Towards the big picture - from one-dimensional footprints to complete environmental sustainability assessments

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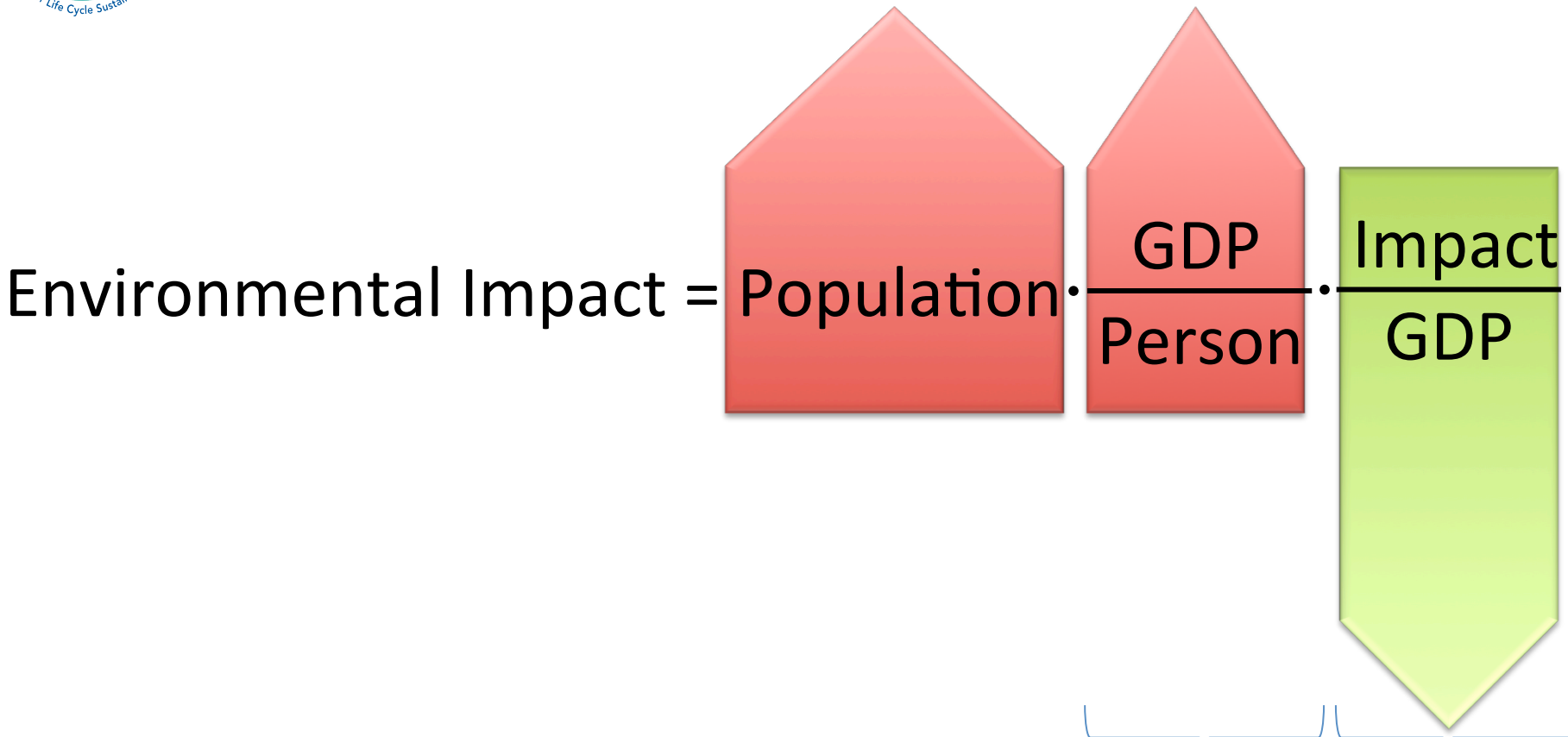
Content

- A short history of LCA
- Future trends in LCA
  - Impact assessment
  - Uncertainty assessment and probabilistic LCA
  - New tendencies and expansions of classic LCA
  - Policy and global harmonisation
- Footprint or LCA?

Master equation for environmental impacts



Ehrlich and Holdren (1971) Impact of population growth. *Science* 171, 1211-1217

LCA History – early years 1960-1990

1963	First calculations of Cumulative Energy Requirements for the production of chemical intermediates and products
1969	Comparison of Coca-Cola beverage containers (refillable bottles, cans, plastic bottle) quantifying resources and environmental release
1975	EPA decided in 1975 that using LCA as a regulatory tool was impractical
1976	Article on Coca-Cola packaging study published in Science (April 9 issue)
1980	Report concerning major commodity of raw materials made public by the Solar Energy Research Institute
1984	EMPA (Swiss Federal Laboratories and Material testing) published Ecological report of packaging material and a report that presented a comprehensive list of data needed for LCA; first impact assessment method based on critical volumes introduced
1990	Adoption of the term LCA “Life Cycle Analysis" in a workshop of the Society of Environmental Toxicology and Chemistry (SETAC) replacing the historical term REPA (resource and environmental profile analysis)

LCA History – 90's

1992	Creation of SPOLD in Sweden (later to become the ecoinvent data format)
1992	First formal framework for the impact assessment phase
1992	First complete presentation of LCA methodology in a peer reviewed scientific journal in the US
1993	Publication of inventory guideline document by US EPA
1993	SETAC Code of Practice published to harmonize LCA framework, terminology and methodology
1994	LCA becomes a part of policy documents and legislation
1997	First series of LCA ISO standards published (14040-14043)
1997	I'm attending my first LCA class at TU Berlin, Germany
1999	Idea on consequential LCA emerged

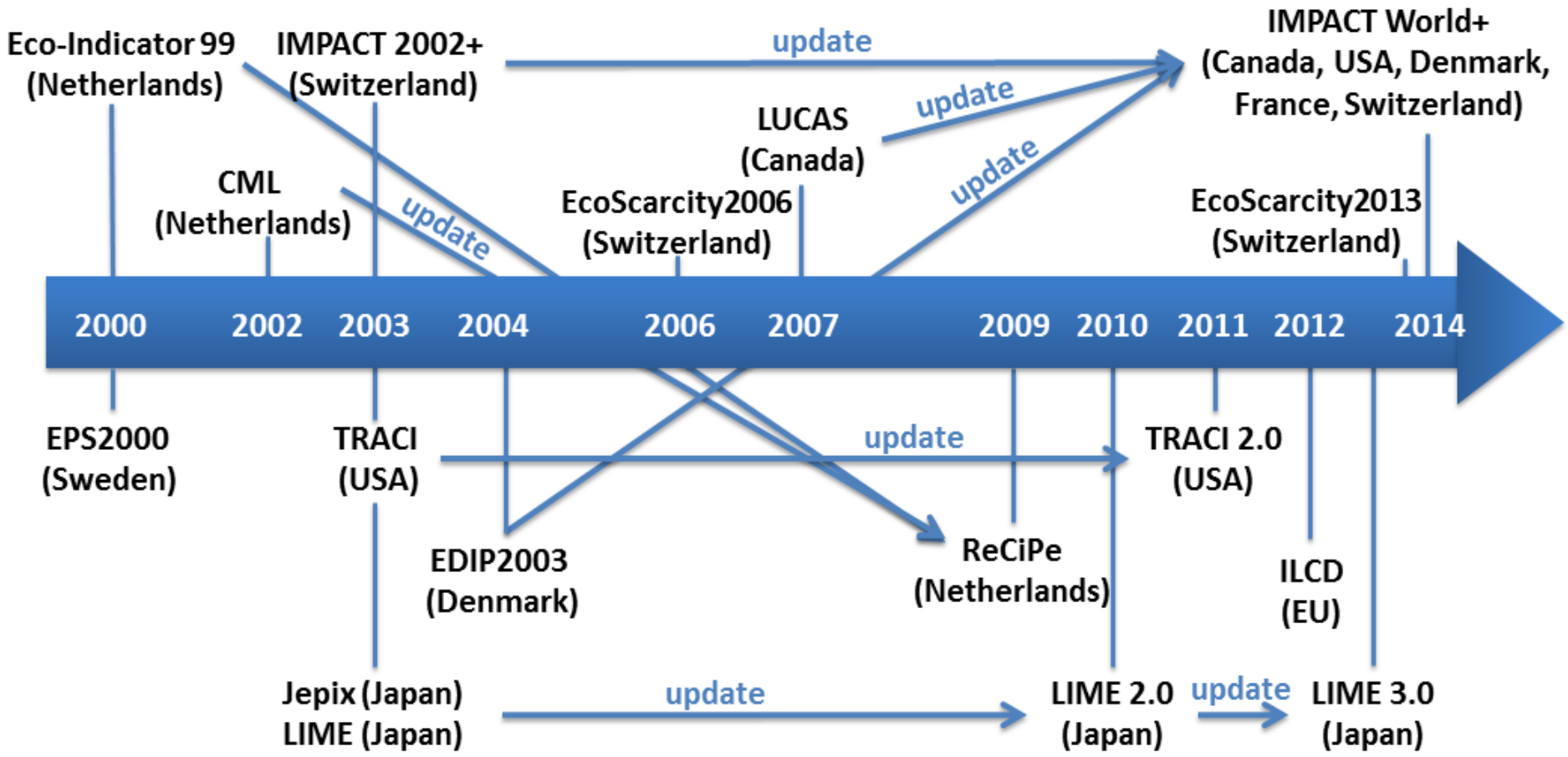
LCA History – 2000…

2002	UNEP-SETAC Life Cycle Initiative launched
2003	European Commission underlined the importance of life cycle assessment and the need for promoting the application of life cycle thinking among the stakeholders of IPP
2006	Revision of ISO standards on LCA: ISO 14040:2006 and ISO 14044:2006
2006	A framework for Life Cycle Sustainability Analysis proposed
2006	Feasibility study on social LCA

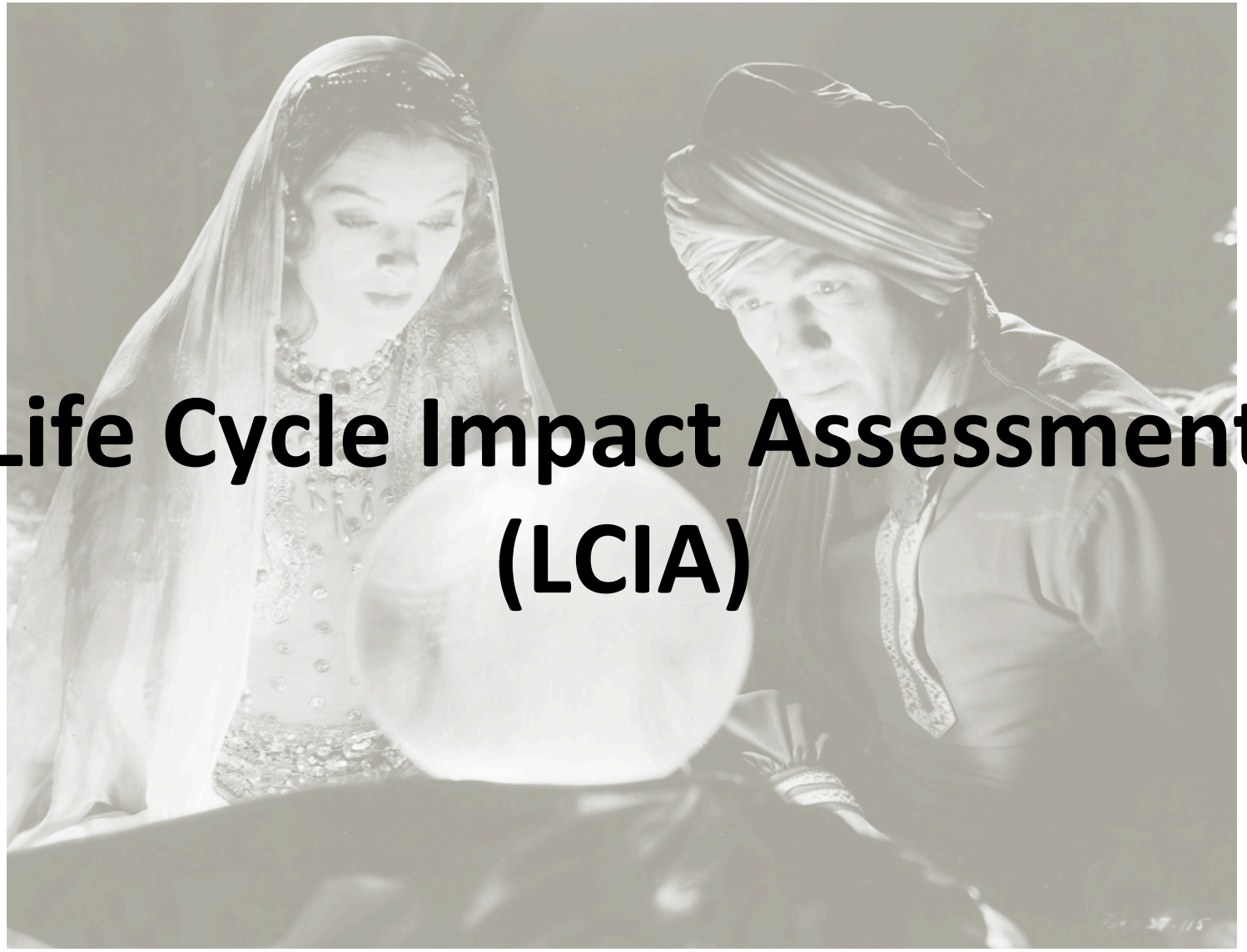
A good read on the US perspective covering the period from 1970 to 1990:

Hunt RG, Franklin WE, (1996): LCA - How it Came About - Personal Reflections on the Origin and LCA in the USA. International Journal of Life Cycle Assessment 1(1) 4-7.

LCIA (modern) History

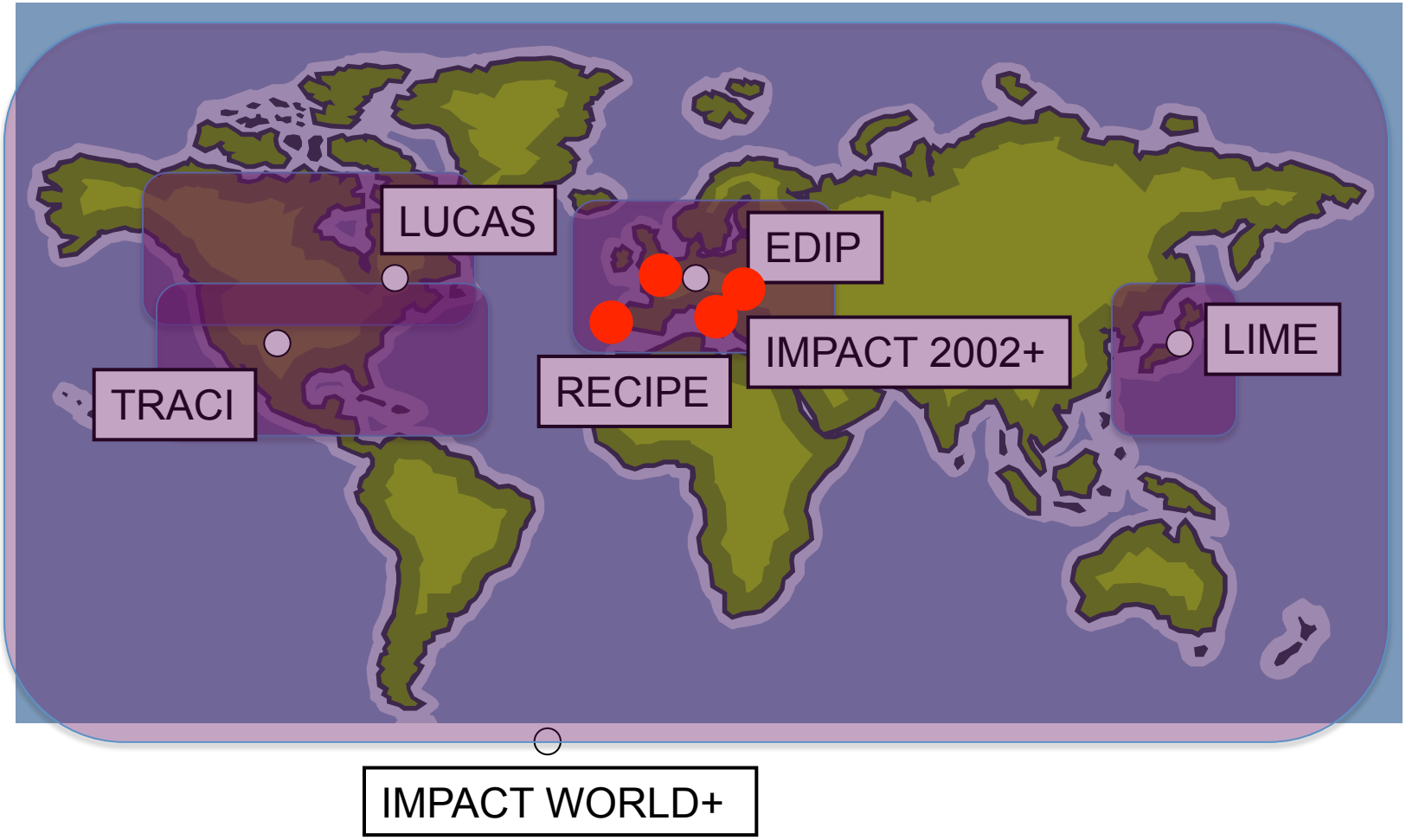


Future trends in LCA



Life Cycle Impact Assessment (LCIA)

From local to global representativeness



From generic to local specificity

Global Warming
Ozone Layer depletion

Aquatic and terrestrial acidification
Photochemical ozone formation
Aquatic and terrestrial Eutrophication

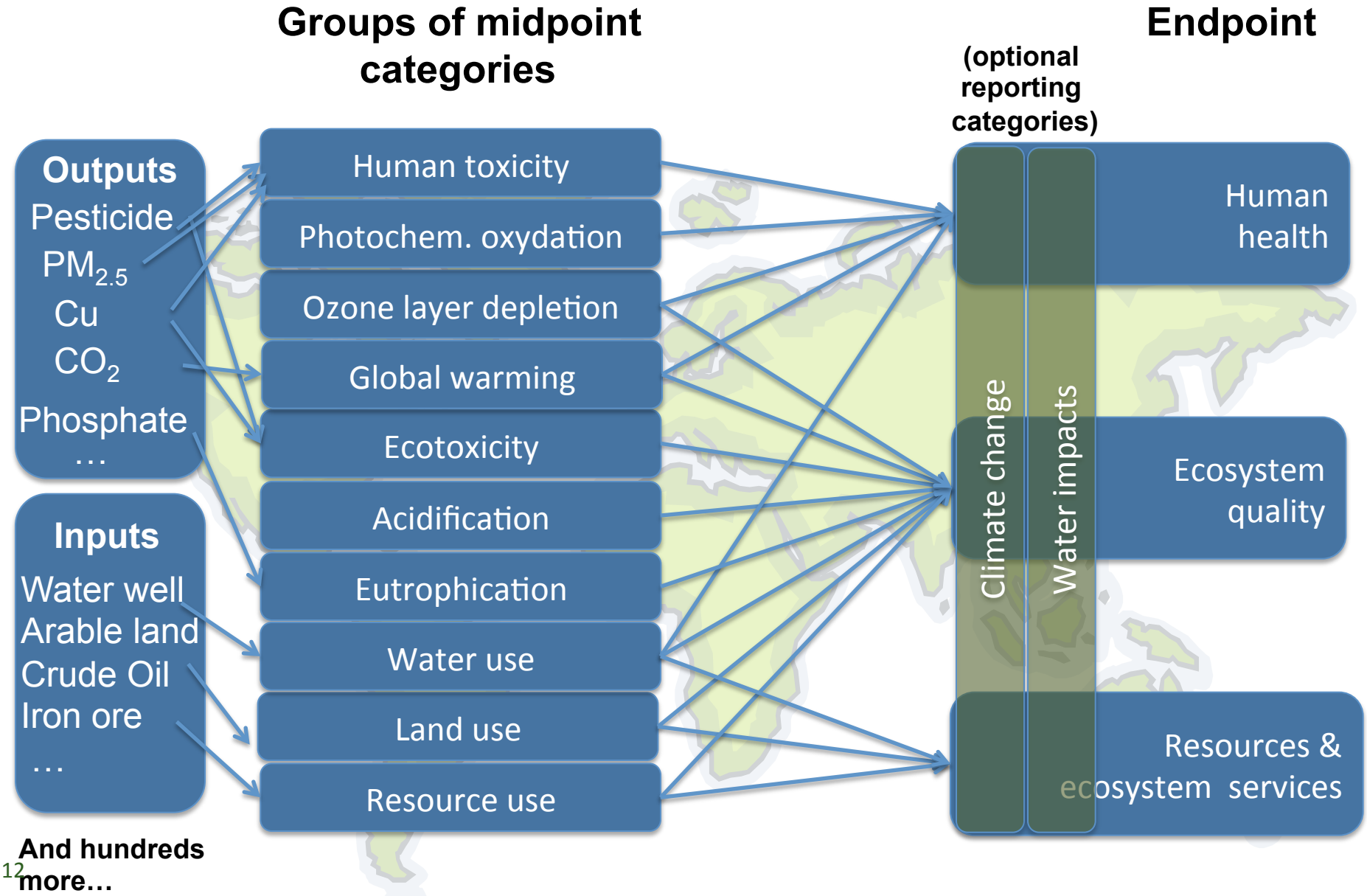
Human toxicity
Ecotoxicity

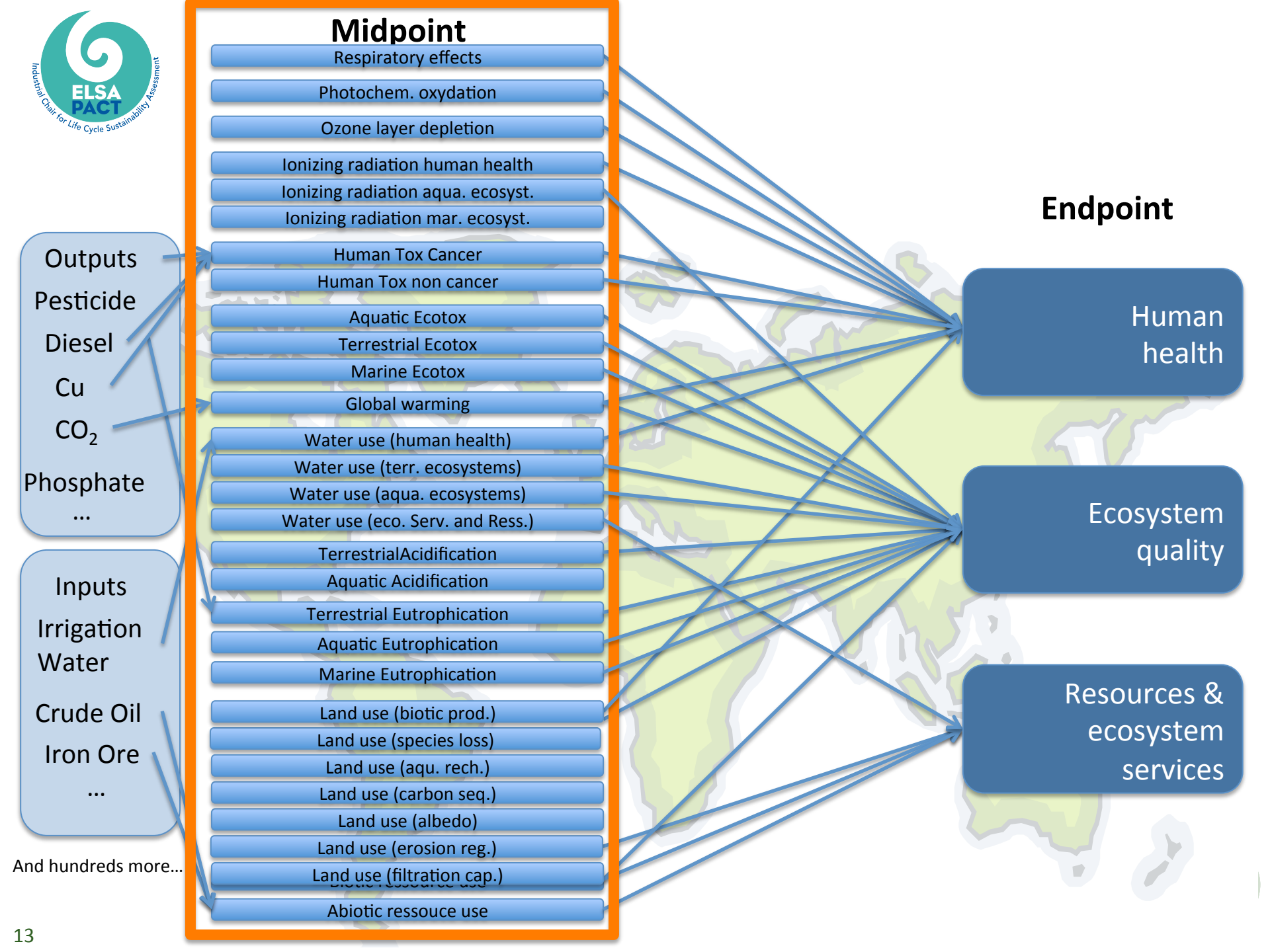
Land Use
Water Use
Biotic and abiotic resources use

Global Impacts, independent from emission site

Regional and local impacts with strong dependency on emission site

IMPACT World+ Framework




Midpoint
Respiratory effects
Photochem. oxydation
Ozone layer depletion
Ionizing radiation human health
Ionizing radiation aqua. ecosyst.
Ionizing radiation mar. ecosyst.
Human Tox Cancer
Human Tox non cancer
Aquatic Ecotox
Terrestrial Ecotox
Marine Ecotox
Global warming
Water use (human health)
Water use (terr. ecosystems)
Water use (aqua. ecosystems)
Water use (eco. Serv. and Ress.)
TerrestrialAcidification
Aquatic Acidification
Terrestrial Eutrophication
Aquatic Eutrophication
Marine Eutrophication
Land use (biotic prod.)
Land use (species loss)
Land use (aqu. rech.)
Land use (carbon seq.)
Land use (albedo)
Land use (erosion reg.)
Land use (filtration cap.)
Abiotic ressouce use
Outputs
Pesticide
Diesel
Cu
CO_2
Phosphate
…
Inputs
Irrigation Water
Crude Oil
Iron Ore
…
And hundreds more…
Endpoint
Human health
Ecosystem quality
Resources & ecosystem services

IMPACT World+ the first regionalised LCIA method

Global default Method : IMPACT World +

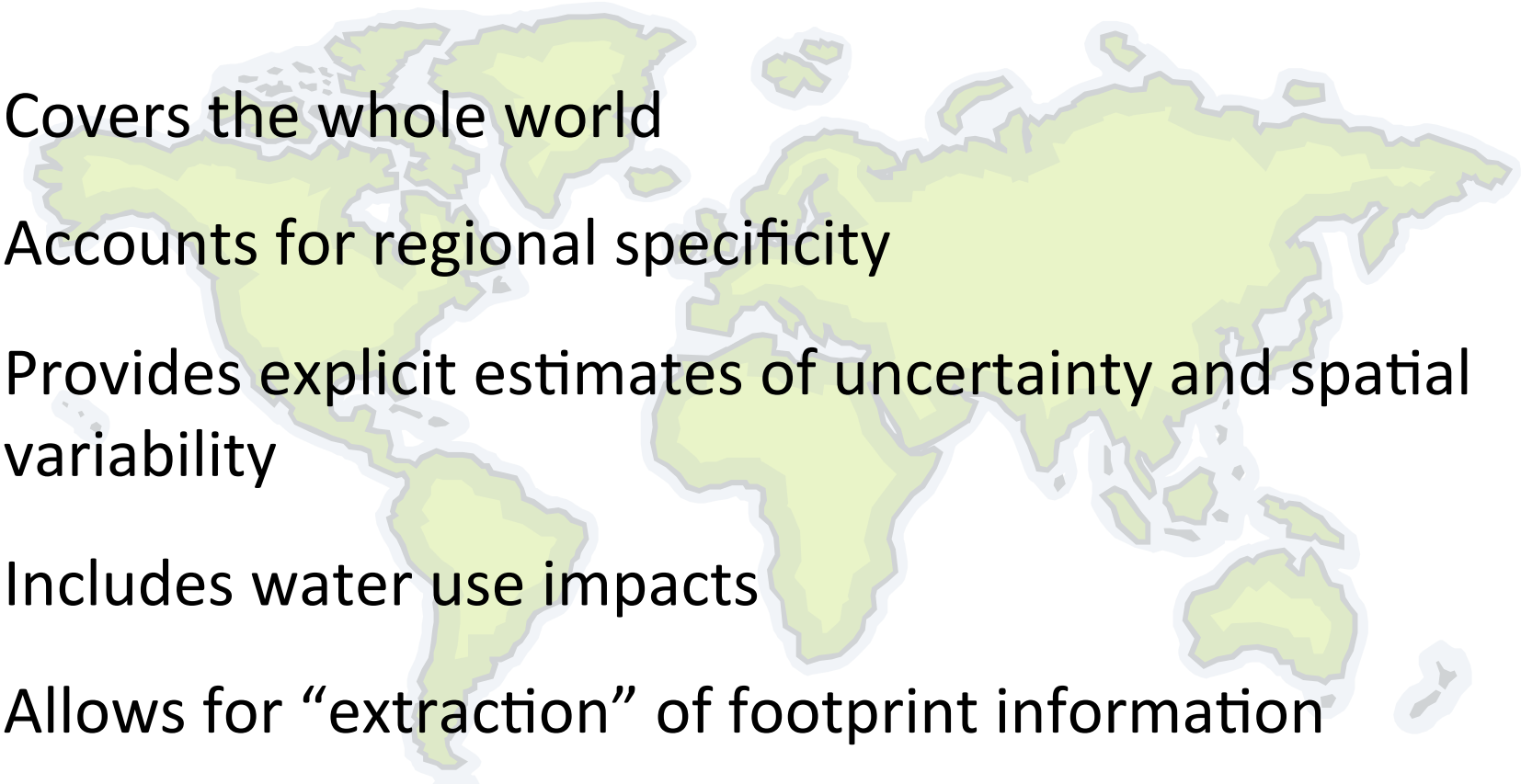
Continental versions of the method :

Arctic

Country level CFs

Fine resolution CFs

IMPACT World+: a new LCIA method



- Covers the whole world
- Accounts for regional specificity
- Provides explicit estimates of uncertainty and spatial variability
- Includes water use impacts
- Allows for “extraction” of footprint information
- …

Uncertainty Assessment and management

Probability-based LCA: hand dryer

XLERATOR Dryer 10s.

Conventional Dryer 30s.

Paper Towels

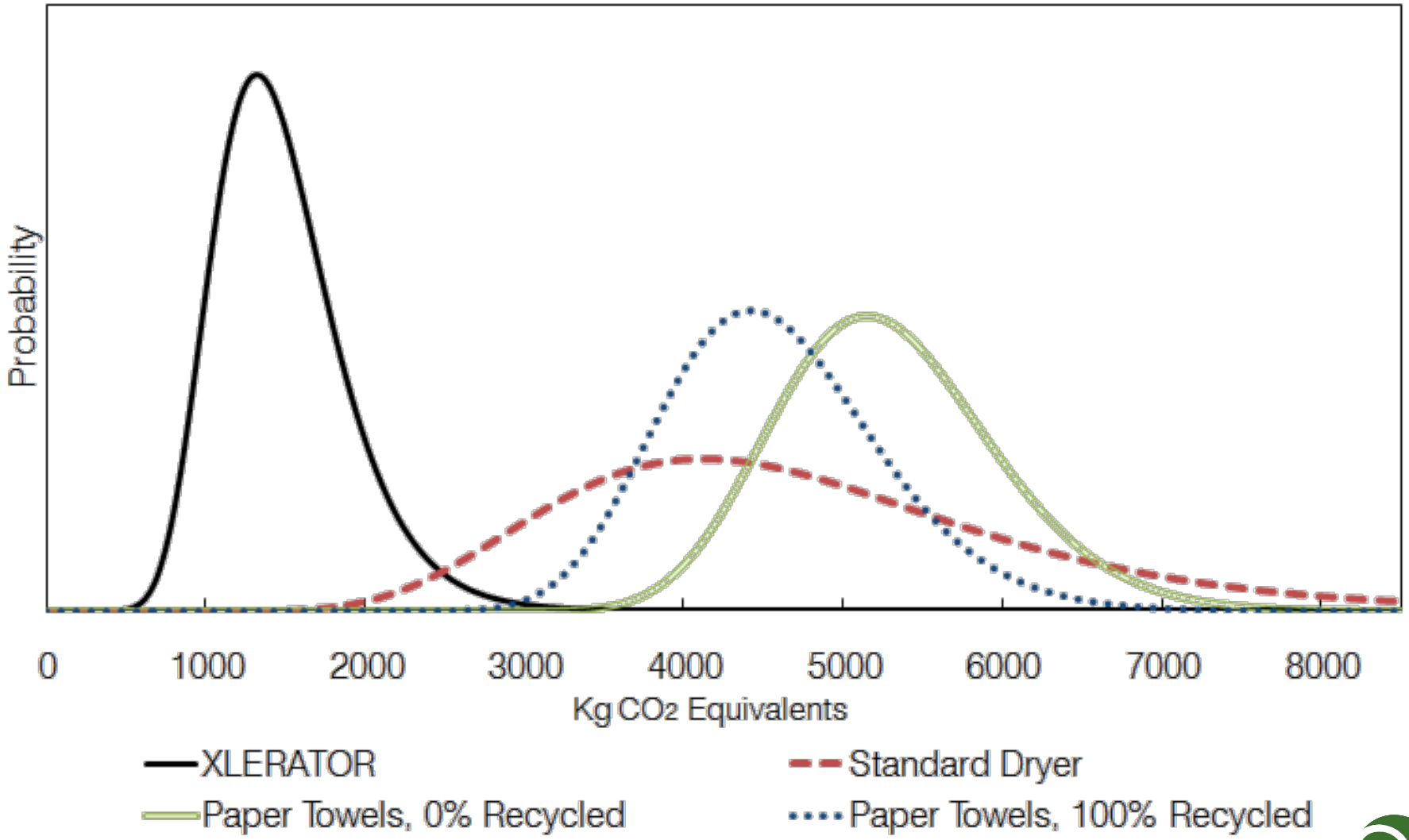
Function: dry hands

Functional Unit:
260,000 pairs of hand dried

Objective:

Compare the climate change impact of three types of hand dryers

Probability-based LCA: hand dryer



New tendencies and expansions of classic LCA

Tendencies and expansions of classic LCA

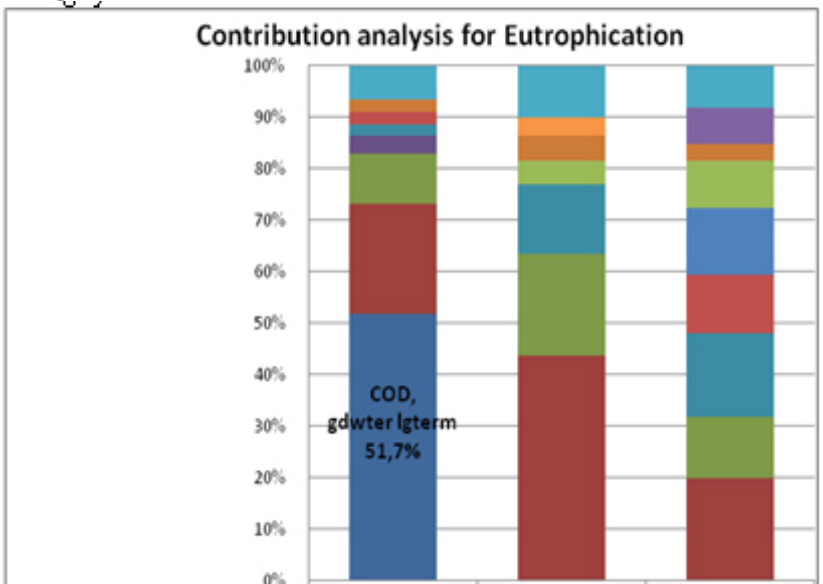
- Social LCA (S-LCA)
- Triple-bottom line sustainability assessment (LCSA)
- Real-time LCA using supply chain data and communication, automated (e.g. via SAP etc.)
- Dynamic LCA: integration of temporal variability
- LCA for territories and organisations
- Planetary boundaries: concept introducing absolute vs. relative sustainability, e.g. for normalisation

Policy and global harmonisation

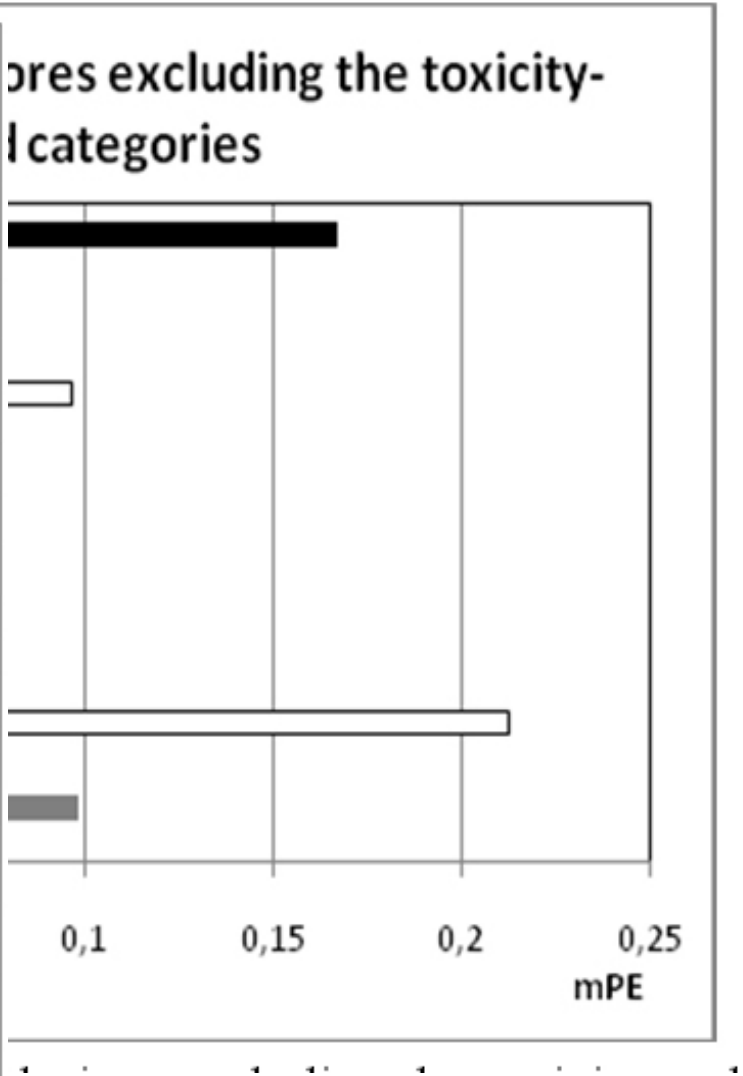
Consensus and harmonisation

- ISO standardisation
- UNEP-SETAC's work for global consensus and dissemination
- Harmonisation efforts on EU level (ILCD handbook series and database)

Consensus and harmonisation



	CML 2001	EDIP 2003	ReCiPe 2008
Others	6,5%	10,0%	8,2%
Phosphorus, river		3,5%	
Nitrate, groundwater			7,0%
NOx, air, low pop.	2,4%	5,1%	3,3%
Nitrate, river		4,6%	9,1%
Nitrogen, orgbd, gdwter lgterm			13,1%
Ammonium, ion, gdwter, lgterm	2,3%		11,4%
Phosphate, gdwater, lg-term	2,2%	13,5%	16,2%
COD, river	3,5%		
NOx, air high pop.	9,7%	19,8%	11,8%
NOx, air unsp.	21,5%	43,6%	20,0%
COD, gdwter lgterm	51,7%		



UNEP/SETAC Life Cycle Initiative harmonisation efforts

Mainstreaming the use of life cycle approaches, increasing the accessibility of cost-effective, robust methodologies and tools based on reliable data and global guidance:

- Sustainability Approaches
- Environmental life cycle impact assessment indicators [Flagship 1b]
- LCA of Organisations [Flagship 1c]
- Data and database management [Flagship 2a]
- Global Principles and Practices for Hotspot Analysis [Flagship 3a]

European Union harmonisation efforts

Drivers for an internationally co-ordinated approach

- Global environmental problems
- Product life cycles are global
- Assure quality and robustness
- Coherent sustainable consumption and production policies and instruments
- Avoid unnecessary costs
- Improve acceptance
- Avoid misleading claims

International Reference Life Cycle Data System (ILCD)

Robust, quality-assured LCAs in the private and public sectors

ELCD Data Network

- Network of consistent and quality-assured LCI data
- Inline with ILCD Handbook
- Open for all to join, providing data under own conditions
- Decentralized with register of available data

ILCD Handbook

- Technical guidance documents inline with ISO 14040 series
- scope-dependent applications and supporting tools
- Review procedure
- Recommendations for LCIA including factors
- Documentations and nomenclature

NEW: Ecological Footprint for

- Organisations
- Products

European policy (examples)

A resource-efficient Europe – Flagship initiative of the Europe 2020 Strategy, 2011:

Roadmap to a Resource Efficient Europe (2011): common methodological approach to enable Member States and the private sector to assess, display and benchmark the environmental performance of products, services and companies based on a comprehensive assessment of environmental impacts over the life-cycle ('environmental footprint').

Building the Single Market for Green Products, 2013:

Commission Communication (2013)196 final and related Recommendation (2013/179/EU) on Product Environmental Footprint and Organisation Environmental Footprint have the objective to "improve the availability of clear, reliable and comparable information on the environmental performance of products and organisations to all relevant stakeholders, including to players along the entire supply chain."

Labels and certifications using LCA

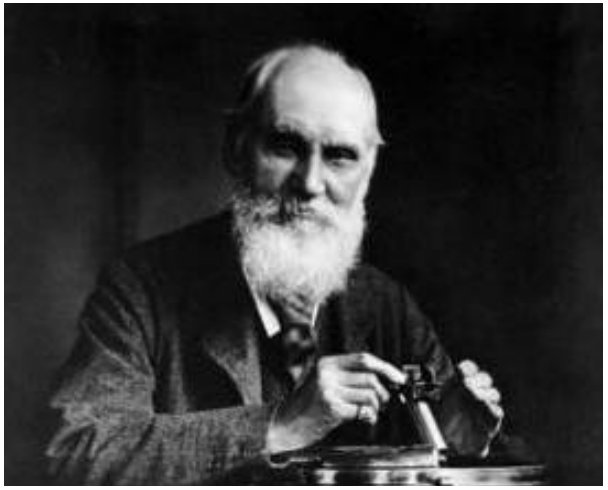
- Sustainable buildings LEED v4: integration of life cycle thinking, LCA-based data and criteria, points for complete building LCA, …
- French Grenelle: obligatory, LCA-based labelling of consumer products for impacts on:
  1. Climate change
  2. Water impacts (pollution and consumption)
  3. Biodiversity

Footprint or LCA?

Why LCA?

"If you cannot *measure* it, you cannot *improve* it"

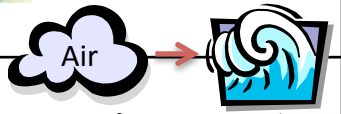
(Lord Kelvin)

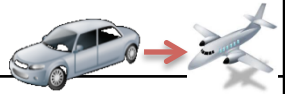


Sustainable decisions: Avoid problem shifting!

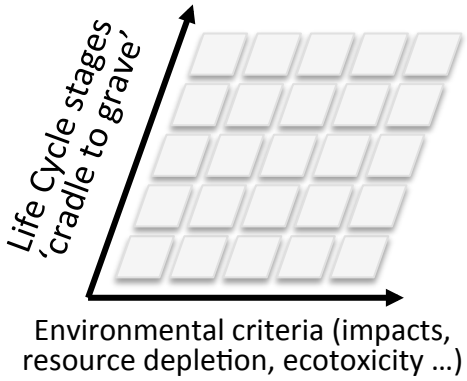
Shifting	Example
in *time*	Recycling products containing heavy metals
in *space*	Exporting hazardous waste
to other *substances*	Replacing zinc gutters with PVC gutters
to other *compartments*	Incinerating waste containing heavy metals
to other *problems*	Reducing acidifying emissions by increasing GHG
to other *consumption pattern*	Spending automobile savings on plane travel
Cancelling out *efficiency* gains by increasing size	Using ever more powerful automobiles even if more efficient
Prioritizing actions with a limited scope	Using expensive technologies to treat contaminated soil

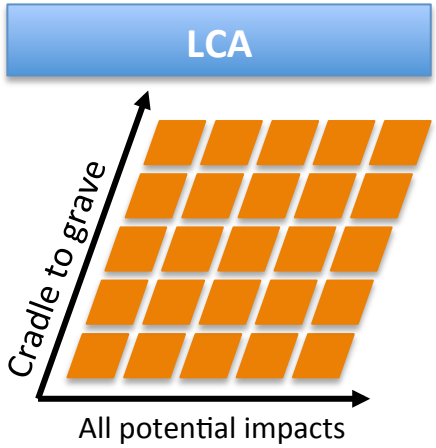


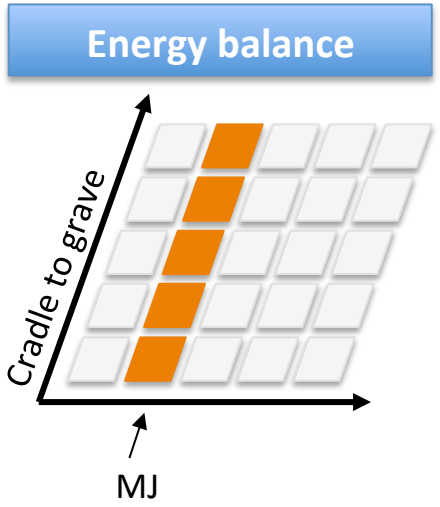



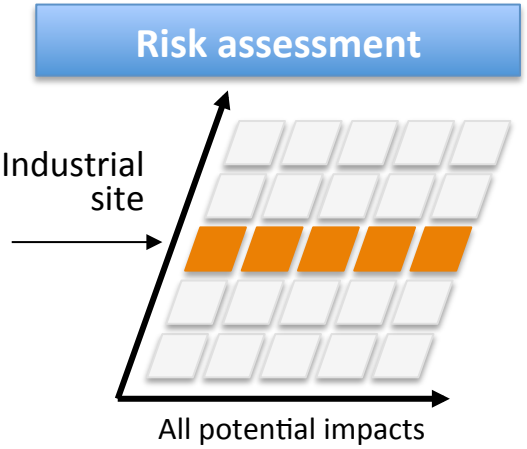



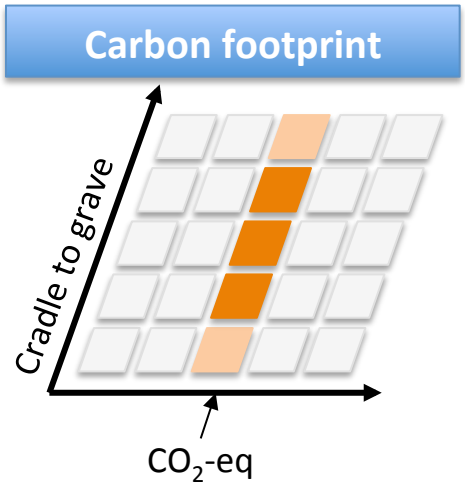
Environmental assessment & LCA

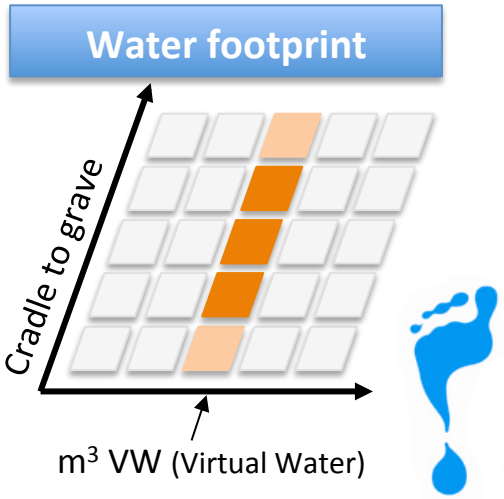




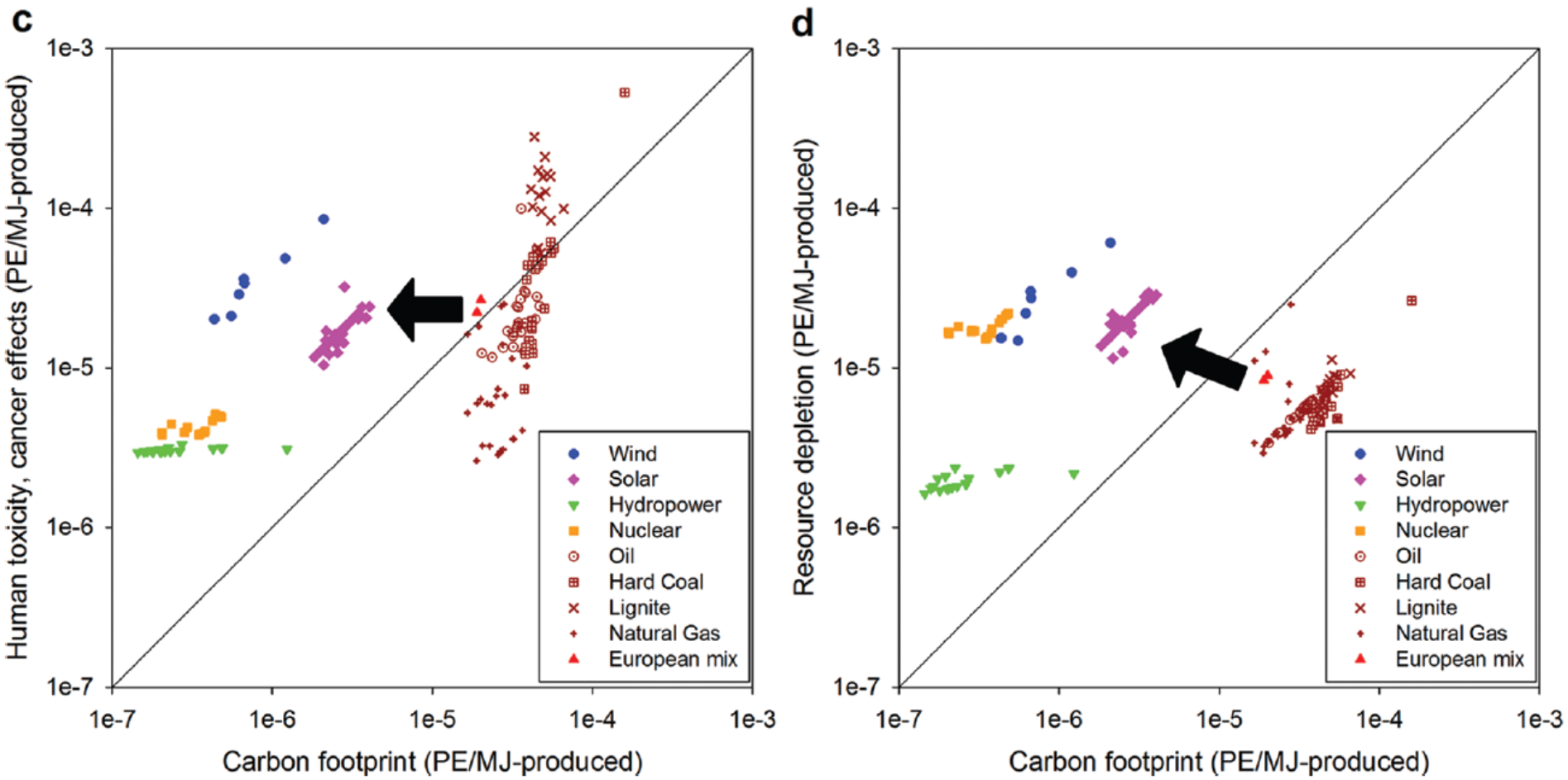








Isn't climate change a proxy for all impact categories anyway?



Laurent A, Olsen SI, Hauschild MZ (2012): Limitations of Carbon Footprint as Indicator of Environmental Sustainability. Environ. Sci. Technol. 46, 4100−4108.

Excursus: The concept of "Spaceship Earth"

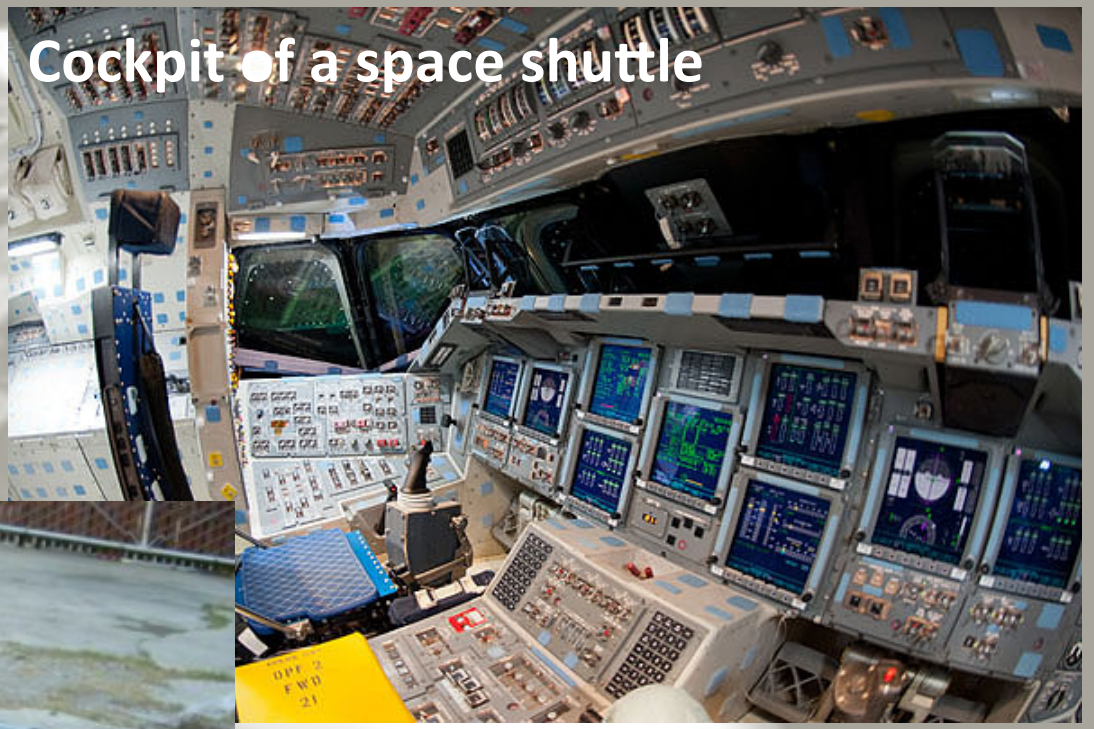
Buckminster Fuller "Operating Manual for Spaceship Earth" (1963):

- Earth is a spaceship and we are all astronauts.
- Earth as a "mechanical" vehicle that requires maintenance, otherwise it will malfunction.
- The sun is our only energy source.
- We cannot re-supply the resources we have on board.

Marshall McLuhan (1965):
"There are no passengers on Spaceship Earth.
We are all crew."

Excursus: The concept of “Spaceship Earth”

Who are the pilots?



Thank you for your attention!

Thank you very much!

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