

Water Footprint: Methods, State of the Art, Outlook

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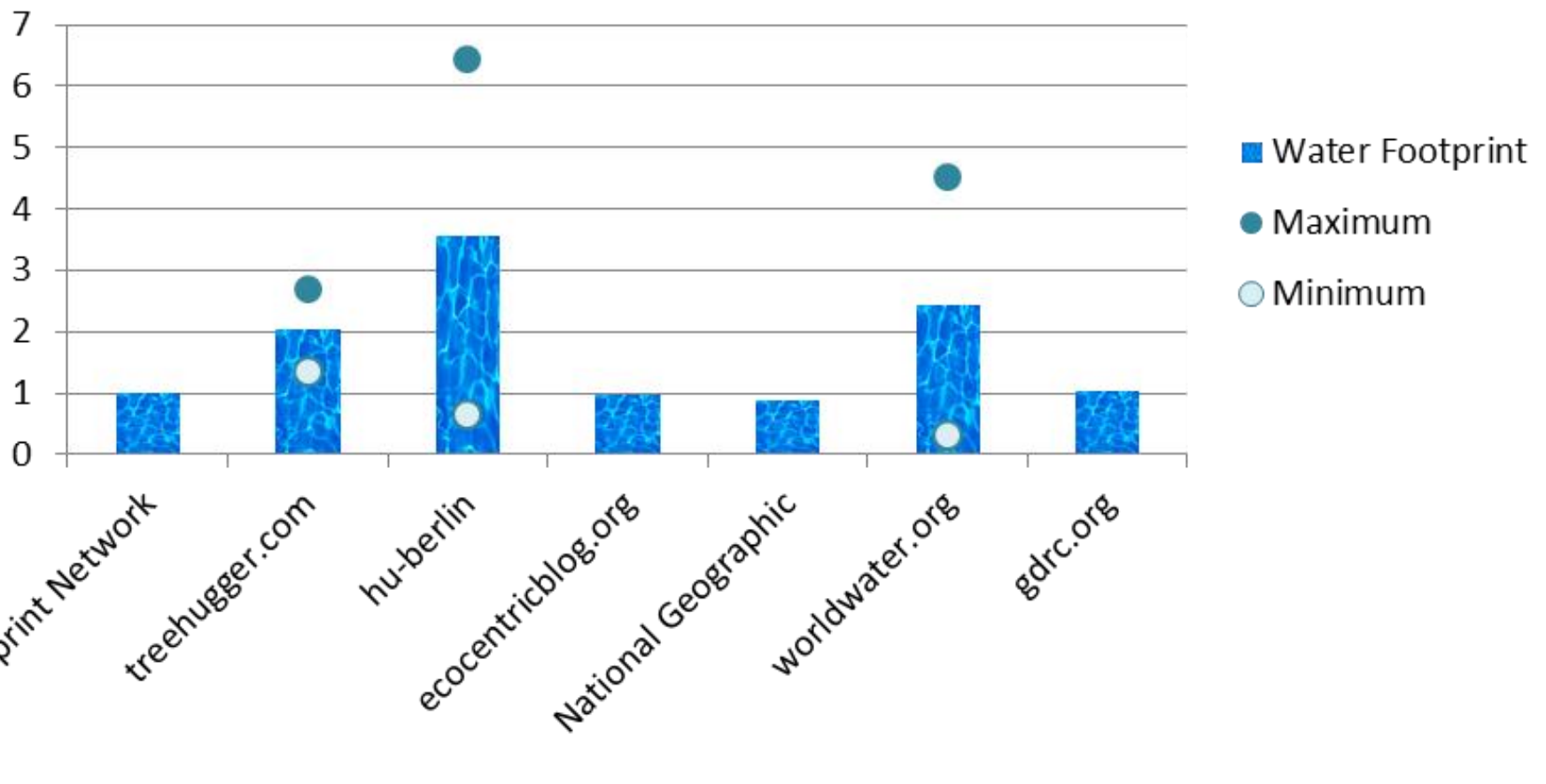
Presentation and Discussion

cewas, Willisau

22. September 2011

Water Footprint - a common and vague term

Results of “Water Footprint 1kg beef” in Google



Overview

- Short introduction to Life Cycle Assessment (LCA) method
- Definitions of “Water Footprint”
- Impact assessment methods of the water use and consumption
- Requirements and guidelines
- Conclusions
- Discussion

Life Cycle Assessment

- Assessment of the environmental impacts of a product, including the whole life cycle of the product (from cradle to grave)
- Assessment of all the emissions to air, soil and water
- Identification of the resource consumption such as energy, land, water and minerals

Life cycle of drinking water

spring



groundwater



treatment



transport



dispersion



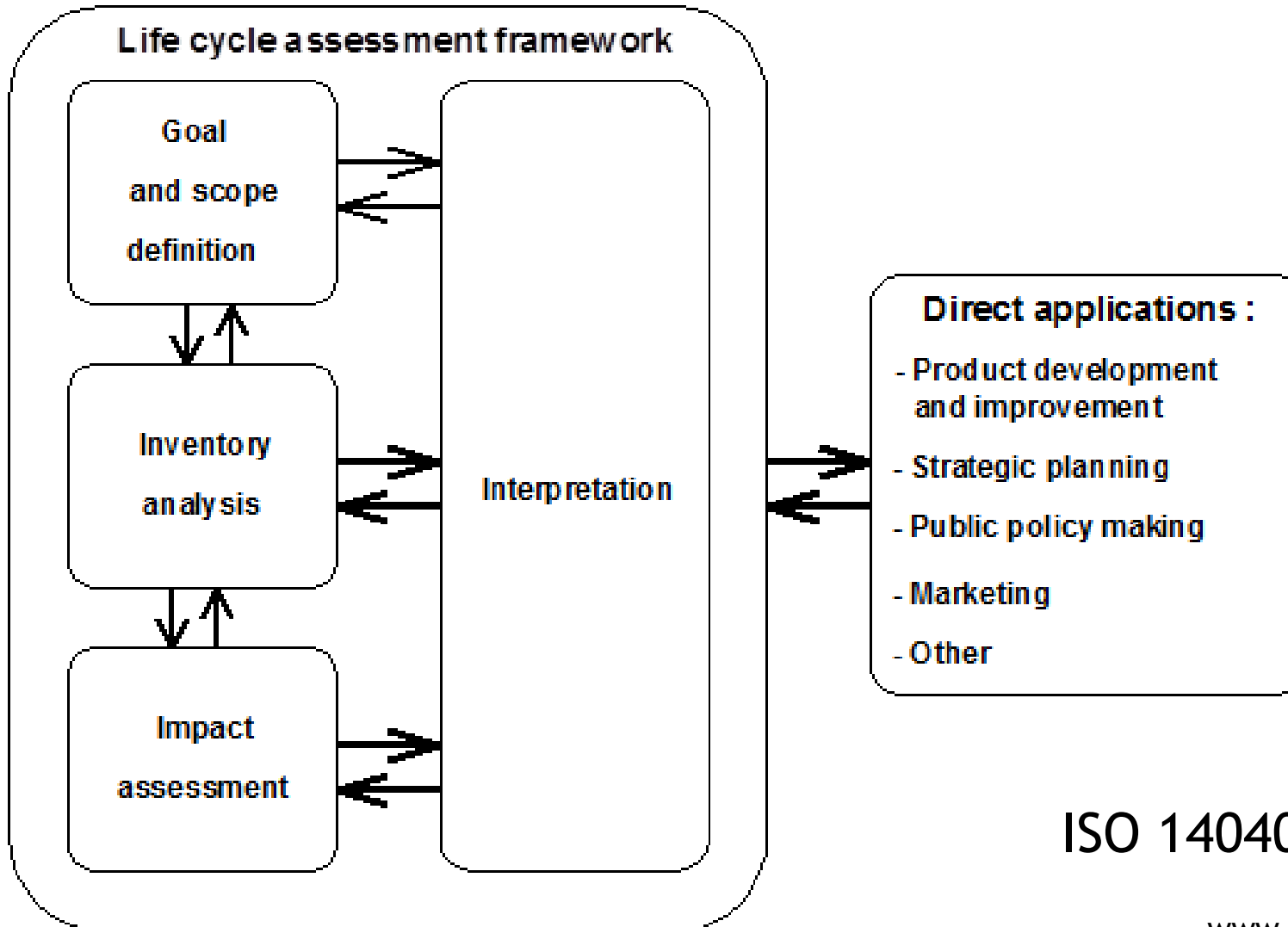
consumption



surface water

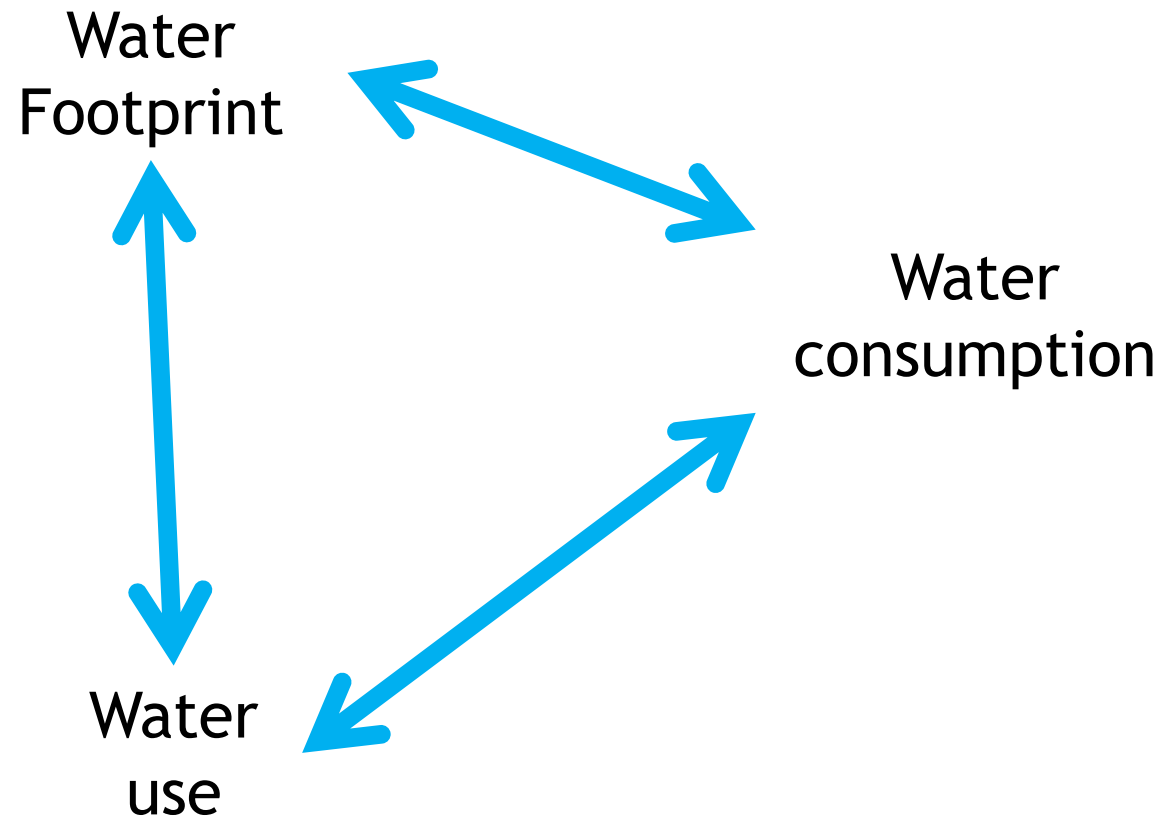


Components of a Life Cycle Assessment (LCA)

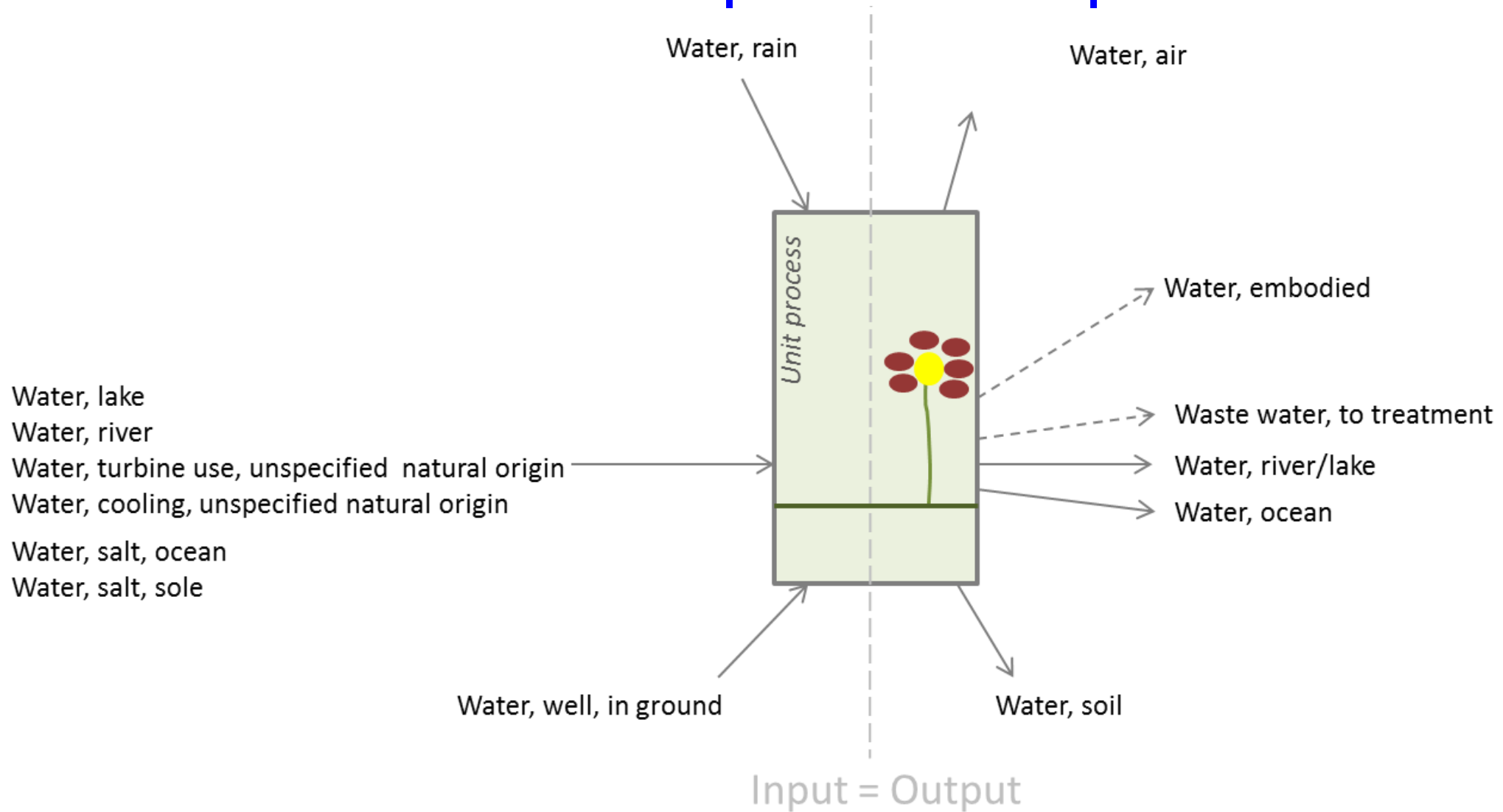


ISO 14040 & 14044

Definitions



Water flows in a production process



Water flows, specification and example

	Elementary flow	Specification	Example of an agricultural process: Cultivation of potatoes
Input	water, lake/river	Water taken from surface water	Water used for the irrigation
	water turbine/cooling	Water used in hydropower plants and for cooling, unspecified origin	/
	water, salt, ocean/sole	Saline water from ocean or sole	/
	water, rain	Rain water on area under study	Not accounted for
	water, embodied	Water contained in a product	Water embodied in seed potatoes
Output	water, air	Water that evaporates from the plants or from industrial processes	Evaporated water from the plants cultivated
	water, river/lake	Water that flows to surface water	Runoff from the fields
	water, ocean	Water that flows into the ocean	Runoff from the fields
	water, soil	Water that drains away	Infiltration from the fields
	water, embodied	Water contained in a product	Water embodied in the potatoes harvested

Definitions of «Water use»

- Water withdrawal (*Water Footprint Network*)
- Water is returned to the original basin and may be used by other users after leaving the system (*Milà I Canals*)

Definitions of «Water consumption»

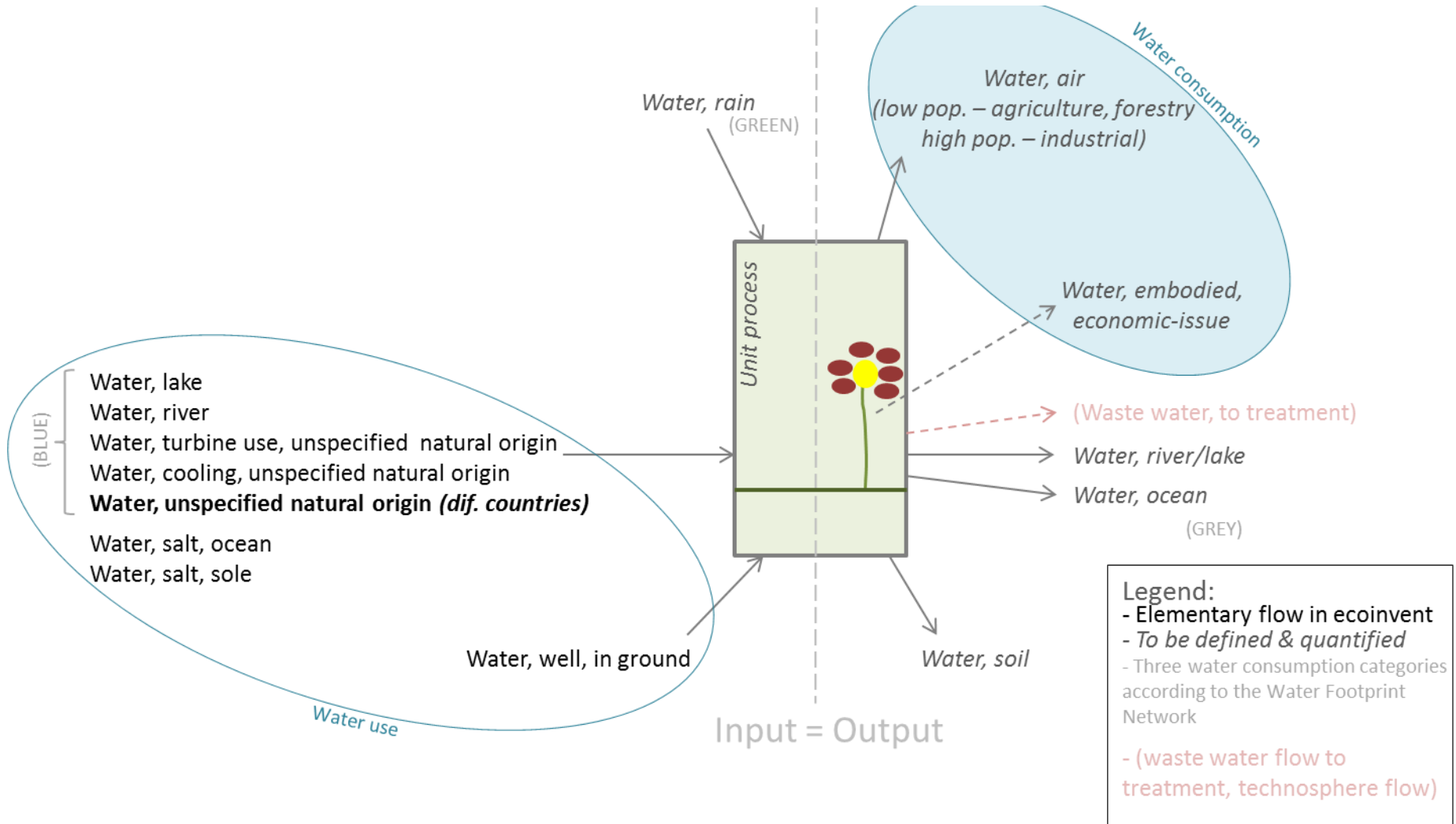
- Refers to loss of water from the available ground-surface water body in a catchment area. Losses occur when water evaporates, returns to another catchment area or the sea or is incorporated into a product (*Water Footprint Network*)
- Water is dissipated and not immediately available after use (*Milà I Canals et al.*)
- Freshwater withdrawals which are evaporated, incorporated in products and waste, transferred into different watersheds, or disposed into the sea after usage (*Pfister et al.*)

Definition of «Water Footprint» (WFP)

- The water footprint is an indicator of freshwater use that looks not only at direct water use of a consumer or producer, but also at the indirect water use.
- **Blue WFP** = consumption of surface and groundwater
- **Green WFP** = consumption of rainwater insofar as it does not become run-off
- **Grey WFP** = pollution; defined as volume of freshwater required to assimilate the load of pollutants given natural background conc. & existing ambient water quality standards

Source: Water Footprint Network

Definitions followed by ESU-services

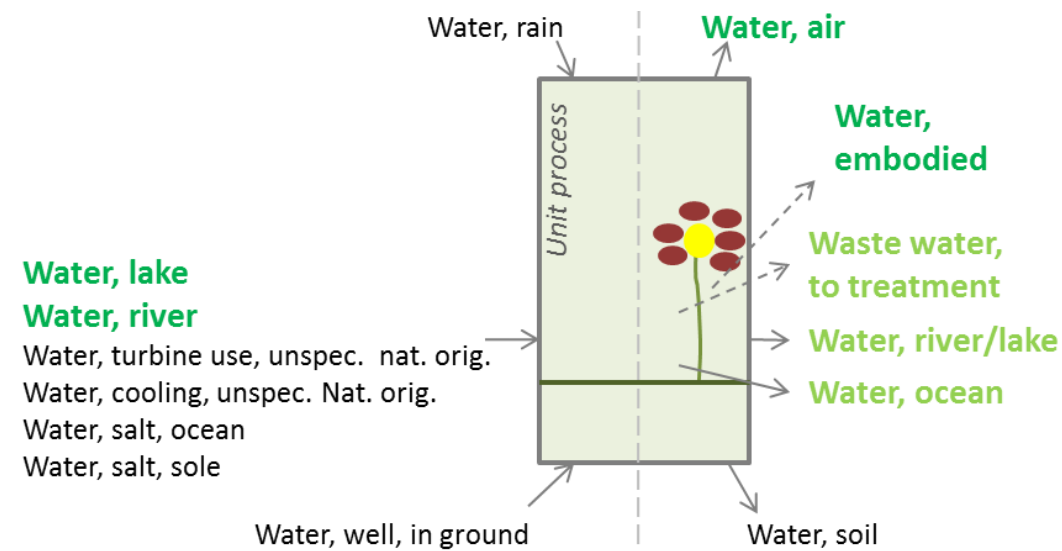


Overview of Assessment Methods of the water use and consumption

- Life Cycle Impact Assessment methods
 - Ecological Scarcity Method 2006
 - ReCiPe
 - Pfister et al.
- Other methods
 - Milà I Canals et al.
 - Water Footprint

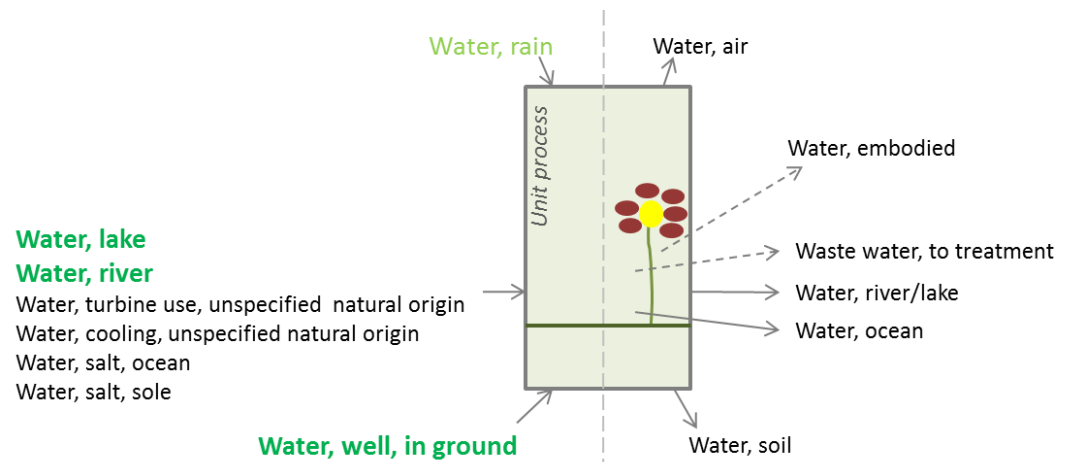
Water Footprint

- Indicator of freshwater use [consumption] (direct and indirect) measured over the full supply chain
- Water flows considered:
 - Blue water
 - Green water
 - Grey water
- System boundary: Water shed
- Volumetric measure, not a measure of severity of the environmental impact of a certain amount of water consumption and pollution → not exactly an LCIA method



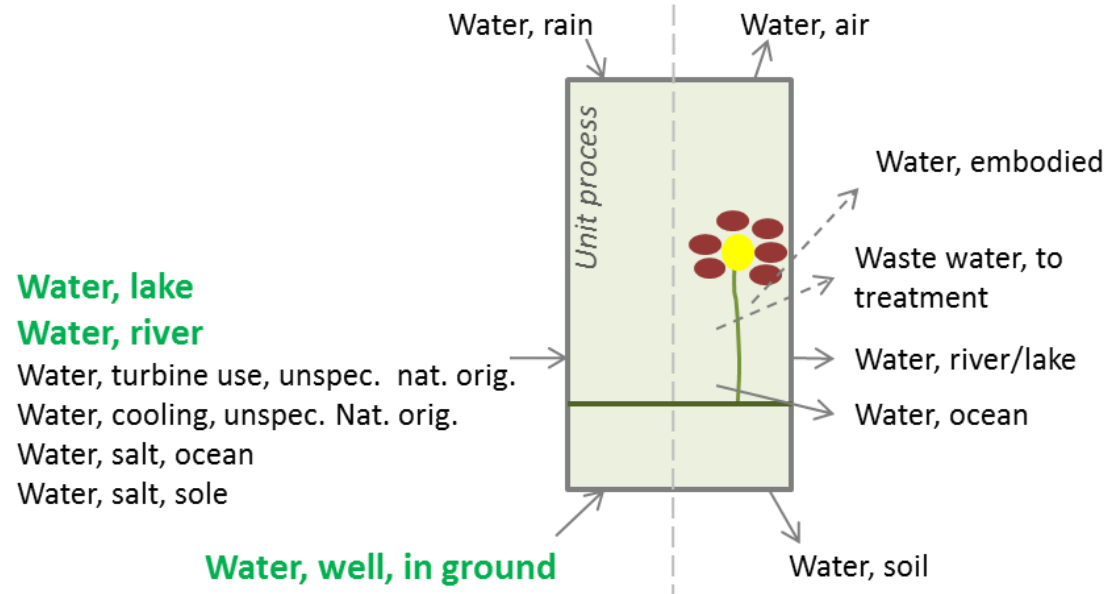
Method of Milà I Canals et al.

- Two areas: Freshwater ecosystem impact and Freshwater depletion
- Water stress index = water withdrawal / water available to human use after subtracting the needed amount for ecosystems
- Water flows considered:
 - **Blue water**: Flow from rivers, lakes, funds, stocks
 - **Green water**: Not included as no impact on environment; but: Land use change
- Not compatible with other LCIA impact assessment methods
- System boundary: river basin; flow to other watershed not incl.



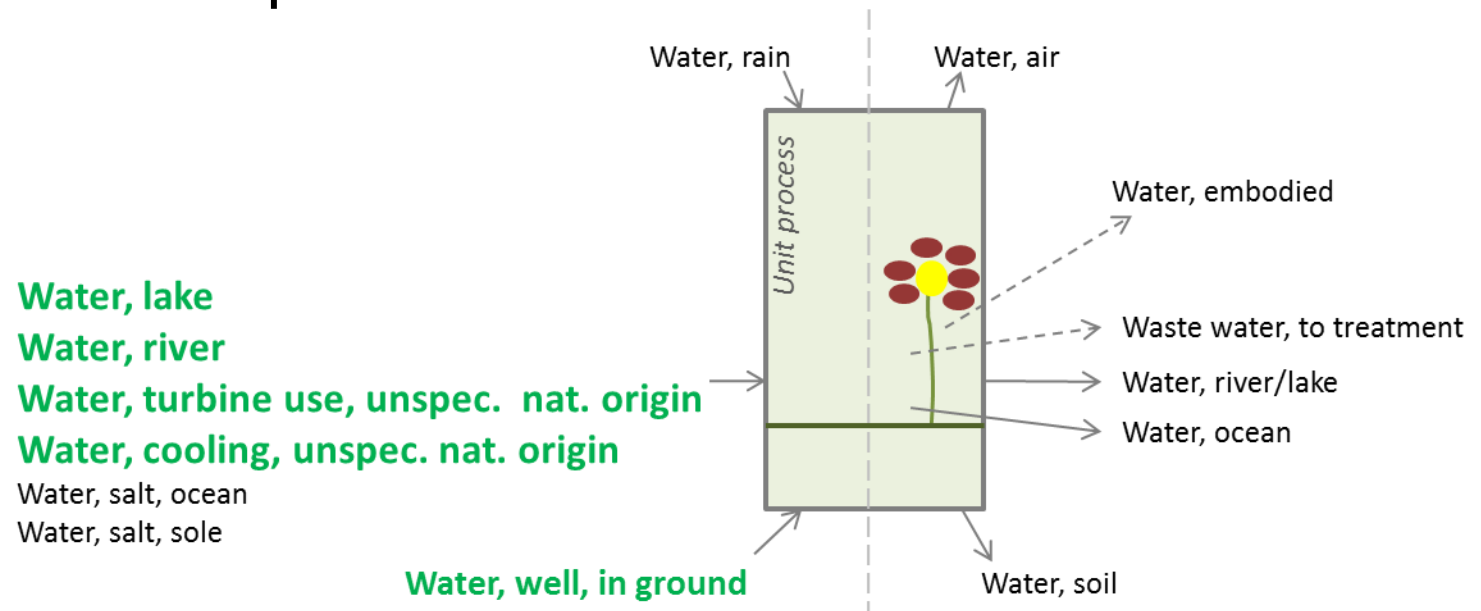
Method of Pfister et al.

- Three areas: Human health, ecosystem quality, resources
- Water stress index = $f(\text{water consumption, water scarcity})$
- Water flows considered:
 - **Blue water** consumption: Water no longer available to the watershed
- Adapted to Eco-indicator 99 impact assessment method
- System boundary: watershed



ReCiPe method

- The category of the “water depletion (WD)” includes the water use from lakes, rivers, wells and unspecific natural origin
- Quantifies the water use on a mid-point level but it is not considered in the end-point indicators → no assessment



Ecological Scarcity Method 2006, general

- Purpose:
 - Impact assessment according to the „distance to target principle“
- Characteristics:
 - fully aggregated
 - various environmental impacts (and wastes) considered
 - based on Swiss national policy targets

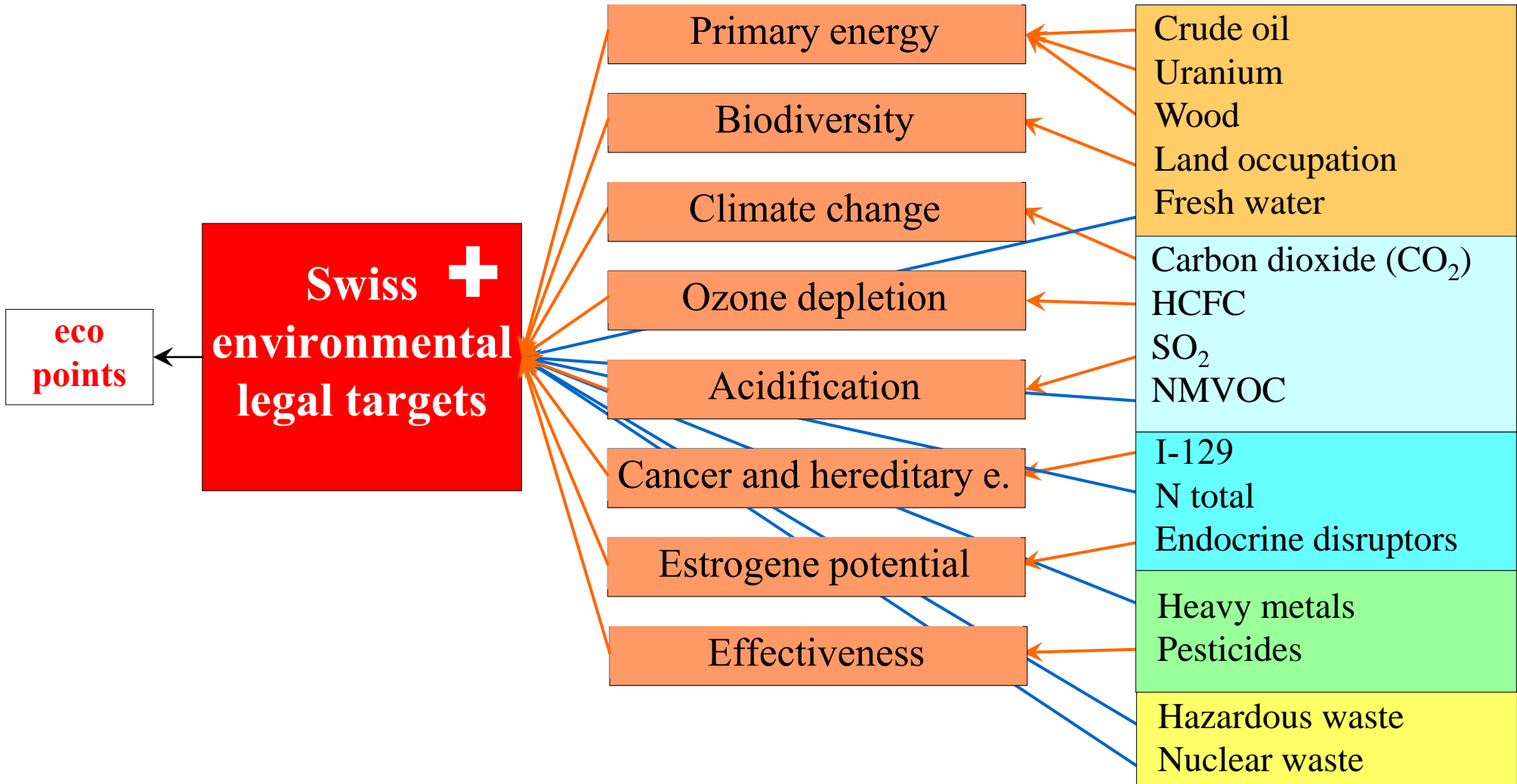
Ecological Scarcity 2006

Result

Weighting

Characterisation

Inventory



eco
points

**Swiss +
environmental
legal targets**

Primary energy

Biodiversity

Climate change

Ozone depletion

Acidification

Cancer and hereditary e.

Estrogene potential

Effectiveness

Crude oil

Uranium

Wood

Land occupation

Fresh water

Carbon dioxide (CO₂)

HCFC

SO₂

NMVOC

I-129

N total

Endocrine disruptors

Heavy metals

Pesticides

Hazardous waste

Nuclear waste

Ecological Scarcity Method 2006, freshwater

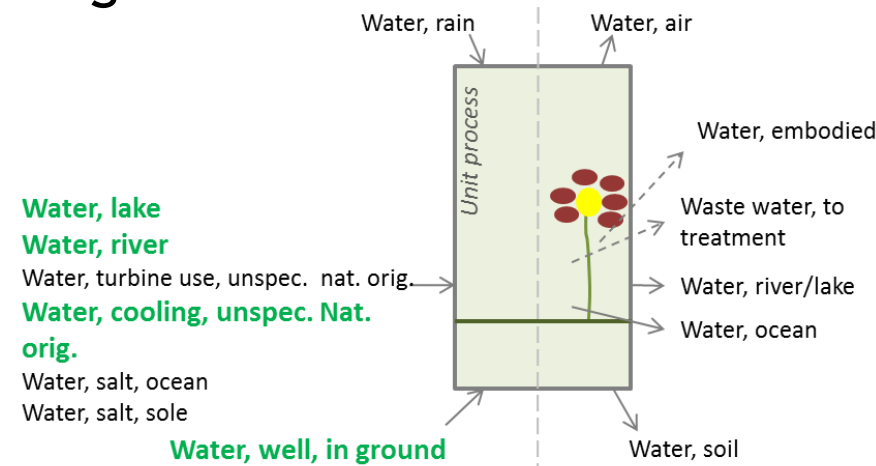
- Scarcity of freshwater defined according to the water stress index of OECD

= Consumption / Available water
 (precipitation + inflows - evaporation)

- Water flows considered:

- Chemically or physically altered water flows and long-term withdrawal of water
- (net) water withdrawal of drinking water supply, irrigation, industrial processes (incl. cooling water) etc.

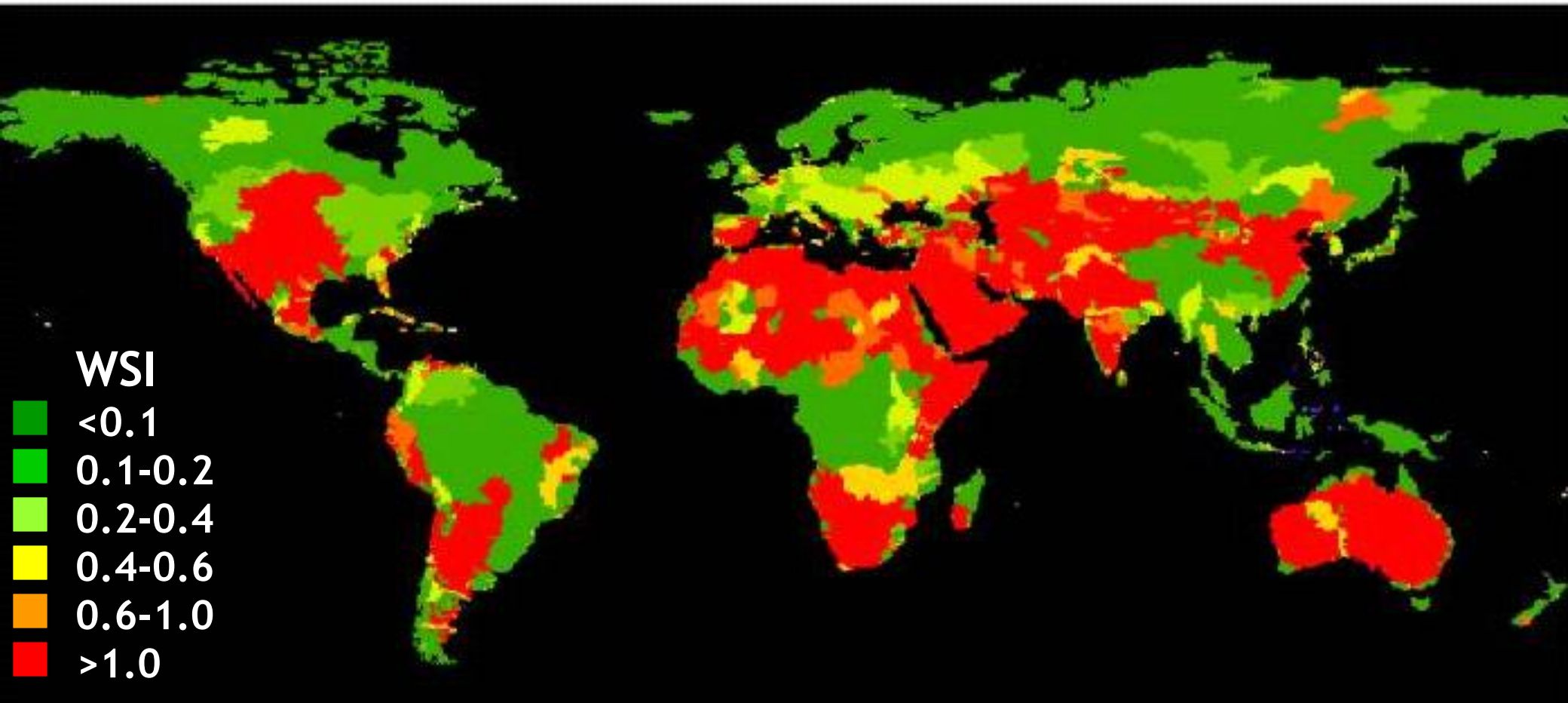
- System boundary: national level, watershed level



Regional „water stress“

Category	Range of stress index	Current water stress	Countries
<i>low</i>	<0.1	0.05	Argentina, Madagascar, Russia, Switzerland
<i>moderate</i>	0.1 to <0.2	0.15	France, Greece, Mexico, USA
<i>medium</i>	0.2 to <0.4	0.3	Japan, Thailand, China, Germany, Spain
<i>high</i>	0.4 to <0.6	0.5	Algeria, Morocco, Sudan, Tunisia
<i>very high</i>	0.6 to <1.0	0.8	Pakistan, Syria, Tajikistan, Turkmenistan
<i>extreme</i>	≥ 1	1.5	Israel, Yemen, Kuwait, Saudi-Arabia

Differentiation of WSI of the watersheds



Source: S. Pfister, ETHZ/ESD

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Summary of main characteristics

		Water use (ESU)	Water consumption (ESU)	Water footprint	Milà I Canals et al.	Pfister et al.	ReCiPe	Ecological Scarcity Method
Water flow, in	Water, lake	+		+	+	+	+	+
	Water, river	+		+	+	+	+	+
	Water, turbine use, unspecified natural origin	+					+	
	Water, cooling, unspecified natural origin	+					+	+
	Water, salt, ocean							
	Water, salt, sole							
	Water, well, in ground	+			+	+	+	+
	Water, rain				(+)			
Water flow, out	Water, air		+	+				
	Water, embodied		+	+				
	Waste water, to treatment			(+)				
	Water, river/lake			(+)				
	Water, ocean			(+)				
	Water, soil							
Boundary	River basin				+			
	Water shed			+		+		
	National leve							
Method	Impact assessment					+	(+)	+
	Other method			+	+			

Requirements and guidelines

- ISO
- UNEP/SETAC: Water Use in Life Cycle Assessment (WULCA)
 - General assessment framework for water resources and water use as basis for LCA and water footprinting
 - Adequate inventory scheme and parameters
 - Develop impact assessment methods for characterizing water usage and related environmental impacts
- Quantis & ecoinvent

ISO14046 Water footprint (Working Draft)

- “Water Footprint” assesses magnitude of env. impacts associated with water use
- The ISO standard provides a wide range of detailed definitions
- Requirements a Water Footprint study:
 - All stages of the life cycle of a product, process or activity
 - Focus on env. aspects, no economic or social aspects considered
 - Study is structured around a functional unit
- Methodological framework following the framework LCA studies
- General categories: quantity, resources type of water, quality, forms of water use, geographic location, temporal aspects

Main Challenges

- What is water consumption? Water is never used up, but only changes in availability, quantity and quality
- Assessment of quantity and/or quality
- Calculation over life cycle, thus e.g. allocation issues
- Overlaps with LCIA indicators on pollution

Conclusions

- Definition of «the» Water Footprint not yet definite, further discussions needed
- Assessment methods are not consistent, different aspects are considered
- Frameworks are needed for a coordinated work
- Exact definitions are needed when talking about the water footprint

Outlook

- The water consumption and use will remain or will become an even more important issue in the future
- A lot of discussions are ongoing, which definitions/methods/approach will establish themselves is unclear yet
- ISO Standard 14046 (?)

Discussion

References

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