processes determining availability and exposure of sensitive environments are missing	A-B	Environmental relevance high, removal processes in aquatic system modelled, but no distinction between freshwater and marine systems	B-C	Environmental relevance is high although removal processes for nutrients are missing	A-B	Environmental relevance high, removal processes modelled, distinction between N- and P-limited systems	A-B	Environmental relevance is high although removal processes for nutrients are missing

Scores are aggregated under each main criterion

Criteria	CML 2002		EDIP2003 aquatic		LIME midpoint		ReCiPe mipoint		TRACI	
	Score	Comments	Score	Comments	Score	Comments	Score	Comments	Score	Comments
Completeness of scope: Overall evaluation	B-C	The scope of the model for the evaluation of eutrophying substances is applicable for aquatic as well as terrestrial ecosystems. Global validity, no temporal differentiation	A-B	The scope of the model for the evaluation of eutrophying substances is applicable for aquatic ecosystems on the European scale. No consideration of terrestrial ecosystems. Spatial differentiation at the level of countries, no temporal differentiation	C	The scope of the model for the evaluation of eutrophying substances is limited to aquatic ecosystems and only addresses issues related to oxygen depletion. No consideration of terrestrial ecosystems. The model represents Japanese coastal waters, freshwater systems ignored	B	The scope of the model for the evaluation of eutrophying substances is limited to aquatic ecosystems where it addresses all relevant issues. The model represents European freshwaters and marine coastal waters. Spatial differentiation according to archetype emission situations, no temporal differentiation	B-C	The scope of the model for the evaluation of eutrophying substances is applicable for aquatic ecosystems, but not for terrestrial ecosystems. The model is parameterized for US and spatially differentiated at the level of US states, no temporal differentiation
Environmental relevance: Overall evaluation	D-E	Environmental relevance is low, most important fate processes determining availability and exposure of sensitive environments are missing	A-B	Environmental relevance high, removal processes in aquatic system modelled, but no distinction between freshwater and marine systems.	B-C	Environmental relevance is high although removal processes for nutrients are missing	A-B	Environmental relevance high, removal processes modelled, distinction between N- and P-limited systems.	A-B	Environmental relevance is high although removal processes for nutrients are missing
Scientific robustness & Certainty: Overall evaluation:	D-E	Midpoint model of limited environmental relevance due to missing fate considerations, no treatment of uncertainty	B	Underlying fate model and adaptation to LCIA use reviewed, uncertainty from spatial variability quantified and several emission situations covered	C	Model components based on existing Japanese models and partially reviewed (?). No uncertainty considerations.	B	Model components based on existing European models and reviewed quantification of spatially determined uncertainty range and characterisation of different emission situations	B-C	Midpoint model reviewed, further components derived from reviewed information, some treatment of uncertainty in resulting CFs.
Documentation & Transparency & Reproducibility: Overall evaluation	A	The method principles and the CFs are documented and accessible for use in a reproducible way. Characterization model and input data easily accessible and applicable.	B	The method and CFs documented and accessible for use in a reproducible way. Characterization model and input data not easily accessible.	B-C	The method is documented and accessible, the CFs only available in Japanese, reproducibility not clear. Characterization model and input data not easily accessible.	B	The method is documented and accessible with all CFs for use in a reproducible way. Characterization model and input data not easily accessible.	C	The method principles and the CFs are documented and accessible for use in a reproducible way. Characterization model and input data not easily accessible.
Applicability: Overall evaluation	A	Characterisation factors for most relevant compounds available and easy to supplement	A	Characterisation factors for most relevant compounds available and easy to supplement - update depends on developers of underlying model	A	Characterisation factors for most relevant compounds available and easy to supplement - update depends on developers of underlying model	A	Characterisation factors for most relevant compounds available and easy to supplement - update depends on developers of underlying model	A	Characterisation factors for most relevant compounds available and easy to supplement - update depends on developers of ASTRAP model

Analysis of characterisation models

Each model is scored against each sub criterion

- A: full compliance to E: no compliance

… for all five main Scientific criteria and the Stakeholder criteria

Scores are aggregated under each main criterion

- Consideration of assigned importance

Resulting scores are interpreted to arrive at draft recommendation

Separate analysis of midpoint and endpoint models, accompanied by report (10-15 p per impact category)

Internal review, consistency

External domain experts are consulted on analysis and recommendations

Results

Draft recommendations of methods and factors

- … at midpoint and at endpoint
- … in a consistent framework, where possible

Classification of recommendations

- I: Recommended and satisfactory
- II: Recommended, some improvements needed
- III: Interim, i.e. the most appropriate among the existing approaches but immature for recommendation

Identification of future research needs

- Classification according to importance
- Estimation of work load

Preliminary results (1)

Impact category	Recommended model Midpoint	Class.	Recommended model Mid to Endpoint	Class.
Climate change	IPCC (GWP) (100 years)	I	ReCiPe	III
Ozone depletion	WMO (ODP) (infinite)	I	ReCiPe	III
Human toxicity, carcinogenics	USEtox	II/III	DALY calculation applied to USEtox midpoint	II/III
Human toxicity, non- carcinogenics	USEtox	II/III	DALY calculation applied to USEtox midpoint	III
Particulate matter/Respiratory inorganics	Not settled yet: Greco et al., 2007 or RiskPoll	I/II	Adapted DALY calculation applied to midpoint	II
Ionising radiation, human health	Frischknecht et al., 2000	II	Frischknecht et al., 2000	III
Ionising radiation, ecosystems	Garnier-Laplace et al., 2008	III	PDF calculation applied to midpoint	III

Preliminary results (2)

Impact category	Recommended model Midpoint	Class.	Recommended model (Mid to) Endpoint	Class.
Photochemical ozone formation	LOTOS-EUROS as applied in ReCiPe	II	ReCiPe for human health, nothing for vegetation	II
Acidification	Accumul. Exceedance	II	ReCiPe	III
Eutroph. terrestrial	Accumul.Exceedance	II	None	-
Eutroph. aquatic	ReCiPe	II	ReCiPe for freshwater, none for marine waters	III
Ecotoxicity	USEtox	II/III	PDF calculation applied to USEtox midpoint	III
Land use	Milà i Canals	III	ReCiPe	III
Resource depletion, water	Swiss Ecoscarcity	III	None	-
Resource depletion, mineral . fossil (and renewable)	Category 1: None Category 2: EDIP97 update 2004	- II	Category 4: ReCiPe	III

What are the deliverables?

1. Analysis of existing LCIA methodologies

2. Draft Technical Guidance Document on LCIA
   - Introduction to LCIA
   - Recommended models at midpoint and endpoint level
   - Consistency across midpoint and endpoint indicators
   - Research needs (per impact category)
   - Annexes with analysis results, procedure, vocabulary

3. Draft recommendation of characterisation factors in ILCD system

Where are we now?

- Technical Guidance Document in LCIA drafted
- Domain expert hearing of analysis
- Expert review of draft TGD completed
  - Business, LCIA method developers, LCA tool and database developers Advisory Groups
  - Member states
  - European Commission DG's (Environment, Enterprise, Eurostat etc.)
- Stakeholder hearing completed; important comments from many, among who is US-EPA on the validity of recommendations on a global scale
- Project in internal improvement procedure in EU
- Follow up projects on future research in planning phase