Analysis of Ecological Footprints per Person and Its Majors Allocation

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1. Ecology Background:

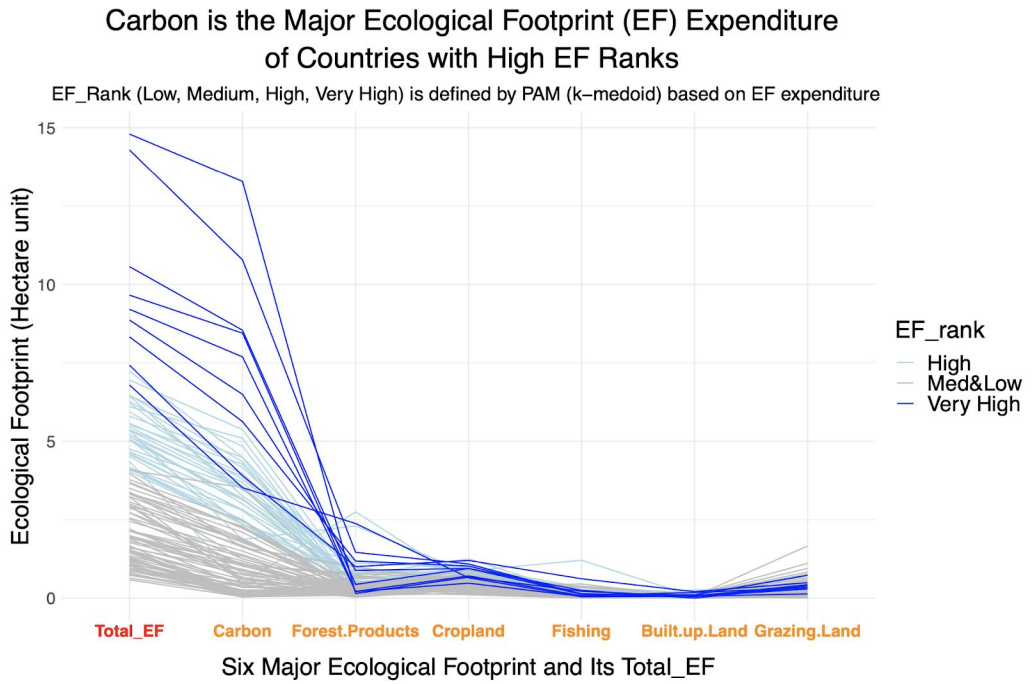
Mathis Wackernagel, for his PhD thesis in ecology at University of British Columbia, has developed and promoted metrics for sustainability called ecological footprint [1]. Data is downloaded from data.footprintnetwork.org [2]. Here are the basic metric concepts:

- Hectares are the accounting unit for the Ecological Footprint and Biocapacity accounts.
- Biocapacity per person (in hectares) is the productive area to produce biological materials and to absorb waste material generated for each resident. It is their "ecological income."
- Ecological Footprint (EF) per person (in hectares) is defined as the biologically productive areas required to provide everything one person consumes. It is their "ecological expenditures." Each ecological Footprint is further segregated into six major footprints including:
  - Carbon Footprint measures CO2 emissions associated with fossil fuel used.
  - Build-up land is the land used for housing.
  - Cropland consists of areas used to produce food and fiber for human consumption.
  - Grazing land is used to raise livestock for meat, dairy, hide, and wool products
  - Forest land is the amount of wood product consumed by a person.
  - Fishing is an estimate of the maximum sustainable catch of various fish species.

Based on this definition, a country or a person is in good shape if the subtraction of ecological footprint from biocapacity is a positive value, otherwise, that country or person has "spent" their ecology more than what they can really afford. Therefore, it is crucial to first understand how countries, especially countries with high EF, allocate their six major footprint lands; and that is the focus of this analysis. First off, I use an unsupervised technique--Partitioning Around Medoids to classify countries' Ecological Footprint into 4 groups: very high, high, medium, and low.

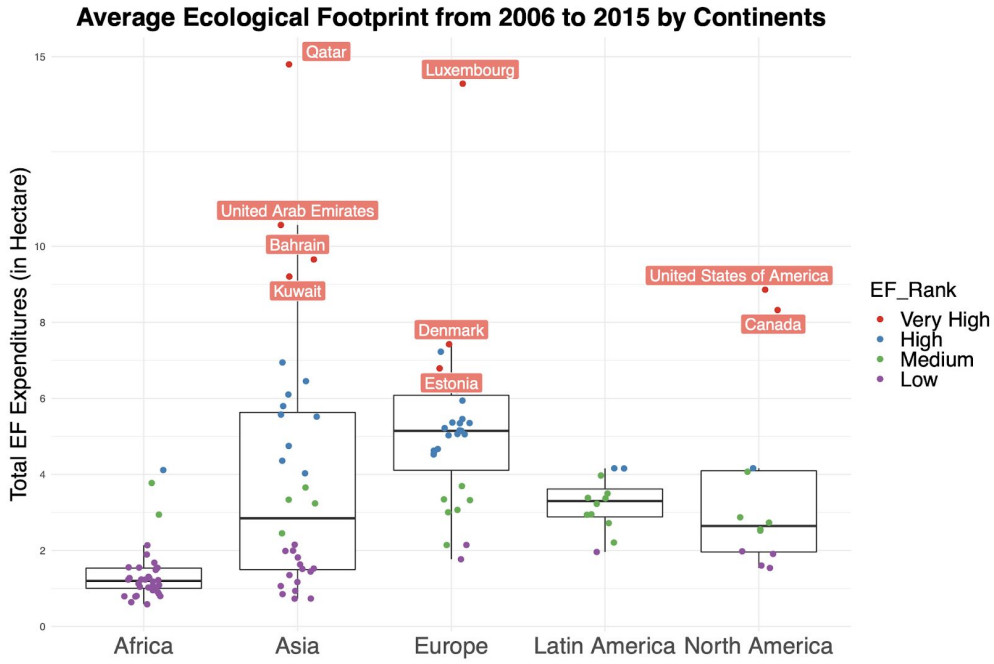
2. First plot: Carbon dominates in high EF rank countries.

It turns out that Carbon is the core consumption of countries with high EF rank. Based on the plot, I can estimate that Carbon used accounts for about 80% to 90% of all EF expenditures of countries in "High" and "Very High" groups.



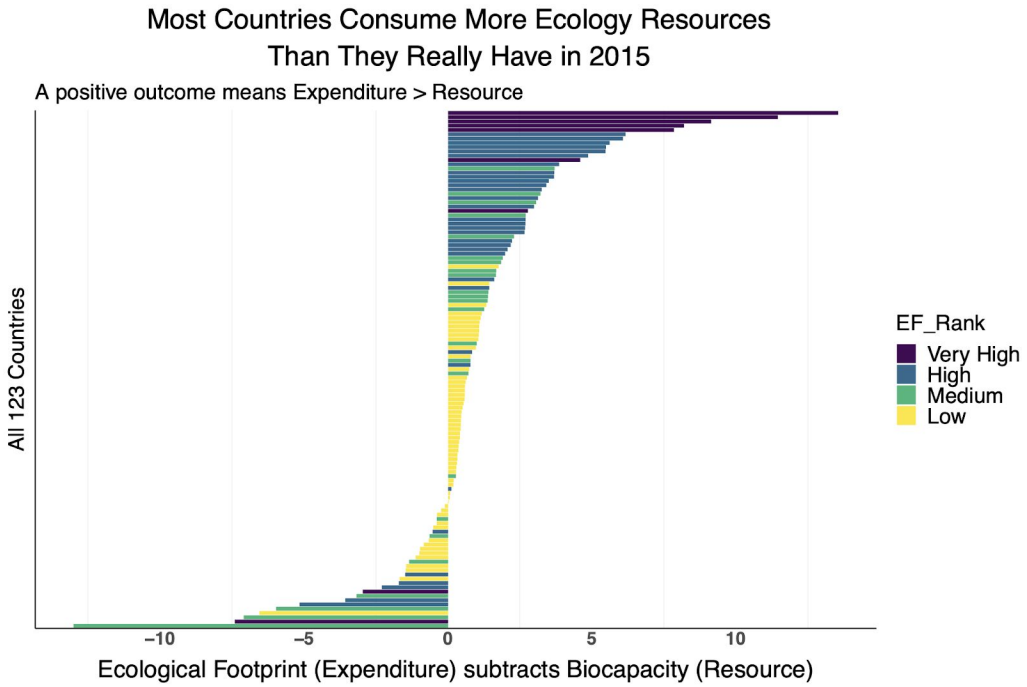
3. Second plot: EF expenditure rank by Continents

The first plot makes me curious about the relationship between EF rank with continents they sit in. It is not surprising to find out that most African countries are in the low EF expenditure rank and most European countries are in the high rank, what is interesting to me is how large the expenditure gap is in Asian countries: about half of countries are in Low, and another half are way higher. Beside, all countries in "Very High" rank, with the highest carbon footprints, are among richest countries in the world by Gross National Income (GNI) [3] including Bahrain,Canada, Denmark, Kuwait, Qatar, United Arab Emirates, USA, Australia and Luxembourg. They are also on top of crude oil exporters [4].



4. Third plot: About ¾ number of countries spend more ecology resources than they have.

It is quite surprising to learn that even low rank countries have spent more resources than they can afford (positive outcome) and countries in "Very High" and "High" ranks have huge positive outcomes. Combining with the second plot, the picture that emerges is top developed countries, such as Qatar, Canada, U.S etc, are built upon the "carbon" industry.



References:

[1] Wackernagel, M. (1994). Ecological Footprint and Appropriated Carrying Capacity: A Tool for Planning Toward Sustainability (PDF) (PhD thesis). Vancouver, Canada: School of Community and Regional Planning. The University of British Columbia. OCLC 41839429

[2] "Open Data Platform." *Open Data Platform*, data.footprintnetwork.org/#/?/.

[3] Suneson, Grant. "These Are the 25 Richest Countries in the World." *USA Today*, Gannett Satellite Information Network, 8 July 2019, www.usatoday.com/story/money/2019/07/07/richest-countries-in-the-world/39630693/.

[4] Workman, Daniel. "Crude Oil Exports by Country." *World's Top Exports*, 8 Mar. 2020, www.worldstopexports.com/worlds-top-oil-exports-country/.