

LCA VIII conference, Seattle, WA, 02 October 2008

*A framework for assessing (fresh)water use  
within LCA:*

*First results from the related project under the  
UNEP/SETAC Life Cycle Initiative (Phase 2)*

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# State-of-the Art in LCA (I): (Fresh)water as a Resource

- **(Fresh)water = the only abiotic, renewable resource**
- **Fundamental distinction of resource types**
  - Flows (rivers, streams): renewable
  - Funds (groundwater aquifers, lakes): renewable when sustainably used
  - Deposits (fossil groundwater reservoirs): non-renewable
- **(Fresh)water usage types**
  - Use/utilization: Water released into the same watershed it was withdrawn
  - Consumption: Water transfers to different river basins and evaporation
  - In-stream use (hydroelectric generation, water transport)
  - Off-stream use: withdrawal from water body (irrigation, water supply)

(Owens, 2002)

➔ **Focus on reduction of freshwater availability (quantity)  
(Quality aspects covered in LCA)**

# State-of-the Art in LCA (II)

## (Fresh)water in Life Cycle Inventory (LCI)

- **No harmonized scheme**
    - for inventory parameters
    - for environmental reporting of water use/consumption in industry, agriculture, domestic use
  - **LCA databases**
    - Various water inventory parameters (on level of elementary flows and technical flows)
  - **Water resource inputs sometimes, water outputs almost never reported**
    - Water outputs needed for water balance (water losses?)
- ➔ **Simplistic measure of total water input insufficient**
- ➔ **Higher level of detail needed**  
**(resource types/origin, quality, geographic info, location of release)**

# State-of-the Art in LCA (III)

## (Fresh)water in Life Cycle Impact Assessment (LCIA)

- **Assessment frameworks for abiotic resources exist, but not specific for (fresh)water**
    - Depletion of freshwater resources: backup technology concept (e.g. Stewart & Weidema, 2002)
  - **Hardly any LCIA methods and characterization factors available**
    - Cumulative Exergy Demand (CExD) (Bösch et al. 2007)
    - Cumulative Exergy Extraction from Natural Environment (CEENE) (Dewulf et al. 2008)
    - Swiss Ecological Scarcity method 2006 (Frischknecht et al. 2008)
    - Adapted water stress index according to Suridge & Brent (2008)
- ➔ **Available methods assess only impacts on the resource itself**
- ➔ **Other impact pathways leading to impacts on human health and ecosystems neglected so far**

Koehler, A. (2008): Water use in LCA: managing the planet's freshwater resources. Int J LCA 13(6) , pp. 451-455.

# State-of-the Art in LCA (III)

## (Fresh)water in Life Cycle Impact Assessment (LCIA)

### Just published:

- Assessing freshwater use impacts in LCA: Part I—inventory modelling and characterisation factors for the main impact pathways (Milà I Canals et al. 2008, *Int J LCA*)
- Characterization factors for Freshwater Depletion (FD) and Freshwater Ecosystem Impact (FEI) based on virtual water concept

### Just submitted:

- Assessing the environmental impacts of freshwater consumption in LCA (Pfister, S., A. Koehler & S. Hellweg, 2008; *Submitted to ES&T*)
- Damage characterization factors for human health, ecosystem quality and freshwater resource damages
- A Framework for Assessing Off-Stream Freshwater Use in LCA (Bayart, J.B, C. Bulle, L. Deschênes, M. Margni, S. Pfister, F. Vince, A. Koehler 2008, *Submitted to Int J LCA*)

# UNEP/SETAC Project Group: Assessment of Use and Depletion of Water Resources within LCA

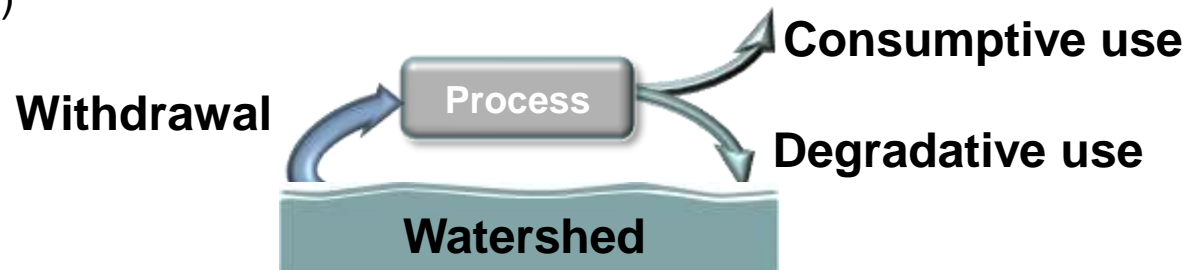
- Develop operational LCA framework for water resources
- Elaborate integrative LCI scheme and inventory parameters
- Develop midpoint-endpoint LCIA framework for environmental consequences of freshwater use in LCA
  - 3 Areas of Protection (AoP):  
Resources, human health, and ecosystem quality
  - Impact pathway approach (cause-effect relationships)
- Develop impact assessment methods
- Provide operational characterization factors
- Establish recommended practice and guidance for LCA practitioners

Koehler, A. & E. Aoustin (2007): Assessment of use and depletion of water resources with LCA. Accessible at:  
[http://fr1.estis.net/builder/includes/page.asp?site=lcinit&page\\_id=2AAEA21D-4907-4E16-BF28-A63C072B6BF7](http://fr1.estis.net/builder/includes/page.asp?site=lcinit&page_id=2AAEA21D-4907-4E16-BF28-A63C072B6BF7)

# Framework for Assessing Freshwater Use within LCA

## Definitions I

- **In-stream/off-stream waster use**  
(according to Owens 2002)
- **Consumptive water use (consumption):**  
Evaporation/product integration or discharge into different watershed or into sea  
(Owens 2002; Pfister et al. submitted)
- **Degradative water use:**  
Withdrawal and discharge into the same watershed after quality alteration  
(Pfister et al. submitted)



# Framework for Assessing Freshwater Use within LCA

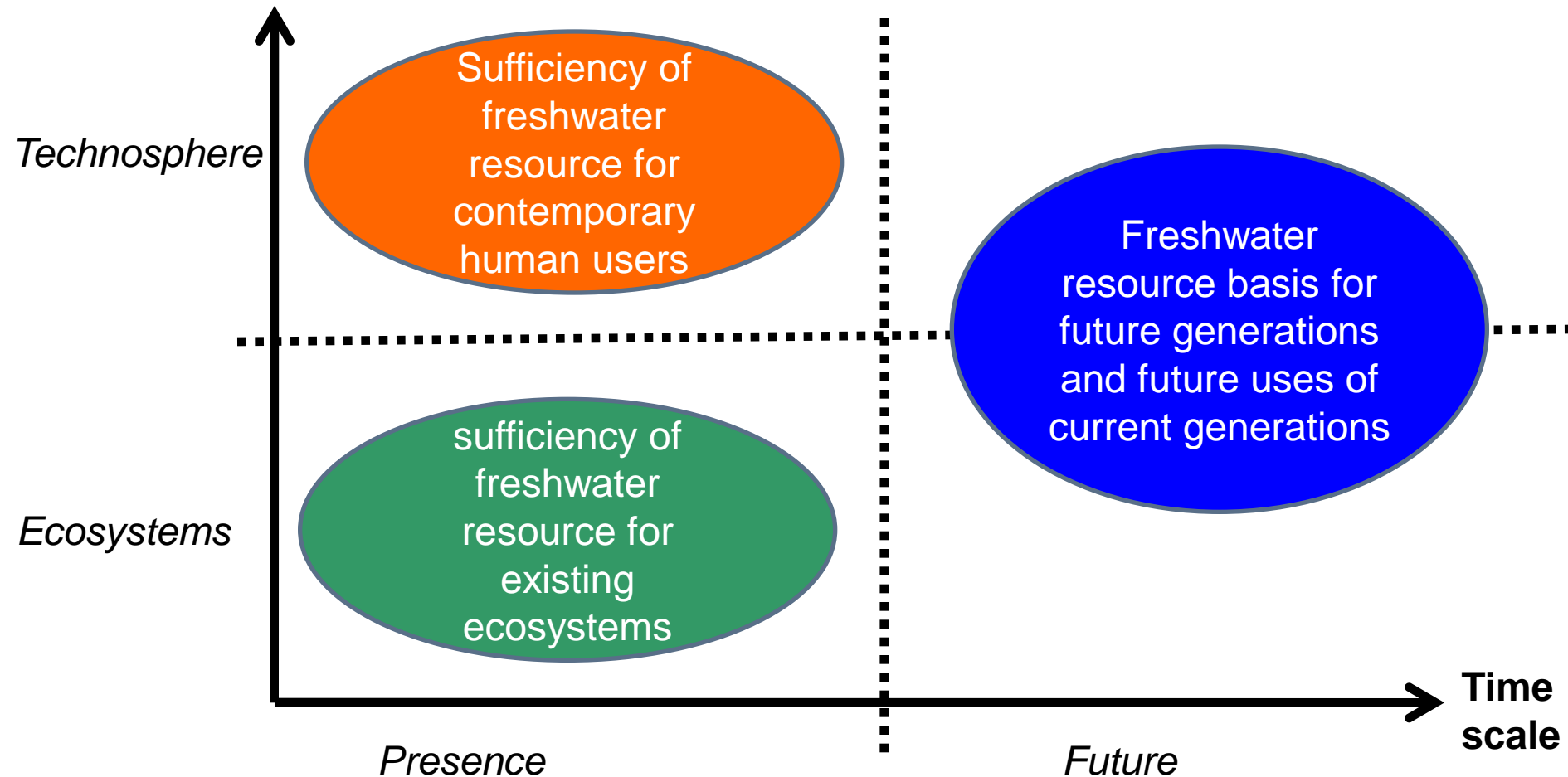
## Definitions II

- **Competition for freshwater resource**
    - Current freshwater availability too low to fulfill requirements of all freshwater users over limited time period → allocation problem!
    - Withdrawal-to-Availability ratio: **WTA < 1**
    - Threshold for competition:  
Human withdrawals  $\geq$  10% resource renewability rate (availability) (OECD 2004)
  - **Depletion of freshwater**
    - Consumption rate higher than renewability rate (availability) → exhaustive decrease
    - Withdrawal-to-Availability ratio: **WTA > 1**
    - Net reduction of freshwater availability in watershed over significant, long time periods
  - **Water function**
    - Supporting human uses in technosphere and sustaining life in ecosphere
- ➔ **Distinction as fundamental basis for framework**

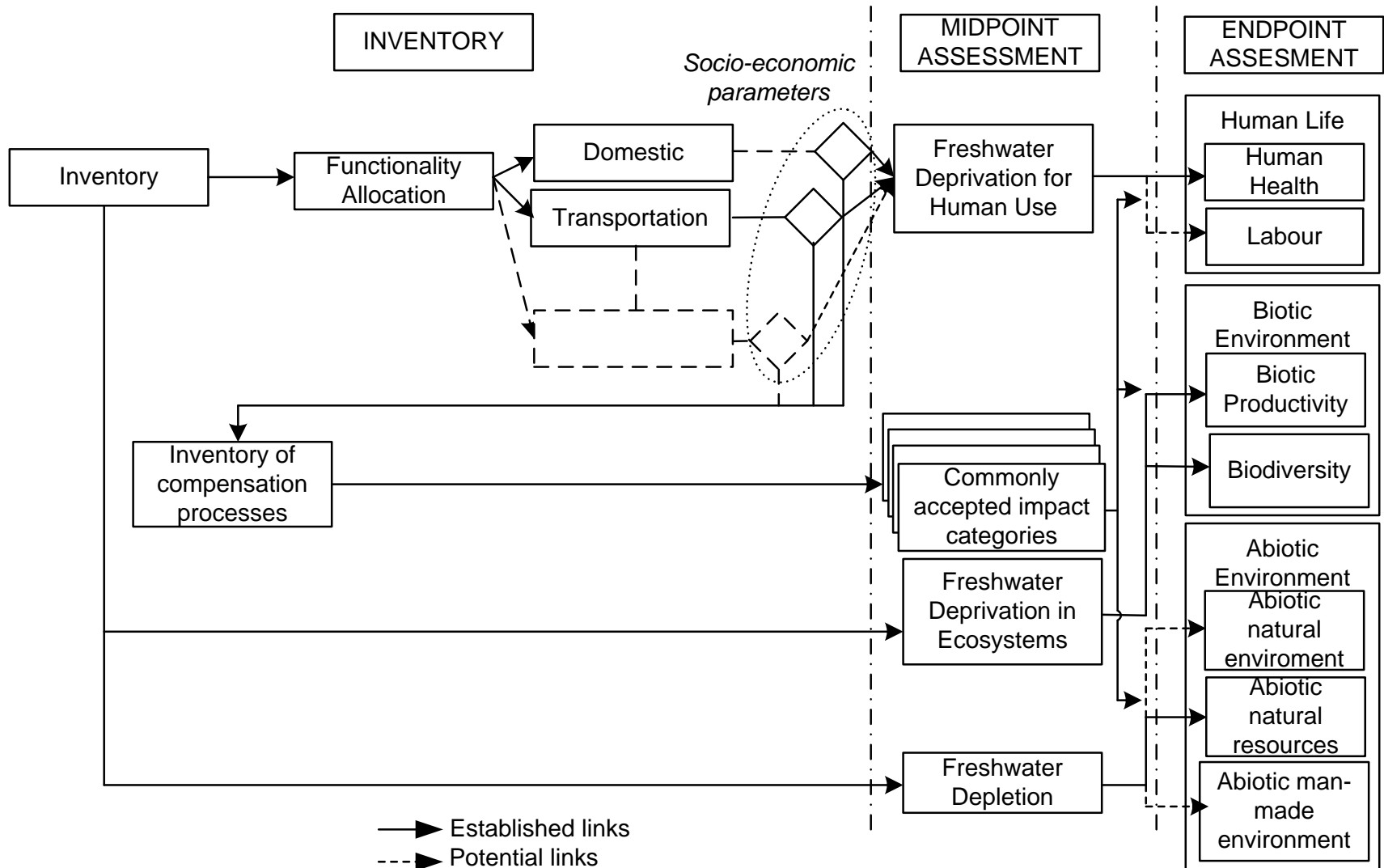
# Framework for Assessing Freshwater Use within LCA

## Three elements of environmental concern

Water function



# Framework for Assessing Freshwater Use within LCA



# Future Challenges

- How to get appropriate LCI data?  
Recommendations for corporate water reporting?
- Which level of resolution in the inventory?
- How to regionalize the assessment of water use?  
(GIS, archetypes, watershed level, country level?)
- How to isolate impacts from water use from other influencing factors to properly describe the cause-effect chains?
- Which indicators are meaningful for water-related impacts?
- How to secure practical implementation (e.g. in databases?)

# Thank you very much for your attention!

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**Bayart, J.B, C. Bulle, L. Deschênes, M. Margni, S. Pfister, F. Vince,  
A. Koehler (2008):  
A Framework for Assessing Off-Stream Freshwater Use in LCA,  
*Submitted to Int J LCA***