Methods in Water Footprinting: The LCA-Based Approach

Sarah McLaren

NEW ZEALAND LIFECYCLE MANAGEMENT CENTRE

MASSEY UNIVERSITY TE KUNENGA KI PŪREHUROA

Overview

- LCA approach
- Interactive exercise
- Fundamentals of LCA:
  - Systems approach
  - Inter- and intra-generational equity
  - Impact assessment
- Method of Pfister et al. (2009)
- An example

Life cycle thinking (1)

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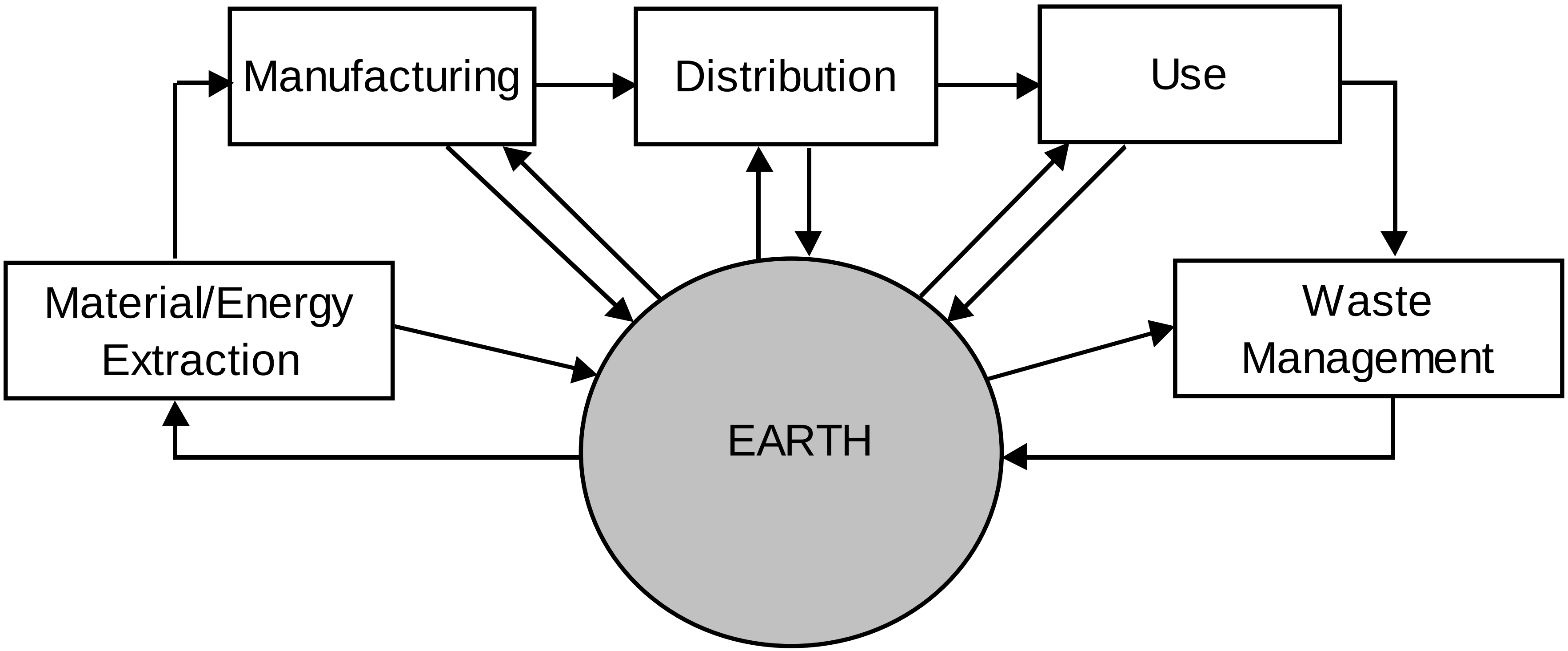
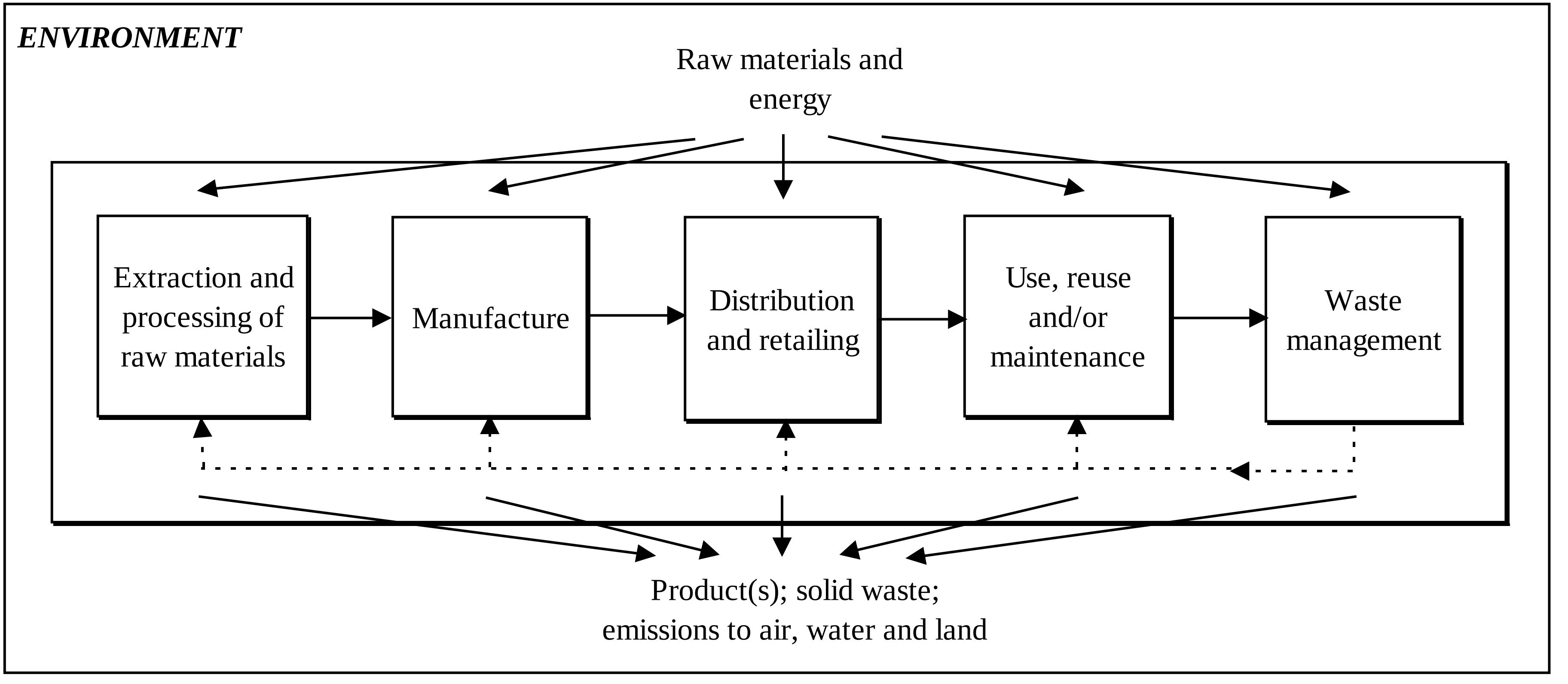
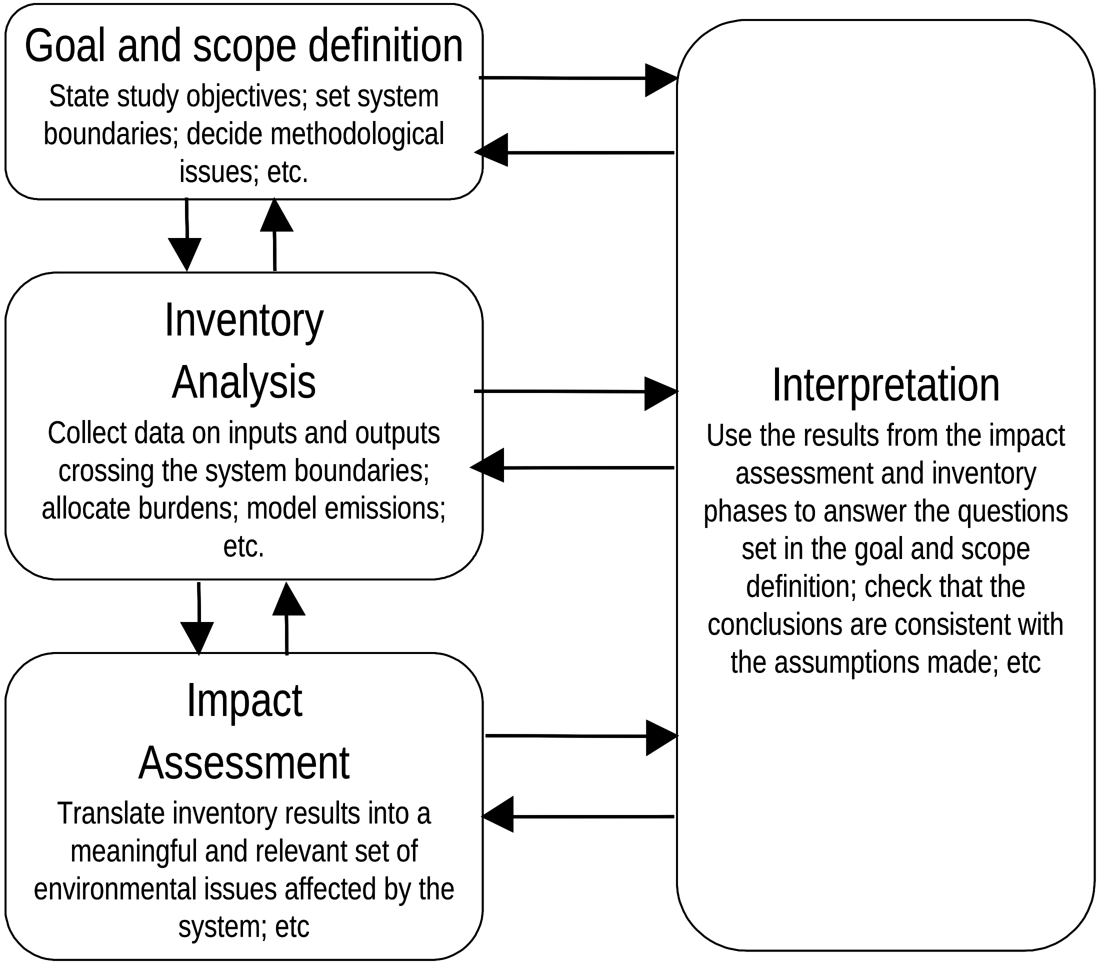


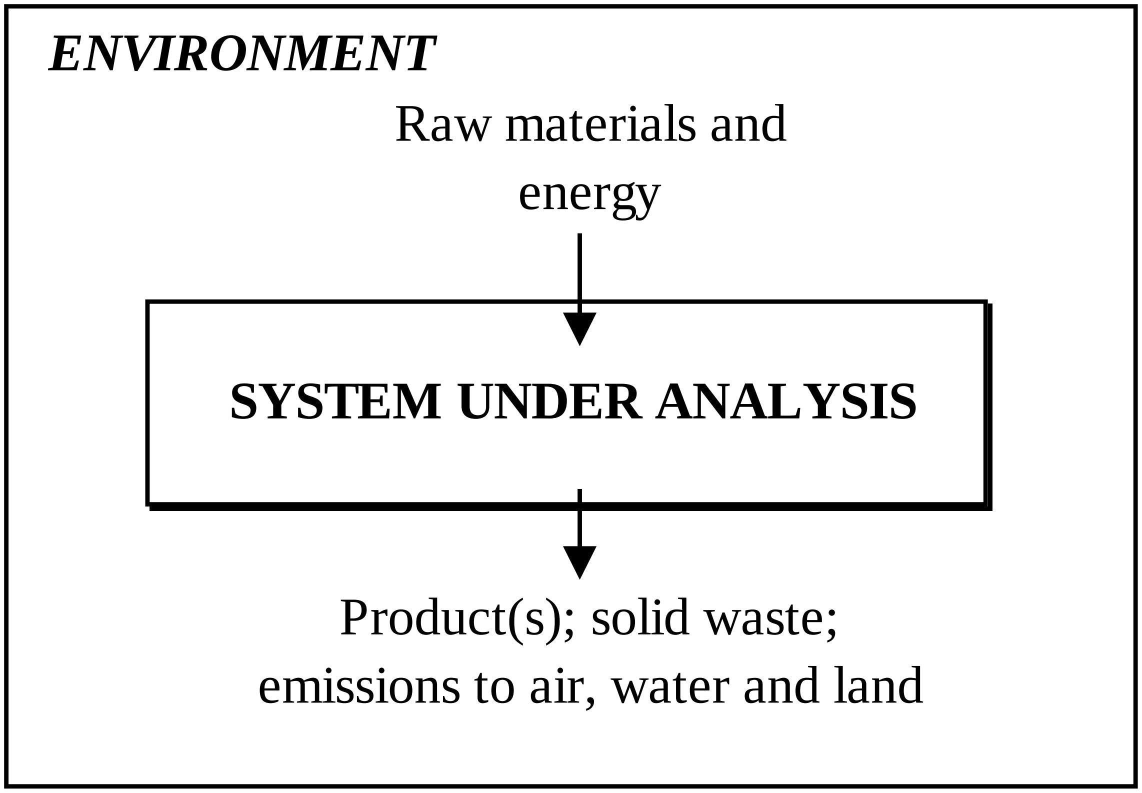
LCA framework (2)



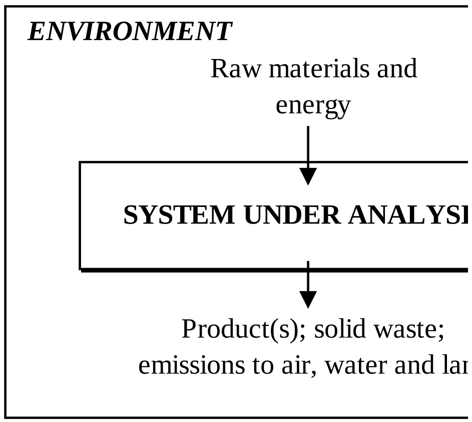
LCA framework (3)



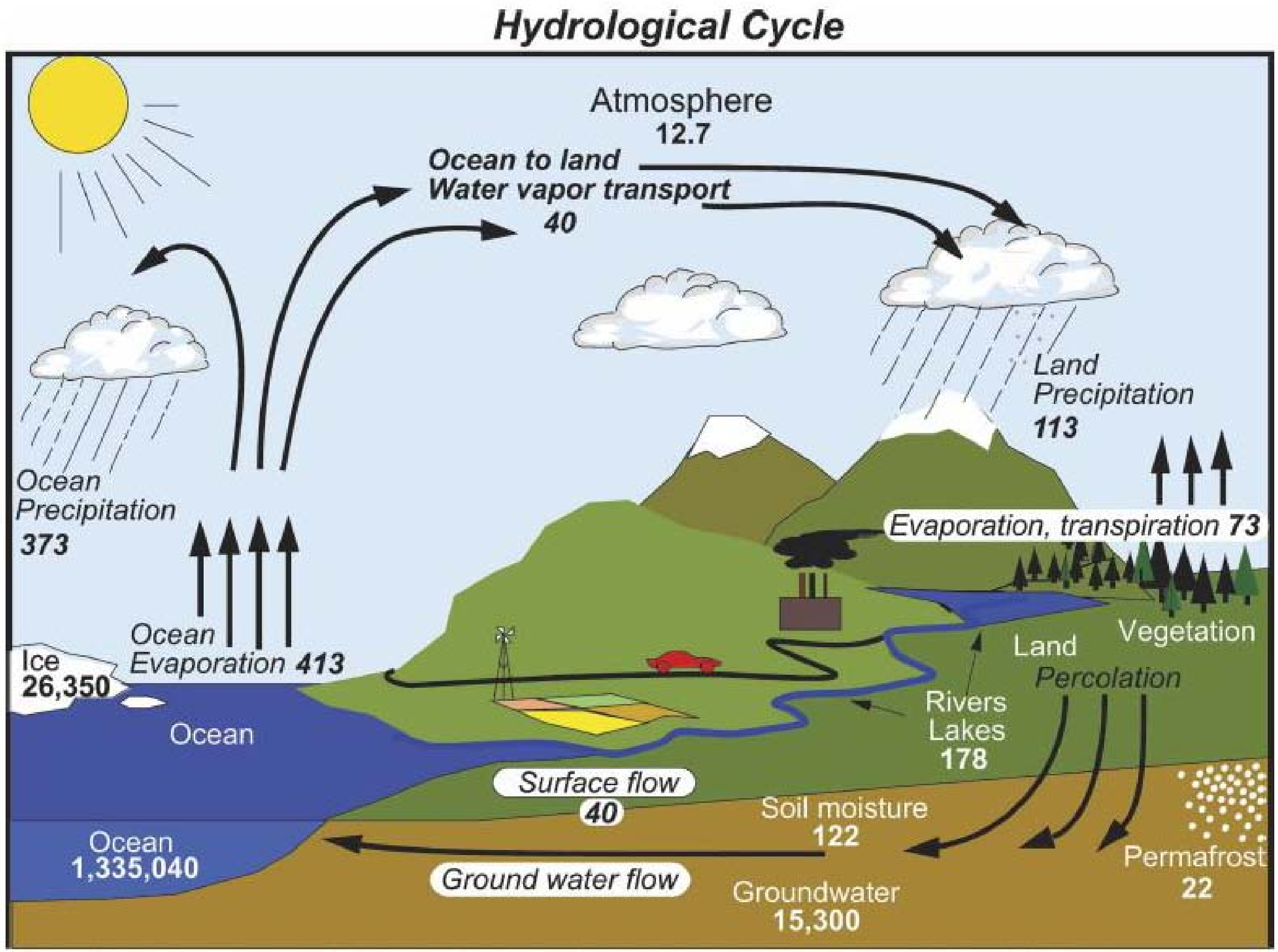
1. Systems approach



1. Systems approach



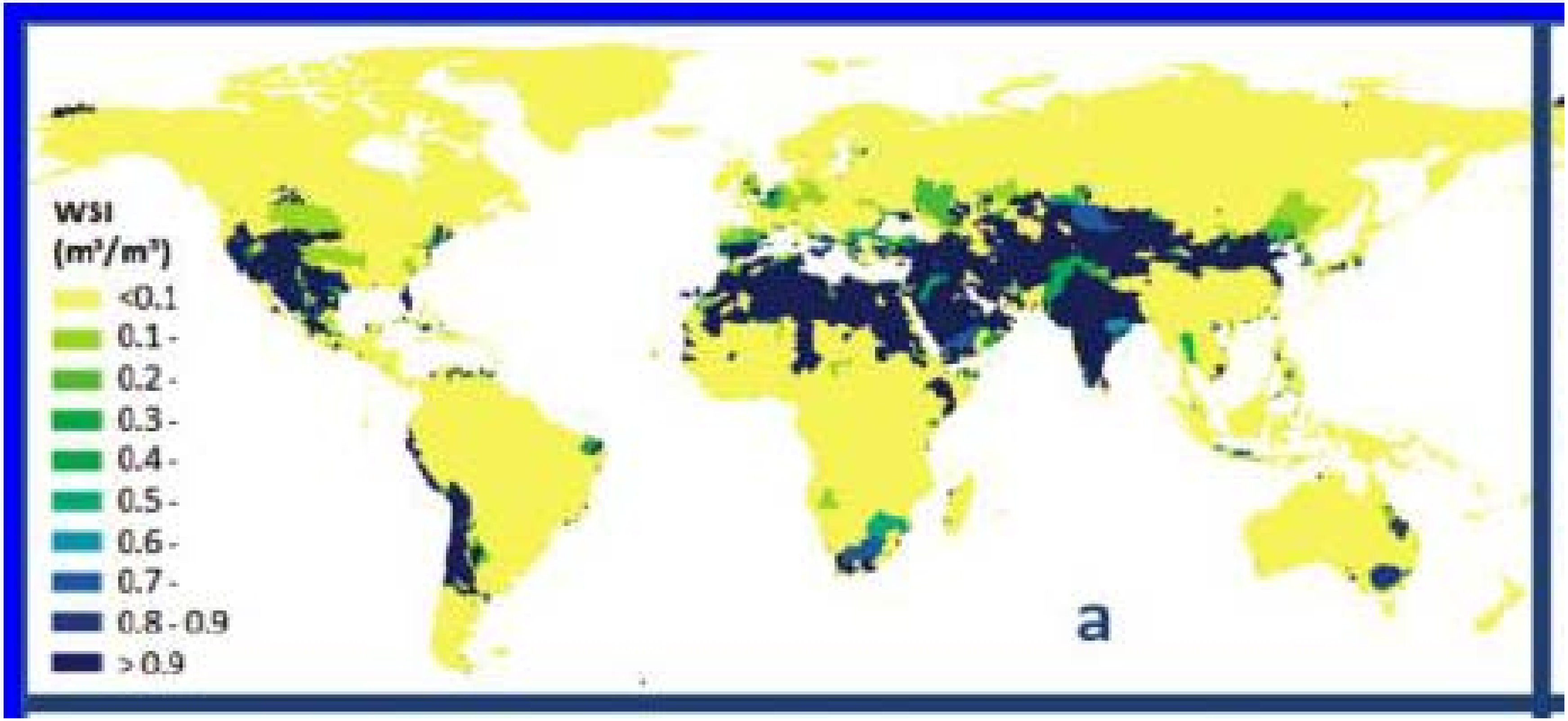
Source: Trenberth et al., 2007



Units: Thousand cubic km for storage, and *thousand cubic km/yr* for exchanges

FIG. 1. The hydrological cycle. Estimates of the main water reservoirs, given in plain font in 10^3 km^3, and the flow of moisture through the system, given in slant font (10^3 km^3 yr^{-1}), equivalent to Eg (10^{18} g) yr^{-1}.

2. Inter- and intra-generational equity



Source: Pfister et al., 2009

3. Impact assessment

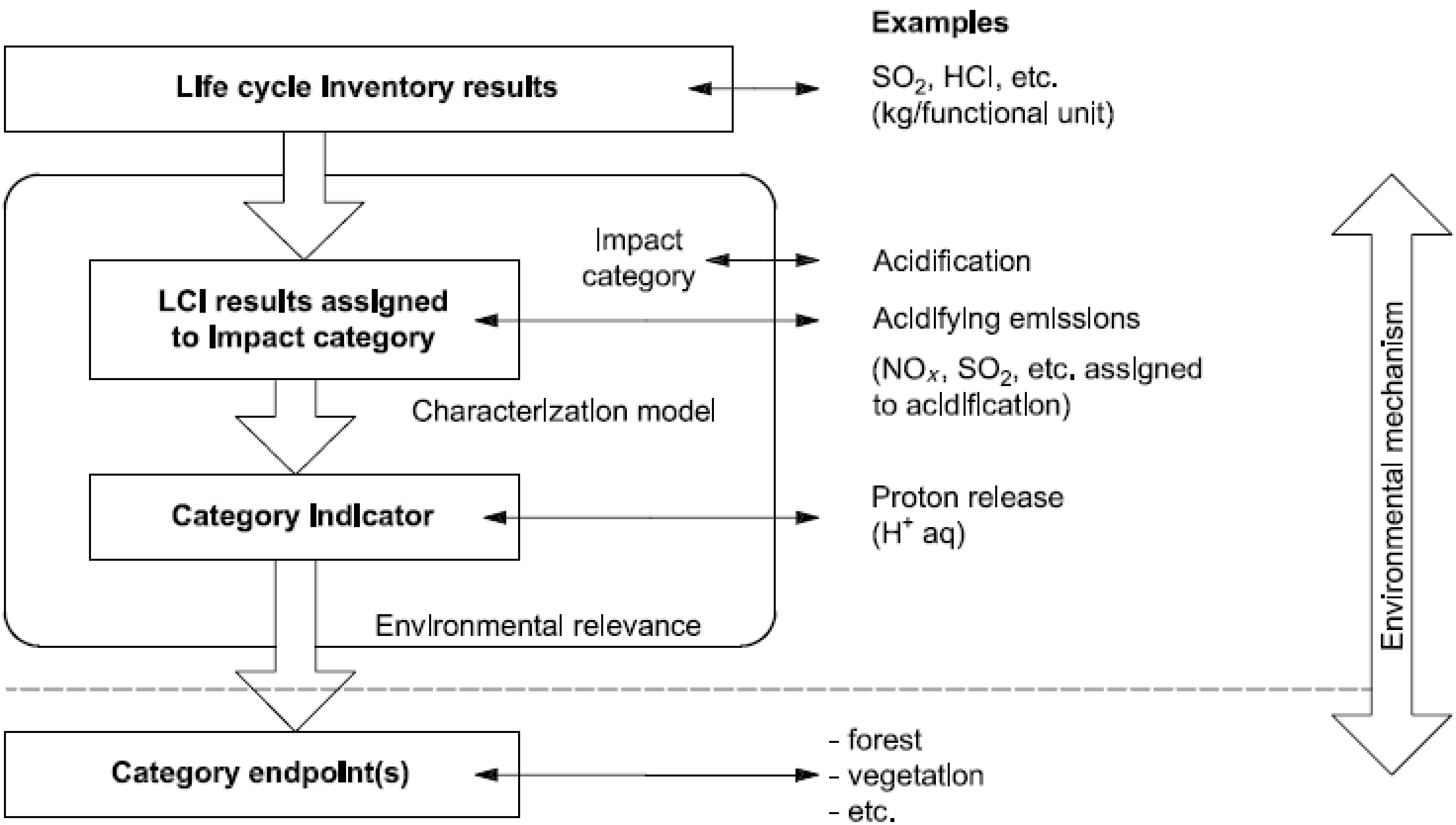


Figure 3 — Concept of category indicators

Source: ISO 14044

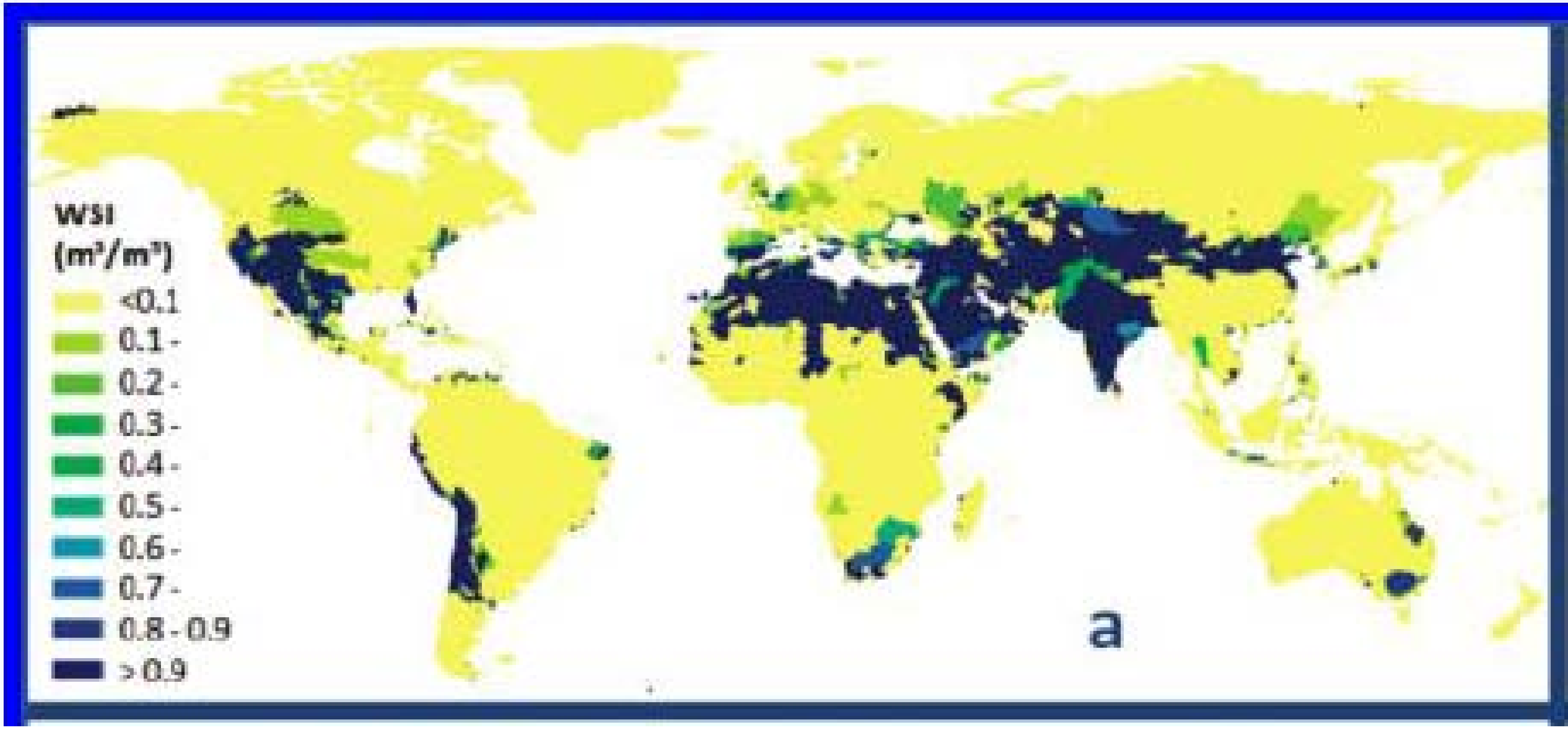
3. Addition of inventory data

Inventory data:

- Quantity of water used
- Resource type of water e.g. precipitation, surface water, sea water, soil misture, groundwater (excluding fossil water), brackish water, fossil water
- Water quality characteristics e.g. chemical, physical
- Forms of water use e.g. evaporation, displacement from groundwater to surface water, change in water quality
- Geographical location of water withdrawal and/or return
- Temporal aspects

3. Impact assessment (characterisation) factors

Potential impacts BUT as site-dependent as possible ...



Method of Pfister et al. (2009)

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$$\mathrm{WTA}_i = \frac{\sum_j \mathrm{WU}_{ij}}{\mathrm{WA}_i}$$

Water use by industry, agriculture, households

Freshwater available (10,000 watersheds)

Ratio of total annual freshwater withdrawals to hydrological availability

Pfister et al. (2009)

$$\mathrm{WTA}_i = \frac{\sum_j \mathrm{WU}_{ij}}{\mathrm{WA}_i}$$

$$\mathrm{WTA}^* = \begin{cases} \sqrt{\mathrm{VF}} \times \mathrm{WTA} & \text{for SRF} \\ \mathrm{VF} \times \mathrm{WTA} & \text{for non} - \text{SRF} \end{cases}$$

Variation factor (representing precipitation distribution)

Strongly regulated flows

Pfister et al. (2009)

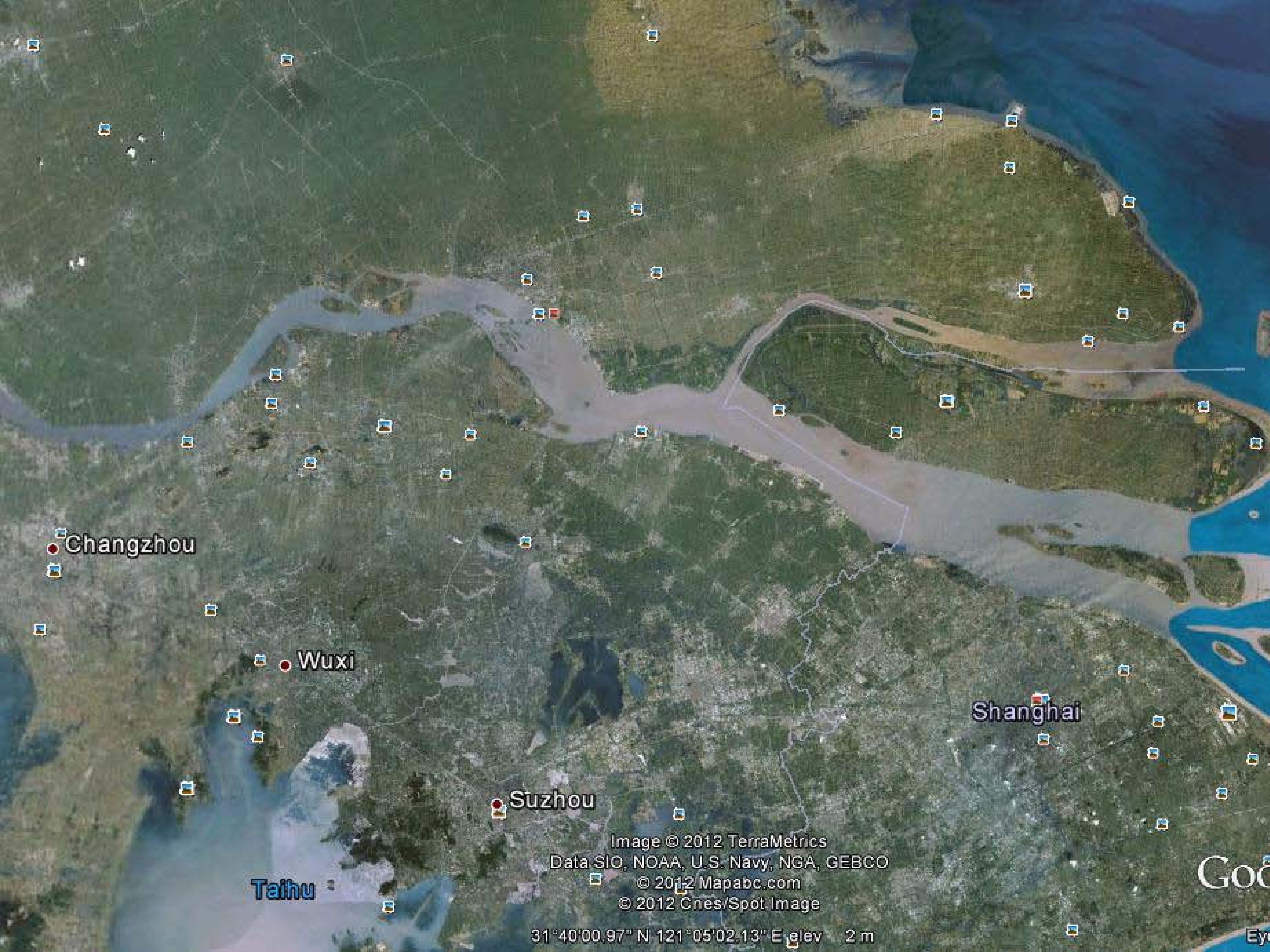
$$\mathrm{WTA}_i = \frac{\sum_j \mathrm{WU}_{ij}}{\mathrm{WA}_i}$$

$$\mathrm{WTA}^* = \begin{cases} \sqrt{\mathrm{VF}} \times \mathrm{WTA} & \text{for SRF} \\ \mathrm{VF} \times \mathrm{WTA} & \text{for non} - \text{SRF} \end{cases}$$

$$\mathrm{WSI} = \frac{1}{1 + e^{-6.4 \cdot \mathrm{WTA}^*}\left(\frac{1}{0.01} - 1\right)}$$

WSI from 0.01 to 1.0

WSI 0.5 is threshold between moderate and severe water stress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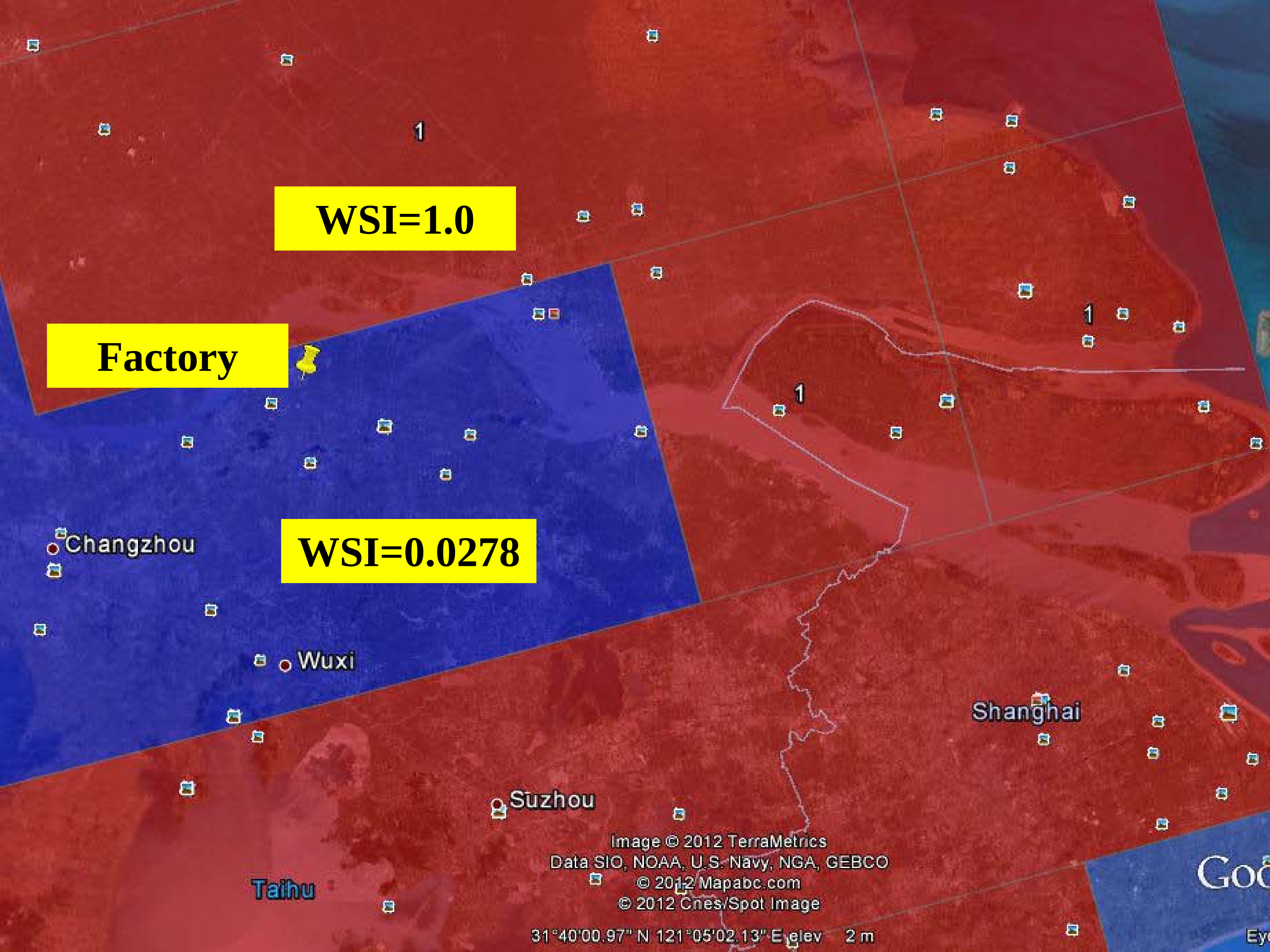

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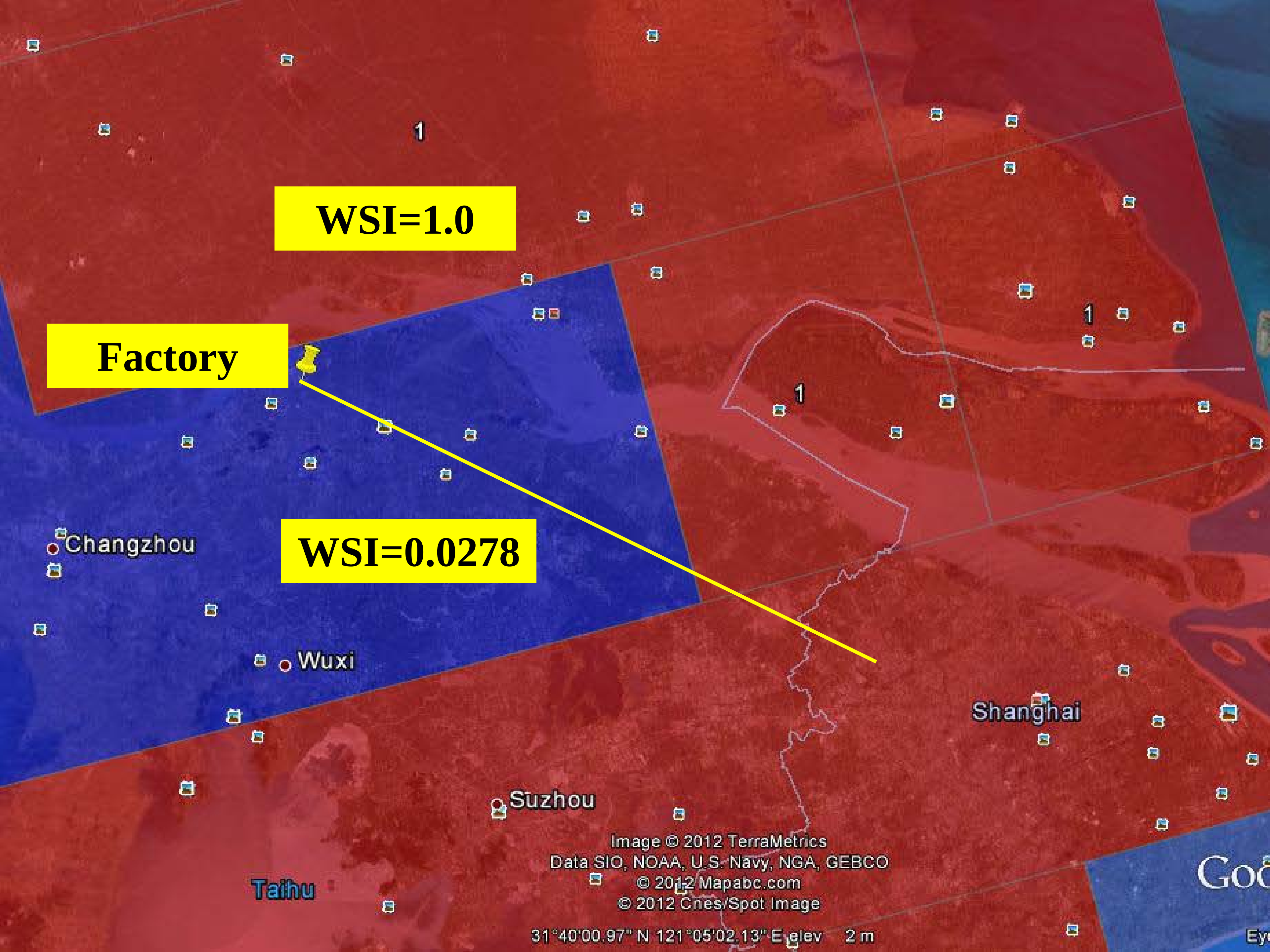
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Table 3

Major agricultural ingredients contributing to the volumetric and stress-weighted water footprints (including gray water) of Dolmio® pasta sauce and Peanut M&M's® manufactured and consumed in Australia. Volumetric water footprint data: Ridoutt et al. (2009a,b).

Ingredient	Volumetric water footprint (l)	Stress-weighted water footprint (l)
Dolmio® pasta sauce		
Tomato products	149.9	133.9
Sugar	22.9	<0.1
Onion	12.0	1.8
Garlic	5.9	0.1
Minor ingredients	3.3	1.9
Peanut M&M's®		
Cocoa derivatives	690.1	4.1
Peanuts	140.2	1.1
Sugar	135.1	0.9
Milk derivatives	133.6	5.3
Palm oil derivatives	27.3	<0.1
Minor ingredients	17.8	0.2
Tapioca starch	7.9	0.5

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Example: pasta sauce and M&Ms

Stress-weighted water footprint (l)	
Dolmio® pasta sauce	Peanut M&M's®
141	13

Source: Ridoutt et al., 2010

Example: pasta sauce and M&Ms

Tomatoes, Australia and US

Cocoa derivatives (tropical rainforest understory crop)

Method	Category	Pasta sauce	M&Ms
Volumetric WF	Blue	63 %	11 %
	Green	11 %	86 %
	Grey	26 %	3 %
	Total	202 litres	1153 litres
Stress-weighted WF	Blue	98 litres	5 litres
	Blue + grey	141 litres	13 litres

Tomatoes

Milk derivatives (California) + cocoa derivatives

Source: Ridoutt et al., 2009; Ridoutt and Pfister, 2010

Conclusions

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LCA-based approach:

- Focus on environmental impacts related to water use
- Life cycle stages typically in different geographical areas
- Inter- and intra-generational equity
- Water withdrawal or water consumption