

# Introduction to Material Flow Accounting (MFA)



**Dr. Stephan Lutter**

Vienna University of Economics and Business (WU)

Workshop on Material Flow Accounts and Waste  
Statistics for SDG indicators

JULY 16-18, 2018

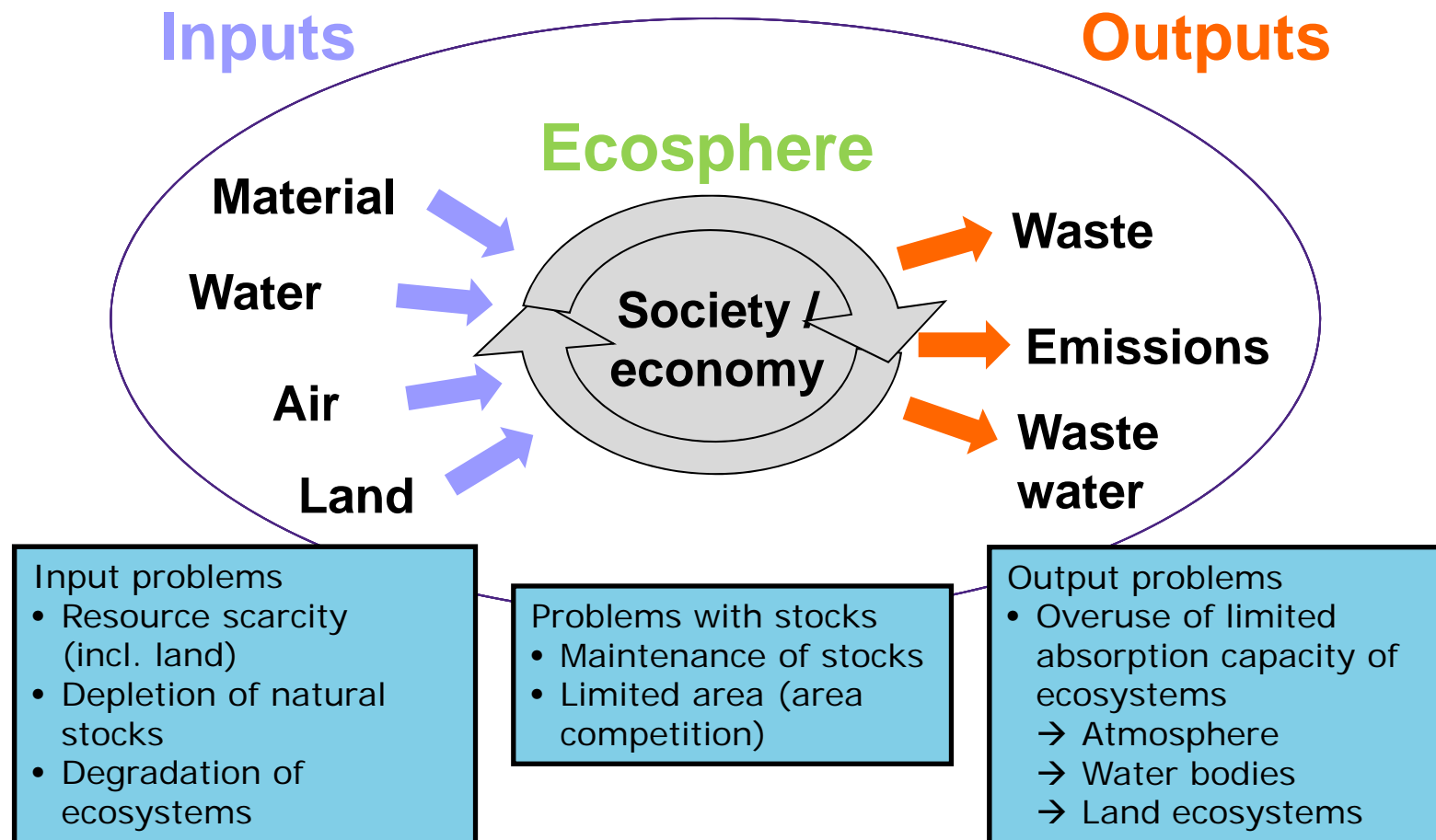


# Content

---

1. Introduction into concept of societal metabolism
2. Environmental accounts
3. Short history of EW-MFA
4. Insight in methodological basics
5. Environmental policy making & MFA

# Social metabolism – the concept



# Social metabolism – the concept

Inputs



Stock



Outputs



# Social metabolism – the concept

---

- Monitoring of physical flow between the socio-economic and the natural system (on the input- and output-side)
- Socio-economic patterns shape physical flows  
(economic production, technology, life-styles, culture)
- **Environmental problems as a result of the quantity and quality of physical flows**
- Two functions of „nature“:
  - Source for socio-economic inputs
  - Sink for socio-economic outputs
- Systemic perspective → all inputs are transformed to outputs (corr. by stock changes) → mass balance principle
- Pressure indicators (vs. environmental impacts)



# Environmental accounts

---

- Physical flows put pressure on the natural environment; they can be translated to environmental impacts.
- Physical indicators enable objective and concrete measurement of progress towards sustainability, e.g. as defined in the SDGs.
- Physical accounts, among those MFA, align well with economic accounts in the System of Environmental-Economic Accounting (SEEA) context.

# Economy-wide Material flow accounts (EW-MFA)

---

- Measuring (Raw) Material flows (excl. water and air) between the environment and the economy
- Measurement unit: metric tons per year
- System boundaries
  - between the natural and the socio-economic system
  - between national economies
- Stocks within the socio-economic system:
  - Humans, animal livestock (domestic)
  - Artefacts (buildings, infrastructure, machines, devices)
- Flows pass system boundaries and are used to produce, maintain, and run societal stocks
  - Inputs: domestic extraction; imports
  - Outputs: emissions, wastes, dissipative uses/losses; exports

# Categories of material flows

---

- Direct vs. indirect:
  - Direct flows: refer to actual weight of products; do not take into account life-cycle dimension of production chains.
  - Indirect flows: refer to all materials required for processing (up-stream material requirements)
    - Also: Raw material equivalents, material footprint, ecological rucksacks, hidden flows
- Used vs. unused:
  - Used materials: amount of extracted resources, which enters economic system for further processing or direct consumption
  - Unused materials: materials that never enter the economic system (overburden, parting materials from mining, by-catch from fishing, wood and agricultural harvesting losses, etc.)
- Domestic versus Rest of the World:
  - Refers to origin and/or destination of material flows

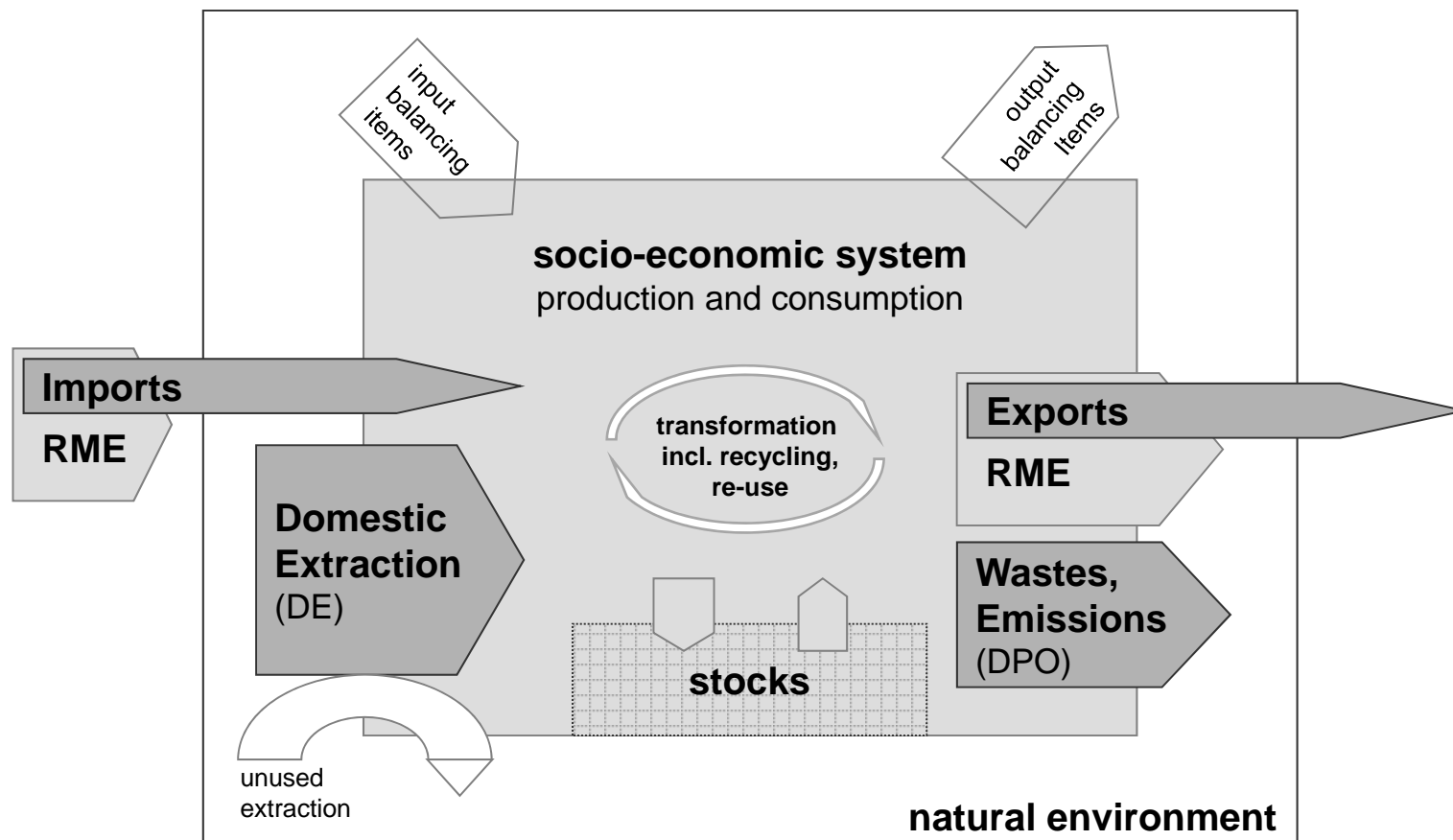


# Standards for EW-MFA: Eurostat & UN

- European Strategy for Environmental Accounting (ESEA) identifies Economy-wide Material Flow Accounts (EW-MFA) as core module of Environmental Accounts
- ...to be produced regularly and timely to support policy making.
- EW-MFA included in Regulation (EU) No 691/2011 on European Environmental Economic Accounts => entered into force in 2013
- Current version of the EW-MFA Compilation Guide from 2013
- Attempt to further improve the methodological foundation for harmonised EW-MFA across Europe
- Primary objective to facilitate and support compilation of the 2013 questionnaire
- New version being elaborated
- UN Environment currently finalizing global MFA manual for application in countries with different levels of expertise

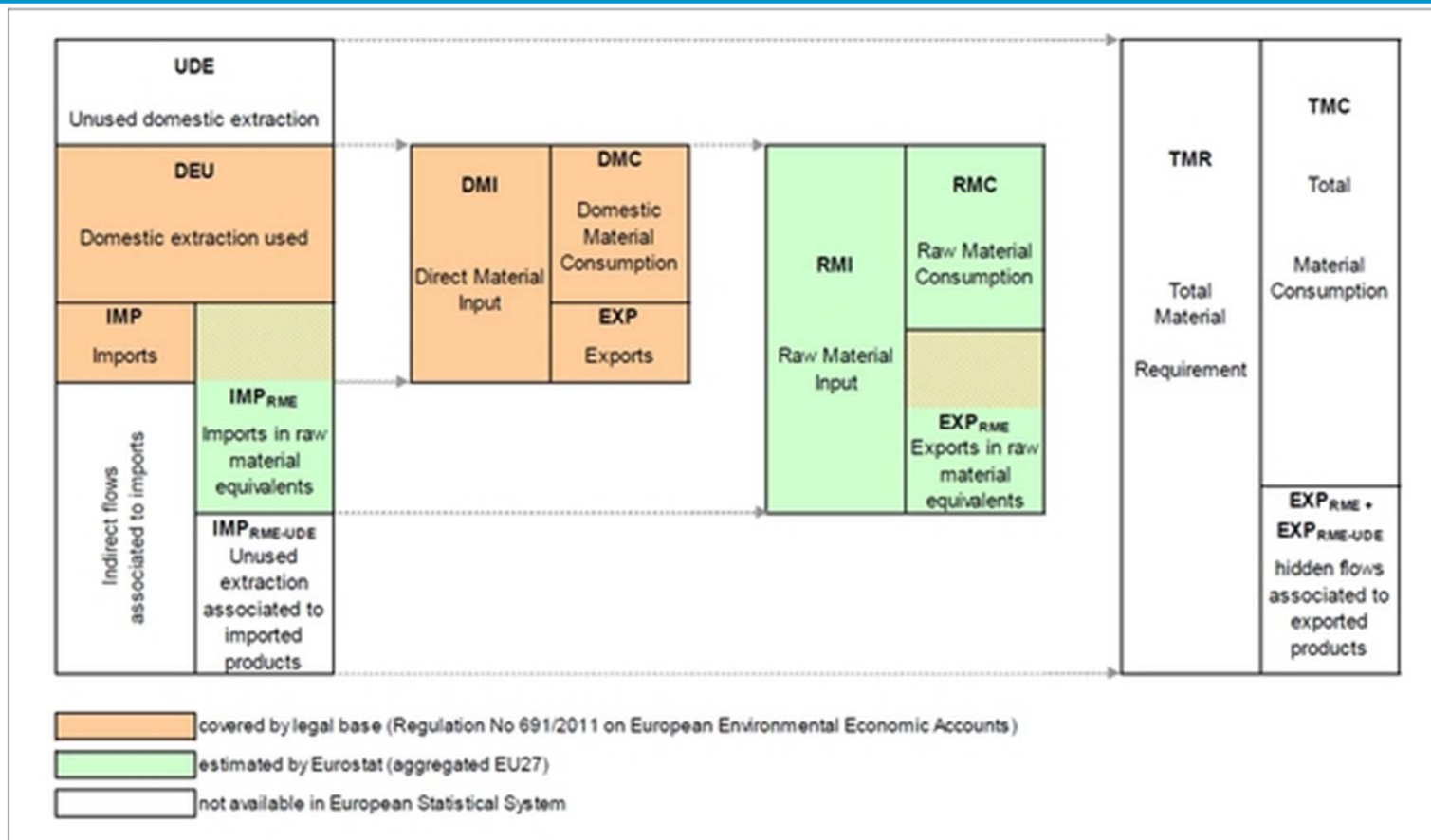


# EW-MFA scheme



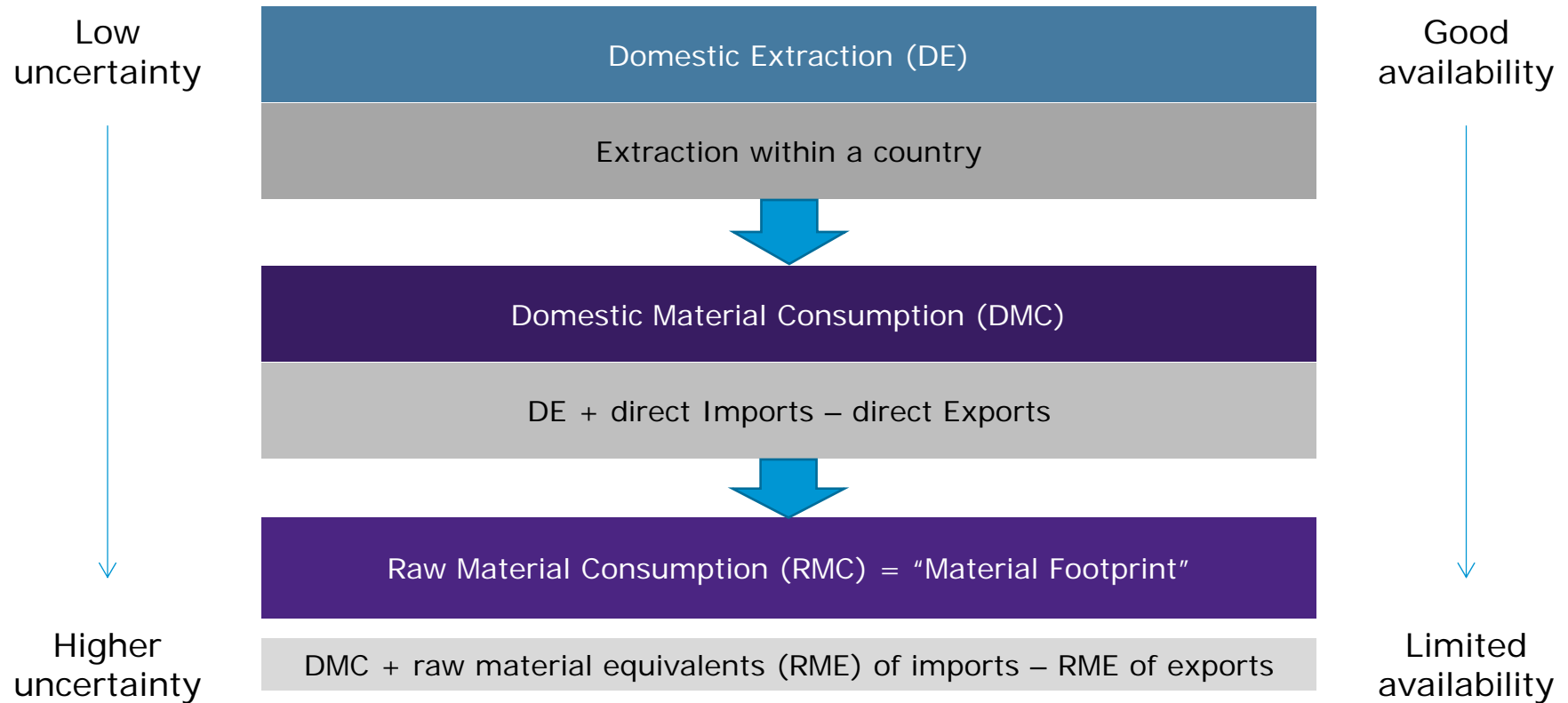
Source: Eurostat, 2013

# EW-MFA scheme



Source: Eurostat, 2013

# Selected MFA indicators for extraction and consumption



## MFA provides headline indicators on ...

---

- **Patterns of resource use:** how many and what kind of materials do we use? why and how do economies vary in their metabolic patterns?
- **Trends and resource productivity:** how does material use develop over time and in relation to economic development? Do we find dematerialisation / decoupling?
- **Globalisation:** how is resource extraction, industrial production and final consumption distributed around the globe? Is resource use in industrialized countries declining due to externalisation?
- **Circular economy:** what fraction of resource inputs is released into the environment within one year? Is recycling successfully substituting for primary resource inputs?

# MFA indicators and their policy relevance (selection)

Indicator	Analysis
DE	Environmental pressures due to material extraction - trends
DMI/DMC	Local pressures due to material use within a specific economic system; dependence on direct imports
RMI/RMC	Resource requirements along supply chains – outsourcing of resource extraction and related impacts; dependence on direct and indirect imports
GDP/DMC	How much economic value is created per direct material input; has decoupling been reached
GDP/RMC	How much economic value is created per material input along supply chains; has decoupling been reached

DE ... Domestic Extraction; DMI ... Domestic Material Input; DMC ... Domestic Material Consumption  
RMI ... Raw Material Inputs; RMC ... Raw Material Consumption („Material Footprint“)



## 4 main material categories

---

### Biomass

- Uses: nutrition ( $\frac{3}{4}$  of harvest = animal fodder), energy (food-feed-fuel), construction
- Environment: soil fertility and degradation

### Fossil energy carriers

- Occurrence in deposits, strategic relevance for industrial processes
- Economics: scarcity, peak oil? Rising prices, import dependence
- Environment: CO<sub>2</sub> emissions, climate change

## 4 main material categories

---

### **Metallic minerals**

- Occurrence in deposits, heterogeneous groups, strategic relevance for industrial processes
- Economics: Scarcity (critical metals), “pollution” issues, rising prices
- Large anthropogenic stocks, „urban mining“, Recycling
- Environment: Impacts of mining

### **Non-metallic minerals**

- Construction a. industrial minerals
- Bulk flows, large stocks → future resource requirements
- Scarcity due to urban and landscape planning
- High correlation with energy flows

# MFA accounting modules

**Module 1: Direct material flows  
(Domestic Extraction, Imports and Exports)**

Module 2: Indirect material flows (Raw material equivalents of trade, material footprint)

Module 3: Waste and emissions (Domestic processed output)

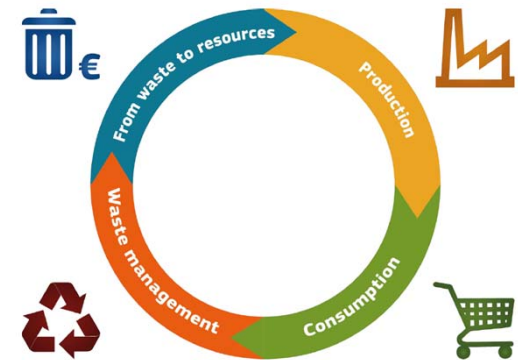
Module 4: Material balance and stock accounts  
(Net Additions to Stock)

Module 5: Unused extraction

Module 6: Material flow accounts by industry sector  
(Physical Input-Output Tables)

# MFA on the policy agenda

- EU:
  - EU 2020: Roadmap to a Resource-Efficient Europe
    - „Monitoring and communicating progress“ → RE Scoreboard
  - Circular Economy Action Plan
    - EC & EEA in 2017, “propose a simple and effective monitoring framework”, building on Efficiency Scoreboard and the Raw Materials Scoreboard
- Green Economy (UNEP), Green Growth (OECD), Green Industry (UNIDO)
  - Resource efficiency as central pillar to ensure growth but reduce environmental impacts
- UN:
  - Resource efficiency in two SDGs - 8.4 (resource efficiency in consumption and production), 12.2 (sustainable management and efficient use of natural resources)

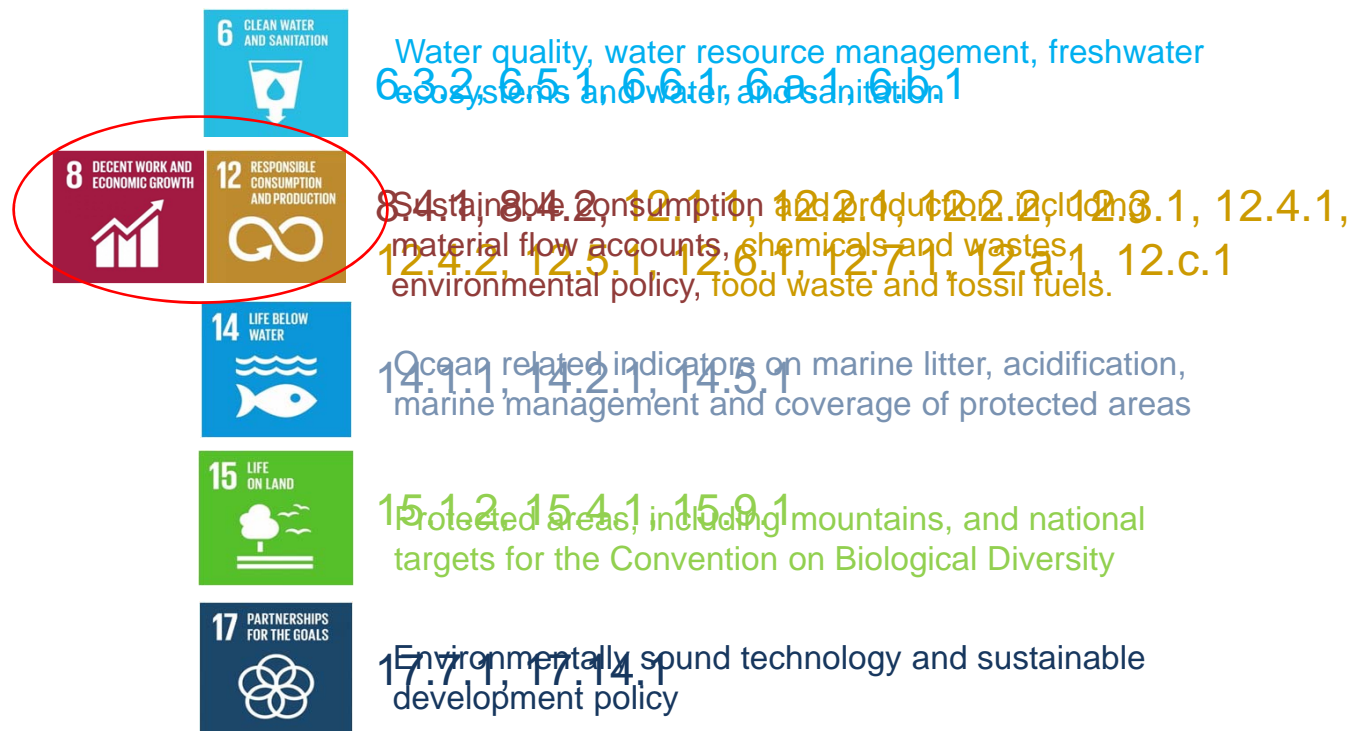


# UN Environment & SDGs and MFA

---

- UN Environment is the custodian for 26 indicators.
- SDGs to support national decision making and monitoring
- MFA as a flagship statistical product, both for the SDGs and for measuring resource efficiency at national level
- Goals:
  - Defining/refining the methodologies to be of the greatest use to members
  - Capacity building
  - Engagement with countries to increase national compilation of MFA, national ownership and the overall relevance of MFA

# UN Environment indicators





# MFA indicators for SDG Monitoring

---

## **SDG 8.4**

Improve progressively through 2030 global resource efficiency in consumption and production, and endeavor to decouple economic growth from environmental degradation in accordance with the 10-year framework of programs on sustainable consumption and production with developed countries taking the lead

## **SDG 12.2**

By 2030, achieve the sustainable management and efficient use of natural resources

## **SDG 12.5**

By 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse

# MFA indicators adopted by IAEG

---

## **SDG 8.4**

Resource productivity indicator  
(production approach)

Gross Domestic Product (GDP) per  
unit of Domestic Material  
Consumption (DMC) in US\$/kg

Resource productivity indicator  
(consumption approach)

Gross Domestic Product (GDP) per  
unit of Material Footprint (MF) in  
US\$/kg

## **SDG 12.2**

Resource Use (territorial approach)

Domestic Material Consumption  
(DMC) per capita in tonnes

Resource Use (consumption  
approach)

Material Footprint (MF) per capita in  
tonnes

## **SDG 12.5**

Waste and Emissions

Domestic Processed Output (DPO)  
per capita in tonnes

# UN Environment Global Raw Material Dataset Version 2017

---

- Aim: to provide one harmonized global reference dataset on material extraction and trade
- For use by wide range of stakeholders, e.g. policy makers, civil society organizations, scientists
- Coverage:
  - 191 countries
  - 1970-2017
  - Policy database: 4/13 material categories
  - Research database: 64 material categories
  - Biomass, metal ores, minerals, fossil fuels (reported in tonnes)
- Authors: CSIRO & WU Vienna

# UN Environment Global MFA Manual

---

- Aim: Build MFA capacity around the globe
- For different levels of expertise
  - focus on countries in (statistical) development
- Building on available manuals and reporting requirements
- Test countries: Philippines, Laos, South Africa, Chile
- Officially supported by Eurostat and OECD
- Submitted for official adoption by UNSD in 2019
- Team: CSIRO, WU Vienna, SEC Vienna, Nagoya University

# Conclusions

---

- Natural resources are the basis of the societal metabolism.
- Environmental problems are a result of the quantity and quality of physical flows → environmental accounting
- MFA focuses on raw materials.
- Standards like the ESEA/UN-SEEA ensure comparability of results.
- For comprehensive analyses territorial AND footprint indicators are needed.
- MFA indicators are pressure indicators – linkage to impacts can be established.
- Ex-post and ex-ante analyses are feasible.

# Thank you for your attention!

---



VIENNA UNIVERSITY OF  
ECONOMICS AND BUSINESS

**DEPARTMENT SOCIOECONOMICS**

Welthandelsplatz 1, 1020 Vienna, Austria

**DR. STEPHAN LUTTER**

T +43-1-313 36-5754

stephan.lutter@wu.ac.at  
www.wu.ac.at