The Treadmill of Destruction and Ecological Exchange in Comparative Perspective: A Panel Study of the Biological Capacity of Nations, 1961-2007

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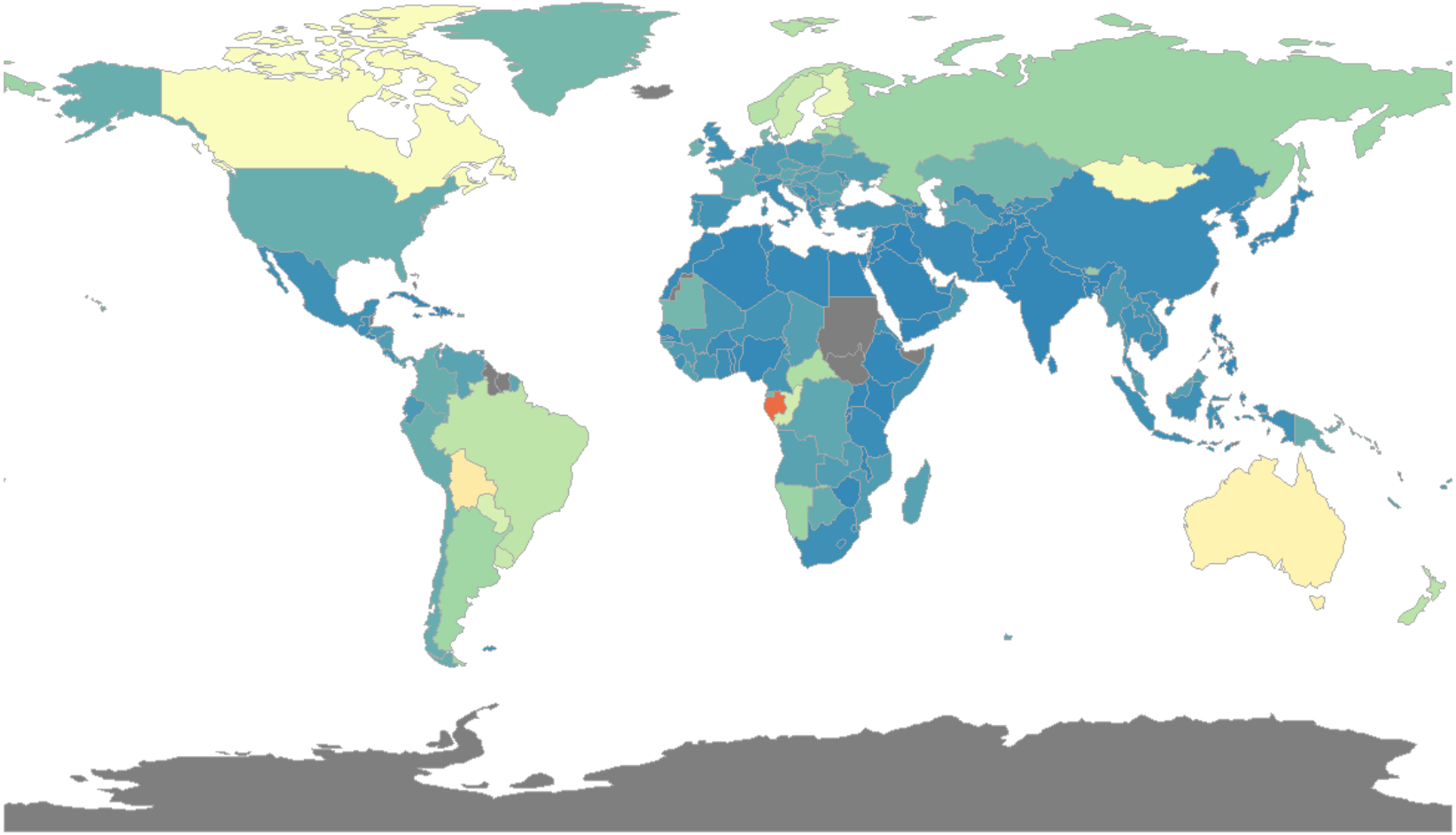
What is Biological Capacity?

- **Biocapacity:** an estimate of the quantity of ecosystem resources utilized in the production (rather than consumption) of final goods and services.

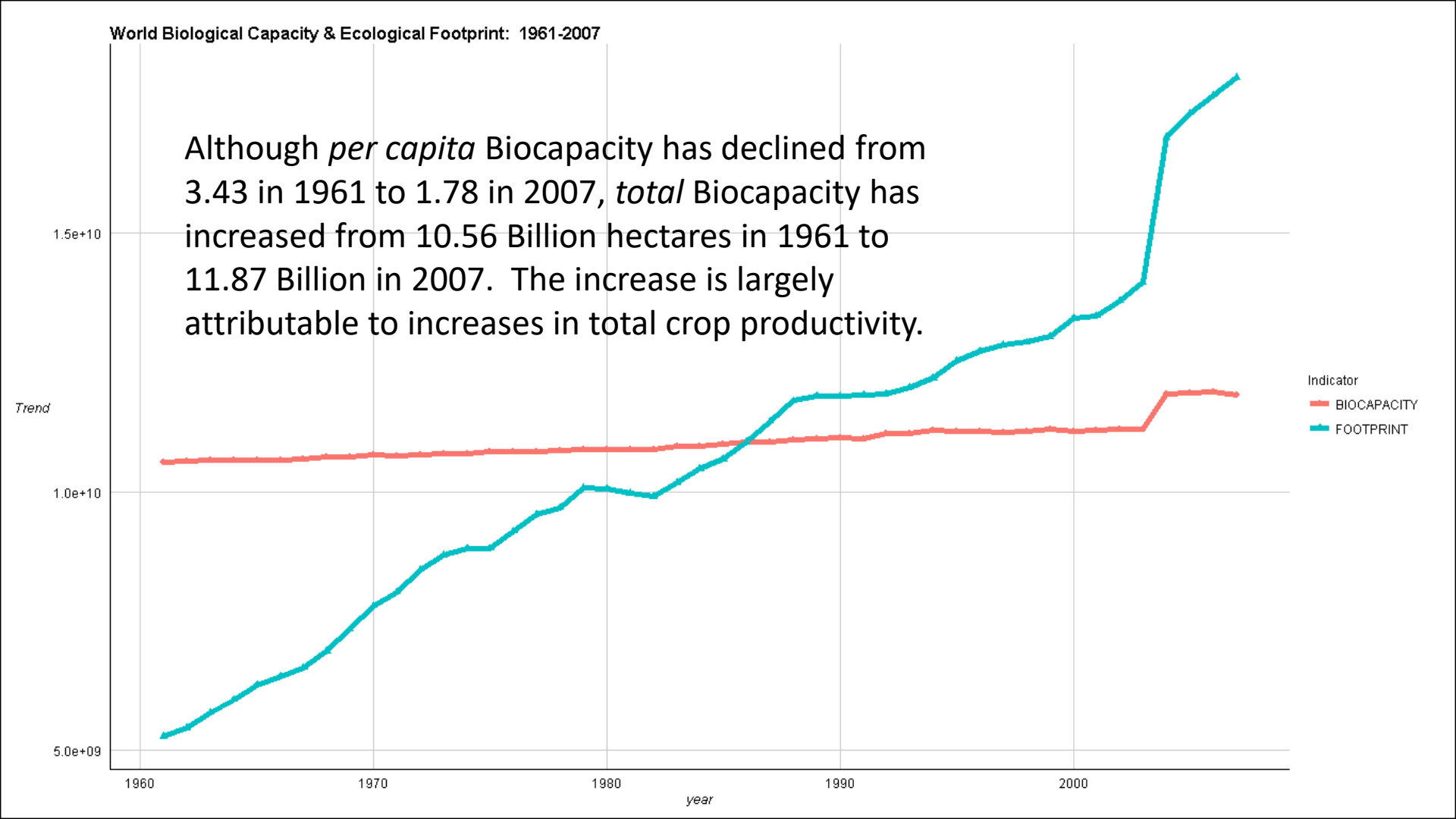
Ecological Footprint = Biocapacity + Net Exports + Carbon Uptake Land

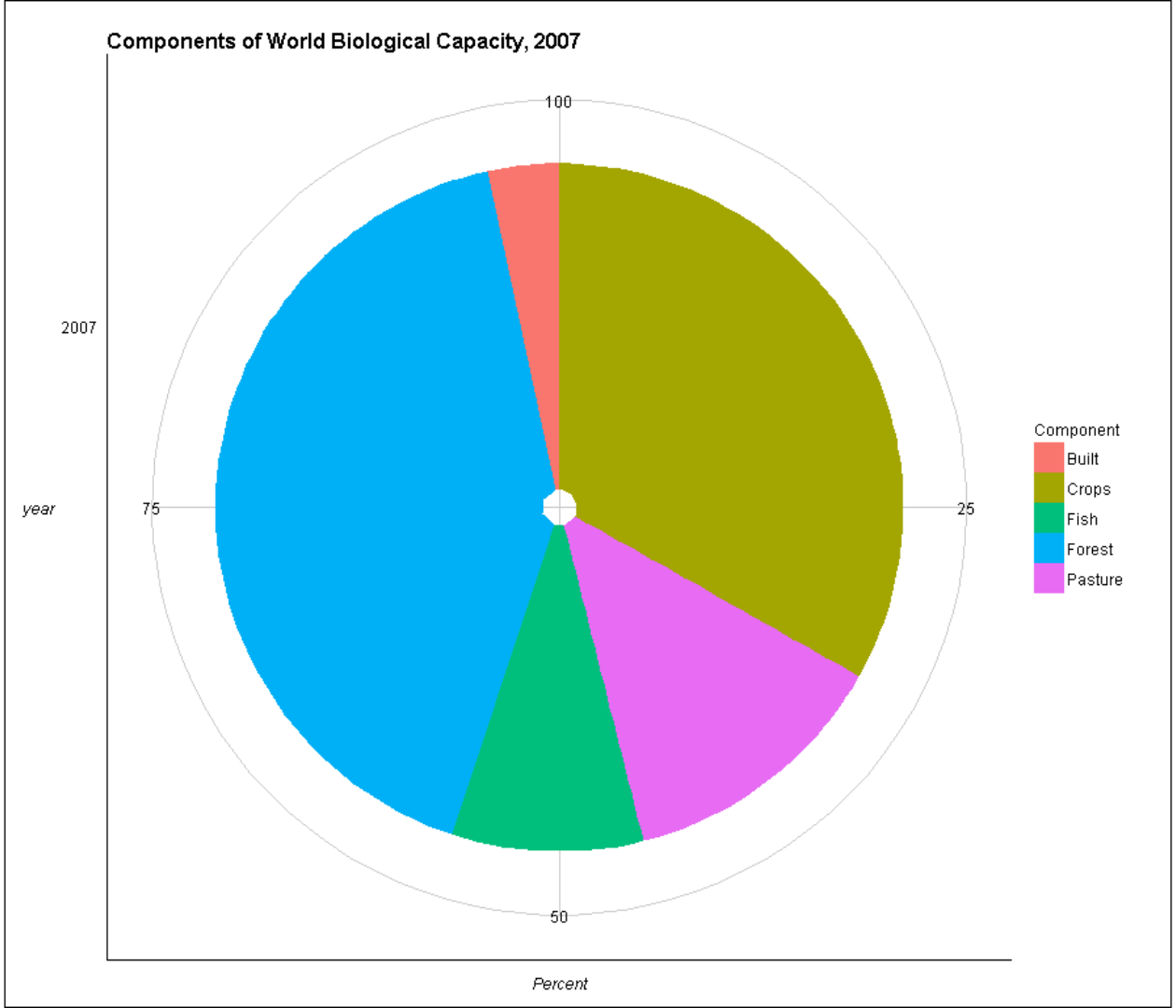
Per Capita Biological Capacity of Nations, 2011



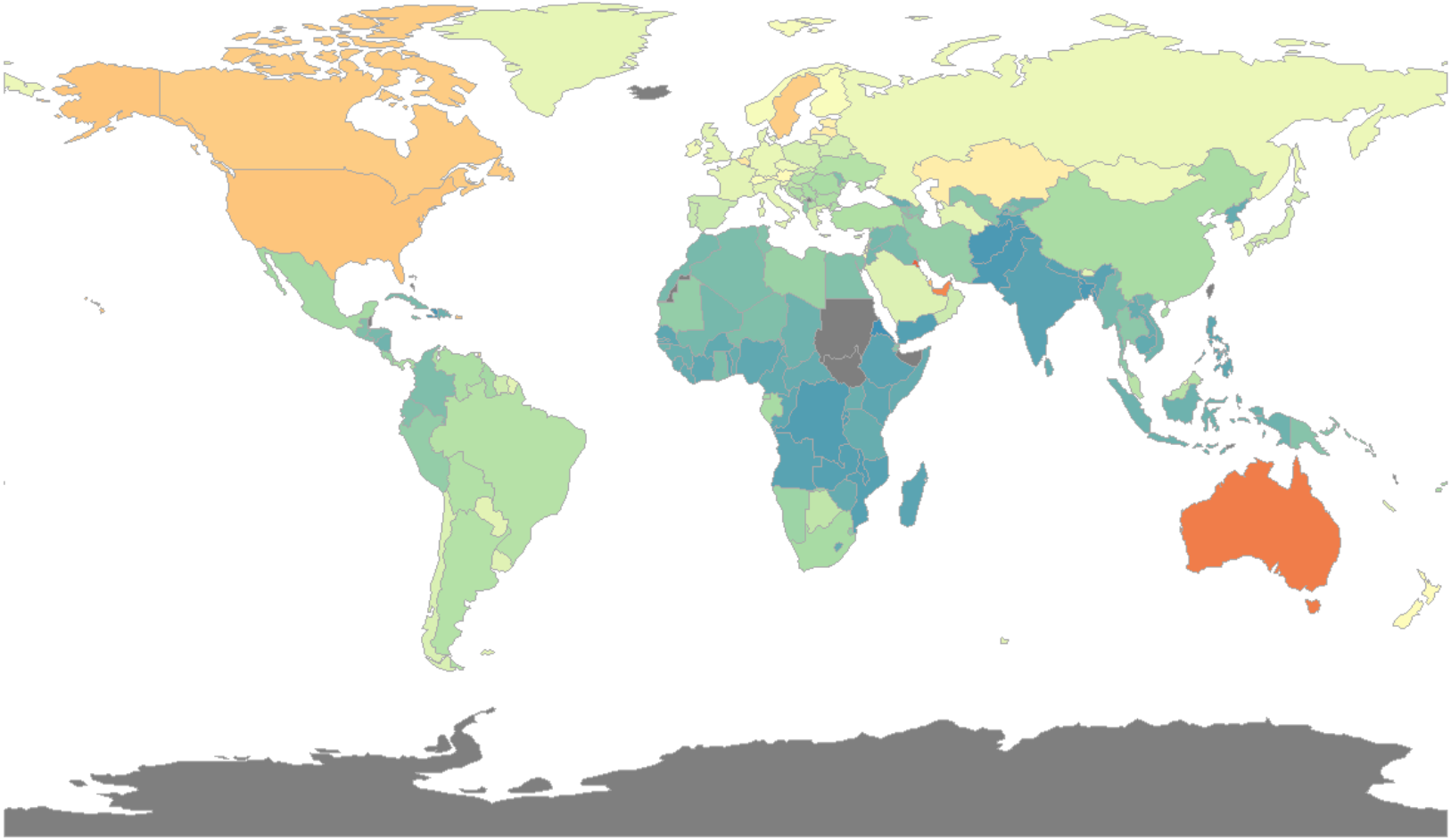
What is Biological Capacity *NOT*?

- Biocapacity is *not* a measure of **capacity** (or potential)
- Biocapacity does *not* quantitatively assess **carrying capacity** - maximum pop. of a species that can be supported indefinitely (Catton, 1980).
  - Measurements of Biocapacity contain **no assumptions** about how productive lands could or should be used; instead estimates are derived exclusively from *actual,* measurable land area required in a given country in a given year to supply over 60 categories of commodities…
- **IS BIOCAPACITY ONE PROXY MEASURE FOR BIOLOGICAL *THROUGH-PUT*?**

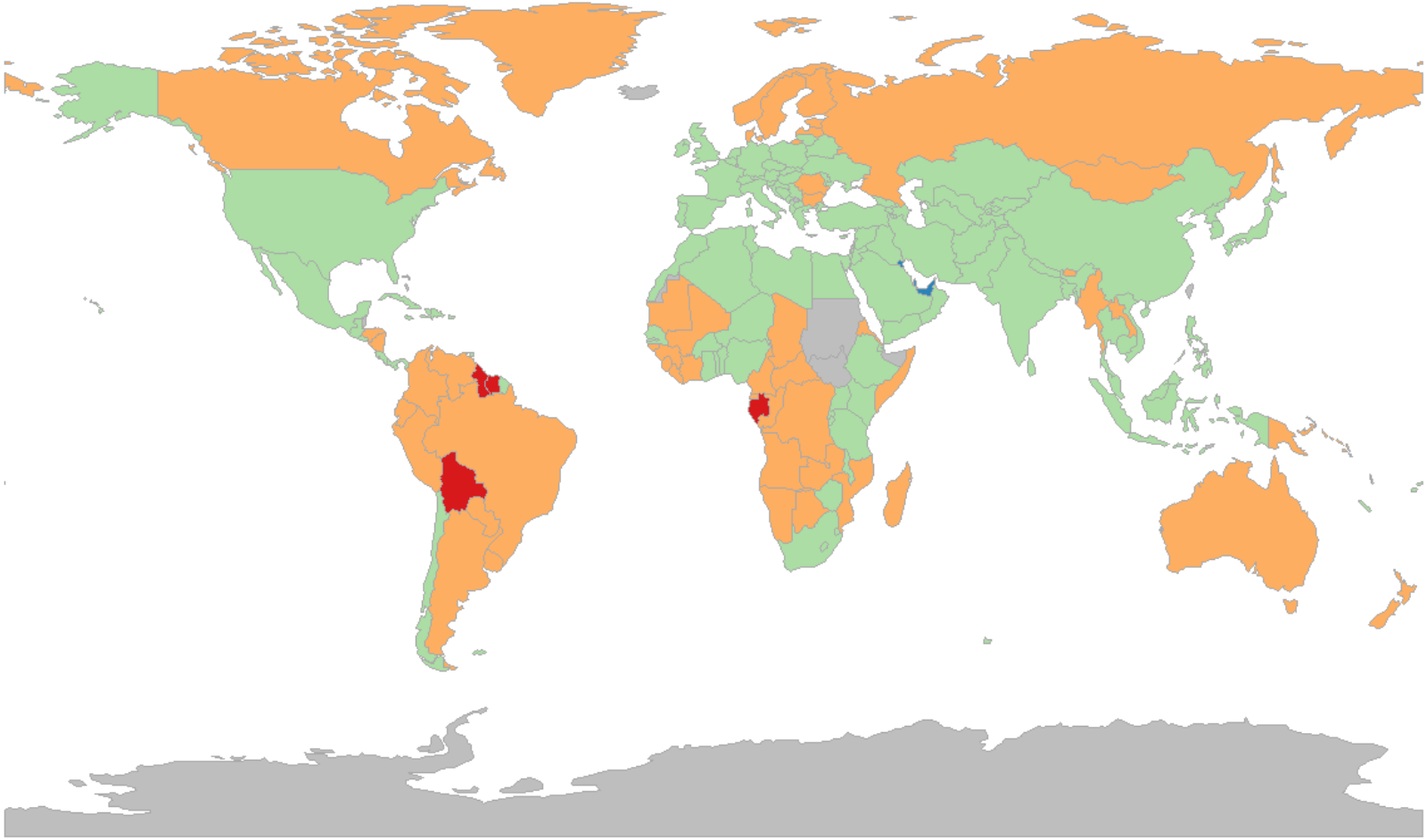

World Biological Capacity & Ecological Footprint: 1961-2007
Although *per capita* Biocapacity has declined from 3.43 in 1961 to 1.78 in 2007, *total* Biocapacity has increased from 10.56 Billion hectares in 1961 to 11.87 Billion in 2007. The increase is largely attributable to increases in total crop productivity.
1.5e+10
1.0e+10
5.0e+09
Trend
1960
1970
1980
1990
2000
year
Indicator
BIOCAPACITY
FOOTPRINT

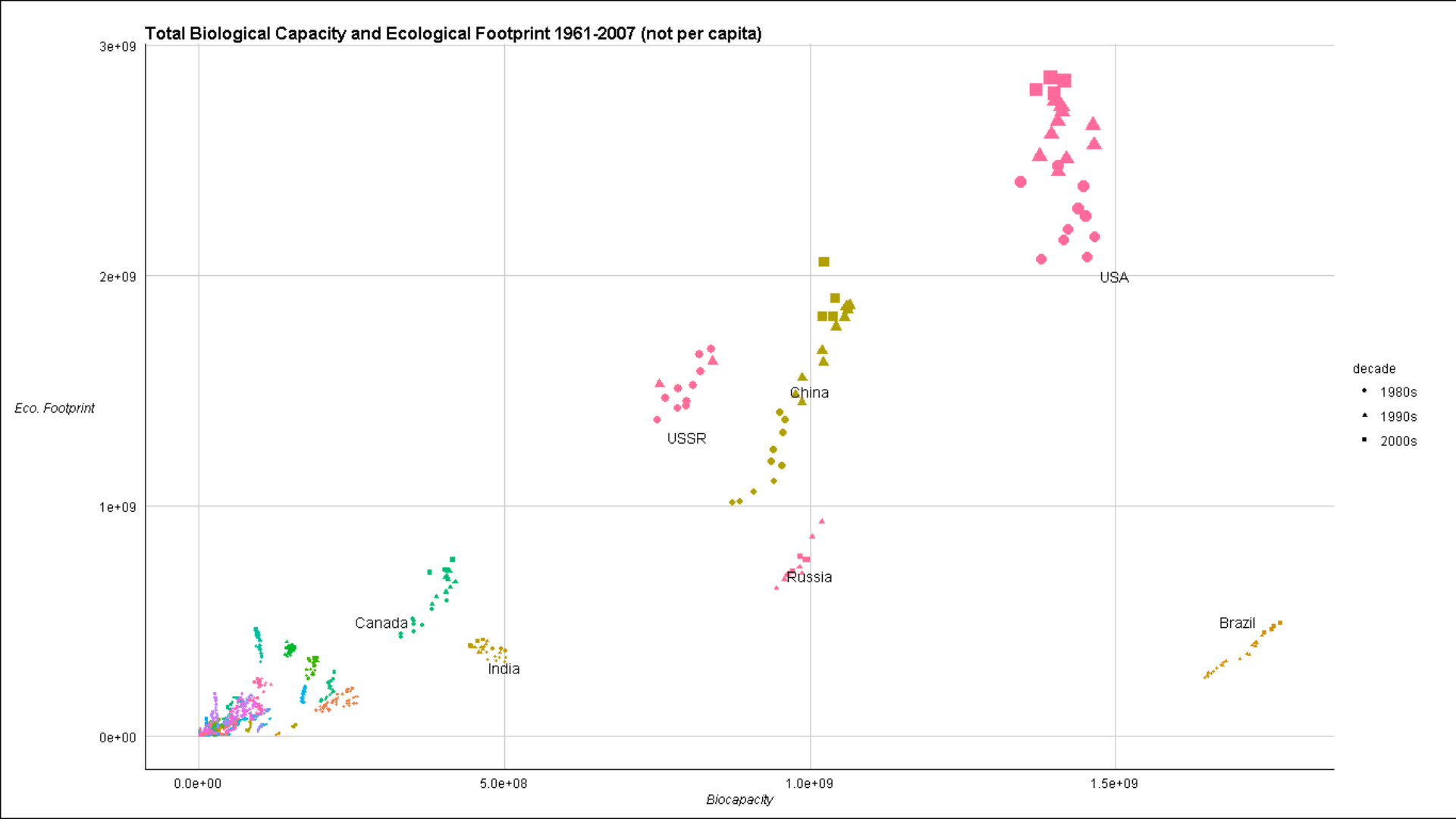

Components of World Biological Capacity, 2007
2007
year
100
75
25
50
Percent
Component
Built
Crops
Fish
Forest
Pasture

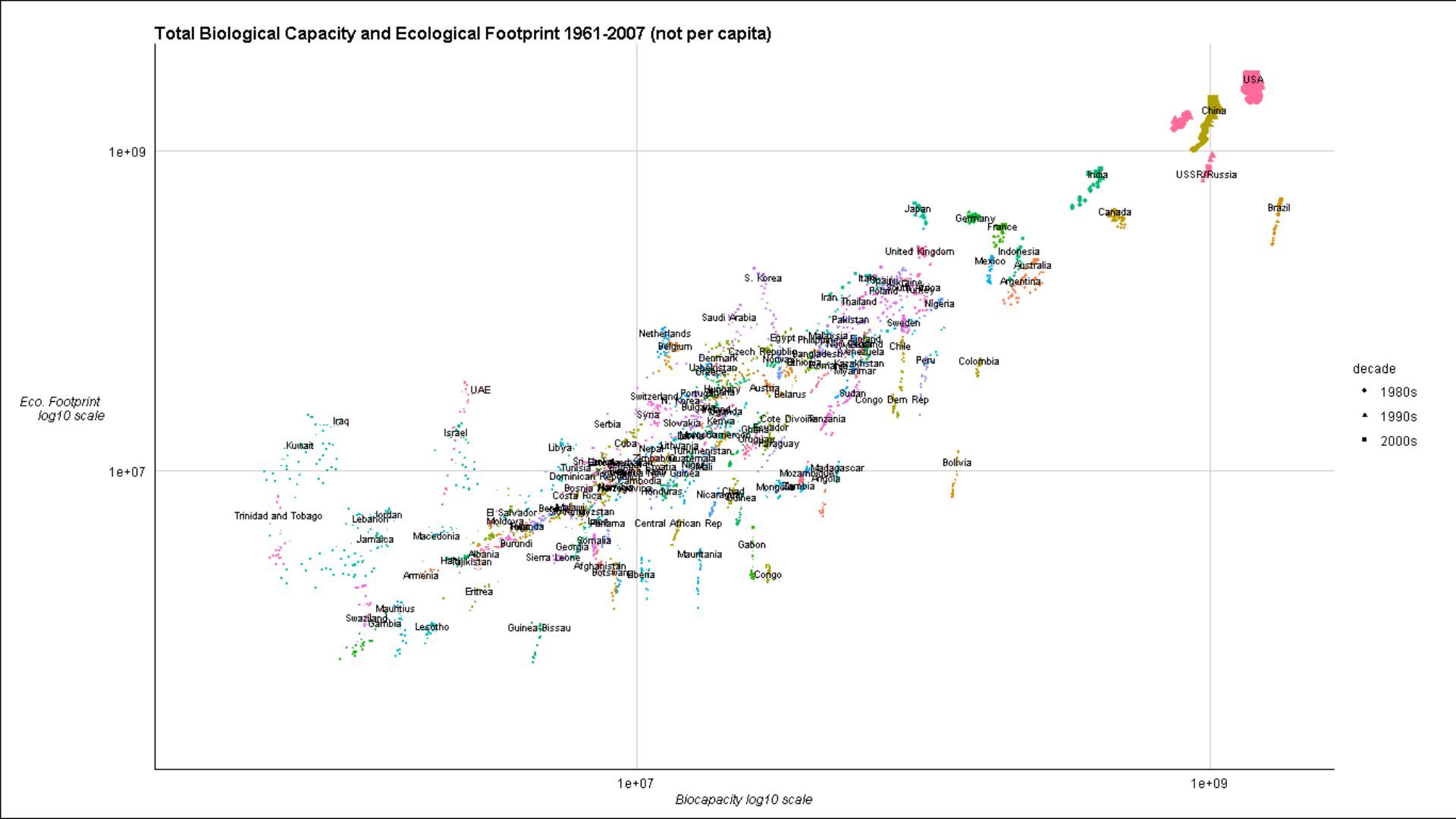
Per Capita Ecological Footprint of Nations, 2011

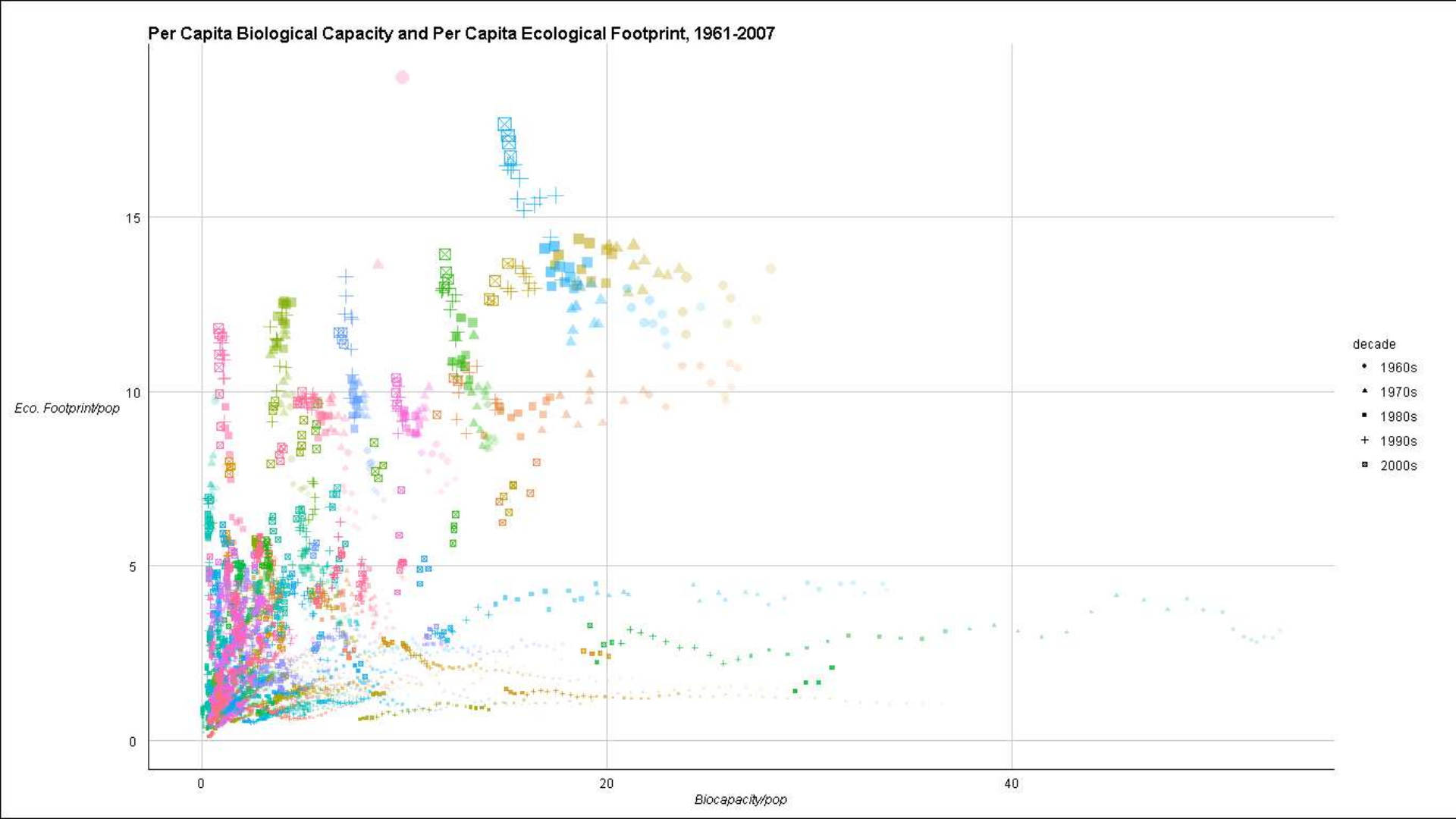


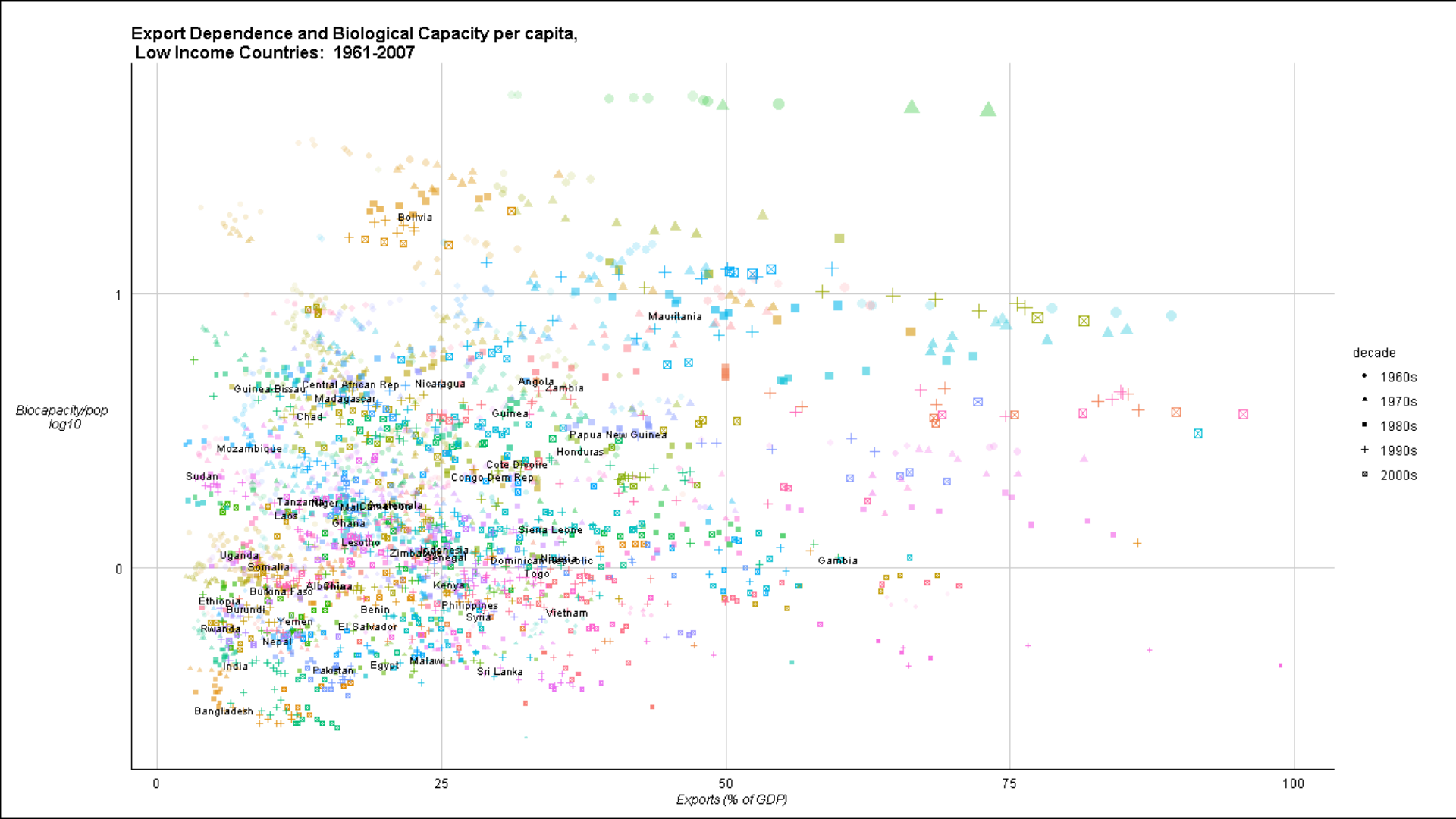
Per Capita Biocapacity Deficit/Reserve, 2011

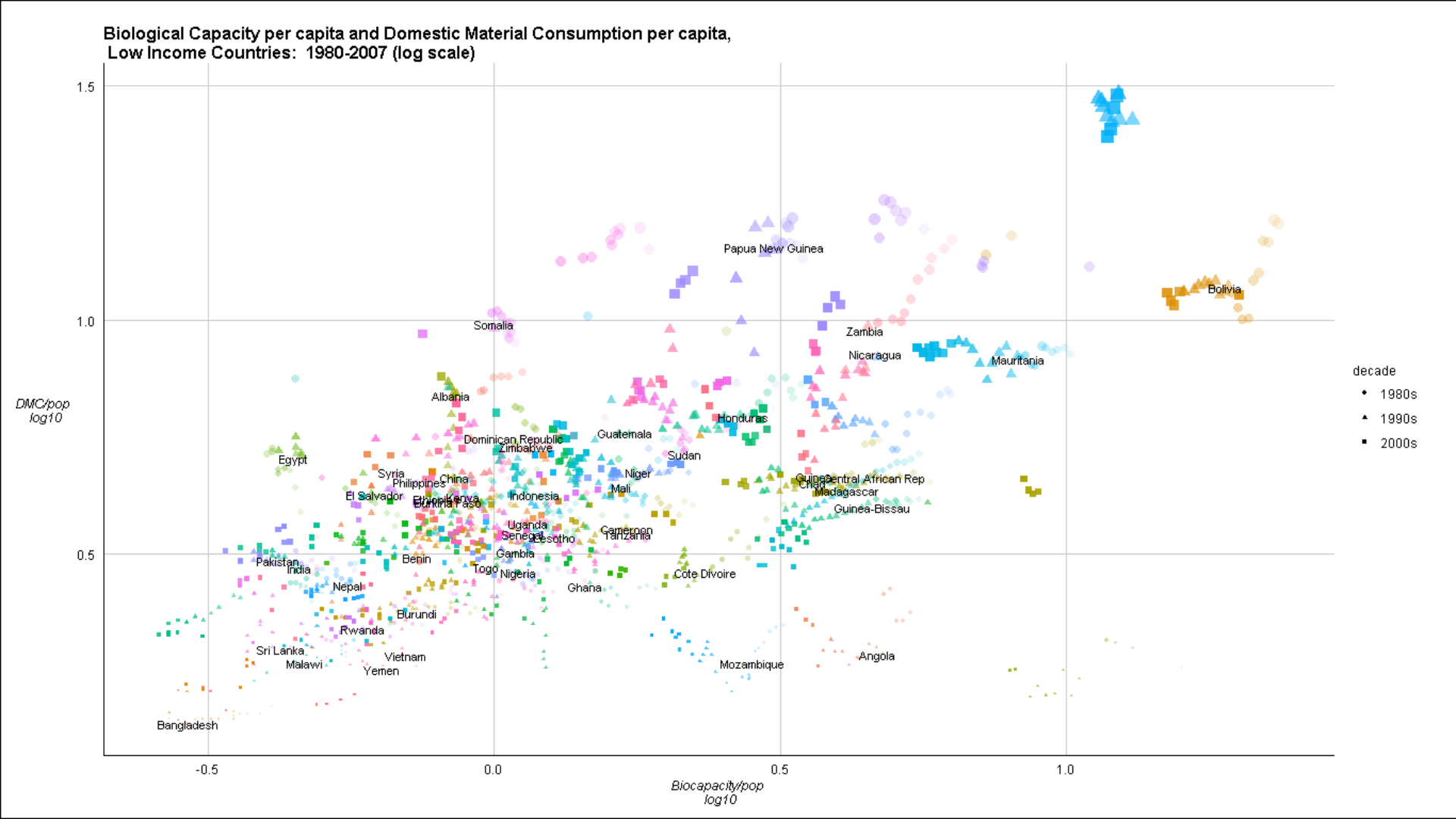


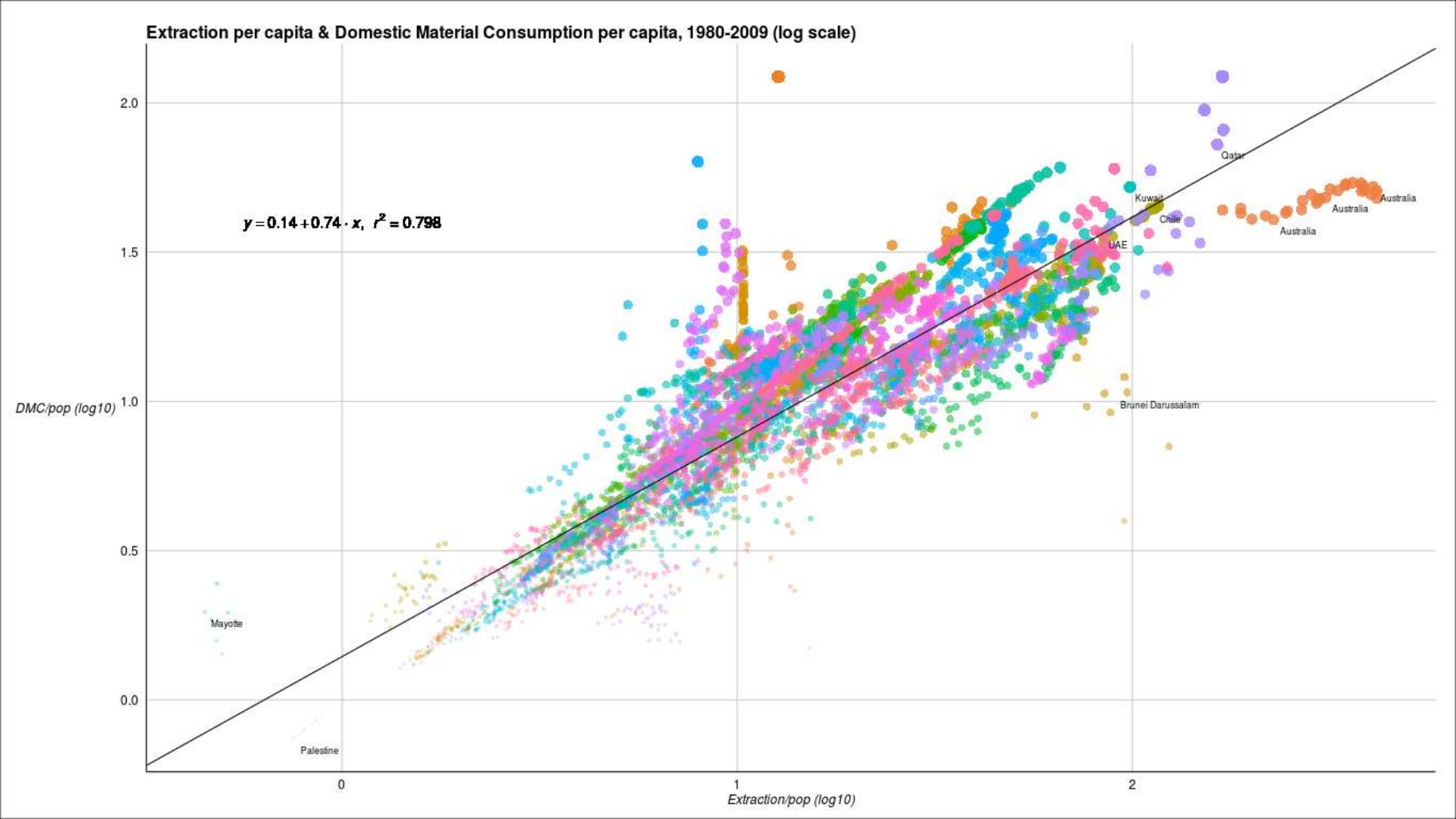

Total Biological Capacity and Ecological Footprint 1961-2007 (not per capita)
3e+09
2e+09
1e+09
0e+00
Eco. Footprint
0.0e+00
5.0e+08
1.0e+09
1.5e+09
Biocapacity
USA
China
USSR
Russia
Canada
India
Brazil
decade
1980s
1990s
2000s

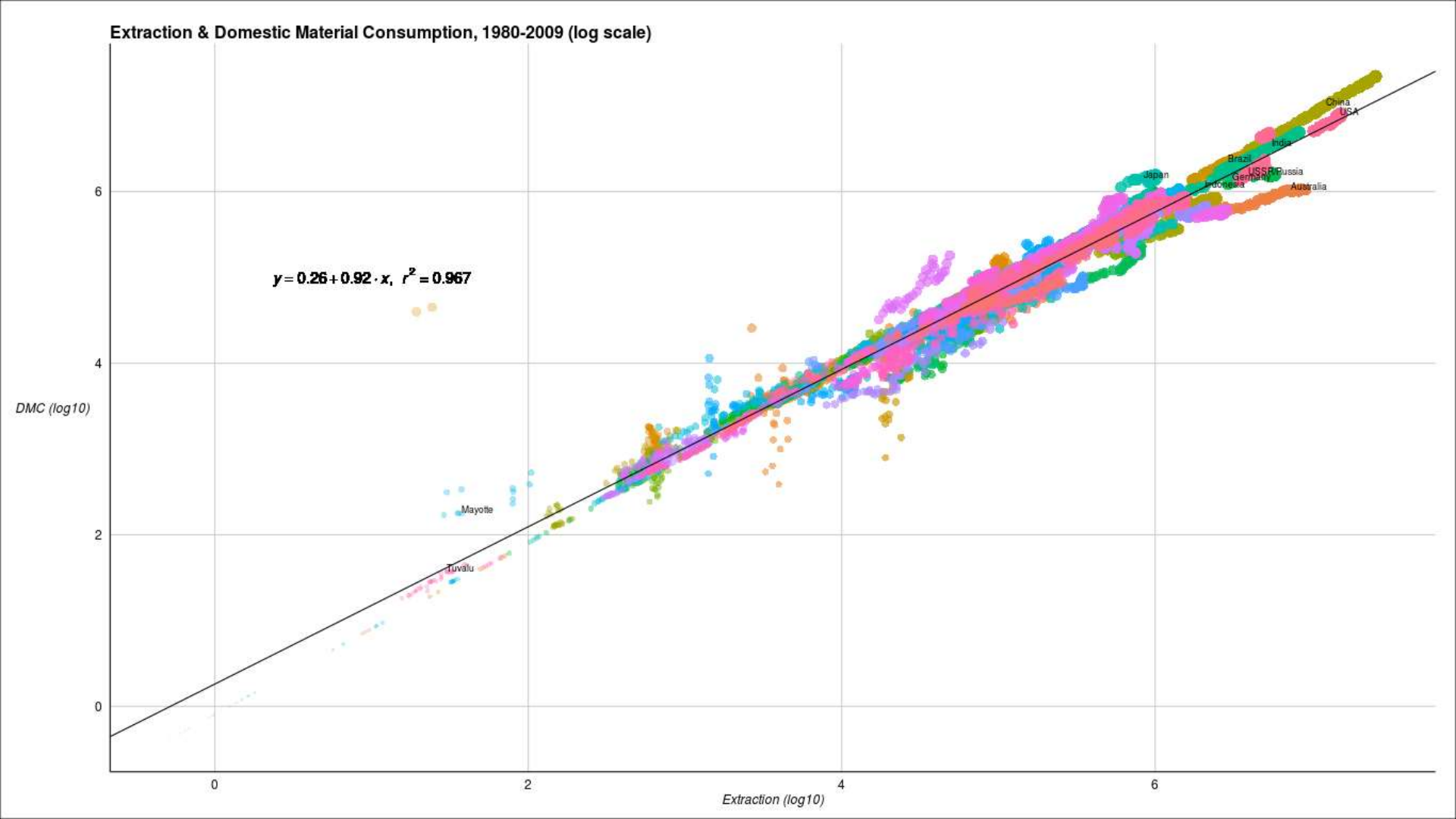

Total Biological Capacity and Ecological Footprint 1961-2007 (not per capita)
Eco. Footprint log10 scale
Biocapacity log10 scale
1e+09
1e+07
1e+07
1e+09
decade
1980s
1990s
2000s
USA
China
USSR/Russia
India
Canada
Brazil
Japan
Germany
France
United Kingdom
Indonesia
Mexico
Australia
Argentina
S. Korea
Iran
Thailand
Nigeria
Saudi Arabia
Pakistan
Sweden
Netherlands
Belgium
Egypt
Chile
Peru
Colombia
Bolivia
UAE
Iraq
Israel
Kuwait
Libya
Serbia
Switzerland
Austria
Belarus
Sudan
Congo Dem. Rep
Trinidad and Tobago
Lebanon
Jordan
Jamaica
Macedonia
Armenia
Eritrea
Mauritius
Swaziland
Gambia
Lesotho
Guinea-Bissau
Central African Rep
Gabon
Mauritania
Congo
Somalia
Sierra Leone
Afghanistan
Botswana
Liberia
Madagascar
Angola
Mozambique
Zambia
Nicaragua
Honduras
Guinea
Cambodia
Nepal
Paraguay
Uruguay
Tanzania
Cote Divoire
Ecuador
Ghana
Kenya
Slovakia
Lithuania
Guatemala
Dominican Rep
Tunisia
Costa Rica
El Salvador
Moldova
Panama
Georgia
Albania
Burundi
Haiti
Tajikistan
Bosnia
Cuba


Per Capita Biological Capacity and Per Capita Ecological Footprint, 1961-2007
Eco. Footprint/pop
0
5
10
15
0
20
40
Biocapacity/pop
decade
1960s
1970s
1980s
1990s
2000s


Export Dependence and Biological Capacity per capita,
Low Income Countries: 1961-2007
Biocapacity/pop
log10
1
0
0
25
50
75
100
Exports (% of GDP)
decade
1960s
1970s
1980s
1990s
2000s
Bolivia
Mauritania
Guinea-Bissau
Central African Rep
Nicaragua
Madagascar
Angola
Zambia
Chad
Guinea
Papua New Guinea
Mozambique
Honduras
Cote Dhoire
Sudan
Congo Dem Rep
Tanzania
Niger
Mali
Guatemala
Laos
Ghana
Sierra Leone
Lesotho
Indonesia
Uganda
Zimbabwe
Senegal
Dominican Republic
Nigeria
Gambia
Somalia
Togo
Kenya
Burkina Faso
Albania
Ethiopia
Philippines
Burundi
Benin
Vietnam
Syria
Yemen
El Salvador
Rwanda
Nepal
Malawi
India
Egypt
Sri Lanka
Pakistan
Bangladesh


Biological Capacity per capita and Domestic Material Consumption per capita,
Low Income Countries: 1980-2007 (log scale)
DMC/pop log10
Biocapacity/pop log10
1.5
1.0
0.5
-0.5
0.0
0.5
1.0
Papua New Guinea
Bolivia
Somalia
Zambia
Nicaragua
Mauritania
Albania
Honduras
Dominican Republic
Guatemala
Zimbabwe
Sudan
Egypt
Syria
China
Philippines
Niger
Central African Rep
El Salvador
Kenya
Indonesia
Mali
Madagascar
Guinea-Bissau
Uganda
Cameroon
Senegal
Lesotho
Tanzania
Pakistan
India
Benin
Gambia
Togo
Nigeria
Cote Divoire
Nepal
Ghana
Burundi
Rwanda
Sri Lanka
Vietnam
Malawi
Yemen
Mozambique
Angola
Bangladesh
decade
1980s
1990s
2000s


Extraction per capita & Domestic Material Consumption per capita, 1980-2009 (log scale)
$y = 0.14 + 0.74 \cdot x,\ r^2 = 0.798$
DMC/pop (log10)
Extraction/pop (log10)
2.0
1.5
1.0
0.5
0.0
0
1
2
Qatar
Kuwait
Chile
UAE
Australia
Australia
Australia
Brunei Darussalam
Mayotte
Palestine


Extraction & Domestic Material Consumption, 1980-2009 (log scale)
$y = 0.26 + 0.92 \cdot x,\ r^2 = 0.967$
China
USA
India
Brazil
USSR
Russia
Japan
Germany
Indonesia
Australia
Mayotte
Tuvalu
DMC (log10)
Extraction (log10)
0
2
4
6

How does Ecological Unequal Exchange Work?

- Do export dependent, low income countries consume fewer resources *because* they ***export away*** the resources they would have otherwise consumed?
- (Apparently, NO)

Table 2. Unstandardized Coefficients for the Regression of Per Capita Biological Capacity on Selected Predictor Variables: Fixed Effects and Prais-Winsten with panel-corrected standard errors (PCSEs) estimates, utilizing AR(1) correction for 142 countries, 1961-2007

VARIABLES	(1) Fixed Effects	(2) Fixed Effects	(3) PCSE	(4) PCSE
Military expenditures (ln)	-0.0153***	-0.0154***	-0.0388***	-0.0374***
	(0.00425)	(0.00425)	(0.00649)	(0.00639)
	[1.31]	*[1.32]*	*[1.31]*	*[1.32]*
War	-0.0146**	-0.0174**	-0.0168	-0.0196
	(0.00731)	(0.00764)	(0.0122)	(0.0125)
	[1.12]	*[1.16]*	*[1.12]*	*[1.16]*
GDP per capita (ln)	0.00658	0.00488	0.147***	0.146***
	(0.0162)	(0.0163)	(0.0161)	(0.0164)
	[1.07]	*[1.07]*	*[1.07]*	*[1.07]*
GDP per capita squared (ln)	-1.723***	-1.701***	1.725***	1.683***
	(0.462)	(0.464)	(0.463)	(0.470)
	[1.09]	*[1.11]*	*[1.09]*	*[1.11]*
Exports (% of GDP) (ln)	-0.0282***	-0.0135	-0.0245*	-0.0102
	(0.00952)	(0.0118)	(0.0139)	(0.0169)
	[1.16]	*[1.42]*	*[1.16]*	*[1.42]*
Urban population (ln)	-0.494***	-0.494***	0.0891	0.0858
	(0.0452)	(0.0454)	(0.0609)	(0.0612)
	[1.17]	*[1.23]*	*[1.17]*	*[1.23]*
High Income x War		0.0345		0.0327
		(0.0259)		(0.0328)
		[1.04]		*[1.04]*
Low income x Exports		-0.0422**		-0.0405
		(0.0199)		(0.0248)
		[1.38]		*[1.38]*
Constant	0.677***	0.689***	-0.362***	-0.358**
	(0.0218)	(0.0217)	(0.139)	(0.141)
Observations	4,722	4,722	4,865	4,865
R-squared (overall)	0.0020	0.0026	0.153	0.152
R-squared (within)	0.0380	0.0391	--	--
R-squared (between)	0.0178	0.0196	--	--
Number of id	142	142	143	143

Coefficients flagged for statistical significance. Standard errors in parentheses. Variance Inflation Factors are in italics and brackets. Two-tailed tests: *** p<0.01, ** p<0.05, * p<0.1

- Negative Association between Biocapacity and Export Dependence, at least for Low Income Countries.
- This result is stable across multiple model specifications:
  - When analyzing *within-country variation over time* (Models 1-2), *controlling for unobserved time-invariant factors.*
  - When analyzing both *within and between-country variation over time* (Models 3-4), *correcting for AR(1) disturbance and heteroskedasticity (cf. Jorgenson and Clark 2012)*
  - *We also conducted Random Effects Regression as well as a Regression on the 'First-Differences' (of the standard deviations) of our independent variables…*

Figure 4. Marginal effect of Exports on Biocapacity, conditional on GDP. Fixed Effects, Model 2

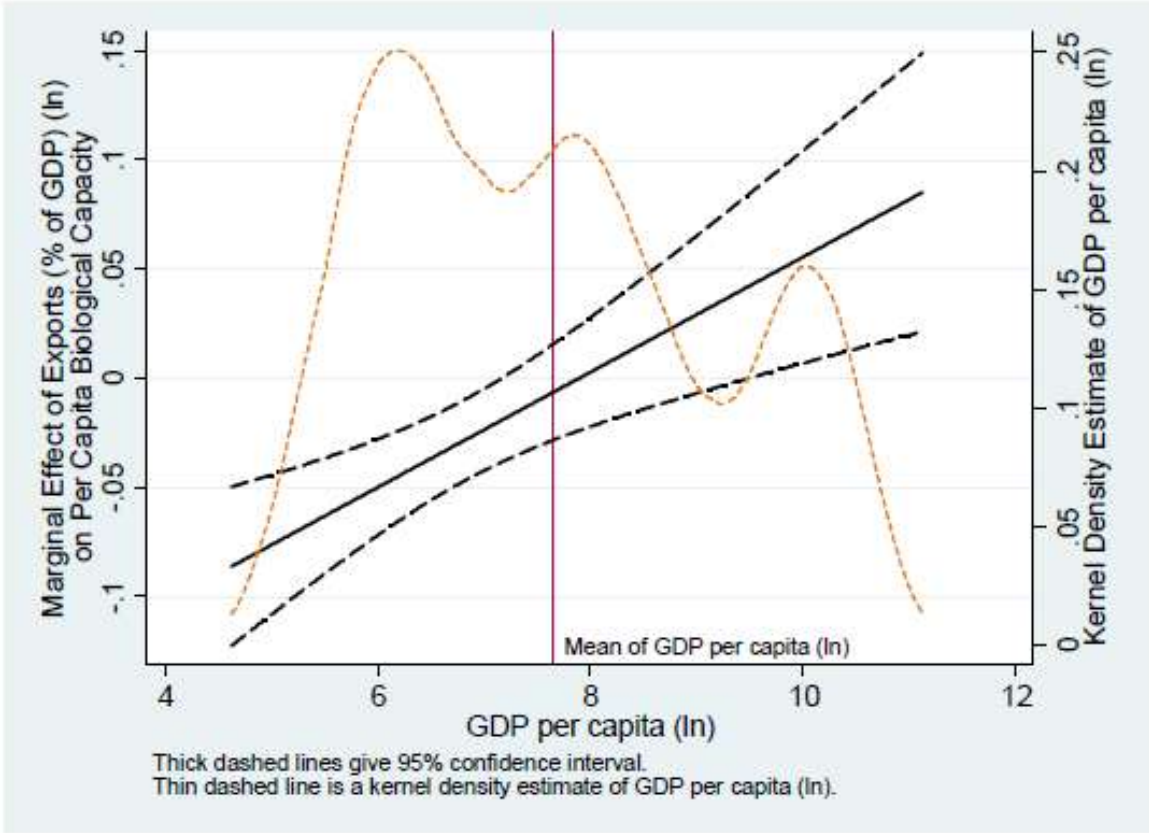
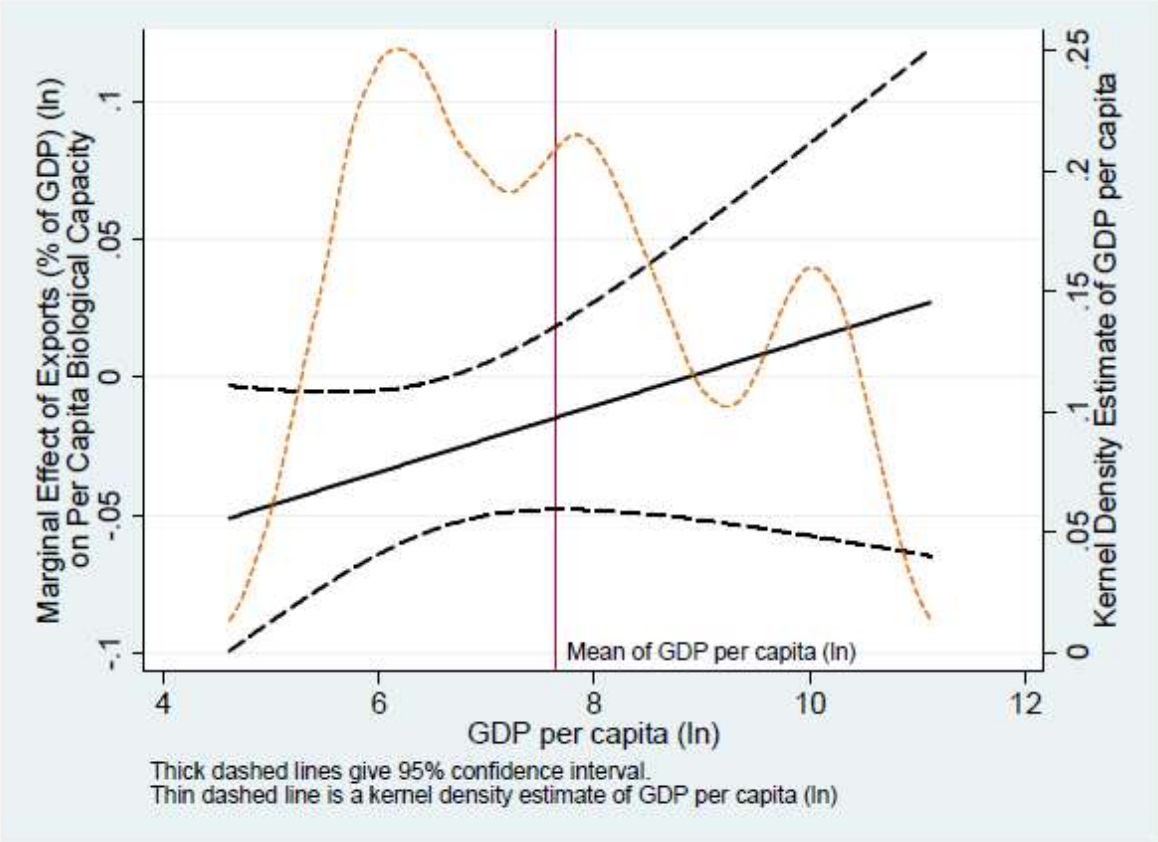


Figure 6. Marginal Effect of Exports on Biocapacity, conditional on GDP. Prais-Winsten, Model 4



How does Ecological Unequal Exchange Work?

- **Primary Finding:** **export-dependent, low income countries tend to consume fewer material resources (as measured by Biological Capacity) in large part *because they produce, prior to exchange, relatively fewer domestic material resources to consume*.**