Water Footprint training

San Francisco, October 8th, 2014

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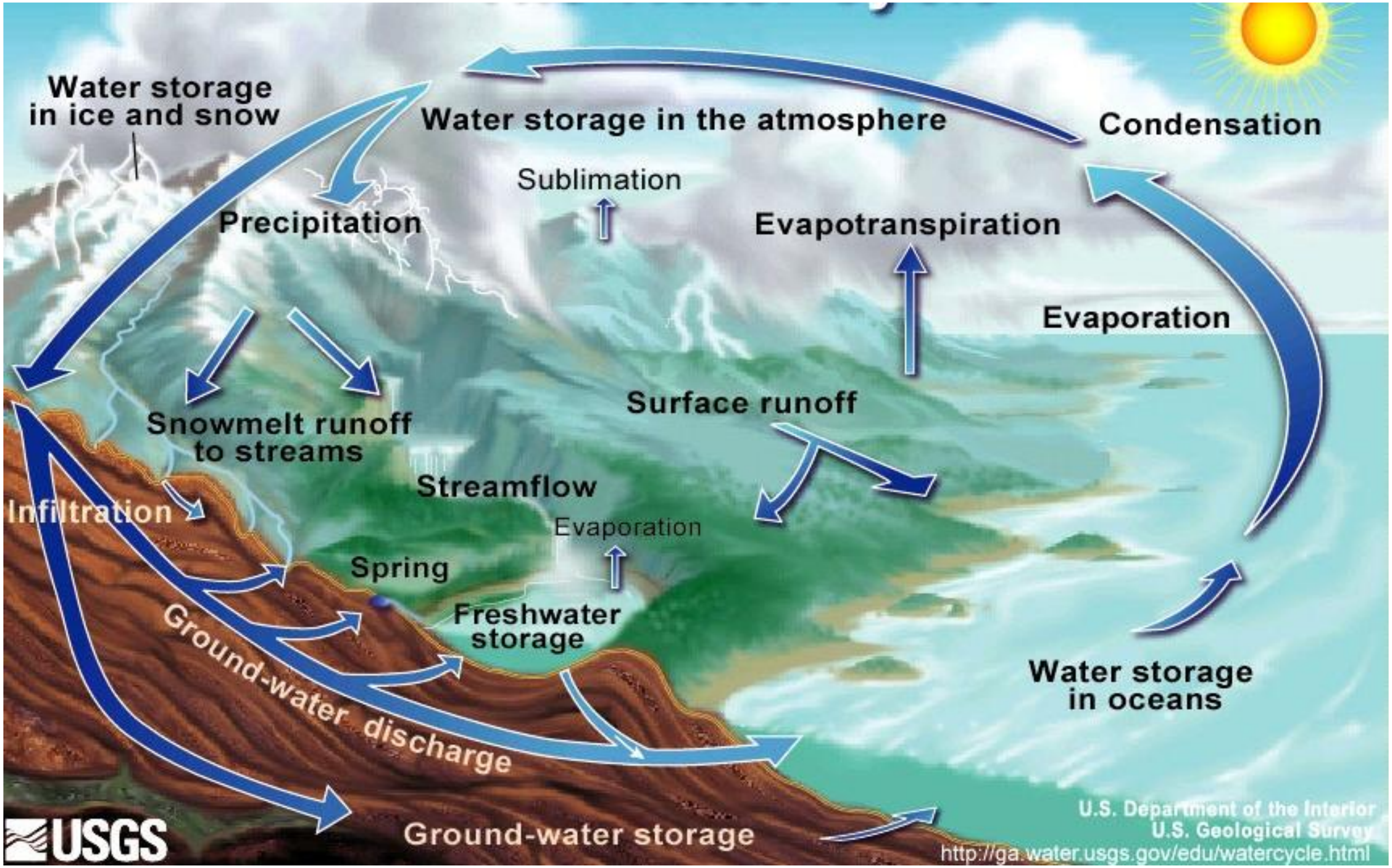
WULCA

A LIFE CYCLE INITIATIVE PROJECT

PLAN

- Presentations
- Water Cycle and related problems
- LCA: the basis of water footprinting
- Water Footprint: ISO 14046, definition and metrics
- Water footprint step by step
- Examples of application
- Tools available and input from practitioner
- WULCA: current developments

A Water Problem?
Water Natural Cycle



Adapted from Source:
U.S. Department of the Interior | *U.S. Geological Survey*
URL: http://ga.water.usgs.gov/edu/watercycle.html

Water: How much is there?

Precipitation on land:

119’000 km^3 / year (100%)

Evaporation and transpiration (62%)

Runoff (38%)

Human water use (3%)

2.1%

0.3%

0.6%

Water: what is the problem?

"There is a water crisis today. But the crisis is not about having too little water to satisfy our needs. It is a crisis of managing water so badly that billions of people - and the environment - suffer badly."

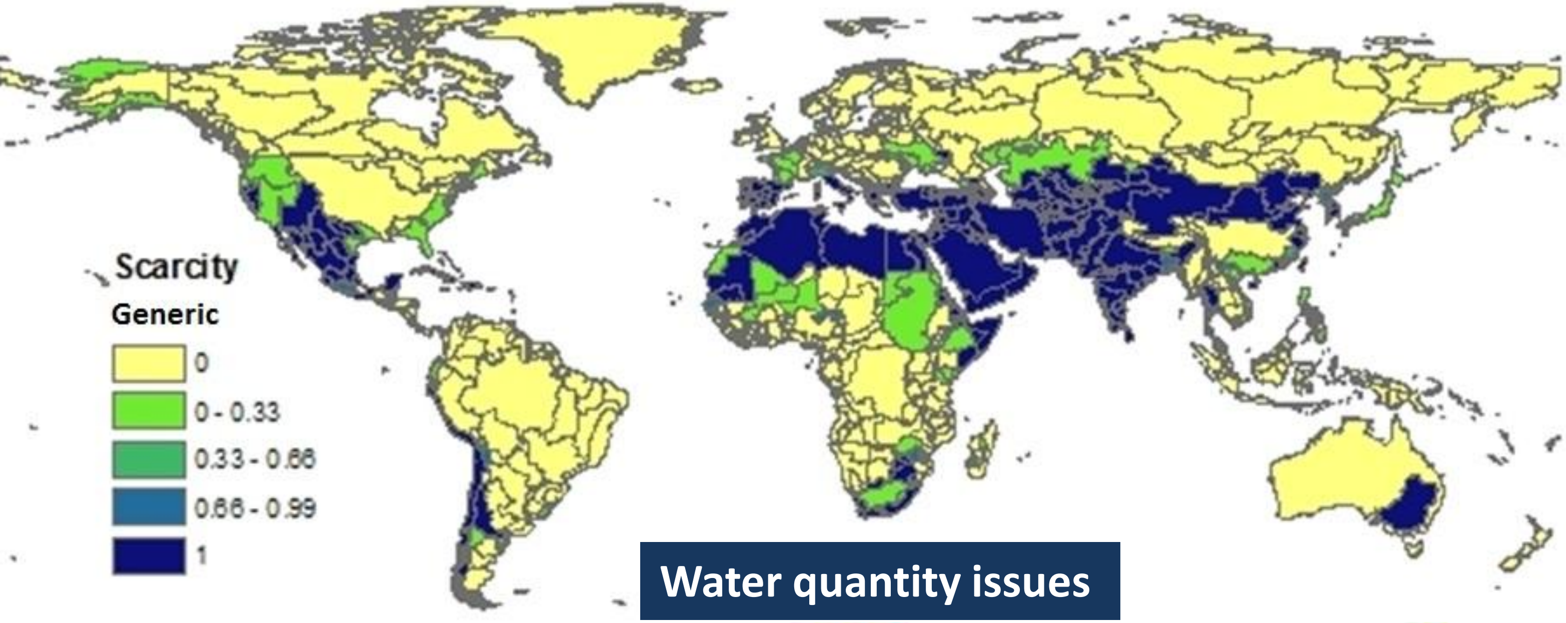
World Water Council

- 3900 children die every day from water borne diseases

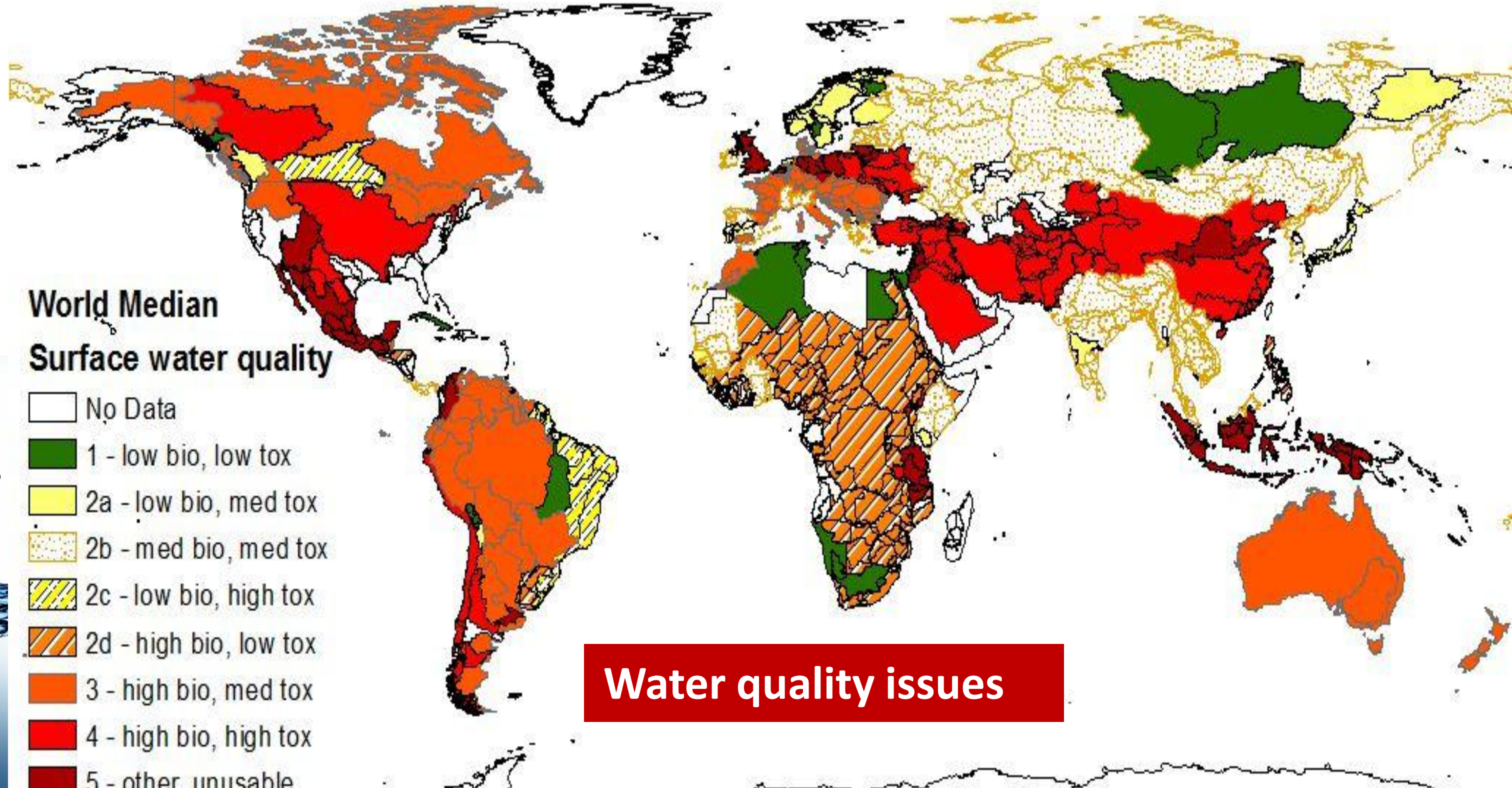
- 1 out of 6 people lack access to safe drinking water

- 8 Mighty rivers are running dry from overuse, greatly affecting humans and ecosystems *(Colorado, Indus, Amu Darya, Syr Darya, Rio Grande, Yellow, Teesta and Murray)*

→ *WATER IS NOT EQUALLY DISTRIBUTED IN TIME AND SPACE, AND ITS QUALITY IS DEGRADING AROUND THE GLOBE*



Water quantity issues



Water quality issues

Source: Boulay et al, 2013


The water footprint:
making a link between consumption in one place and impacts on water systems elsewhere
Endangered Indus River Dolphin
[Photo: WWF]
Source WFN, 2012

Signs of global water pollution

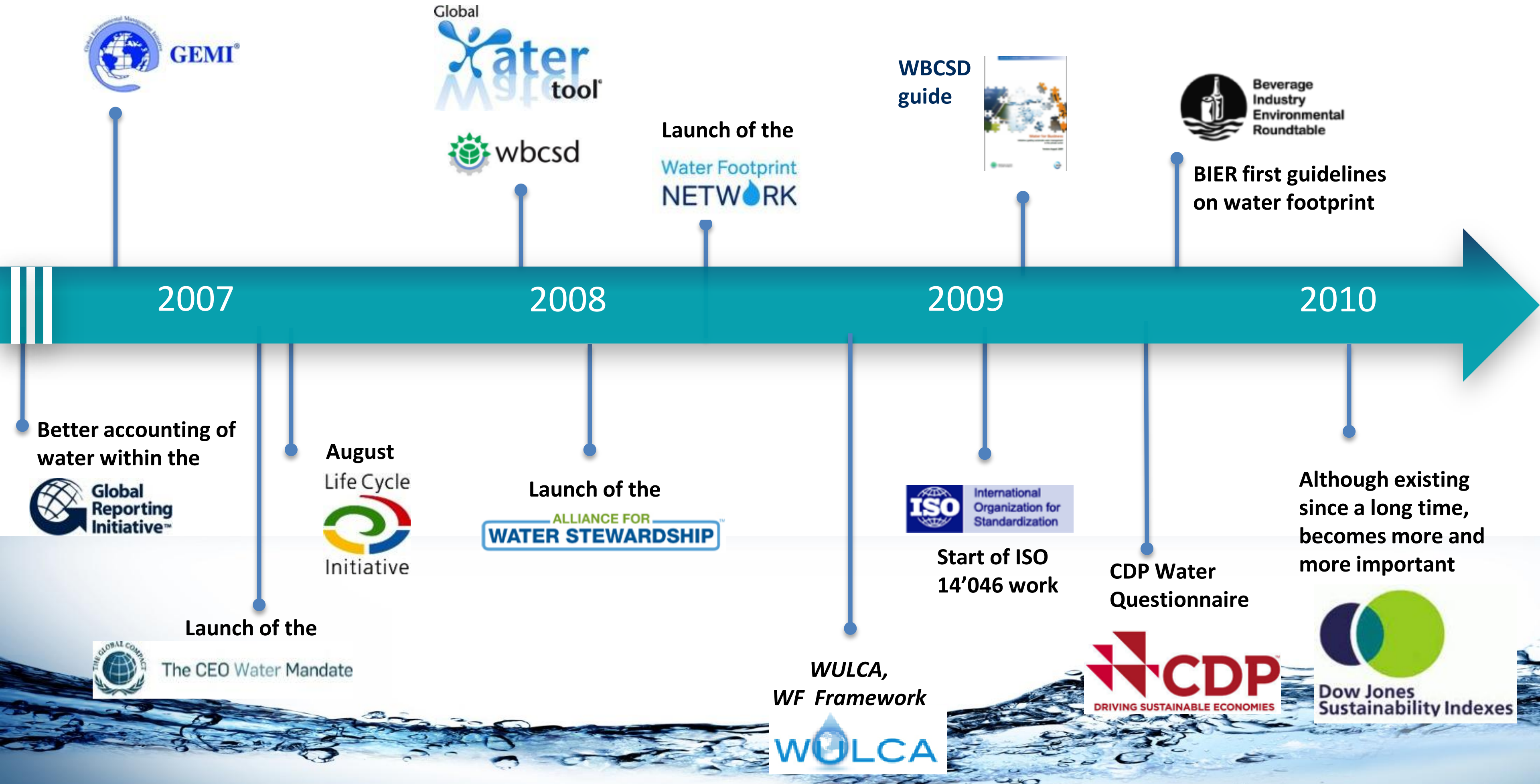
Source WFN, 2012

Devecser, Hungary, Oct. 5, 2010

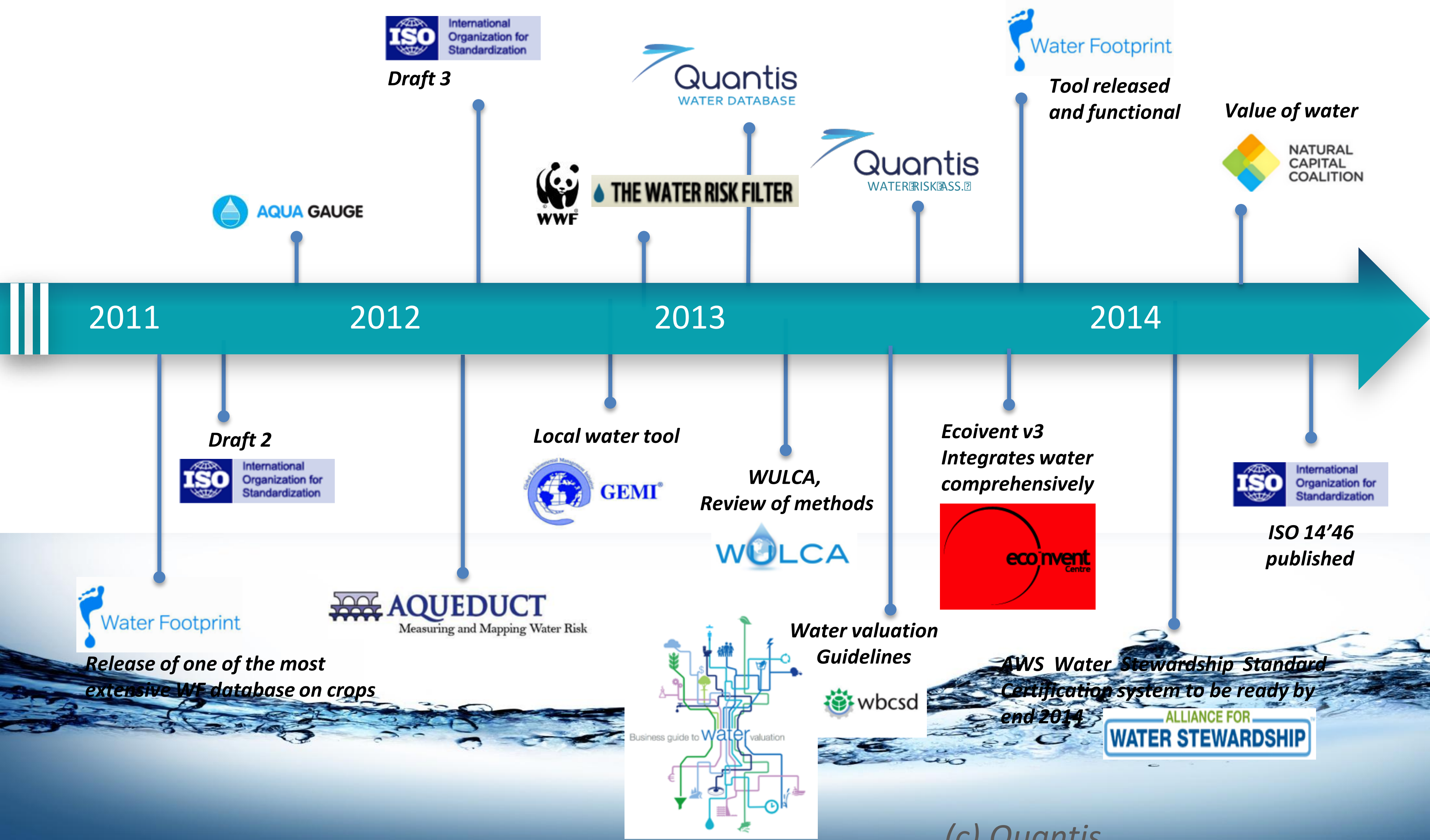
Signs of global water pollution

Source WFN, 2012

The water footprint stream: Initiatives and timeline



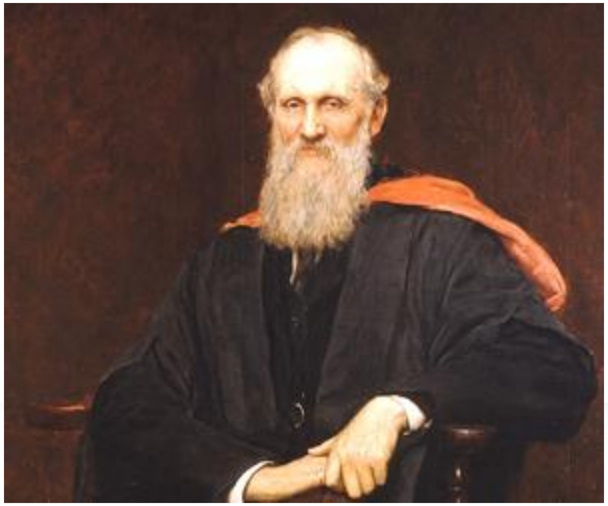
The water footprint stream: Initiatives and timeline



(c) Quantis

As Kelvin said…

“If you can not measure it, you can not improve it.”



Life Cycle approach: a global view

Mid-point – damage conventional framework

Emissions and Waste

Pesticide
SO_2
Cu
CO_2
Phosphate
…

Energy and Resources

Irrigation Water
Crude Oil
Iron Ore
…

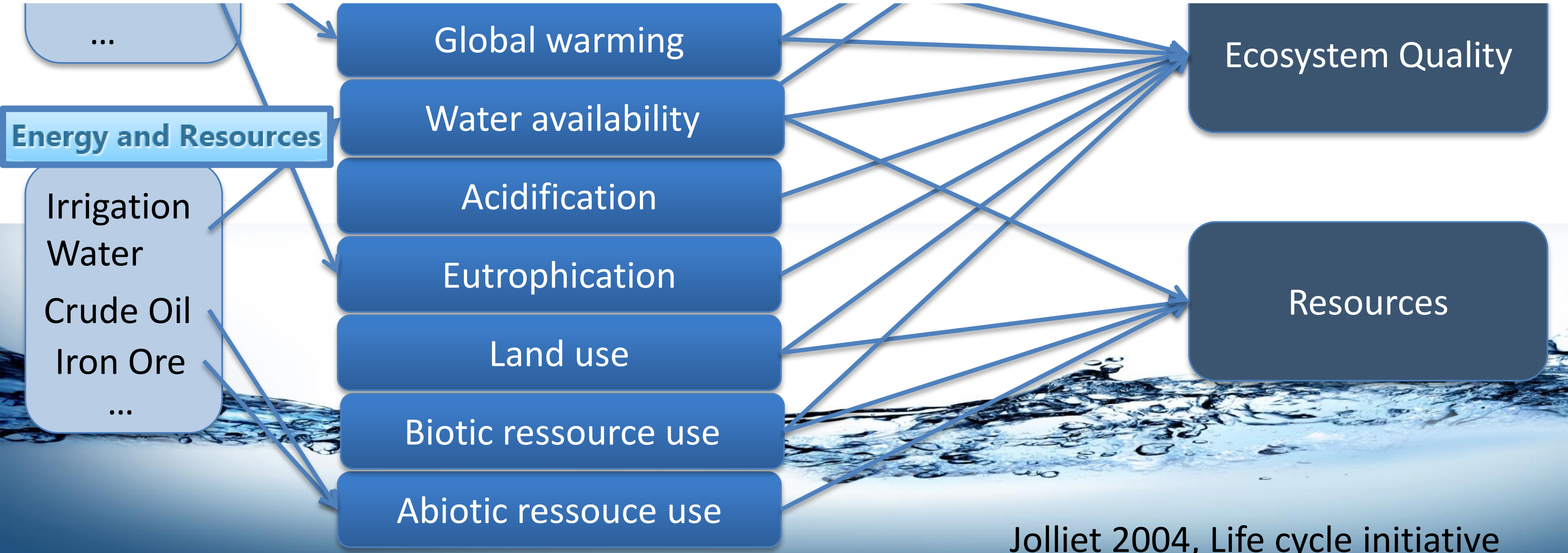
Electric car: Better or Worst?

Zero emissions?

Emissions elsewhere!

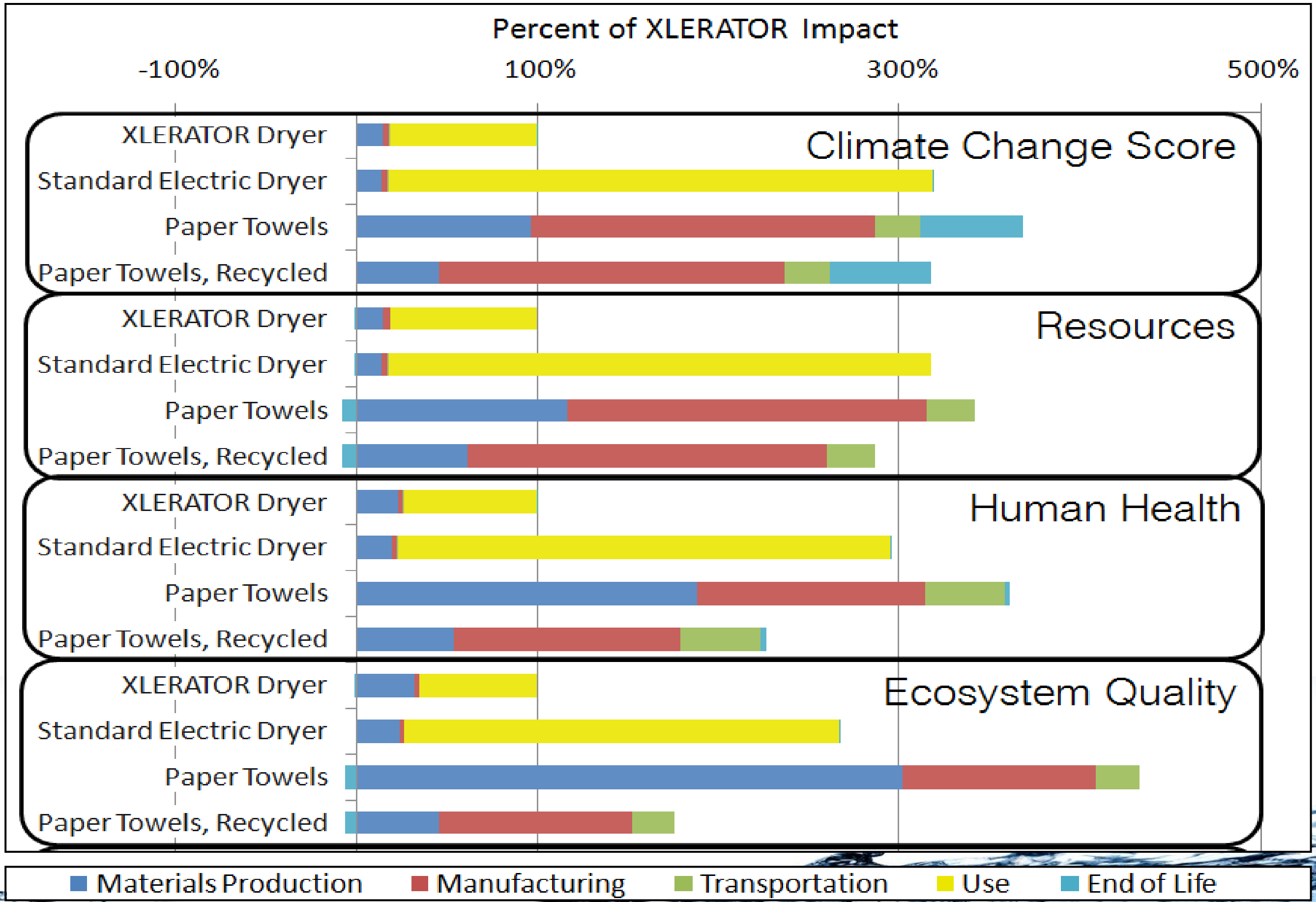
Mid-point – damage conventional framework

- **Methodological tool, decision making**
- Quantifies potential environmental impacts
- **Entire life cycle of a product**
- ISO standards 14 040/44



Jolliet 2004, Life cycle initiative

Comparison of alternatives



Source: © CIRAIG 2013, used with permission

Food packaging: Angel or Demon?

VS

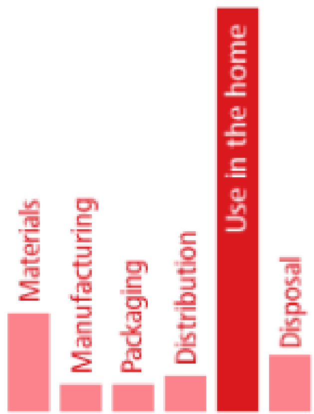
Source: © CIRAIG 2013, used with permission

Individual packaging: Angel or Demon?

VS

Source: © CIRAIG 2013, used with permission

Innovations stemming from life cycle thinking



Energy analysis

Cold water detergents

Inverted bottle to stop wasting the last 5% of the product

Environmental labeling

Type II (ISO 14021) Self-declared claims

- Established by the manufacturer
- Usually based on a single environmental criteria
- No verification
- No threshold criteria
- Example: "recycled content, biodegradable"

Type I (ISO 14024) Ecolabels

- Life Cycle thinking based
- Points to best alternative in a product category
- Threshold criteria
- Third party verified

Type III (ISO 14025) Environmental product declaration

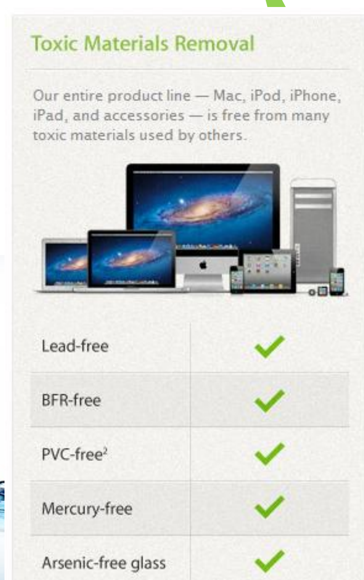
- Life Cycle Assessment based
- Analogy: Nutritional facts
- Third party verified
- Registered trademark

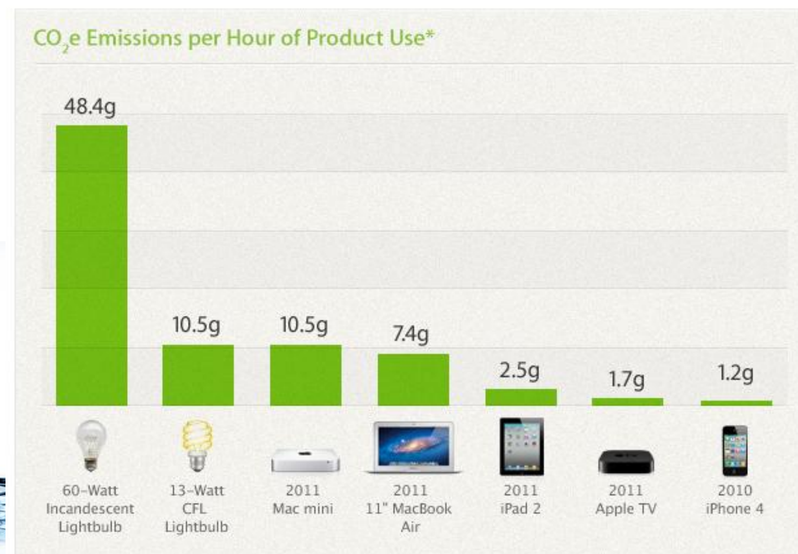
Source: © CIRAIG 2013, used with permission

Environmental labeling

Source: © CIRAIG 2013, used with permission

Apple





http://www.apple.com/environment/

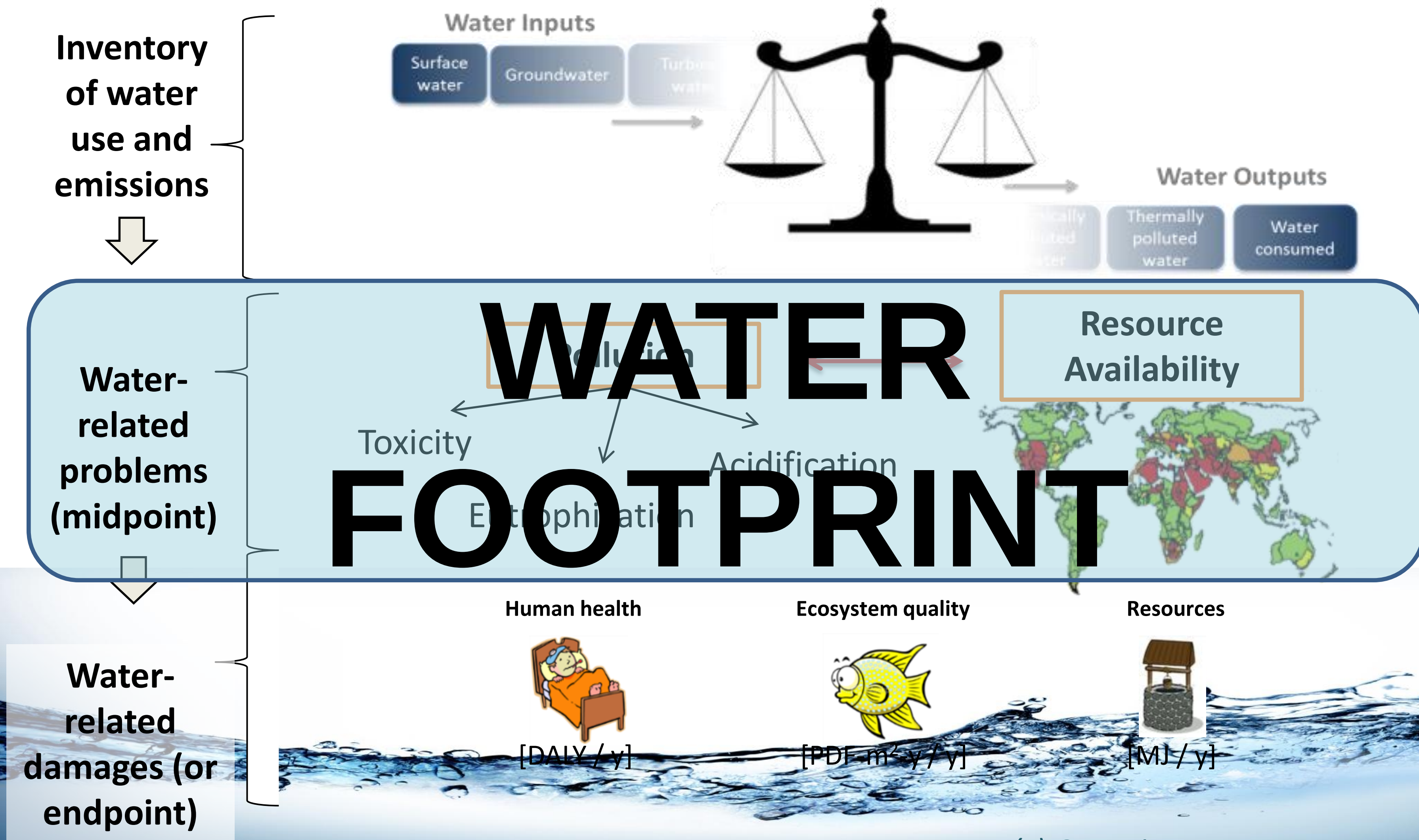
Source: © CIRAIG 2013, used with permission

LCA vs Water Footprint

A water footprint, is an LCA which includes only the water-related impacts

- ***Same use, interpretation and opportunities with a specific water-related scope***
- ***Since it does not include all impacts, it cannot serve to claim product superiority***
- ***Different types of water footprint exists, based on which "water-related impacts" are considered. They have different labels.***

From inventory, to risk, to impacts…



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Types of water footprint metrics and assessments

Water Footprint Network (WFN)

A Volumetric Approach:

Blue water

Green water

Grey water

Water Footprint components (WFN)

Green water footprint

► volume of rainwater evaporated or incorporated into product

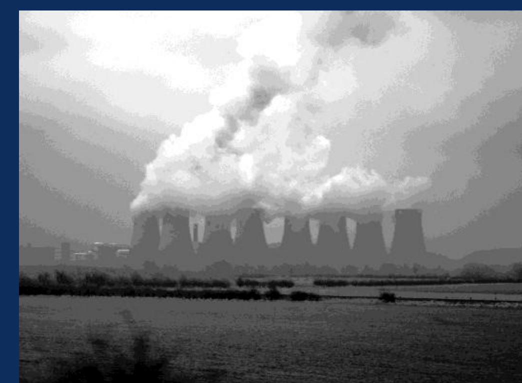
Blue water footprint

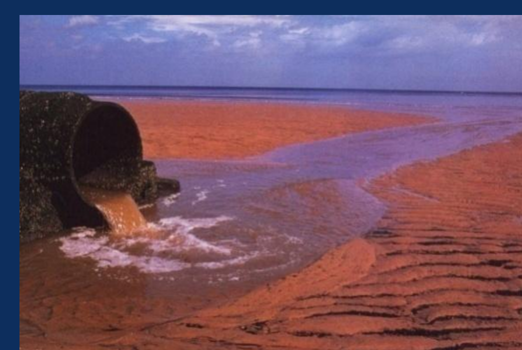
► volume of surface or groundwater evaporated or incorporated into product

Grey water footprint

► volume of water needed to assimilate pollution

Source: Water Footprint Network





ISO 14046: Water footprint: Principles, requirements and guidelines

International Organization for Standardization

Developed in an international consensus-based process 2009 – 2014

Approved in May 2014

Published in August 2014

ISO 14046 WATER FOOTPRINT

International Organization for Standardization

IMPORTANT CONCEPTS

–Should be life-cycle based

–Could be “stand-alone” or part of a full Life Cycle Assessment

–Results should include impact assessment (volumes not sufficient) and address regional issues

–Both quantity and quality should be considered

–Comprehensive impact assessment related to water (not only water use but all impacts related to water)

–Can result in one or several indicators

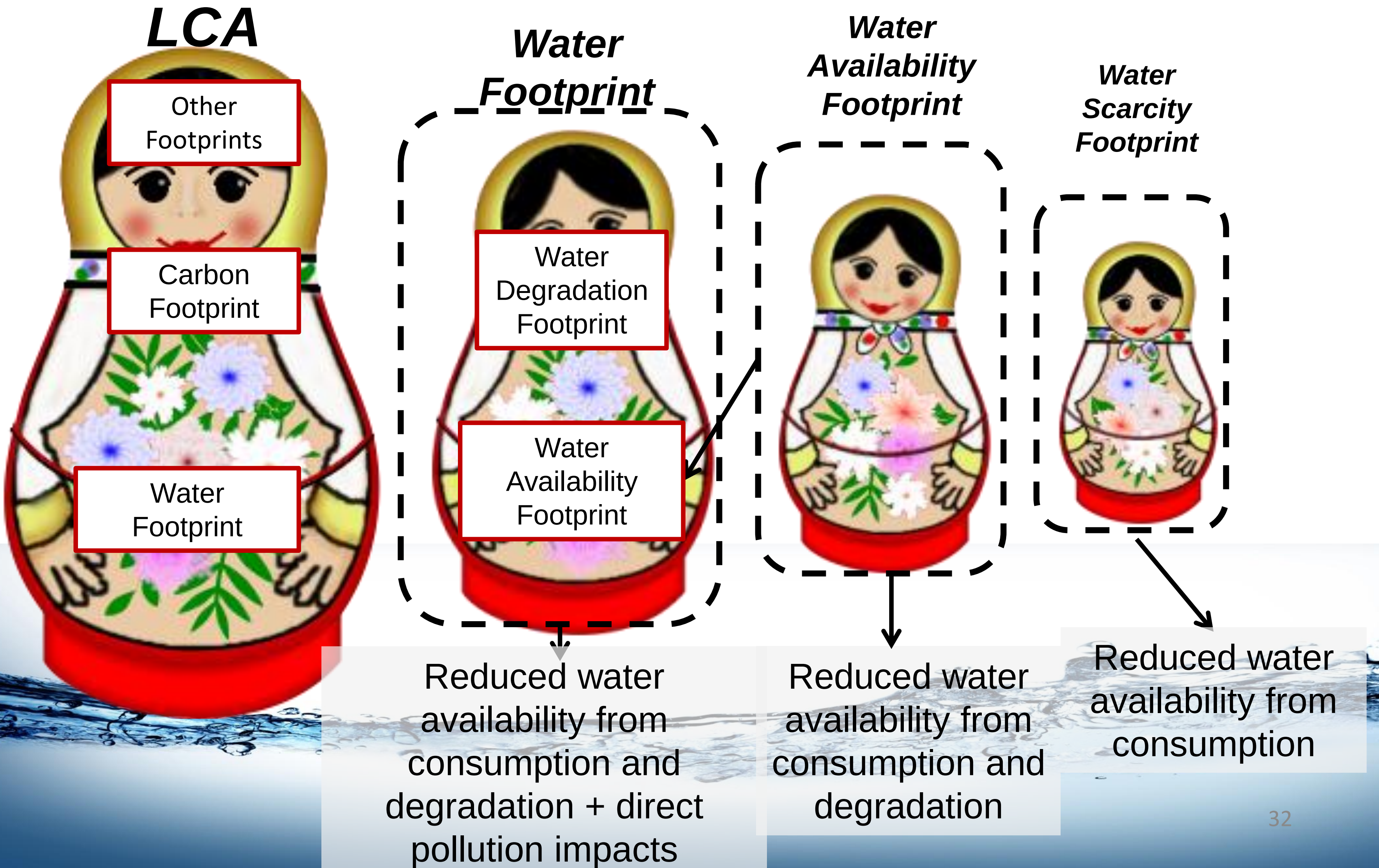
Water Footprint types as per ISO 14046

	Water availability	Water degradation
	MIDPOINT	
Profile of midpoint indicators	-Water scarcity footprint OR - Water availability footprint	-Human toxicity -Ecotoxicity -Eutrophication -Acidification
	ENDPOINT	
Human health	- Malnutrition and/or water related diseases	Human toxicity
Ecosystems	- Terrestrial ecosystems - Aquatic ecosystems	-Ecotoxicity -Eutrophication -Acidification

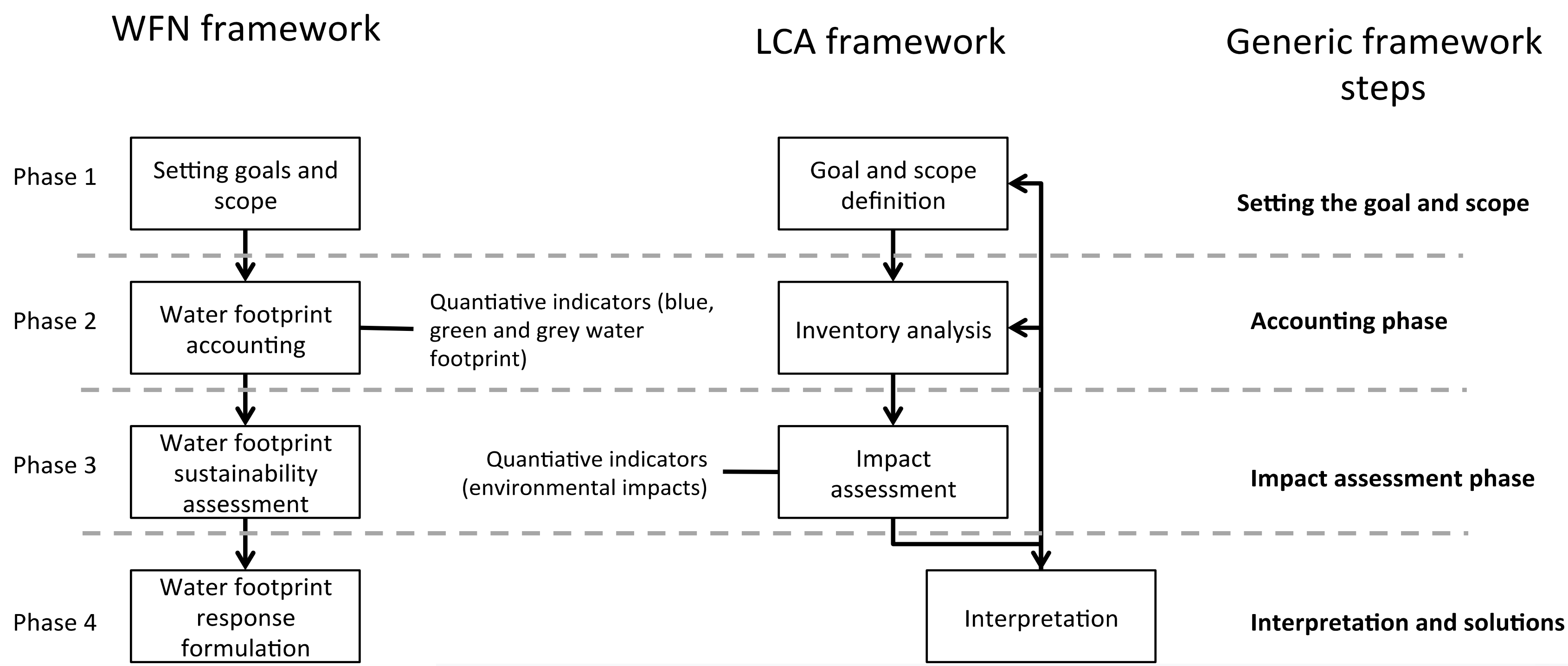
"qualified" water footprint (ex: "degradation" WF, "scarcity" WF, etc)

Water footprint

Types of Water Footprints



ISO 14'046 and WFN



Environmental Science & Technology

Complementarities of Water-Focused Life Cycle Assessment and Water Footprint Assessment

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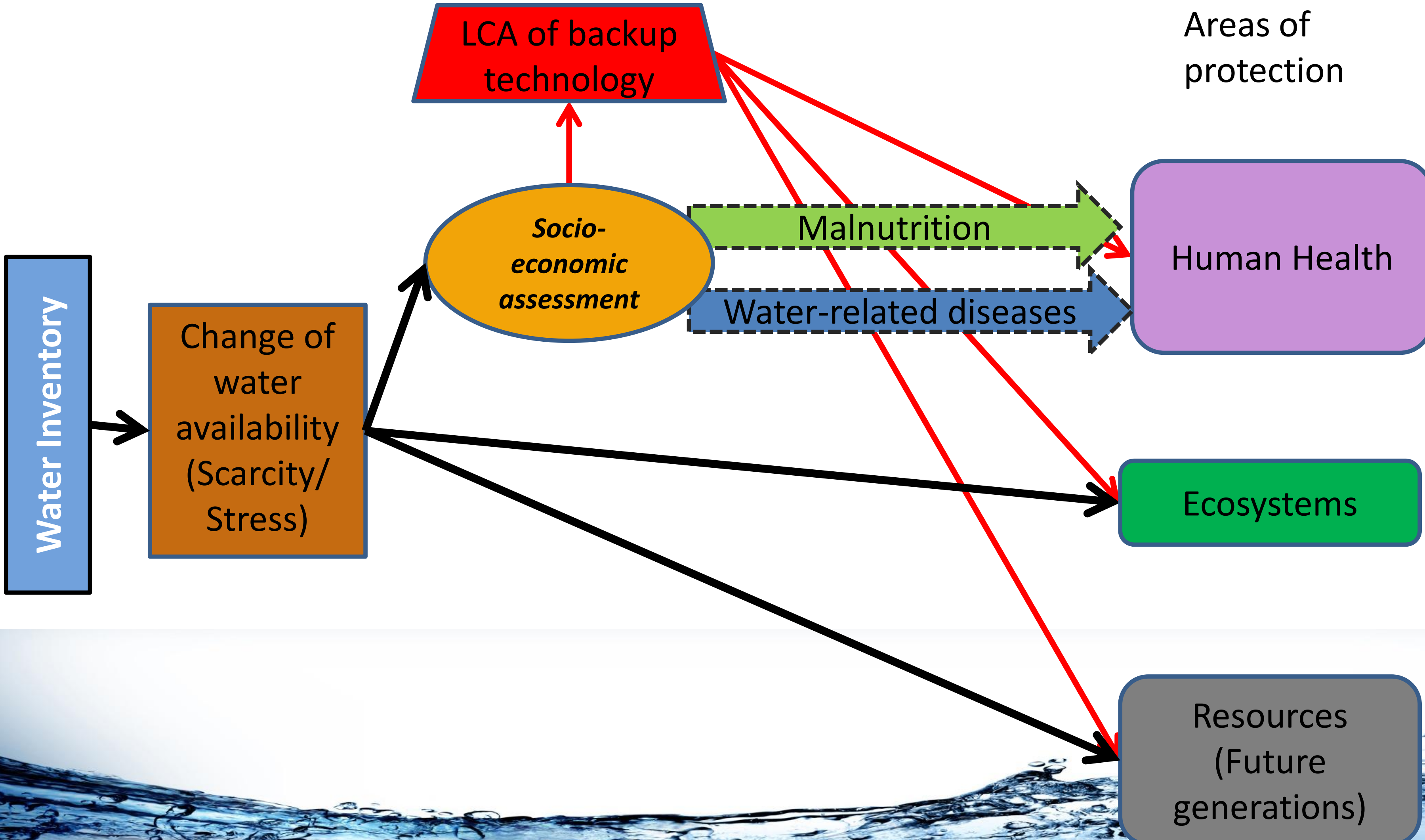
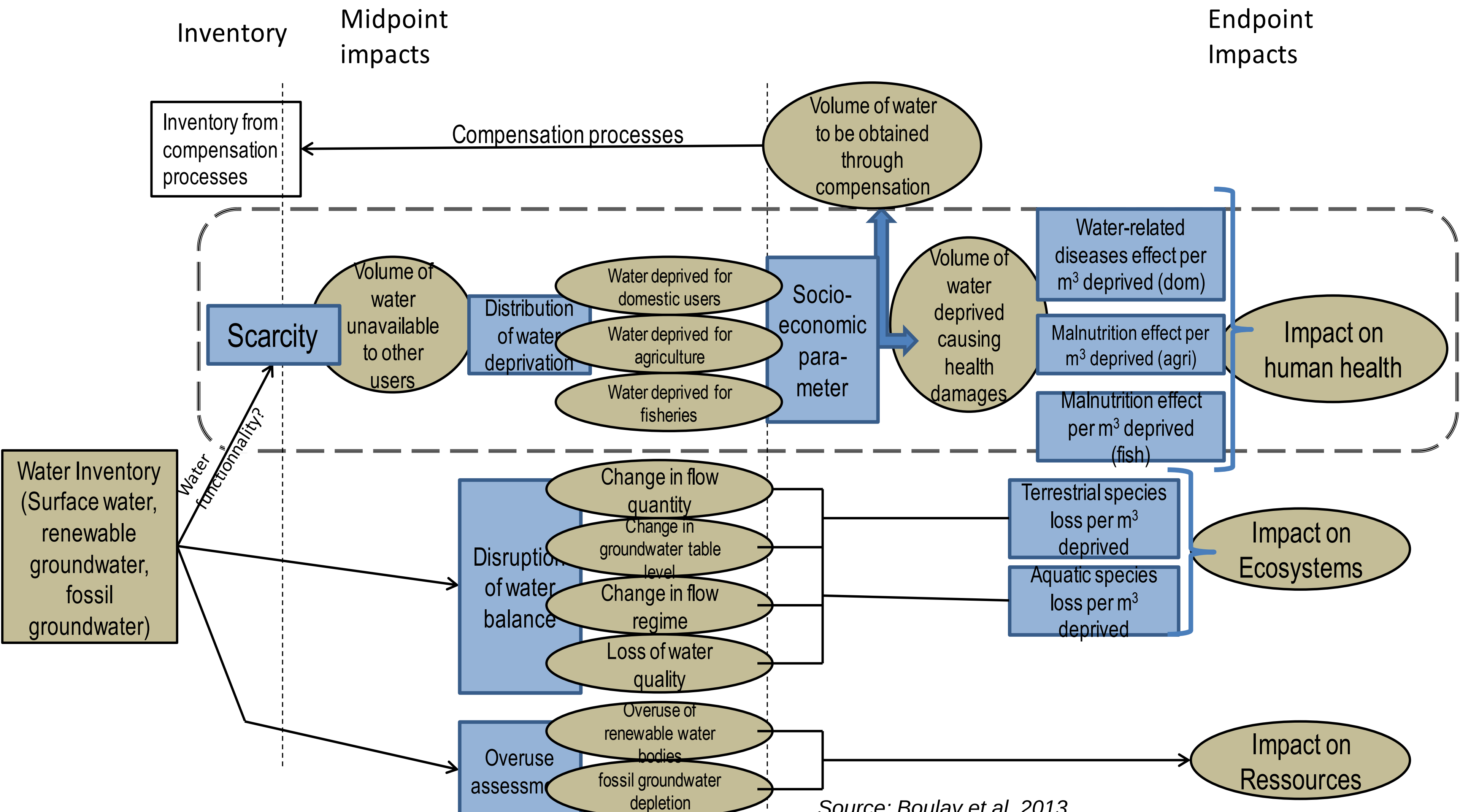
†CIRAIG, Ecole Polytechnique of Montreal, Montreal QC H3T 1J4, Canada
‡University of Twente, Enschede 7522 NB, The Netherlands
§Quantis, Lausanne, Switzerland

Impact pathway Framework for Freshwater use



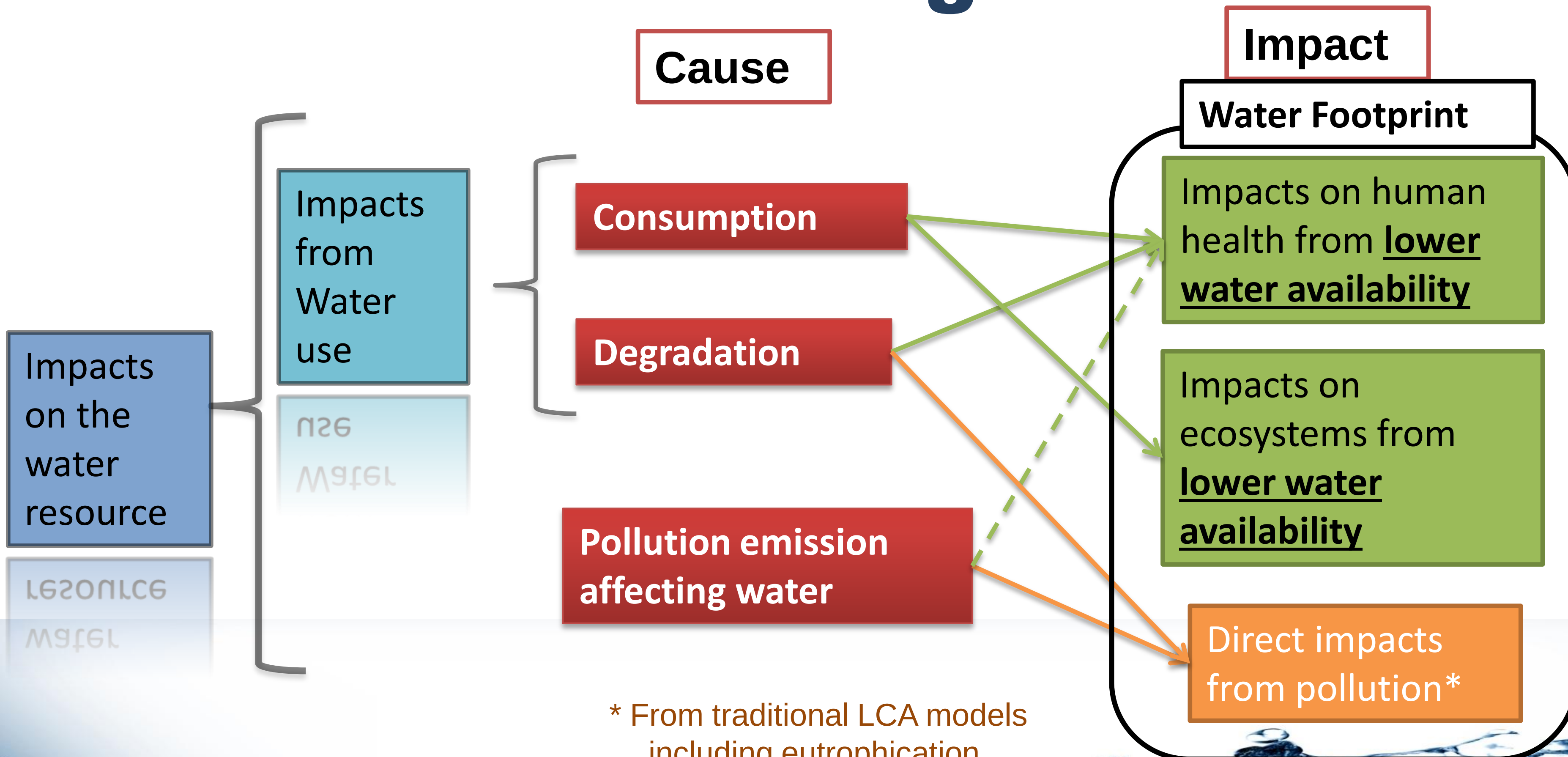
Bayart et al, 2010

Detailed impact pathways



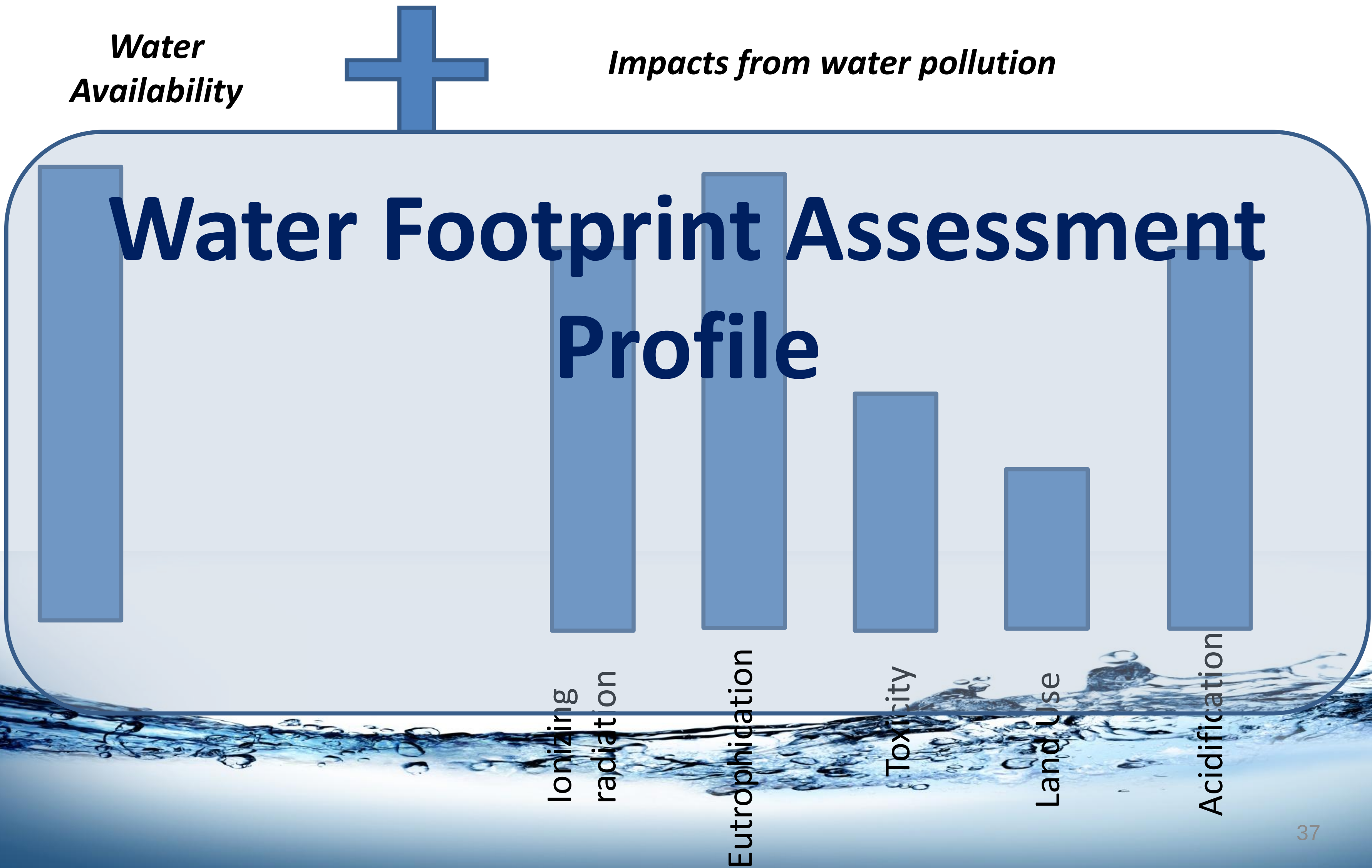
Source: Boulay et al, 2013

Distinction in water impact modeling

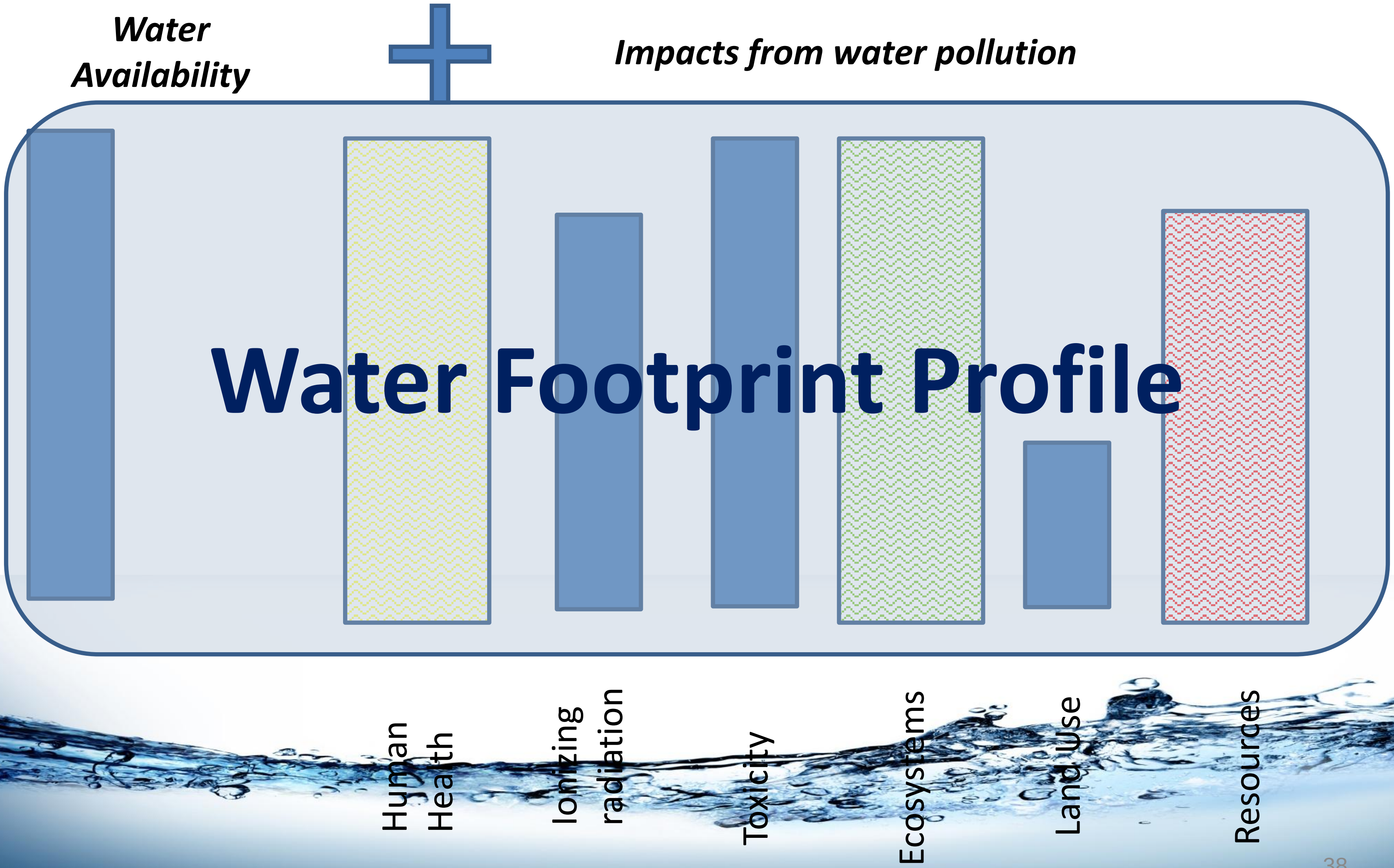


* From traditional LCA models including eutrophication, ecotoxicity, thermal, etc.

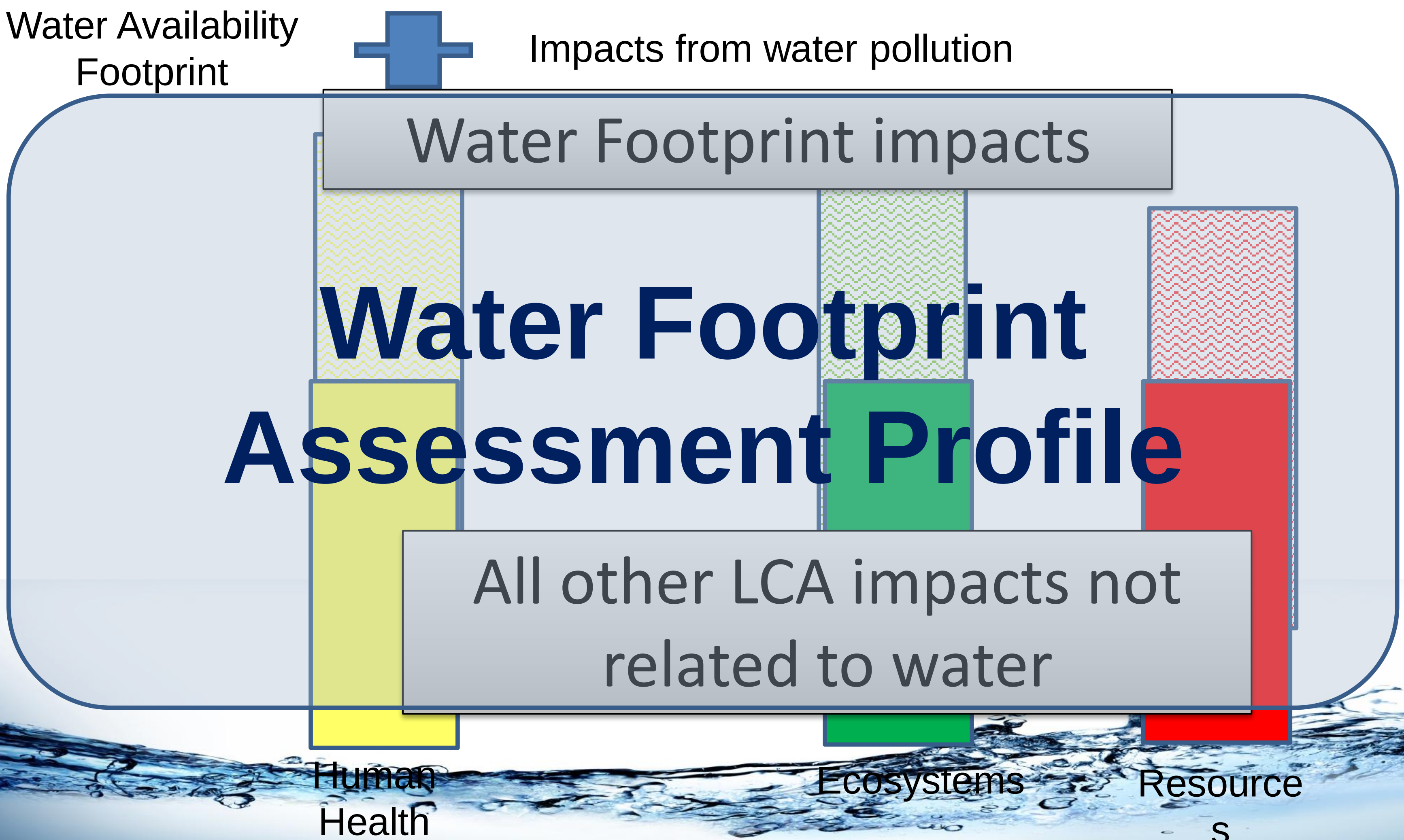
From inventory, to risk, to impacts…



From inventory, to risk, to impacts…



From inventory, to risk, to impacts…



KNOWLEDGE REVIEW 1

1	How can doing a water footprint help your organization?
2	What are the main issues associated with the water resource?
3	What is the difference between a midpoint and an endpoint in LCA?
4	What decisions can an LCA help you with?
5	What are the 3 areas of protection identified in LCA?
6	What is the difference between impacts from water use and impacts on the water resource?
7	What types of impacts are caused by water pollution?
8	What is the main difference between the Water Footprint Network methodology and a life cycle-based water footprint?

STEPS OF A WATER FOOTPRINT

- Goal and scope
- Inventory
- Impact assessment
- Interpretation

Goal and Scope

- Decision tool: which decision?
- Internal, public?
- Time and money available
- →Type of water footprint

Water Footprint Inventory
The Life Cycle Perspective

A WATER FOOTPRINT INVENTORY IS THE COMPILATION AND QUANTIFICATION OF INPUTS AND OUTPUTS RELATED TO UNIT PROCESSES MAKING UP THE PRODUCT SYSTEM

THE INVENTORY IS MUCH MORE THAN JUST WATER VOLUMES,
IT ENCOMPASSES ALL INPUTS AND OUTPUTS OF A PRODUCT SYSTEM THAT MAY RESULT IN ENVIRONMENTAL IMPACTS ASSOCIATED WITH WATER

Water Footprint Inventory
Useful definitions

Drainage basin:

Area from which direct surface runoff from precipitation drains by gravity into a stream or other water body (ISO DIS 14046)

Water Withdrawal:

Anthropogenic removal of water from any water body or from any drainage basin , either permanently or temporarily (ISO DIS 14046)

Water Consumption

Water removed from but not returned to the same drainage basin (ISO DIS 14046)

Elementary water flow

Water entering the system being studied and that has been drawn from the environment, or water leaving the system being studied that is released into the environment (ISO DIS 14046)

Technosphere water flow

Water embedded in the system being studied and that has been drawn from the environment at some previous stage in the product system

Water Footprint Inventory

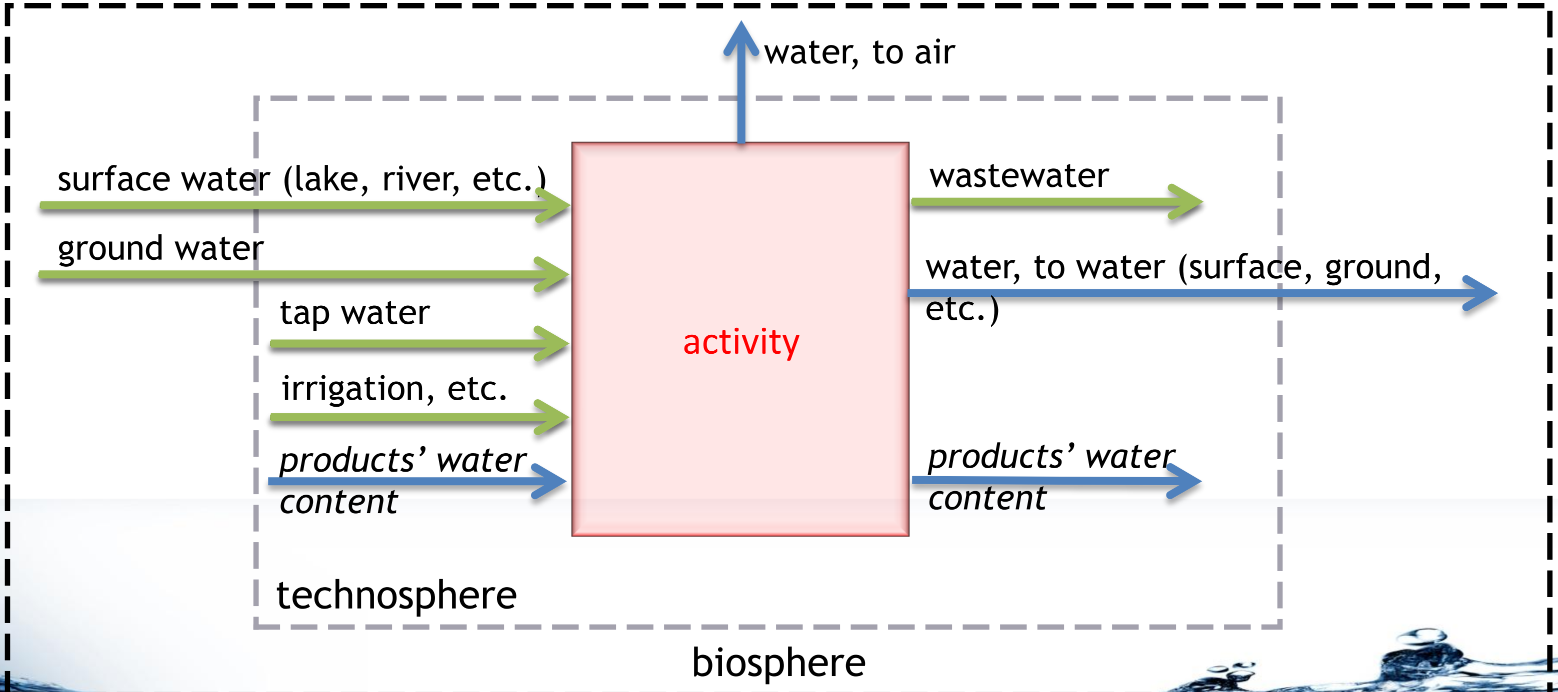
Area from which direct surface runoff from precipitation drains by gravity into a stream or other water body (ISO DIS 14046)

Image source: Water Footprint Network

Water balance for consumptive water use

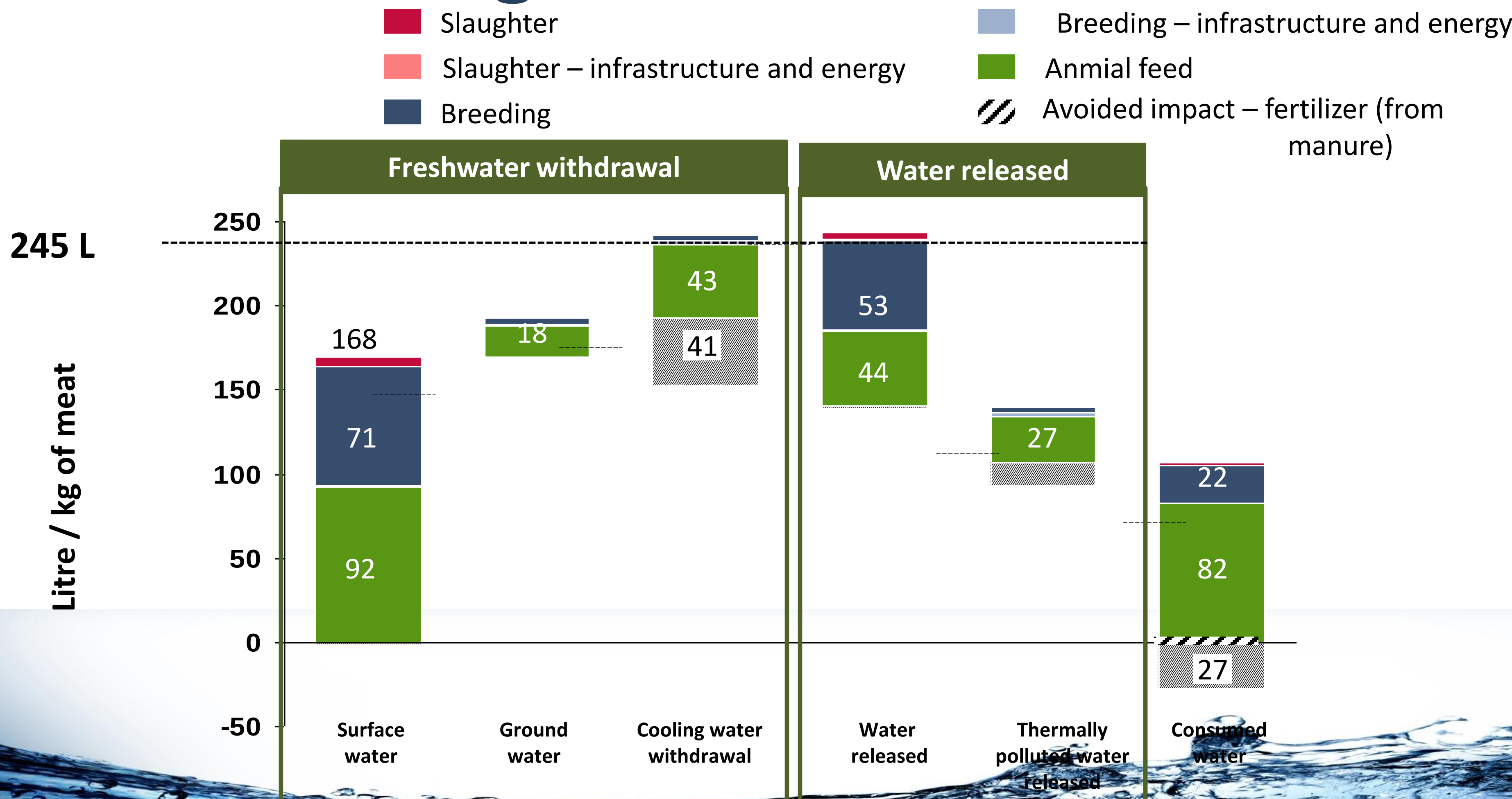
water IN = water OUT

ecoinvent version 3

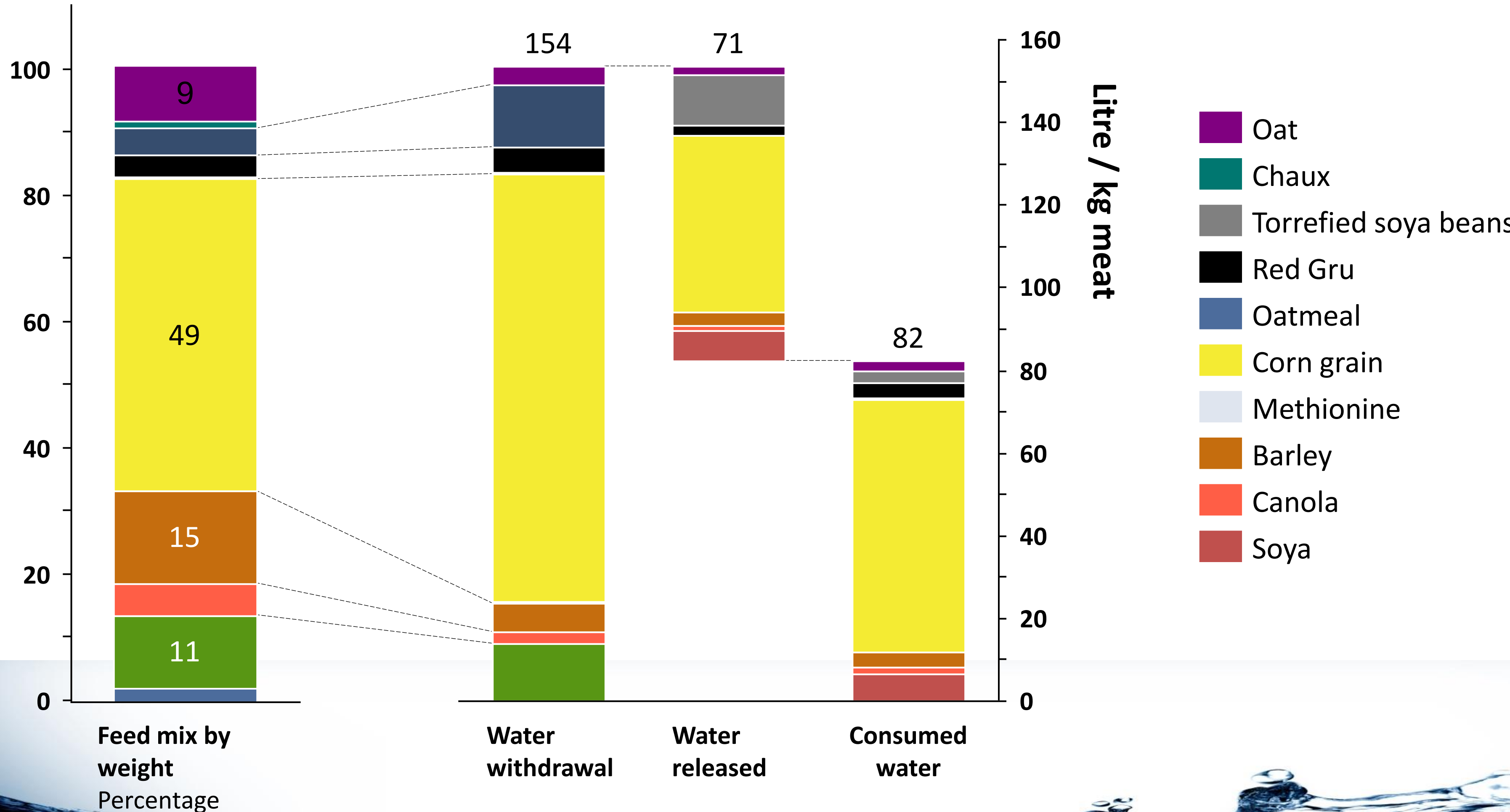


(c) Ecoinvent, use with permission
(Levova et al, LCAXIII, Orlando, 2013)

Pork water inventory in low water stressed region - Results



Pork water inventory – Feed mix



(c) Quantis

A t-shirt – Example of Switcher

- Environmental labelling of Switcher products
  - Carbon footprint – climate change
  - Water footprint – water consumption and associated impacts

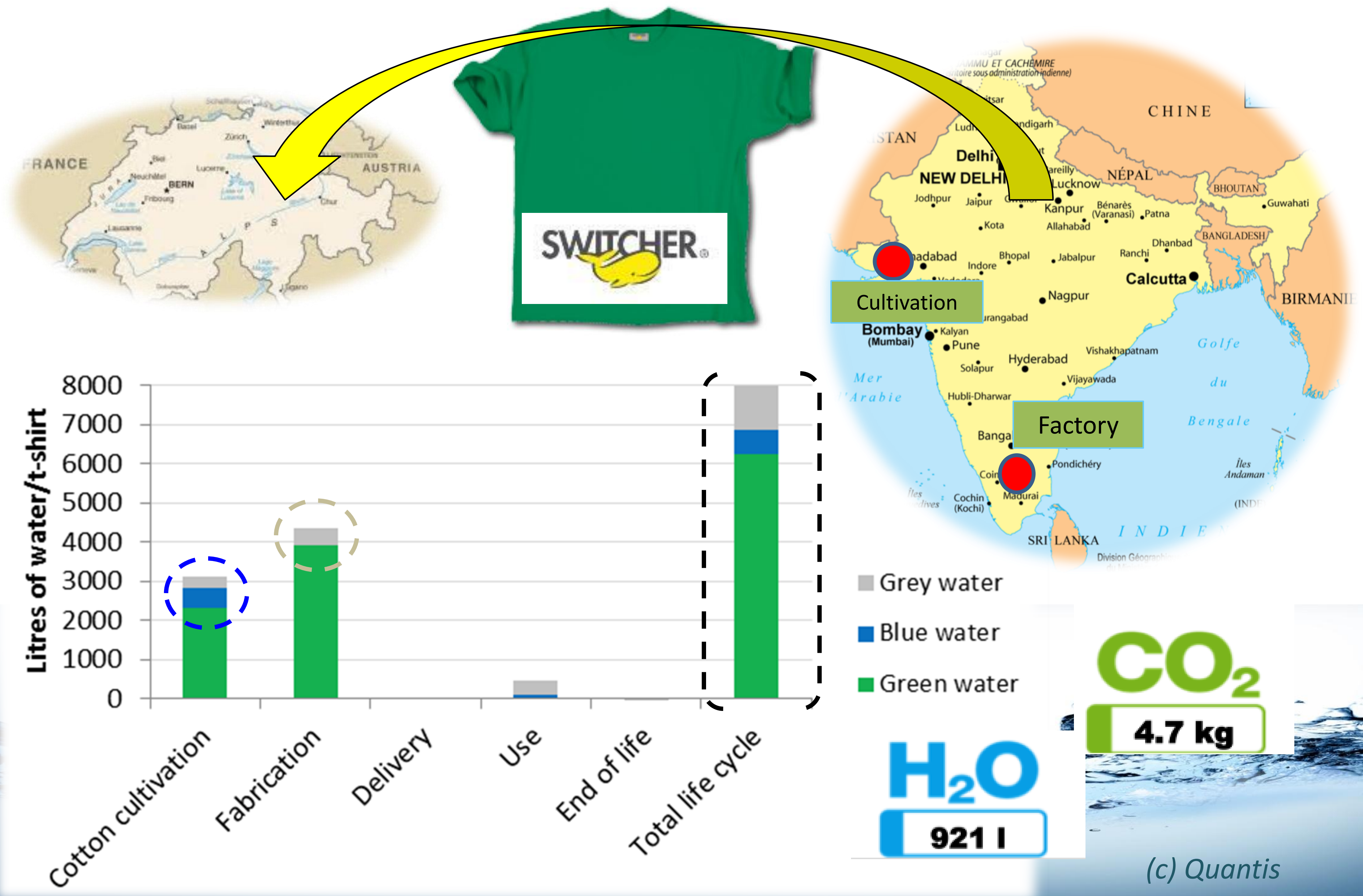
CO_2

4.7 kg

H_2O

921 l

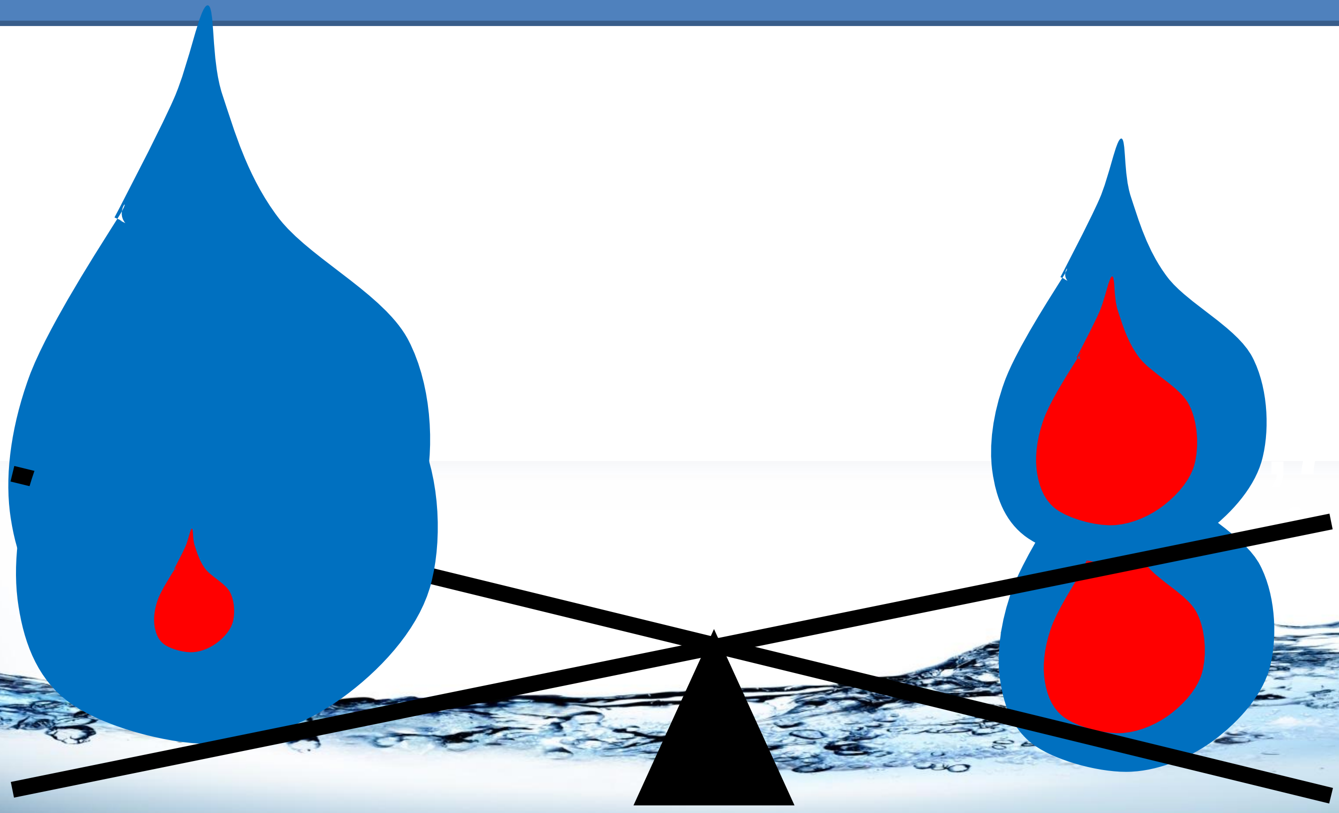
(c) Quantis



FRANCE
AUSTRIA
BERN
SWITCHER
CHINE
NÉPAL
BHOUTAN
BANGLADESH
BIRMANIE
Delhi
NEW DELHI
Lucknow
Kanpur
Calcutta
Nagpur
Bombay (Mumbai)
Pune
Hyderabad
Cultivation
Factory
SRI LANKA
Golfe du Bengale
8000
7000
6000
5000
4000
3000
2000
1000
0
Litres of water/t-shirt
Cotton cultivation
Fabrication
Delivery
Use
End of life
Total life cycle
Grey water
Blue water
Green water
CO_2
4.7 kg
H_2O
921 l
(c) Quantis

Water Footprint Inventory

A VOLUMETRIC INVENTORY IS INSUFFICIENT FOR ASSESSING A WATERFOOTPRINT BECAUSE RESULTS OF SUCH INVENTORY AND THE IMPACTS RELATED TO WATER ARE OFTEN NOT CORRELATED



Data sources and database

- + Other publications

KNOWLEDGE REVIEW 2

1. What is a water footprint inventory?
2. Why is regionalization important in performing an inventory?
3. What decision can a water inventory help you make?
4. What is the difference between an elementary flow and a technosphere flow?
5. Does a water footprint inventory only contain water flows? Explain.
6. What information is essential in a water footprint inventory?
7. What is the difference between water withdrawal and water consumption?

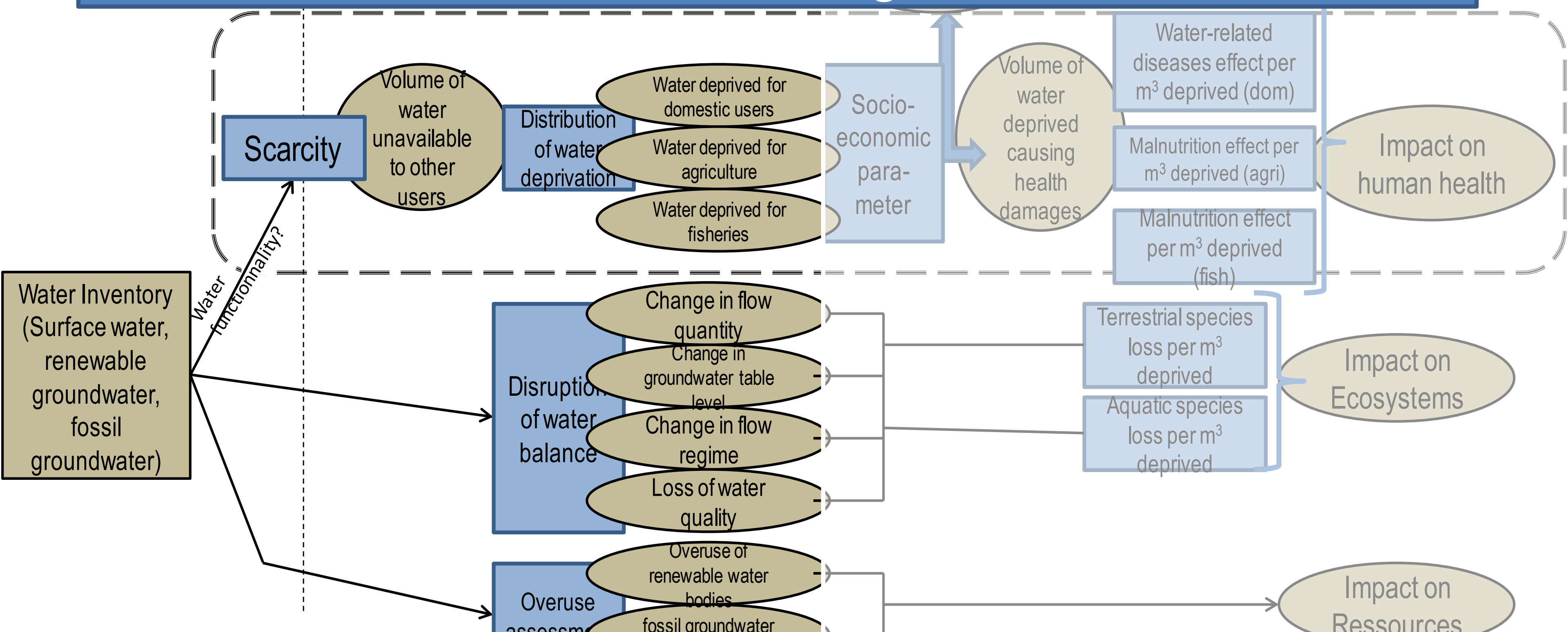
BREAK

STEPS OF A WATER FOOTPRINT

- Goal and scope
- Inventory
- Impact assessment
- Interpretation

Problem (midpoint) impacts: availability

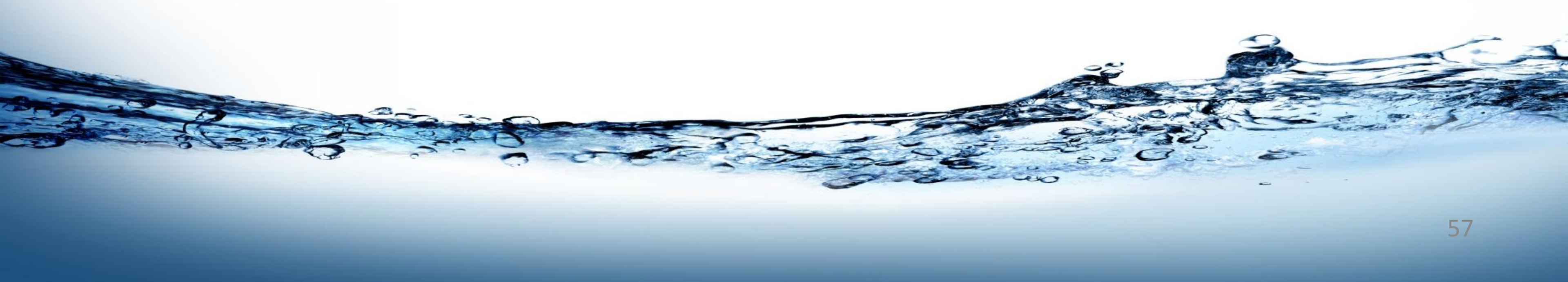
At this point, water scarcity or water availability indicators are being used as generic midpoints for water consumption in LCA, until ecosystem-specific midpoint become available.
WULCA's development on the topic is presented at the end of this training.



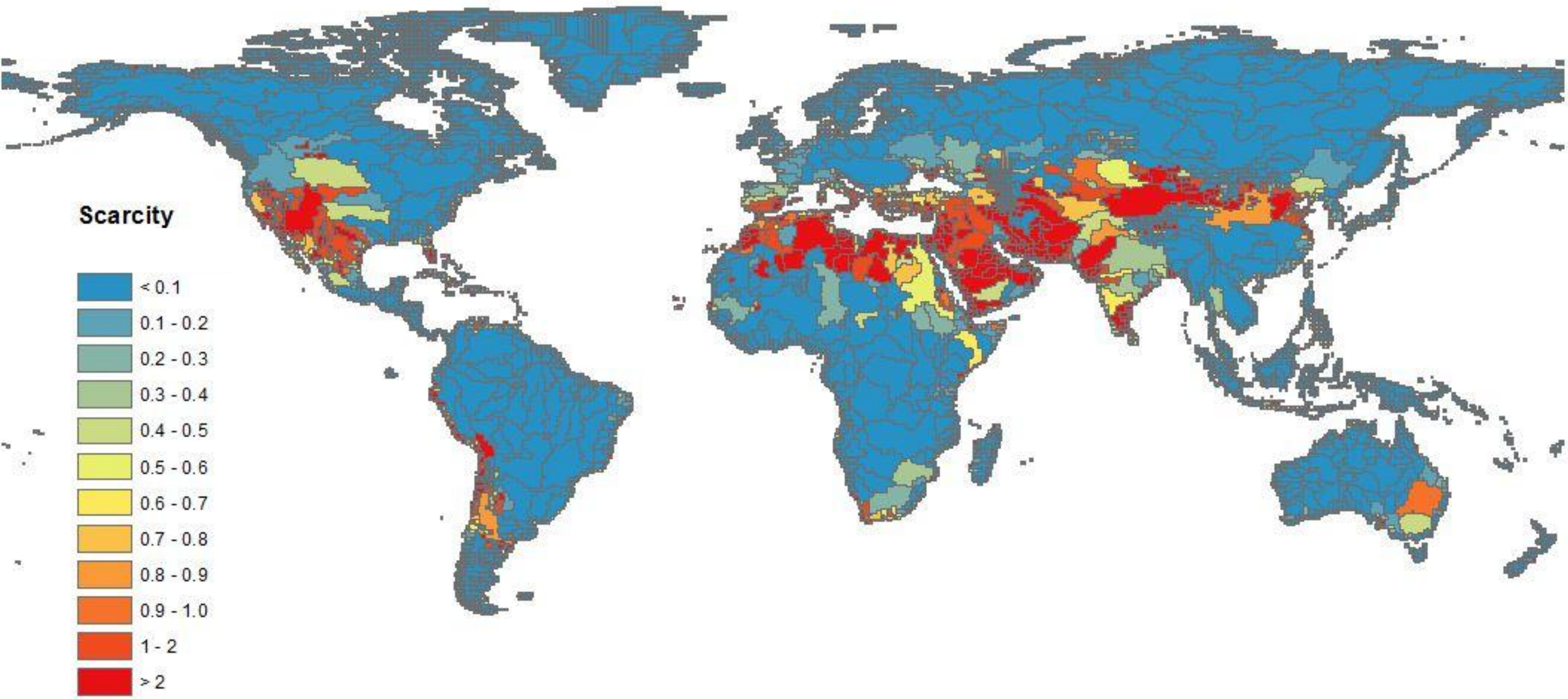
Source: Boulay et al, 2013

Availability assessment

- Can be associated with a midpoint assessment in LCA
- Most methods are related to a water scarcity index
  - **Withdrawal to availability ratios (WTA)**
    (Pfister et al. 2009; Ridoutt and Pfister 2010b; Frischknecht et al. 2006; Veolia 2011; Milà i Canals et al. 2009)
  - **Consumption to availability ratios (CTA)**
    (Boulay et al. 2011; Hoekstra et al. 2011).
- Are used as a Characterization Factor (CF) to assess impacts from:
  - **Water withdrawal**
    (Ridoutt and Pfister 2010b; Frischknecht et al. 2006; Veolia 2011),
  - **Water consumption**
    (Boulay et al. 2011; Pfister et al. 2009 Hoekstra et al. 2011; Milà i Canals et al. 2009)
  - **Water Degradation**
    (Hoekstra et al. 2011; Veolia 2010; Boulay et al. 2011).



Consumption-to-availability ratio



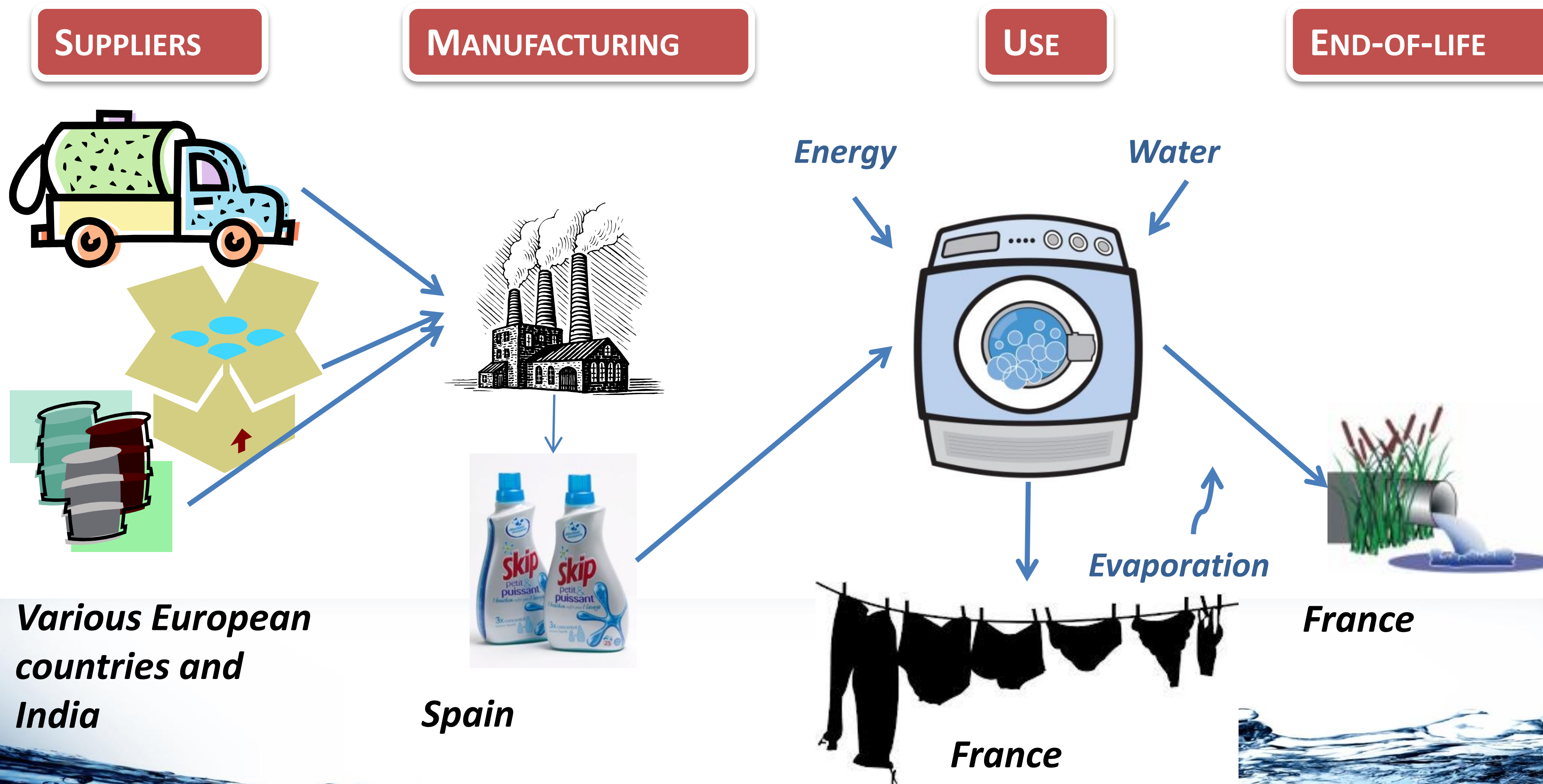
Problem (midpoint) impacts: quality

Do you know what these mean?

- Human toxicity
- Ecotoxicity
- Eutrophication
- Acidification

Example of application: Water Footprint at the problem level (midpoint)

Example: Water Footprint from a load of laundry



Source: Boulay et al (2013b)

Methodology overview - Midpoint

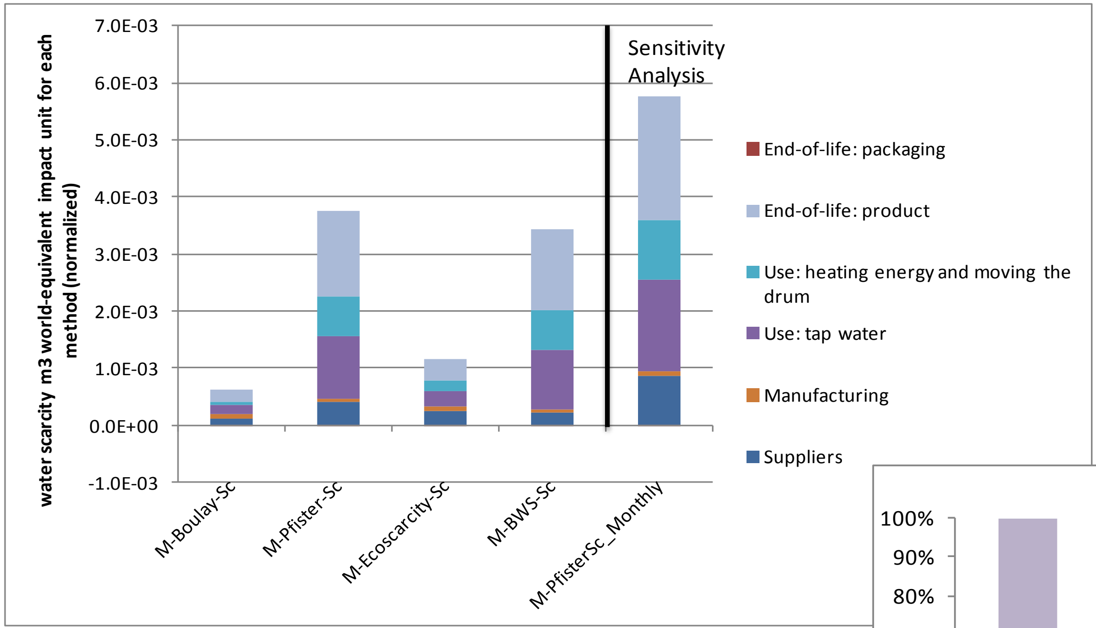
Water Footprint profile at midpoint: Water availability and water degradation

	Indicator	Reference
	Water Availability	
1	Scarcity	Pfister et al.
1		Boulay et al.
1		Swiss Eco-Scarcity
1		WFN, Hoekstra et al.
1a	Availability	Boulay et al.
1a		Veolia Impact Index, Bayart el al.
	Water Degradation	
2	Eutrophication	ReCiPe
3	Acidification	Impact 2002+
4	Ecotoxicity	USEtox
5	Human Toxicity	USEtox

→Only one method needed

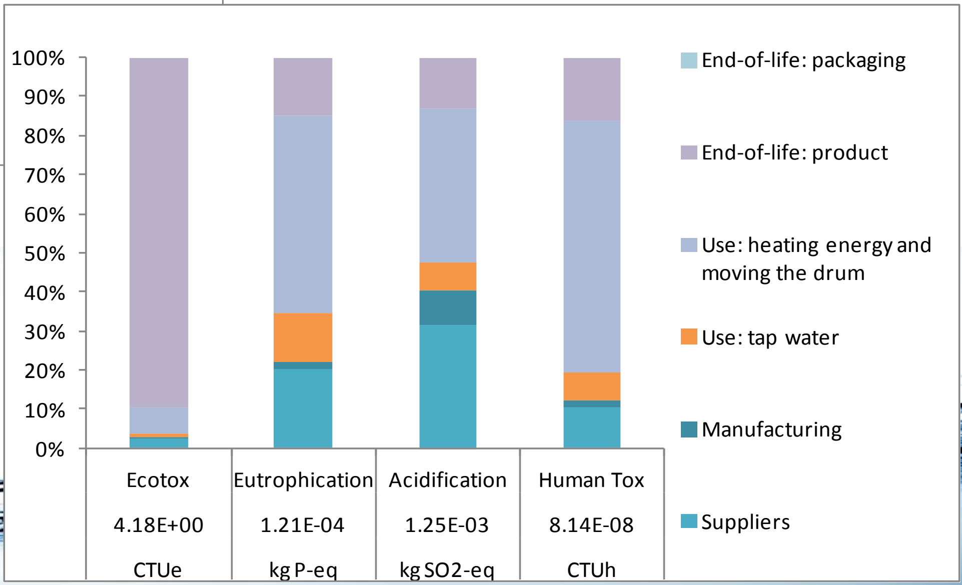
Boulay, A.-M., Bayart, J.-B., Bulle, C., Franceschini, H., Motoshita, M., Muñoz, I., Pfister, S., et al. (2013). Water impact assessment methods analysis (Part B): Applicability for water footprinting and decision making with a laundry case study. *International Journal of Life Cycle Assessment*, *Submitted*.

Midpoint Water Footprint profile

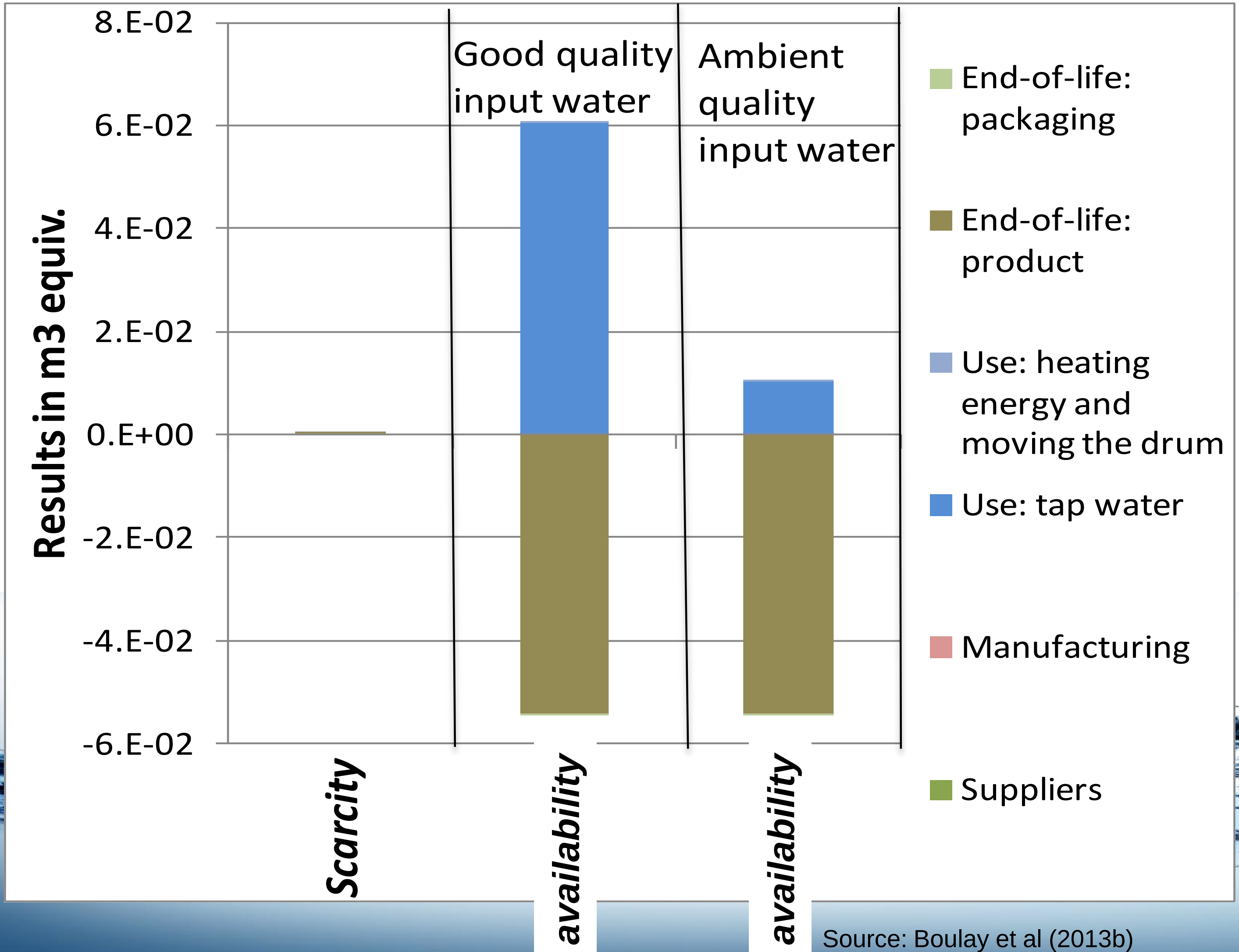


Water Scarcity indicators

Water degradation indicators



Scarcity vs availability



Source: Boulay et al (2013b)

KNOWLEDGE REVIEW 3

1 What information is used to calculate water scarcity?

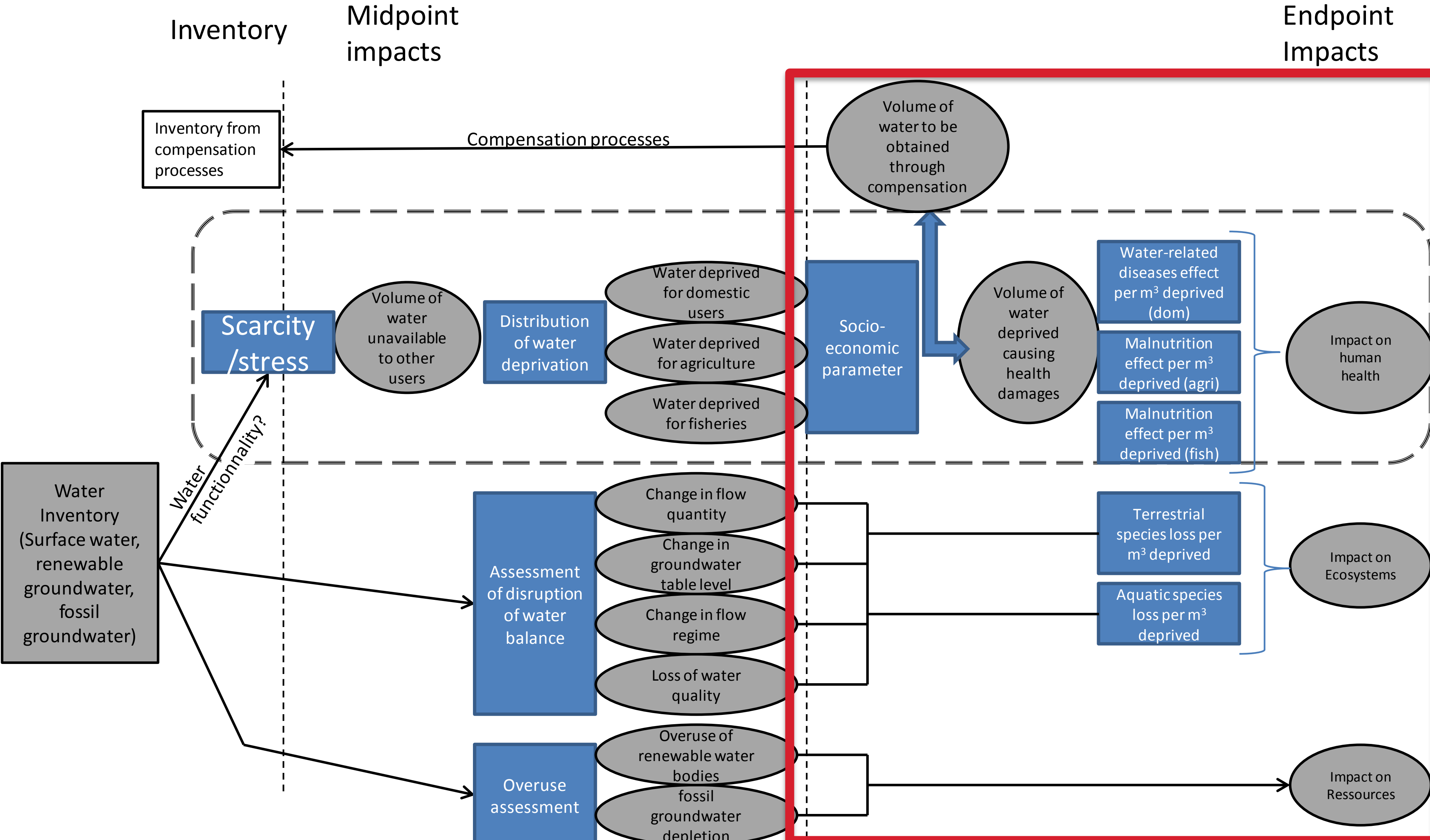
3 What are the specific water pollution impact categories? Describe each of them.

4 What is the difference between scarcity and availability?

5 Which indicators do you need at a minimum to perform a water footprint at the midpoint?

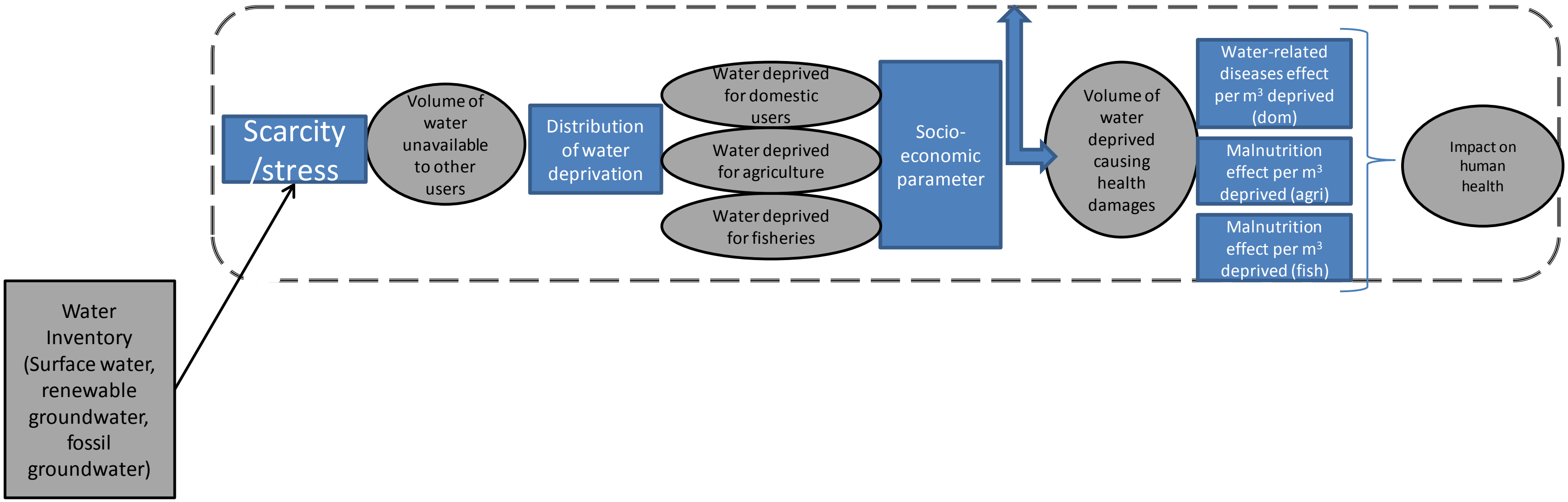
6 What type of assessment can you perform if you do not have any water quality information?

Damage (endpoint) impacts: availability



Source: Boulay et al (2013a)

Human Health impact pathway



→ Impacts are assessed in DALY: Disabled adjusted life years

Human Health

Dependent on the level of human development and economic welfare

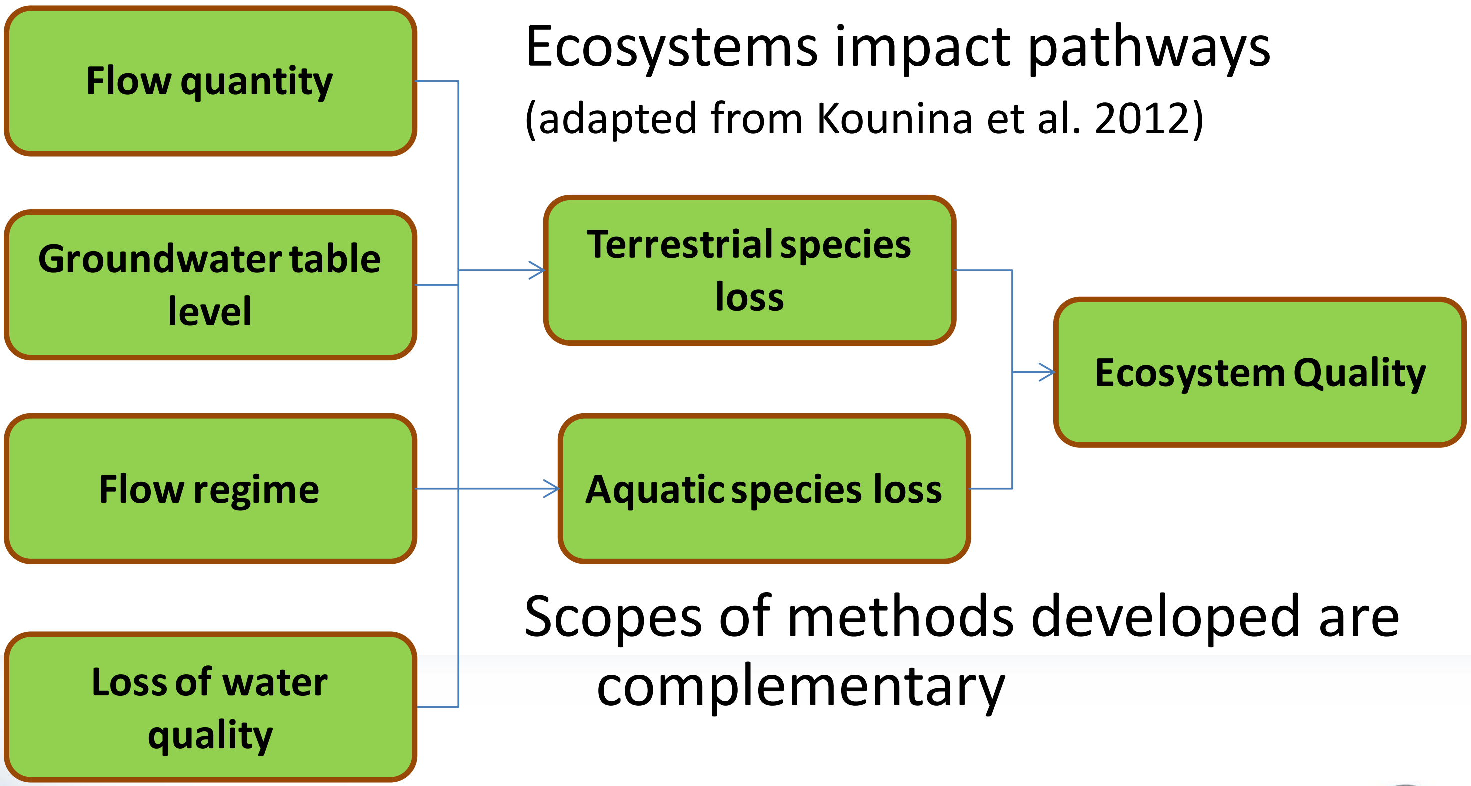
Water use ultimately leads to an aggregated impact on human health, generally expressed in disability-adjusted life years (DALY)

- Lack of freshwater for hygiene and ingestion (spread of communicable diseases) (Motoshita et al. 2010b; Boulay et al. 2011b)
- Water shortages for irrigation resulting in malnutrition (Pfister et al. 2009; Motoshita et al. 2010a; Boulay et al. 2011)
- Water shortage for freshwater fisheries resulting in loss of productivity and food supply (Boulay et al. 2011b).

Human Health impact pathway

Ecosystems impact pathways

(adapted from Kounina et al. 2012)

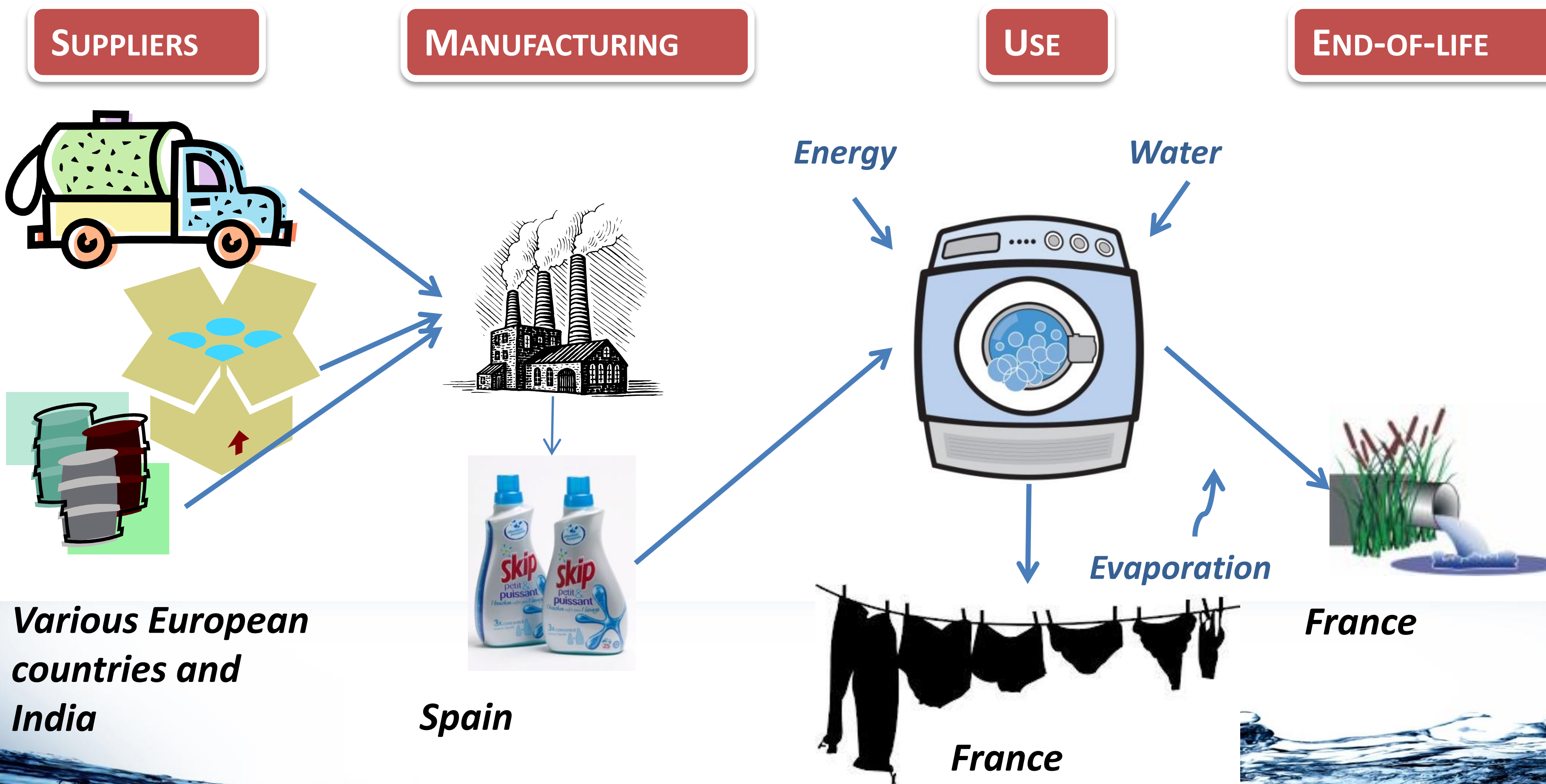


Scopes of methods developed are complementary

Impacts are generally assessed in PDF: Potentially disappeared fraction of species

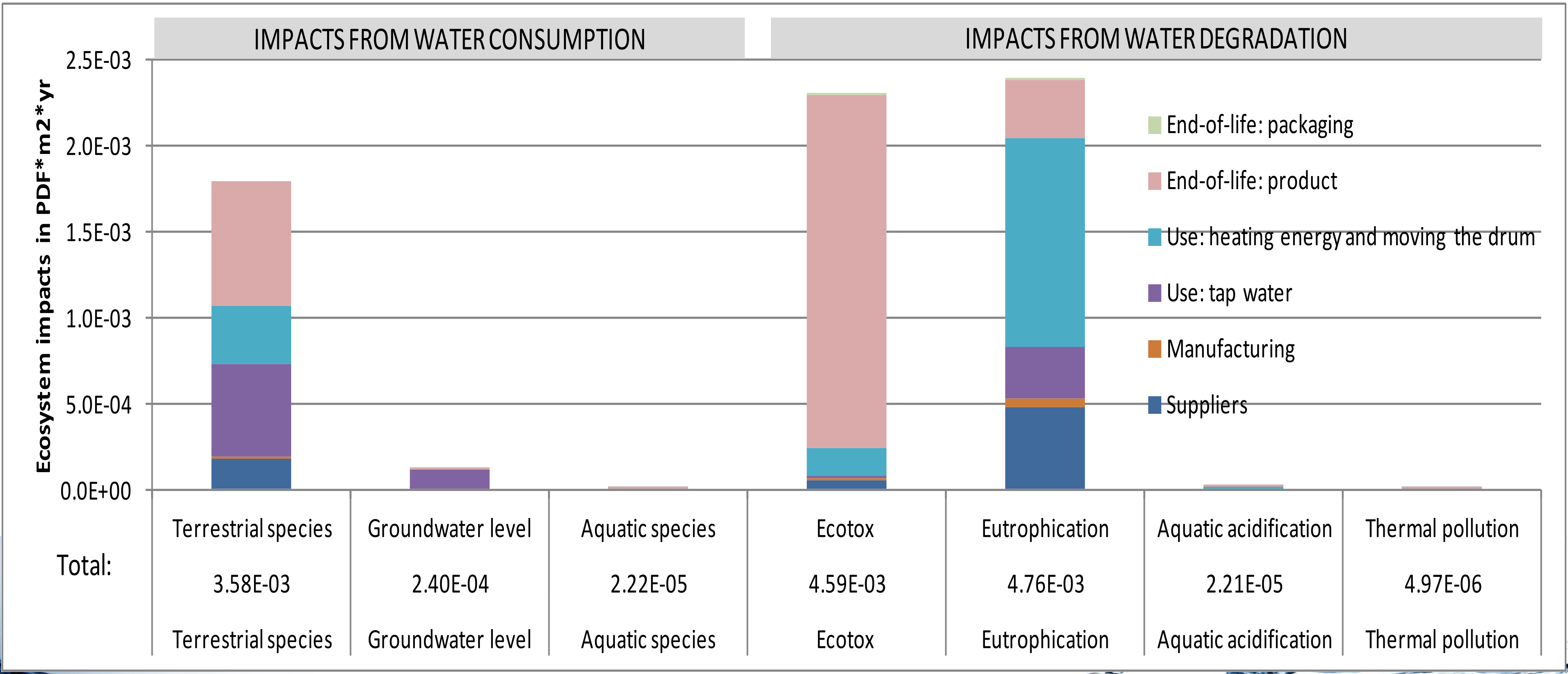
Example of application: Water Footprint at the damage level (endpoint)

Example: Water Footprint from a load of laundry



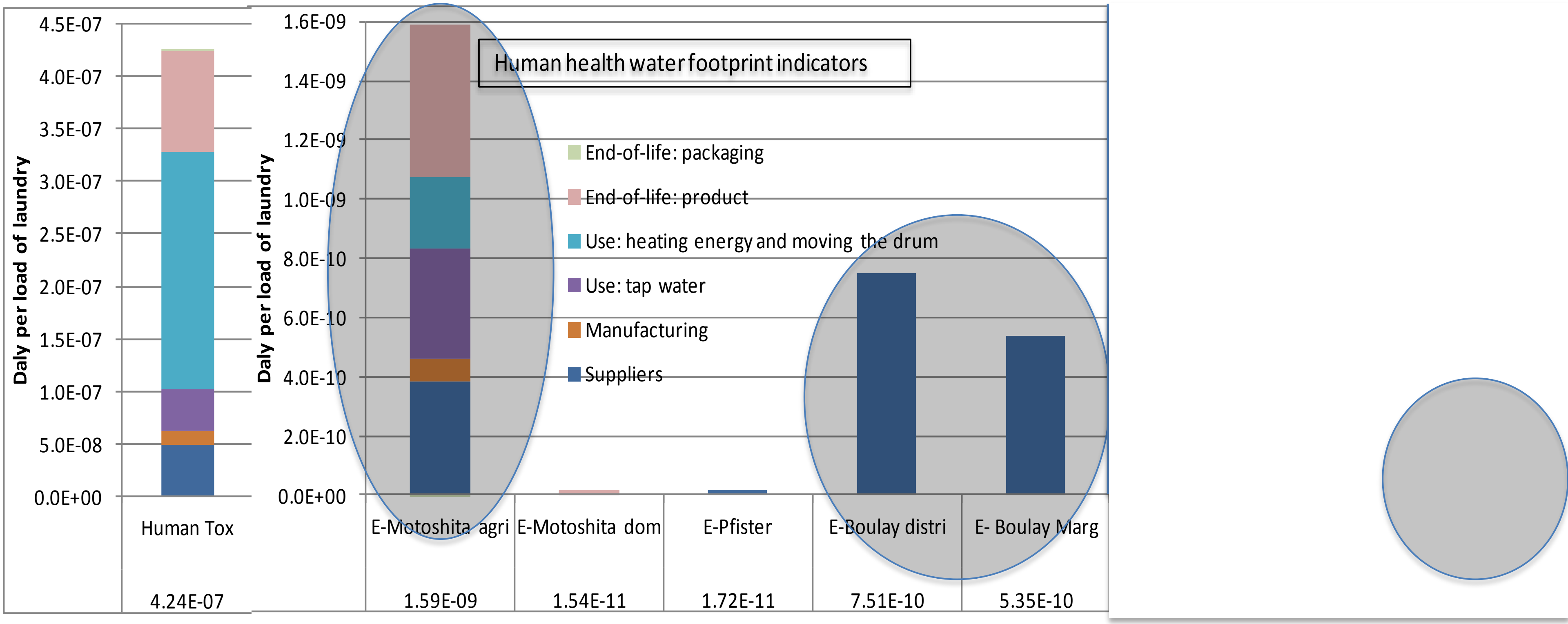
Source: Boulay et al (2013b)

Ecosystem Water Footprint



Source: Boulay et al (2013b)

Endpoint WF profile Human health



Boulay, A.-M., Bayart, J.-B., Bulle, C., Franceschini, H., Motoshita, M., Muñoz, I., Pfister, S., et al. (2013). Water impact assessment methods analysis (Part B): Applicability for water footprinting and decision making with a laundry case study. *International Journal of Life Cycle Assessment*, *Submitted*.

Source: Boulay et al (2013b)

KNOWLEDGE REVIEW 4

1 How may water consumption affect human health?

2 How are impacts from human health assessed for water consumption in developed countries?

3 What is the advantage of presenting results at the endpoint?

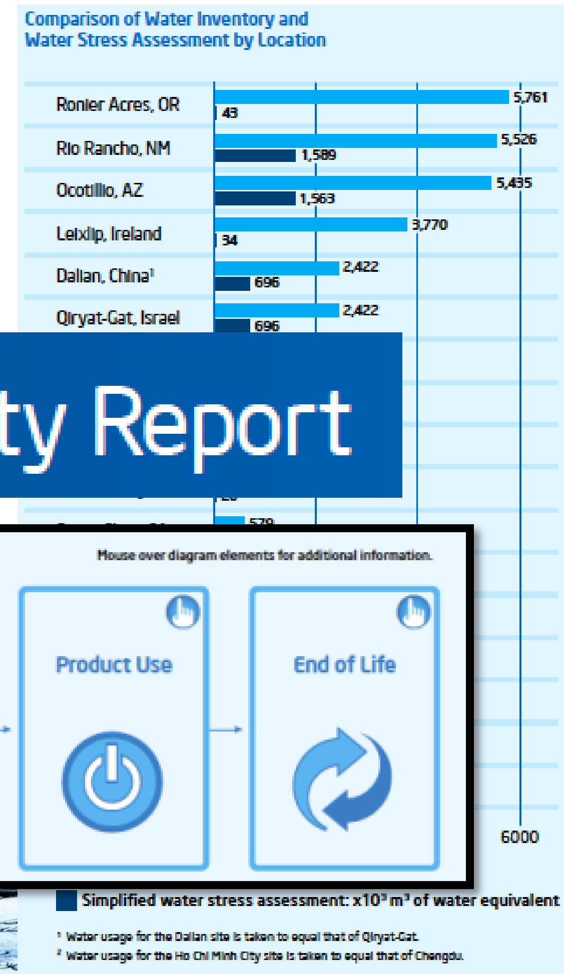
4 What types of impacts on the ecosystems are caused by water consumption?

5 What types of water footprint results can you present if you go to the endpoint?

Examples

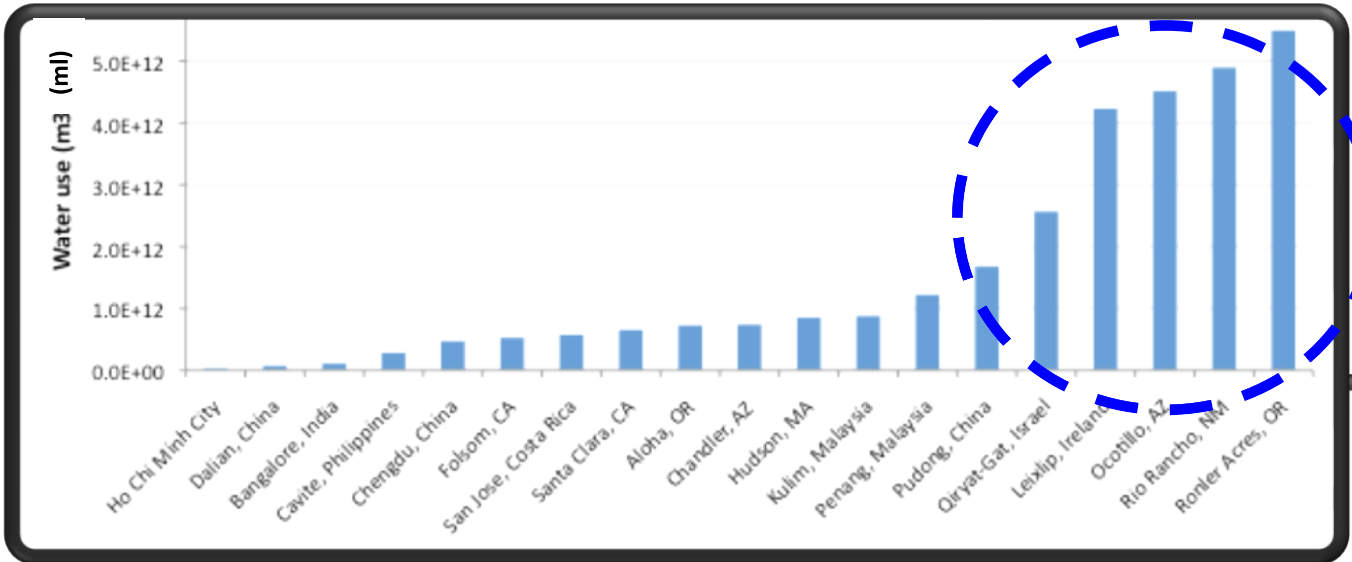
(until 3:45 pm)

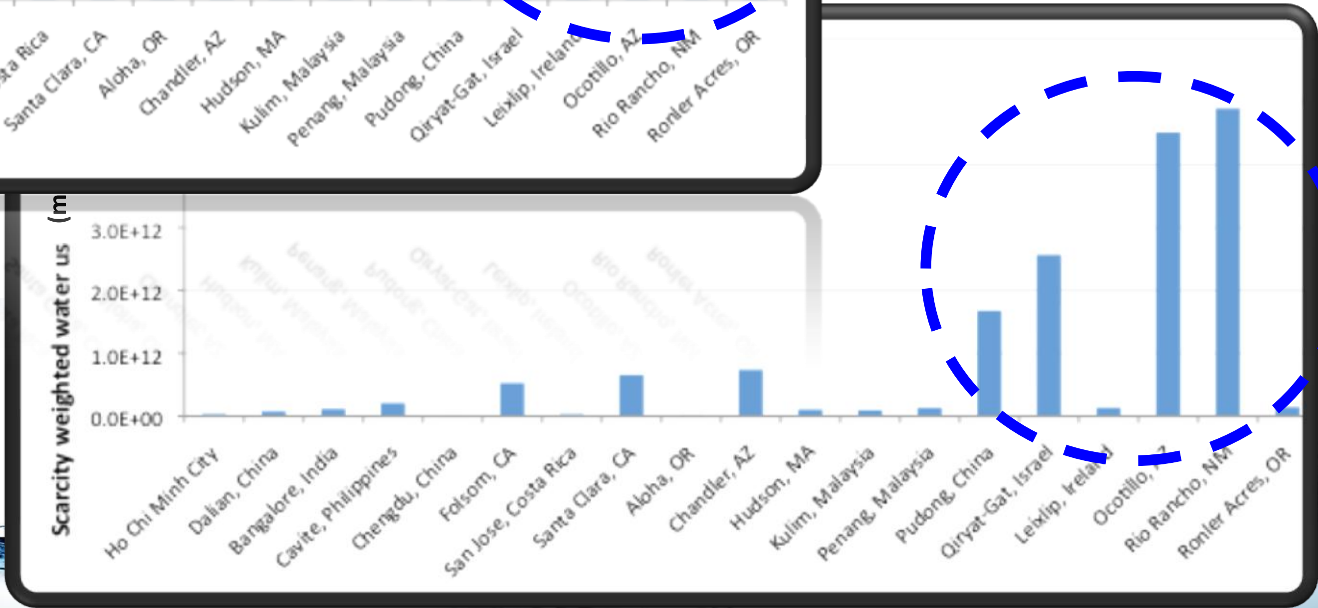
Case study: Water scarcity and water footprint of Intel



2010 Corporate Responsibility Report

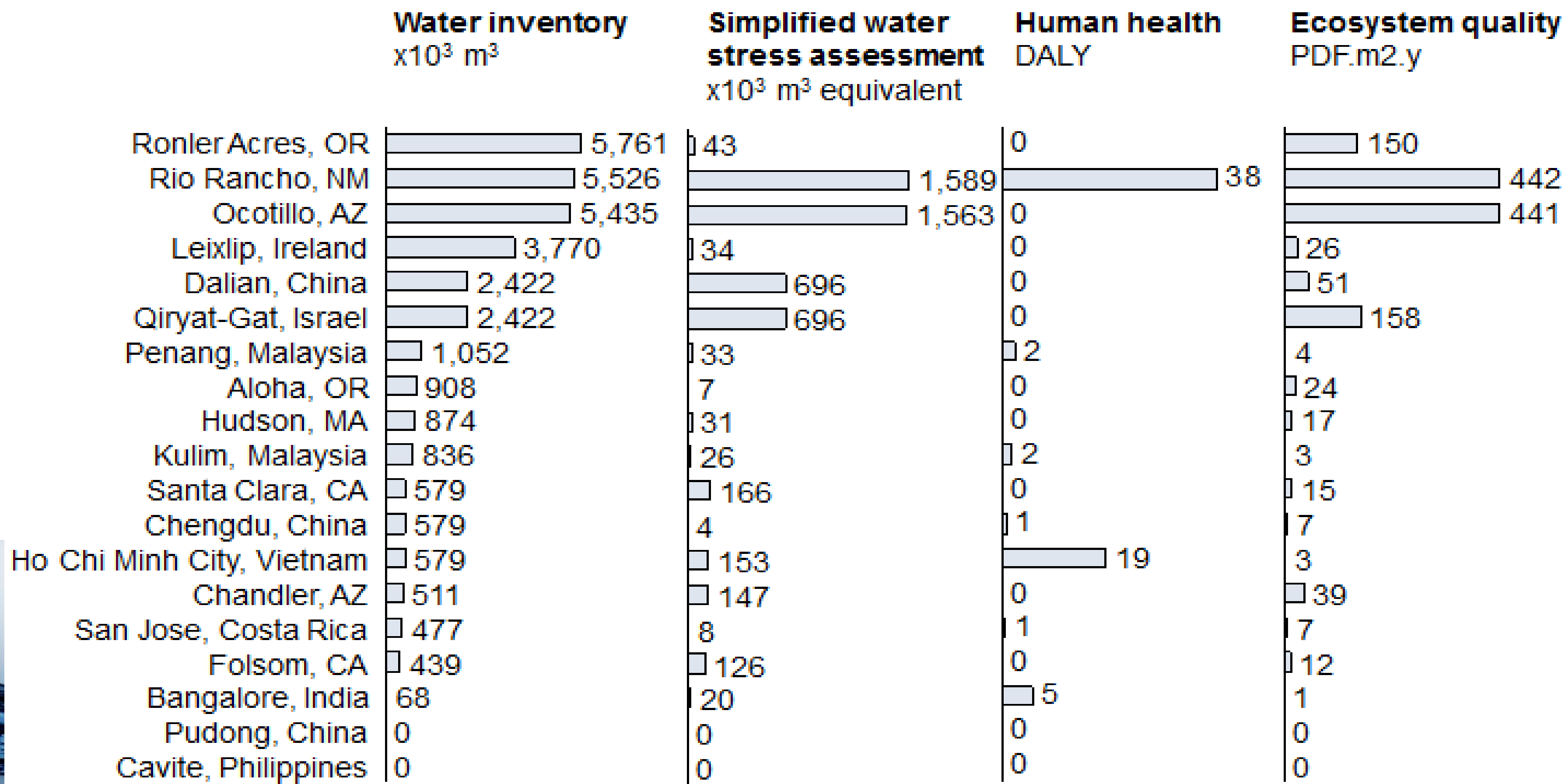
Intel case study: Importance to assess impacts





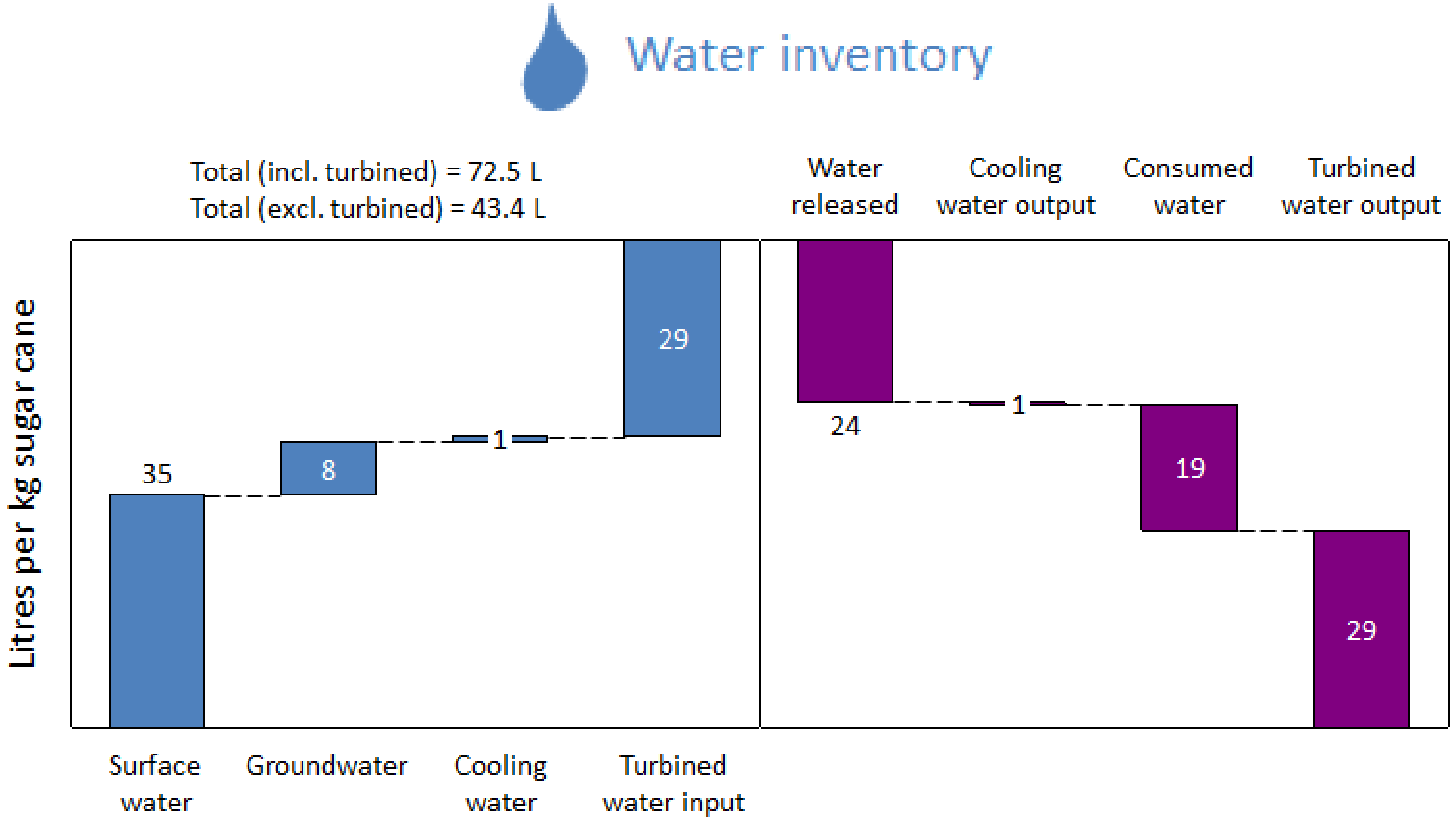
(c) Quantis

Intel case study: Water scarcity footprint at the endpoint



Example of water inventory results

1 kg sugar cane cultivated in Brazil



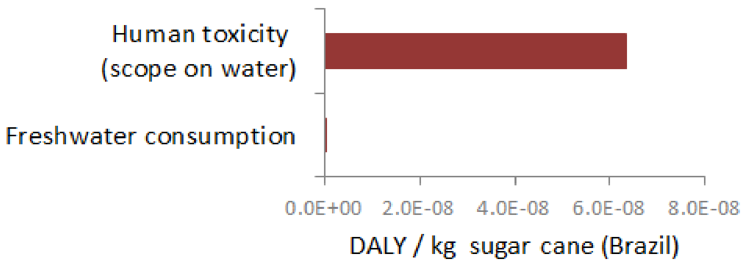
Of total freshwater withdrawal **43% is consumed**

(c) Quantis

Example of water footprint results

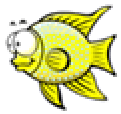
1 kg sugar cane cultivated in Brazil

Impacts on human health (from water use)

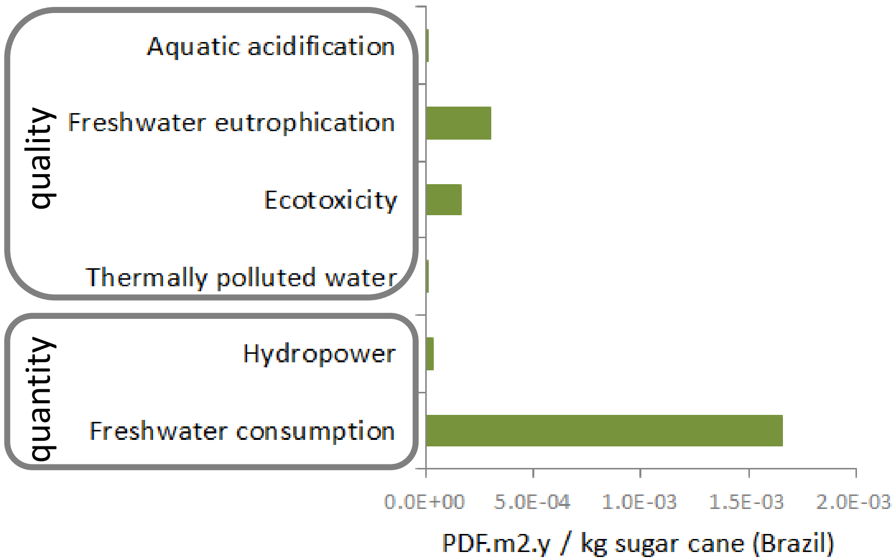


Human health impacts are dominated by direct and indirect **toxic emissions** to environment

Little irrigation in Brazil



Impacts on ecosystems quality (from water use)

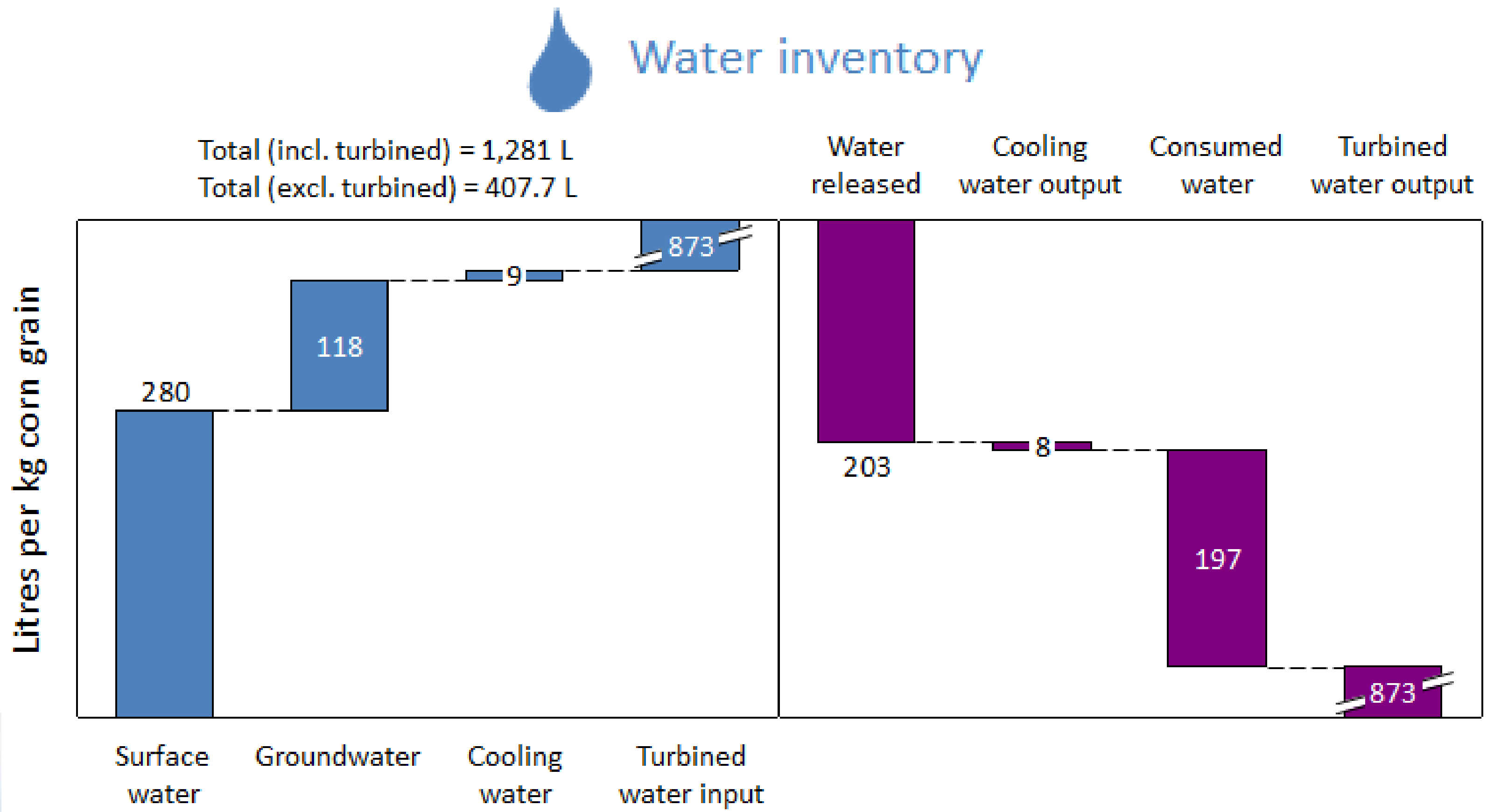


Ecosystem quality impacts are dominated by **freshwater consumption** (crop irrigation)

Freshwater **eutrophication** (fertilisers) and **ecotoxicity** are also contributors (herbicides)

Example of water inventory results

1 kg maize cultivated in China

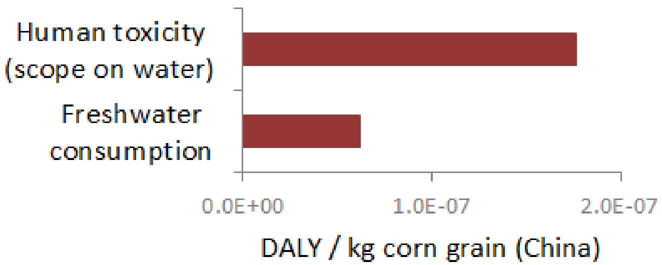


Of total freshwater withdrawal **48% is consumed**

Example of water footprint results

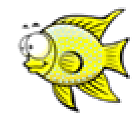
1 kg maize cultivated in China

Impacts on human health (from water use)

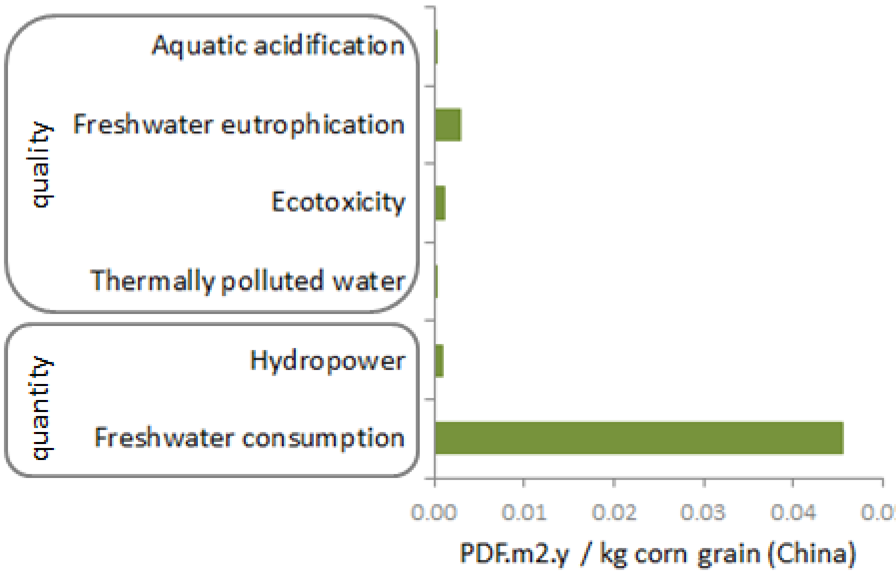


Human health impacts are dominated by direct and indirect **toxic emissions** to environment

Freshwater consumption impacts are due to **irrigation water use**



Impacts on ecosystems quality (from water use)

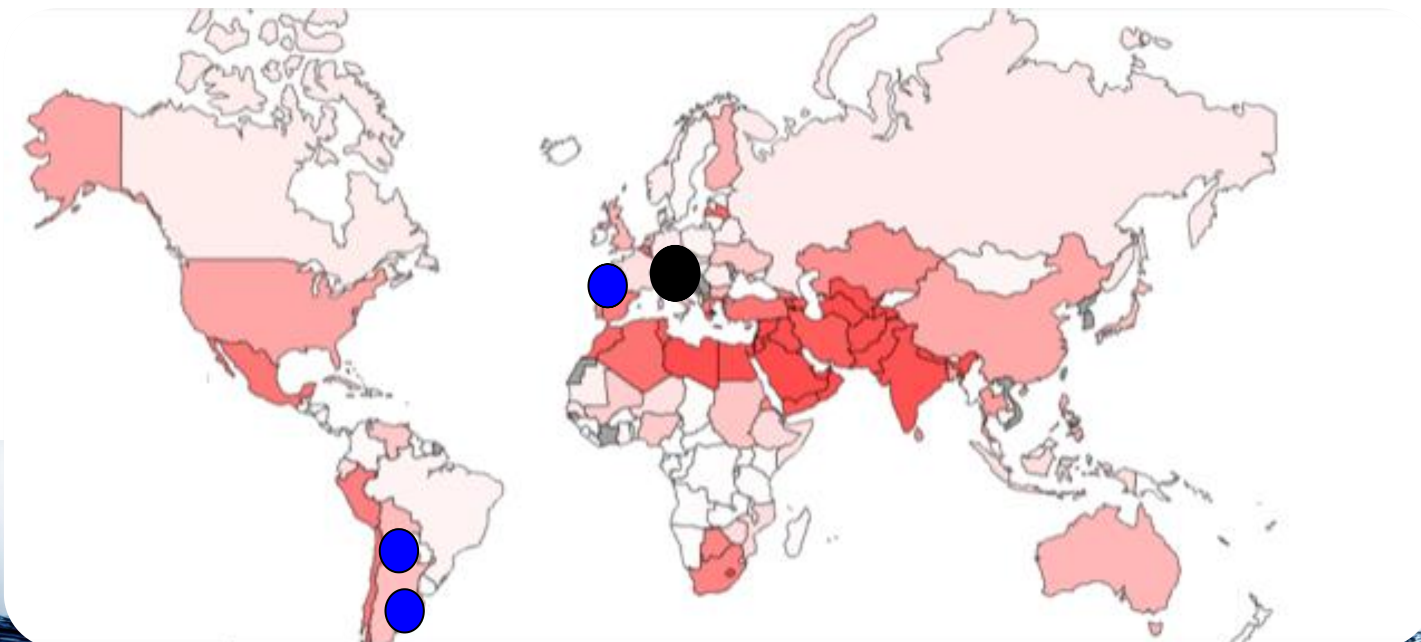


Ecosystem quality impacts are dominated by **freshwater consumption** (crop irrigation)

Danone – The water footprint of bottled water

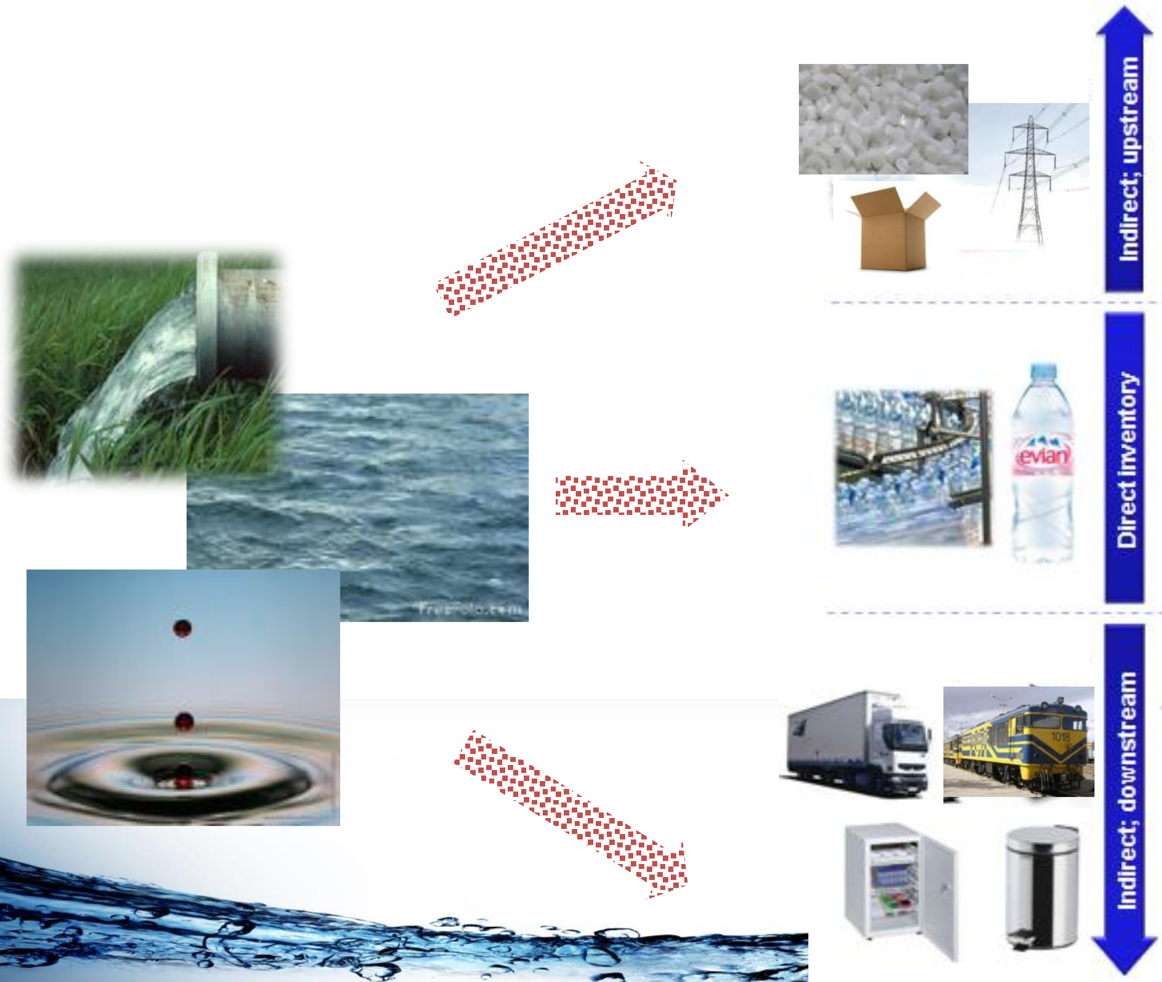
System studied: Evian bottled water

– Four different production sites assessed in this project



Water Stress Index map per country (Pfister et al. 2009)

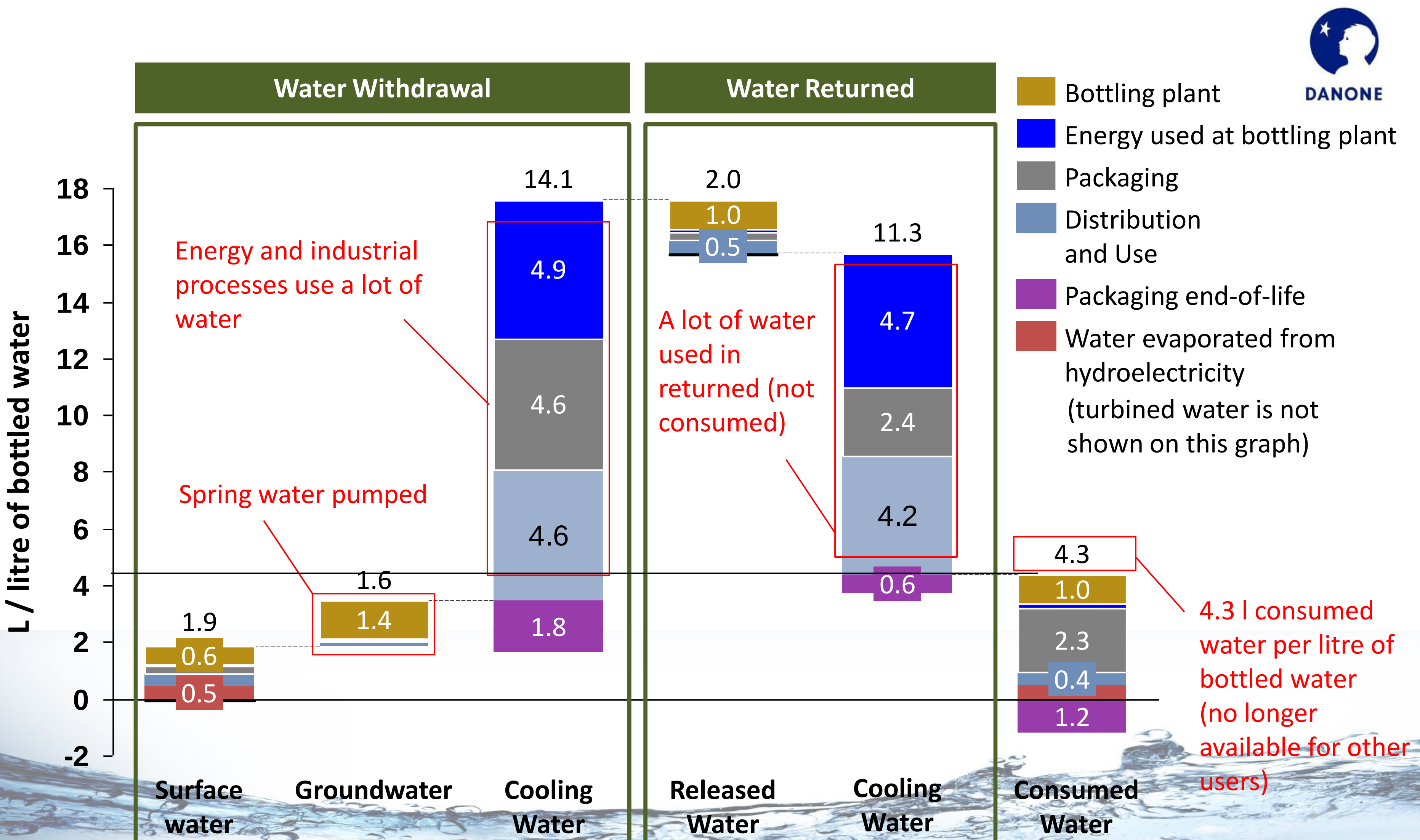
Danone – Life cycle of a bottle of water



- Packaging
- Energy used at bottling plant
- Bottling plant
- Distribution and use
- End-of-life (packaging)

Life cycle

Danone – Inventory analysis

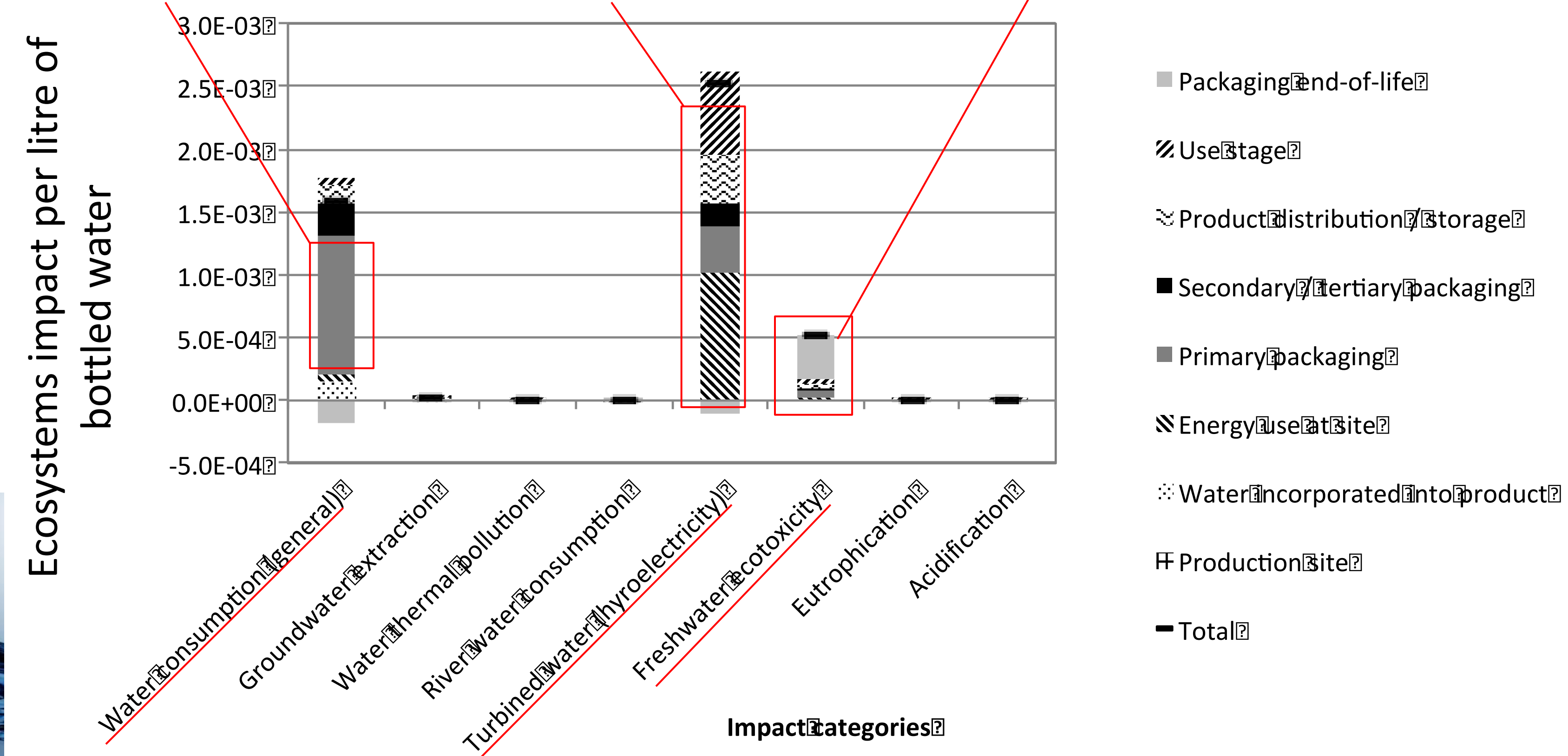


Overview of the results - Ecosystem impacts (biodiversity)

PET production happens in a water stress region

A lot of industrial processes use electricity and thus turbined water

Pollution of water is an important issue (indirect pollutant emission to water from incineration at end of life)



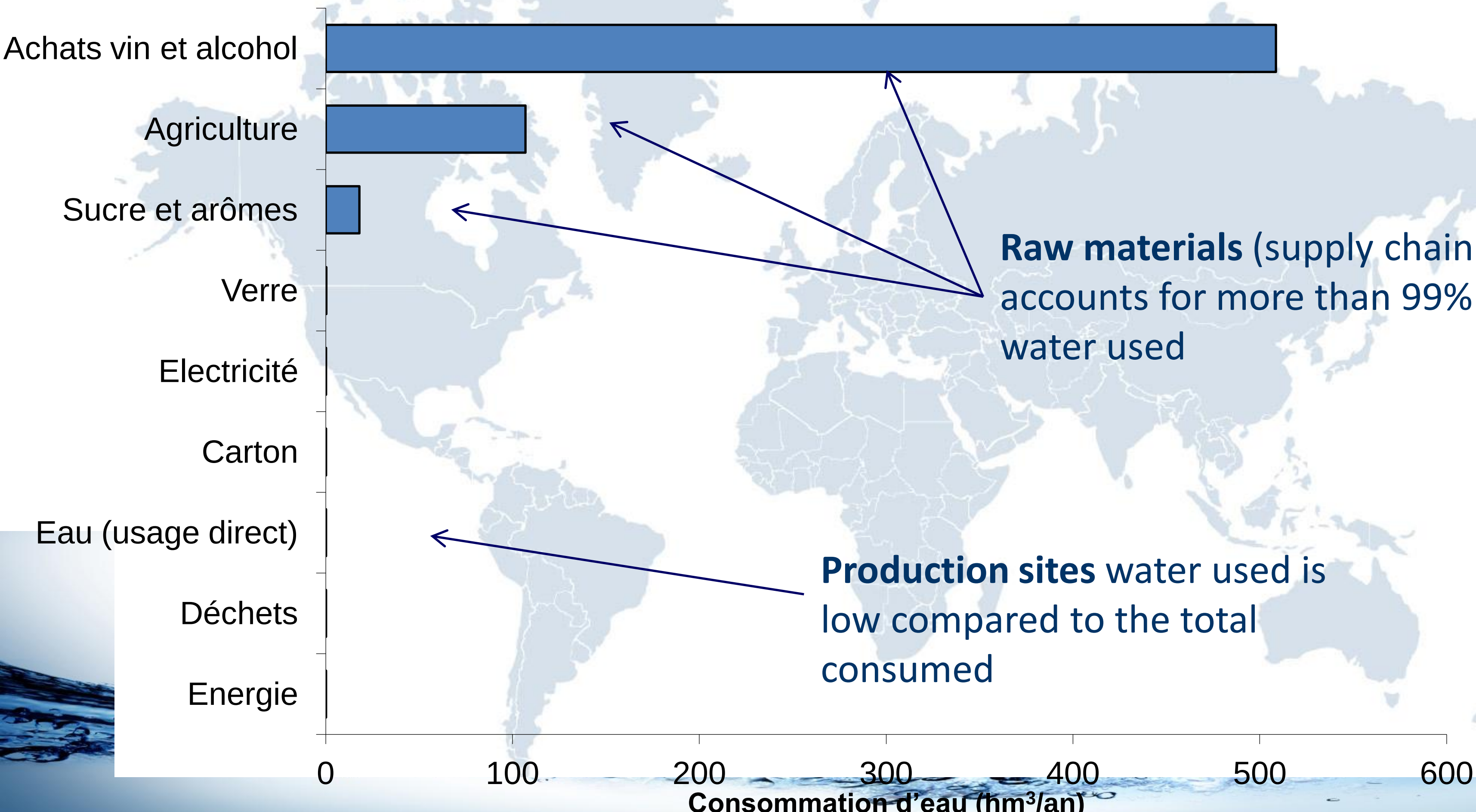
Engage with stakeholders to reduce water footprint (watershed level)

- Reducing water pollution using **waste water treatment plants**
  - Reduction of 2’600’000 m^3 of grey water at Evian watershed per year
  - Engage with local villages and towns inside the watershed to support the creation of waste water treatment plant

- Reducing water pollution through a **change in agricultural practices**
  - Prevention of 400’000 m^3 of grey water per year at the Evian site through label (organic production) and best practice agriculture

- Improvement of ecosystem quality through **wetlands and ecosystem maintenance**
  - Benefit for the biodiversity app. 400’000 PDF·m^2·y at Evian watershed per year

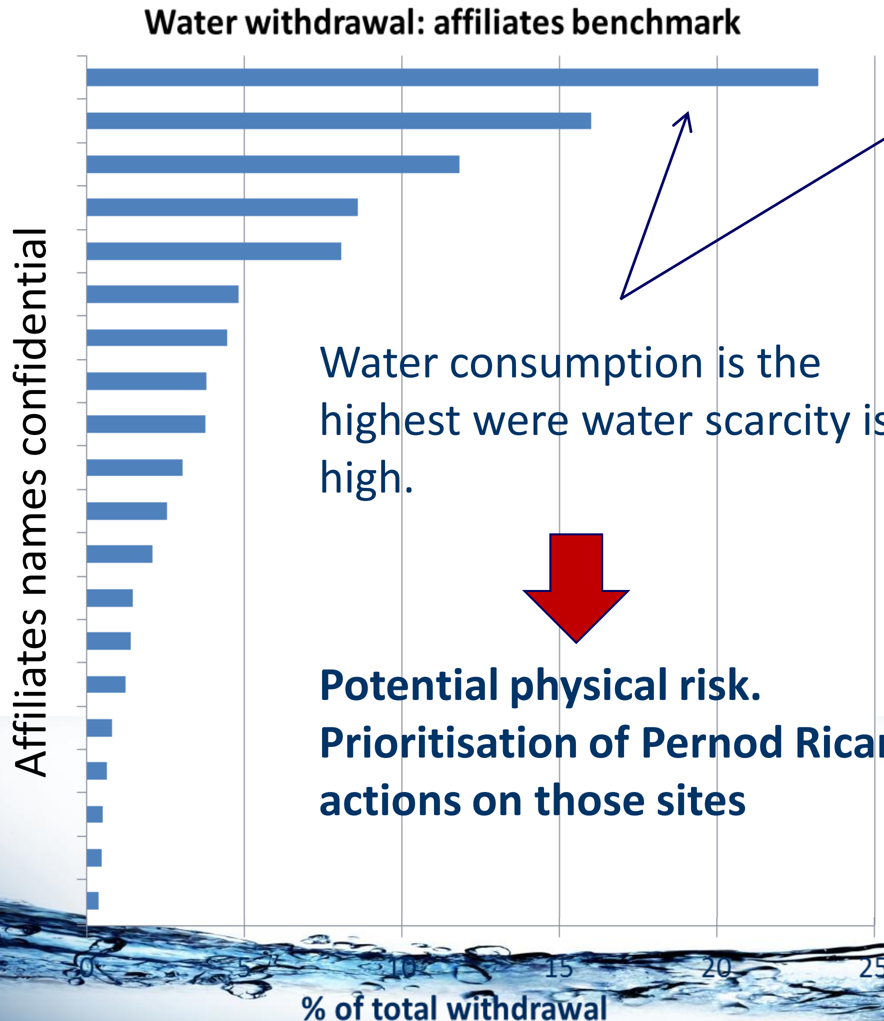
Inventory results

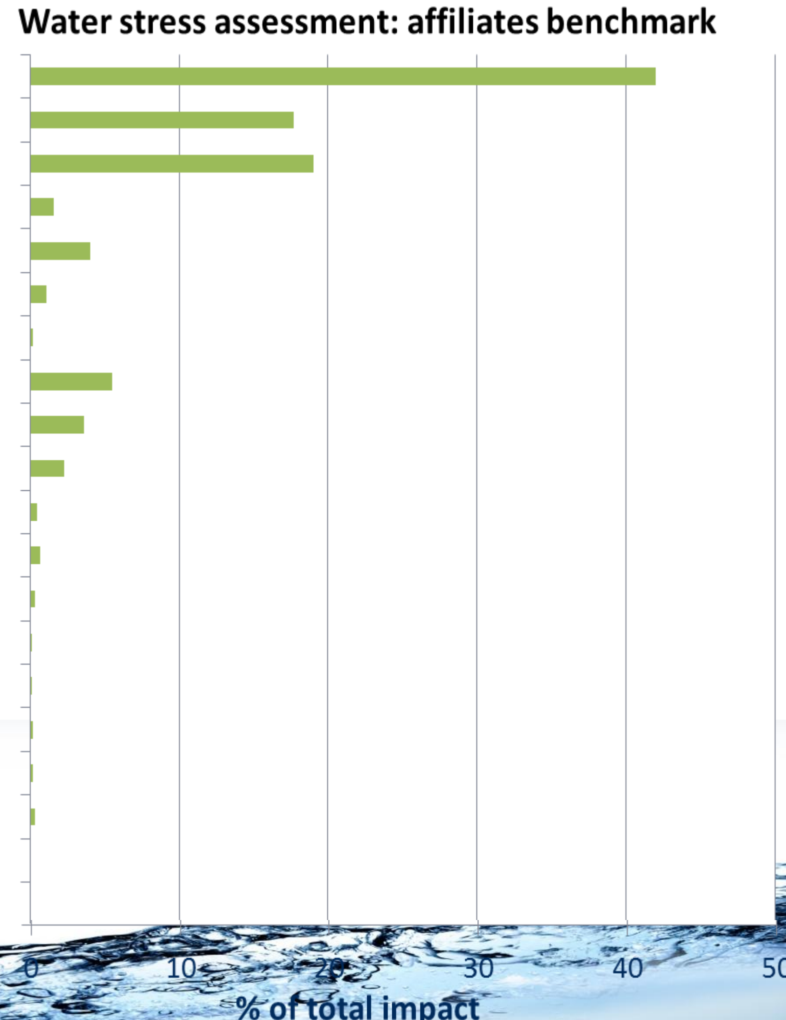


Raw materials (supply chain) accounts for more than 99% of water used

Production sites water used is low compared to the total consumed

Priorisation des filiales et sites de production





Water consumption is the highest were water scarcity is high.

Potential physical risk. Prioritisation of Pernod Ricard actions on those sites

(c) Quantis

Tools available and input from practitioner

Tools

SimaPro

GaBi Software
PRODUCT SUSTAINABILITY

ETC…

openLCA
framework

Quantis
SUITE 2.0

- **Regionalization not yet operationalized**
- **Tools don't integrate water footprint methods yet**

Method development: the WULCA working group of the UNEP/SETAC Life Cycle Initiative

UNEP/SETAC Life Cycle Initiative

Water Use in LCA (WULCA)

Founded in 2007, now includes → 100 experts from 21 countries

- **Phase 1:** Proposed a framework to evaluate water in LCA (Bayart et al. 2009)
- **Phase 2:** Review of different methods (Kounina et al. 2012)
- **Phase 3:** Quantitative comparison (Boulay et al A and B, under review)

Current mandate (2014-2015):

Guide the scientific development of a **consensual and operational method** which shall be in line with both the **ISO Water Footprint Standard** and the **LCA principles**

www.wulca-waterlca.org

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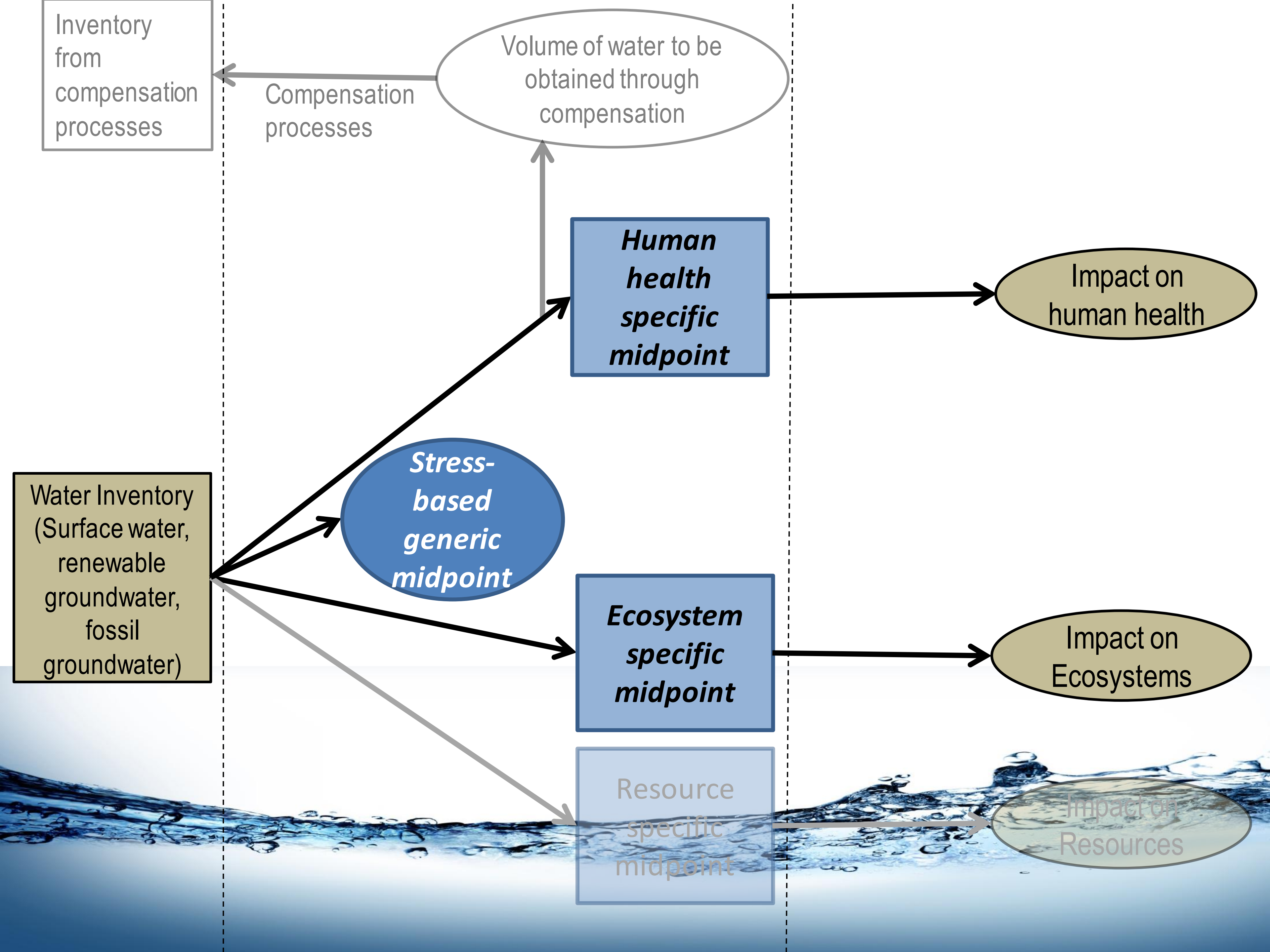
Stephan Pfister, Ph.D. (Switzerland) Deputy Manager


Inventory from compensation processes
Compensation processes
Volume of water to be obtained through compensation
Human health specific midpoint
Impact on human health
Stress-based generic midpoint
Water Inventory (Surface water, renewable groundwater, fossil groundwater)
Ecosystem specific midpoint
Impact on Ecosystems
Resource specific midpoint
Impact on Resources

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References

Please visit:
http://wulca-waterlca.org/publications

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