A review of global SUT and IOT for measuring the globalisation and use of natural resources

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Outline

1. Key international sustainability policies
2. Data needs: detailed MR EE IO essential
3. How UN SD can build upon the experiences of the science community
4. Collaborative data and data processing environments
5. Outlook

CML
Institute of Environmental Sciences

TNO

KEY INTERNATIONAL SUSTAINABILITY POLICIES

Policy programs feeding into the UN Sustainable Development Goals

1. SCP

*“the use of services and related products which respond to basic needs and bring a **<u>better quality of life</u>** while **<u>minimizing the use of natural resources</u>** and toxic materials as well as the emissions of waste and pollutants over the life-cycle so as not to jeopardize the needs of future generations*

2. Green Economy

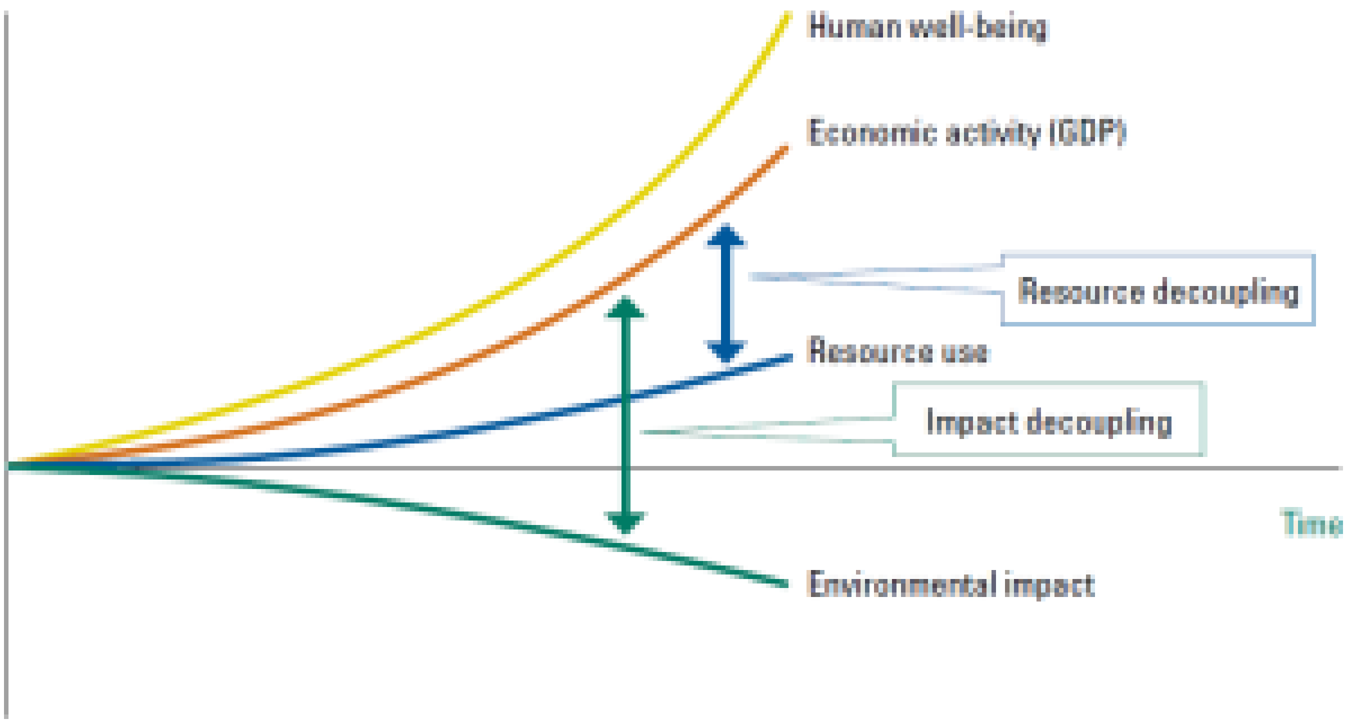
*“one that results in **<u>improved human well-being</u>** and social equity, while significantly **<u>reducing environmental risks and ecological scarcities</u>**”*

3. Resource Efficiency

*using the Earth's limited resources in a sustainable manner while minimising impacts on the environment. It allows us to create more with less and to **<u>deliver greater value</u>** with **<u>less input</u>***

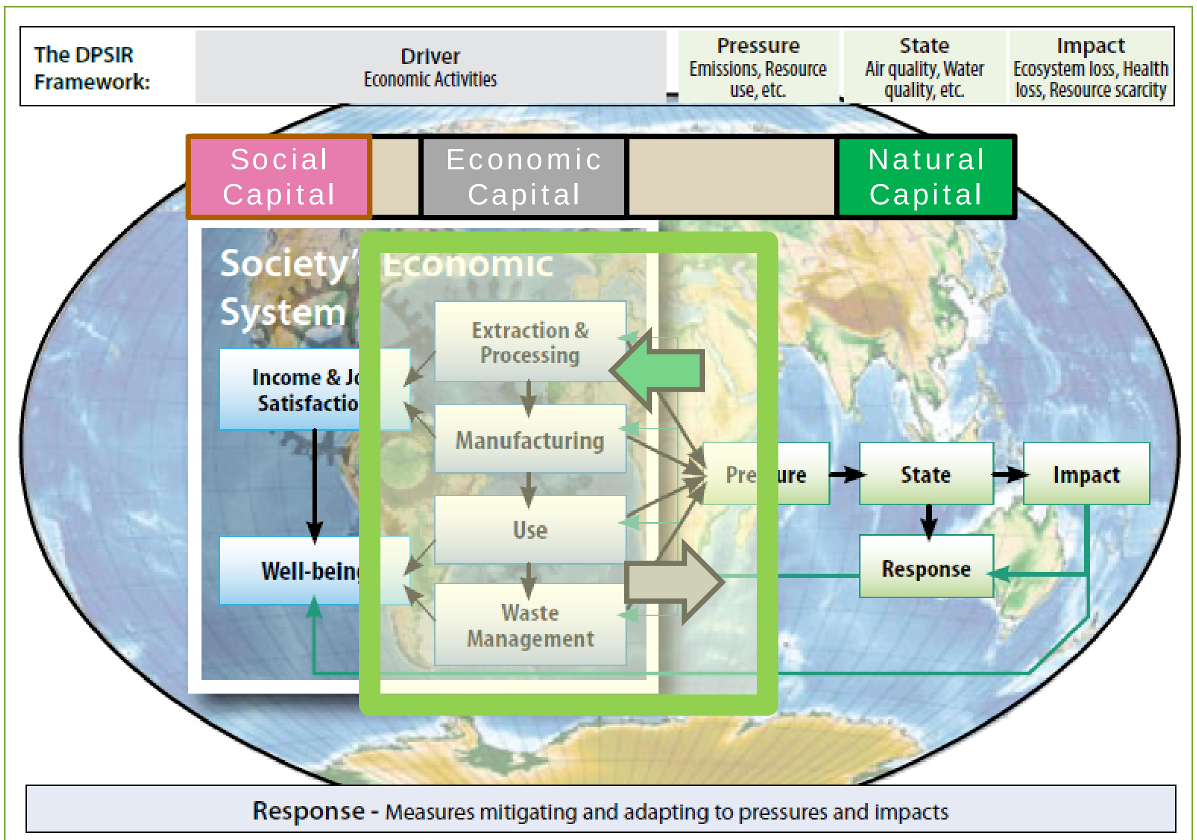
SCP, Resource Efficiency, Green Economy…

All aim at improved human well-being decoupled from resource use and emissions



Basis for data and indicator harmonization: SEEA 2012

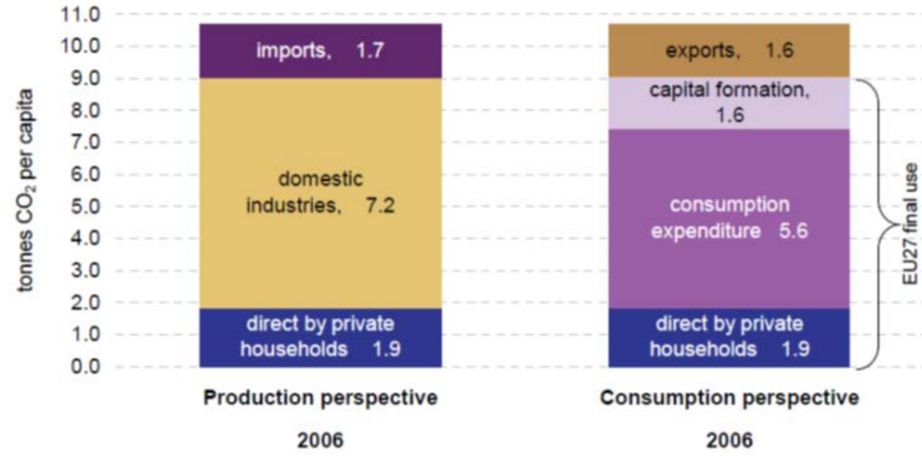
- Natural system and Socio-economic system
- Natural-Economic-Social capital stocks
- Economic relations: (global) SUT/IOT
- Environmental pressures: resource extraction, emissions as (sectoral) extensions



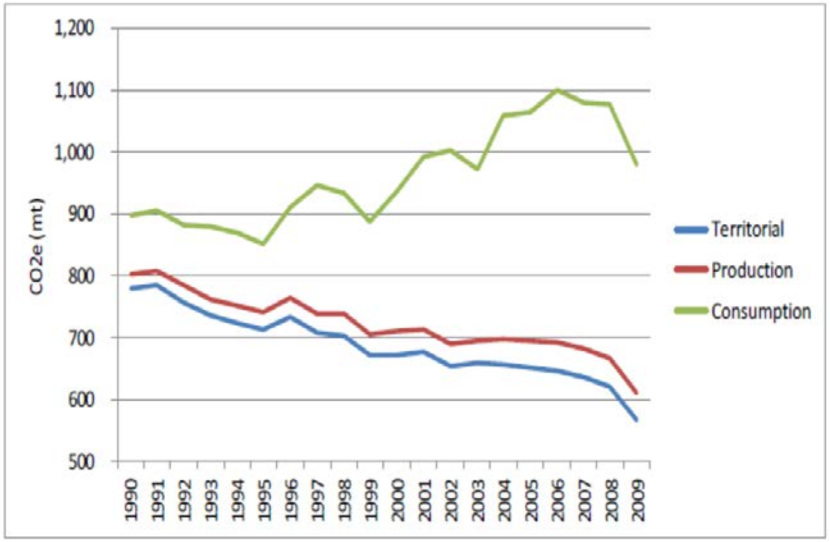
USEFULNESS OF MR EE IO

Relevance of imports and exports

- Eurostat: territorial emissions equal to consumption based emissions



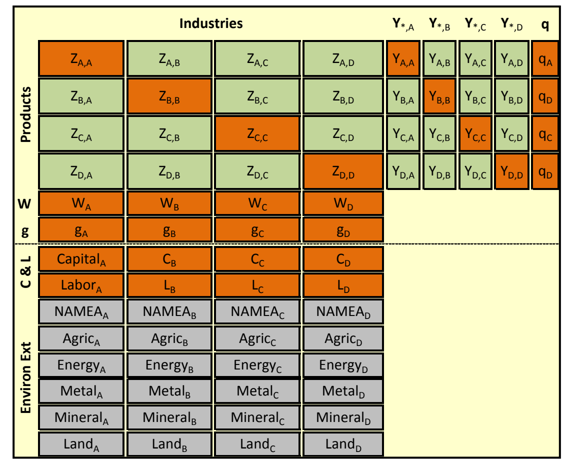
- But such 'domestic technology assumption' forgets trade
  - Blue: UK territorial CO2 emissions
  - Green: UK consumption-based CO2 emissions



Source: Barrett, Lenzen, Le Quere, Peters, Roelich and Wiedmann, 2011

Detailed Multi-Regional EE SUT / IOT = core

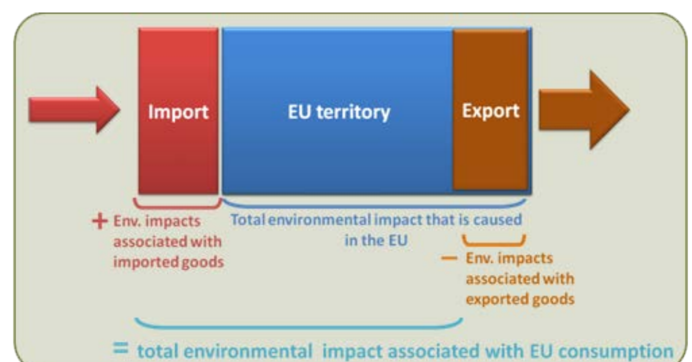
- Global SUT/IOT linked via trade
  - Country SUT/IOT (red)
  - Import/export trade matrices (green)
  - Exensions: emissions, energy, materials, land water (grey)



- Detail in environmentally relevant sectors (agri, energy, resources)

- One consistent dataset for territorial and consumption based assessments

  .



MR EE IO work from the scientific community (1)

1. EXIOBASE consortium (TNO, CML, NTNU, WU)

- Eurostat Data Centre Projects

- Some 15 Million Euro EU FP7 funding (EXIOPOL, CREEA, DESIRE, CARBON CAP)
  - 160 sectors/ 200 product groups per country
  - 43 countries + 5 Rest of Continents (8000 sectors, 10.000 products)
  - Time series based on UN main aggregates developed in DESIRE
  - 40 emissions, 80 resources, land, water, added value and employment
  - …linked to various impact indicators (e.g. GWP)

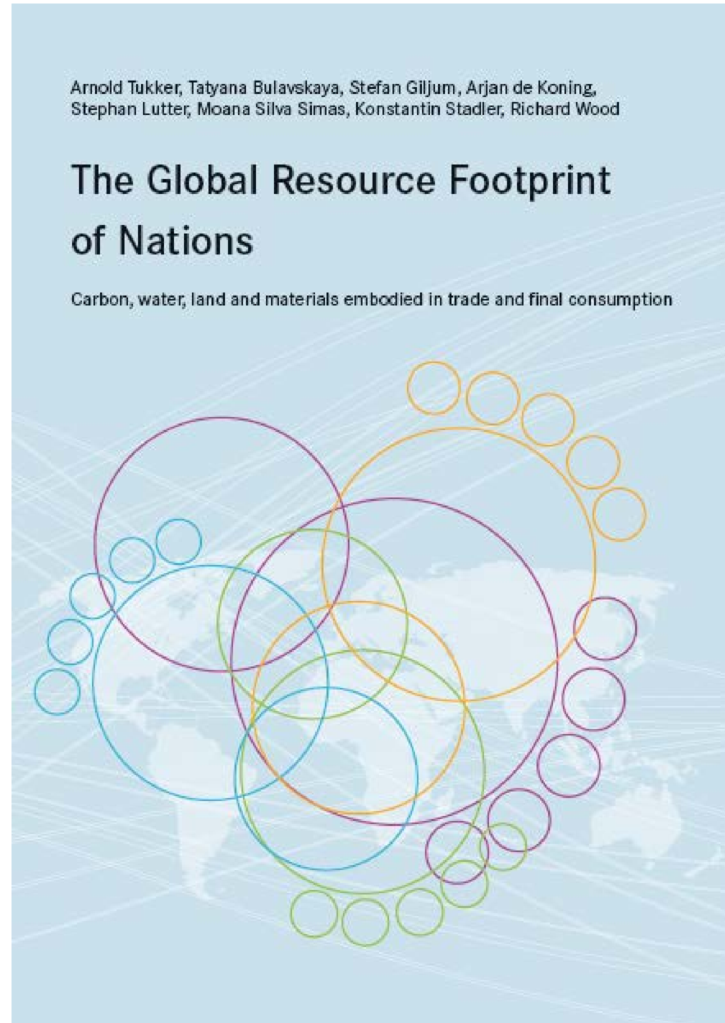
- Work on improved assessment methods (e.g. spatially explicit water and land use impacts, advanced biodiversity impact indicators)

MR EE IO work from the scientific community (2)

2. The University of Sydney
   - Developed the Eora database
     - 187 individual countries
     - Heterogeneous data classification: Countries are represented in their native classification. Total number of sectors ~15,000
     - Continuous time series for the years 1990-2011
     - Large set of environmental indicators for each year (GHG, land, water, employment, biodiversity threats, …)
   - Currently developing a collaborative data processing network (the Industrial Ecology Virtual Laboratory).

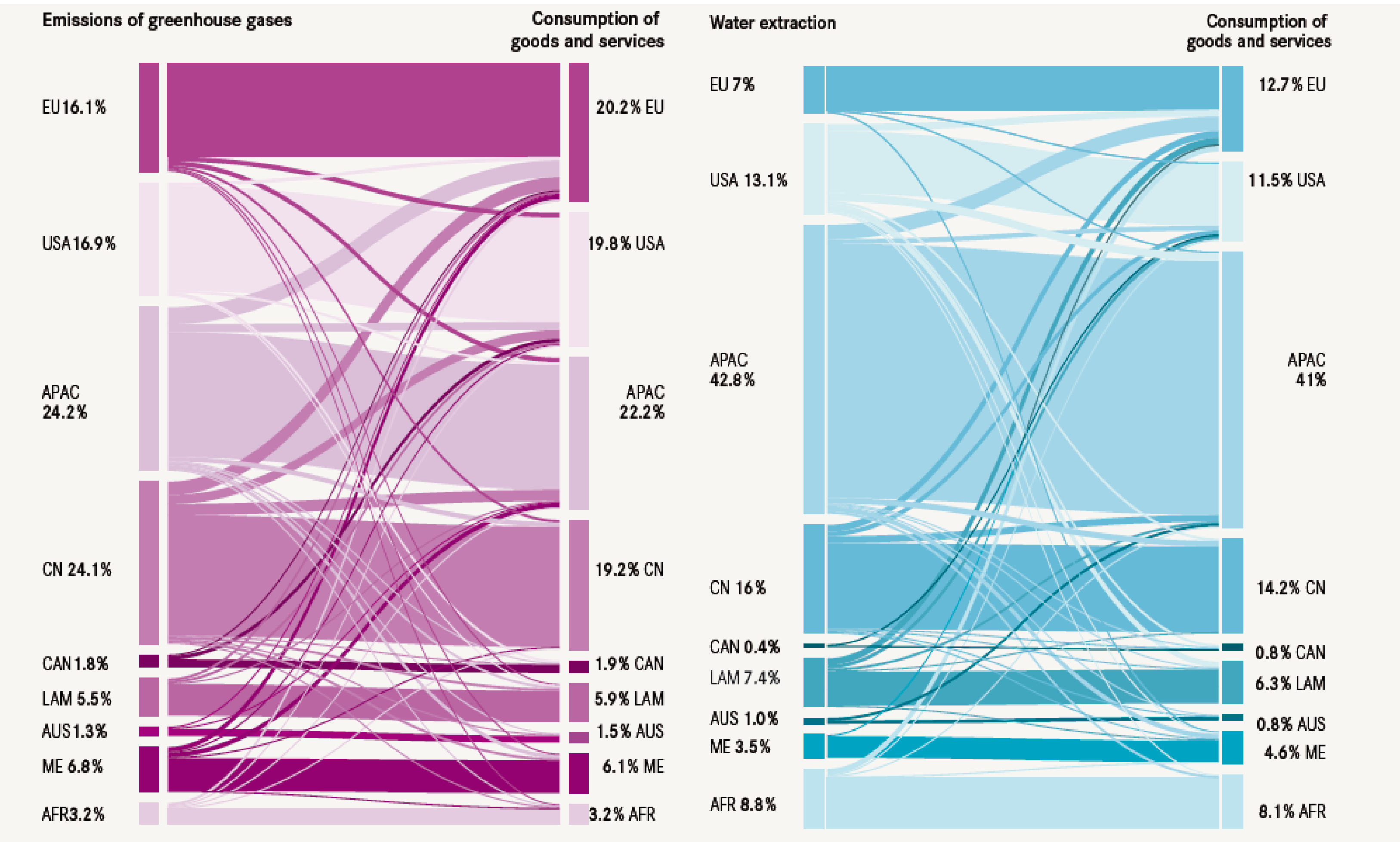
3. Others: economic focus, limited detail in environmental sectors
   - WIOD -> TIVA (RU Groningen, OECD)
   - GTAP (Purdue)
   - GRAM (GwS, based on OECD IOTs)

- Ilustrative results: ***‘The Global Resource Footprint of Nations’***
  - Published at the May 2014 EU Greenweek
  - Carbon, land, water and material footprints of 43 countries
  - Endorsed by FoE Europe and WRF

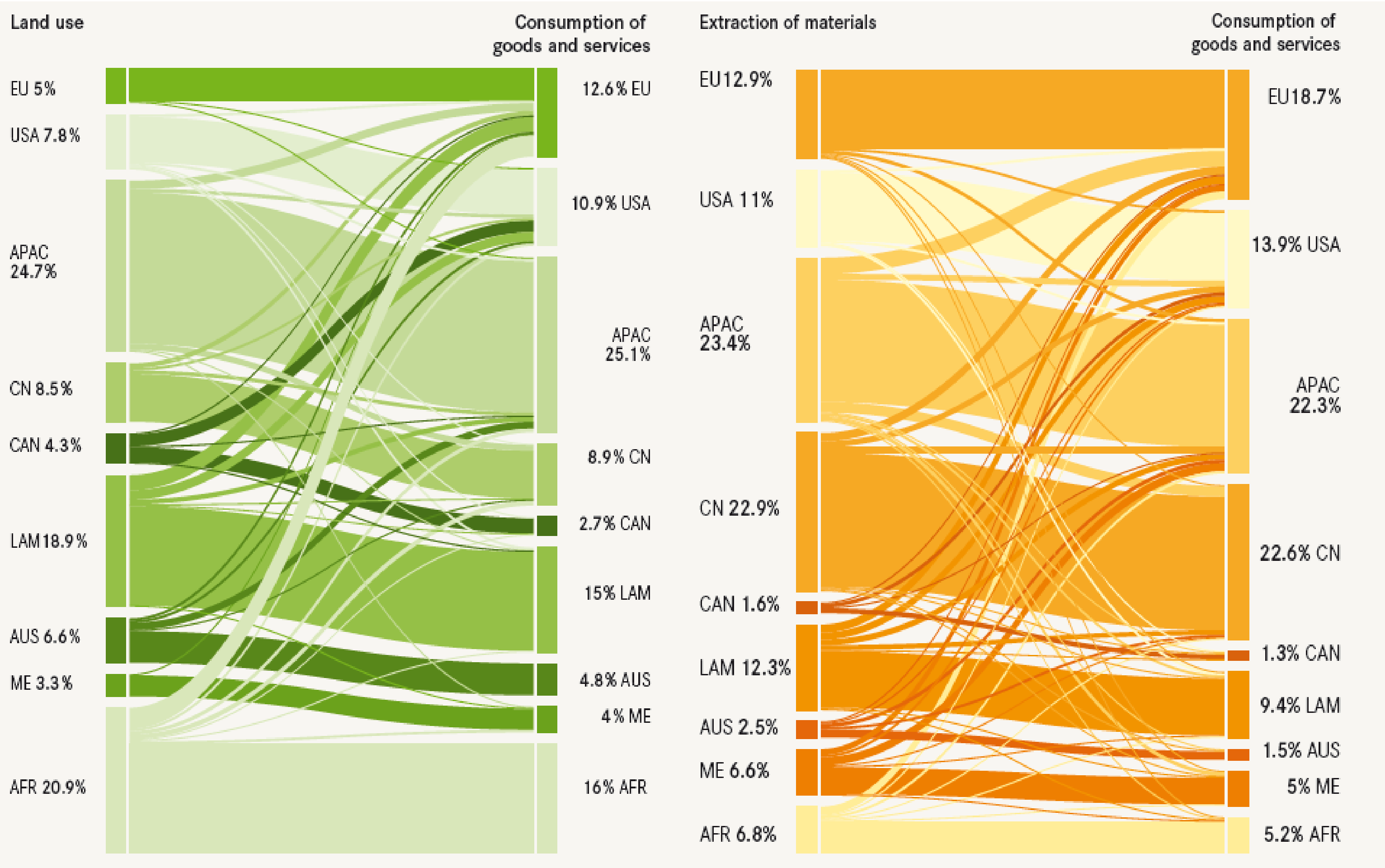


www.exiobase.eu; www.creea.eu

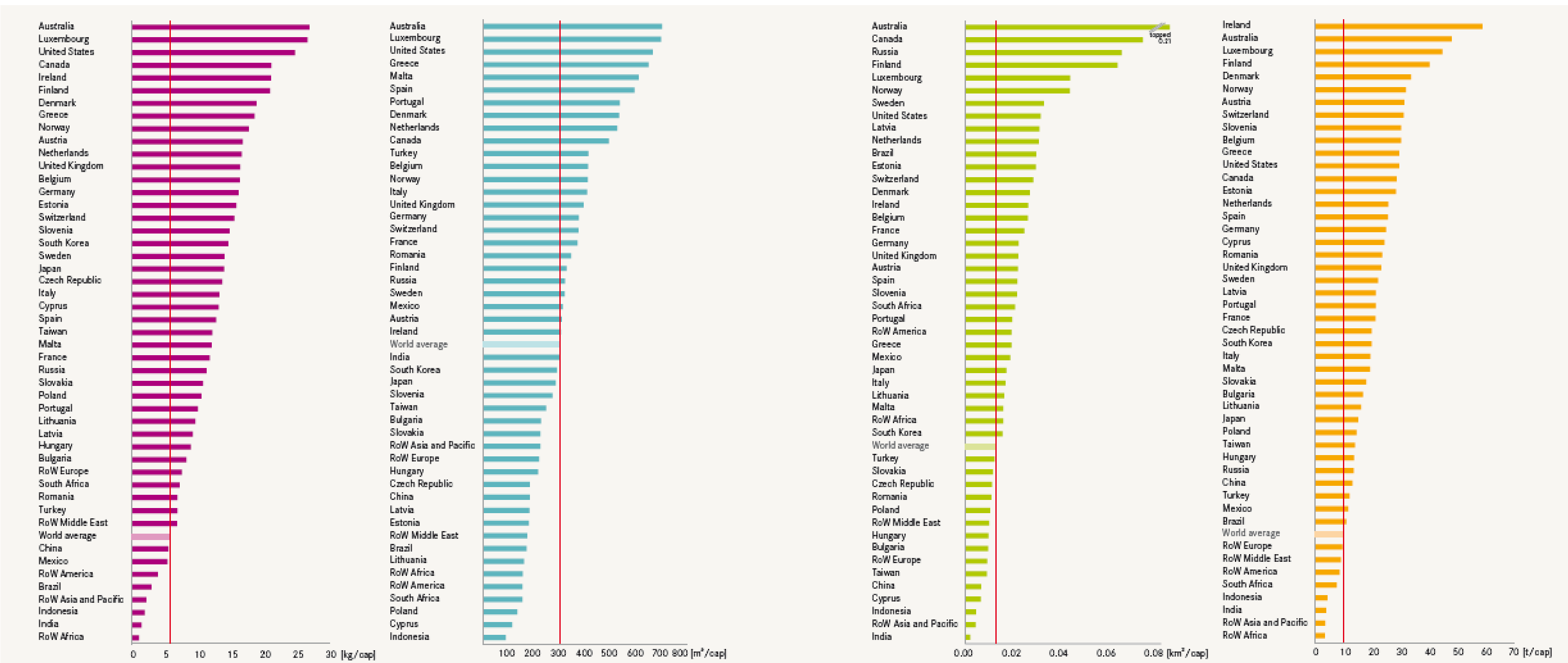
Carbon and water footprints



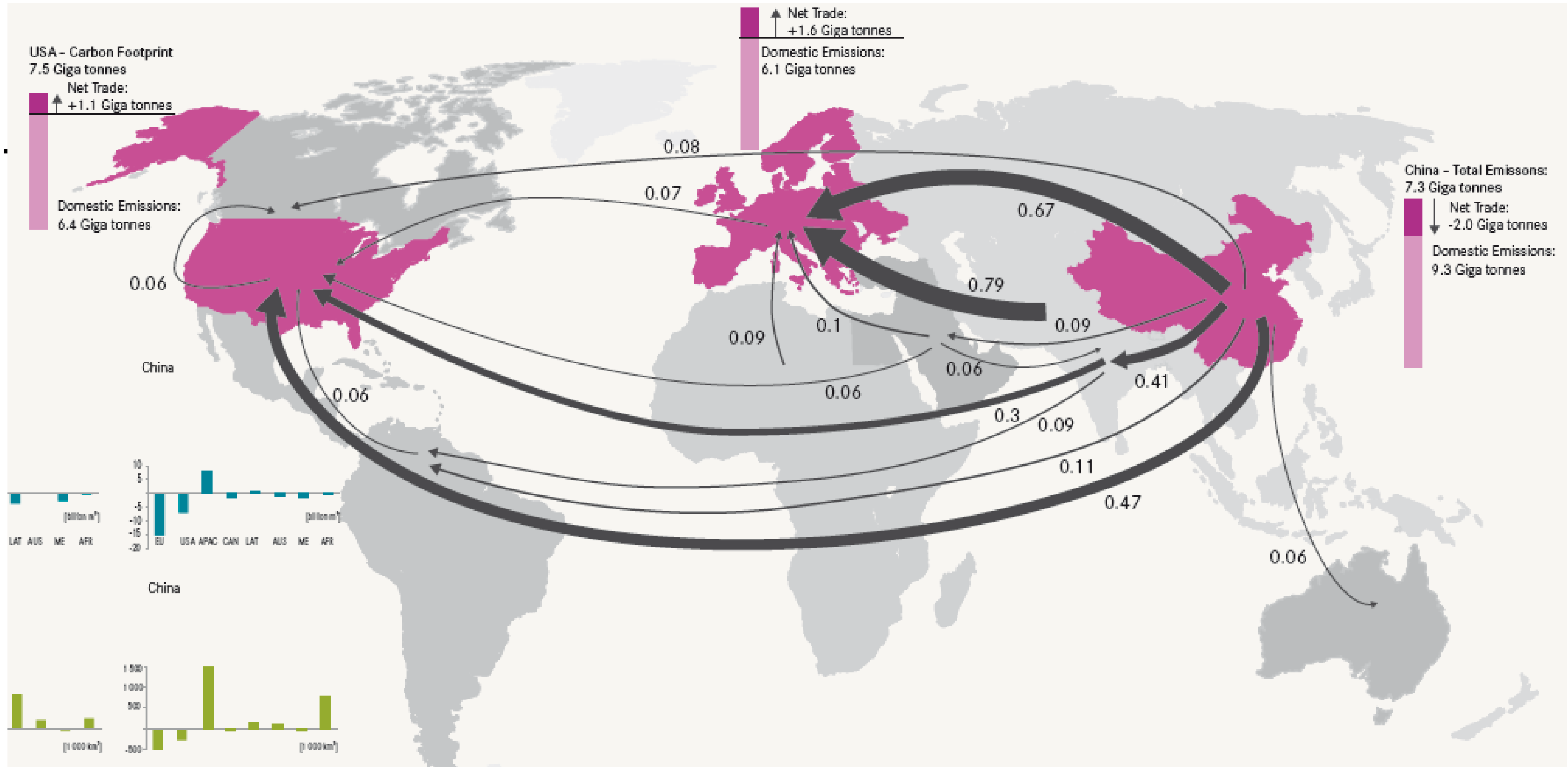
Land and material footprints



Per capita footprints



Trade of embodied carbon



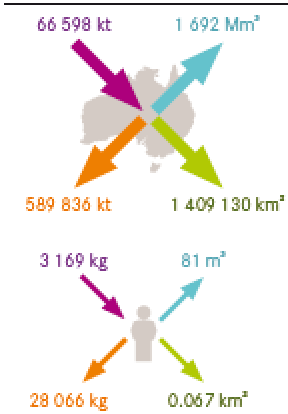
HDI and happiness versus footprints

Country fact sheets

FOOTPRINTS

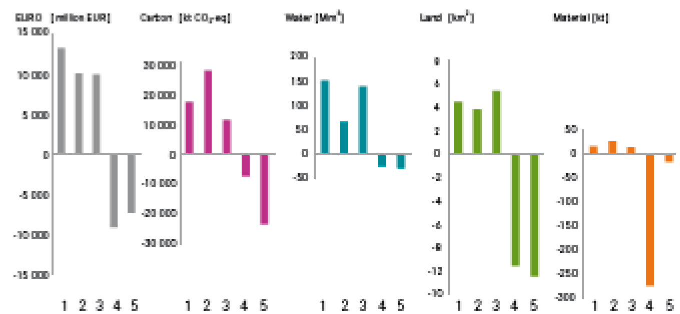
	Carbon	Water	Land	Material
per country	586 226 kt	14 743 Mm³	4 366 080 km²	1 010 228 kt
per capita	27 040 kg	701 m³	0.208 km²	27 038 kg

NET TRADE



TRADE FLOWS BY PRODUCT

Shown below are the net trade of products imported/exported to/from a country (imports minus exports) – the products include products for both further processing into more advanced goods/services (that may be later exported) and for final consumption. Environmental impacts are shown for the complete up-stream international supply chain of each product.



1 Machinery and equipment n.e.c.
2 Gas/Diesel Oil
3 Radio, television and communication equipment and apparatus
4 Iron ores
5 Other Bituminous Coal

RANKING

Carbon
1 Australia
2 Luxembourg

Water
1 Australia
2 Luxembourg

Land
1 Australia
2 Canada

Material
1 Ireland
2 Australia
3 Luxembourg

SOME WORDS ABOUT DETAIL IN COUNTRIES, SECTORS AND EXTENSIONS

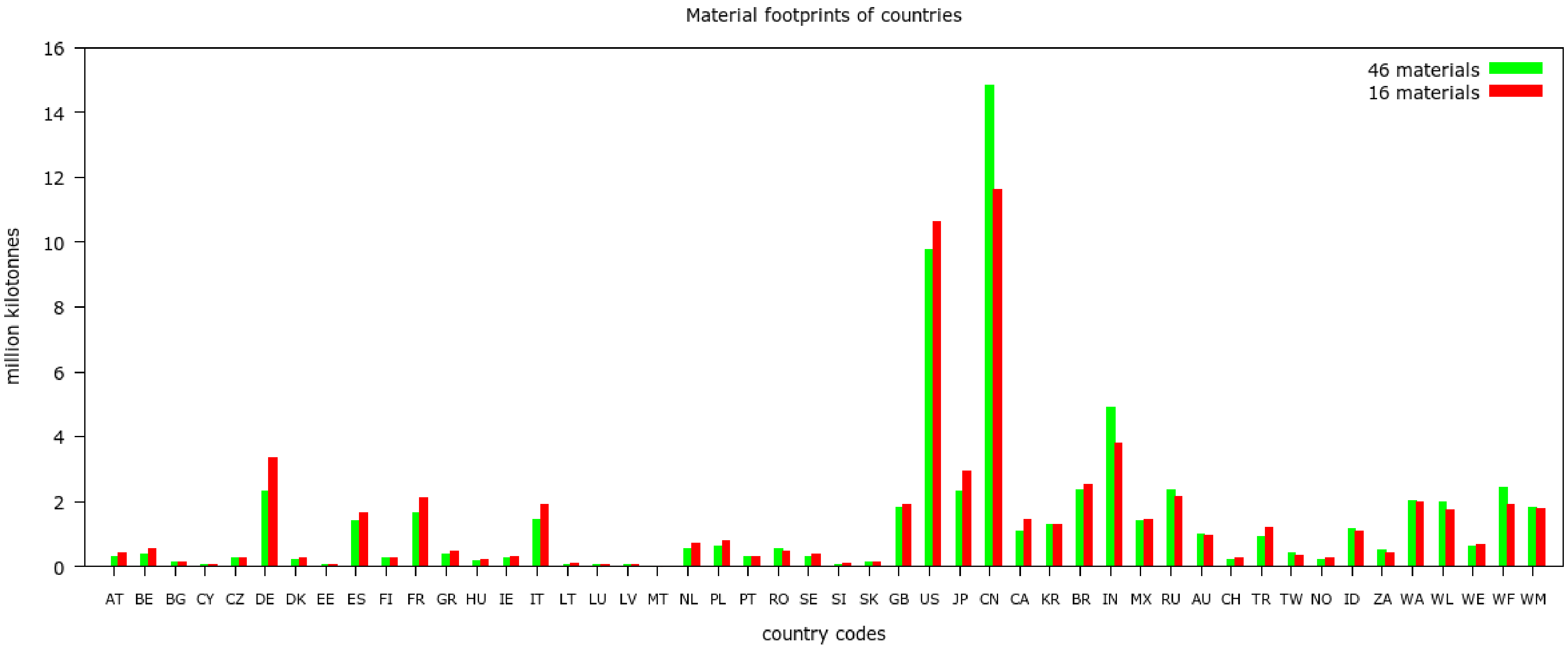
Detail in sector and extensions relevant for environmental analyses

- MR EE IO with mainly economic applications – 60 sectors
  - Look at high value added sectors
  - Must distinguish these
  - Disaggregation of mining, energy production, and agriculture is not so relevant due to low contributions to GDP (<5%)

- MR EE IO with environmental applications – up to 180 sectors
  - Look at high impact sectors
  - Must distinguish these (if sub-sectors have different pressures)
  - Hence MUST have detail in agriculture, energy production and also mining (high impact, large differences in impact)

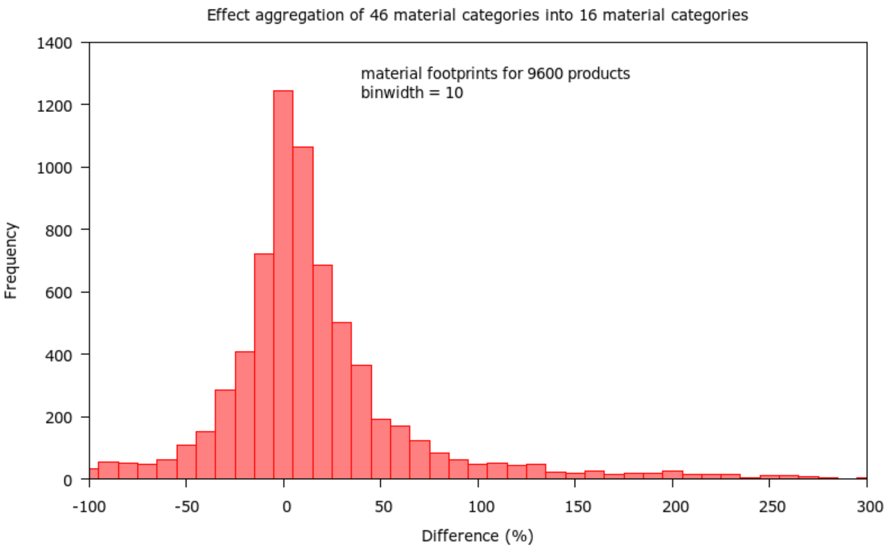
Impact of aggregation of sectors/extensions: country resource footprints

- Differentiation between aggregating in 16 of 46 material extraction categories and related sectors
- Significant changes, up to 50% for Belgium



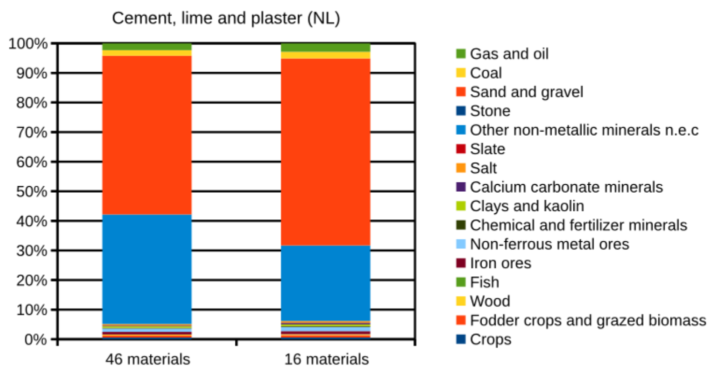
Impact of aggregation of sectors/extension: product footprints

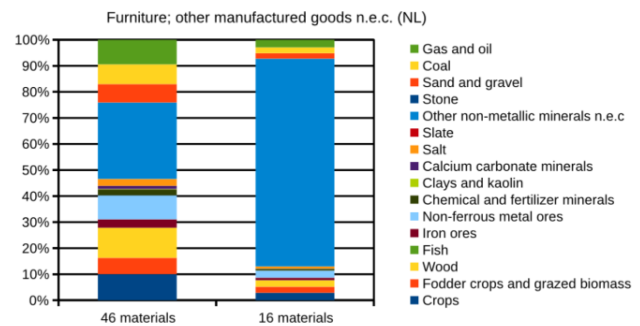
- Exiobase has 48 countries * 200 products
- Figure shows difference in footprint when using 16 instead of 46 materials and extractive sectors

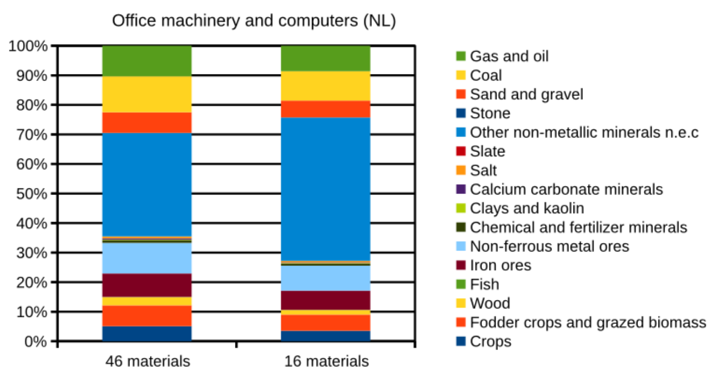


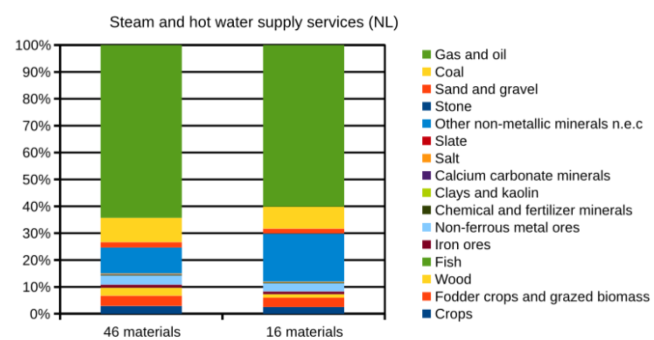
- Result
  - Only 1200 of the 9600 products have the same resource footprint
  - Differences up to 300%

But even for the products where the footprint in ton does not differ, the type of embodied resources will differ









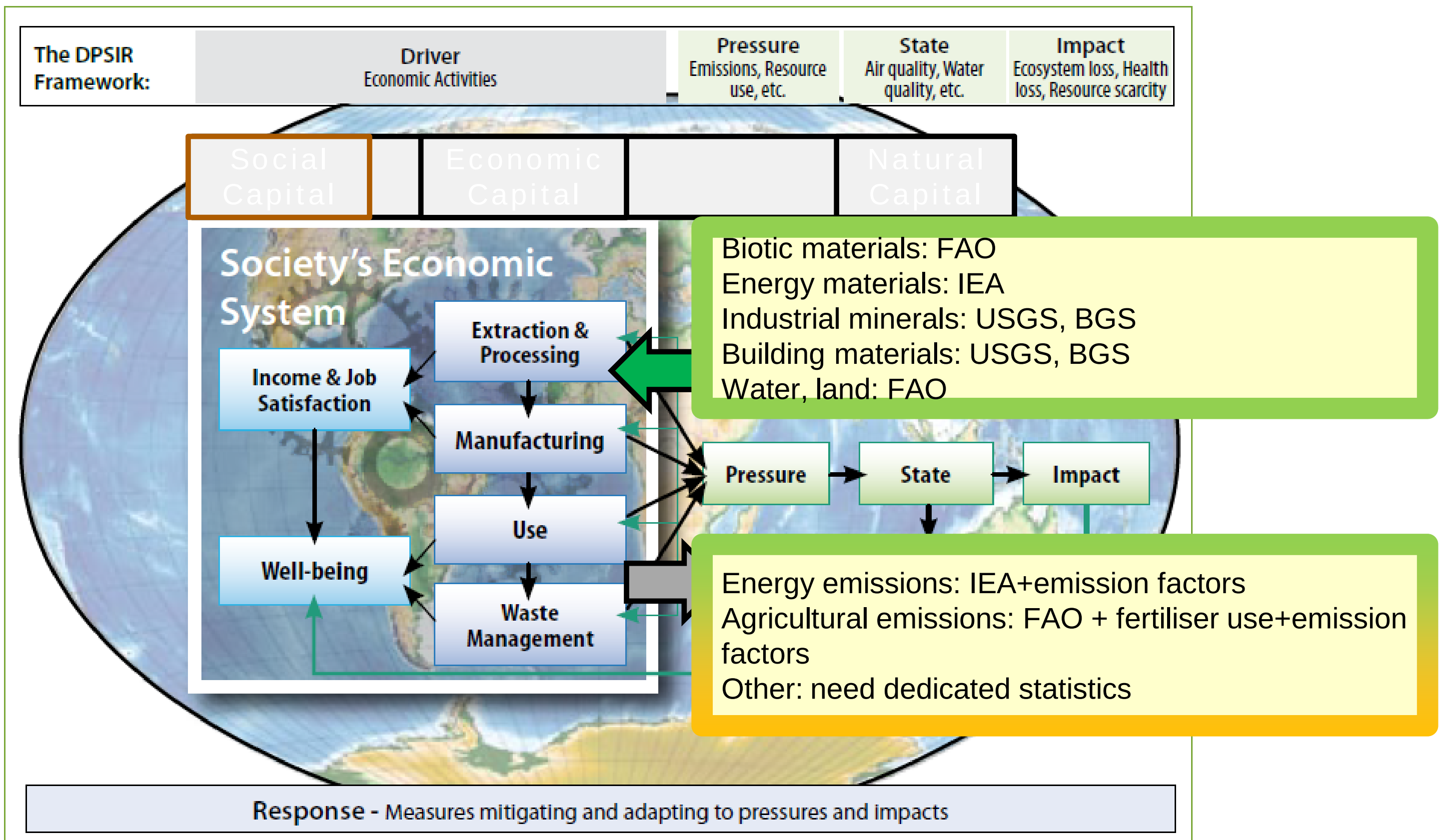
DATA AND TOOLS SUPPORTING THE BUILDING DETAILED (MR) EE IOs

a) Creating detailed MR EE SUT/IOT

b) Linking them via trade

Typical data situation: pressures

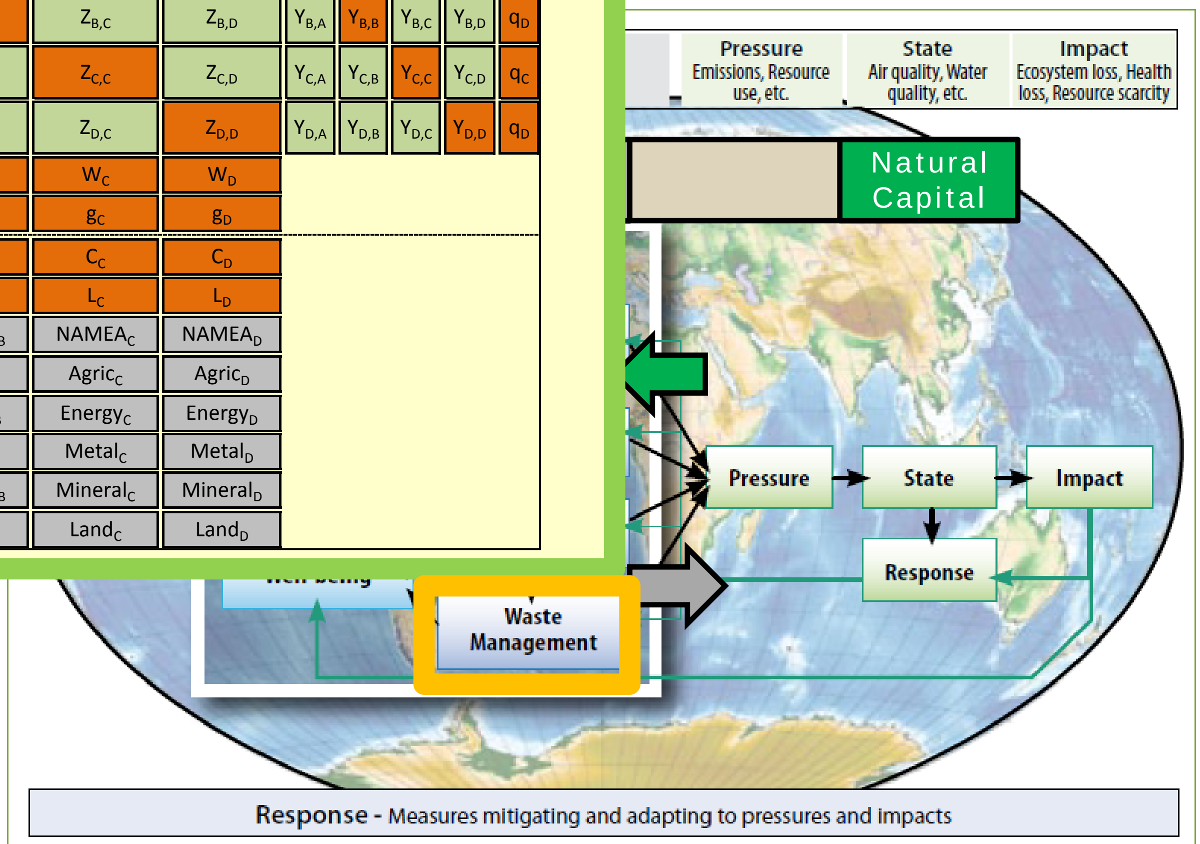
Pressures broken down by industry: resource extraction good , emissions: good to medium



Typical data situation: economic system

Economic data: SUT/IOT: good – often not detailed (waste: medium)

	Industries				$Y_{*,A}$	$Y_{*,B}$	$Y_{*,C}$	$Y_{*,D}$	q
Products	$Z_{A,A}$	$Z_{A,B}$	$Z_{A,C}$	$Z_{A,D}$	$Y_{A,A}$	$Y_{A,B}$	$Y_{A,C}$	$Y_{A,D}$	q_A
	$Z_{B,A}$	$Z_{B,B}$	$Z_{B,C}$	$Z_{B,D}$	$Y_{B,A}$	$Y_{B,B}$	$Y_{B,C}$	$Y_{B,D}$	q_D
	$Z_{C,A}$	$Z_{C,B}$	$Z_{C,C}$	$Z_{C,D}$	$Y_{C,A}$	$Y_{C,B}$	$Y_{C,C}$	$Y_{C,D}$	q_C
	$Z_{D,A}$	$Z_{D,B}$	$Z_{D,C}$	$Z_{D,D}$	$Y_{D,A}$	$Y_{D,B}$	$Y_{D,C}$	$Y_{D,D}$	q_D
W	W_A	W_B	W_C	W_D					
g	g_A	g_B	g_C	g_D					
C & L	Capital_A	C_B	C_C	C_D					
	Labor_A	L_B	L_C	L_D					
Environ Ext	NAMEA_A	NAMEA_B	NAMEA_C	NAMEA_D					
	Agric_A	Agric_B	Agric_C	Agric_D					
	Energy_A	Energy_B	Energy_C	Energy_D					
	Metal_A	Metal_B	Metal_C	Metal_D					
	Mineral_A	Mineral_B	Mineral_C	Mineral_D					
	Land_A	Land_B	Land_C	Land_D					



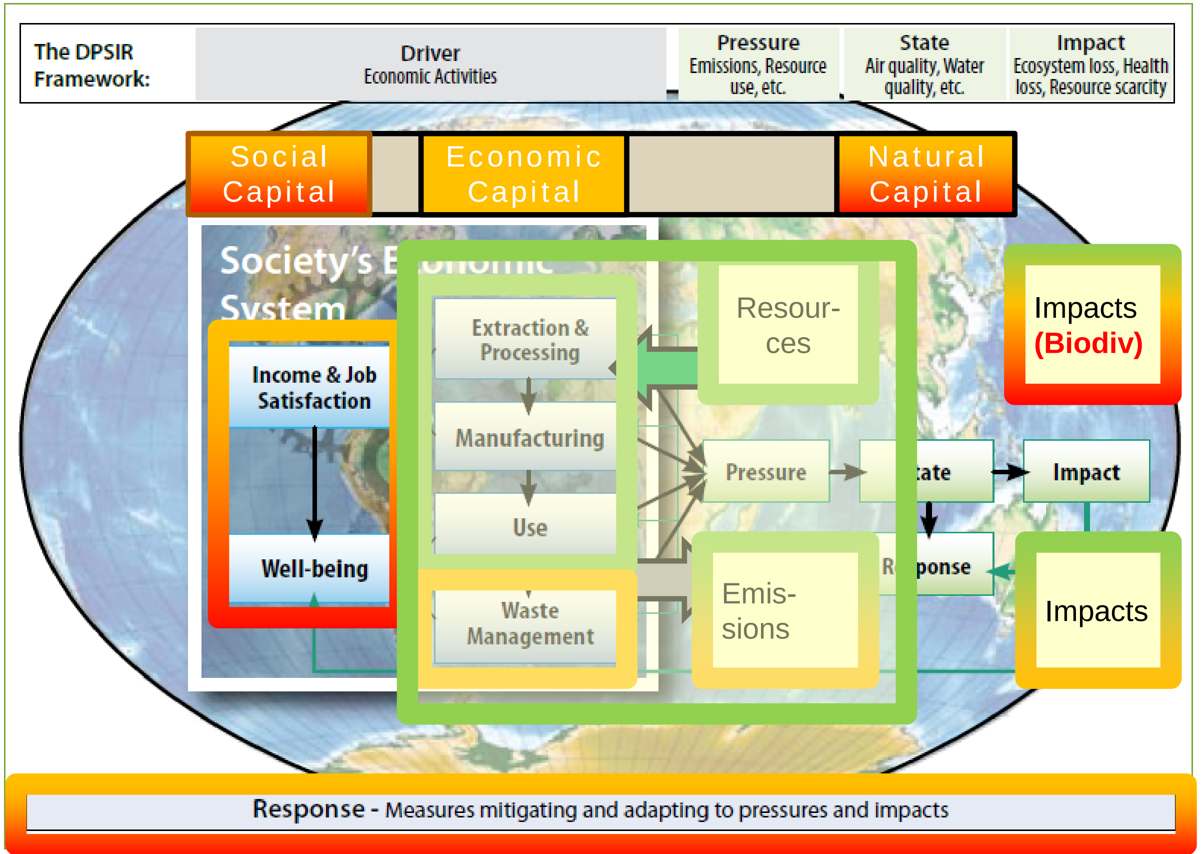
Summary

Good: economic system; resource & emission pressures, some impacts

Medium: Some emission pressures, some impacts, economic capital, waste

Bad: part of social capital, natural capital, responses, biodiversity impacts

Global MR EE IO hence feasible

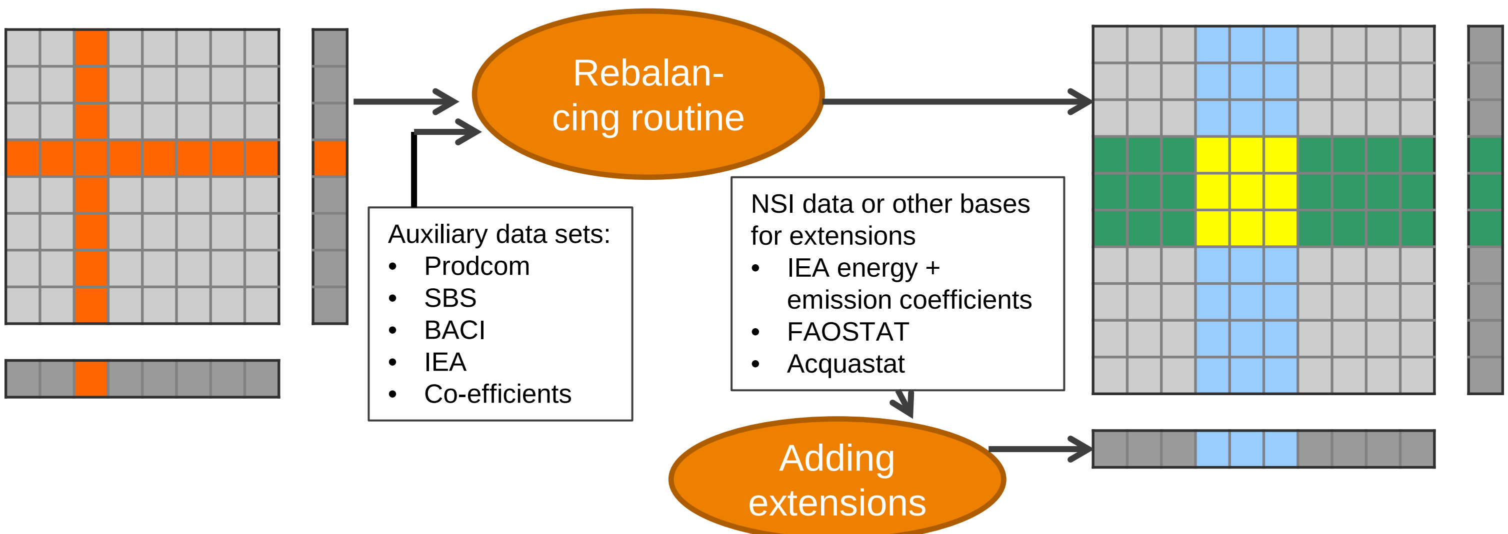


EXIOBASE: Detailing SUT ('red' to 'yellow')

1. Auxiliary data
   - Product statistics to split up rows (e.g. ProdCom)
   - Industry statistics to split up columns (e.g. Structural Business Statistics)
   - COMTRADE/BACI, IEA to split imports and exports
   - Co-efficients from various sources (AgriSams, similar country, etc.)

2. Rebalancing routine via minimum entropy between 'first guess' and balanced tables

3. Estimating valuation layers and extensions afterwards

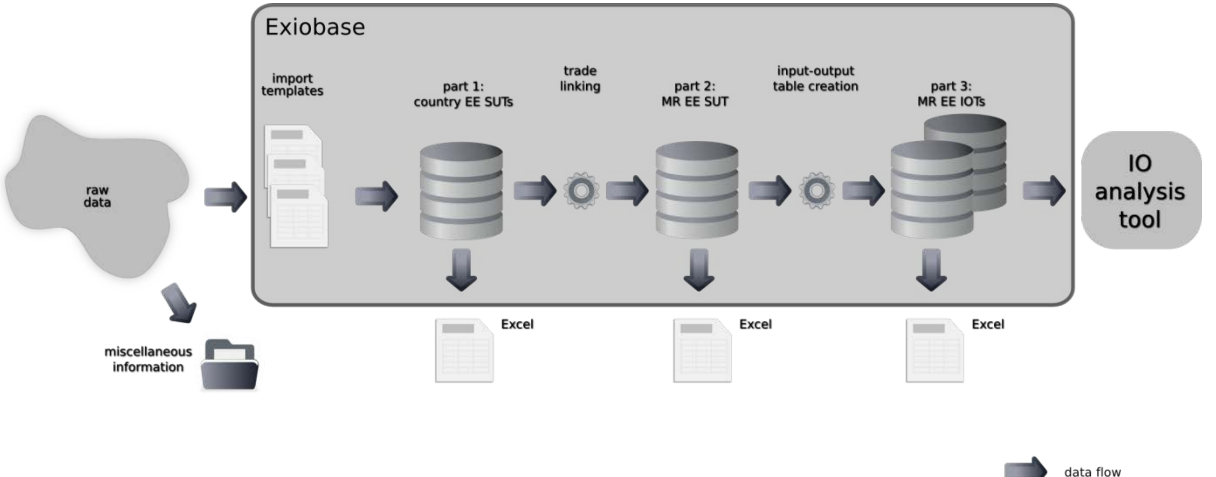


EXIOBASE: link country SUT via trade

1. Trade linking
   - Construct trade shares from COMTRADE/BACI, others
   - Split Import use up via trade shares and confront with Export
   - Rebalance

2. SUT to IOT: automated calculation using Eurostat Model B

3. All fully automated and done in minutes



A word about harmonized bilateral trade data

- To be blunt: nice, not sufficient nor essential!
- EXIOBASE, WIOD, EORA all start with country SUT/IOT
- Country SUT/IOT contain trade (but not bilateral)
- Imports and Exports in national SUTs inconsistent at global level -> 'trade with aliens'
    - 0.2% of all trade in EXIOBASE
    - >100% of trade of specific products
    - COMTRADE cannot solve this!

	Industries				$Y_{*,A}$	$Y_{*,B}$	$Y_{*,C}$	$Y_{*,D}$	q
Products	$Z_{A,A}$	$Z_{A,B}$	$Z_{A,C}$	$Z_{A,D}$	$Y_{A,A}$	$Y_{A,B}$	$Y_{A,C}$	$Y_{A,D}$	q_A
	$Z_{B,A}$	$Z_{B,B}$	$Z_{B,C}$	$Z_{B,D}$	$Y_{B,A}$	$Y_{B,B}$	$Y_{B,C}$	$Y_{B,D}$	q_D
	$Z_{C,A}$	$Z_{C,B}$	$Z_{C,C}$	$Z_{C,D}$	$Y_{C,A}$	$Y_{C,B}$	$Y_{C,C}$	$Y_{C,D}$	q_C
	$Z_{D,A}$	$Z_{D,B}$	$Z_{D,C}$	$Z_{D,D}$	$Y_{D,A}$	$Y_{D,B}$	$Y_{D,C}$	$Y_{D,D}$	q_D
W	W_A	W_B	W_C	W_D					
g	g_A	g_B	g_C	g_D					
C & L	$Capital_A$	C_B	C_C	C_D					
	$Labor_A$	L_B	L_C	L_D					
Environ Ext	$NAMEA_A$	$NAMEA_B$	$NAMEA_C$	$NAMEA_D$					
	$Agric_A$	$Agric_B$	$Agric_C$	$Agric_D$					
	$Energy_A$	$Energy_B$	$Energy_C$	$Energy_D$					
	$Metal_A$	$Metal_B$	$Metal_C$	$Metal_D$					
	$Mineral_A$	$Mineral_B$	$Mineral_C$	$Mineral_D$					
	$Land_A$	$Land_B$	$Land_C$	$Land_D$					

HOW THE STATISTICAL COMMUNITY AND THE SCIENTIFIC COMMUNITY CAN JOIN FORCES

Limitations of current work

1. Current MR EE IO projects are done by scientists

2. Participation and input of NSIs is limited
   - Scientists do not use all available data (e.g. valuation layers in some EU countries)
   - NSIs do not comment on detailing, harmonization and trade linking

3. Problem areas
   - NSIs (still) have own interpretations of classifications, etc.
   - Inconsistencies between FAO, IEA and NSI IO & emission data
   - Aforementioned trade inconsistencies of SUT/IOT (is not the problem of inconsistencies in COMTRADE)
   - NSIs are bound to confidentiality issues

How UNSD, OECD and WTO could move forward

1. Goal: ‘more official’ Global MR EE IO.

2. Collaboration of: UN SD, OECD, WTO, interested NSIs, team of EXIOBASE and e.g. Usyd scientists
   - UN SD provide: platform, supervision, harmonized COMTRADE
   - NSIs provide
     - Their best available EE SUT/IOT & auxiliary data
     - Cross-checks on the harmonization & detailing, or do this themselves
   - EXIOBASE team and ISA team provide
     - Harmonization and detailing tools
     - A ‘virtual laboratory’ platform for collaboration with others
     - Insights in ‘thorny issues’

3. Maybe also a way to do
   - Use databases like WIOD or TiVA
   - Use EXIOBASE tools to get the detail for environmental analyses?

Possible financing & organisation

1. Typical budget EU projects 1.5-3 Mio, more modest starts possible

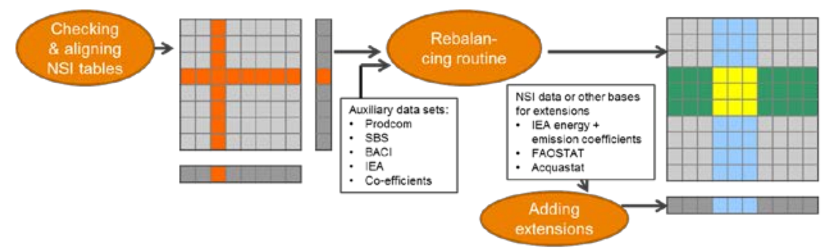
2. Already available resources
   - Ongoing EU projects (DESIRE, Carbon CAP: running till 2016)
   - Submitted EU projects (Climate ACTT: CML, USydney, UN DESA)
   - 2015 EU H2020 proposal on Climate-food-water nexus
   - Infrastructure from EXIOBASE, EORA and the Virtual Lab projects
   - University of Sydney has just launched a “Global Virtual Laboratory” project funded by the Australian Research Council (until 2017).

3. Additional sources to consider
   - Large programs (e.g. EuropeAid / Switch Asia an SwitchMed), or funding related to monitoring the UN SDGs
   - Secondments or contributions of countries / NSIs
   - PhD stipend programs available in many countries (would provide a considerable workforce)

Possible financing & organisation

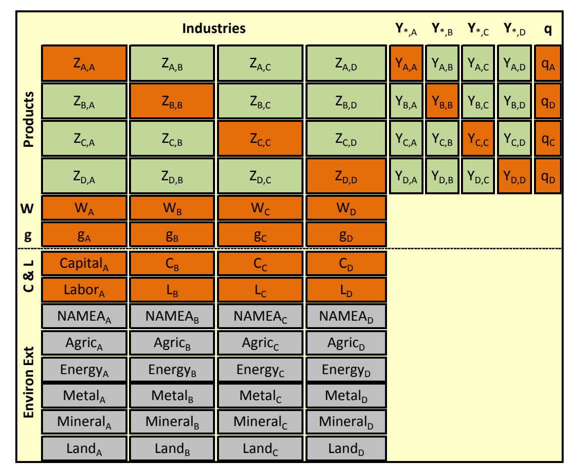
Country level

- NSI-researcher interaction – can be added to existing projects
    - EU FP7 DESIRE
    - CLIMATE ACTT
- Capacity via PhD stipends
- Using a virtual lab



Global level & integration

- Steering group with UNCEEA, OECD, WTO…..
- UN SD providing trade data
- Using tools of e.g. EXIOBASE and USydney for integration



Actions we could discuss now

- Are there organisations interested in working with us in our ongoing EU funded programs?

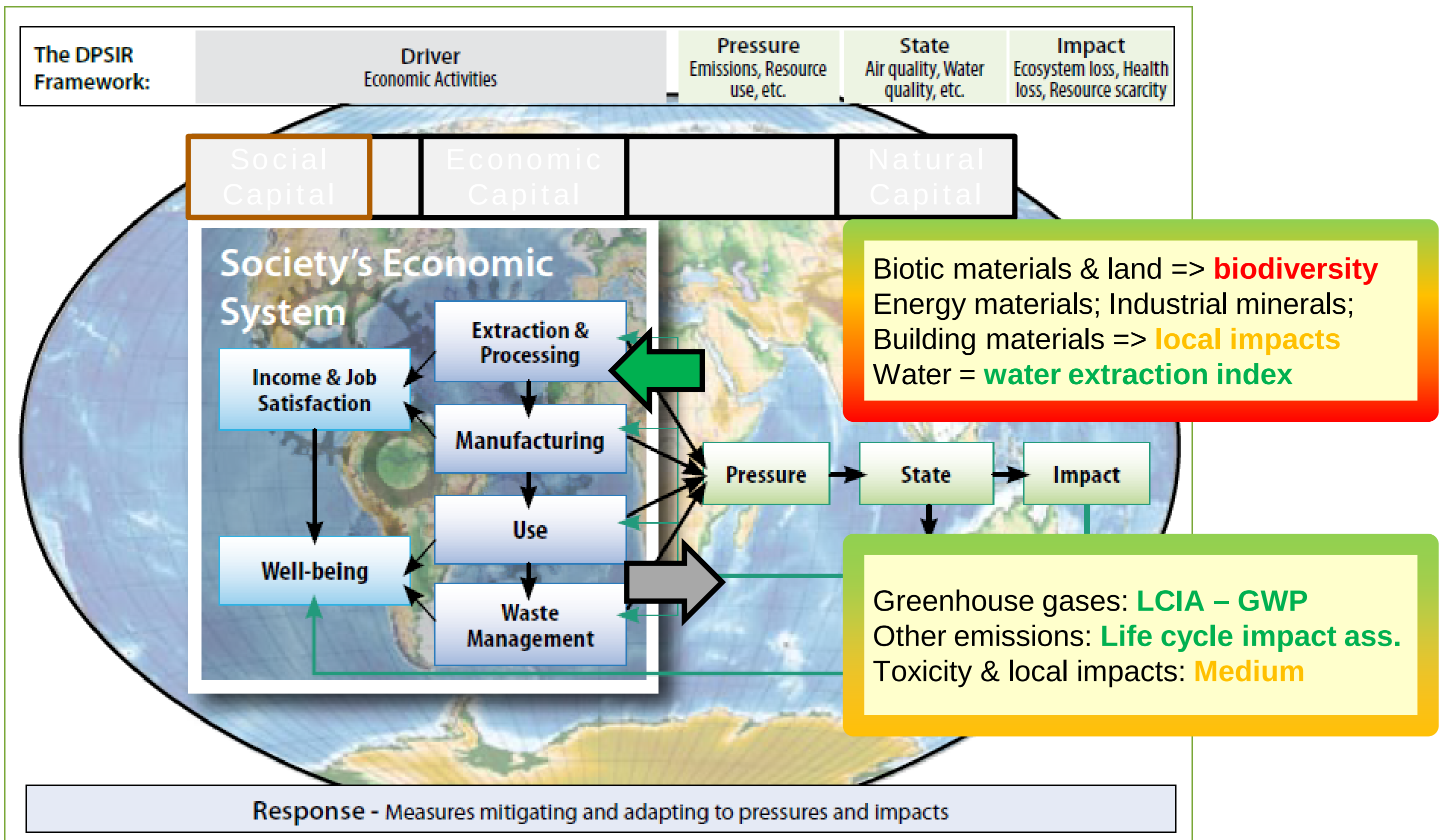
- Could we form a WG pursuing this idea (UNSD, OECD, UNEP, NSIs)?

- Who is interested to explore the following funding routes with us?
  - UNCEEA endorsed proposals to PhD stipend organisations (CSC, DIKTI, NUFFIC, EC Marie Curie,…)
  - Seconded staff to support a central UNCEEA secretariat
  - Major funding programs (e.g. Europe Aid)
  - Direct lobby for support funding of UNSD

Thanks for your attention!

Typical data situation: impacts

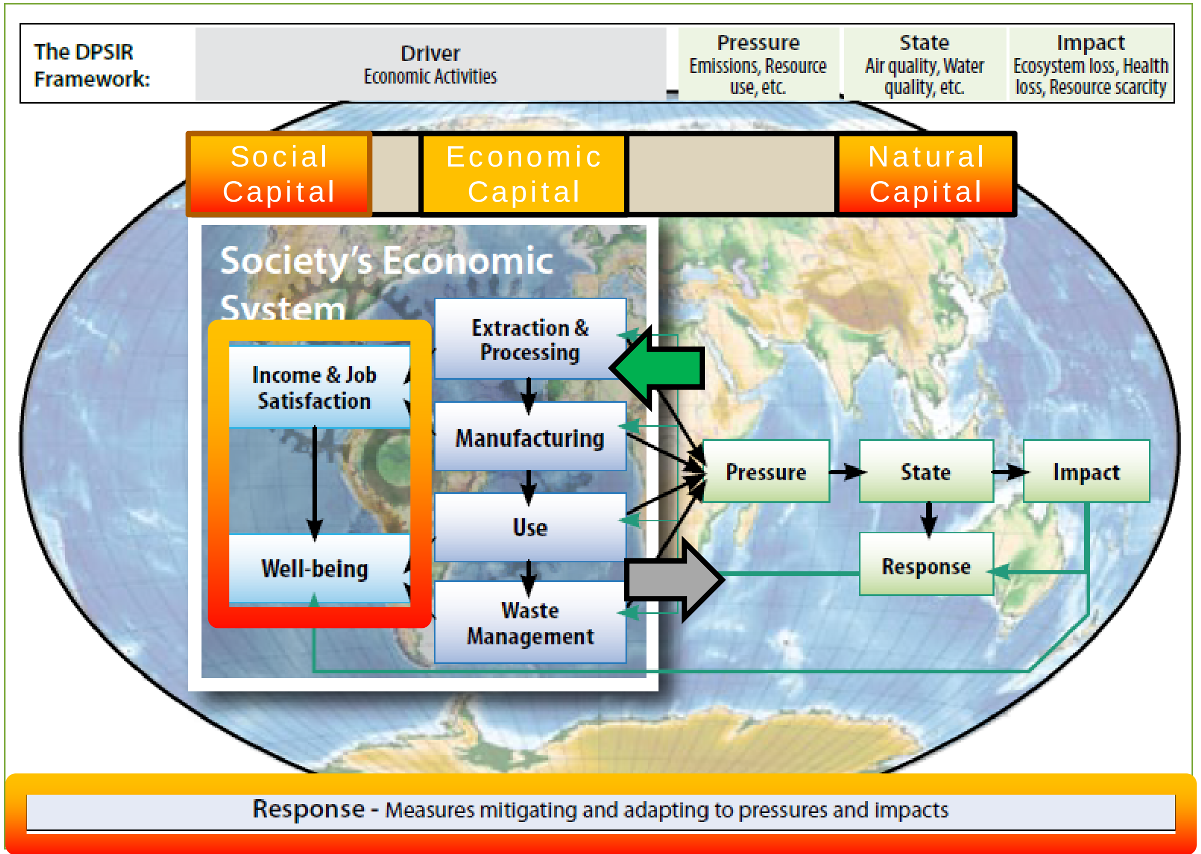
Impact indicators: emissions good (global warming) to medium (toxic impacts); resources good (water) to bad (biodiversity)



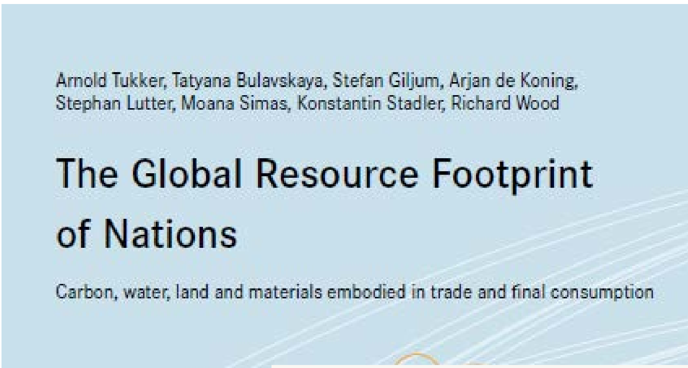
Typical data situation: responses & capital stocks

Responses: **medium** to **bad**

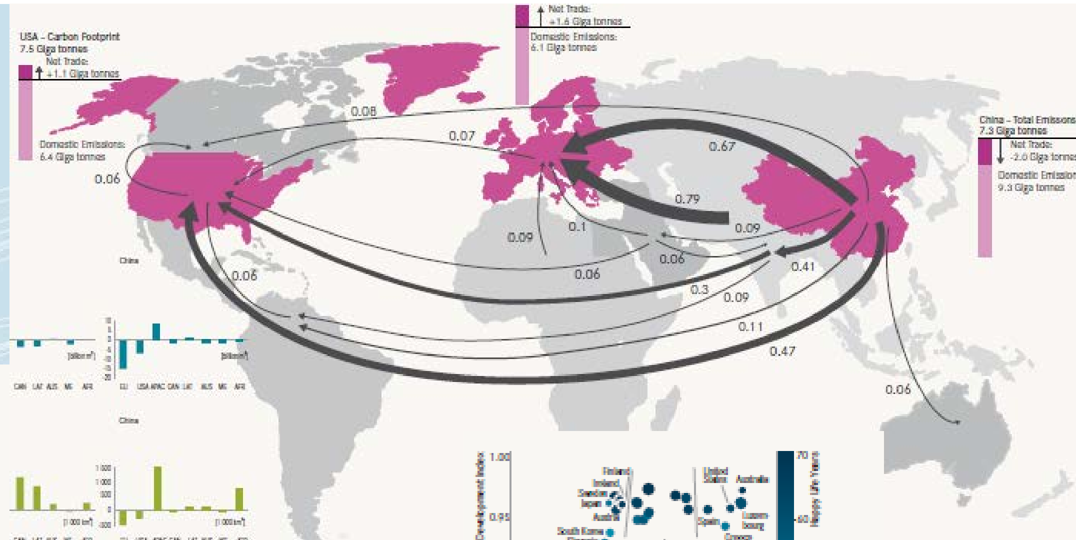
Economic/"produced" capital: **medium**; Social/"intangible" and Natural capital: **medium** to **bad**; limited insights in **safe thresholds**

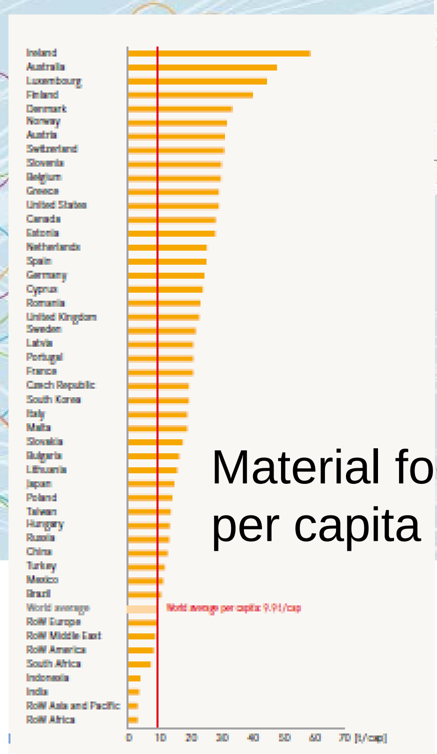


Some illustrative results

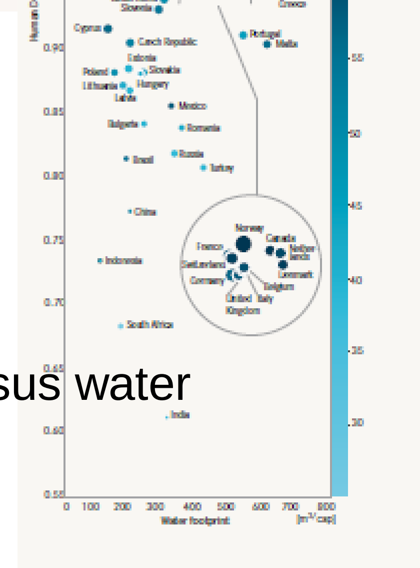


Carbon embodied in trade





Material footprint per capita



HDI versus water footprint

To conclude

- For environmental footprint analyses we need
  - Detail in environmental extensions
  - Detail in related sectors with high, differentiated pressurs such as agriculture, mining, energy production

- What may be less relevant is a very high detail in countries
  - The top 43 countries generate most of the emissions
  - Resource extraction, land use and water extraction may take place in the 150 other countries, but using here average impact intensities may still work
  - Country detail seems hence mainly relevant to allow all countries to do analyses for their own purposes