Ecological Footprint and Biocapacity Accounting:

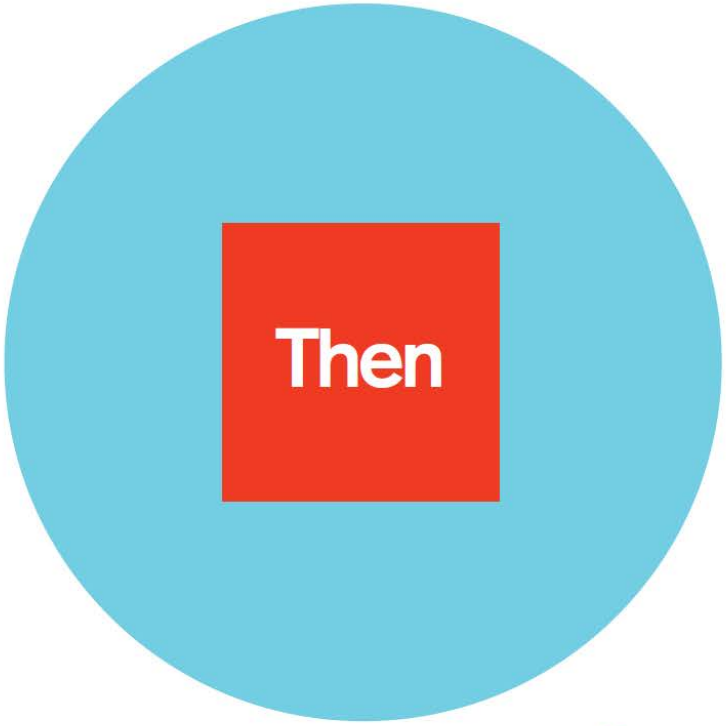
Arab Region perspective and implications for SDG12

Global Footprint Network®
Advancing the Science of Sustainability

"Resource Efficiency in the Arab Region:
Monitoring Progress of SDG 12 and Building Back Better from COVID-19"

Table of Contents

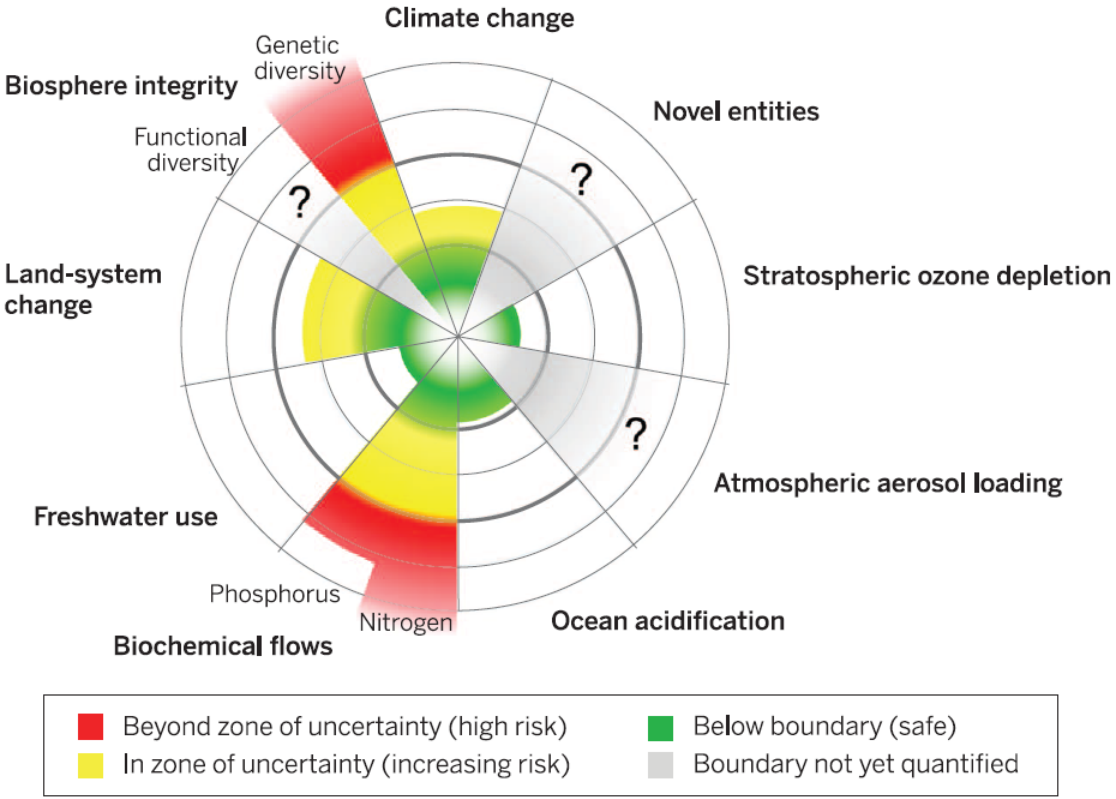
The rules of the game have changed.



An empty world allows for unlimited production of goods.

Economy
Biosphere

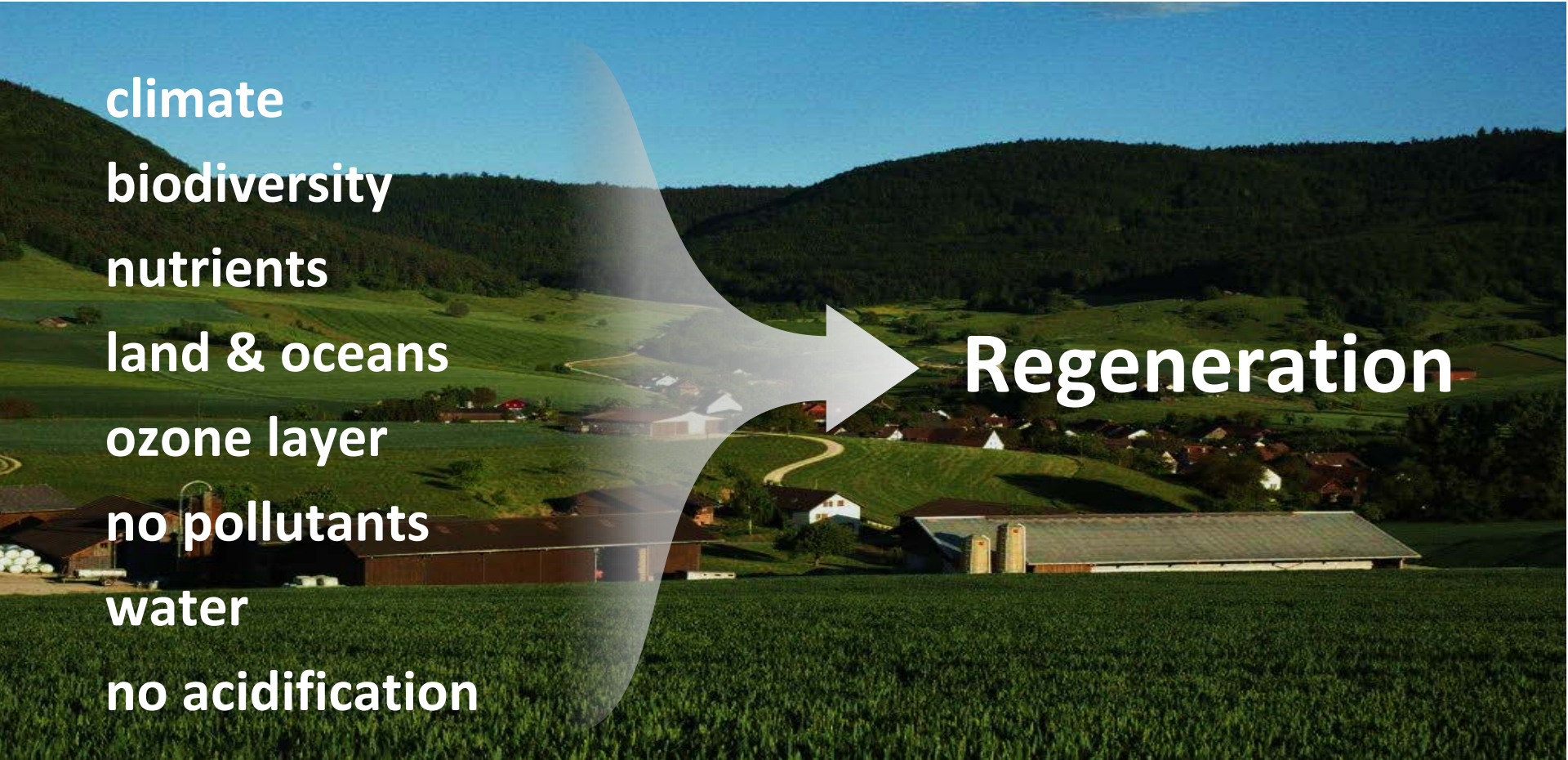
A full world turns the economy into a global auction.



Lots of evidence.

But how do we operationalize this?

Conditions → Outcome




Access to basic living resources underlies every economic activity a society can undertake.

We call nature's regeneration "Biocapacity"

- the ability of ecosystems to regenerate plant matter (ecologists call "NPP")
- the food source for all non-plant life
- powered by the sun
- attached to surface

ECOLOGICAL FOOTPRINT: An Ecological Balance Sheet For Countries

The Ecological Footprint is an environmental accounting tool that identifies the extent to which human activities exceed **two types of environmental limits:**

- resource production
- waste absorption

Biocapacity:
*How much bioproductive area is **available to us**?*

Ecological Footprint:
*How much bioproductive area do we **demand**?*

NATIONAL FOOTPRINT ACCOUNTS FRAMEWORK

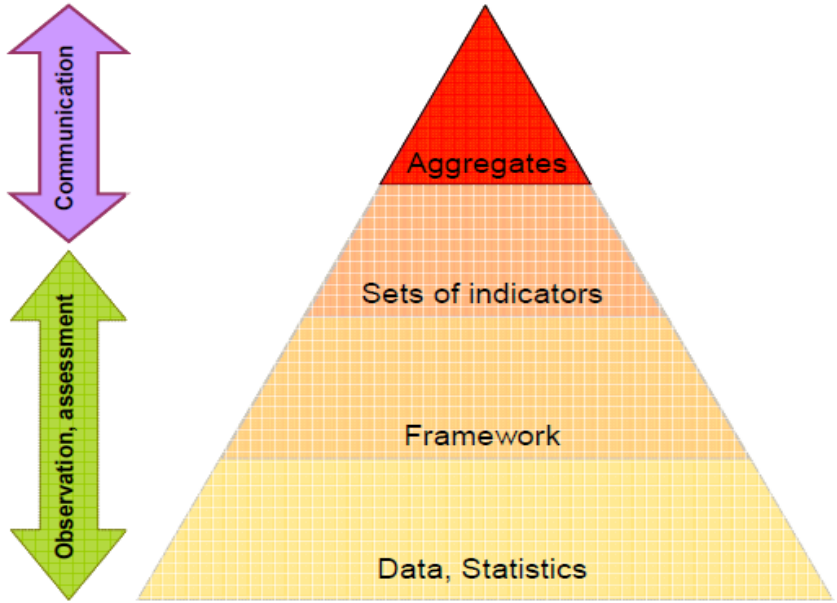


Figure 3: Pyramid structure of the National Footprint Accounts (NFA). All levels of the pyramid exist in the NFA, potentially allowing for both system's description and support to policy makers. However, data used and the framework in place are not fully consistent with SNA and SEEA (transparent colors are used here to represent this not full consistency). *Source: adapted from Weber and Martin (2009).*

Outcomes: National Footprint Accounts - NFA

- **Every year** we release an updated version of the NFA, based on most up-to-date Footprint methodology and input data
- Input to the EF framework: **UN Data** (15'000 data points per country and year)
- **Each edition** tracks EF and BC values for almost 200 countries (and the World), over five decades (1961-2016) and with different level of aggregation:
  1. Aggregate national EF and BC values (most known)
  2. EF and BC values by land type
  3. EF values by variable
  4. EF values for all individual products
  5. Values are provided both per capita and total
  6. Results in both ha and gha (not for totals)
  7. Megabyte data workbook

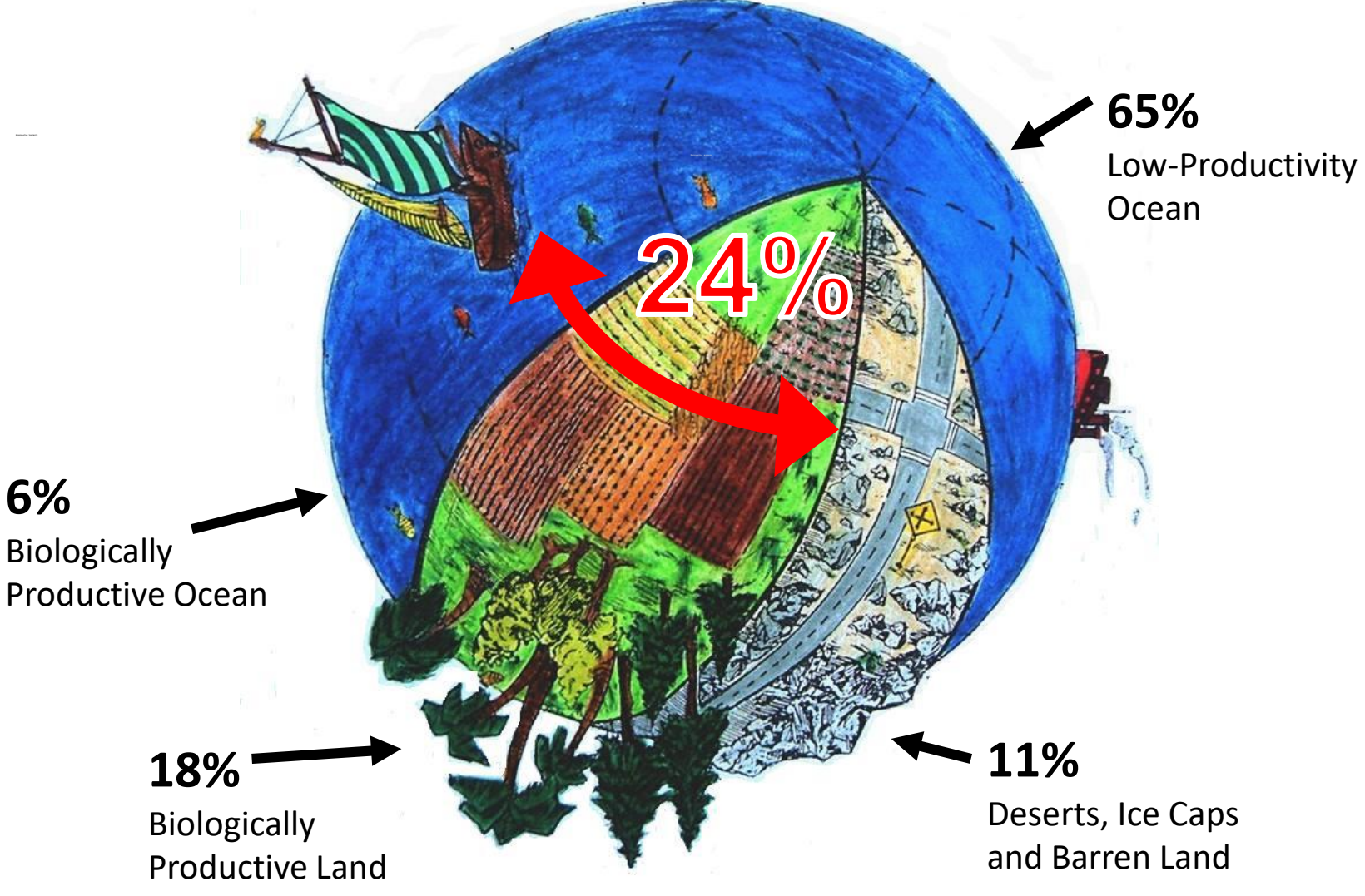
data.footprintnetwork.org

“Income” or Biocapacity

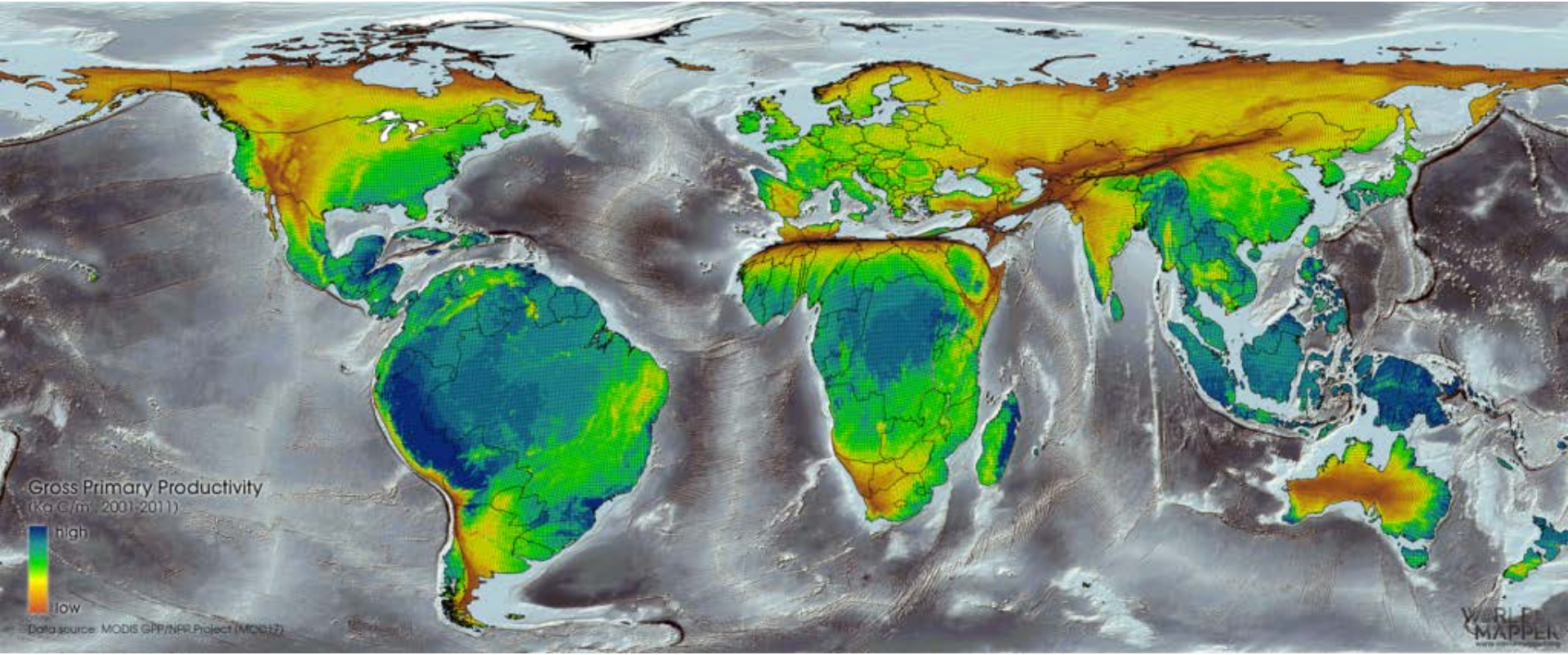
How much nature do we have?

“Expenditure” or Ecological Footprint

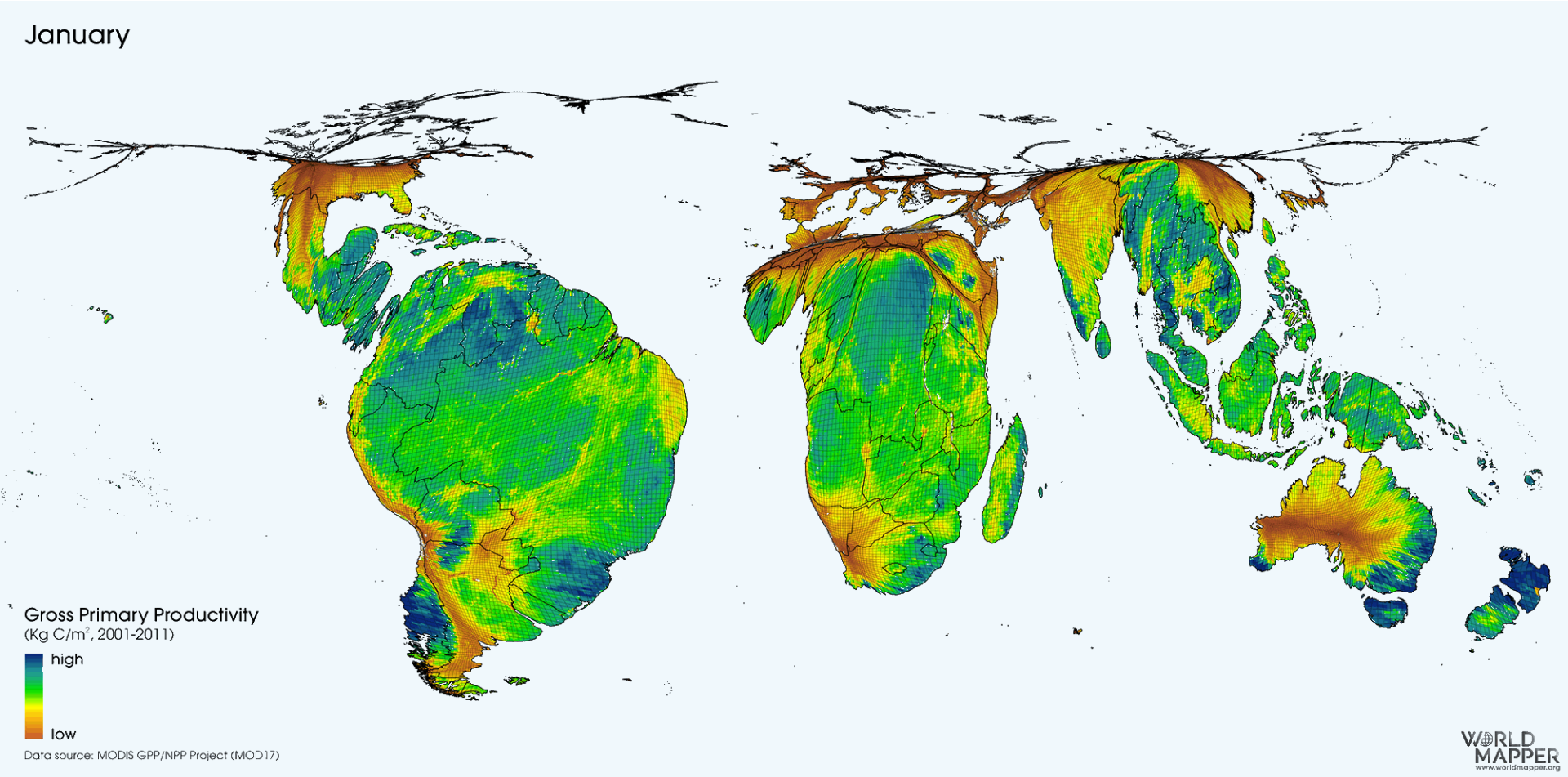
How much nature do we use?


65%
Low-Productivity
Ocean
24%
6%
Biologically
Productive Ocean
18%
Biologically
Productive Land
11%
Deserts, Ice Caps
and Barren Land

Our Planet's Biocapacity



Our Planet's Biocapacity (by month)



Unit: hectare-equivalent or global hectare (gha)

The Ecological Footprint is an indicator of human appropriation of Earth's photosynthetic capacity, although expressed in hectare-equivalents.

The release of 1 t of CO_{2eq} does not mean that such amount is actually released (no molecule called CO_{2eq}). Rather, it means that various GHGs with the global warming potential of 1 t of CO_2 is released.

Similarly, an Ecological Footprint of 1 gha doesn't mean that 1 ha of physical land is used. It rather means that the capacity of 1 hectare-equivalents (or gha) is needed to produce (via photosynthesis) the renewable resources consumed and to sequester the carbon dioxide emitted

“Income” or Biocapacity

How much nature do we have?

“Expenditure” or Ecological Footprint

How much nature do we use?

Ecological Footprint Research Question

How many ecological assets are necessary to renew people's demand for:

- food, fiber, timber,
- accommodation of roads and structures,
- waste absorption: CO_2 from fossil fuel?

Global Footprint Network
Advancing the Science of Sustainability

Dataset	Source	Description
Production of primary agricultural products	FAO ProdSTAT	Physical quantities (tonnes) of primary products produced in each of the considered countries
Production of crop-based feeds used to feed animals	Feed from general marketed crops data is directly drawn from the SUA/FBS from FAOSTAT Data on crops grown specifically for fodder is drawn directly from the FAO ProdSTAT	Physical quantities (tonnes) of feeds, by type of crops, available to feed livestock
Production of seeds	Data on crops used as seeds is calculated by Global Footprint Network based on data from the FAO ProdSTAT	Physical quantities (tonnes) of seed
Import and Export of primary and derived agricultural and livestock products	FAO TradeSTAT	Physical quantities (tonnes) of products imported and exported by each of the considered countries
Import and Export of non-agricultural commodities	COMTRADE	Physical quantities (kg) of products imported and exported by each of the considered countries
Livestock crop consumption	Calculated by Global Footprint Network based upon the following datasets: • FAO Production for primary Livestock • Haberl et al. (2007)	Data on crop-based feed for livestock (tonnes of dry matter per year), split into different crop categories
Production of primary forestry products as well as import and export of primary and derived forestry products	FAO ForeSTAT	Physical quantities (tonnes and m^3) of products (timber and wood fuel) produced, imported and exported by each country
Production of primary fishery products as well as import and export of primary and derived fishery products	FAO FishSTAT	Physical quantities (tonnes) of marine and inland fish species landed as well as import and export of fish commodities
Carbon dioxide emissions by sector	International Energy Agency (IEA)	Total amounts of CO_2 emitted by each sector of a country's economy
Built-up/infrastructure areas	A combination of data sources is used, in the following order of preference: 1. CORINE Land Cover 2. FAO ResourceSTAT 3. Global Agro-Ecological Zones (GAEZ) Model 4. Global Land Cover (GLC) 2000 5. Global Land Use Database, SAGE, University of Wisconsin	Built-up areas by infrastructure type and country. Except for data drawn from CORINE for European countries, all other data sources only provide total area values

Dataset	Source	Description
Cropland yields	FAO ProdSTAT	World average yield for 164 primary crop products
National yield factors for cropland	Calculated by Global Footprint Network based on cropland yields and country specific unharvested percentages	Country specific yield factors for cropland
Grazing land yields	Monfreda, C., personal communication, 2008. SAGE, University of Wisconsin, Madison	World average yield for grass production. It represents the average above-ground edible net primary production for grassland available for consumption by ruminants
Fish yields	Calculated by Global Footprint Network based on several data sources including: • Sustainable catch value (Gulland, 1971) • Trophic levels of fish species (Fishbase Database available at www.fishbase.org) • Data on discard factors, efficiency transfer, and carbon content of fish per tonne wet weight (Pauly and Christensen, 1995)	World-average yields for fish species. They are based on the annual marine primary production equivalent.
Forest yields	World average forest yield calculated by Global Footprint Network based on national Net Annual Increment (NAI) of biomass. NAI data is drawn from two sources: • Temperate and Boreal Forest Resource Assessment – TBFRA (UNECE and FAO, 2000) • Global Fiber Supply Model – GFSM (FAO, 1998)	World average forest yield. It is based on the forests' Net Annual Increment of biomass NAI is defined as the average annual volume over a given reference period of gross increment less that of neutral losses on all trees to a minimum diameter of 0 cm (d.b.h.)
Carbon Uptake land yield	Calculated by Global Footprint Network based on data on terrestrial carbon sequestration (IPCC, 2006) and the ocean sequestration percentage (Khatiwala et al., 2009) Further details can be found in Borucke et al. (2013)	World average carbon uptake capacity. Though different ecosystems have the capacity to sequester CO_2, carbon uptake land is currently assumed to be forest land only by the Ecological Footprint methodology
Equivalence Factors (EQF)	Calculated by Global Footprint Network based on data on land cover and agricultural suitability Data on agricultural suitability is obtained from the Global Agro-Ecological Zones (GAEZ) model (FAO and IIASA, 2000) Land cover data drawn from the FAO ResourceSTAT database	EQF for crop, grazing, forest and marine land. Based upon the suitability of land as measured by the Global Agro-Ecological Zones model

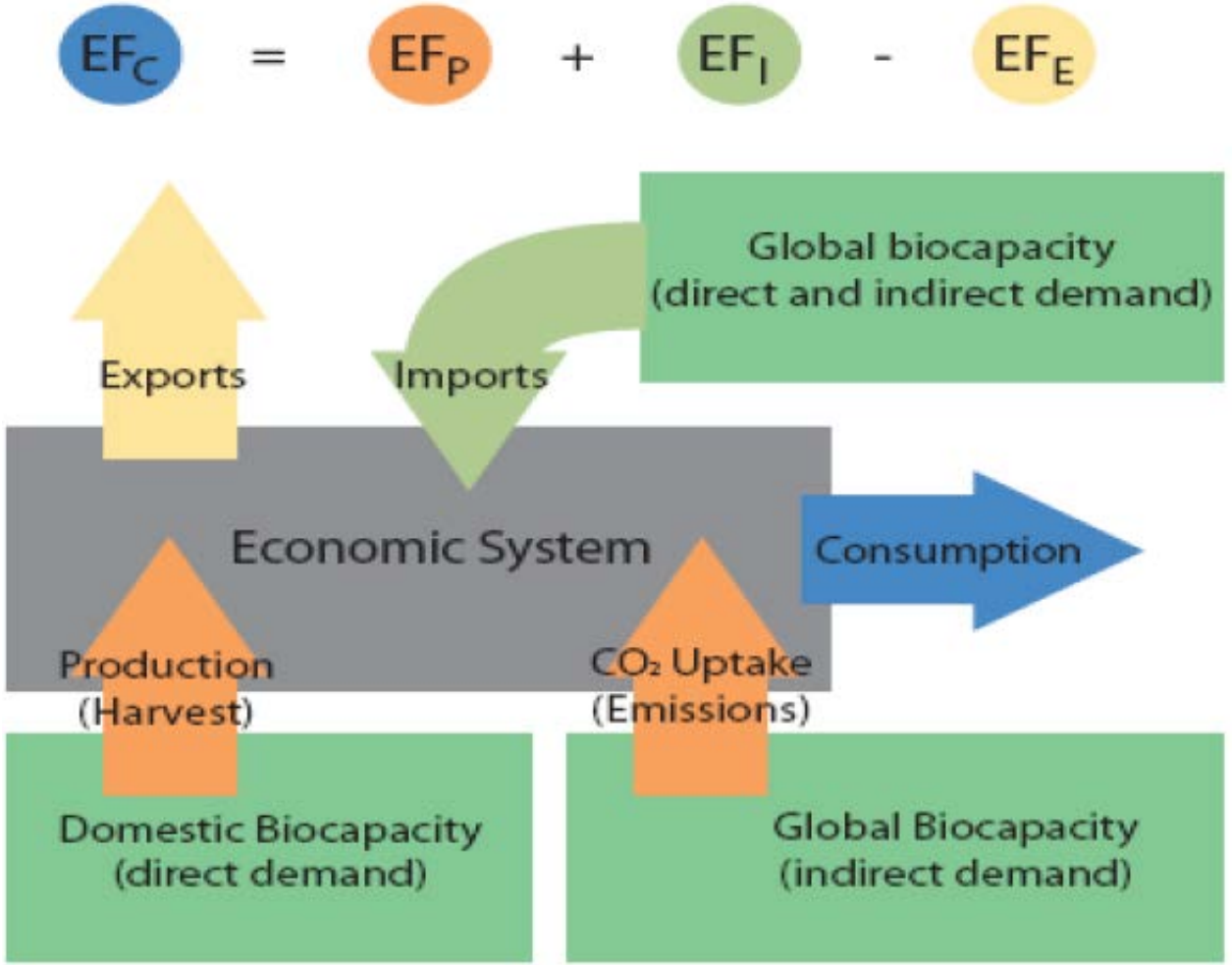
The Ecological Footprint is a flows indicator, though it is measured in terms of the bioproductive land areas needed to generate such flows (expressed in the unit of global hectares - gha).

$$EF = \frac{P}{Y_N} \cdot YF \cdot EQF$$

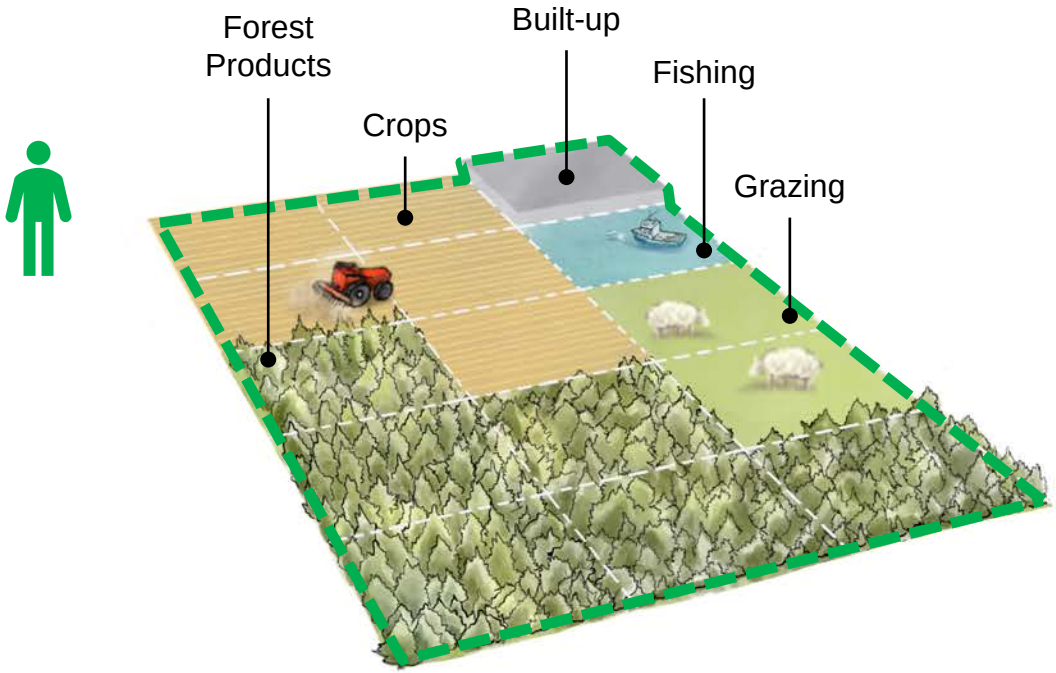
Input variable: flow of resource used by humans

From FLOW to AREA :

- **Y_N** is used to convert the consumption of a resource flow into the correspondent amount of area locally required to produce that flow
- **YF** is used to scale national to world average productivity for a given land use type
- **EQF** is used to scale world average productivity for a given land type to gha.

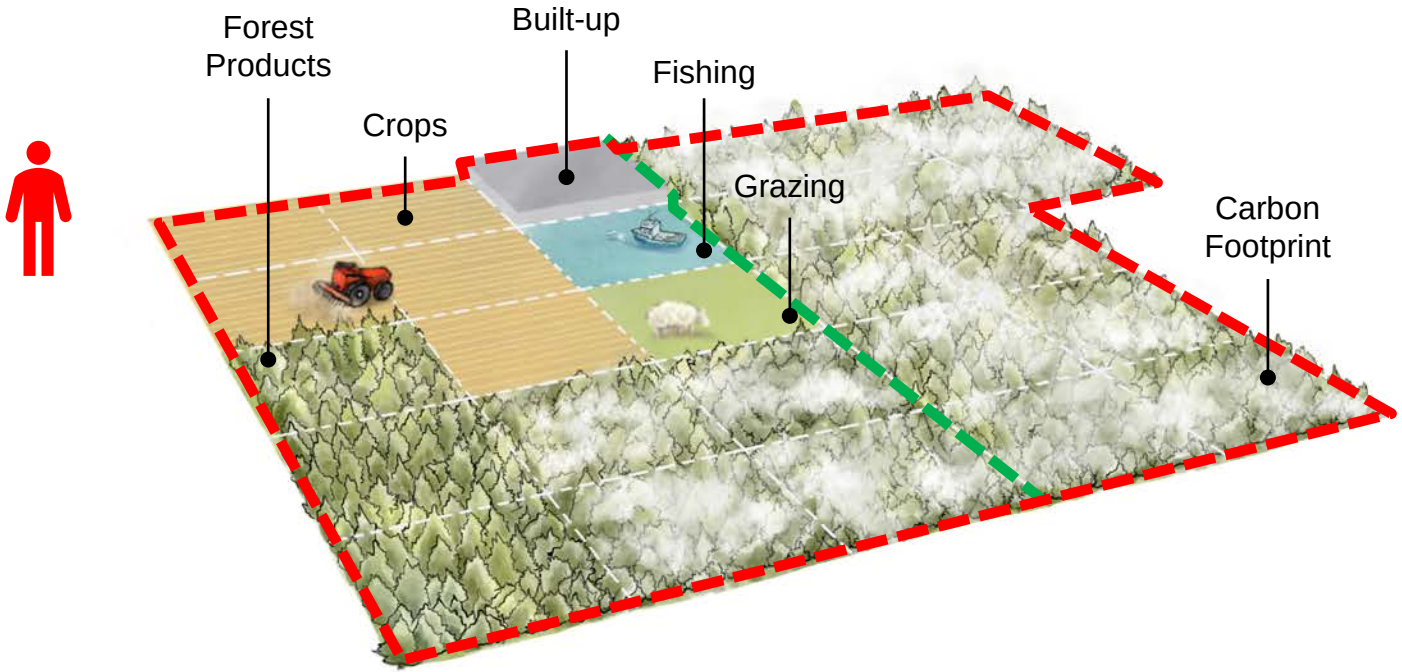

EF_C = EF_P + EF_I - EF_E
Global biocapacity
(direct and indirect demand)
Exports
Imports
Economic System
Consumption
Production
(Harvest)
CO_2 Uptake
(Emissions)
Domestic Biocapacity
(direct demand)
Global Biocapacity
(indirect demand)

Our biocapacity per person in the world (2020)

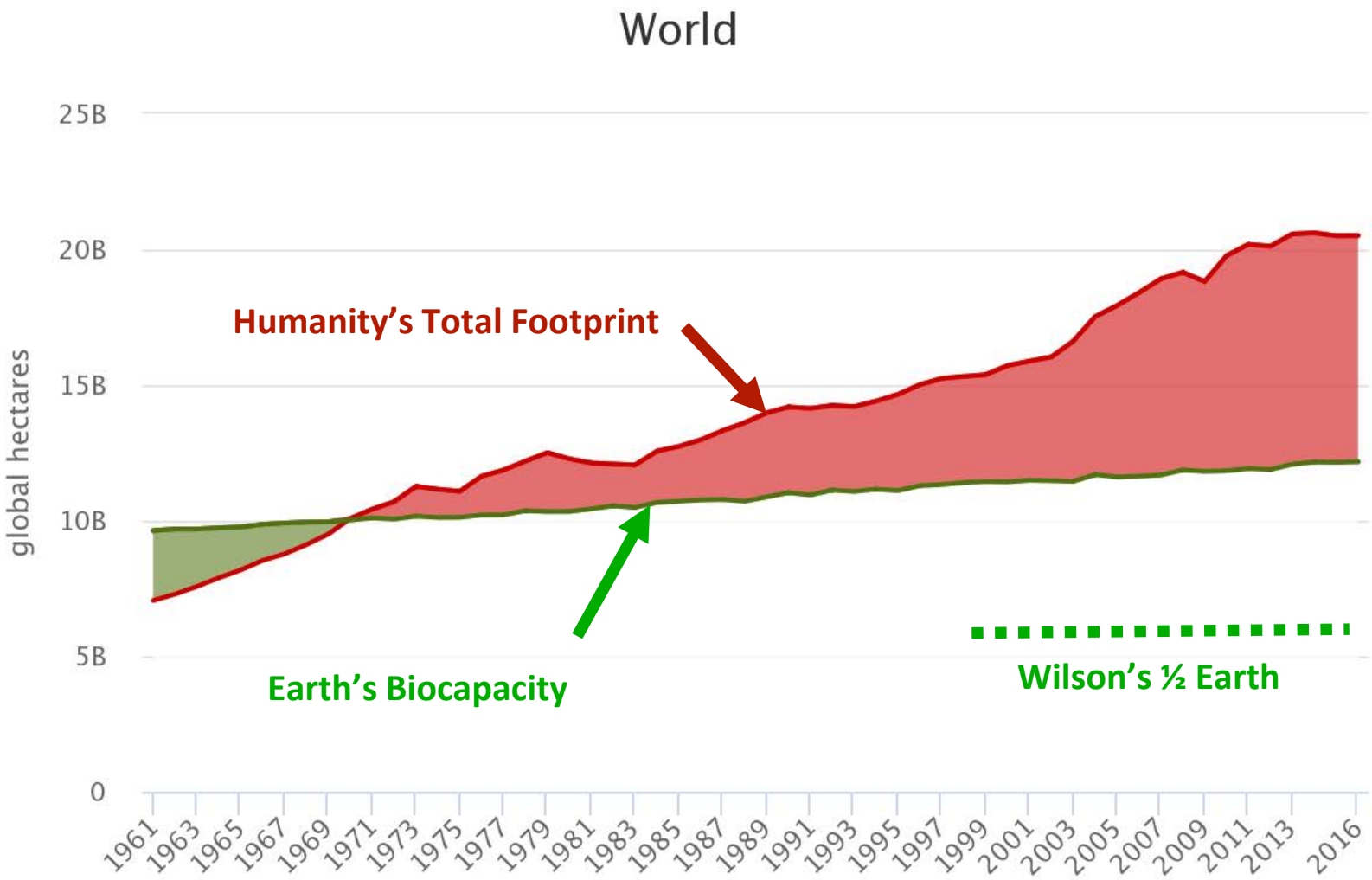


12.3 (billion ha) ➡ **7.8** (billion people) = **1.6** (global ha/ person)

Our global Ecological Footprint per person (2020)



19.2 (billion global ha) → **7.8** (billion people) = **2.5** (global ha/ person)

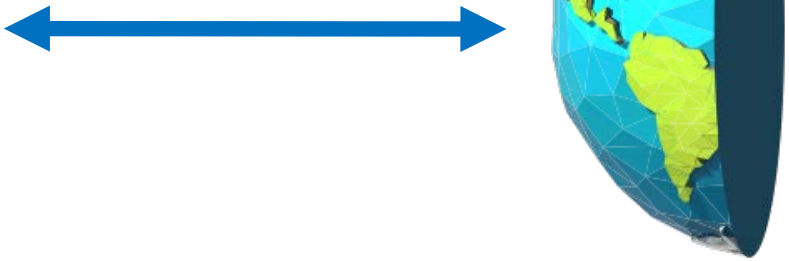

World
25B
20B
15B
10B
5B
0
global hectares
Humanity's Total Footprint
Earth's Biocapacity
Wilson's ½ Earth
1961
1963
1965
1967
1969
1971
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2016

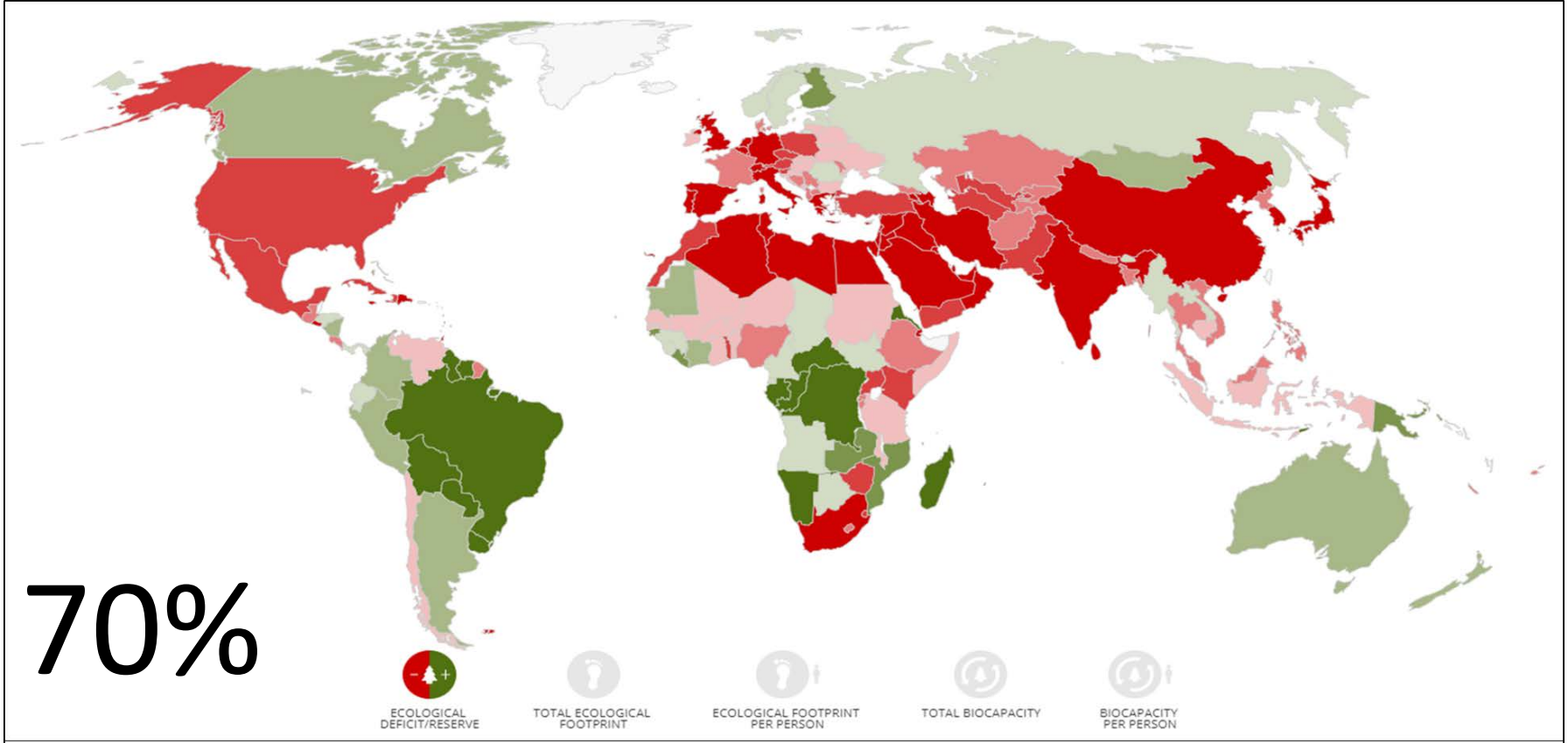
Demand on Regeneration

- Current use:
  1.56 Earths

- Prof. E.O Wilson's goal:
  "Half-Earth" to keep 85% of biodiversity:

Factor 3





70%

ECOLOGICAL DEFICIT/RESERVE

An ecological deficit occurs when the Ecological Footprint of a population exceeds the biocapacityof the area available to that population. A national ecological deficit means that the nation is importing biocapacity through trade, liquidating national ecological assets or emitting carbon dioxide waste into the atmosphere. An ecological reserve exists when the biocapacity of a region exceeds its population's Ecological Footprint.

BIOCAPACITY CREDITORS
BIOCAPACITY GREATER THAN FOOTPRINT

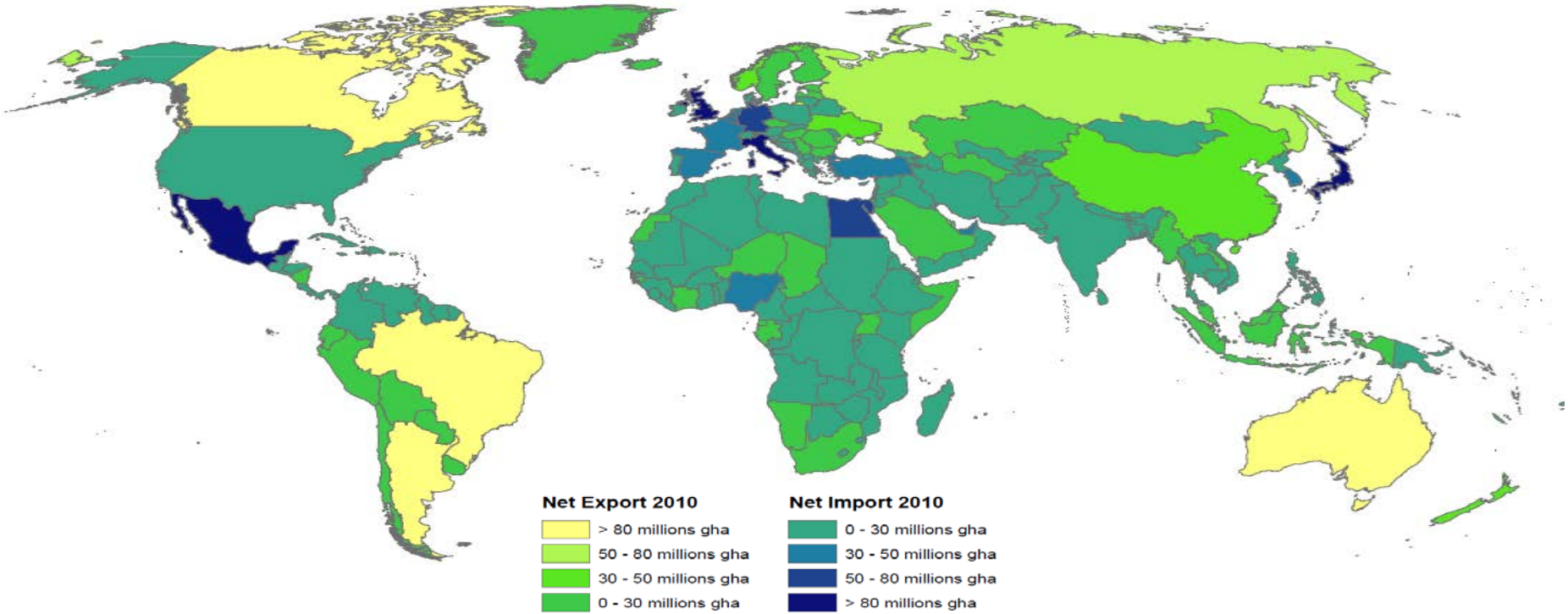
>150% 100% - 150% 50% - 100% 50% - 0%

BIOCAPACITY DEBTORS
FOOTPRINT GREATER THAN BIOCAPACITY

>150% 100% - 150% 50% - 100% 50% - 0%

data.footprintnetwork.org

Net biocapacity Importer/Exporter



Countries are highly interconnected and depend on each other

Source: Updated from Galli et al., 2014

Ecological Footprint flows around the world

Cropland Footprint

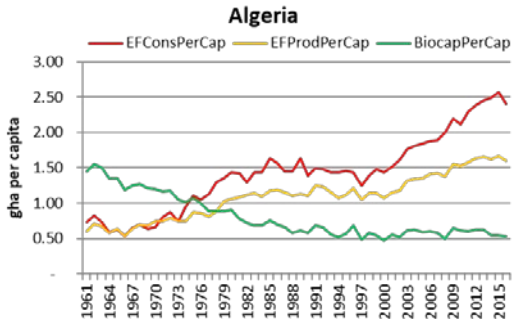
Fish Footprint

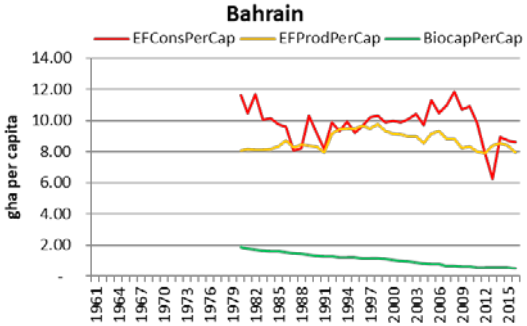
Forest Footprint

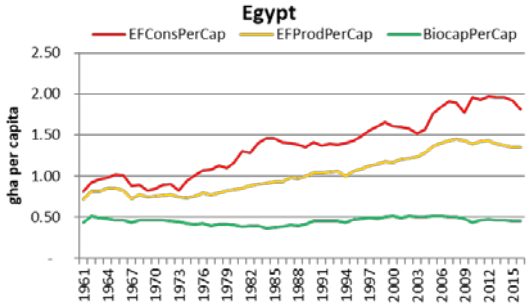
Grazing Footprint

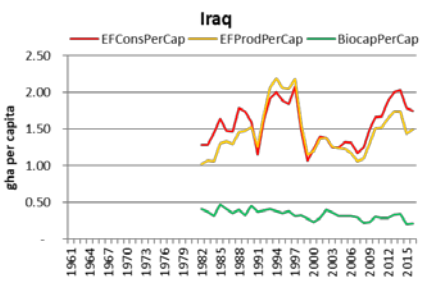
Source: Lazarus et al, 2015

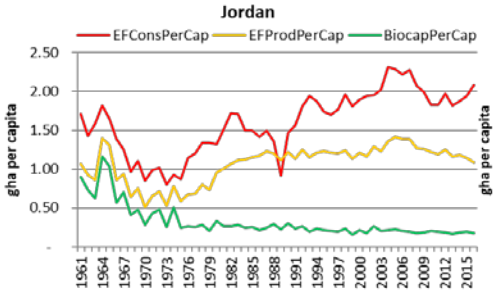
Ecological Footprint trends in the Arab Region

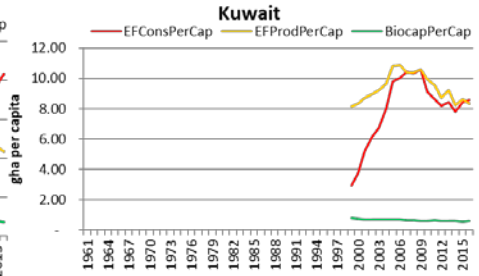


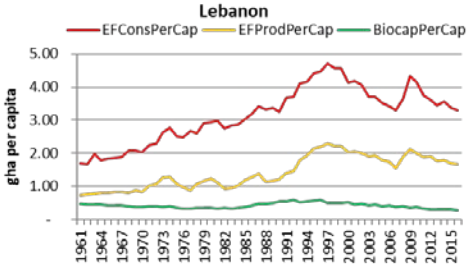


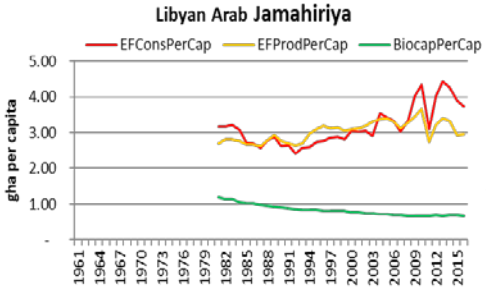


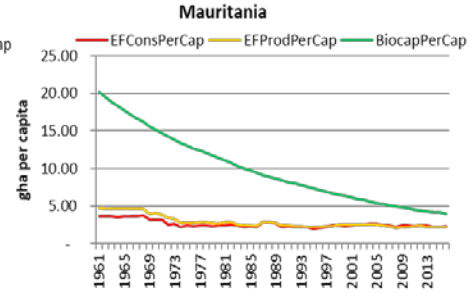


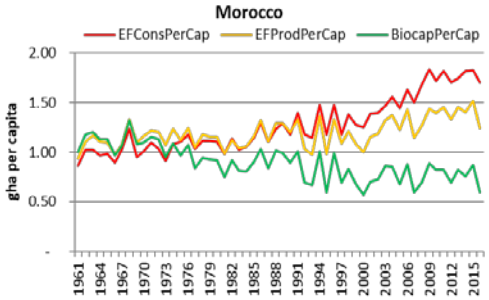


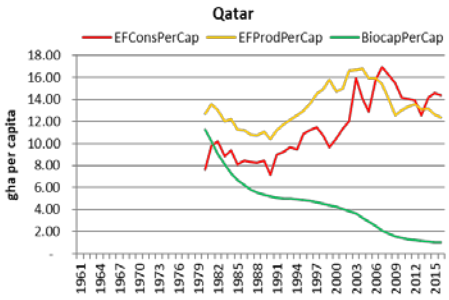


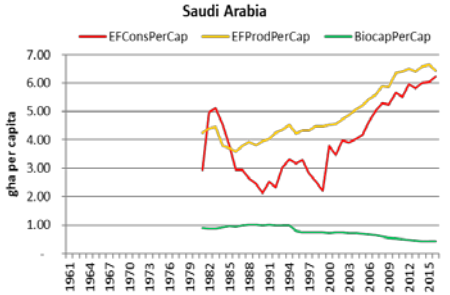


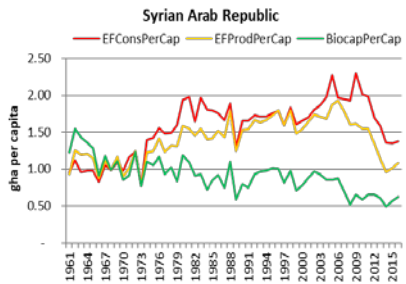

Libyan Arab Jamahiriya
EFConsPerCap
EFProdPerCap
BiocapPerCap
gha per capita

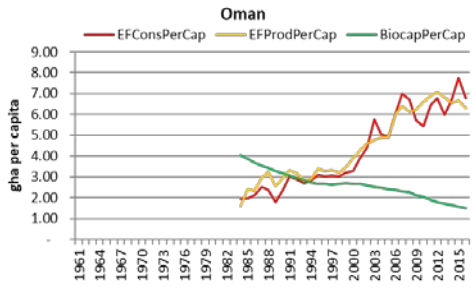

Mauritania
EFConsPerCap
EFProdPerCap
BiocapPerCap
gha per capita

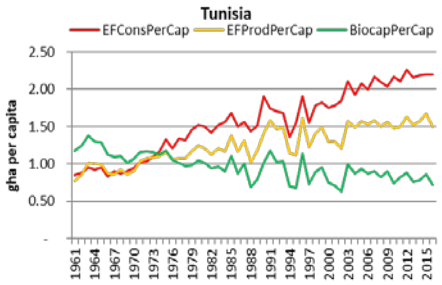

Morocco
EFConsPerCap
EFProdPerCap
BiocapPerCap
gha per capita

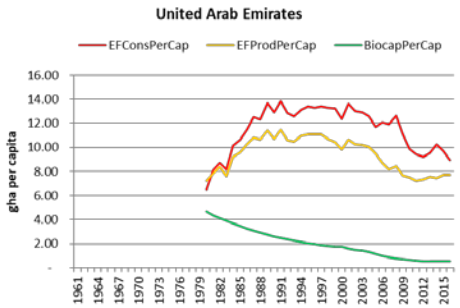

Qatar
EFConsPerCap
EFProdPerCap
BiocapPerCap
gha per capita

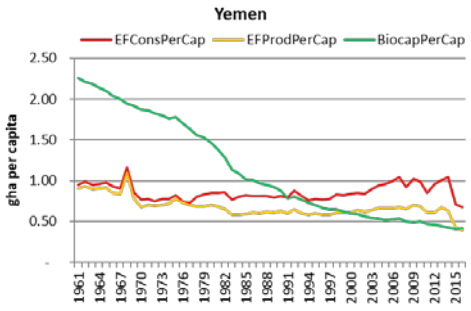

Saudi Arabia
EFConsPerCap
EFProdPerCap
BiocapPerCap
gha per capita

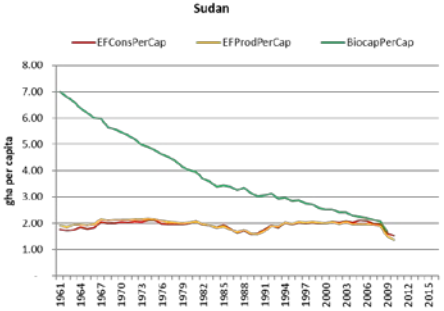

Syrian Arab Republic
EFConsPerCap
EFProdPerCap
BiocapPerCap
gha per capita

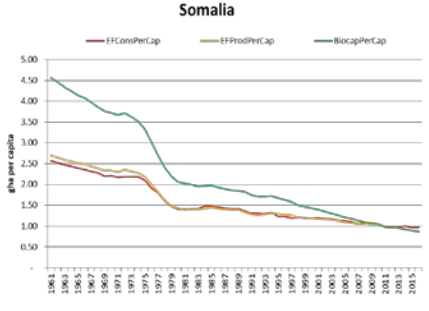

Oman
EFConsPerCap
EFProdPerCap
BiocapPerCap
gha per capita


Tunisia
EFConsPerCap
EFProdPerCap
BiocapPerCap
gha per capita

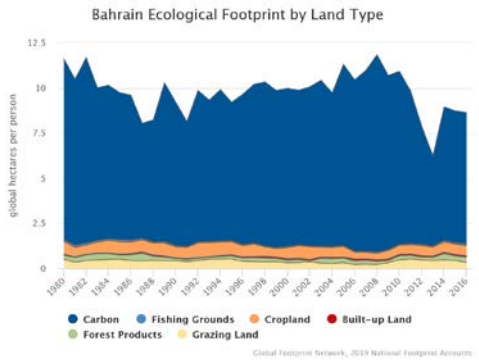

United Arab Emirates
EFConsPerCap
EFProdPerCap
BiocapPerCap
gha per capita

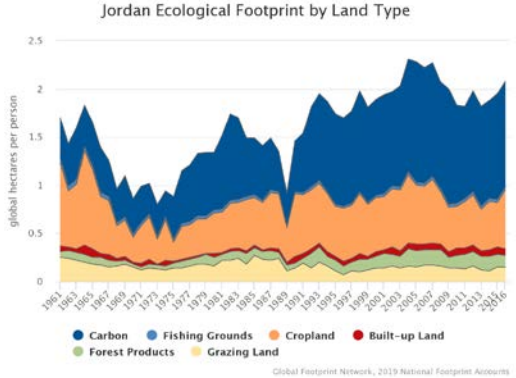

Yemen
EFConsPerCap
EFProdPerCap
BiocapPerCap
gha per capita

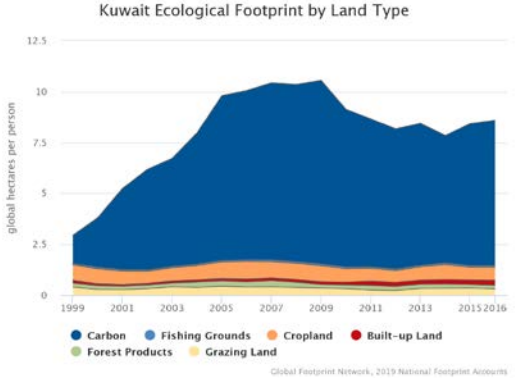

Sudan
EFConsPerCap
EFProdPerCap
BiocapPerCap
gha per capita

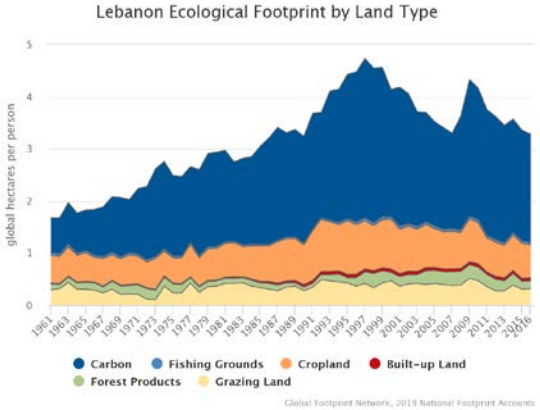

Somalia
EFConsPerCap
EFProdPerCap
BiocapPerCap
gha per capita

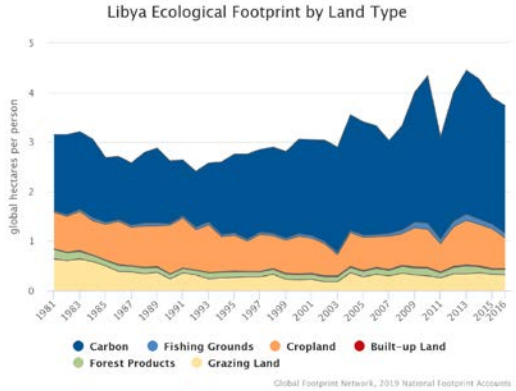
Ecological Footprint trends in the Arab Region

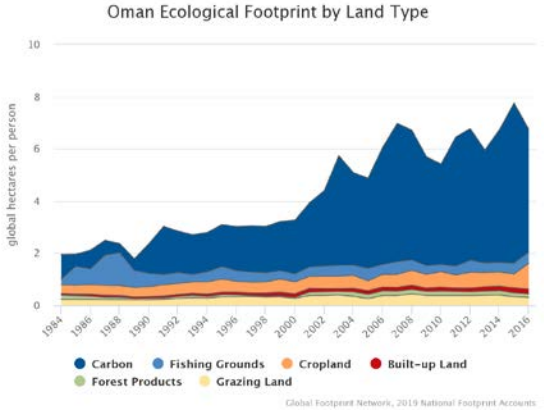


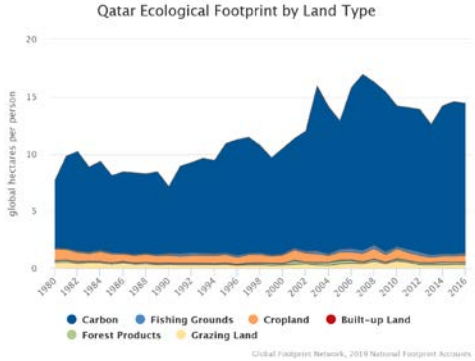


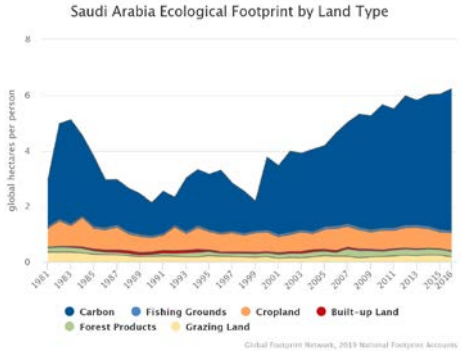


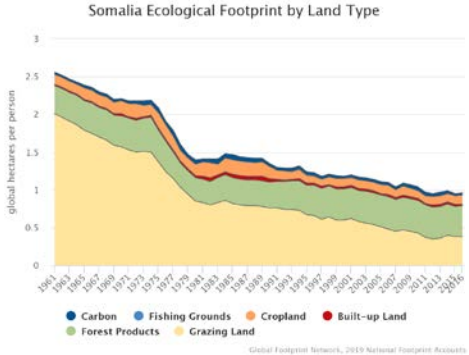


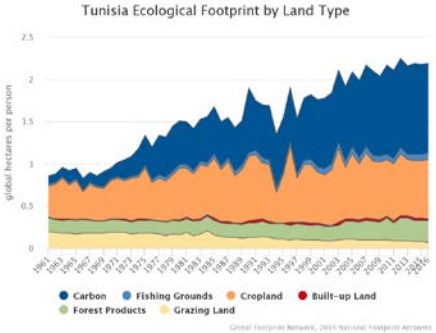


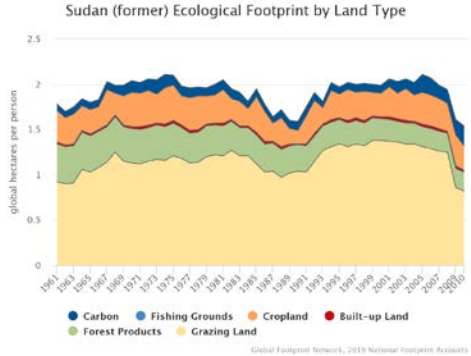


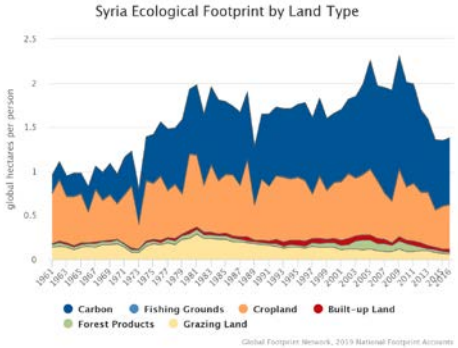

Qatar Ecological Footprint by Land Type
global hectares per person
Carbon
Fishing Grounds
Cropland
Built-up Land
Forest Products
Grazing Land
Global Footprint Network, 2019 National Footprint Accounts

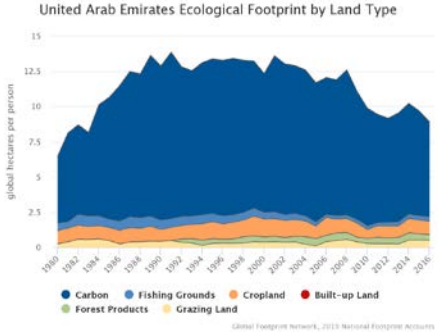

Saudi Arabia Ecological Footprint by Land Type
global hectares per person
Carbon
Fishing Grounds
Cropland
Built-up Land
Forest Products
Grazing Land
Global Footprint Network, 2019 National Footprint Accounts

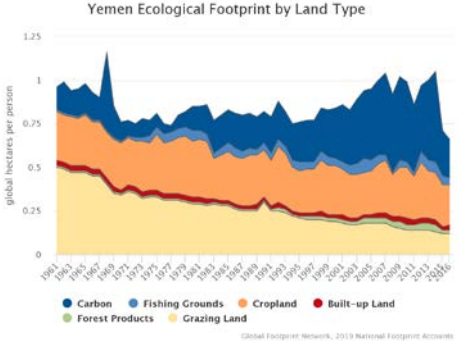

Somalia Ecological Footprint by Land Type
global hectares per person
Carbon
Fishing Grounds
Cropland
Built-up Land
Forest Products
Grazing Land
Global Footprint Network, 2019 National Footprint Accounts


Tunisia Ecological Footprint by Land Type
global hectares per person
Carbon
Fishing Grounds
Cropland
Built-up Land
Forest Products
Grazing Land
Global Footprint Network, 2019 National Footprint Accounts


Sudan (former) Ecological Footprint by Land Type
global hectares per person
Carbon
Fishing Grounds
Cropland
Built-up Land
Forest Products
Grazing Land
Global Footprint Network, 2019 National Footprint Accounts


Syria Ecological Footprint by Land Type
global hectares per person
Carbon
Fishing Grounds
Cropland
Built-up Land
Forest Products
Grazing Land
Global Footprint Network, 2019 National Footprint Accounts


United Arab Emirates Ecological Footprint by Land Type
global hectares per person
Carbon
Fishing Grounds
Cropland
Built-up Land
Forest Products
Grazing Land
Global Footprint Network, 2019 National Footprint Accounts


Yemen Ecological Footprint by Land Type
global hectares per person
Carbon
Fishing Grounds
Cropland
Built-up Land
Forest Products
Grazing Land
Global Footprint Network, 2019 National Footprint Accounts

Conclusions: how EF informs progresses on SDG12

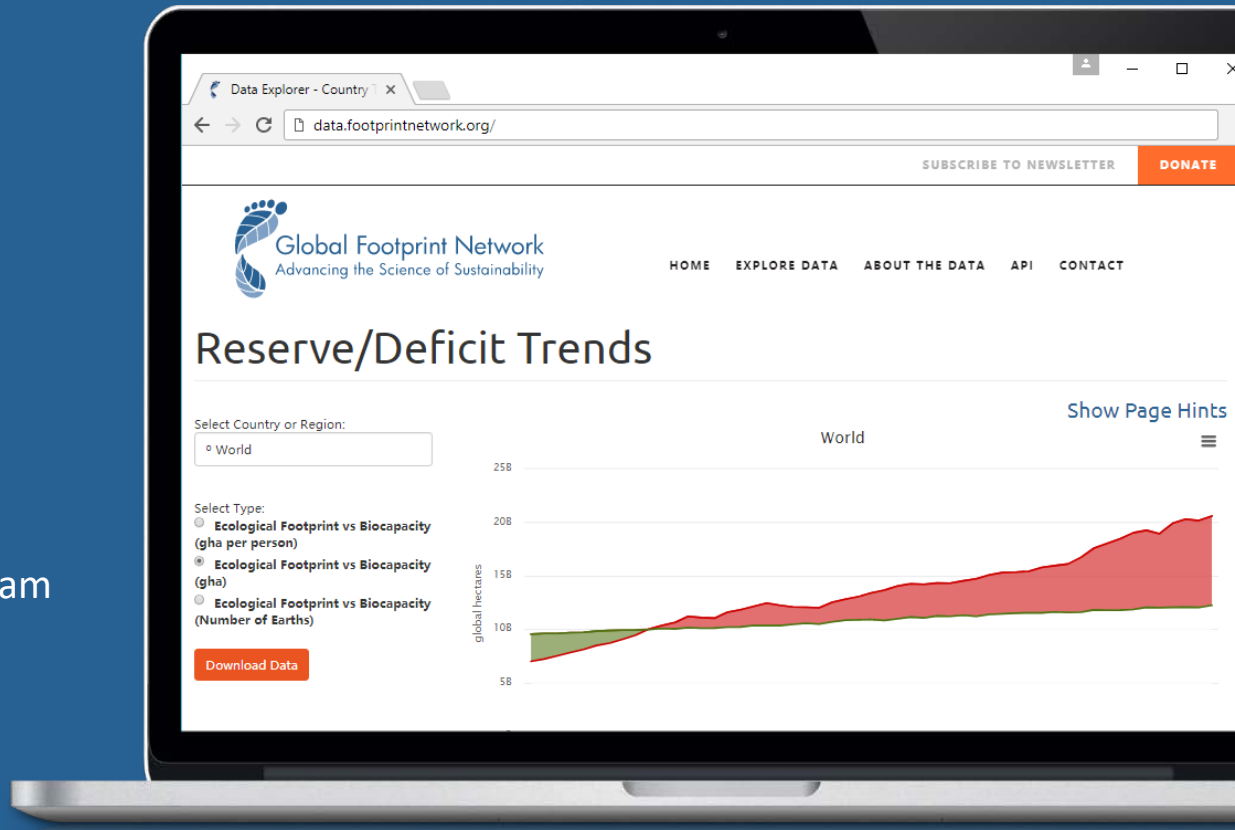
- EF allows comparing the impact of a country's production and consumption activities vs. the ecological budget available (globally or nationally).
  - It offers a framework to assess the **appropriation of ecological assets** due to both **production and consumption (PC) activities** thus offering a way to track progresses on **SDG12**
  - It also allows comparing the impact of PC activities against the regeneration of the planet thus **complementing** the **"efficiency"** side of human PC activities with the **"one-planet-consistency"** side (whether they fit within planetary limits)
  - EF clearly shows that **overall, the human enterprise is operating well beyond safe planetary limits**
  - The same holds true for several **Arab countries**

Conclusions: how EF informs progresses on SDG12

- At country level, EF accounting allows connecting the location of resource consumption to those of resource production thus shedding light on the **teleconnections of our economies** and their **associated environmental externalities**.
  - Comparing production Footprint vs. local biocapacity tells us about the extra pressure that economic activities place on the ecosystems of a country, thus representing an **indicator of direct (anthropogenic) drivers** of change in the state of biodiversity and ecosystems functioning (**IPBES Core Indicator**)
  - Ecological Footprint helps track the underlying drivers of biodiversity loss (**C indicator for the Aichi Target 4**)

Key results by country available on public data platform

Alessandro Galli, PhD
Director Mediterranean-MENA Program
Global Footprint Network
alessandro@footprintnetwork.org



Global Footprint Network
Advancing the Science of Sustainability

data.footprintnetwork.org