Webinar

# What’s your country’s footprint?

## A close look at environmental footprint indicators and multi-regional input-output tables

**18 March 2020** **16:00 CET**

GGKP

# GREEN GROWTH
## Knowledge Partnership

Green Industry Platform

Green Growth Knowledge Platform

Green Finance Platform

# GREEN GROWTH
## Knowledge Partnership

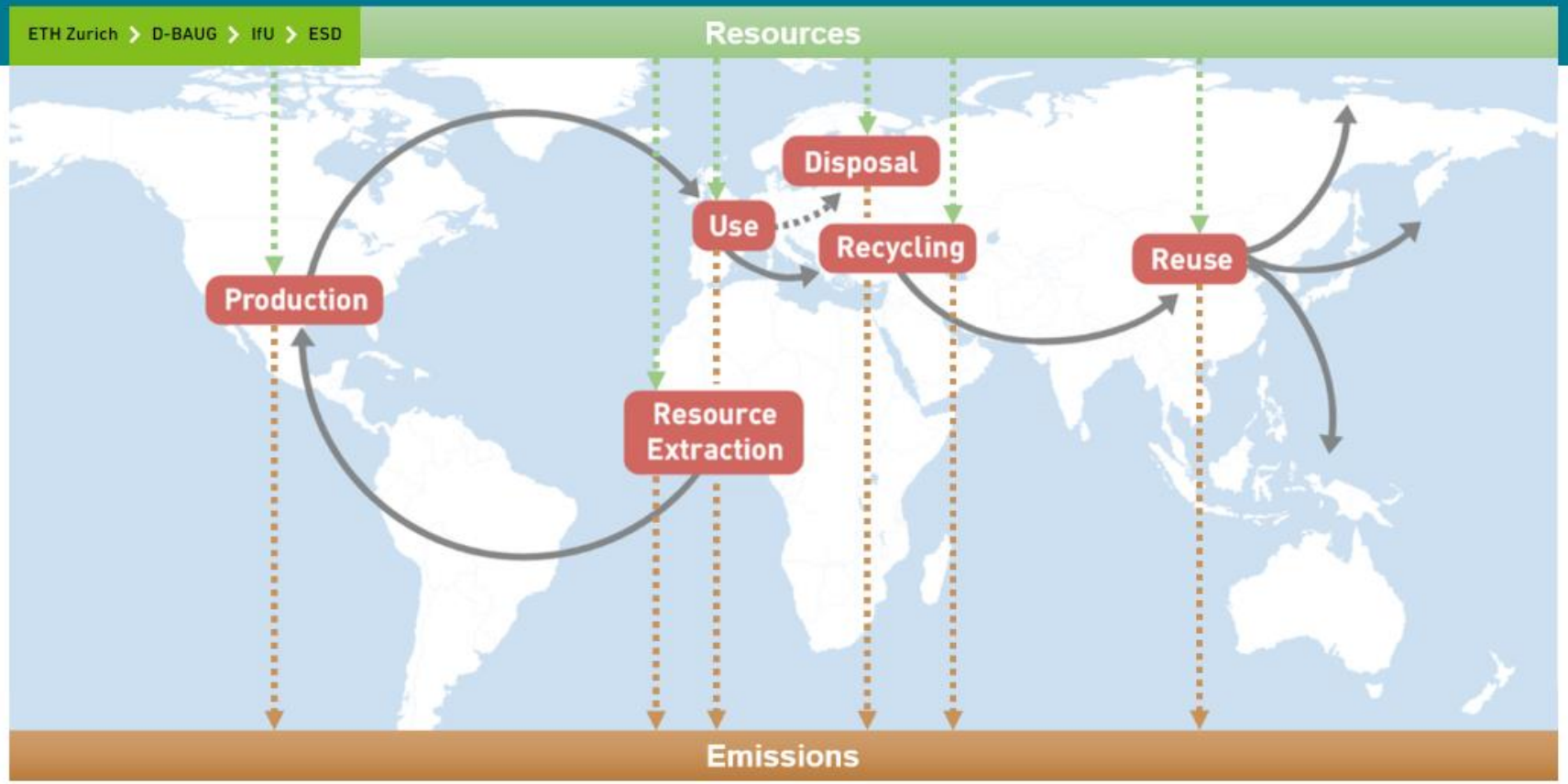
Green Industry Platform

Green Growth Knowledge Platform

Green Finance Platform

GGKP

**Stefanie Hellweg**
Professor,
Ecological Systems Design
ETH Zurich




# Welcome to the chair of Ecological Systems Design

Our mission is to model, analyze, evaluate, and improve the resource efficiency and environmental performance of products and processes, new technologies, and consumption patterns from a systems perspective. Read more →

Our mission is to model, analyze, evaluate, and improve the resource efficiency and environmental

**Niklas Nierhoff**
Scientific Officer,
Swiss Federal Office
for the Environment

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

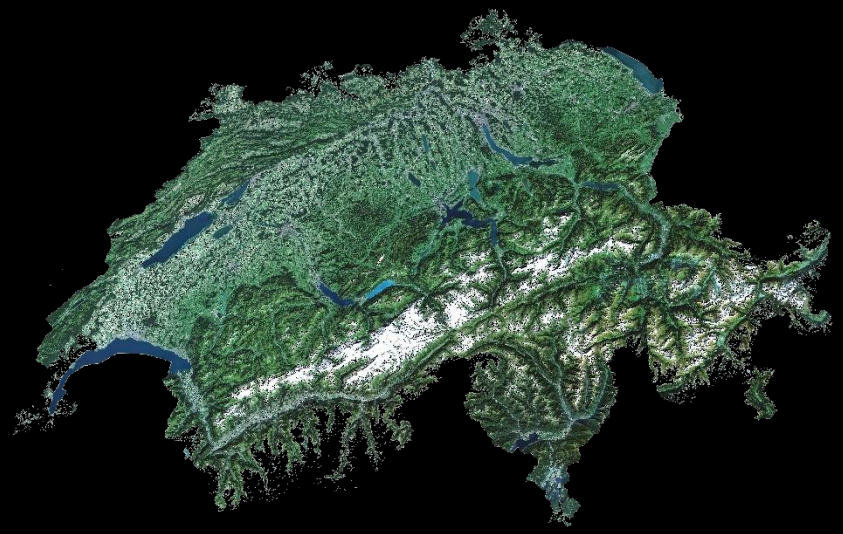
Swiss Confederation

**Federal Office for the Environment FOEN**

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Federal Department of the Environment,
Transport, Energy and Communications DETEC

**Federal Office for the Environment FOEN**



# Completing the Picture

## The Importance of Environmental Footprint Indicators

**Niklas Nierhoff**
**Swiss Federal Office for the Environment, FOEN**

Source: esa

# Why use Environmental Footprint Indicators?

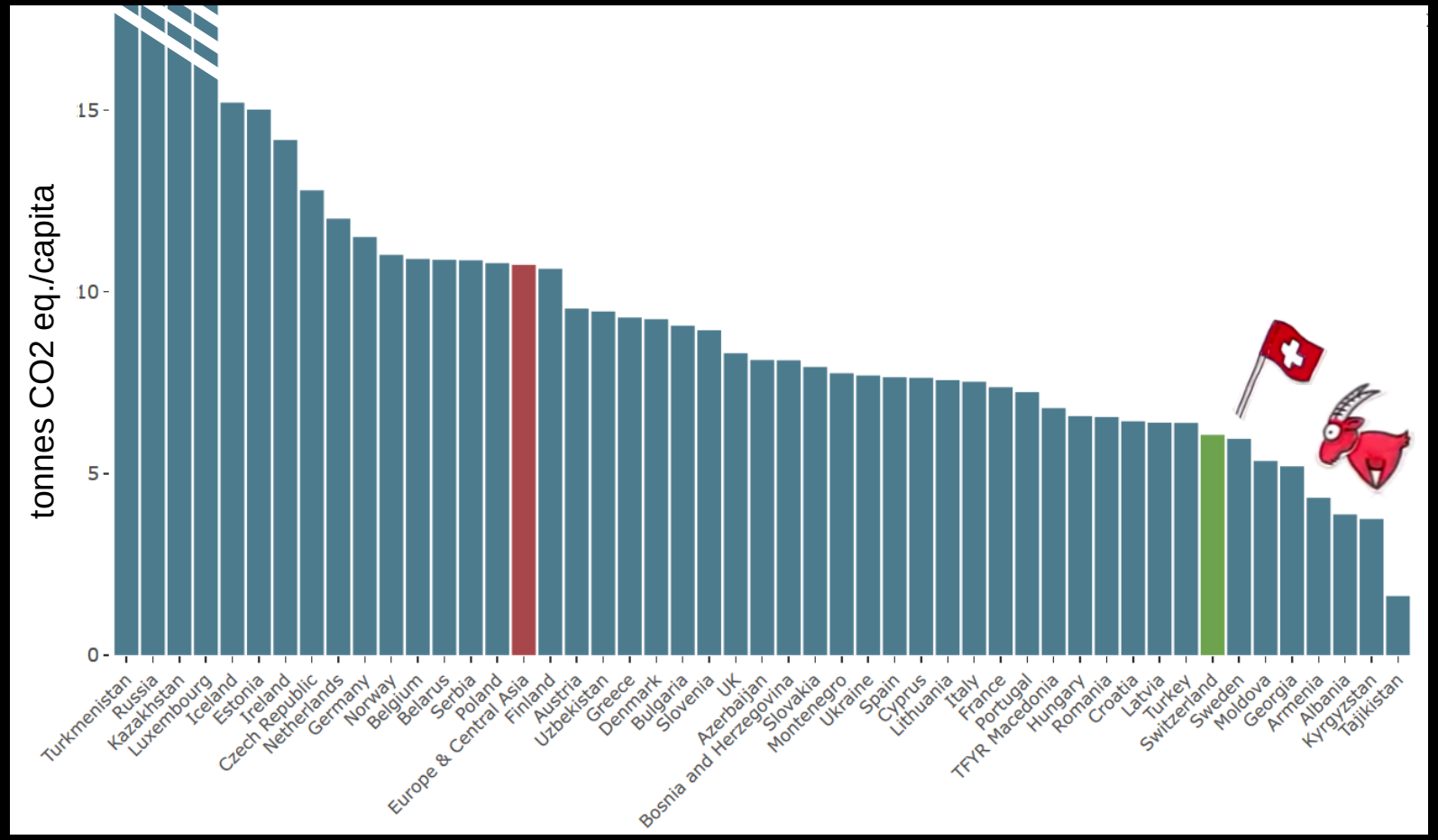
## Consumption perspective

- *Spillovers*: Environmental Impact Abroad
- Comparison with *Planetary Boundaries*
- Guidance for *Lifestyle Choices*

# Sustainability Leader
# or
# Sustainability Laggard?

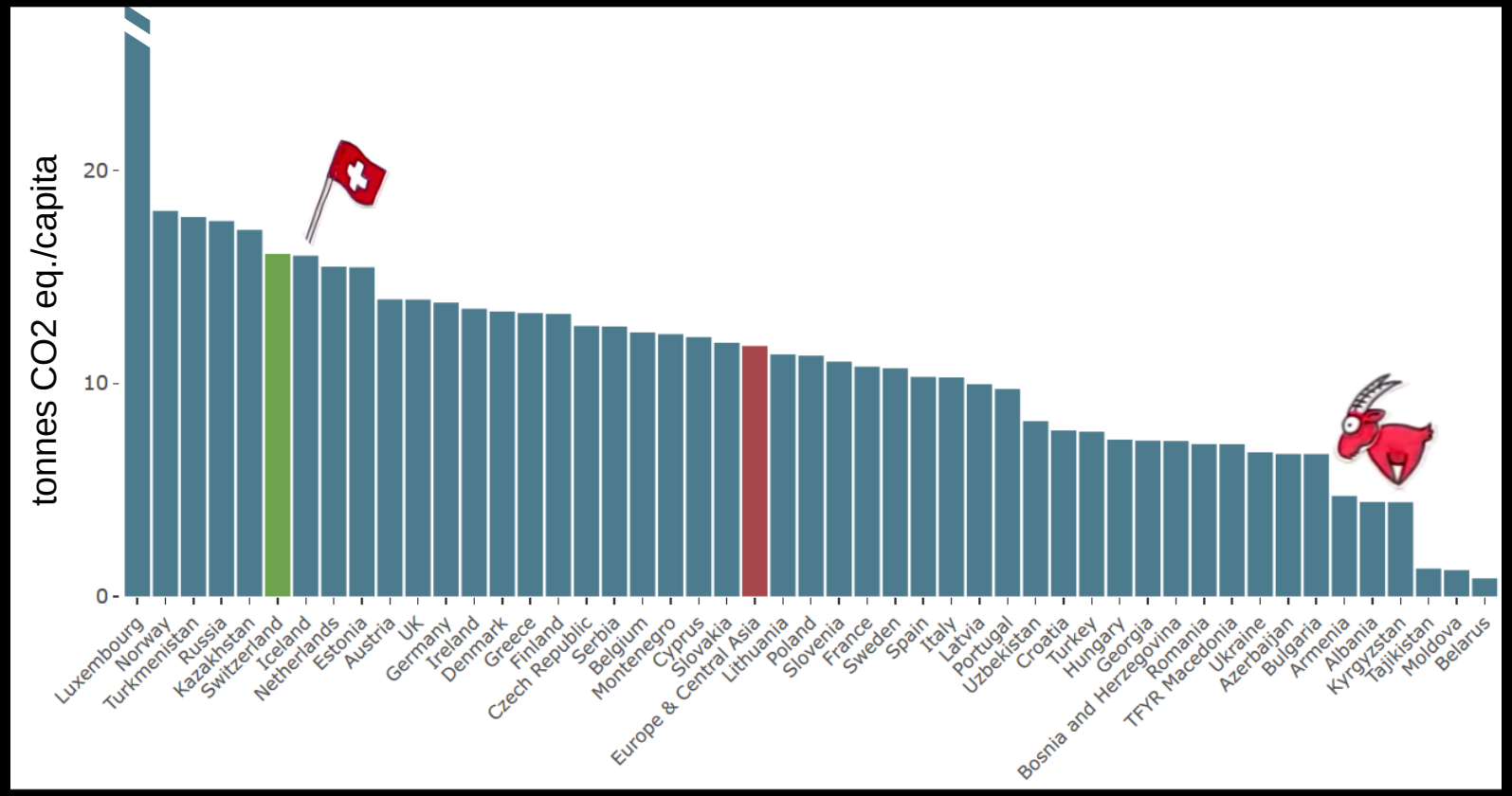
# International Comparison

# Greenhouse Gas Emissions
# Domestic Production per capita




Source: SCP HAT

# Greenhouse Gas Footprint per capita




Source: SCP HAT

# Aggregated Indices: GEP+ (High HDI) and Green Growth Index (Europe)

## D. RANKING OF GEP INDEX-DASHBOARD PROFILES USING THE PROTECTIVE CRITERION (GEP+), 100 COUNTRIES BY HDI GROUP[72]

| Rank | Country | Progress Greenhouse gas emissions | Progress Nitrogen emissions | Progress Land use | GEP Index | Protective criterion | HDI group |
|---|---|---|---|---|---|---|---|
| 1 | Cyprus | 0,5566 | 0,5971 | **0,1800** | 0,5862 | 0,1800 | Very High |
| 2 | Portugal | 0,9080 | 0,7315 | 0,1120 | **0,0999** | 0,0999 | Very High |
| 3 | Spain | 1,3180 | 1,7082 | **0,0873** | 0,2118 | 0,0873 | Very High |
| 4 | Italy | 0,9423 | 1,9024 | **0,0664** | 0,2598 | 0,0664 | Very High |
| 5 | France | 0,8247 | 1,4731 | **0,0338** | 0,1664 | 0,0338 | Very High |
| 6 | Hungary | 0,6927 | 0,2506 | **0,0279** | 0,3902 | 0,0279 | Very High |
| 7 | Slovenia | 0,2241 | 0,8939 | **0,0238** | 0,4997 | 0,0238 | Very High |
| 8 | Japan | 0,1101 | 0,2728 | **0,0167** | 0,1120 | 0,0167 | Very High |
| 9 | Denmark | 1,5100 | 0,3706 | **0,0125** | 0,0640 | 0,0125 | Very High |
| 10 | Austria | 0,3920 | 3,3070 | **0,0093** | 0,1031 | 0,0093 | Very High |
| 11 | Germany | 0,5734 | 0,2181 | **0,0039** | 0,1664 | 0,0039 | Very High |
| 12 | United Kingdom | 1,3344 | 0,7411 | **0,0033** | 0,1655 | 0,0033 | Very High |
| 13 | United States | 1,6188 | 0,3984 | **0,0020** | 0,0823 | 0,0020 | Very High |
| 14 | Ireland | 2,3998 | 7,8447 | **0,0012** | 0,6197 | 0,0012 | Very High |
| 15 | Norway | 0,5814 | 1,0264 | **0,0006** | 0,1789 | 0,0006 | Very High |
| 16 | Sweden | 1,0784 | 0,5890 | **-0,0023** | 0,0443 | -0,0023 | Very High |
| 17 | New Zealand | 1,1858 | 4,7342 | **-0,0096** | 0,1482 | -0,0096 | Very High |
| 18 | Netherlands | 0,6090 | 1,4448 | **-0,0194** | 0,1519 | -0,0194 | Very High |
| 19 | Luxembourg | 0,6066 | 1,5436 | **-0,0331** | 0,2536 | -0,0331 | Very High |
| 20 | Greece | 0,8965 | 2,0803 | **-0,0410** | 0,2209 | -0,0410 | Very High |
| 21 | Croatia | 0,1319 | 3,7294 | **-0,0412** | 0,1999 | -0,0412 | Very High |
| 22 | Australia | 1,0147 | 0,6382 | -0,0017 | **-0,0601** | -0,0601 | Very High |
| 23 | Israel | **-0,0968** | 1,0527 | 0,0040 | 0,0676 | -0,0968 | Very High |
| 24 | Switzerland | 0,5174 | **-0,1158** | -0,0002 | 0,1830 | -0,1158 | Very High |
| 25 | Singapore | 0,6208 | 0,4228 | 0,0211 | **-0,1218** | -0,1218 | Very High |
| 26 | Finland | 1,3523 | **-0,2502** | 0,0018 | 0,1193 | -0,2502 | Very High |
| 27 | Slovak Republic | 0,6501 | **-0,5558** | 0,0319 | 0,0251 | -0,5558 | Very High |
| 28 | Czech Republic | 0,8040 | **-1,2523** | -0,0016 | 0,1637 | -1,2523 | Very High |
| 29 | Argentina | -0,4092 | **-1,4991** | 0,0000 | 0,1040 | -1,4991 | Very High |
| 30 | Estonia | -1,1256 | **-1,8189** | 0,0392 | 0,0647 | -1,8189 | Very High |
| 31 | Chile | -0,8764 | **-2,5840** | -0,0115 | 0,1501 | -2,5840 | Very High |
| 32 | Poland | -0,1675 | **-2,6289** | -0,0344 | 0,3607 | -2,6289 | Very High |
| 33 | Canada | 0,8991 | **-2,9238** | 0,0279 | 0,0837 | -2,9238 | Very High |
| 34 | Lithuania | -0,7701 | **-5,6591** | 0,0278 | -0,1224 | -5,6591 | Very High |

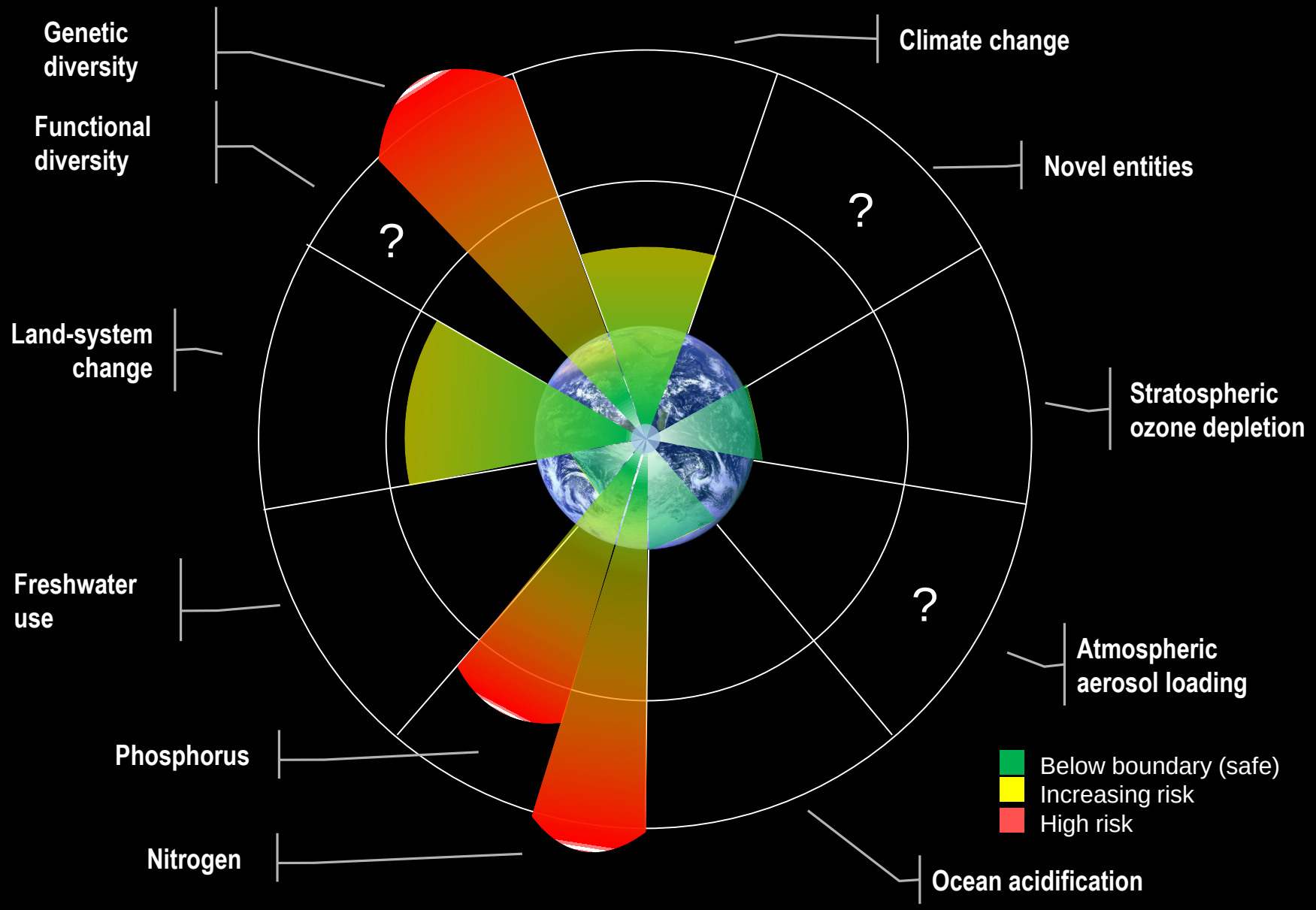
?

| European Countries / Territories | Green Growth Dimensions: Efficient and Sustainable Resource Use | Natural Capital Protection | Green Economic Opportunities | Social Inclusion | Green Growth Index: Scores | Level | Ra |
|---|---|---|---|---|---|---|---|
| Denmark | 75.50 | 72.52 | 63.84 | 92.07 | 75.32 | High | 1 |
| Sweden | 75.79 | 77.26 | 57.96 | 93.70 | 75.09 | High | 2 |
| Austria | 71.57 | 79.56 | 52.27 | 91.92 | 72.32 | High | 3 |
| Finland | 67.36 | 72.25 | 58.86 | 92.23 | 71.69 | High | 4 |
| Czech Republic | 63.04 | 78.40 | 61.85 | 84.48 | 71.29 | High | 5 |
| Italy | 58.31 | 83.15 | 57.63 | 87.01 | 70.22 | High | 6 |
| Germany | 55.02 | 81.52 | 60.55 | 88.65 | 70.04 | High | 7 |
| Estonia | 62.02 | 69.31 | 59.12 | 86.66 | 68.50 | High | 8 |
| Latvia | 72.05 | 74.43 | 49.40 | 81.87 | 68.24 | High | 9 |
| Slovakia | 61.57 | 83.35 | 49.51 | 82.21 | 67.60 | High | 10 |
| Portugal | 58.77 | 80.40 | 47.25 | 86.66 | 66.32 | High | 11 |
| Belgium | 46.51 | 75.74 | 55.88 | 90.34 | 64.94 | High | 12 |
| Hungary | 49.04 | 82.52 | 55.10 | 79.20 | 64.82 | High | 13 |
| France | 55.80 | 77.74 | 45.39 | 88.77 | 64.66 | High | 14 |
| Croatia | 64.05 | 81.37 | 44.29 | 74.94 | 64.49 | High | 15 |
| Slovenia | 60.39 | 77.58 | 41.78 | 85.73 | 64.00 | High | 16 |
| Spain | 50.04 | 78.47 | 47.61 | 87.90 | 63.67 | High | 17 |
| Lithuania | 60.01 | 70.87 | 46.47 | 83.02 | 63.65 | High | 18 |
| Netherlands | 50.41 | 74.39 | 46.76 | 91.99 | 63.38 | High | 19 |
| United Kingdom | 60.41 | 76.96 | 39.20 | 88.09 | 63.30 | High | 20 |
| Switzerland | 74.34 | 77.70 | 29.30 | 91.44 | 62.72 | High | 21 |
| Norway | 67.12 | 64.26 | 37.62 | 91.67 | 62 | High | 22 |
| Poland | 46.07 | 70.77 | 52.48 | 84.55 | 62 | High | 23 |
| Romania | 46.64 | 76.56 | 44.56 | 78.32 | 59 | Moderate | 24 |
| Ireland | 63.23 | 58.46 | 38.15 | 84.08 | 59 | Moderate | 25 |
| Luxembourg | 53.53 | 73.84 | 33.19 | 90.13 | 59 | Moderate | 26 |
| Greece | 53.28 | 80.47 | 30.95 | 81.94 | 57 | Moderate | 27 |
| Bulgaria | 41.69 | 78.25 | 40.67 | 78.85 | 57 | Moderate | 28 |
| Iceland | 52.87 | 45.77 | 40.56 | 89.39 | 54 | Moderate | 29 |
| Serbia | 40.26 | 74.02 | 33.89 | 74.83 | 52 | Moderate | 30 |
| Albania | 50.27 | 80.49 | 23.42 | 75.14 | 52 | Moderate | 31 |

Source: UN PAGE, GGGI

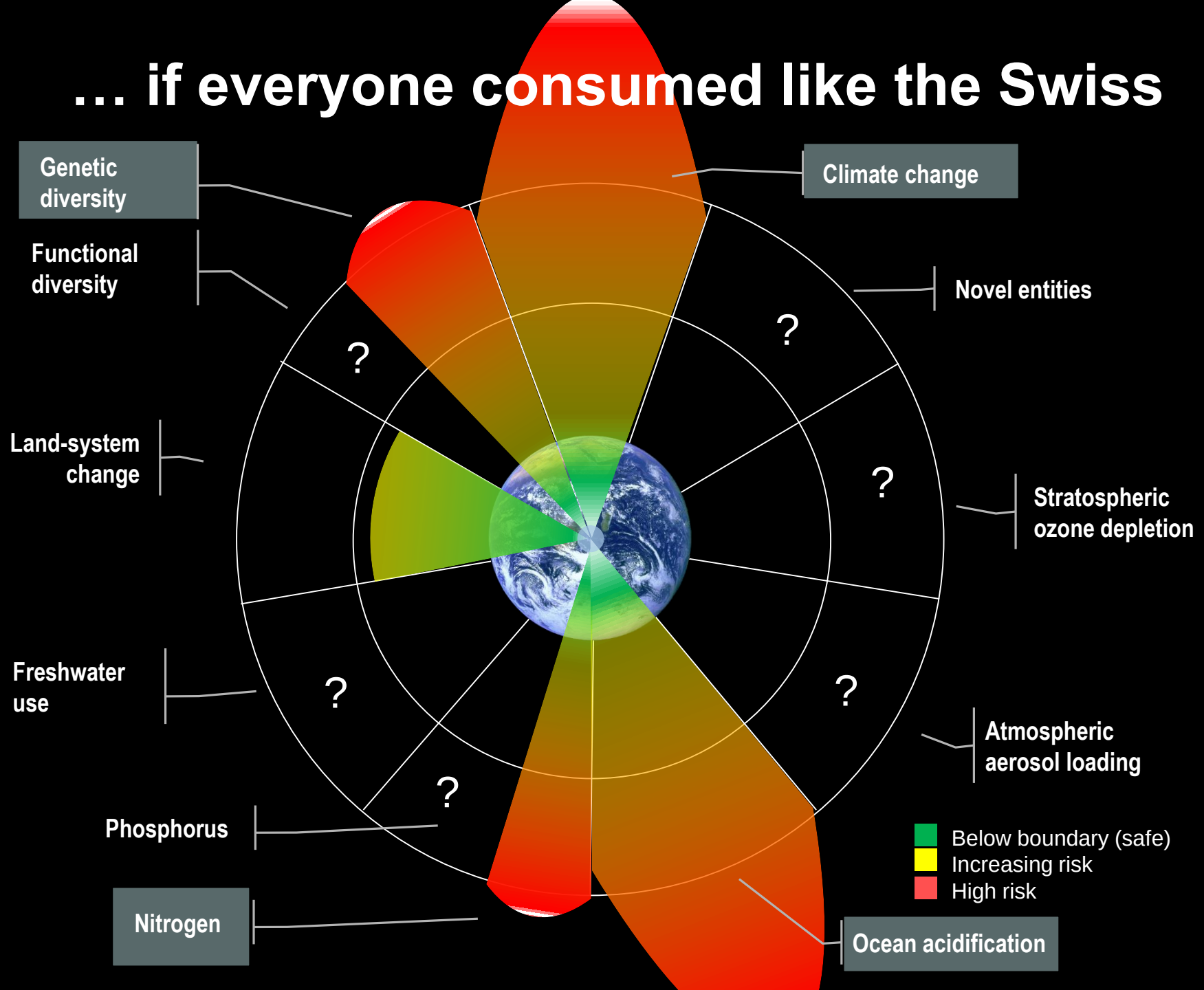
# Planetary Boundaries

# Planetary Boundaries




Source: Steffen et al. 2015 (adapted)

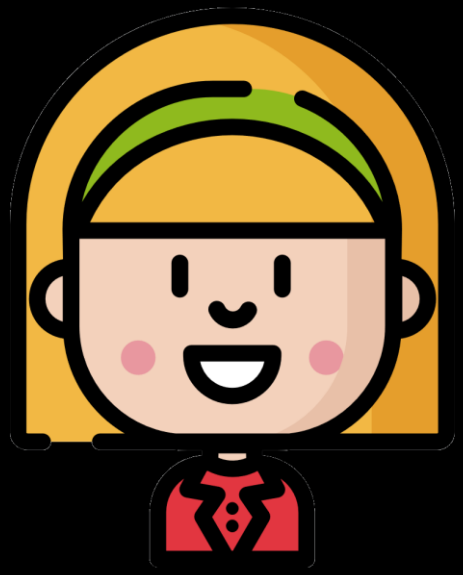
# … if everyone consumed like the Swiss

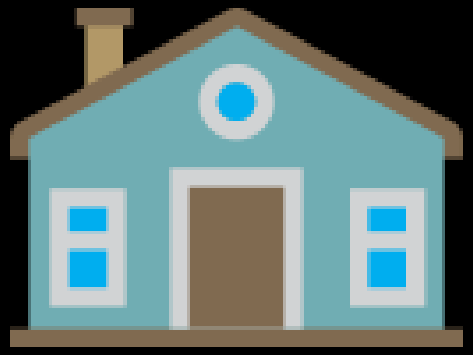



Source: Steffen et al. 2015; Frischknecht et al. 2018 (adapted),

# Lifestyles

# Guidance for Environmental Impact of Lifestyles





Sources: iconify; Squid.ink; BomSymbol; strongicons; Cemagraphics, Smashicons

# Putting Progress Measurement into the Consumption Perspective

Focus of this webinar

**José Pineda**
Senior Consultant, UNEP
Adjunct Professor, University of British Columbia

UN environment programme

UBC THE UNIVERSITY OF BRITISH COLUMBIA

# What is the Green Economy Progress (GEP) Measurement Framework?

José Pineda, University of British Columbia

# The Green Economy Narrative

- An Inclusive Green Economy (IGE) is **too**l for delivering **sustainable development** and a response to **three sets of challenges facing humanity**: persistent poverty, inequitable sharing of the growing prosperity, and overstepped planetary boundaries.

- The **Green Economy Progress (GEP) Measurement Framework** is a response to the need of indicators supporting an integrated and inclusive policymaking approach. It has two main purposes:
  1. to provide a sound formula to measure progress towards an IGE; and
  2. to offer a tool that could be used as a guide for policymaking, adding value to the current reporting system on individual indicators, including the SDGs.

# The Green Economy Measurement Framework

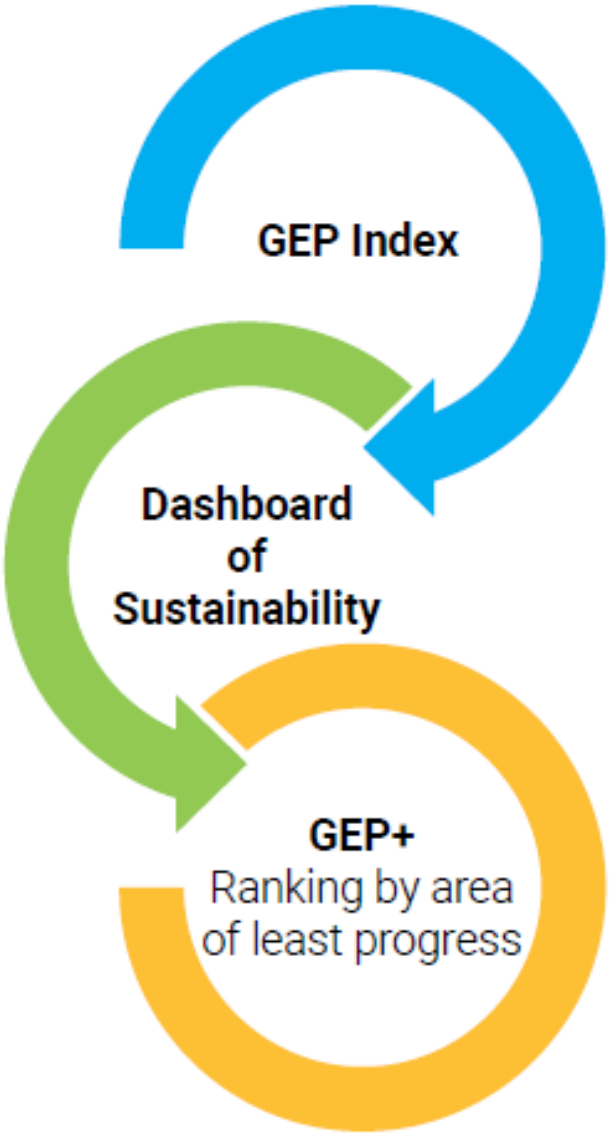
*GEP index:* track **progress** in green economy indicators, relative to the desired changes, impacting current well-beir

- Reflects weighted progress achieved by countries with respect to targets set within relevant thresholds across several indicators
- The score of the GEP index gives a country an indication of its overall progress towards an IGE

*Dashboard of progress on sustainability indicators:* monitor the **sustainability** of well-being (well-being of future generations).

- Keeps track of some of the main forms of natural capital as well a: other key stocks of capital which affect long term sustainability.

*GEP+* **ranking** of progress is done by comparing progress or indicators in the *dashboard* with progress measured by the *GEP index*.



# The Green Economy Progress (GEP) Index

- The main features of this index are the following:
  i. it focuses on the **measurement of changes** rather than levels (it is an index of progress);

  ii. it evaluates realizations relative to some **targets**, which are an expression of underlying policy goals;

  iii. it involves the use of **critical thresholds** that describe the existence of some barriers (related to sustainability) that must not be trespassed;

  iv. it allows for different societies to **value differently** the dimensions included in the evaluation; and

  v. it is **flexible** enough so that one can encompass "positive and negative" dimensions.

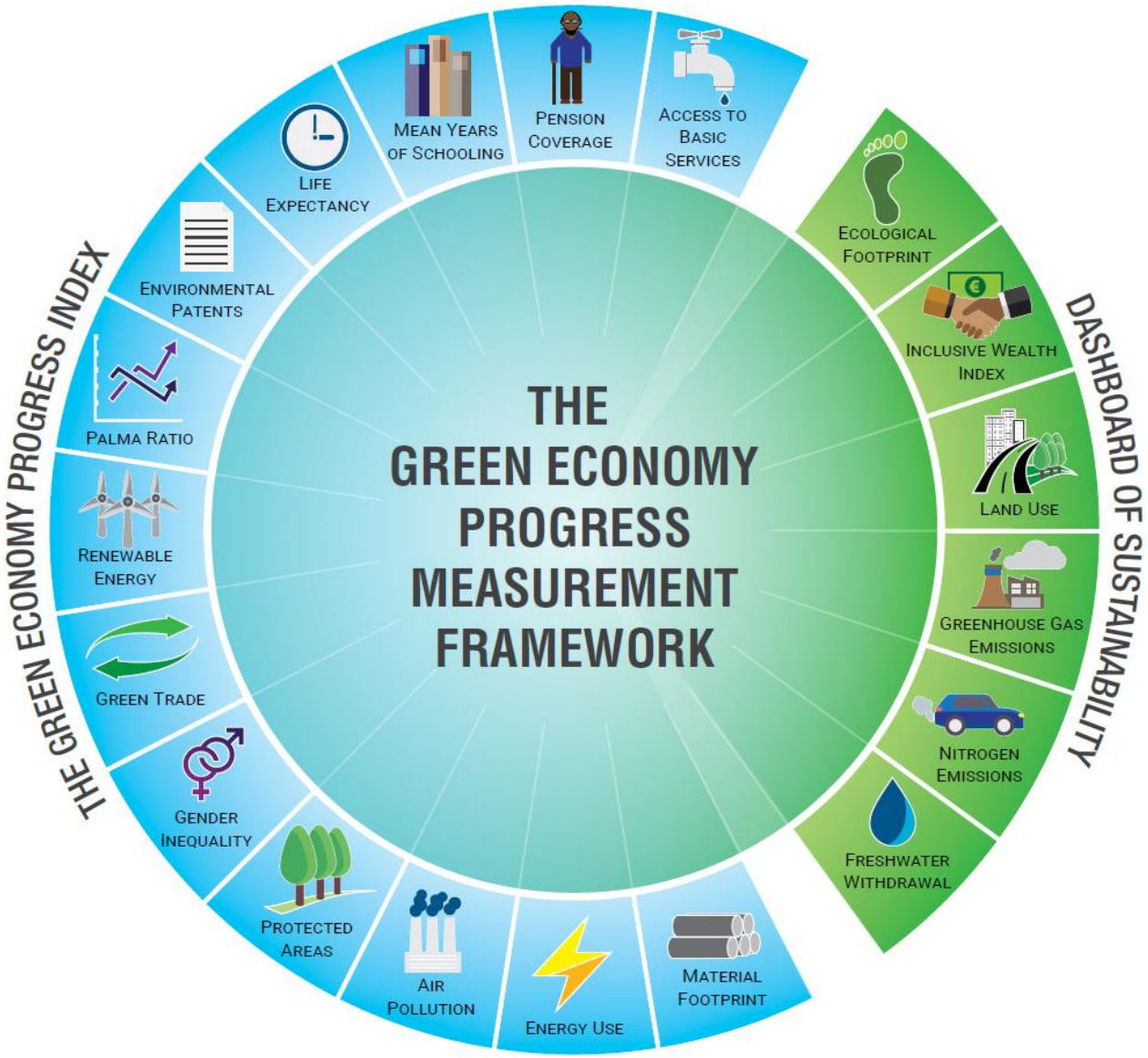
# Overall ranking: Aggregating information in GEP index and dashboard

- Rank all index-dashboard profiles but do not combine their information into a synthetic index.

- When comparing progress based on the GEP index and the dashboard, countries are ranked according to their least-performing progress.

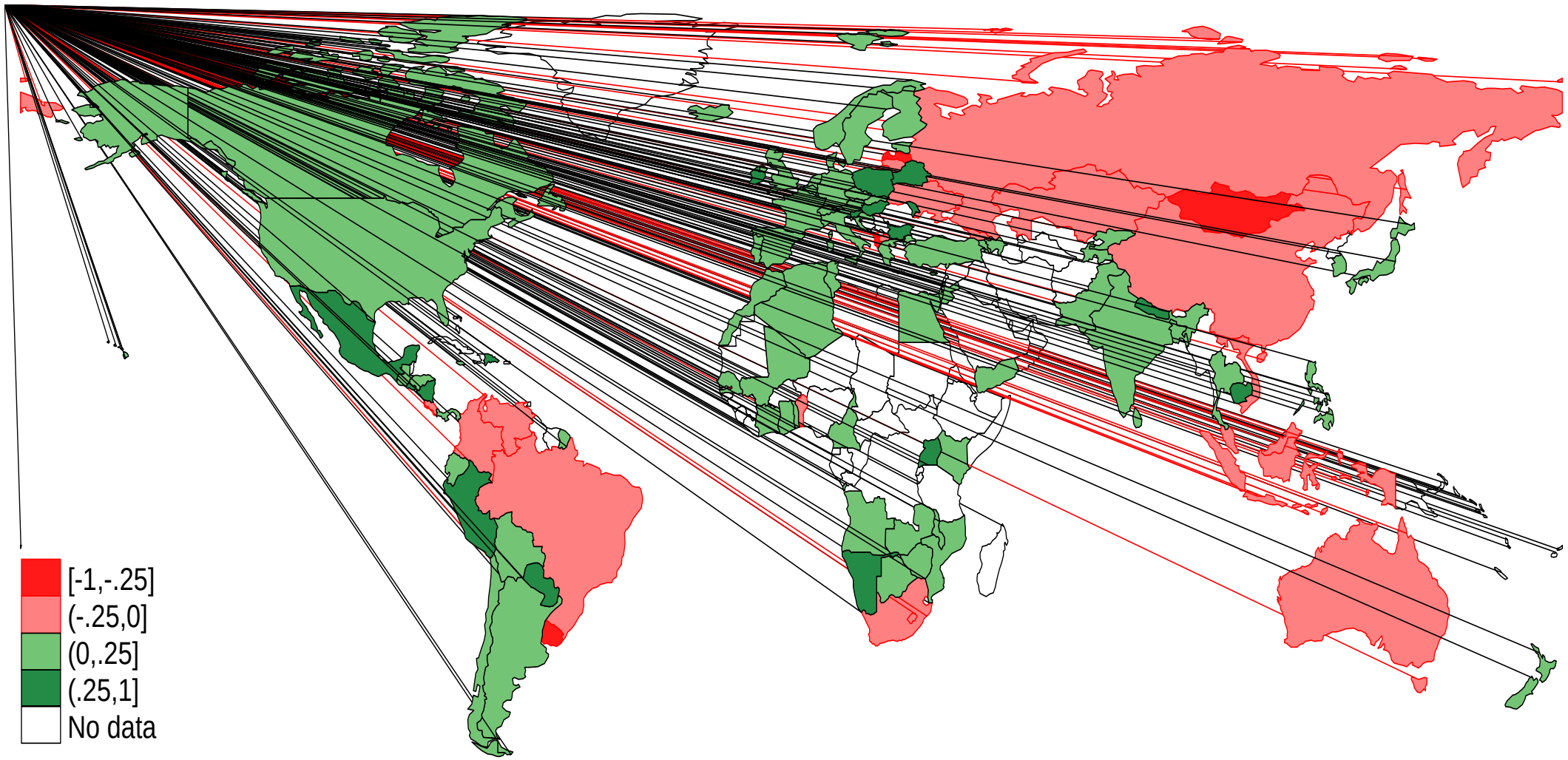
- Carries a double signal for countries:
  - Learn about their relative green economy progress with the GEP index and dashboard indicators.
  - Learn how their least-performing progress compares with the achievements of other countries.

# Indicators and links with SDGs




| | |
|---|---|
| **Green Trade**<br>Export of environmental goods (% of total export) | 8 Decent Work and Economic Growth |
| **Environmental Patents**<br>Measure of green technology innovation (% of total patents) | 12 Responsible Consumption and Production |
| **Renewable Energy**<br>Share of renewable energy supply (of total energy supply) | 7 Affordable and Clean Energy |
| **Energy Use**<br>Energy use (kg of oil equivalent) per USD 1,000 GDP | 7 Affordable and Clean Energy |
| **Palma Ratio**<br>Ratio of the richest 10% of the population income over income of the poorest 40% | 10 Reduced Inequalities |
| **Access to Basic Services**<br>Access to improved water sources, electricity, sanitation (% of total population) | 1 No Poverty; 3 Good Health and Well-Being; 6 Clean Water and Sanitation; 7 Affordable and Clean Energy |
| **Air Pollution**<br>PM2.5 pollution mean annual exposure (micrograms per cubic meter) | 3 Good Health and Well-Being; 11 Sustainable Cities and Communities |
| **Material Footprint**<br>Raw material consumption of used biotic and abiotic materials (tonnes/person) | 8 Decent Work and Economic Growth; 12 Responsible Consumption and Production |
| **Protected Areas**<br>Sum of terrestrial & marine protected areas (% of total land area and territorial waters) | 14 Life Below Water; 15 Life on Land |
| **Gender Inequality Index**<br>Inequality in gender across reproductive health, empowerment, & the labour market | 3 Good Health and Well-Being; 4 Quality Education; 5 Gender Equality |
| **Pension Coverage**<br>Share of population above statutory pensionable age receiving a pension | 1 No Poverty; 10 Reduced Inequalities |
| **Mean Years of Schooling**<br>Average number of years of education received by people ages 25 and older | 4 Quality Education |
| **Life Expectancy**<br>Life expectancy by contribution and sex | 3 Good Health and Well-Being |

# GEP index: by country

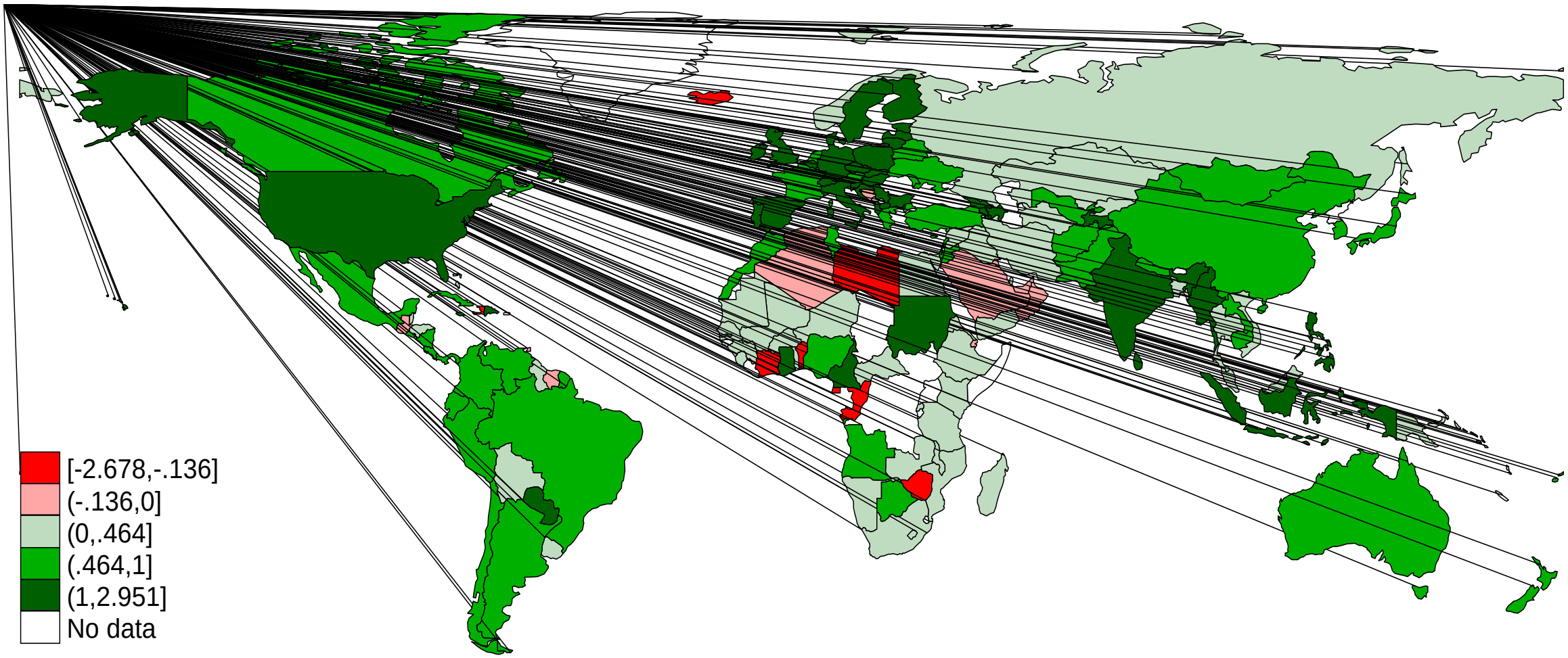


# Application to SDG 7

- SDG 7: *Ensure access to affordable, reliable, sustainable and modern energy for all*.
  - Indicator 7.1.1 (Energy inclusivity). Measured by the percentage of the population with access to electricity. This indicator measures a *good*.
  - Indicator 7.2.1 (Greenness). Measured by the percentage of the renewable energy share in the total final energy consumption. This indicator is a *good.*
  - Indicator 7.3.1 (Efficiency). Energy intensity measured in kg of oil equivalent per $1,000 of GDP in 2001 PPP terms. This indicator measures a *bad*.

- Given data availability, it was possible to calculate progress for the three indicators between 2005 and 2015, for a total of 183 countries.
  - IGE index is calculated is we have values for at least 2 out of 3 indicators.
  - All the data comes from the World Development Indicators of the World Bank.

# Inclusive Green Energy index of progress: by country



# Final Remarks

The GEP Measurement Framework:

i. Focusses on the change of the corresponding variables, rather than on their levels;
ii. Is decomposable, which allows us to integrate several dimensions in a simple way, allowing for the inclusion of “goods” and “bads”; and
iii. Evaluate progress relative to some normatively determined reference values: targets, which can differ between countries, and thresholds -that are to be interpreted as planetary boundaries that ought not to be crossed.

Application illustrates how this evaluation protocol works and permits the identification of countries that are doing particularly well (or particularly poorly), and why.

This is an instrument for monitoring whether countries’ desired targets (e.g. SDG 7) become a reality in the not so distant future.

Methodology is flexible for country applications or adding other indicators

- Specific indicators reflecting national priorities, sub-national measurement, time frame, etc.

**Arnold Tukker**
Scientific Director, Institute of Environmental Sciences
Leiden University

CML
Institute of Environmental Sciences

# Measuring SDGs with Global Environmental Input-Output Tables (IOTs)

Prof. Arnold Tukker
Professor of Industrial Ecology
Scientific Director, CML, Leiden University / senior researcher, TNO

Chair, Leiden-Delft-Erasmus Centre for Sustainability

GGKP webinar ‘What’s your country’s footprint?’, 18 March 2020

Universiteit Leiden The Netherlands

TU Delft Delft University of Technology

Erasmus University Rotterdam

# What is a Multi-regional Input Output Table?

- **<u>Input-output</u>** (RED Blocks)
  - Divides a country economy in sectors (or products)
  - Identifies purchases (input) and sales (output) from a sector to other sectors -> maps value chains

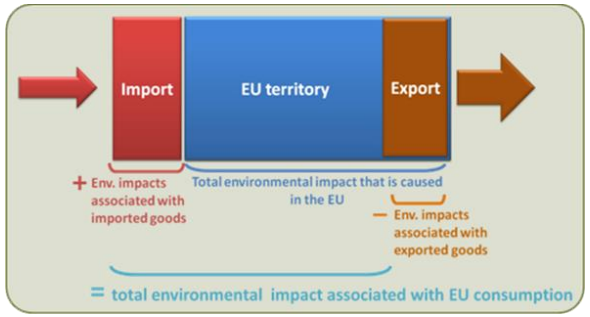
- **<u>Multi-regional</u>**: maps imports and exports by sector, country (GREEN blocks) -> maps global value chains

- **<u>Extensions</u>**: (GREY blocks) give per country, sector:
  - Jobs
  - Value added created (salary, depreciation, profit, tax)
  - Emissions, primary resource use, land, water

- Inherently mapping relations in the global economy
- Inherently covering global GDP, emissions, etc.
- Can support monitoring of many SDGs *IF you have the data*

| | | 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 | | $NAMEA_A$ | $NAMEA_B$ | $NAMEA_C$ | $NAMEA_D$ | | | | | |
| | | $Agric_A$ | $Agric_B$ | $Agric_C$ | $Agric_D$ | | | | | |
| | | $Energy_A$ | $Energy_B$ | $Energy_C$ | $Energy_D$ | | | | | |
| | | $Metal_A$ | $Metal_B$ | $Metal_C$ | $Metal_D$ | | | | | |
| | | $Mineral_A$ | $Mineral_B$ | $Mineral_C$ | $Mineral_D$ | | | | | |
| | | $Land_A$ | $Land_B$ | $Land_C$ | $Land_D$ | | | | | |

# Countries pollute within their borders, *but they drive also pollution via imports and exports*




| Value chain position | Upstream / suppliers | Own operations | Downstream / customers |
|---|---|---|---|
| Activity description | What I purchase | What I own and control | What I sell |
| Accounting perspective *(calculation approach using extended input-output databases)* | Consumption *(Leontief inverse)* | Production *(Extensions per sector)* | Income/Extraction *(Ghosh inverse)* |
| | Value added *(Leontief inverse distributed by added value over value chains)* | | |
| Mitigation principle *(illustrative measures)* | User pays • *Source shifting* • *Shift to low impact products* • *Reduce purchases* | Polluter pays • *Use clean technology* • *Enhance efficiency* • *Reduce emission factors* | Producer responsibility • *Ecodesign* • *Design for re-use, circularity, etc.* • *Offering PSS instead of products.* |
| | Beneficiary pays • *Transfer income to pay for mitigation* | | |

Tukker, Pollitt, Henkemans (2020): Consumption-based carbon accounting – sense and sensibility. Climate policy, in press

# GMRIOs can handle all these perspectives on environmental responsibilities!

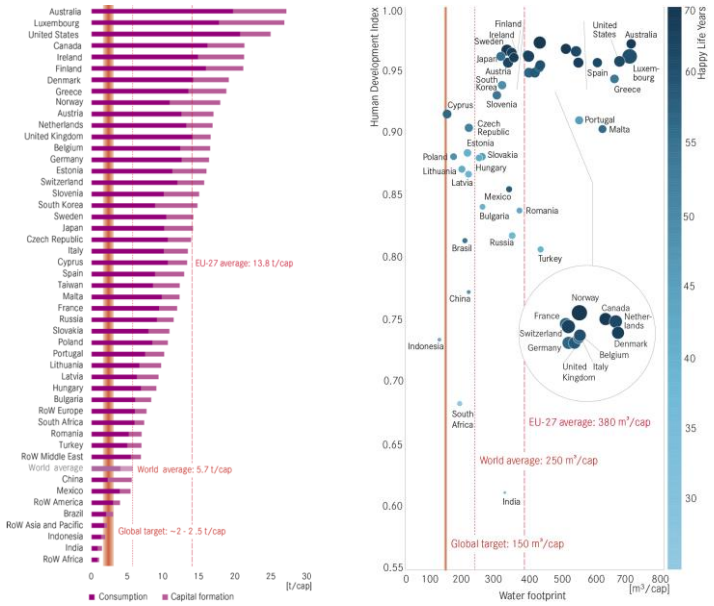
## Moving from production- to consumption-based

- Example: 5 Euro coffee at Starbucks
  - 3 Euro for Starbucks = Restaurant
  - 1 Euro for roaster = Food industry
  - 0.5 Euro for transport = Transport
  - 0.25 Euro for farmer = Agriculture
  - 0.25 Euro for fertiliser, etc.
  - Impacts per sector/country per Euro known
  - Multiply -> you see how impacts of production relate to consumption

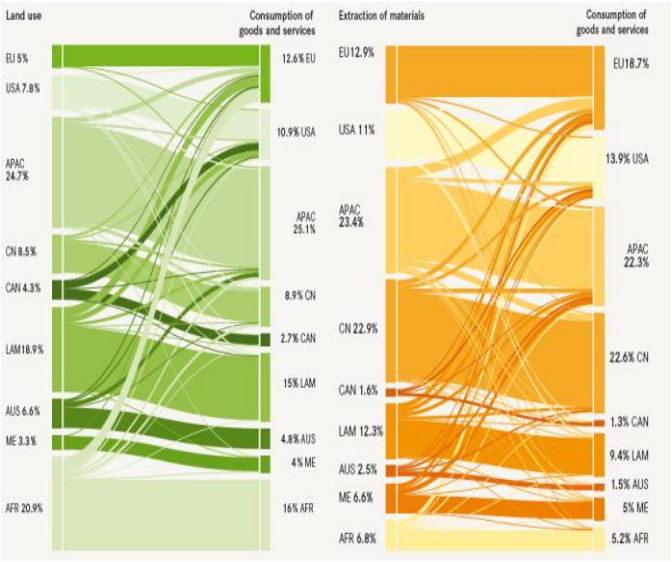
- In essence you redistribute global territorial / production based emissions to consumption

| | 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 | $Capital_A$ | $C_B$ | $C_C$ | $C_D$ | | | | | |
| | $Labor_A$ | $L_B$ | $L_C$ | $L_D$ | | | | | |
| | $NAMEA_A$ | $NAMEA_B$ | $NAMEA_C$ | $NAMEA_D$ | | | | | |
| Environ Ext | $Agric_A$ | $Agric_B$ | $Agric_C$ | $Agric_D$ | | | | | |
| | $Energy_A$ | $Energy_B$ | $Energy_C$ | $Energy_D$ | | | | | |
| | $Metal_A$ | $Metal_B$ | $Metal_C$ | $Metal_D$ | | | | | |
| | $Mineral_A$ | $Mineral_B$ | $Mineral_C$ | $Mineral_D$ | | | | | |
| | $Land_A$ | $Land_B$ | $Land_C$ | $Land_D$ | | | | | |

# Some illustrative applications




Carbon footprint, water footprint versus HDI

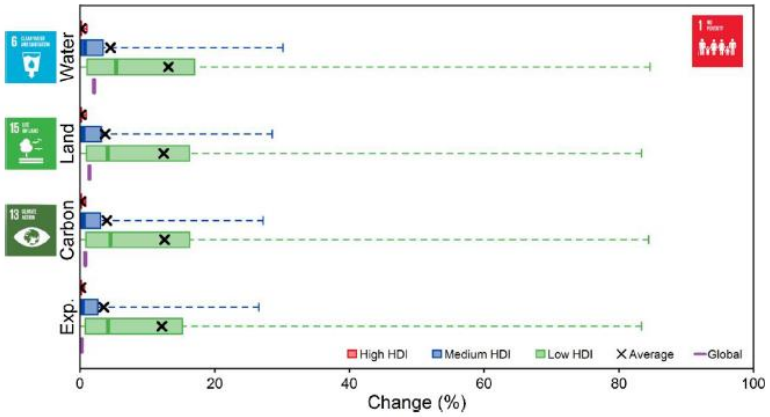



Land use/material extraction per economic block, versus land & material needs for consumption

Trade-offs between social and environmental Sustainable Development Goals

Laura Scherer[a,*], Paul Behrens[a,b], Arjan de Koning[a], Reinout Heijungs[a,c], Benjamin Sprecher[a], Arnold Tukker[a]

[a] Institute of Environmental Sciences (CML), Leiden University, Leiden, the Netherlands
[b] Leiden University College The Hague, 2595 DG, The Hague, the Netherlands
[c] Department of Econometrics and Operations Research, Vrije Universiteit, Amsterdam, the Netherlands




Extra land, water, carbon footprint of a minimum income of 1.25 $ per day

# GMRIOs can handle all these perspectives on environmental responsibilities! However…

Or, in sum: there cannot be one ‘good’ way of building a MRIO. All existing MRIOs are constructs and estimates.

They must chose between conflicting data sources and can’t be fully ‘correct’ (e.g. IEA + emission factors versus EDGAR for carbon)

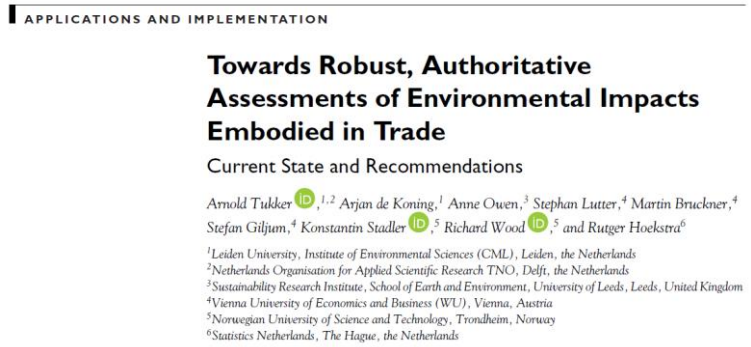
The 5 available may fit different purposes.

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

# Overview of initiatives & thoughts for the future

| | Countries | Sectors | Remark |
|---|---|---|---|
| GTAP | 140 | 57 | Built for value chain analysis, used for carbon footprinting |
| WIOD | 40 (+RoW) | 35 | Built mainly for value chain analysis |
| EORA | 180 | variable: 20 to 500 | 100 countries are 'constructed' IO's and have just 26 sectors |
| EXIOBASE | 48 (+RoW) | 160 | Has detail in agri, energy, resources but less in countries |
| ICIO | 64 | 48 | Built mainly for value chain analysis, by OECD |
| **In progress** | | | |
| PANORAMA | T.b.d. | >1000 | Physical IO: sectors, products ánd composition (materials), paid by EIT Raw Materials to CML&consortium |
| FINEPRINT | | | Detailed spatially explicit resource flow analysis, paid by ERC to WU (Vienna) |

- RoW EXIOBASE can be rather easily be split up
  - Use GDP and final demand distribution estimates from countries
  - Use information on the relative importance of certain sectors (e.g. from FAO, UN, etc.) and UN COMTRADE trade
- My ideal is however (JIE (22) 3 p. 585, 2018)
  - Use ICIO – only made by an international institute (OECD) so 'more official'
  - Detail in sectors using EXIOBASE tricks + FAO, IEA, etc.
  - Create databases of semi-official, global extensions, e.g.
    - UN IRP database for resources
    - Anything agreed upon for Carbon per sector
    - Land, water?


APPLICATIONS AND IMPLEMENTATION

**Towards Robust, Authoritative Assessments of Environmental Impacts Embodied in Trade**

Current State and Recommendations

Arnold Tukker,[1,2] Arjan de Koning,[1] Anne Owen,[3] Stephan Lutter,[4] Martin Bruckner,[4] Stefan Giljum,[4] Konstantin Stadler,[5] Richard Wood,[5] and Rutger Hoekstra[6]

[1]Leiden University, Institute of Environmental Sciences (CML), Leiden, the Netherlands
[2]Netherlands Organisation for Applied Scientific Research TNO, Delft, the Netherlands
[3]Sustainability Research Institute, School of Earth and Environment, University of Leeds, Leeds, United Kingdom
[4]Vienna University of Economics and Business (WU), Vienna, Austria
[5]Norwegian University of Science and Technology, Trondheim, Norway
[6]Statistics Netherlands, The Hague, the Netherlands

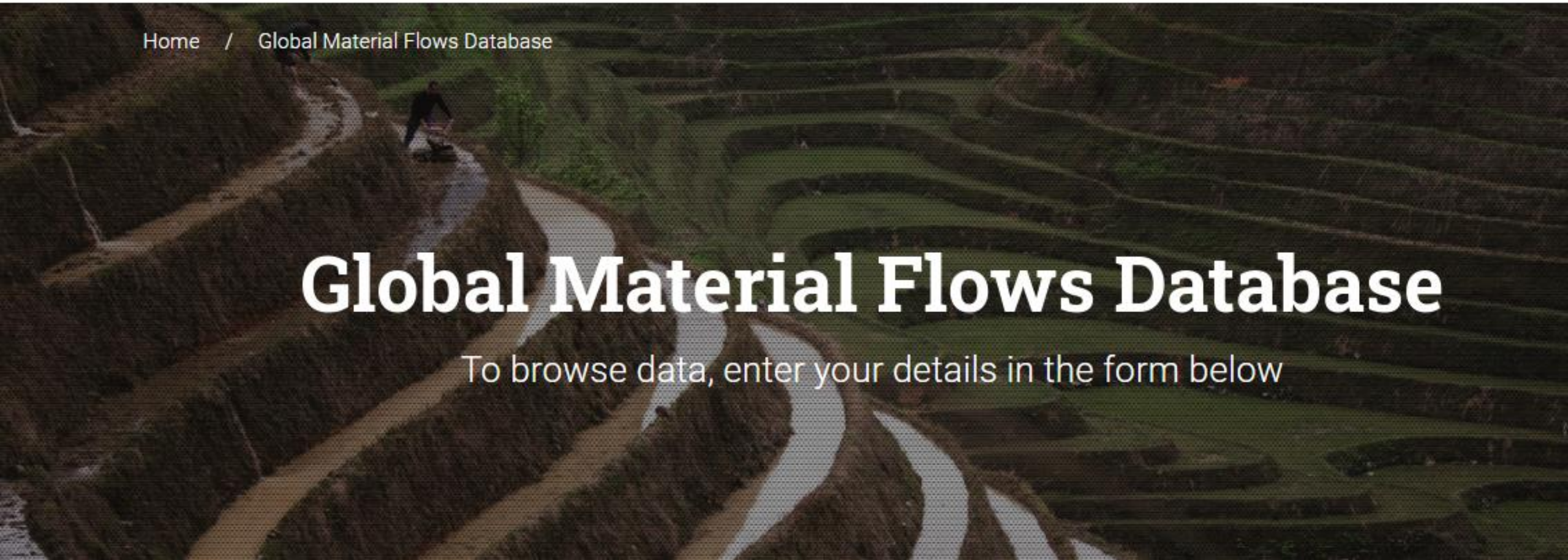
Thanks for your attention!

**Llorenç Milà i Canals**
Head of Secretariat,
Life Cycle Initiative

UN environment programme

Life Cycle Initiative

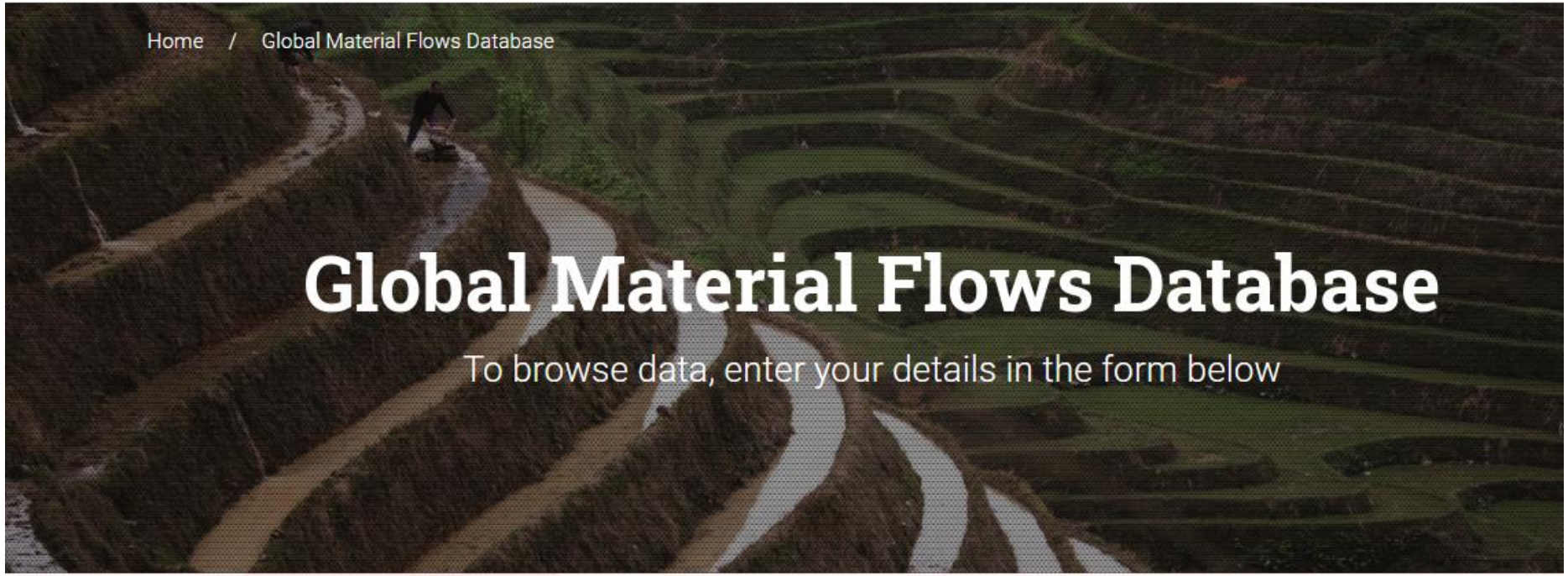
https://www.resourcepanel.org/global-material-flows-database



UN environment | International Resource Panel

Search

REPORTS & DATA | THE PANEL | NEWS & EVENTS




SCP HOTSPOT ANALYSIS

MATERIALFLOWS.NET
The Material Flow Data Portal

***Report launched 12th March 2019***

***#GRO2019***

***#GROBusiness***

***@UNEPIRP***

UN environment programme

International Resource Panel

# HOTSPOT ANALYSIS TOOL FOR SUSTAINABLE CONSUMPTION AND PRODUCTION

to support science-based national policy frameworks

VIEW MODULES

scp-hat.lifecycleinitiative.org/

**Country Profile**

**SCP Hotspots**

**National Data Systems**

One planet
handle with care

International Resource Panel

Life Cycle Initiative

**Stephan Pfister**
Senior Research Associate,
Ecological Systems Design

ETH zürich

# *How can we combine the Green Economy Progress (GEP) Measurement Framework with environmental footprints indicators?*

Stephan Pfister, ETH Zurich, supported by Viktoras Kulionis, ETH Zurich

*Webinar on GEP*

*March 18, 2020*

# Overview

- Planetary boundaries and footprint indicators
- Starting point:
  - SCP-HAT and IRP analysis tool
- Introducing environmental footprint indicators into the GEP Measurement Framework
  - Available data sources
  - Preliminary results
  - What is required to move ahead

# Planetary boundaries and footprint indicators

- Planetary boundaries have been estimated (e.g. Steffen et al. 2015) but are highly uncertain
- They do not account for regional differences which is important for land and water use related impacts
  - No agreed thresholds exists
- The GEP Measurement Framework allows to determine relative thresholds if no absolute boundaries exist
  - Based on percentiles of other countries
  - Not done in presvious application (PAGE 2017)

# Environmental footprints to extend GEP

- Main focus:
  - Carbon footprint (GHG)
  - Land / biodiversity footprint
  - Water footprint

  } Partially covered in the dashboard (freshwater withdrawal, land use, GHG emissions)

- Recent results from UNEP's IRP and Life cycle initiative
  - Consensus impact assessment methods for land and water use
  - Application assessment on MRIO data (IRP)
  - Carbon footprint based on IPCC GHG assessments (100 year GWP)

# Tools available to address carbon, land and water footprints

- SCP HAT v1 (2019)
  - Good user interface
  - Limited functionality for assessments beyond producer or consumer perspective
  - Missing coverage of water consumption and detailed biodiversity impacts
- Cabernard et al. 2019
  - Data used for the GRO analysis
  - Limited user interface (for advanced users)
  - Enhanced functionality for assessing sectors and countries' economy beyond production and consumption footprint
  - Coverage of regionalized assessment for biodiversity and water scarcity impacts
- Other tools miss impact assessment for land and water use

# Introducing environmental footprint indicators into the GEP Measurement Framework

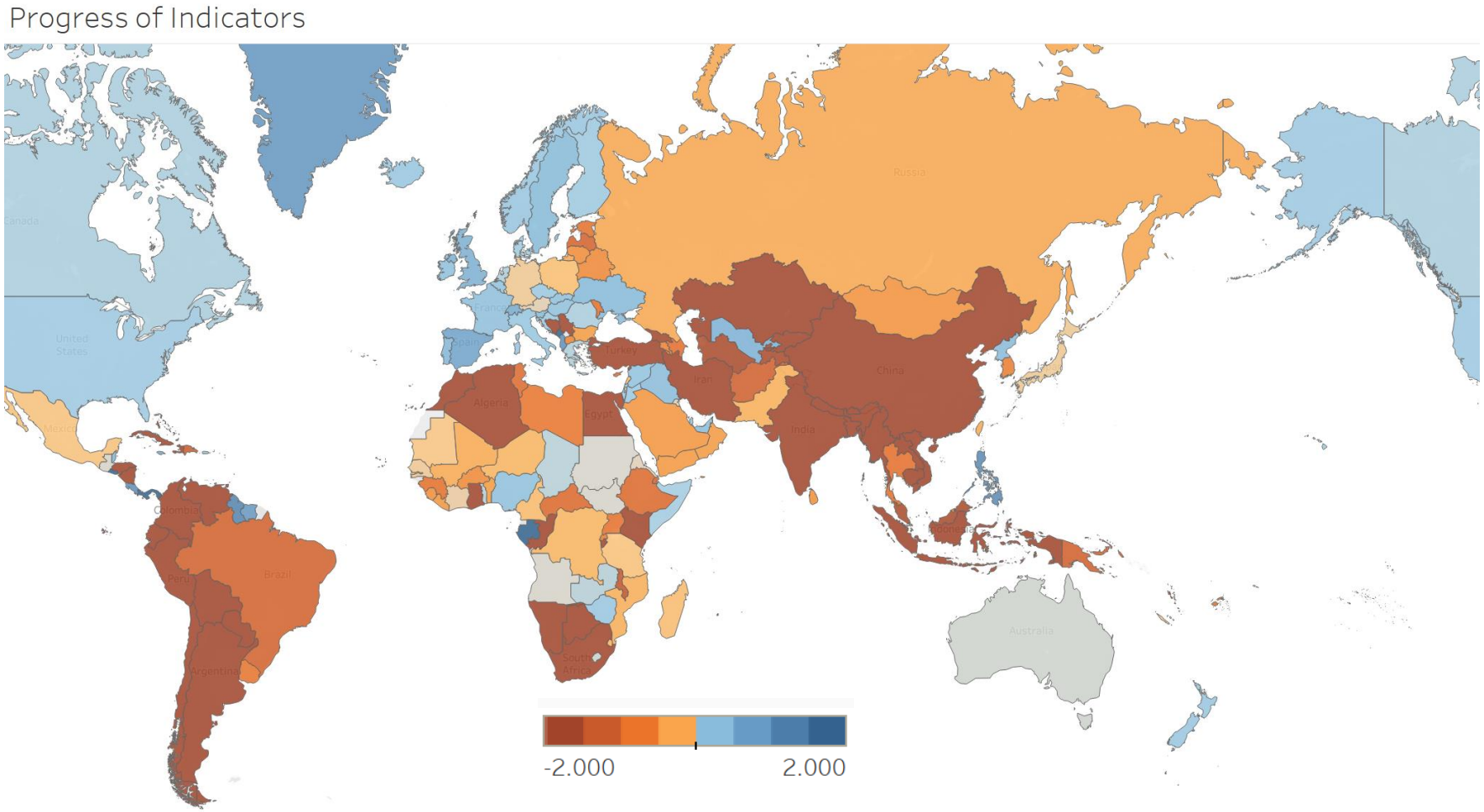
- **Data Source Gap to cover >100 countries**
  - **Preliminary combination** of **Eora** data used in SCP-HAT and **EXIOBASE** used by Cabernard et al. 2019
    - Required to assess all 3 footprints
    - Combination of **country resolution of EORA** with the **sector detail and extensions from EXIOBASE** using FAO and other data sources (publication in preparation)
    - Coupled with spatially explicit impact assessment for agriculture and forestry for land and water use (Cabernard et al. 2019)

# Calculation of the indicator

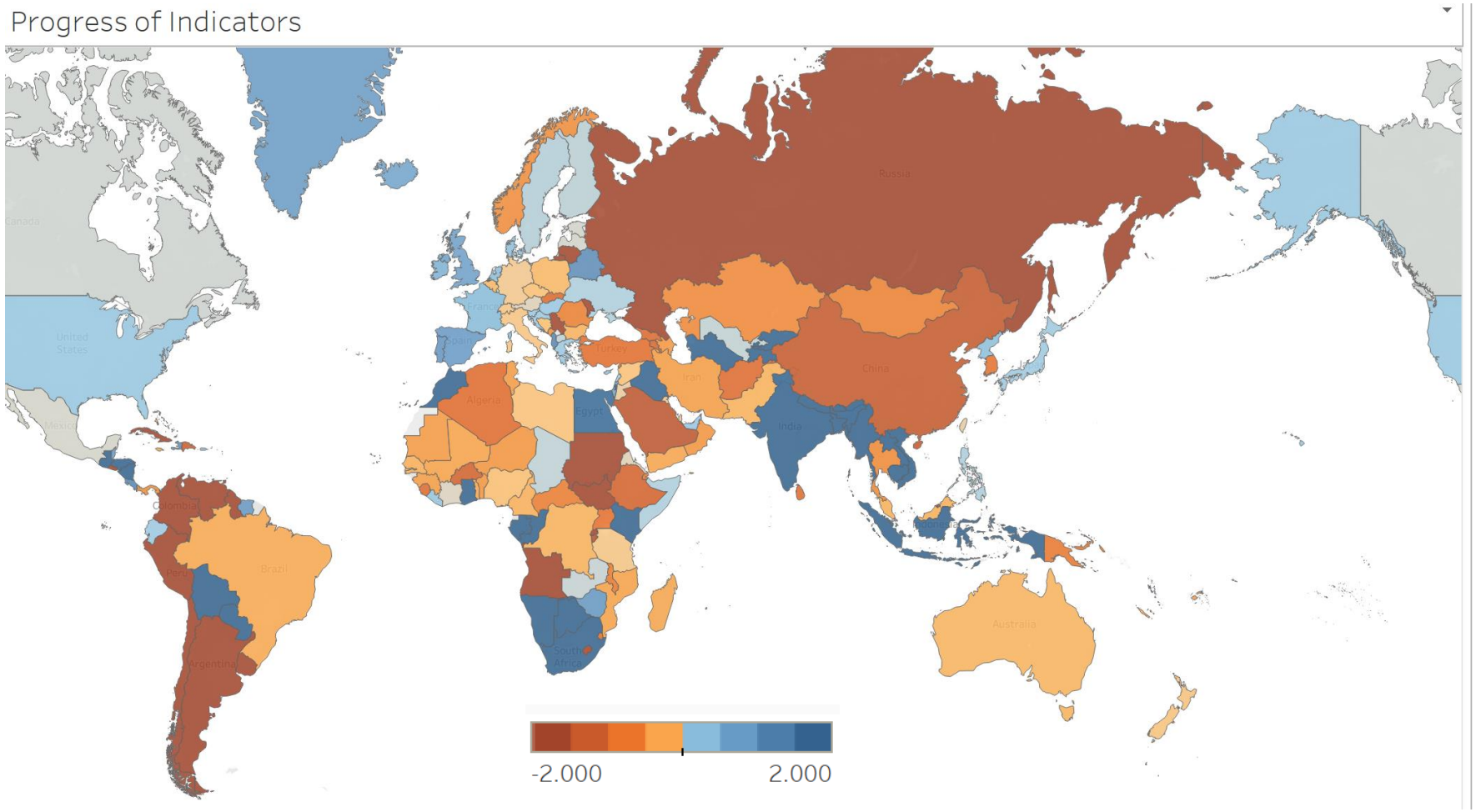
- Progress of indicators is analyzed for the change between a decade, for 5 years per-capita average of footprints:
  - 2001-2005 (y0)
  - 2011-2015 (y1)
  - Progress is calculated as: $\underbrace{(y0 - y1)}_{\text{change}} \;/\; \underbrace{(y0 - y^*)}_{\text{change target}}$
    - Target $y^* = min\ (t, b)$
    - $t$ = threshold (absolute or based on percentile)
    - $b$ = change achieved by the 10 per cent best performing countries in HDI group

- Calculated for
  - consumption perspective (classical footprint)
  - domestic production perspective (domestic impacts)

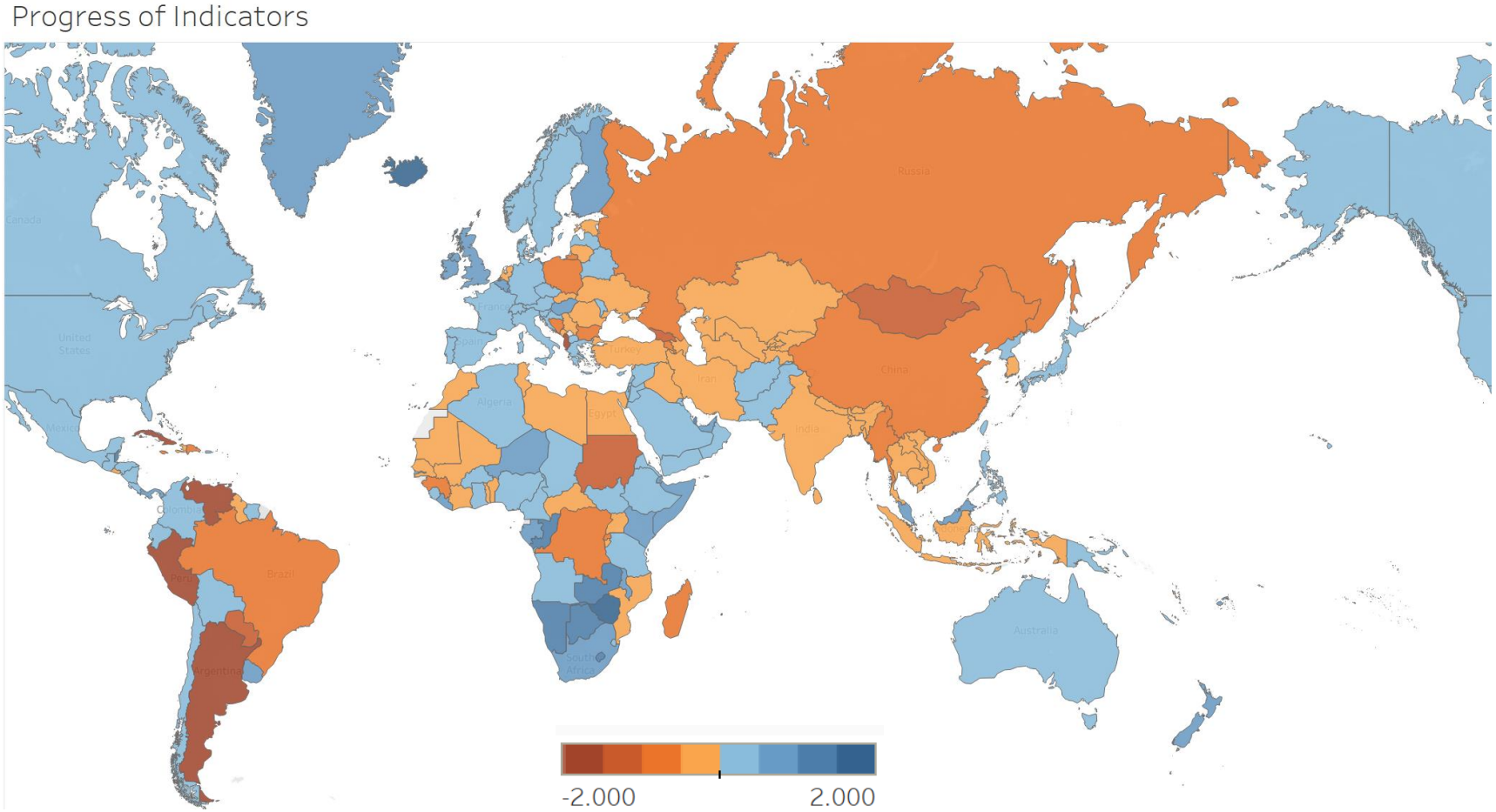
# Progress: GHG impacts of domestic production



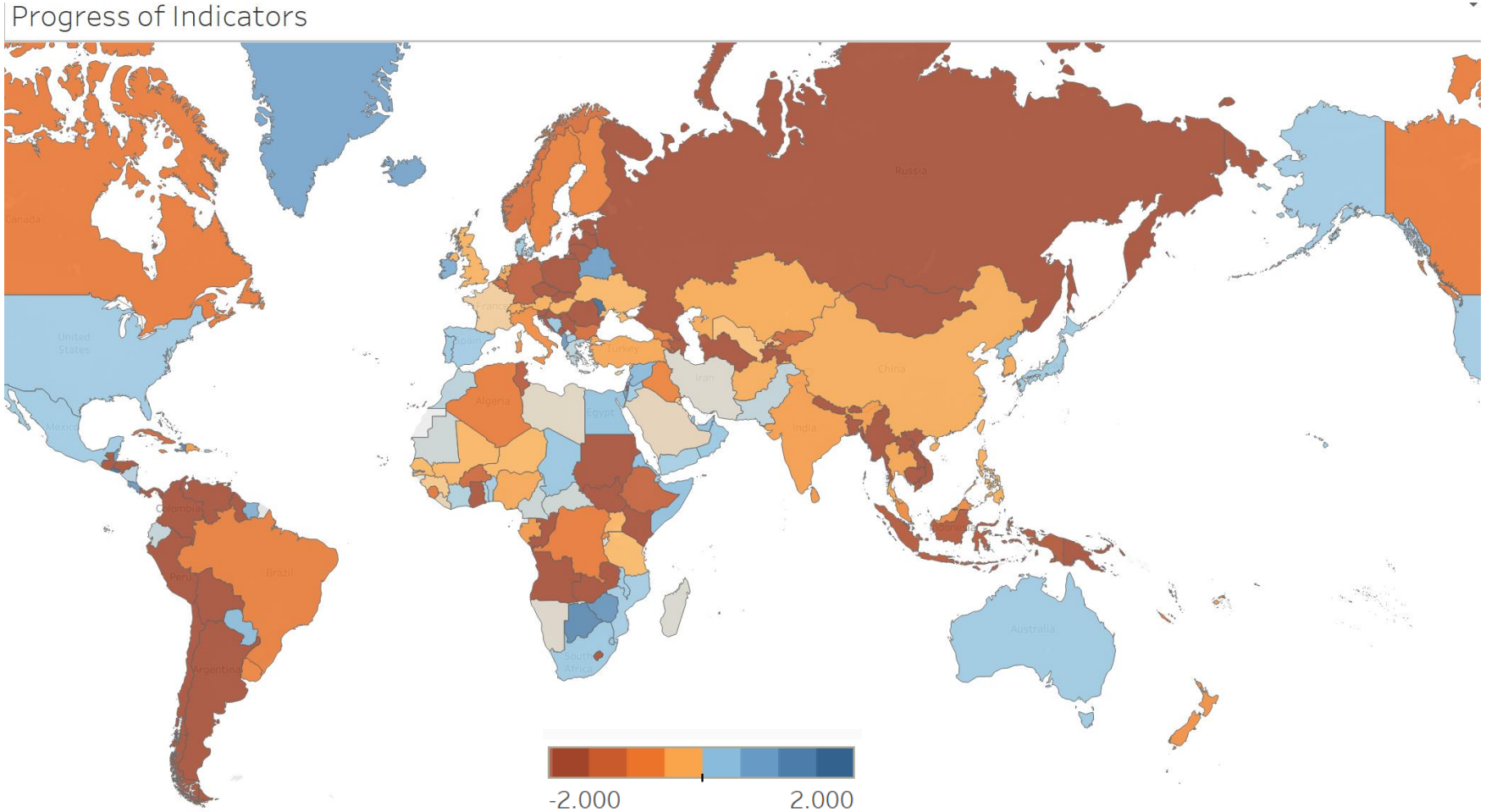
# Progress: Carbon footprint of consumption



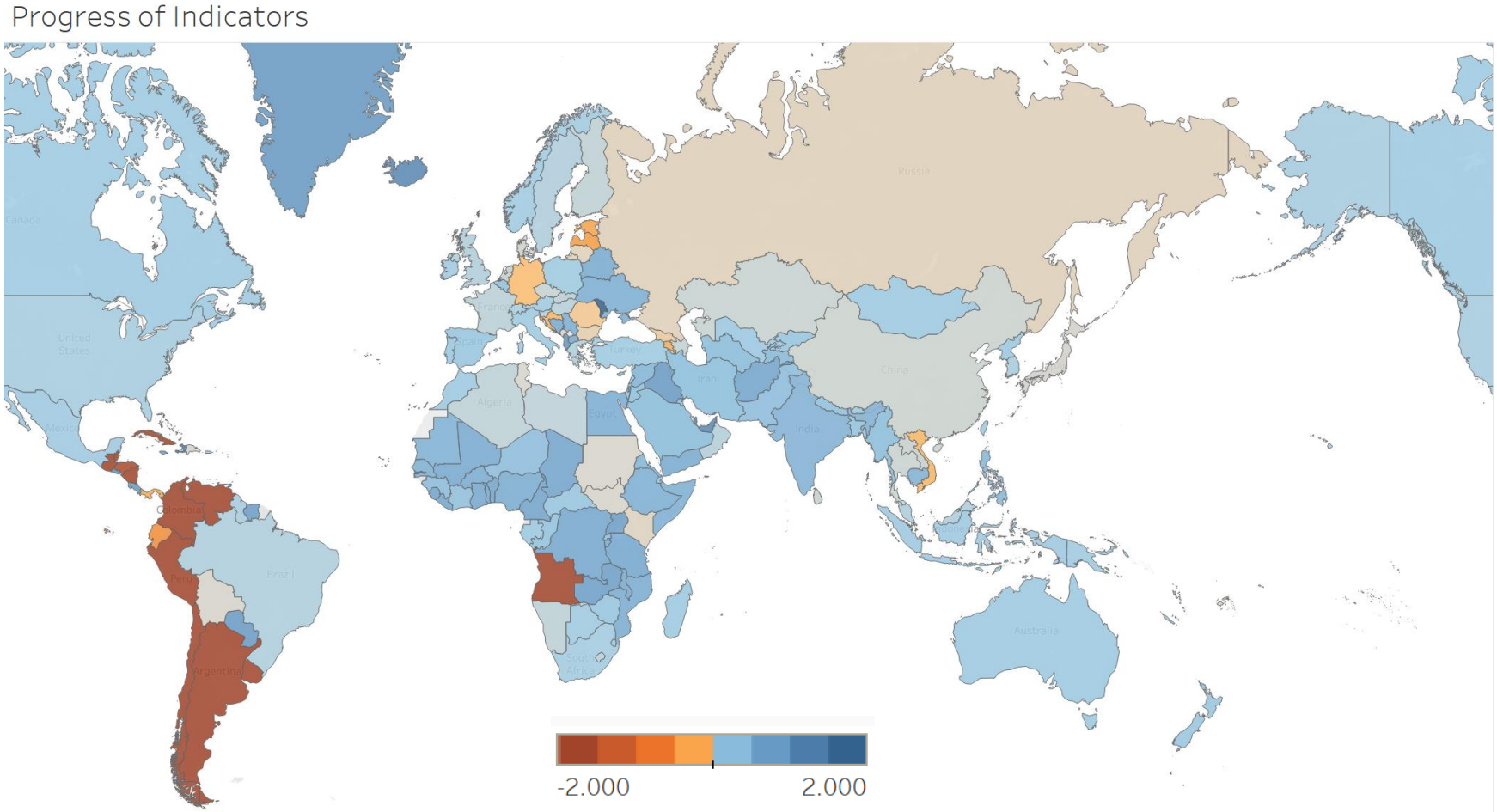
# Progress: Water scarcity impacts of domestic production



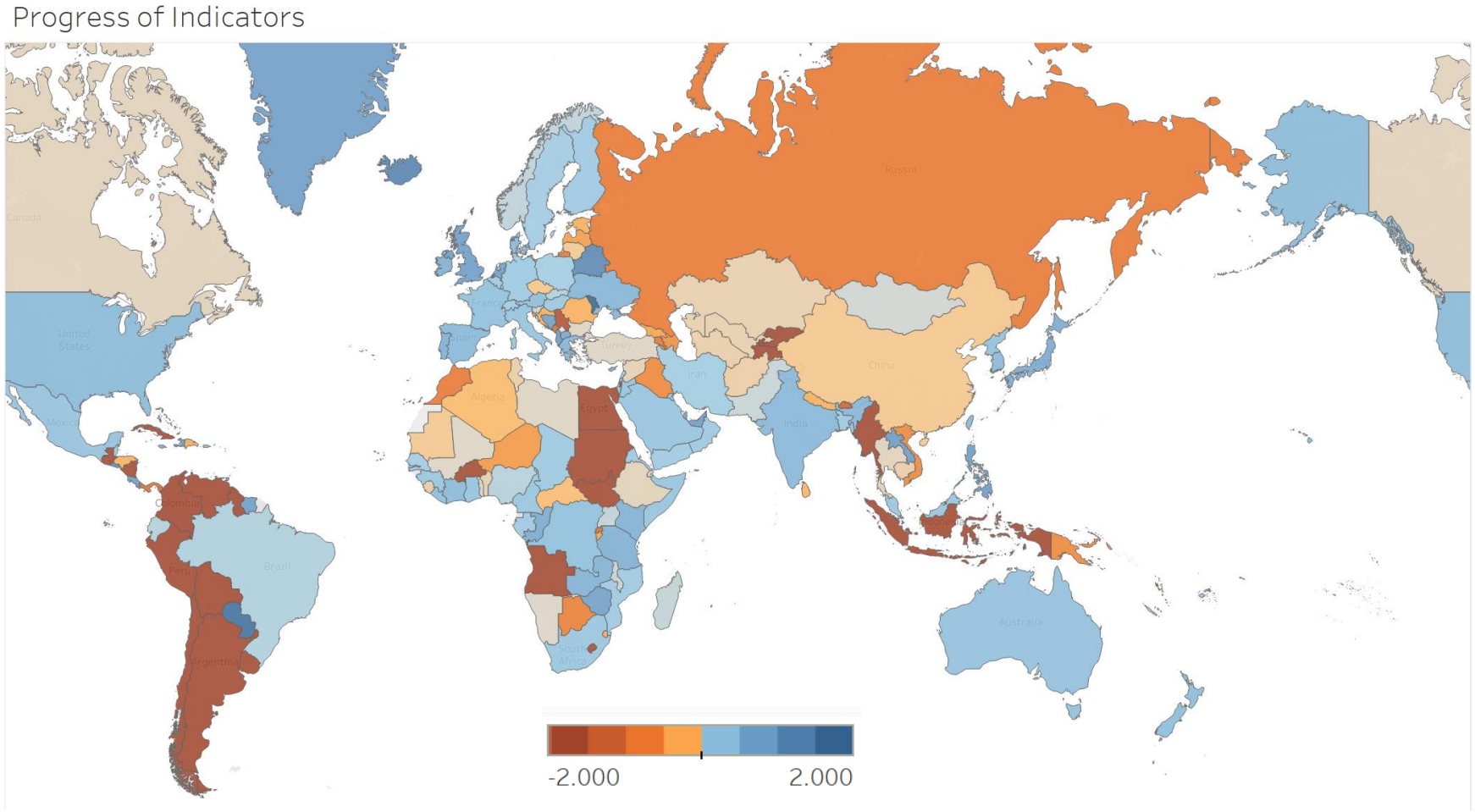
# Progress: Water scarcity footprint of consumption



# Progress: Land use biodiversity impacts of domestic production



# Progress: Land use biodiversity footprint of consumption

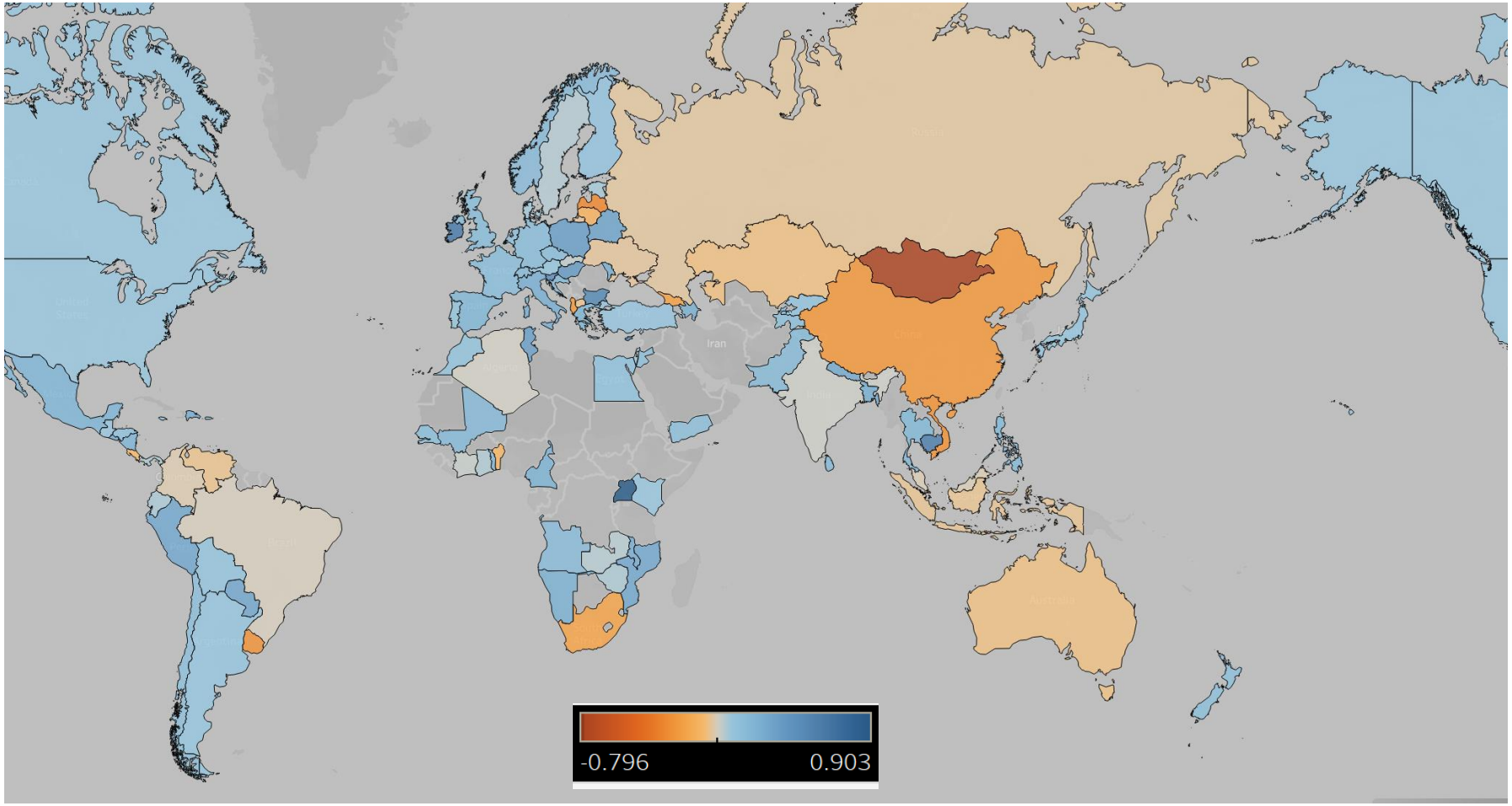


# Integration into the GEP measurement framework

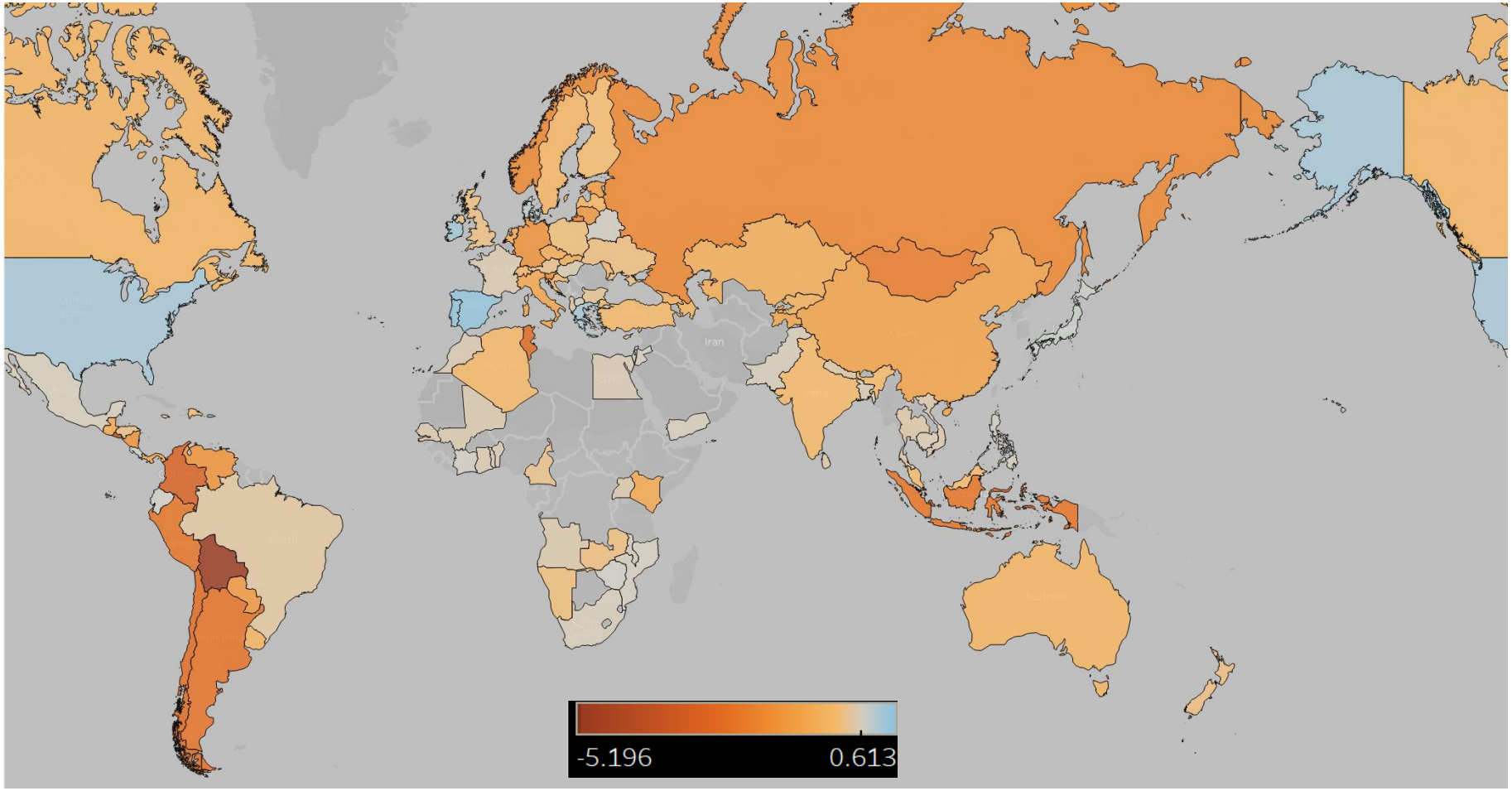
- **Expanding existing indicator set:**
  - Consumption perspective
    - Material footprint (GEP Index): Limited overlap with land, water and carbon footprints
    - ecological footprint (dashboard): High correlation to land use and carbon footprint, since it mainly consists of the two aspects
  - Producer perspective:
    - water use, land use and greenhouse gas emissions are covered already in the dashboard of sustainability.
    - land and water use are reporting pressure indicators, not impacts

  - **Recommendation**
    - Replace ecological footprint by carbon, land and water footprint (incl. impact assessment) in the dashboard

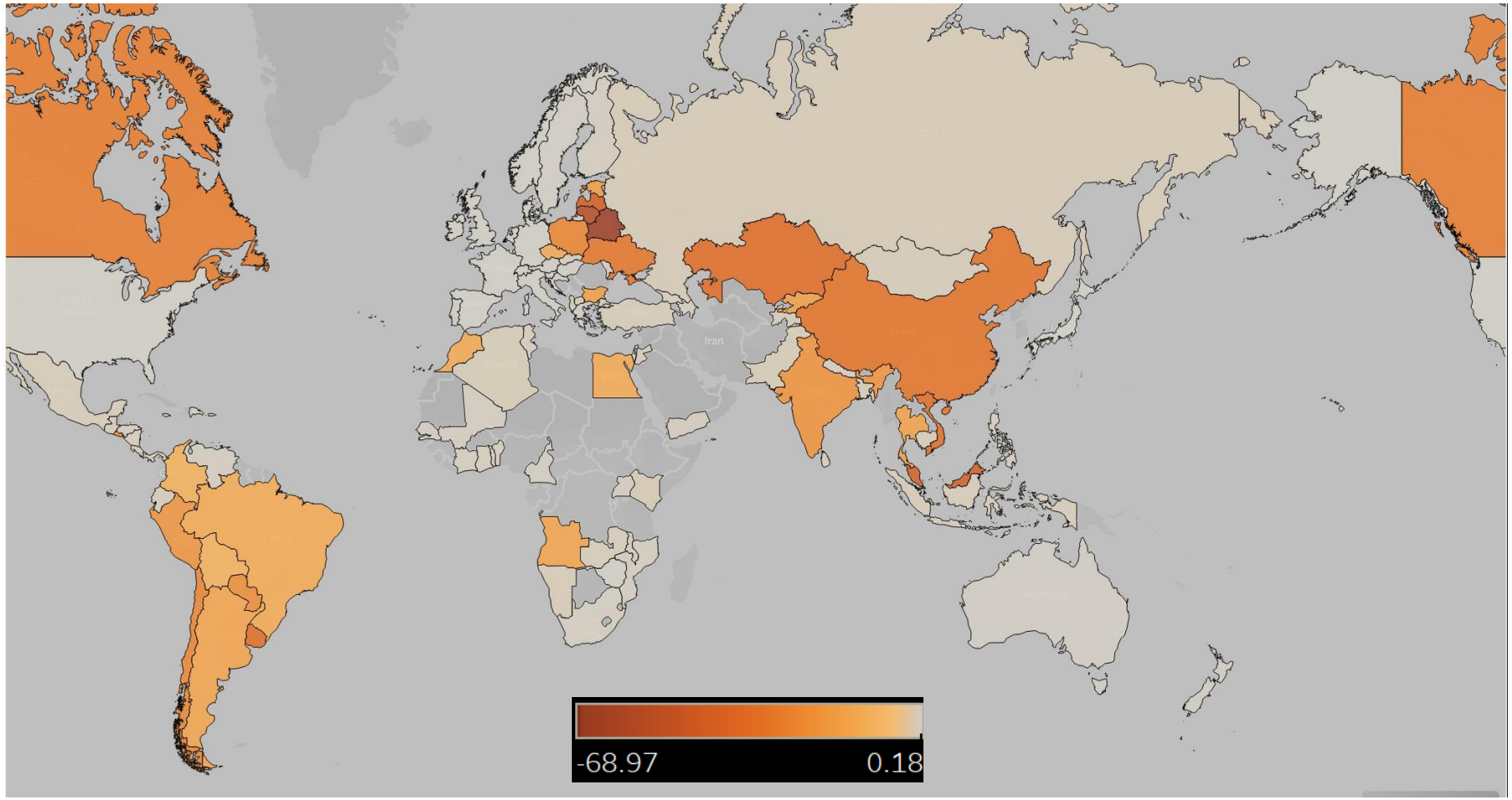
# Results of original GEP Index (100 countries)



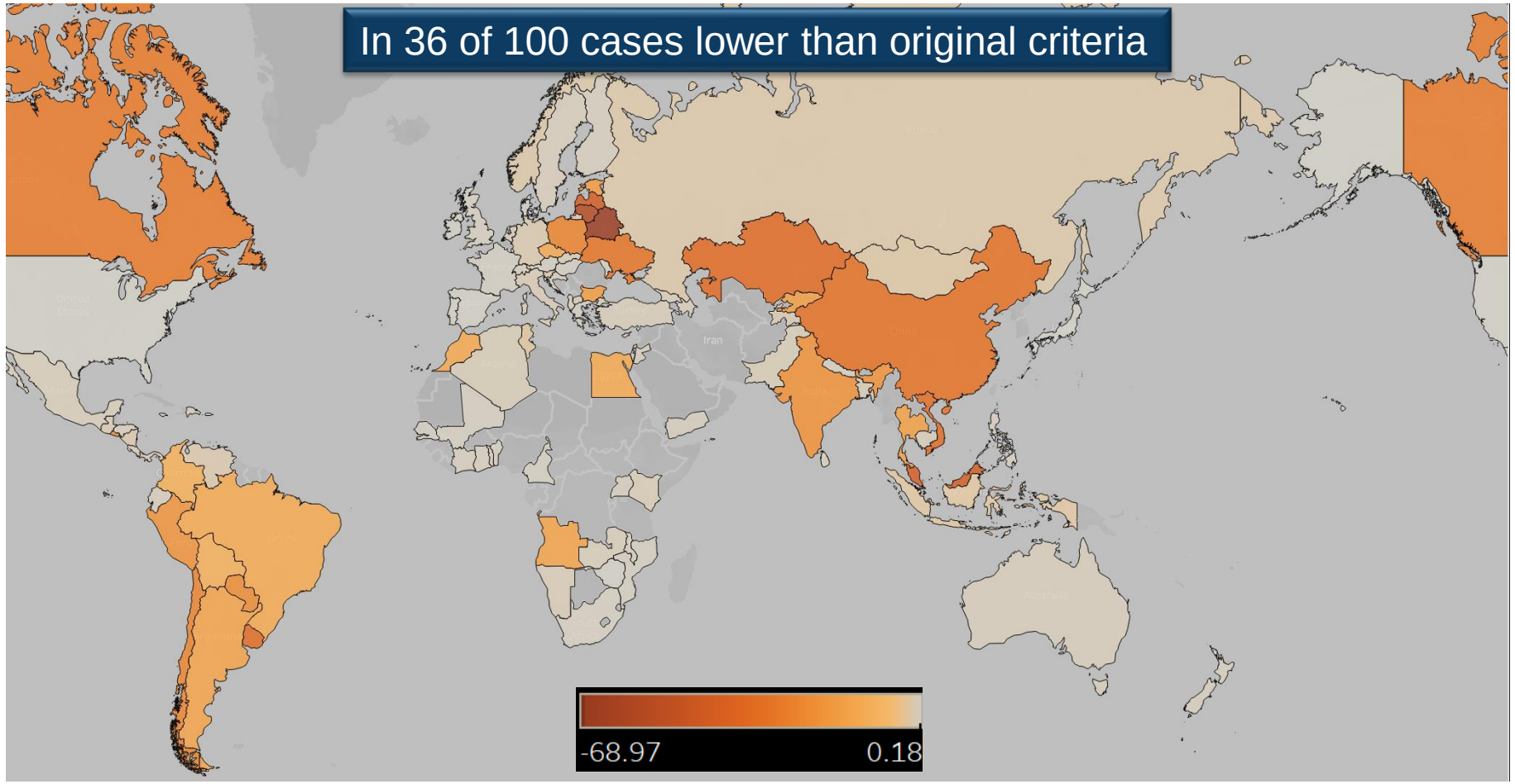
# Protective Criteria result; GEP Index plus water, land and carbon footprint (consumption perspective)



# Protective Criteria result; original application (PAGE 2017) – low values dominated by Nitrogen

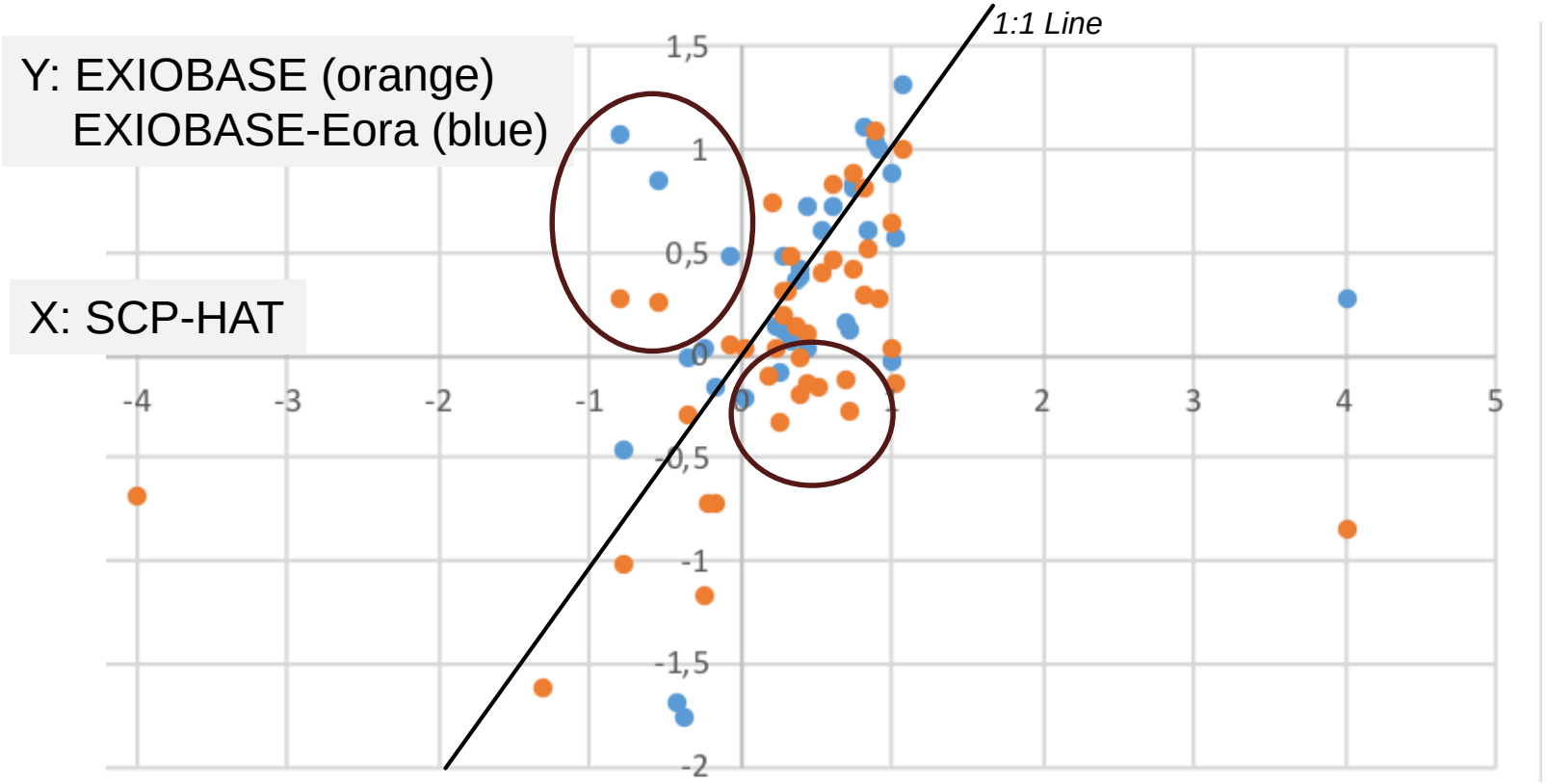


# Protective Criteria result; original plus water, land and carbon footprint (consumption perspective)



# Uncertainties of input data and result on Progress – higher than absolute footprint differences

- Comparison the carbon footprint for very high HDI countries (consumption perspective)



# Next steps

- Suggestion to consider integration of footprint indicators:
  - 1st priority Carbon footprint
  - 2nd priority: land and water footprints

- Methodological challenges
  - Consistency with other indicators of the index
  - Consumption or production perspective, or both?

- Data challenges
  - Better MRIO databases are requried for robust assessments
    - Suggestion to create a task force to define next steps to develop a harmonized MRIO database (structure, actions, costs)

ETH zürich

# Thanks for the attention

pfister@ifu.baug.ethz.ch

*Lutter et al 2016*

Webinar

# What’s your country’s footprint?

## A close look at environmental footprint indicators and multi-regional input-output tables

**18 March 2020** **16:00 CET**

GGKP