**LCA Discussion Forum: Assessment of Water Use in LCA
05 June 2008, Zurich**

Water Use in LCA

State-of-the-Art and Future Challenges
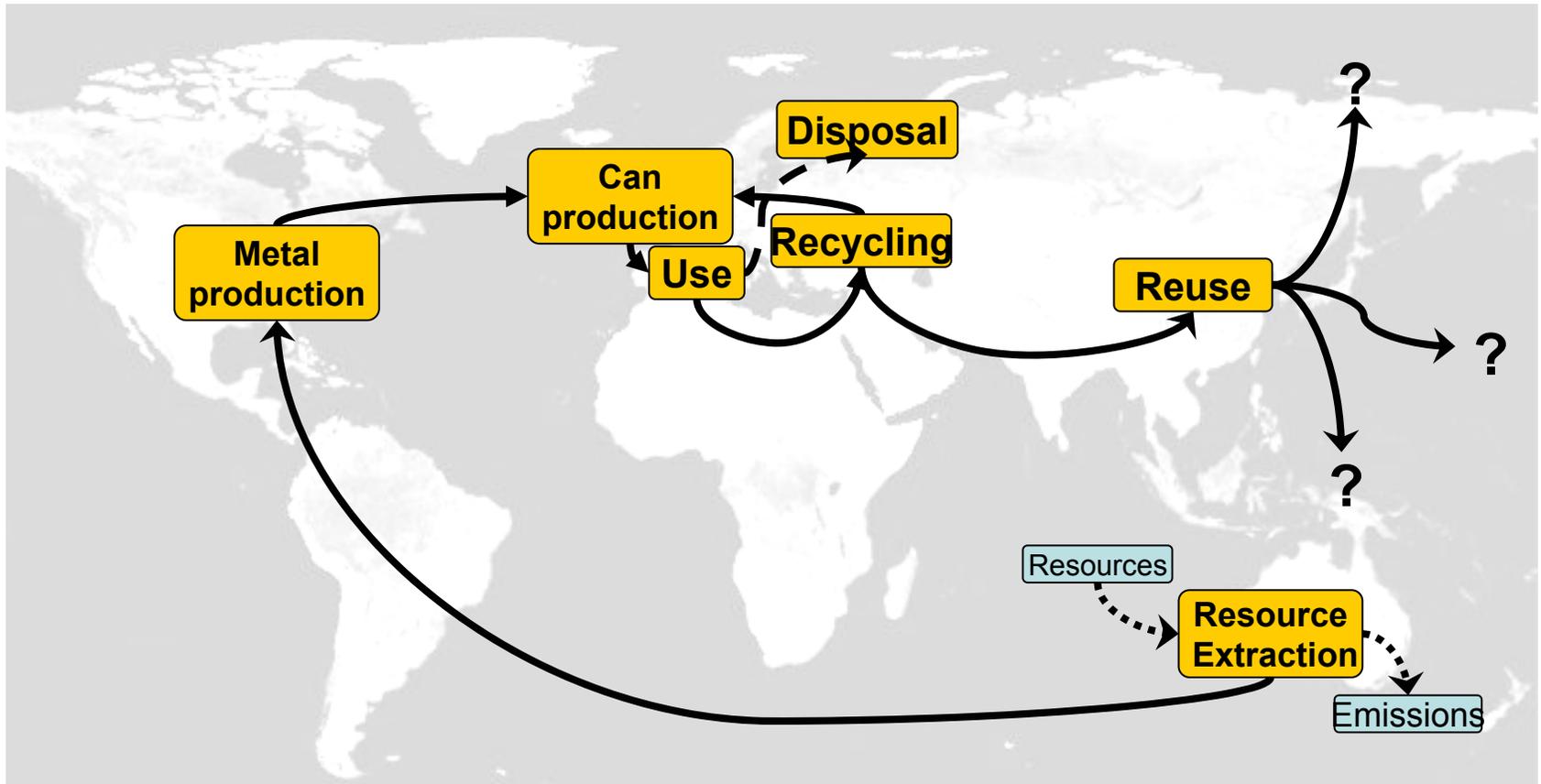
Annette Köhler (ETH Zurich)

Motivation:
Decreasing freshwater resource availability

- 1.1 billion people lacking sufficient access to safe drinking water
- Water scarcity strongly influences food security (malnutrition)
  → Large burden on human health particularly in Africa and Asia

- Increasing agricultural production (irrigation) and damming
  → Reduced freshwater availability for ecosystems

- Overexploitation of freshwater bodies & abstraction of fossil groundwater
  → Diminished availability for future generations

→ Water use and depletion of freshwater resources of extraordinary importance for environmental assessments (LCA)
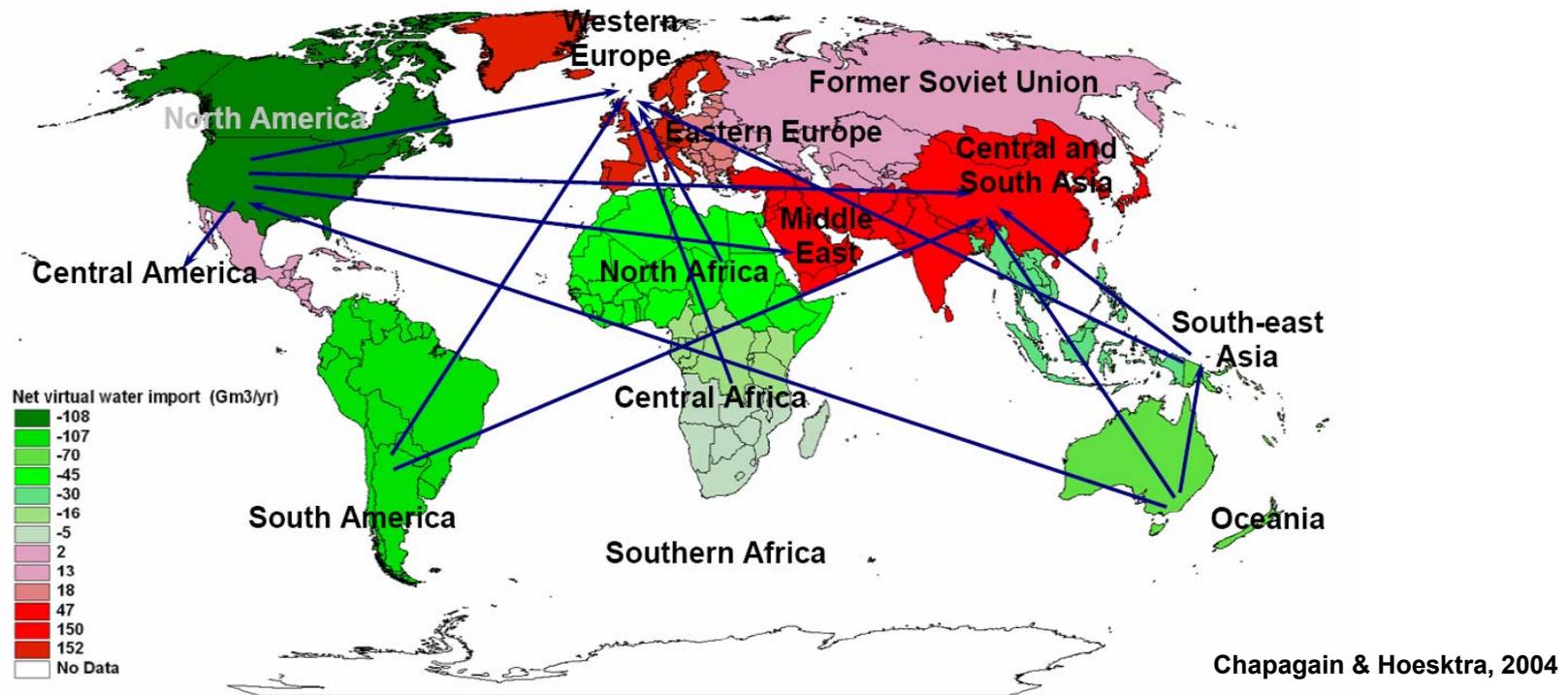
Motivation:
Globalization of water (use) by global value chains

Life cycle of an of an aluminum product (e.g. can for soft drinks)

➔ Environmental performance of global products: Embodied water?

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Motivation:
Global virtual water flows of agricultural products

Chapagain & Hoesktra, 2004

Regional virtual water balances and net interregional virtual water flows related to the trade in agricultural products (period: 1997-2001)

➔ **Water footprint of global products?**

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State-of-the Art in LCA (I):
Water as a Resource

- Water = the only abiotic, <u>renewable</u> resource

- Fundamental distinction of resource types
  - Flows (rivers, streams): renewable
  - Funds (groundwater aquifers, lakes): renewable when sustainably used
  - Deposits (fossil groundwater reservoirs): non-renewable

- Water usage types
  - Use: Water released into the same watershed it was withdrawn
  - Consumption: Water transfers to different river basins and evaporation

  - In-stream usage (hydroelectric generation, water transport)
  - Off-stream usage: withdrawal from water body (irrigation, water supply)

  (Owens, 2002)

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

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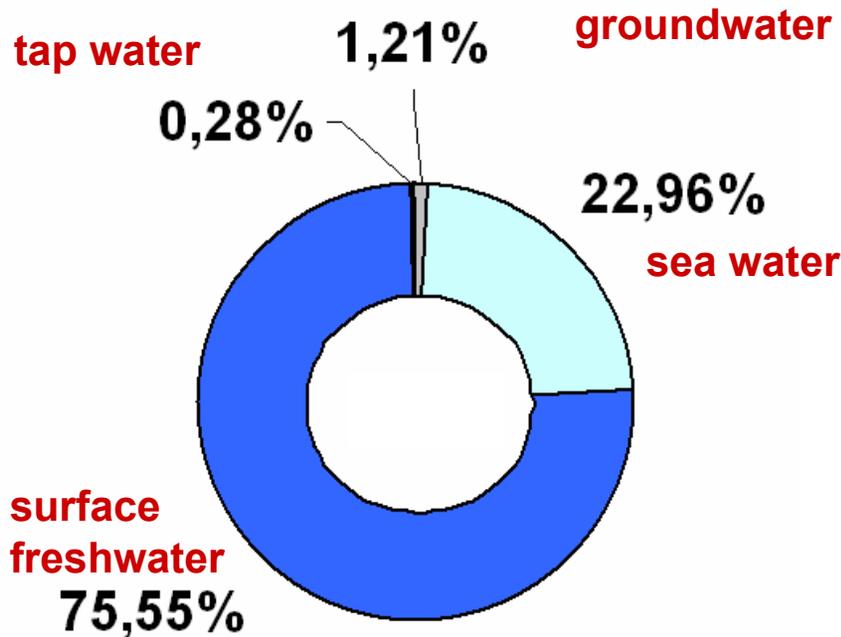Environmental Engineering

State-of-the Art in LCA (II)
Water in Life Cycle Inventory (LCI)

- No harmonized scheme
  - for inventory parameters
  - for environmental reporting of water consumption in industry and agriculture

- 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 to a product system insufficient

➔ Higher level of detail needed
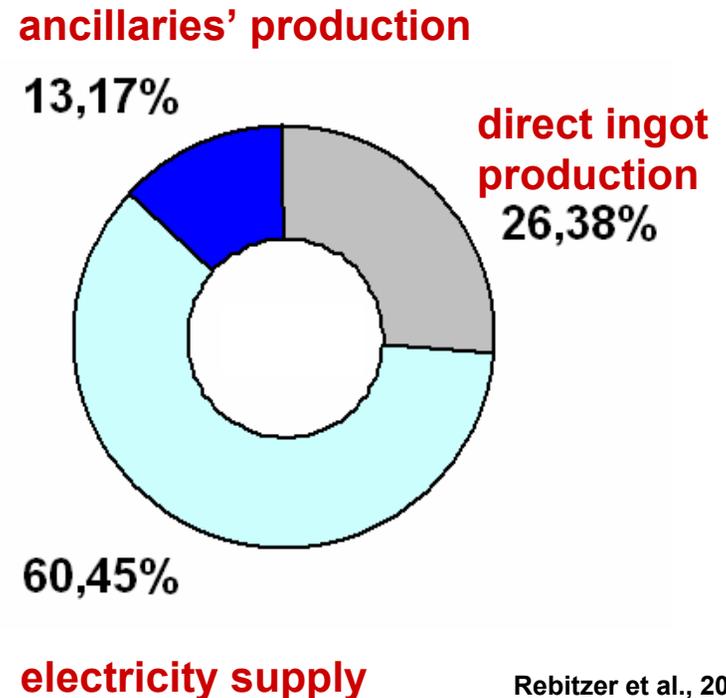(resource types, quality, geographic info, transfer?)

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Example: Aluminum Ingot Production Cradle-to-Gate Water Consumption

- **Aluminum Ingot (European production mix)**

Water types

tap water
1,21%
0,28%
groundwater
22,96%
sea water
surface freshwater
75,55%

Process chain origin

ancillaries' production
13,17%
direct ingot production
26,38%
60,45%
electricity supply

Rebitzer et al., 2007

State-of-the Art in LCA (III)
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
    - Swiss Ecological Scarcity method 2006 (Frischknecht et al. 2006)
    - Cumulative Exergy Demand (CExD) (Bösch et al. 2007)
    - Extraction from Natural Environment (CEENE) (Dewulf et al. 2007)

➔ Available methods assess only impacts on the resource itself

➔ Other impact pathways leading to impacts on human health and ecosystems neglected so far

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UNEP/SETAC Project Group: Assessment of Water Usage and Depletion of Freshwater Resources within LCA

- Develop midpoint-endpoint framework to assess environmental consequences of water usage in LCA
  - Midpoint: Physical environmental impact due to environmental intervention (e.g. global warming)
  - Endpoint: Damage to Areas of Protection

- 3 Areas of Protection (AoP)
  Resources, human health, and ecosystem quality

- Impact pathway approach (cause-effect chains)

- Develop impact assessment methods for characterizing water usage

- Establish recommended practice and guidance for LCA practitioners

Other Environmental Assessment Concept

- Water Stress Index (WSI)
  = Total human water use / renewable water supply

  → High technical water stress: WSI > 40%

- Water Footprint
  =   the total volume of freshwater used to produce goods and services
     (water volumes consumed and/or polluted per unit of time)

  - Metric for individuals, nations, product, business
  - Geographically explicit

  - Blue water: ground- and surface water
  - Green water: rainwater
  - Grey water: water volume for diluting polluted water

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Future Challenges

- How to get good LCI data?
  Recommendations for corporate water reporting?

- Which level of resolution in the inventory?

- How to regionalize the assessment of water usage?
  (GIS, archetypes, watershed level, country level?)

- How to isolate impact from water usage 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?