



Biocapacity Matters

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Rare Earths? →

Fossil Fuel? $\xrightarrow{5X}$ **Move out of fossil?**
1700 ppm?

Biocapacity!
The Food-Water-Energy Nexus **2**

Global Footprint Network
Advancing the Science of Sustainability

Why biocapacity?

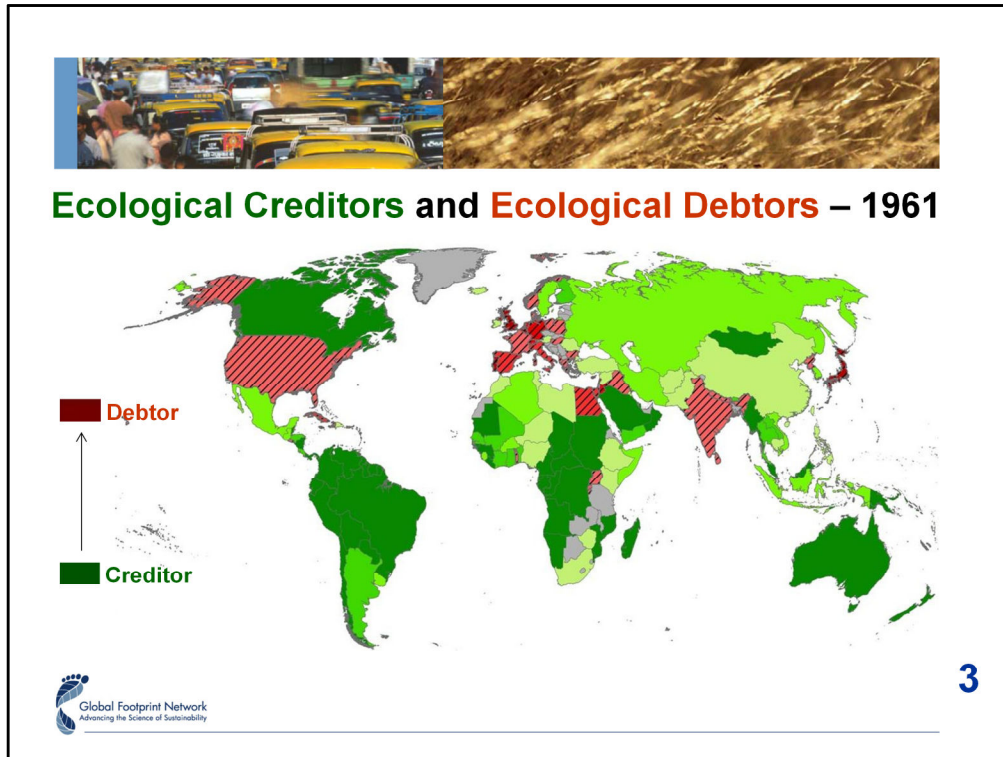
What resource is limiting our ability to secure human well-being?

Is it Rare Earth Metals (particularly special metals like Scandium or Yttrium or Gadolinium http://en.wikipedia.org/wiki/Rare_earth_element) needed for special electronic applications? In the industrial sectors, the limits of rare metals is often considered to be a key bottleneck. But industrial ecology Prof Thomas Graedel from Yale University did an extensive study on those metals. The conclusion: “limiting factor? Not really”. With more energy we can find more special metals (digging deeper, or exploiting lower concentrations).

But do we have the energy? Or is energy the limitation? Currently, fossil fuel is the dominant commercial energy. Is fossil fuel availability then the limitation? In some ways it is (peak oil), but even more so, but in some senses, we may have too much. The reason is that there is not enough biological capacity to use all of it and absorb the corresponding waste. Atmospheric CO₂ concentrations would go to over 1700 ppm if we burnt all fossil fuel we already found (now atmospheric CO₂ concentration is at 400 ppm, up from 270ppm in pre-industrial era).

Whether humanity has the wisdom to move out of fossil fuel quickly (but will need energy substitutes to replace fossil fuel such as biomass) or whether we continue to use fossil fuel and lose biocapacity through climate change, implications are similar: In both cases, biocapacity (the ability to regenerate) is becoming the most limiting factor.

Therefore we say: biocapacity is becoming the currency of the 21st century. It is becoming the limiting ingredient to human well-being.



Today, we are in a new era, defined by biocapacity constraints.

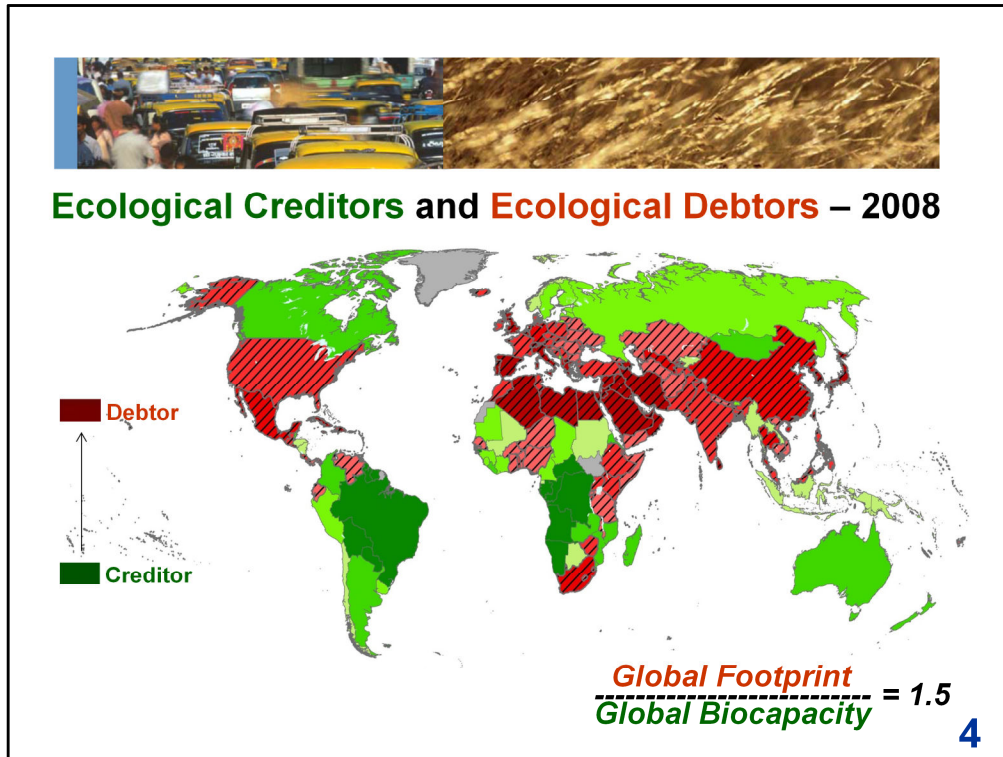
In the old era, as shown on this map here for **1961**, most countries were ecological creditors. Resources were not constraining economies. They seemed plenty.

Residents of **ecological creditor countries** consume on average less resources than their countries' ecosystems can regenerate (the darker the green the higher the ratio). Note: since there is trade among all countries, both demand and supply are calculated from the perspective of net imports (or net exports).

Ecological debtor countries are in the opposite situation. They run a biocapacity deficit. They use, in net terms, more than what their countries' ecosystems can renew.

FURTHER EXPLANATIONS:

- **Ecological Creditors:** Residents of ecological creditor countries use less ecological services than are available within their national borders, and therefore are endowed with a reserve of natural assets. This reserve, in an increasingly resource-constrained world, give those countries an economic advantage and strengthens their strategic positions.
- **Ecological Debtors:** In contrast, countries with ecological deficits depend on net imports of such resources or on liquidating their ecological assets. Both are an economic drain on those countries.



The new era has begun

With global overshoot, and rapidly increasing resource costs since 2000, the situation has shifted. As a whole, humanity's resource demand now exceeds the planet's supply by over 50 percent (2008 data). This ecological deficit means that it took a year and six months to regenerate what humanity used in 2008.

As global overshoot increases, the gap between ecological creditors – countries that have more biocapacity than they use – and ecological debtors – those using more biocapacity than they have – is becoming more pronounced, and is turning into an economically more and more significant divide. Today, 83 percent of the world's people live in countries that run an ecological deficit.

As a result, Global Footprint Network focuses on the economically ever more acute **Ecological Creditors** and **Debtors** dilemma since it makes obvious the self-interest of countries to react to biocapacity constraints.

“We are not facing a ‘global problem’ but a ‘global storm’. The question is: is your ‘boat’ ready? In a world of resource constrained world, can you, as a country, afford to run an ecological deficit? Can you afford ‘not to fix your boat’?”



How do we know? By using Ecological Footprint accounting

The Ecological Footprint is the area of land and water it takes for a human population to generate the renewable resources they consume and degrade the waste it produces in a given technological context. In other words, it measures the "quantity of nature" that we use, and compares it with how much we have (biocapacity). This accounting supports decision makers when it comes to making difficult choices, managing conflicts of objectives and placing themselves in an optimal situation for the future. The accounts can be applied to the global, country, region, individual or product.

Cropland: Cropland is the most bioproductive of all the land-use types and consists of areas used to produce food and fiber for human consumption, feed for livestock, oil crops, and rubber. Due to lack of globally consistent data sets, current cropland Footprint calculations do not yet take into account the extent to which farming techniques or unsustainable agricultural practices may cause long-term degradation of soil. The cropland Footprint includes crop products allocated to livestock and aquaculture feed mixes, and those used for fibers and materials.

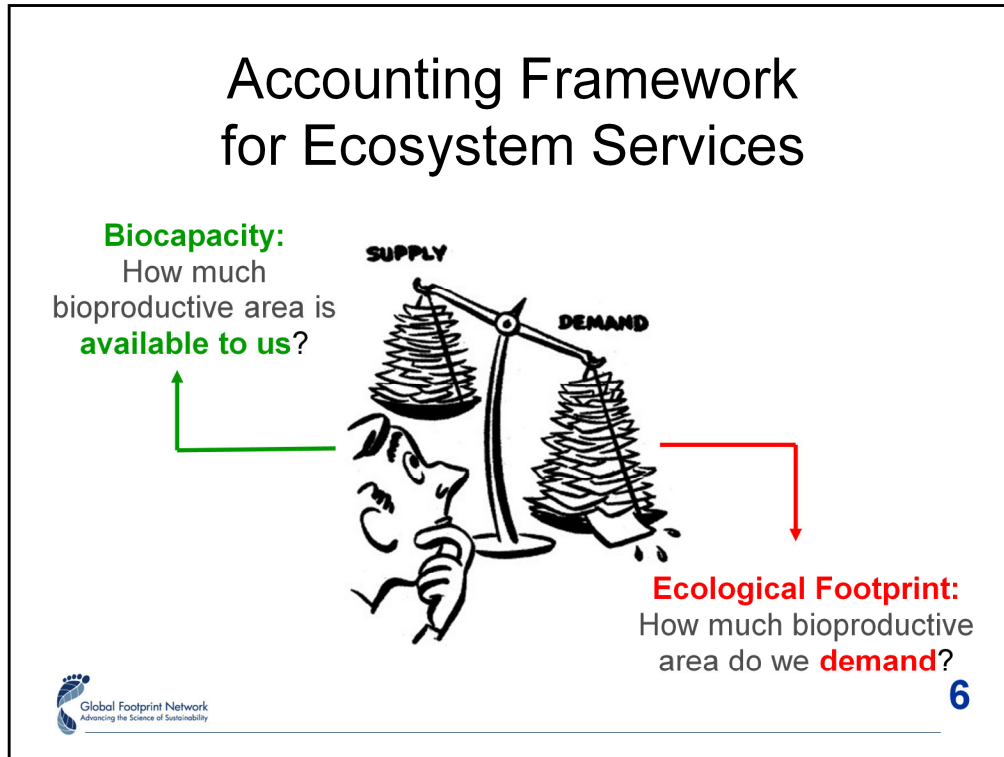
Forest land: The forest Footprint is calculated based on the amount of lumber, pulp, timber products, and fuel wood consumed by a country on a yearly basis.

Grazing land: Grazing land is used to raise livestock for meat, dairy, hide, and wool products. The grazing land Footprint is calculated by comparing the amount of livestock feed available in a country with the amount of feed required for all livestock in that year, with the remainder of feed demand assumed to come from grazing land.

Carbon Footprint: Carbon dioxide emissions from burning fossil fuels are currently the only waste product included in the National Footprint Accounts. The carbon Footprint includes embodied carbon in imported goods. The carbon Footprint component of the Ecological Footprint is calculated as the amount of forest land needed to absorb these carbon dioxide emissions. Currently, it is the largest portion of humanity's Footprint.

Fishing grounds: The fishing grounds Footprint is calculated based on estimates of the maximum sustainable catch for a variety of fish species. These sustainable catch estimates are converted into an equivalent mass of primary production based on the various species' trophic levels. This estimate of maximum harvestable primary production is then divided amongst the continental shelf areas of the world. Fish caught and used in aquaculture feed mixes are included.

Built-up land: The built-up land Footprint is calculated based on the area of land covered by human infrastructure — transportation, housing, industrial structures, and reservoirs for hydro-power. Built-up land may occupy what would previously have been cropland.



What is (physical) accounting for ecosystem services?

Ecosystem Services are the benefits that ecosystems generate, and humans depend on. According to the Millennium Ecosystems Assessment, the services can be divided into four categories:

1. **Provisioning** (food, water, energy, minerals, urban space, etc)
2. **Regulating** (**carbon sequestration**, water purification, pollination, etc)
3. **Supporting** (nutrient cycling, primary production, etc)
4. **Cultural**

Ultimately, all life competes for surface area. The Ecological Footprint is an accounting framework that tracks ecological services that compete for space. Current national accounts cover predominantly provisioning services, urban space provision, and carbon sequestration.

The Basic Equation behind the Footprint

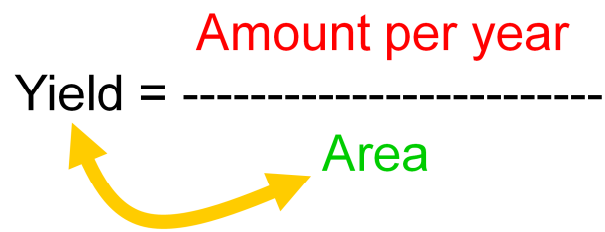
Since $Yield = amount\ per\ year / area$

$Area = amount\ per\ year / yield$

To make results comparable, we translate **hectares** into **global hectares**

As with any account, there are two sides. This allows us to compare one side against the other. Financial accounting, for instance, compares income and expenditures. Footprint accounts compare **how much nature is demanded, to how much is available** (biocapacity).

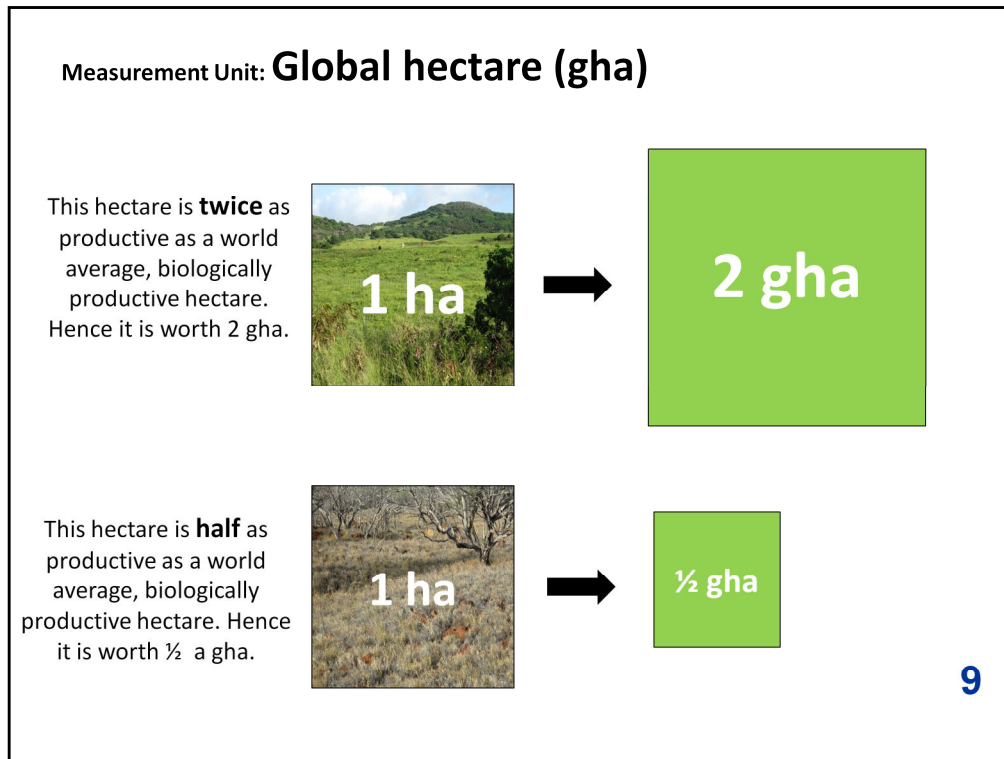
The Basic Equation

$$\text{Yield} = \frac{\text{Amount per year}}{\text{Area}}$$


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$$\text{Area} = \frac{\text{Amount per year}}{\text{Yield}}$$

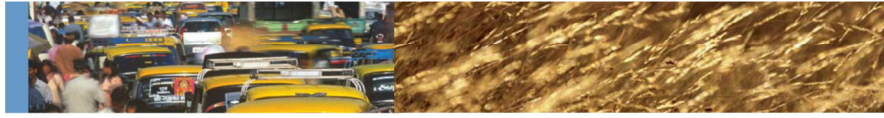
Translate **area** from **ha** into **global ha**...



A global hectare is a biologically productive hectare with world average productivity.

It is the Footprint and biocapacity unit of measurement, representing world average productivity of all the planet's biologically productive land and sea area in a given year. Biologically productive areas include cropland, forest and fishing grounds, and do not include deserts, glaciers and the open ocean.

A [productivity](#) weighted area used to report both the biocapacity of the earth, and the demand on biocapacity (the Ecological Footprint). The global hectare is normalized to the area-weighted average productivity of [biologically productive land and water](#) in a given year. Because different land types have different productivity, a global hectare of, for example, cropland, would occupy a smaller physical area than the much less biologically productive pasture land, as more pasture would be needed to provide the same biocapacity as one hectare of cropland. Because world bioproductivity varies slightly from year to year, the value of a gha may change from year to year.



LIMITATIONS

1. Nations: only 7000 data points per country & year, UN statistics, SEEA compatible
2. Necessary, not sufficient condition for lasting success (only one criterion)
3. Natural capital components have different dynamics
4. Accuracy to be further improved – underestimates biocapacity deficit
5. Only measures biocapacity, not depletion of stocks.

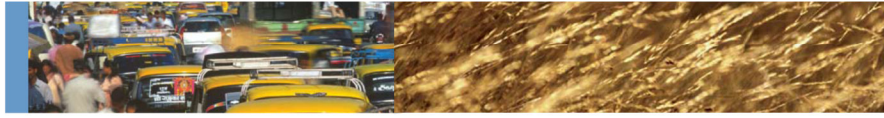


The question is not:

Is it perfect?

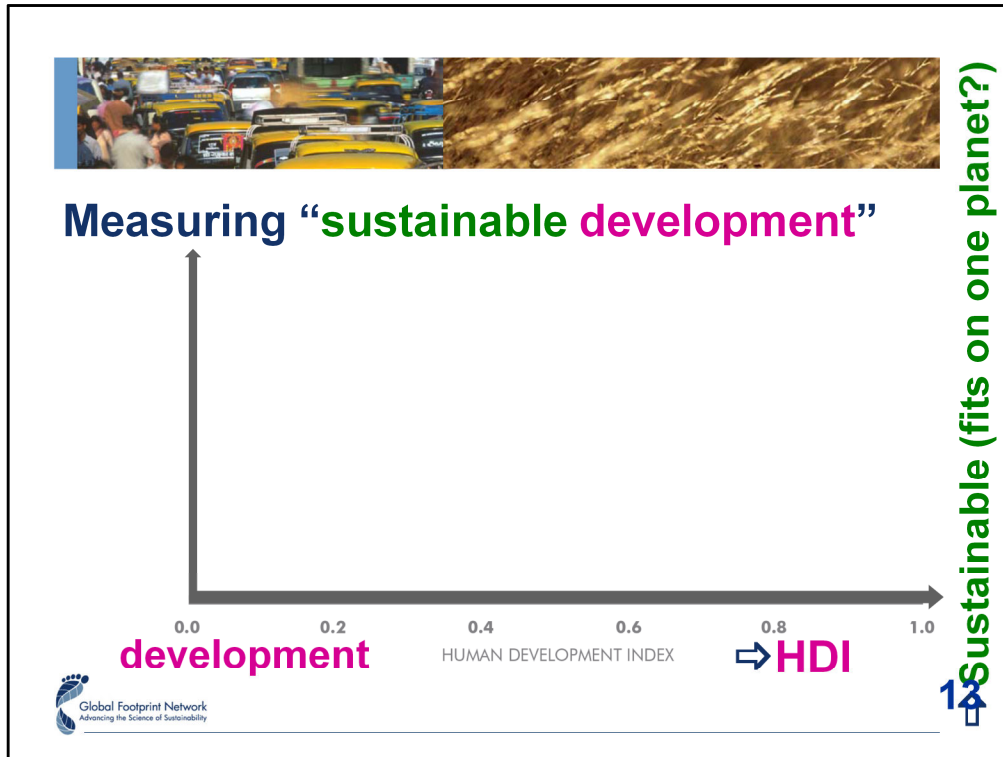
Rather:

Are we better off not knowing how many Switzerlands we have, and (approximately) how many we use?



Dilemma:

Sustainable ↔ **Development**
How many resources does it take compared to what we have? How well do we live?
Footprint? **HDI?**



Where are we today in terms of sustainability: are we living well within the means of nature?

Graph shows where countries are in terms of HDI—UN measure of quality of life (health, education, income)—and Footprint

UN defines high development as 0.8—Mexico, Libya, Russia on average.

To make it replicable worldwide, must do on average less than 1.8 productive hectares—amount available per person worldwide.

Challenge of sustainability is for the world, on average, to be in the *sustainability quadrant*.

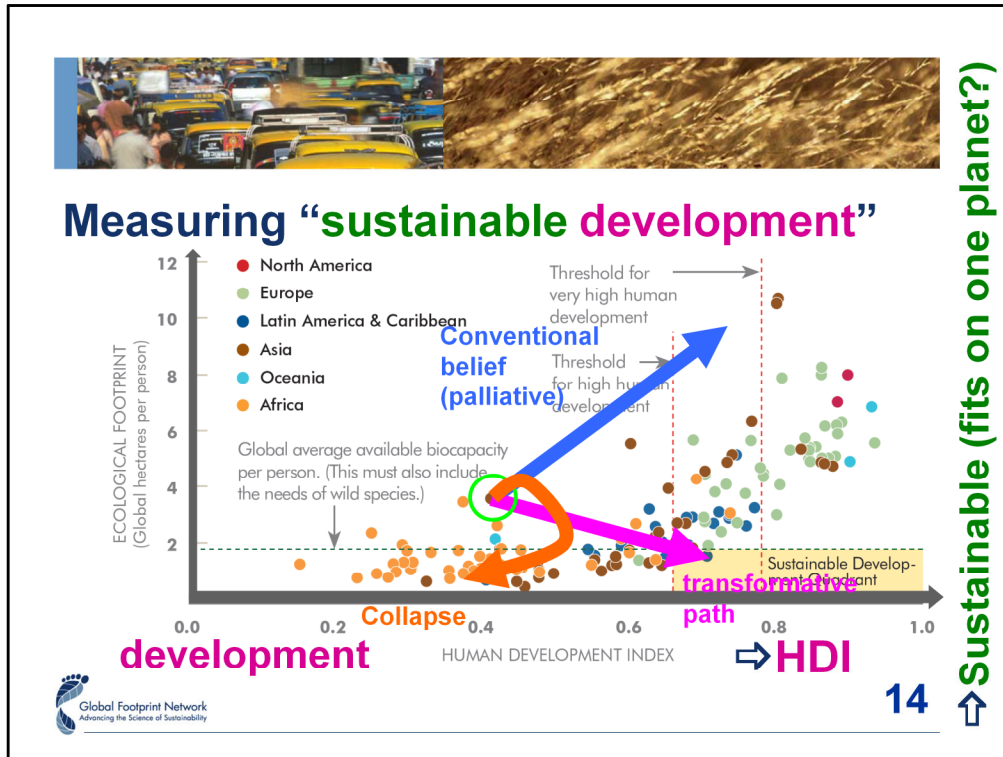
Today, Latin America comes closest to meeting both criteria; only country actually in the quadrant is Cuba.

Why is Cuba in the Sustainability Quadrant?

When the Soviet Union collapsed in 1990, Cuba's economy went into a tailspin. With imports of oil cut by more than half and food by 80 percent - people were desperate. There were hardships and struggles, but also community and creativity of the Cuban people during this difficult time. Cuba successfully transitioned from a highly mechanized, industrial agricultural system to one using organic methods of farming and local, urban gardens. Cuba, the only country that has faced such a crisis - the massive reduction of fossil fuels - was able to reduce its Footprint while maintaining a high level of development (HDI > .8).

Additional detail: Canadians spend up to 12 calories of non-renewable energy to produce one calorie of food on their dinner plate. In Cuba, the ratio is reversed. Welcome to "slow food," Cuban-style, born out of economic constraints rather than philosophical ideals: it was the Cuban economic crisis in the early '90s that forced the country to buckle down and grow over 80 per cent of the fresh produce it consumes. Cubans eat only what they grow within a reasonable proximity to where they live (fuel for transport is scarce); they eat only what's in season (energy to freeze and refrigerate is expensive and unreliable); and food is produced using labour-intensive organic farming methods (chemical inputs, which would be too expensive anyway, are unavailable, and the farms are located within the cities, so people don't want the pollution of chemical fertilizers, pesticides and herbicides).

Note—the HDI x EF results are always a snapshot in time, and much of the underlying data on production and consumption is self-reported by countries to the UN (e.g., FAO).



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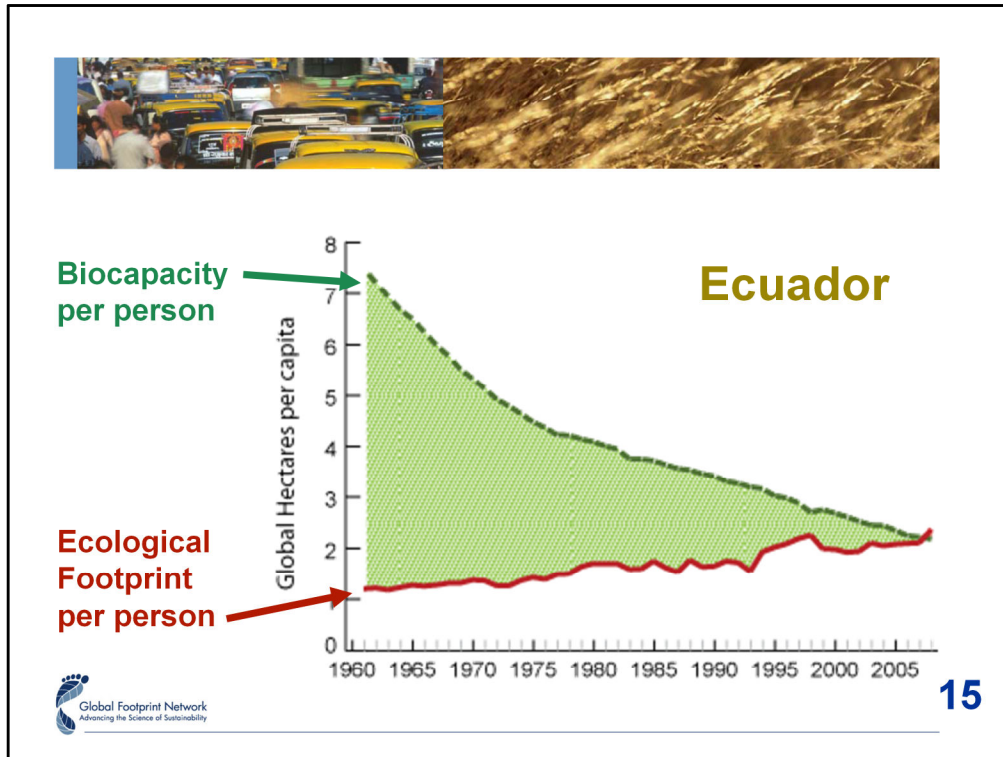
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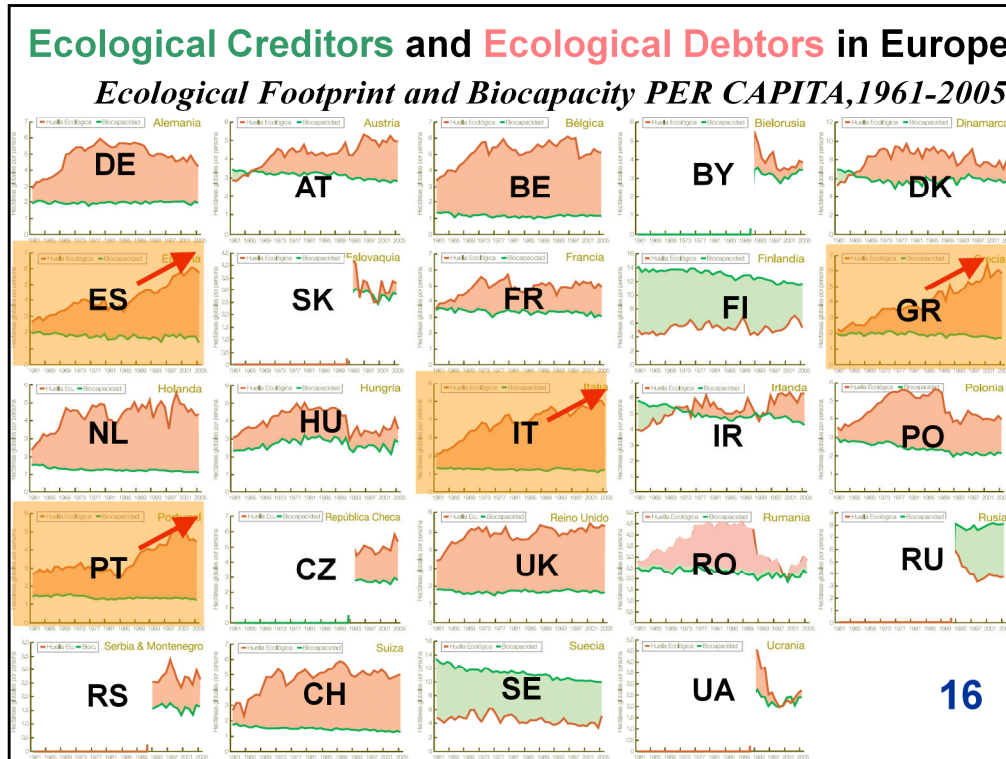


Ecuador – the first country to make biocapacity deficit reduction a national policy goal.

The most biologically diverse country in the world, Ecuador’s ecological wealth once vastly exceeded what its population used to support its activities. Today, that surplus has all but disappeared, and the country’s Ecological Footprint is almost equal to its biocapacity. That is why, in 2009, Ecuador launched a program to keep its country in the ecological black. In its National Development Plan, the government has committed that it will not let Footprint exceed biocapacity, even as its population size and standard of living grow.

This trend is not a reflection of “Global Footprint Network being against the right to develop”. Quite the contrary. It is a commitment to development, but the presented trends are a commitment to collapse.

In Ecuador, we now have a formal agreement with the ministry of environment, but also work with the ministry of planning, and ministry of tourism. Next week, we will be hosting a delegation of the government at our offices in California.



Italy is not alone – 24 European countries compared:

Why the Euro Crisis has been in the making for a while:

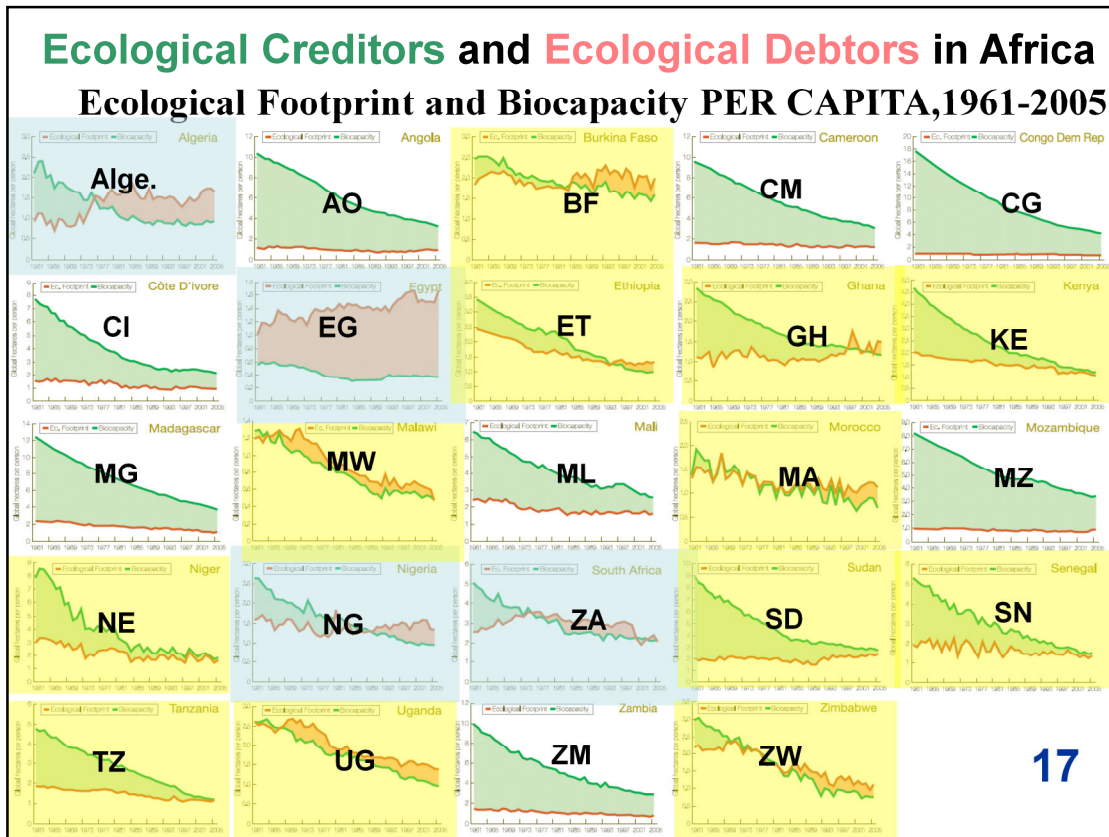
Here are 24 large(r) European countries, 19 of which are part of the European Union. All results are presented in PER CAPITA terms - on the same time scale, but the y-axis is on a different scale for each country. The y-axis is adjusted to the maximum value to best show each country's historical path.

Source Global Footprint Network, National Footprint Accounts edition 2008 (1961- 2005) [Note: newer data are now available].

All 24 countries have their own paths. There are some similarities: for instance that many European countries run significant biocapacity deficits.

What is striking is that Spain, Greece, Italy and Portugal show quite similar dynamics: rapid increase of their biocapacity deficit over the last years. Combined with economic analysis, it becomes clear that this trend caused significant, and rapidly rising cost pressures on those four countries, making them more vulnerable than other countries to economic fragility.

Using Global Footprint Network data (including the cost analysis), it becomes quite obvious, that the Euro crisis in Southern Europe cannot be divorced from the resource performance of those countries.



24 African Countries compared: Here are 24 out of 55 African countries. All presented in PER CAPITA terms - on the same time scale, but the y-axis is different. Y-axis is adjusted to better show each country's trend.

*Source Global Footprint Network, National Footprint Accounts edition 2008 (1961- 2005)
[Note: newer data are now available].*

All 24 African countries are rapidly losing per-capita biocapacity.

Four (**blue-shaded**) countries have assets that allow them to have a net-import and to burn significant quantities of fossil fuel. Countries with economic assets such as fossil fuel are able to run an ecological deficit without necessarily depleting their own ecological assets (through net-imports and emission of CO₂) (Algeria, Egypt, Nigeria, South Africa)

Others do not have that option. Twelve (**yellow-shaded**) countries' development is limited by their declining biocapacity (leading to SEVERE conflicts). Their ecological deficits leads to the liquidation of local ecological assets. Also, due to inability to get biocapacity from elsewhere, declining biocapacity per person is translating into declining per capita Footprints (Malawi, Burkina Faso, Uganda, Zimbabwe, Morocco)

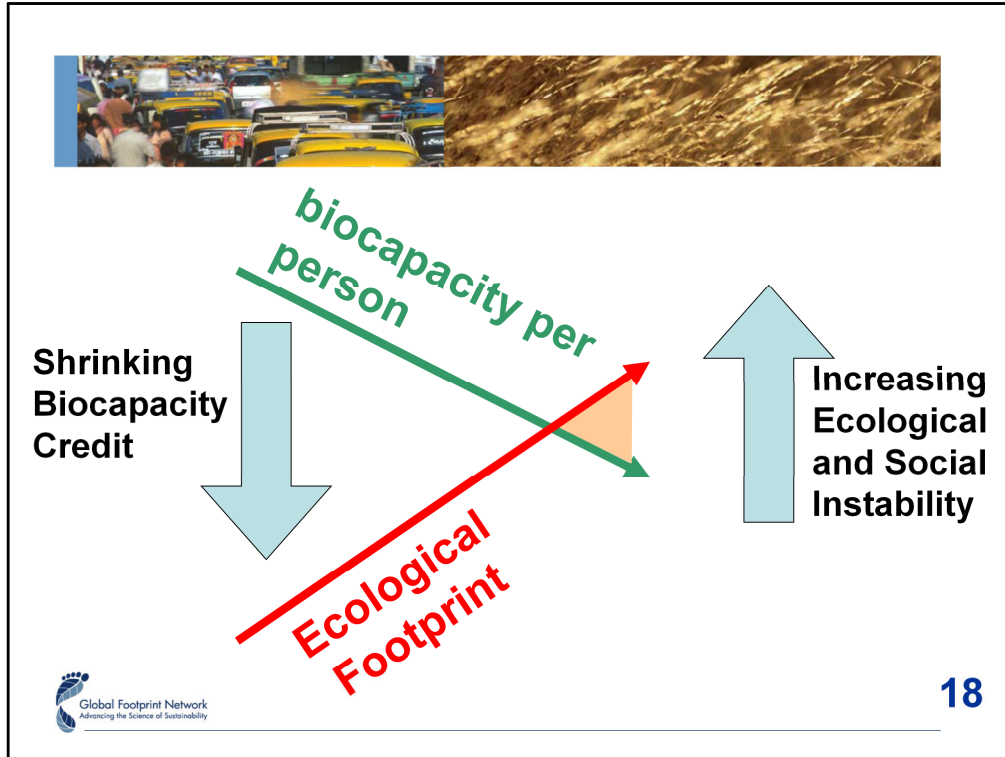
Others have reached ecological limits some time ago (Niger, Burkina Faso, Kenya)

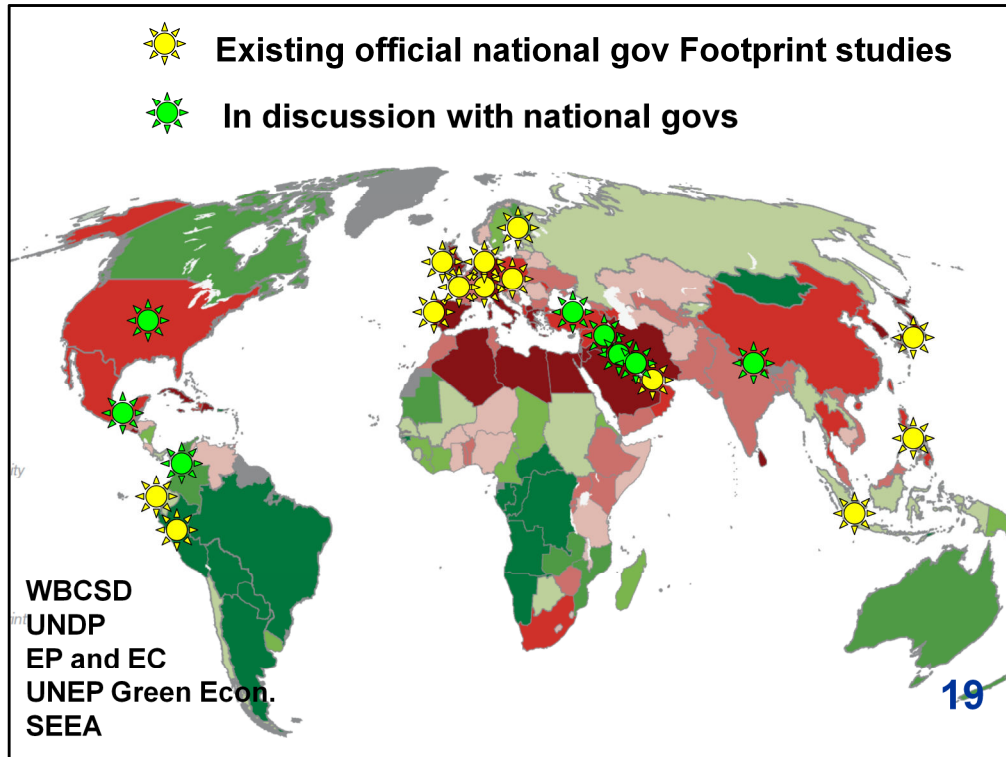
Others are about to hit it (Tanzania, Senegal, Ghana [Ghana spikes might be due to inconsistencies in trade statistics])

Sudan is about to reach limits as a country, but there is also a regional distribution. Some of its areas (Darfur) have been in a much more tight situation than national average.

Congo has a lot of biocapacity, but its surrounding countries do not – hence there is in-migration pressure and conflict.

Note, drier countries have more irregular biocapacity – and climate change might become a particularly challenging threat for them.





Where Global Footprint Network is working

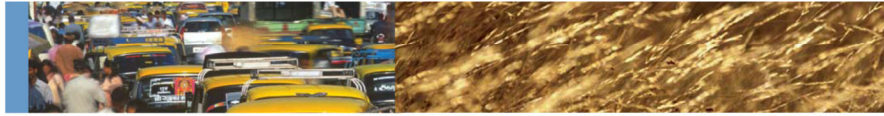
Yellow dots indicate countries where government agencies have performed reviews of Global Footprint Network's Ecological Footprint assessments. The green dots show where discussions towards a collaboration are well on their way.

Various international agencies have taken up the Footprint. The World Business Council for Sustainable Development has used the Footprint as the foundation for its "Vision 2050", UNEP's Green Economy initiative builds on Global Footprint Network's HDI-Footprint approach, and UNDP's *Human Development Report* (as well as *The Economist's World in Figures*) list the Footprint in their data tables.

About Global Footprint Network

Global Footprint Network, an international research organization in Oakland (California), Geneva and Brussels, works to end ecological overshoot by making ecological limits central to decision making, using [Ecological Footprint](#) accounting. Global Footprint Network influences major investments and policy shifts with strategic stakeholders to support global sustainability.

In 2012, Global Footprint Network President Mathis Wackernagel and Dr. William Rees—co-creators of the Ecological Footprint—received both the International Society for Ecological Economics' [Kenneth E. Boulding Memorial Award](#) and the Asahi Glass Foundation's [Blue Planet Award](#). Dr. Wackernagel is also a [Skoll Awardee](#) and co-winner of the 2011 [Zayed International Prize for the Environment](#). Mathis' also received the 2013 [Prix Nature Swissscanto](#) and the main [2012 Binding Prize for Environmental Conservation](#). Mathis and his PhD advisor Bill Rees originally developed the Footprint concept in the early 1990s (out of which also emerged the carbon footprint and the water footprint). www.footprintnetwork.org



New principles for success

- Nature has a budget. Do you know **how much biocapacity you have?** and **how much you use?**
- Biocapacity is the currency of the 21st century. Key to prosperity.
- Self-interest for countries, cities to reduce their resource deficit is overwhelming.



mathis@footprintnetwork.org 20

In summary:

For most of the 20th century, resources were relatively cheap and easily available. As a result most countries have become increasingly dependent on large amounts of natural resources they do not have – both fossil fuels and biological resources. While resources are still relatively cheap, this increasing global demand is meeting a supply crunch. It takes now more effort to harvest fossil fuels and the minerals, and, in some places, fresh water. Also agricultural production is becoming increasingly fuel dependent. As a result, basic commodities, such as food and fibers are becoming costlier.

These resource dynamics are turning into an ever more significant driver of economic performance. Economic planners ignoring these trends may put their country's economy at peril.

Global Footprint Network has comprehensive risk assessment tools to document these changing trends and assess their economic impact for 200 other countries around the world and by extension each country's trading partners. Some overarching trends are presented on our website at www.footprintnetwork.org. The Network's bio-physical assessment of countries' resource performance, coupled with economic analysis, can show structural challenges for countries that are already shaping present economic realities in many locations around the world – and opportunities for overcoming them.