SVENSKA ARALSJÖSÄLLSKAPET

Swedish Aral Sea Society

Quantification of sustainability

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Measuring resource flows

Björn Frostell, Swedish Aral Sea Society
Senior Consultant Ecoloop AB, Stockholm
former Professor in Industrial Ecology, KTH, Stockholm
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Sustainable Development and Sustainability Science
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UN 2015

SUSTAINABLE DEVELOPMENT GOALS

2030


1 NO POVERTY
2 ZERO HUNGER
3 GOOD HEALTH AND WELL-BEING
4 QUALITY EDUCATION
5 GENDER EQUALITY
6 CLEAN WATER AND SANITATION
7 AFFORDABLE AND CLEAN ENERGY
8 DECENT WORK AND ECONOMIC GROWTH
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE
10 REDUCED INEQUALITIES
11 SUSTAINABLE CITIES AND COMMUNITIES
12 RESPONSIBLE CONSUMPTION AND PRODUCTION
13 CLIMATE ACTION
14 LIFE BELOW WATER
15 LIFE ON LAND
16 PEACE, JUSTICE AND STRONG INSTITUTIONS
17 PARTNERSHIPS FOR THE GOALS
SUSTAINABLE DEVELOPMENT GOALS

Not only Climate – ”New” Global Threats

UN Report May 2019: Nature’s Dangerous Decline ‘Unprecedented’; Species Extinction Rates ‘Accelerating’

Current global response insufficient; Transformative changes’ needed to restore and protect nature; Opposition from vested interests can be overcome for public good; Most comprehensive assessment of its kind; 1,000,000 species threatened with extinction

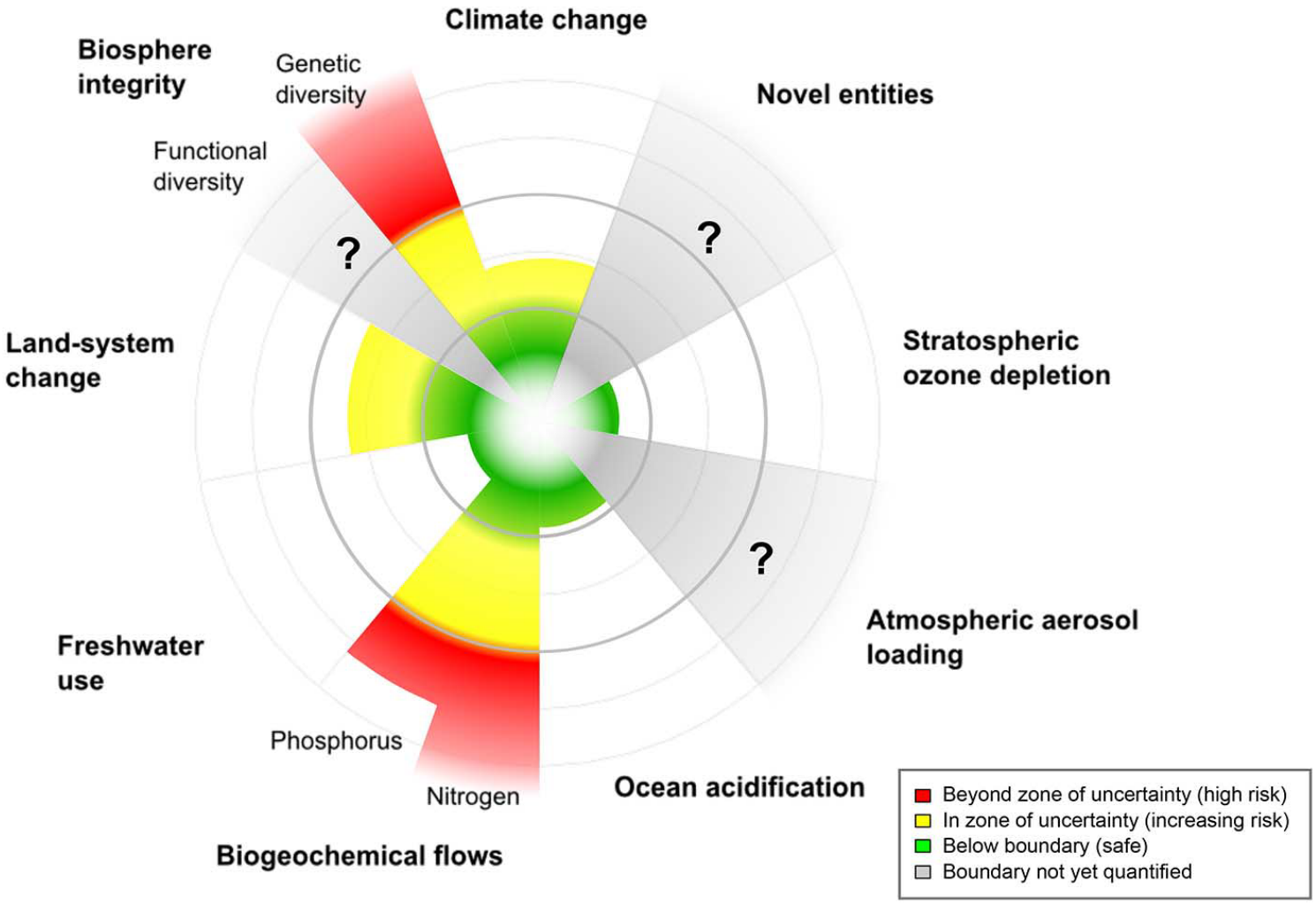
https://www.un.org/sustainabledevelopment/blog/2019/05/nature-decline-unprecedented-report/

60 Per cent of all Vertebrates Extinct since 1970 - ”A New Global Deal for Nature and People Urgently Needed”

https://www.wwf.ch/sites/default/files/doc-2018-10/LPR2018_Full%20Report%20Pages_22.10.2018_0.pdf

A well-known approach

The Planetary Boundaries



Source: Steffen et al. (2015

Limitations of the Planetary Boundary Concept

The Planetary Boundary Concept focuses on emissions from the Human Activity System and does not consider primary resource supply and manmade stocks that have been built up in cities and other infrastructure. Thus, a comprehensive approach requires that both inflows to, outflows from and stocks being built up (or are being eroded) are considered in discussions of human physical resource use

Some sustainability issues on the agenda

Resource supply challenges (economic challenges)

- Food Supply
- Water Supply
- (Sustainable) Energy Supply
- Goods and Services Supply

Ecologic challenges

- Climate change
- Biodiversity
- Waste and wastewater management
- Toxicity (biochemical interference)
- Plastics

Social Challenges

- Income distribution
- Gender challenges
- Education

Challenges with considerable connection to engineering

Broad sustaina-bility oriented challenges

How do we measure?

Follow-up of sustainability-current approaches

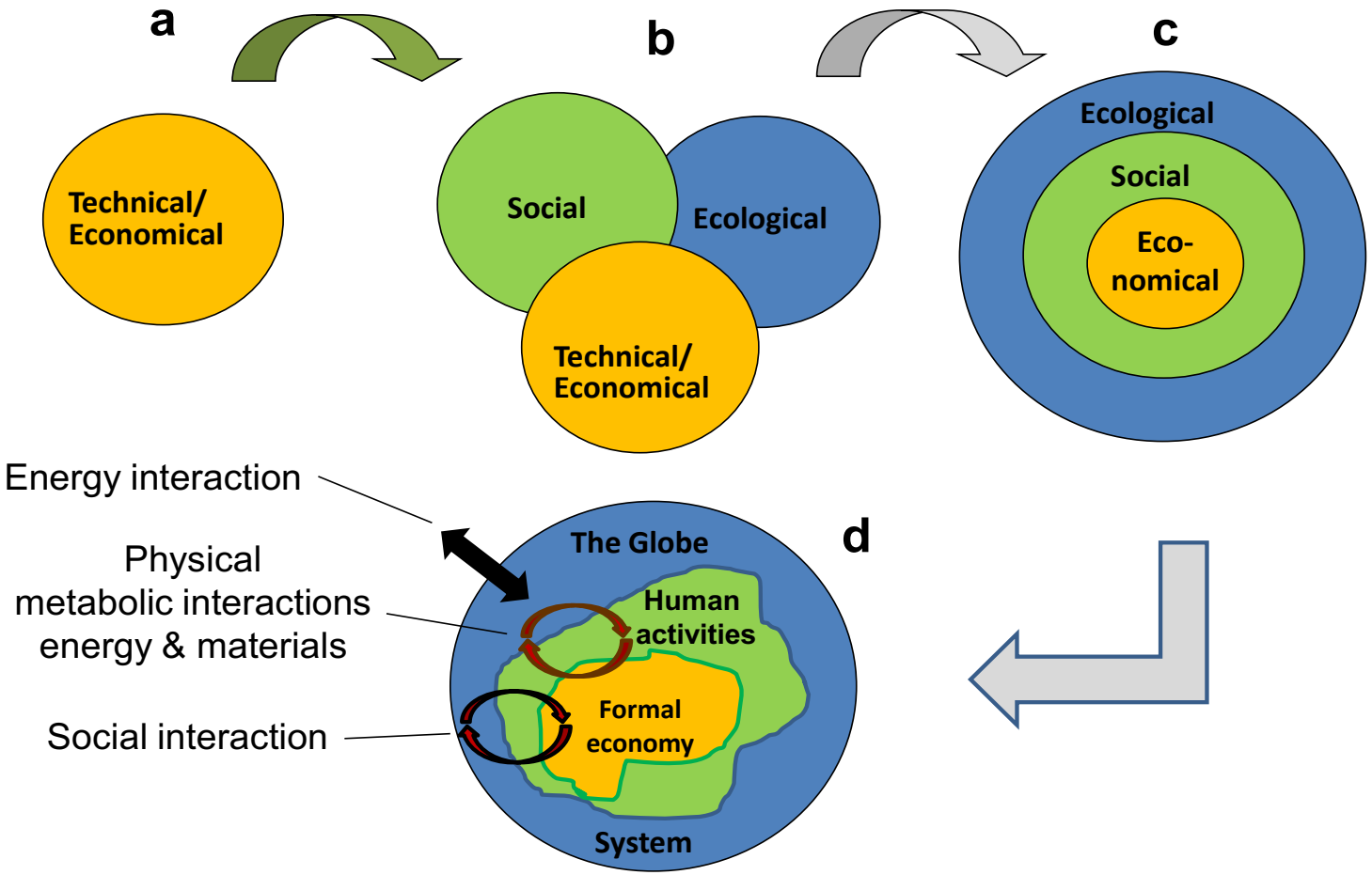
- **Countries typically have established national sustainable development goals and make national (annual) reports to the UN on how the actual national performance is developing. More and more, countries start to follow-up against the UN SD goals for 2030.**

- **There is still very much to do at other administrative levels (than the national), such as provincial, municipal, corporate and family/individual level in order to support and verify the national follow-up procedures. Methods, standards and reporting varies a lot from country to country.**

- **Still, financial accounts dominate the discussion, since economic development is still the main focus in essentially all countries on earth**

Ecological sustainability as a platform for human activity, as well as social and economic sustainability

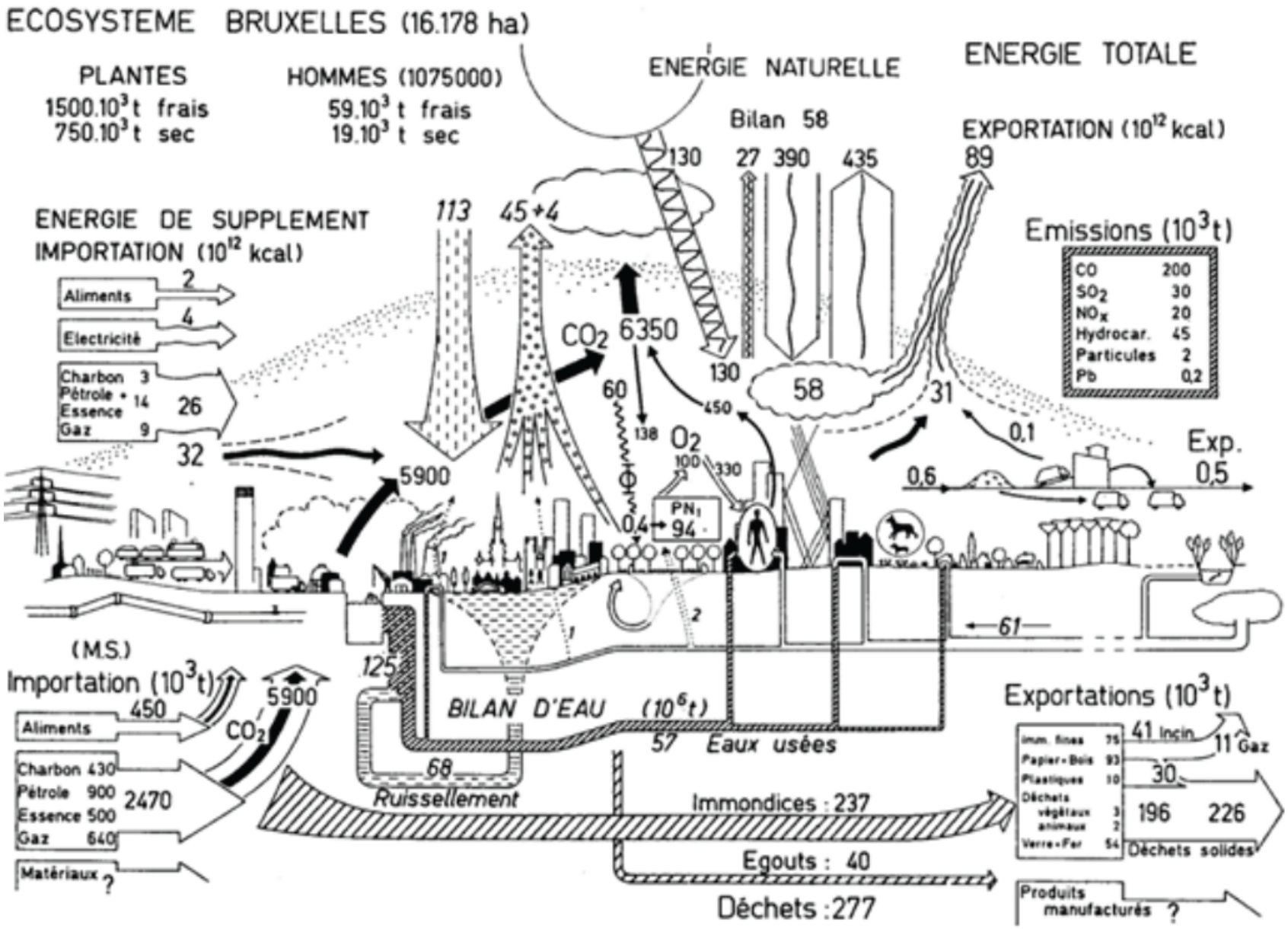
Sustainable Development – A thought Path



cf. Frostell, 2013

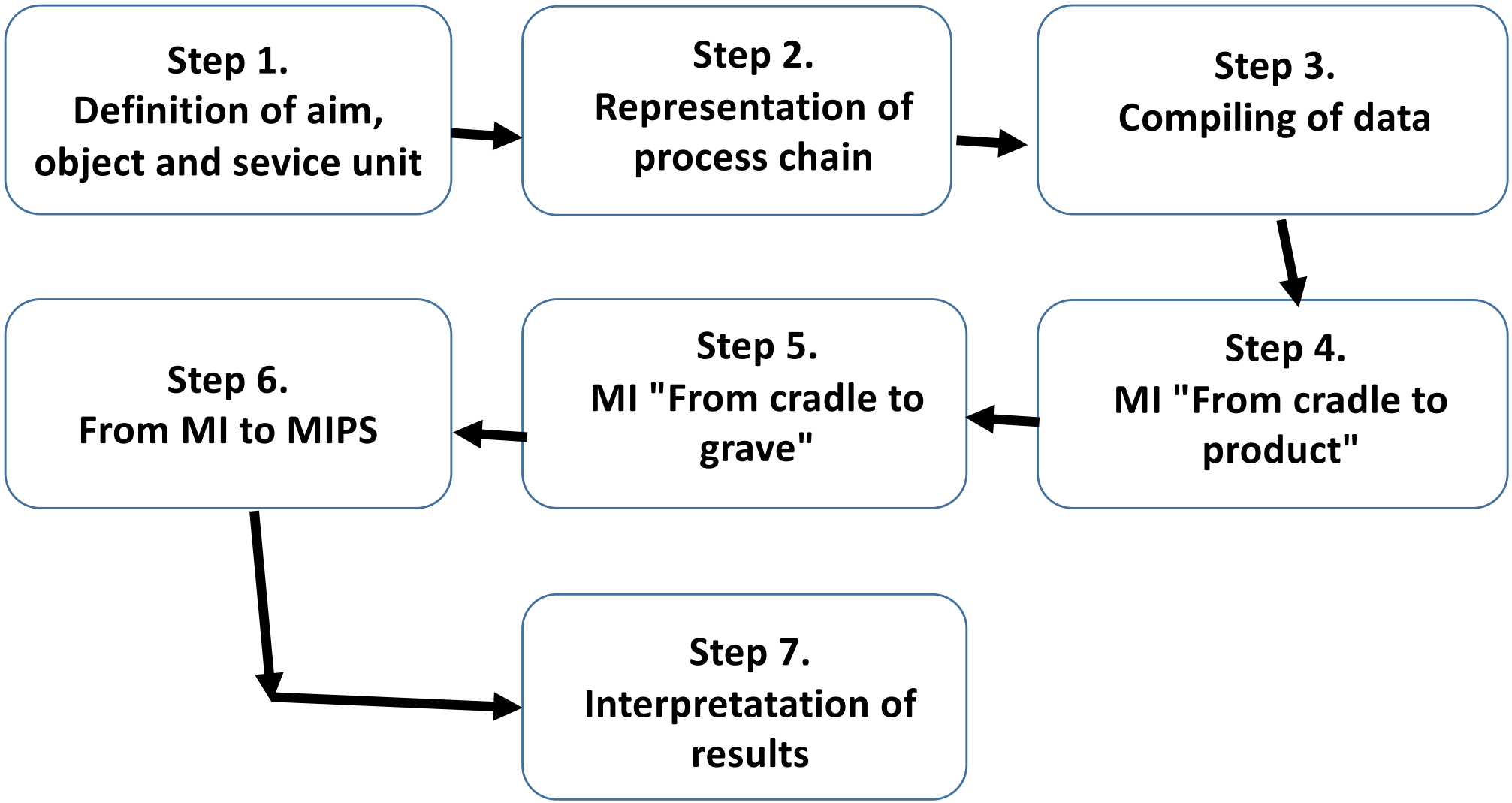
Life on Earth Rests on Ecosystem Functionality!

Early attempt to a metabolic approach



Source: Duvigneaud and Denaeyer-De Smet 1977. ***The urban metabolism of Brussels, Belgium in the early 1970s.***

MIPS - Material Input Per unit of Service - principle



Source: Wuppertal Institute

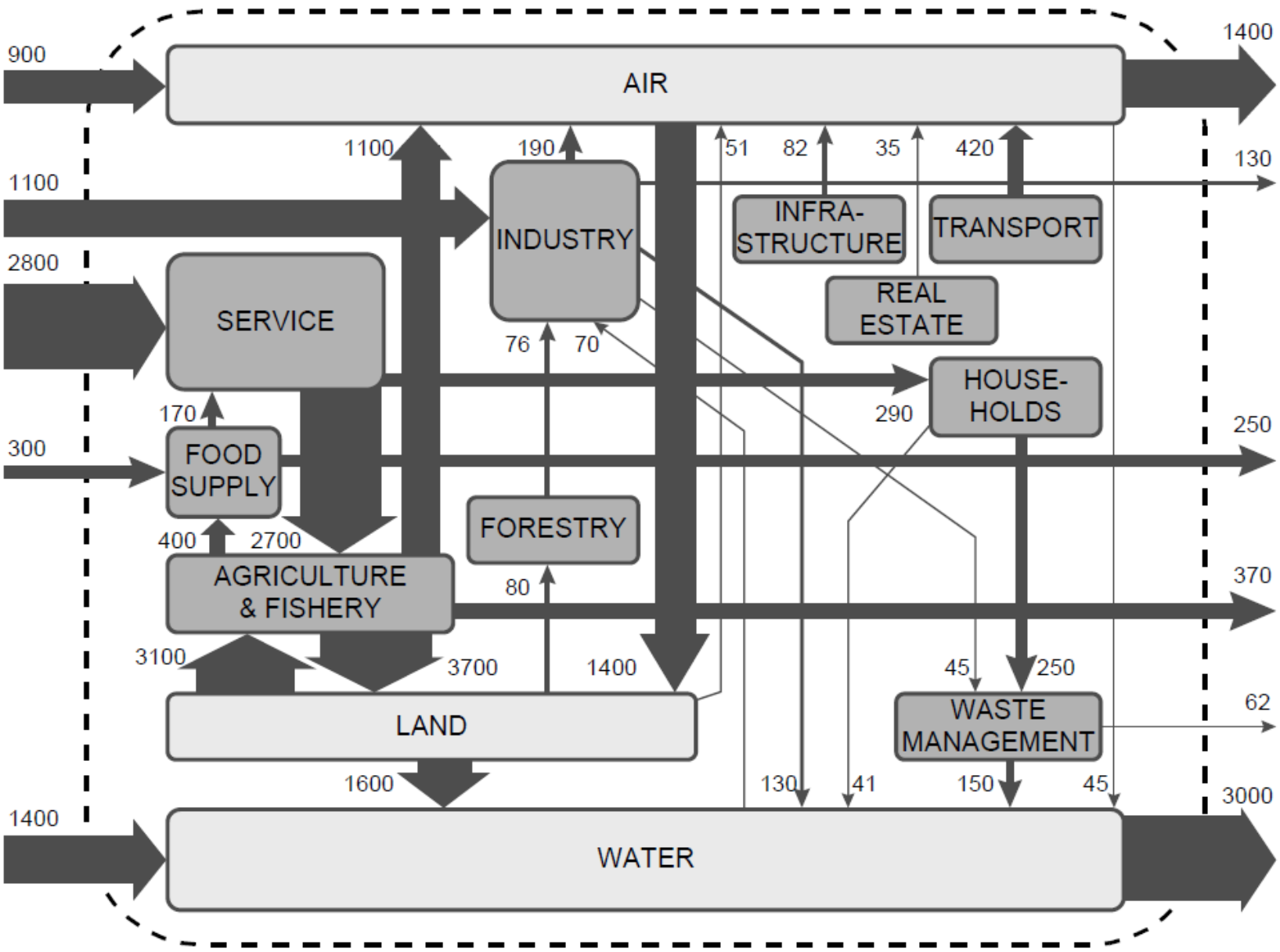
MIPS - Material Input Per unit of Service - example

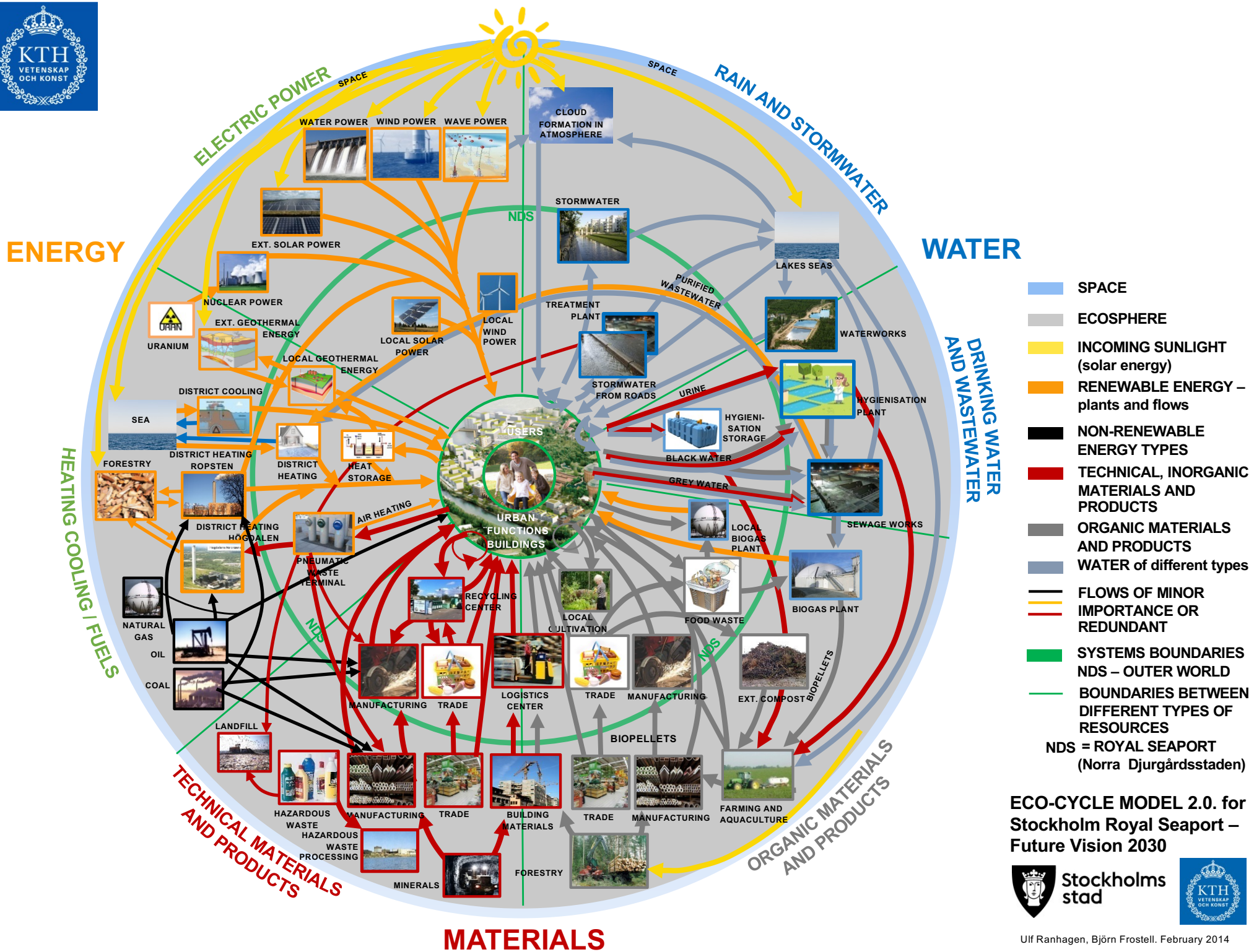
MI factors for electric power are, for example:

	Abiotic Resources [t/MWh]	Biotic Resources [t/MWh]	Water [t/MWh]	Air [t/MWh]	Earth movements [t/MWh]
Electric power (public supply, FRG)	4.7	–	83.1	0.6	–
Electric power (industrial generation, FRG)	2.67	–	37.9	0.64	–
Electric power (European OECD-countries)	1.58	–	63.8	0.425	–

Source: Ritthof, Rohn and Liedtke (2002);
https://epub.wupperinst.org/frontdoor/deliver/index/docId/1577/file/WS27e.pdf

Material flow accounts for municipalities
The ComBox Model





SPACE

ECOSPHERE

INCOMING SUNLIGHT (solar energy)

RENEWABLE ENERGY – plants and flows

NON-RENEWABLE ENERGY TYPES

TECHNICAL, INORGANIC MATERIALS AND PRODUCTS

ORGANIC MATERIALS AND PRODUCTS

WATER of different types

FLOWS OF MINOR IMPORTANCE OR REDUNDANT

SYSTEMS BOUNDARIES
NDS – OUTER WORLD

BOUNDARIES BETWEEN DIFFERENT TYPES OF RESOURCES

NDS = ROYAL SEAPORT (Norra Djurgårdsstaden)

ECO-CYCLE MODEL 2.0. for Stockholm Royal Seaport – Future Vision 2030

Stockholms stad

Ulf Ranhagen, Björn Frostell. February 2014

Environmental Systems Analysis (ESA)

Important tools

Scenario Development and Evaluation

SEA - Strategic Environmental Assessment

EIA - Environmental Impact Assessment

LCA - Life Cycle Assessment

LCC - Life Cycle Costing

CBA - Cost/Benefit Analysis

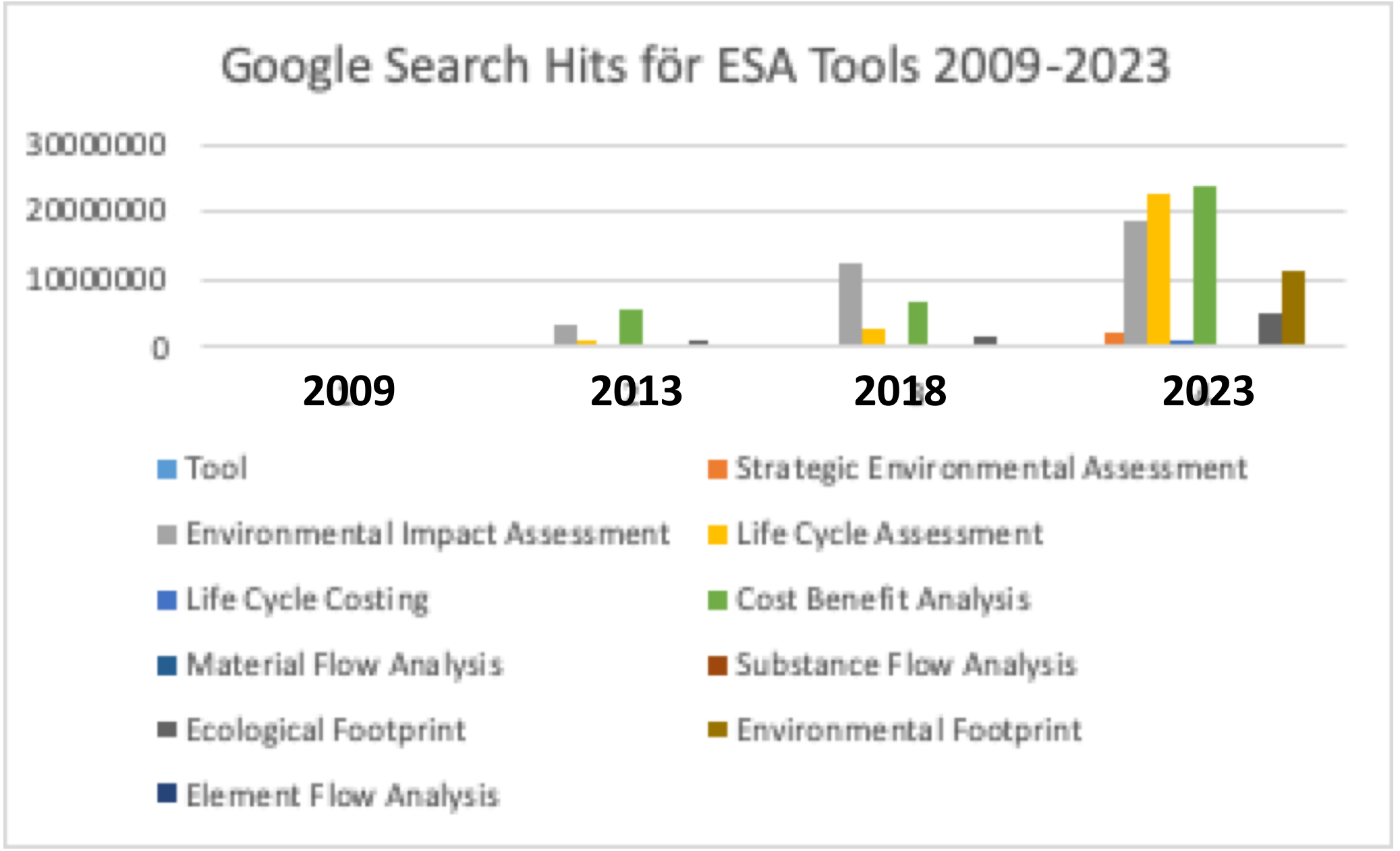
MFA - Material Flow Analysis

SFA - Substance Flow Analysis

PIOTs – Physical Input-Output Tables

EF – (Ecological) footprints

ISA – Integrated Sustainability Assessment



Source: Personal Google searches in September 2009, 2013, 2018 and 2023

Recent alternative footprint approaches

Energy Footprint

1. According to the EF methodology
2. According to LCI methodology
3. Other approaches

Carbon Footprint

GFN (2018) The Carbon Footprint, (www.footprintnetwork.org/en/index.php/GFN/

The Water Footprint

Hoekstra A.Y. & Hung P.Q., 2005. Globalization of water resources: international virtual water flows in relation to crop trade. *Global Environmental Change* (15), pp. 45-56.

Hoekstra A.Y. (2008). Human appropriation of natural capital: A comparison of ecological footprint and water footprint analysis. *Ecological Economics*, 68, 1963-1974.

Quantification of sustainability - an outlook

- **Recent work to quantify sustainability increasingly takes a metabolic approach, seeing human activities in the global economy as a very large organism metabolizing materials and energy. This is reflected in words such as circular economy, eco-cycles, ecologic approach, life cycle thinking and systems thinking**

- **It is important to understand that present-day (financial) economy not has been able to adequatly address sustainability. This should be ascribed to its narrow focus on humans and human activities and neglecting a broader approach and broader system boundaries**

- **There is a fantastic task for students to change this…!**

One way of valuing sustainability

Björn Frostell's friend Lars Sörenson hugging a 400 year (?) old Scots Pine tree on Björn's Hälsingland farm, circumference appr. 4 metres, March 2021

Lecture break discussion questions

Which is in your opinion the most relevant parameter to monitor at the global level in order to combat climate change?

Which are in your opinion the most relevant parameters to monitor at the individual and household level in order to support sustainable development?

Thank you!

bjornfrostell@gmail.com