Supplementary materials SM2.1 (Drivers)

Contents

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1. Additional figures

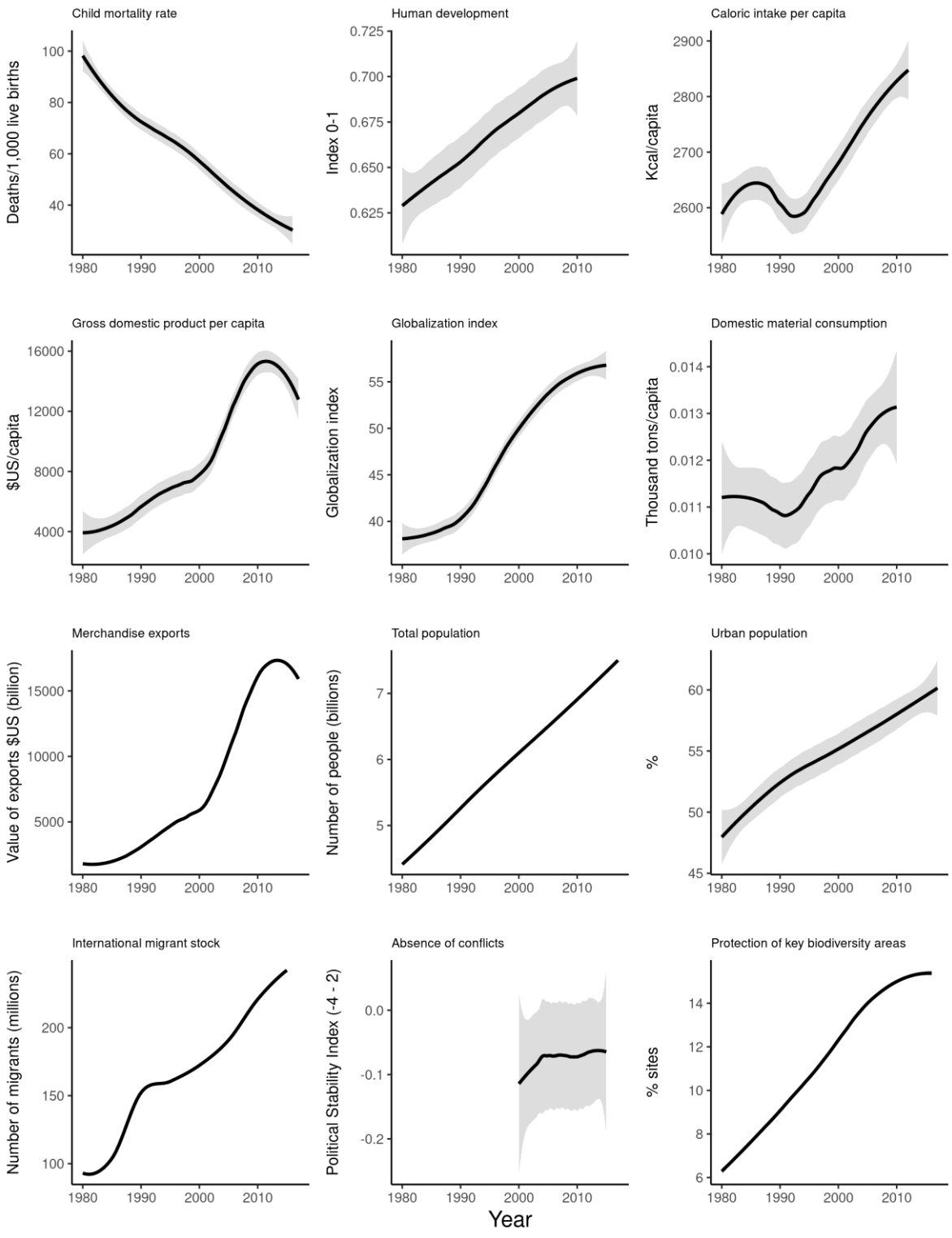
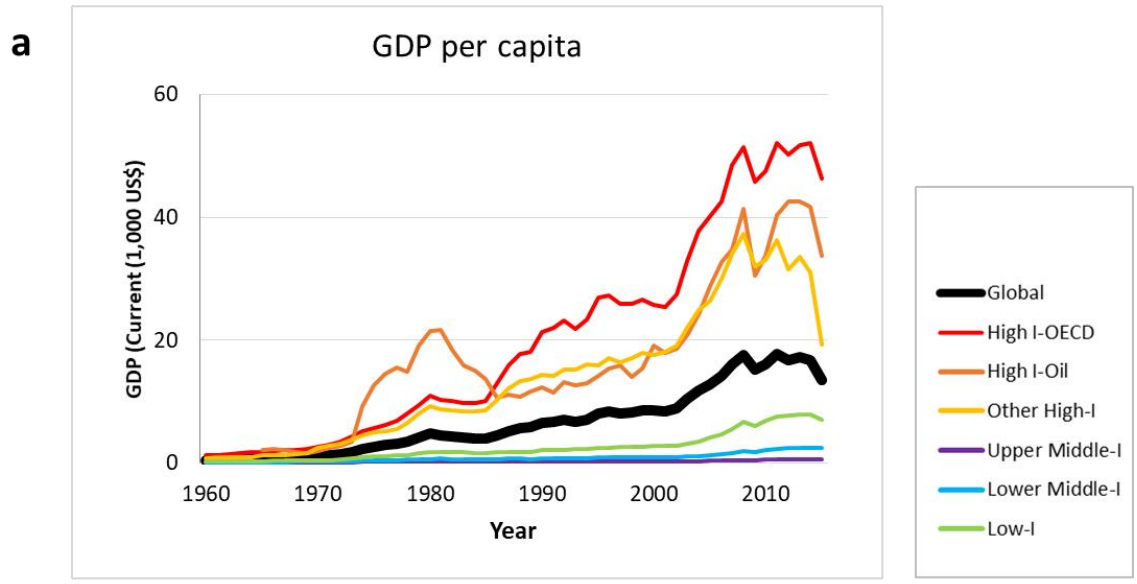


Figure S1. Global temporal trends for selected indicators of indirect drivers.
The data shown are global trends, per country, with a shadow representing 95% confidence intervals unless otherwise stated. A) Child mortality rate: Mortality rate, under-5 (per 1,000 live births), B) Human Development Index: is a summary measure of average achievement in key dimensions of human development: a long and healthy life, being knowledgeable and have a decent standard of living. C) Calorie intake: Kilocalories consumed per person per day, D) Gross Domestic product: GDP per capita is gross domestic product divided by midyear population, Data are in current U.S. dollars., E) Globalization index: The KOF Globalization Index measures the economic, social and political dimensions of globalization., F) Domestic material consumption per capita: all materials used by the economy, either extracted from the domestic territory or imported from other countries, per capita, G) Merchandise exports: value of goods provided to the rest of the world per country valued in current U.S. dollars., H) Total population: Number of people, I) Proportion of urban population: Proportion of the total population that is urban, which refers to people living in urban areas, J) International Migrant Stock: International migrant stock is the number of people born in a country other than that in which they live (includes refugees), K) Absence of conflict as an indicator of political stability: Index that measures perceptions of the likelihood that the government will be destabilized or overthrown by unconstitutional or violent means, including politically-motivated violence as well as terrorism, L) Protection of key biodiversity areas: measures progress towards protecting the most important sites for biodiversity in % of such sites per country. (AZEs). Values provided are averages of country values for World Bank income categories (unless stated otherwise).
Sources: BirdLife International, 2018; KOF Swiss Economic Institute, 2018; Land Portal, 2018; Roser & Ritchie, 2017a; UNDP, 2017; World Bank, 2018n, 2018t, 2018e, 2018s, 2018g, 2018k; WU & Dittrich, 2014).



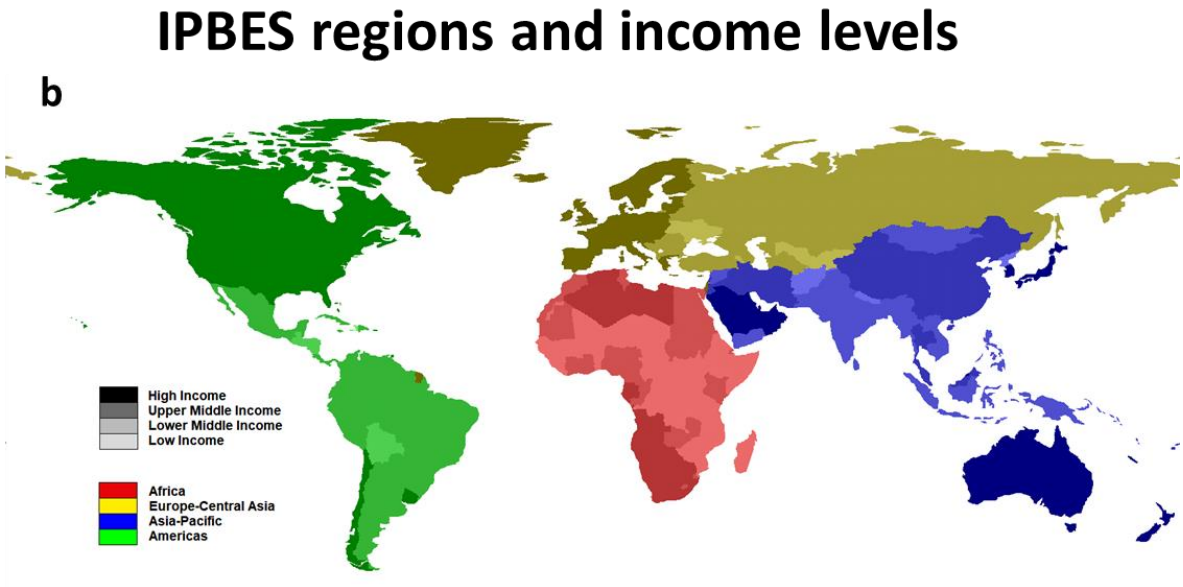


Figure S2. Countries have been divided into different income levels by the World Bank. Inequities among countries are increasing through time. a) Trend of Gross domestic product (GDP) per capita, current (1,000 U$) from 1960 to 2015; the values shown are average values among countries within different income level categories, using World Bank income categories. b) Map of IPBES regions and income levels; the colors in the map represent a combination of incomes and geographic regions; for instance, blue represents Asia-Pacific,

while different intensities of blue represent different income levels. Source: (World Bank, 2018e).

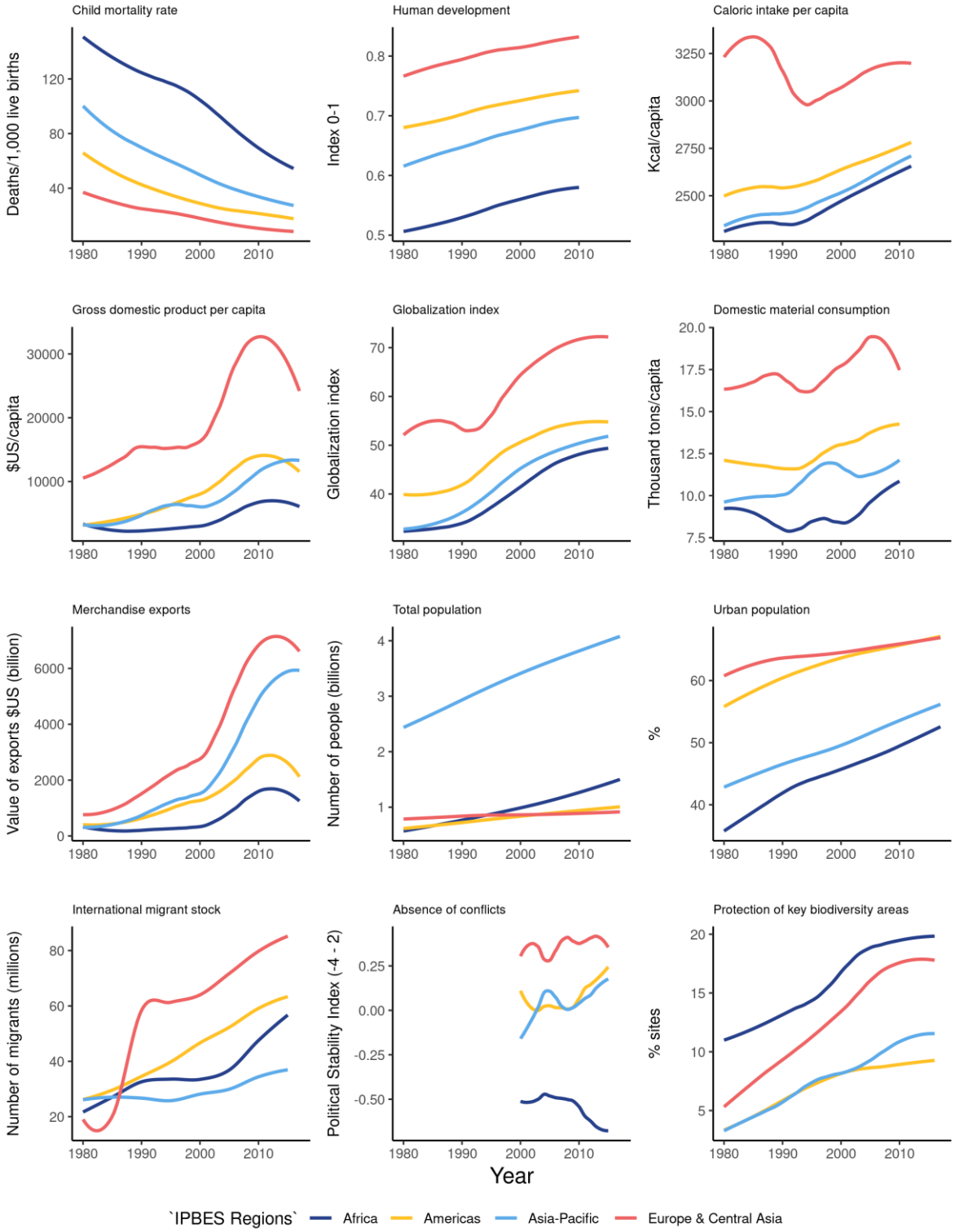
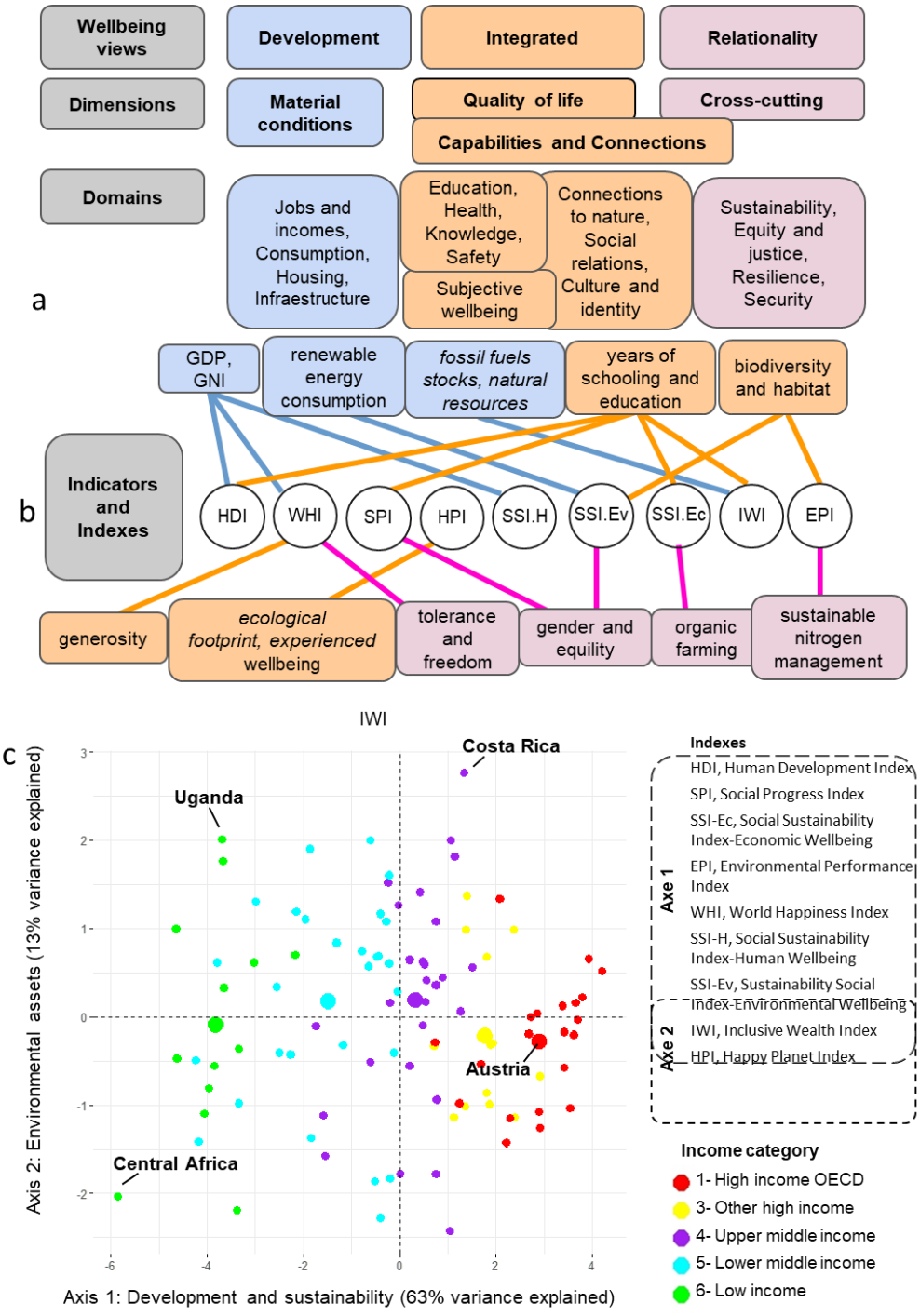


Figure S3. Temporal trends in selected indicators of indirect drivers for the four IPBES regions. The data shown are trends, per country, averaged for each of IPBES regions. Panels shown are: A) Child mortality rate: Mortality rate, under-5 (per 1,000 live births), B) Human Development Index: is a summary measure of average achievement in key dimensions of human development: a long and healthy life, being knowledgeable and have a decent standard of living. C) Calorie intake: Kilocalories consumed per person per day, D) Gross Domestic product: GDP per capita is gross domestic product divided by midyear population, Data are in current U.S. dollars., E) Globalization index: The KOF Globalization Index measures the economic, social and political dimensions of globalization., F) Domestic material consumption per capita: all materials used by the economy, either extracted from the domestic territory or imported from other countries, per capita, G) Merchandise exports: value of goods provided to the rest of the world per country valued in current U.S. dollars., H) Total population: Number of people, I) Proportion of urban population: Proportion of the total population that is urban, which refers to people living in urban areas, J) International Migrant Stock: International migrant stock is the number of people born in a country other than that in which they live (includes refugees), K) Absence of conflict as an indicator of political stability: Index that measures perceptions of the likelihood that the government will be destabilized or overthrown by unconstitutional or violent means, including politically-motivated violence as well as terrorism, L) Protection of key biodiversity areas: measures progress towards protecting the most important sites for biodiversity in % of such sites per country. (AZEs). Values provided are averages of country values for World Bank income categories (unless stated otherwise).
Sources: BirdLife International, 2018; KOF Swiss Economic Institute, 2018; Land Portal, 2018; Roser & Ritchie, 2017a; UNDP, 2017; World Bank, 2018e, 2018t, 2018s, 2018g, 2018k, 2018n; WU & Dittrich, 2014.



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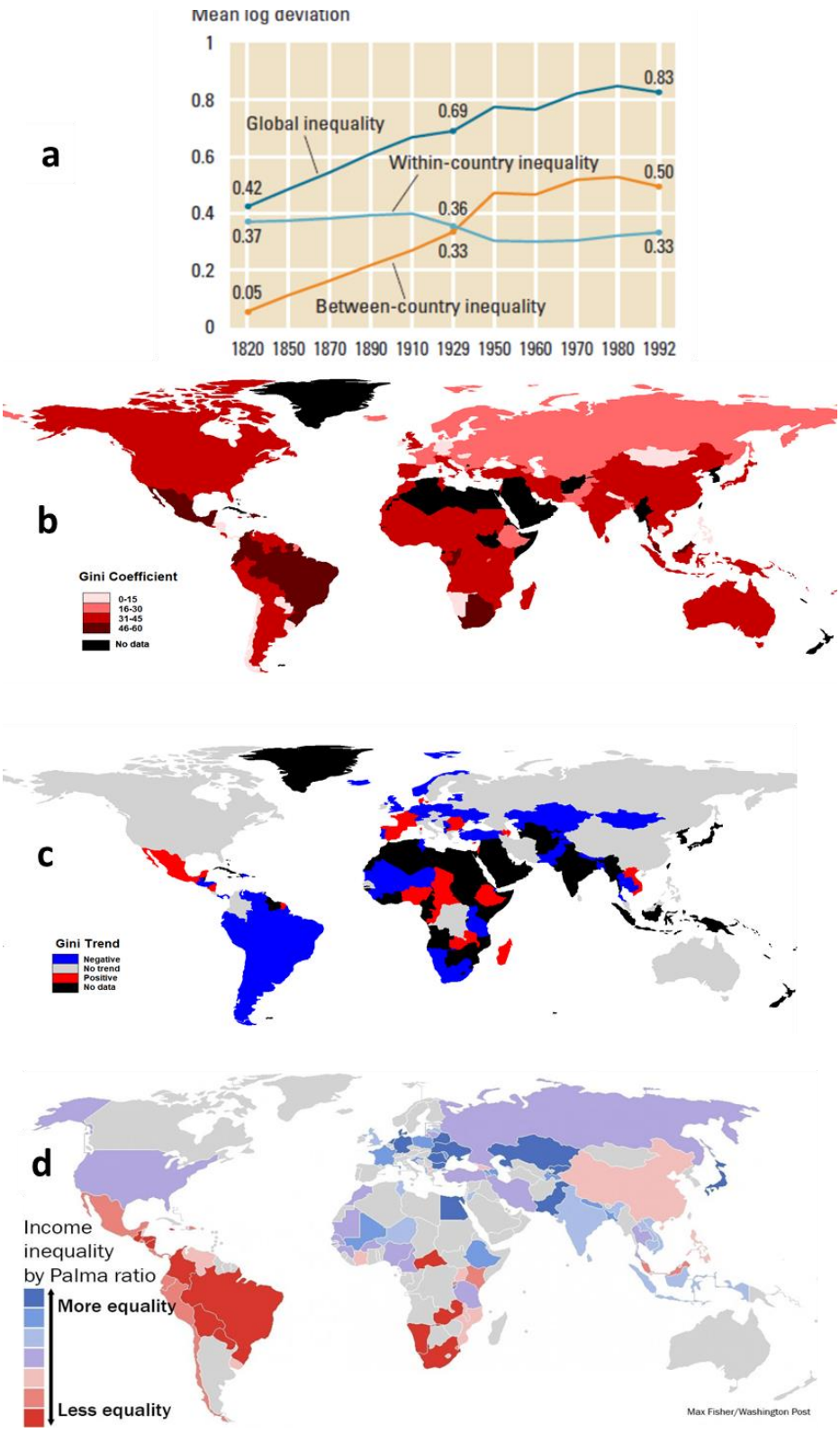
Source: Breslow et al., 2014; EPI, 2018; HPI, 2016; McGregor et al., 2015; UN, 2016a; UNU-IHDP & UNEP, 2014; WHI, 2017.



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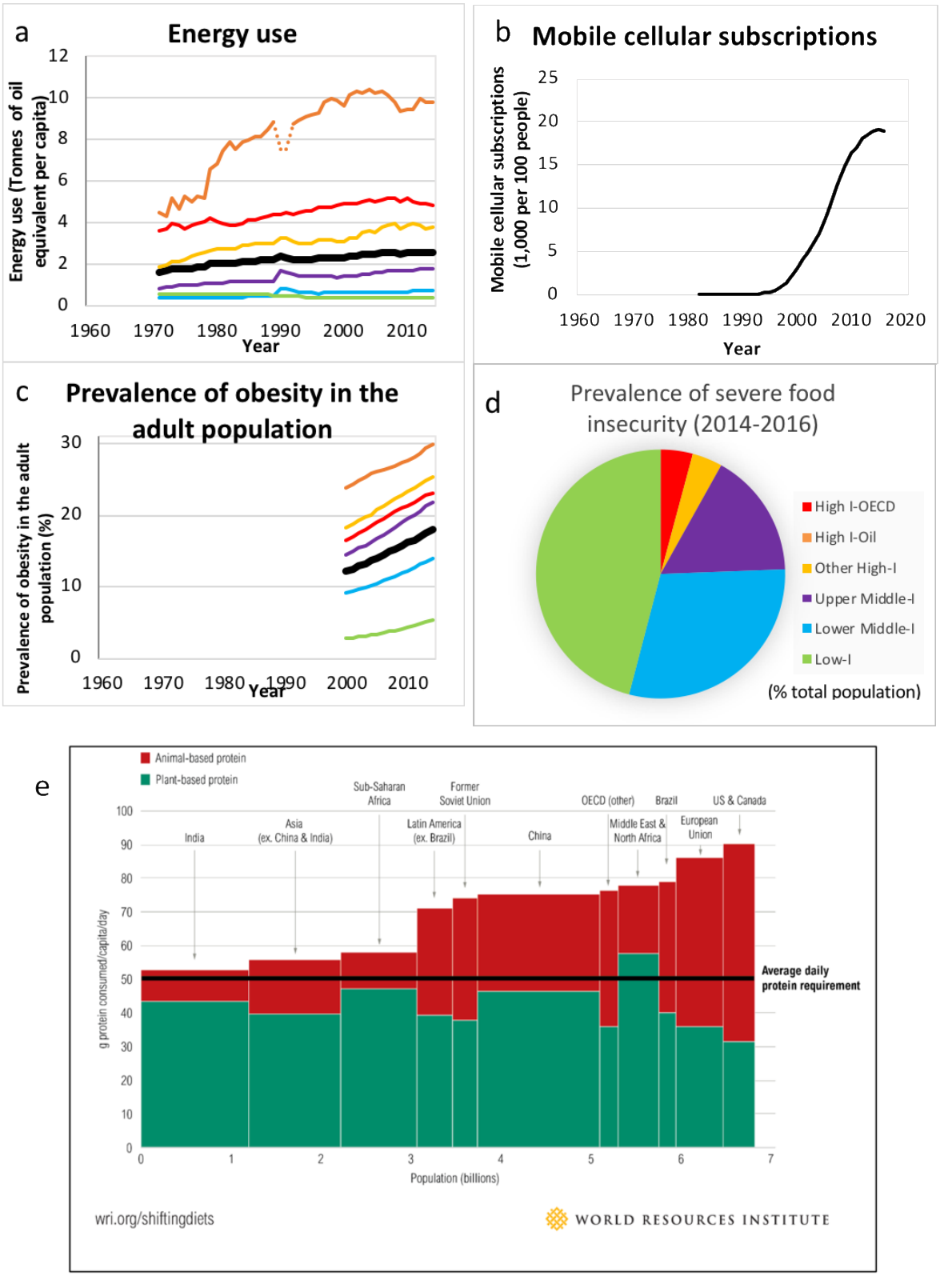

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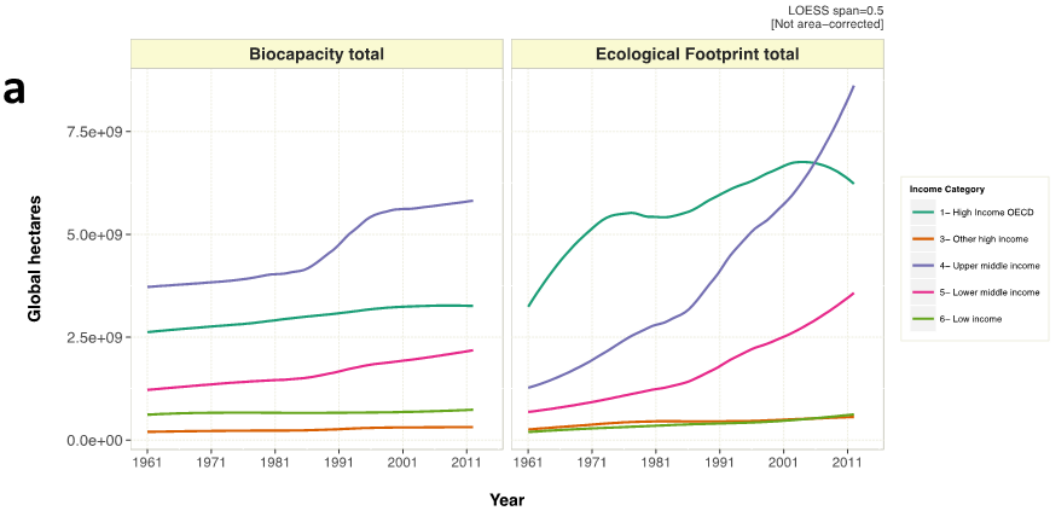
Average values are calculated for countries within World Bank income categories. Data sources: (FAO, 2018f; Ranganathan et al., 2016; Roser & Ritchie, 2017b; World Bank, 2018d, 2018m)

a

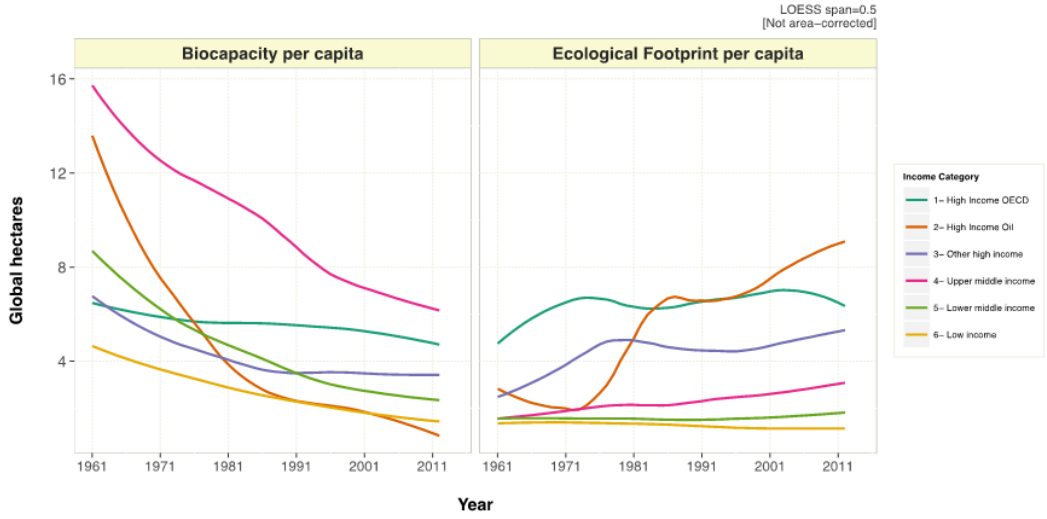
Total Ecological Footprint & Biocapacity (1961~2012)



*Visuals prepared by the IPBES Knowledge and Data TSU based on raw data provided by indicator holders.

b

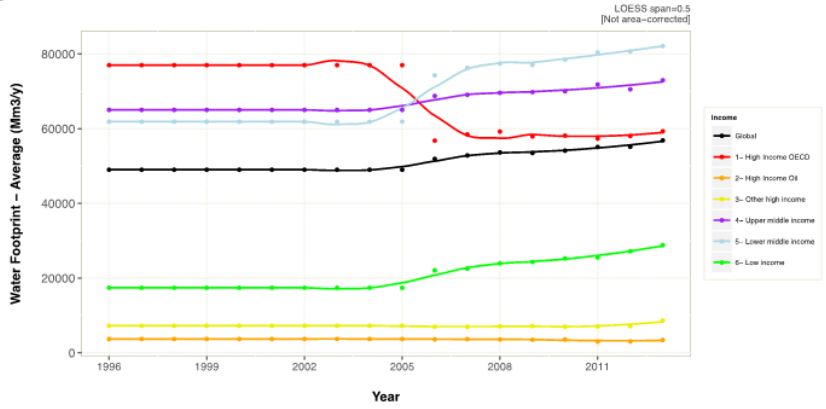
Ecological Footprint & Biocapacity per capita (1961~2012)



*Visuals prepared by the IPBES Knowledge and Data TSU based on raw data provided by indicator holders.

c

Average Water Footprint (1996~2013)



*Visuals prepared by the IPBES Knowledge and Data TSU based on raw data provided by indicator holders.

f

Figure S7. Trends in ecological footprint, biocapacity (capacity to supply renewable resources and absorb waste) and water footprint: Trend of a) total values, and b) per capita values of ecological footprint and biocapacity (1961~2012), and c) Trend of Average values of Water Footprint (1996~2013). Average values per country using world bank income categories. The Ecological Footprint includes all the cropland, grazing land, forest and fishing grounds required to produce the food, fiber and timber it consumes, to house its infrastructure and to absorb its waste (currently limited to CO_2 from fossil fuel combustion, cement production, anthropogenic forest fires and bunker fuels). The biocapacity refers to the capacity of ecosystems to regenerate what people demand from those surfaces i.e. to produce biological materials used by people and to absorb waste material generated by humans, under current management schemes and extraction technologies.
The water footprint includes green water, blue waterand grey footprint. Ecological footprint and biocapacity are expressed in global hectares; water footprint is expressed in Millions of M3/year. Data shown are country data averaged per World Bank Income category.
Source: IPBES Technical Support Unit on Knowledge and Data (Borucke et al., 2013; Galli, et al., 2014; Hoekstra & Mekonnen, 2012).

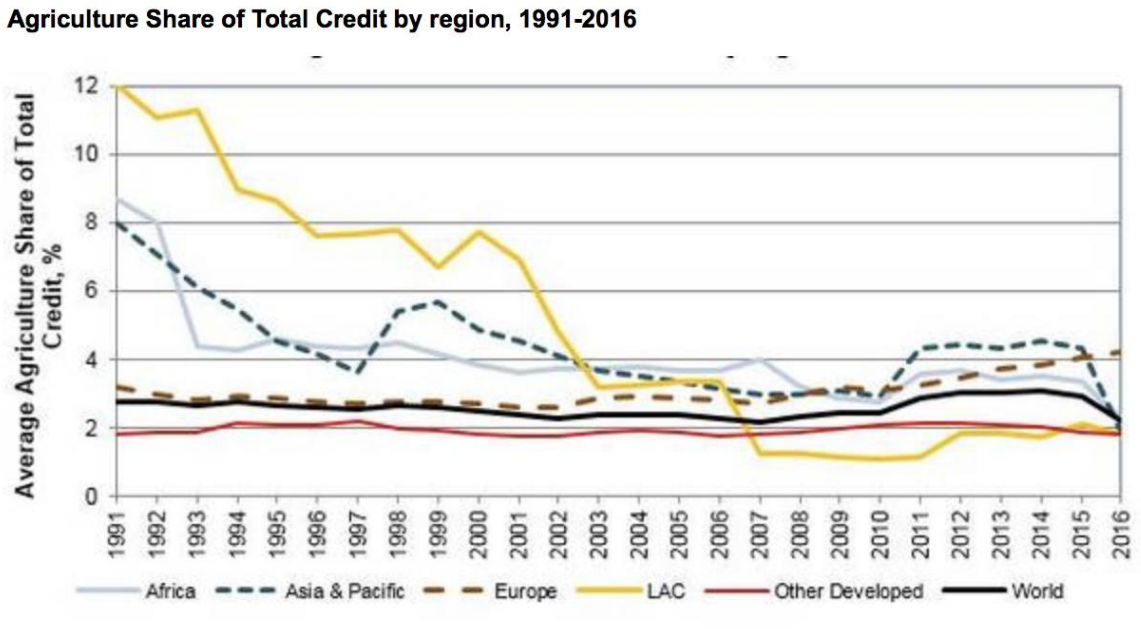


Figure S8. Agriculture Share of Total Credit by region and the world, since 1991 to 2016 (LAC = Latin America and the Caribbean). Source: (FAO, 2018a)

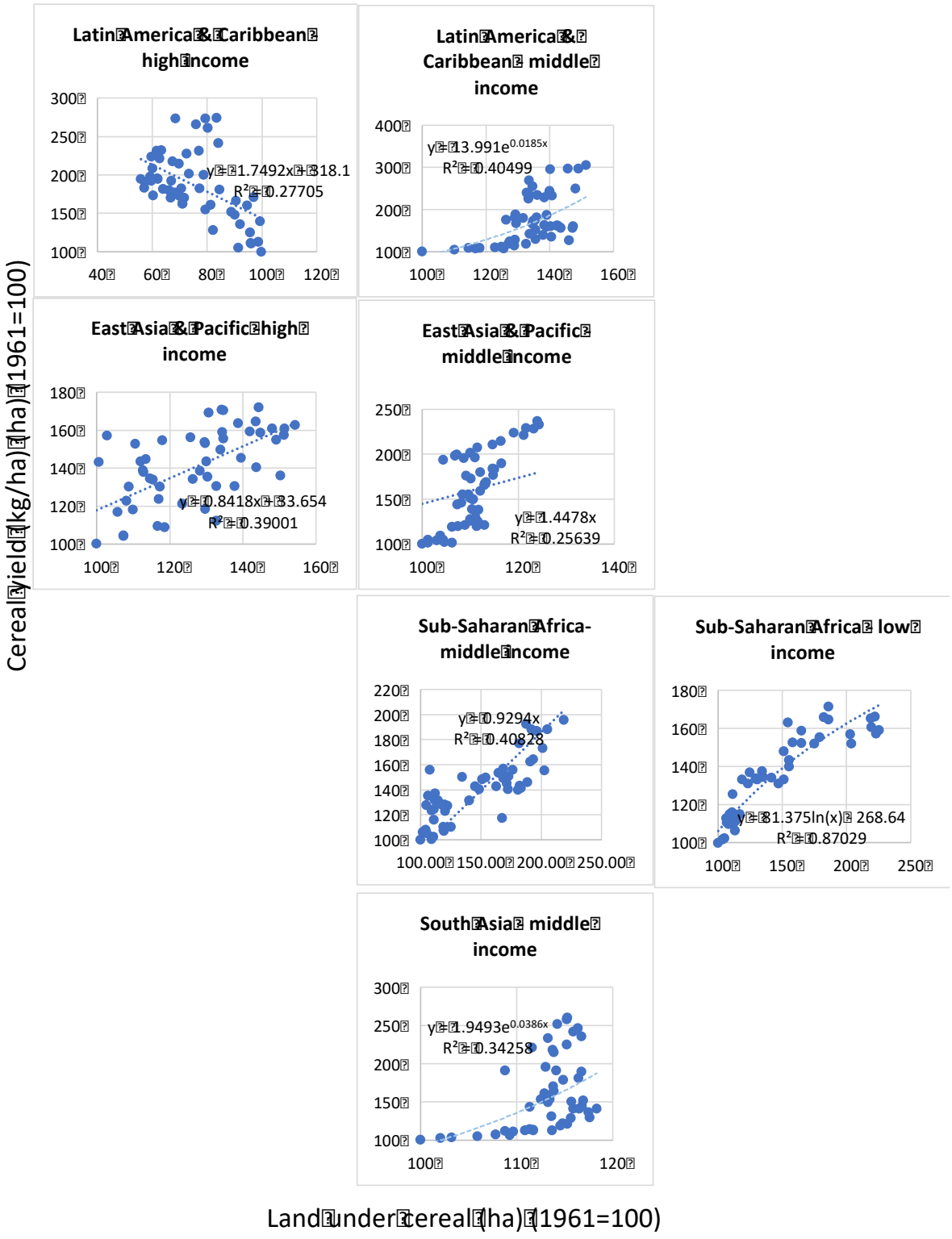
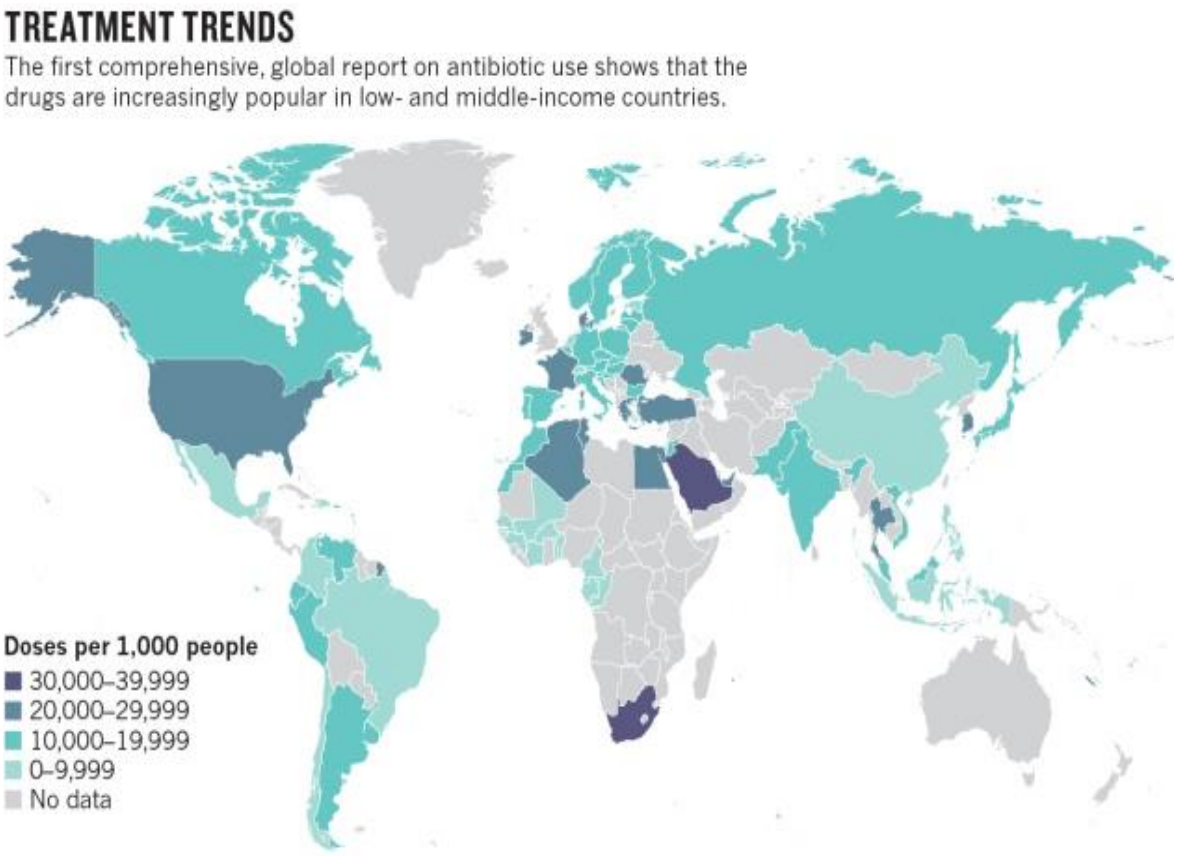


Figure S9. Agriculture intensification by continent, assessing the relationship between yield and amount of land for the case of cereals. Source: (World Bank, 2018b, 2018j)



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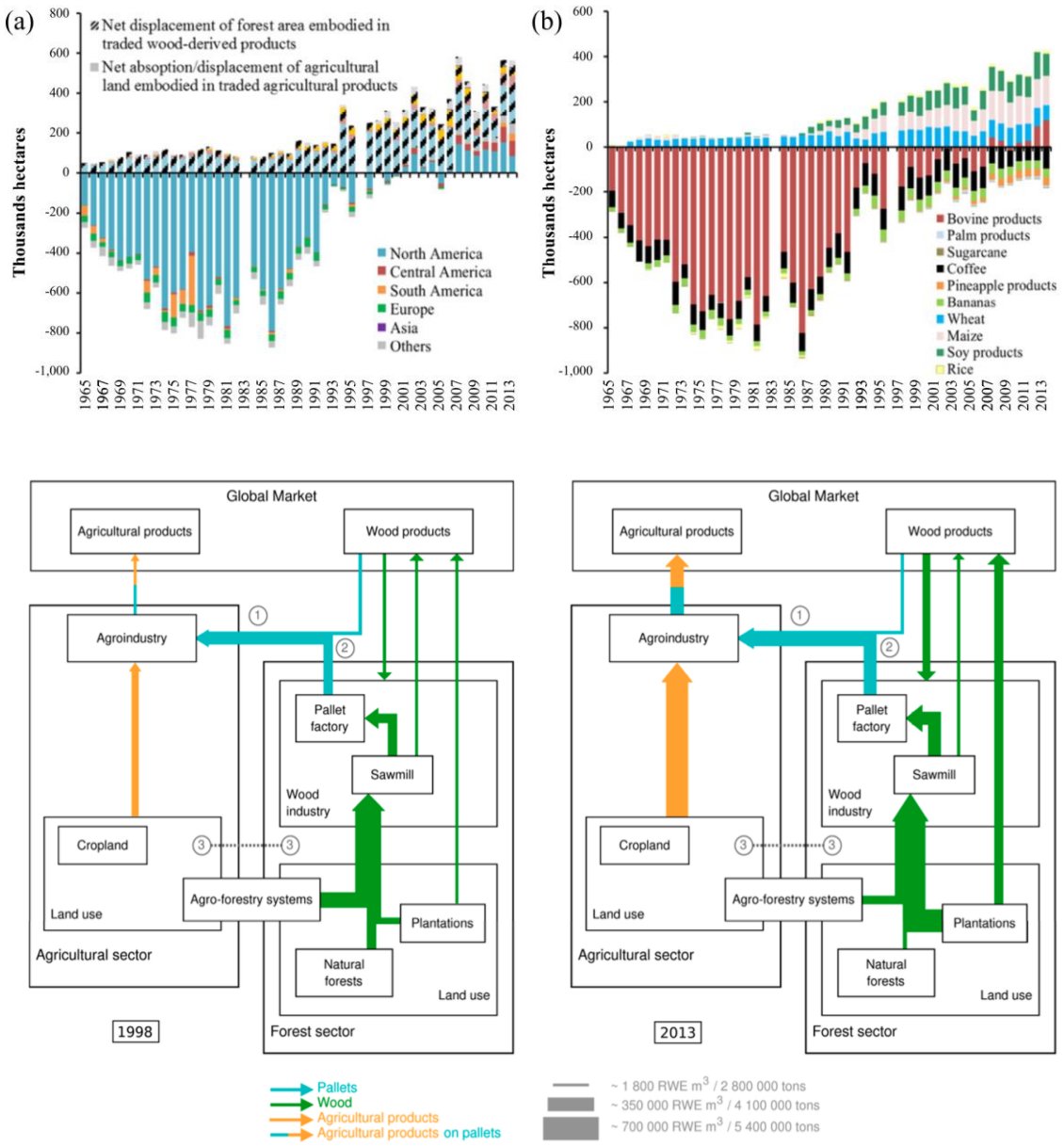

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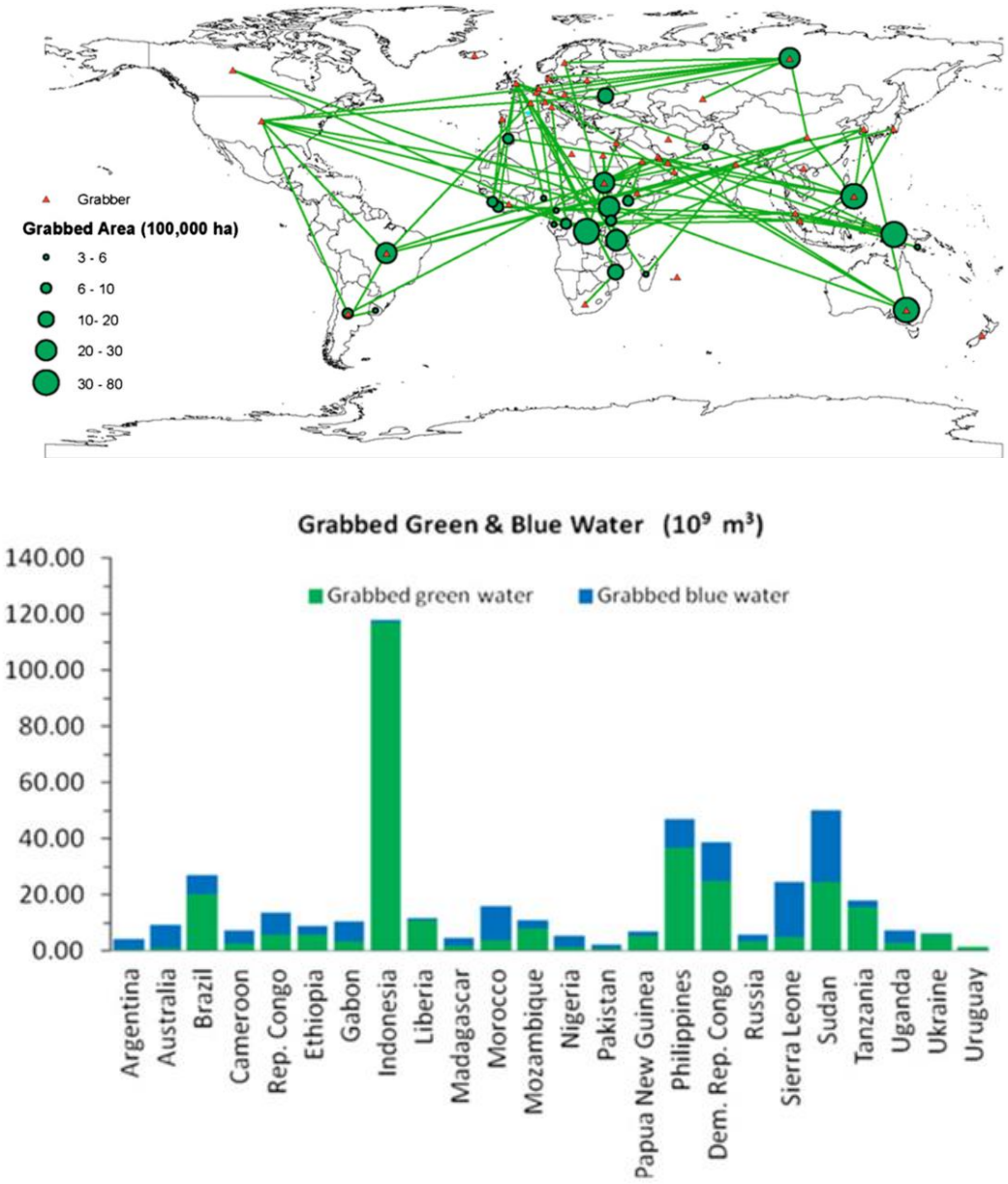
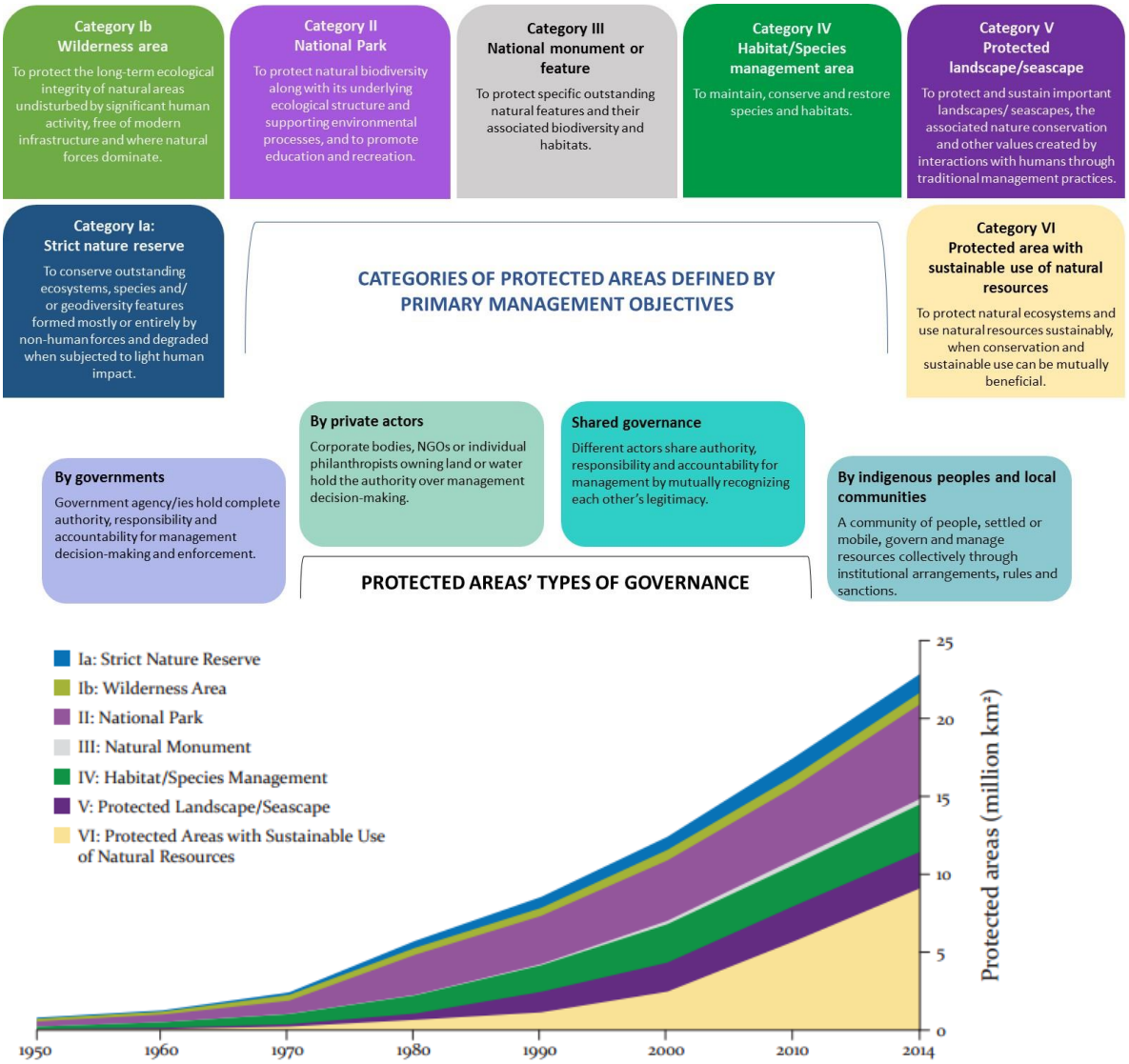


Figure S12. Water and land embedded into trade. A) A global map of the land-grabbing network: land-grabbed countries (green disks) are connected to their grabbers (red triangles) by a network. Based in data on table S1 but considering only 24 major grabbed countries (as in Table 1). Relations between grabbing (red triangles) and grabbed (green circles) countries are shown (green lines) only when they are associated with a land grabbing exceeding 100,000 ha, b) Water grabbing in the 24 most land-grabbed countries. Green and maximum blue water grabbing. Source: (Rulli et al., 2013)



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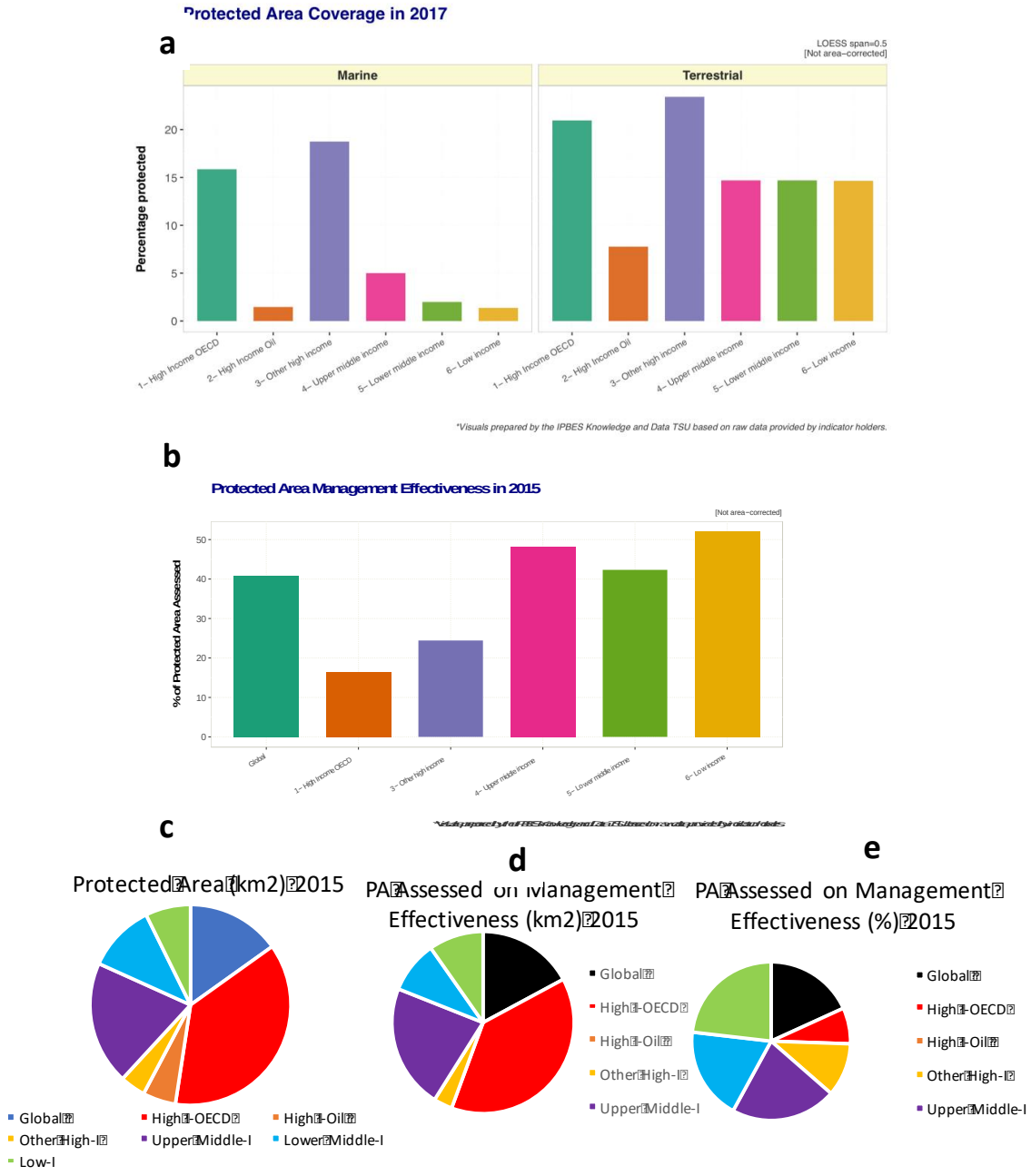

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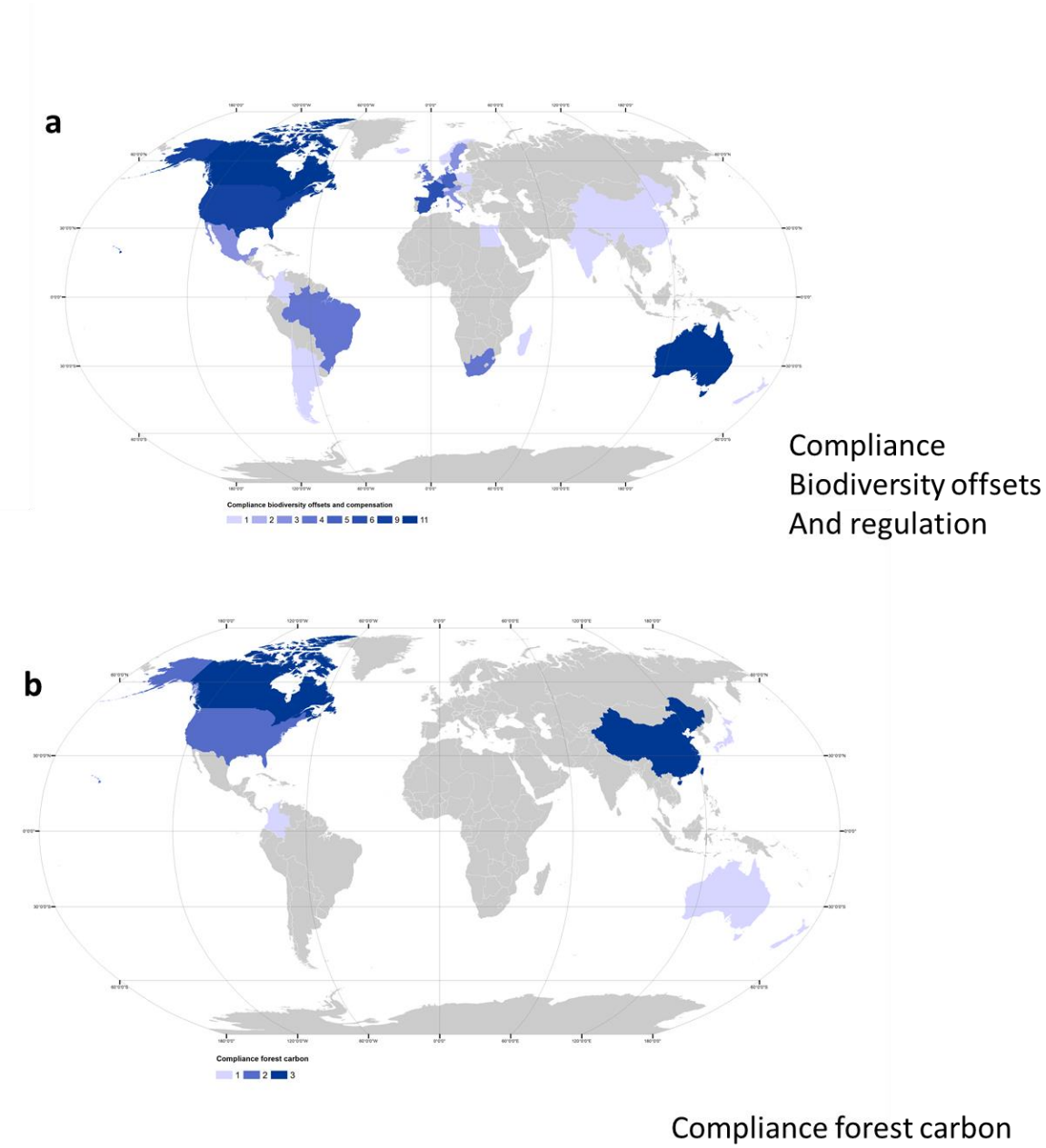
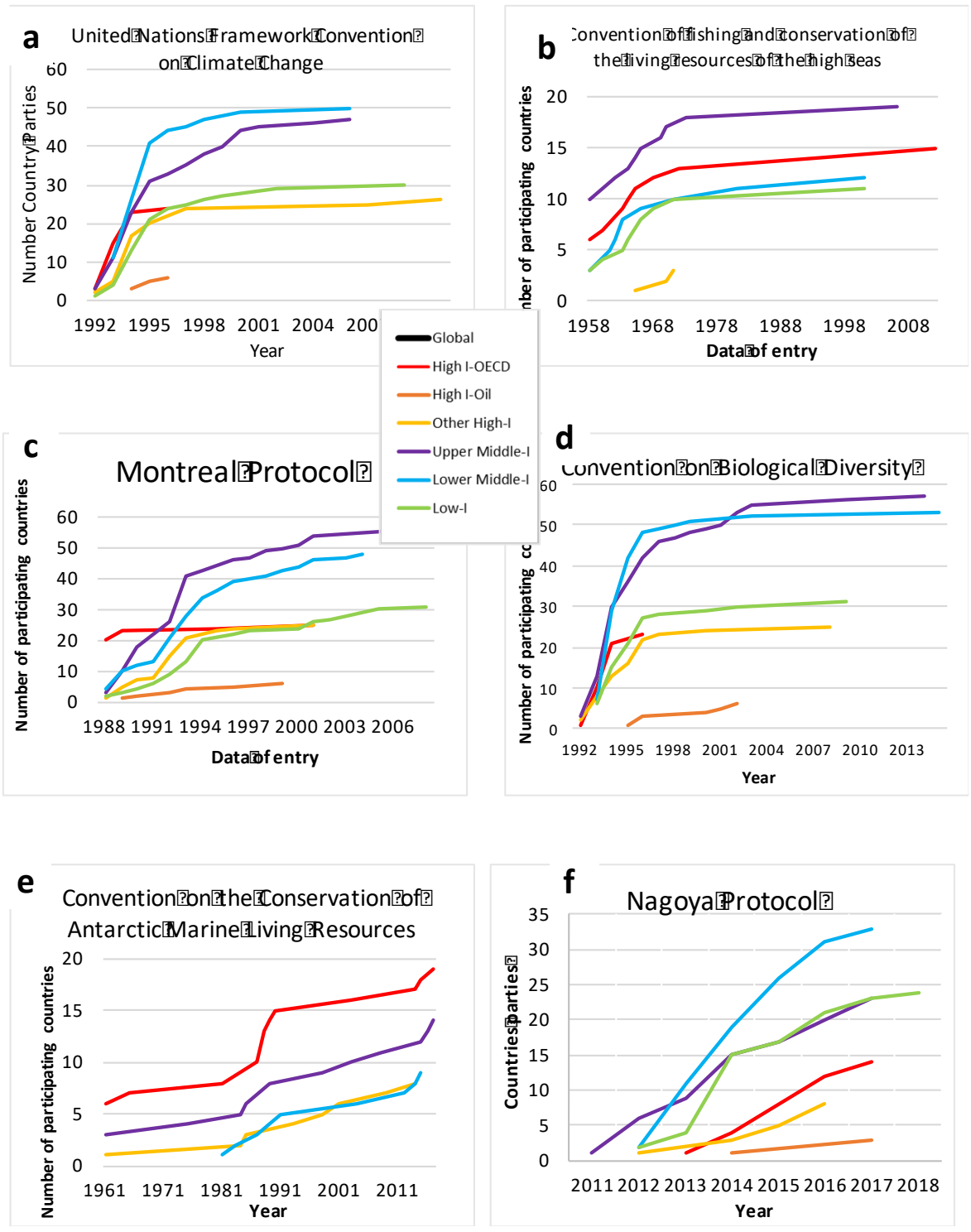


Figure S15. Temporal patterns of payments for ecosystem services. a) Compliance Biodiversity offsets and regulation; b) Compliance forest carbon. Source: Salzman et al., 2018.



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Marine Living Resources from 1961 to 2017 and f) Nagoya Protocol from 2011 to 2017. Average values using world bank income categories Sources: Australian Government - Department of the Environment and Energy, 2017; CBD, 2018a, 2018b; UN - Secretariat to the Antartic Treaty, 2018; UN, 1966; United Nations, 2018

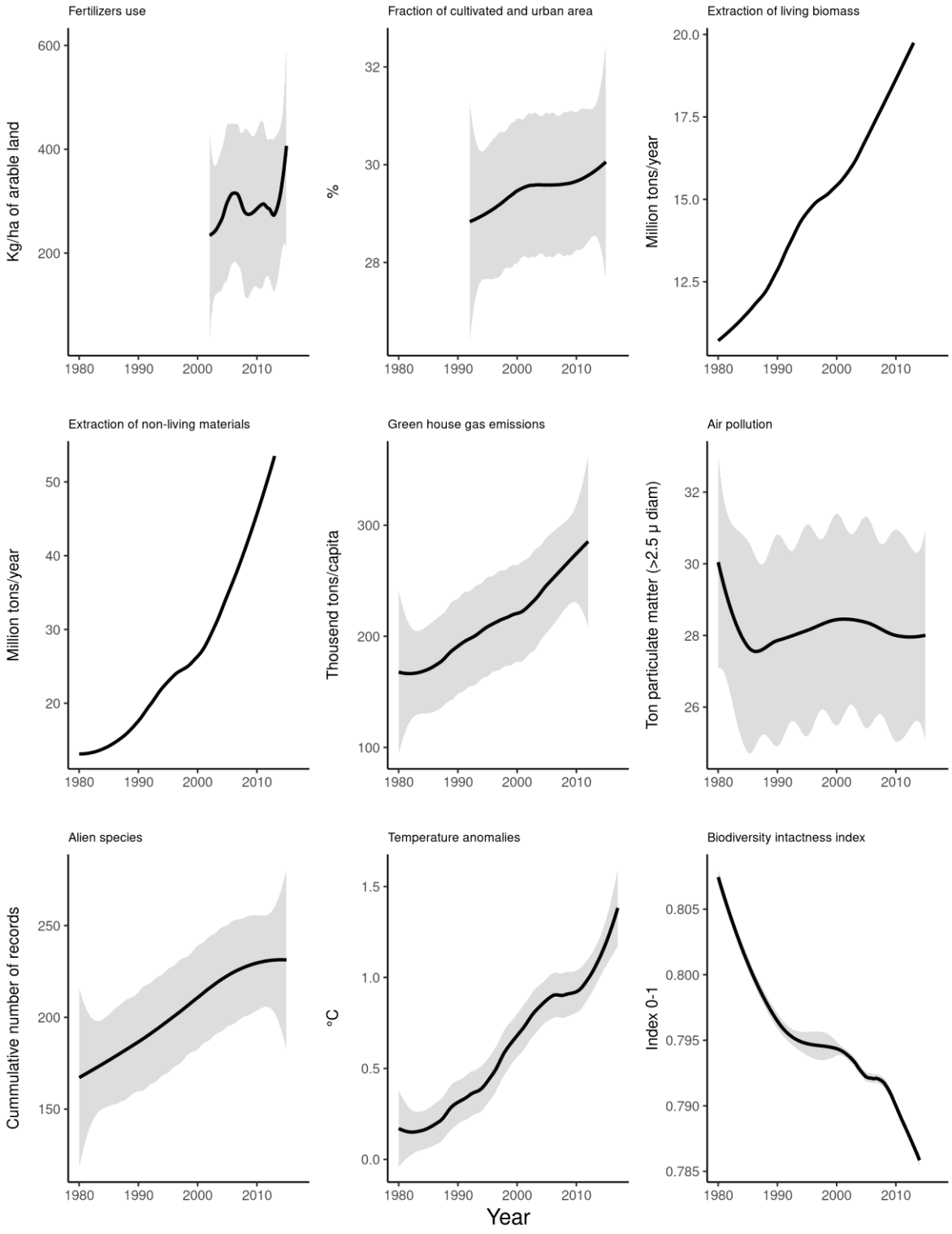


Figure S17. Global temporal trends for selected indicators of actions and direct drivers. Data shown are country averages with a shadow representing 95% confidence intervals unless otherwise stated. A) Fertilizer use: Fertilizer consumption measures the quantity of plant nutrients (kg) used per unit of arable land per year; B) Fraction of cultivated and urban area: Proportion of total area of country with cultivated and urban land cover, based on ESA CCI Global Land Cover v2.0.7; C) Extraction of living biomass: Millions of tons per year extracted from agriculture, forestry, fishing, hunting and other types of living biomass; D) Extraction of non-living materials: Millions of tons per year extracted of fossil fuels, metal ores, and minerals for construction and industry; E) Per capita greenhouse gases emissions: metric tons of CO_2 emitted per year; F) Air Pollution: mean annual exposure to particles larger than 2.5 micrometer of diameter in micrograms per cubic meter; G) Alien species: Cumulative number of first records of alien species; H) Temperature anomalies: measured as the temperature in a given year minus that of the reference period (1960-1969) in degrees celsius - In this case the confidence interval is provided by the modelling tool. I) Biodiversity intactness index: relative change in abundance of native species as compared to a pristine system- values are country averages weighted by country Net Primary Productivity. Source: ESA CCI, 2017; FAO, 2018b; Jones et al., 2012; Newbold et al., 2016; OECD, 2018b; Seebens et al., 2017; World Bank, 2018r; WU & Dittrich, 2014.

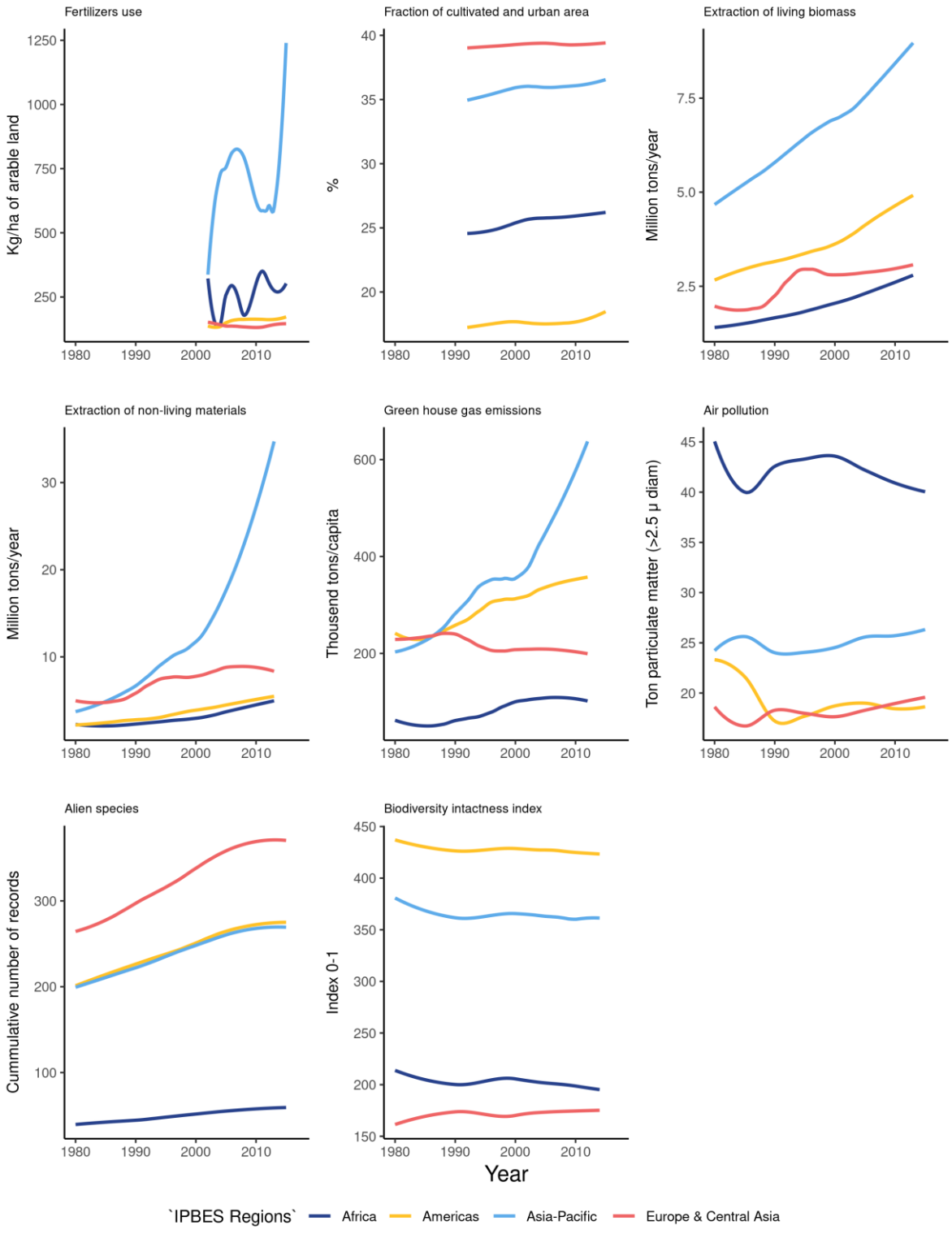


Figure S18. Global temporal trends for selected indicators of actions and direct drivers per IPBES region. Data shown are country averages per IPBES region. A) Fertilizer use: Fertilizer consumption measures the quantity of plant nutrients (kg) used per unit of arable land per year; B) Fraction of cultivated and urban area: Proportion of total area of country with cultivated and urban land cover, based on ESA CCI Global Land Cover v2.0.7; C)

Extraction of living biomass: Millions of tons per year extracted from agriculture, forestry, fishing, hunting and other types of living biomass; D) Extraction of non-living materials: Millions of tons per year extracted of fossil fuels, metal ores, and minerals for construction and industry; E) Per capita greenhouse gases emissions: metric tons of CO_2 emitted per year; F) Air Pollution: mean annual exposure to particles larger than 2.5 micrometer of diameter in micrograms per cubic meter; G) Alien species: Cumulative number of first records of alien species; H) Biodiversity intactness index: relative change in abundance of native species as compared to a pristine system- values are country averages weighted by country Net Primary Productivity. Source: ESA CCI, 2017; FAO, 2018b; Newbold et al., 2016; OECD, 2018b; Seebens et al., 2017; World Bank, 2018r; WU & Dittrich, 2014.

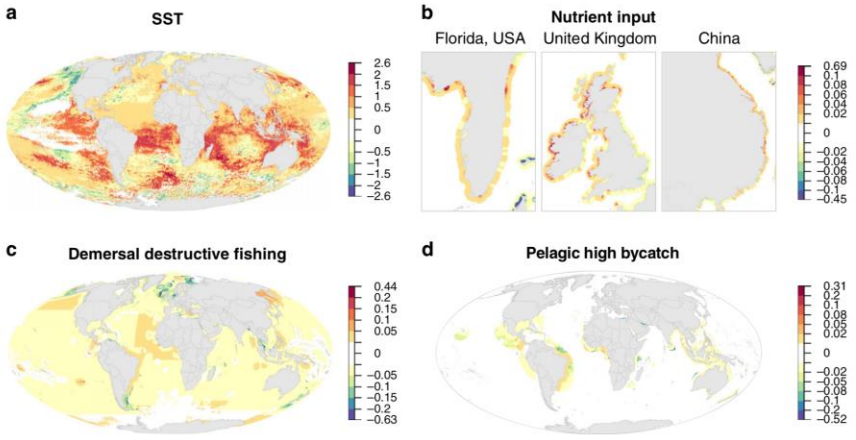


Figure 3 | Absolute difference in 2013 versus 2008 per-pixel stressor intensities for four representative stressors. (**a**) Sea surface temperature anomalies, (**b**) nutrient input, (**c**) demersal destructive fishing and (**d**) pelagic high bycatch fishing. Positive scores represent an increase in stressor intensity. Note that colour scales differ among panels and are nonlinear.

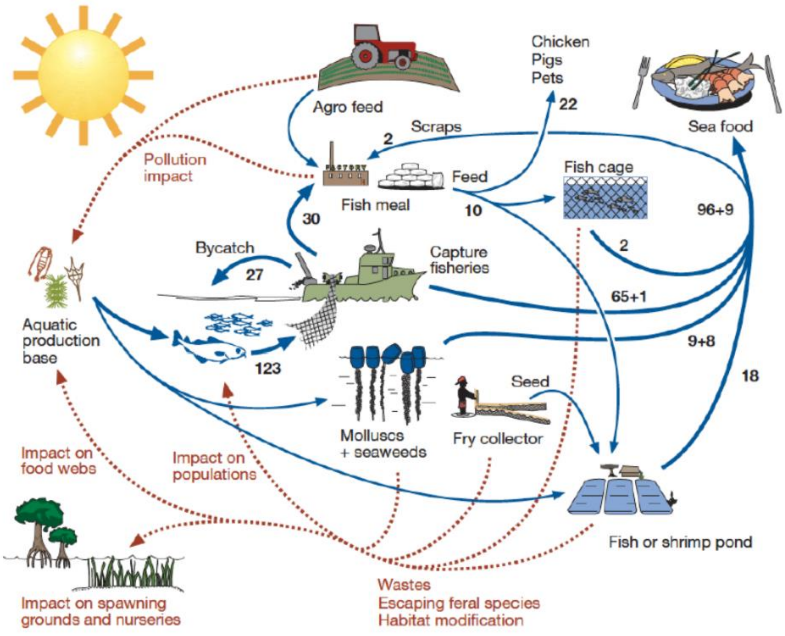


Figure S19. Impacts of fisheries and aquaculture. a) Absolute difference in 2013 versus 2008 per-pixel stressor intensities for four representative stressors. a.1) Sea surface temperature anomalies, b.1) nutrient input, c.1) demersal destructive fishing, and d.1) pelagic high bycatch fishing. Positive scores represent an increase in stressor intensity. Note that color scales differ among panels and are nonlinear, b) Ecological links between intensive fish and shrimp aquaculture and capture fisheries. Thick blue lines refer to main flows from aquatic production base through fisheries and aquaculture to human consumption of seafood. Numbers refer to 1997 data and are in units of megatons (million metric tons) of fish, shellfish and seaweeds. Thin blue lines refer to other inputs needed for production. Hatched red lines indicate negative feedbacks. Source: Halpern et al., 2015; Naylor et al., 2000.

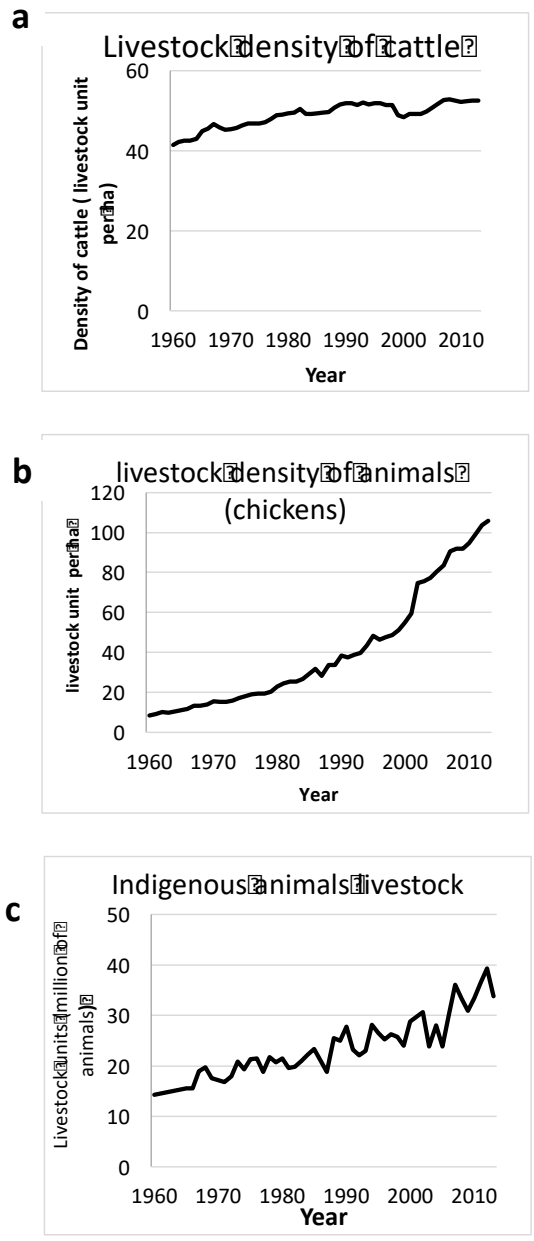


Figure S20. Global trends in livestock density. a) Total of livestock density of cattle calculated in livestock unit per ha, b) Total of livestock density of chicken calculated in livestock unit per ha, c) Total of indigenous animal's livestock calculated in livestock unit per ha. Average values per country using world bank income categories. Source: FAO, 2018d.

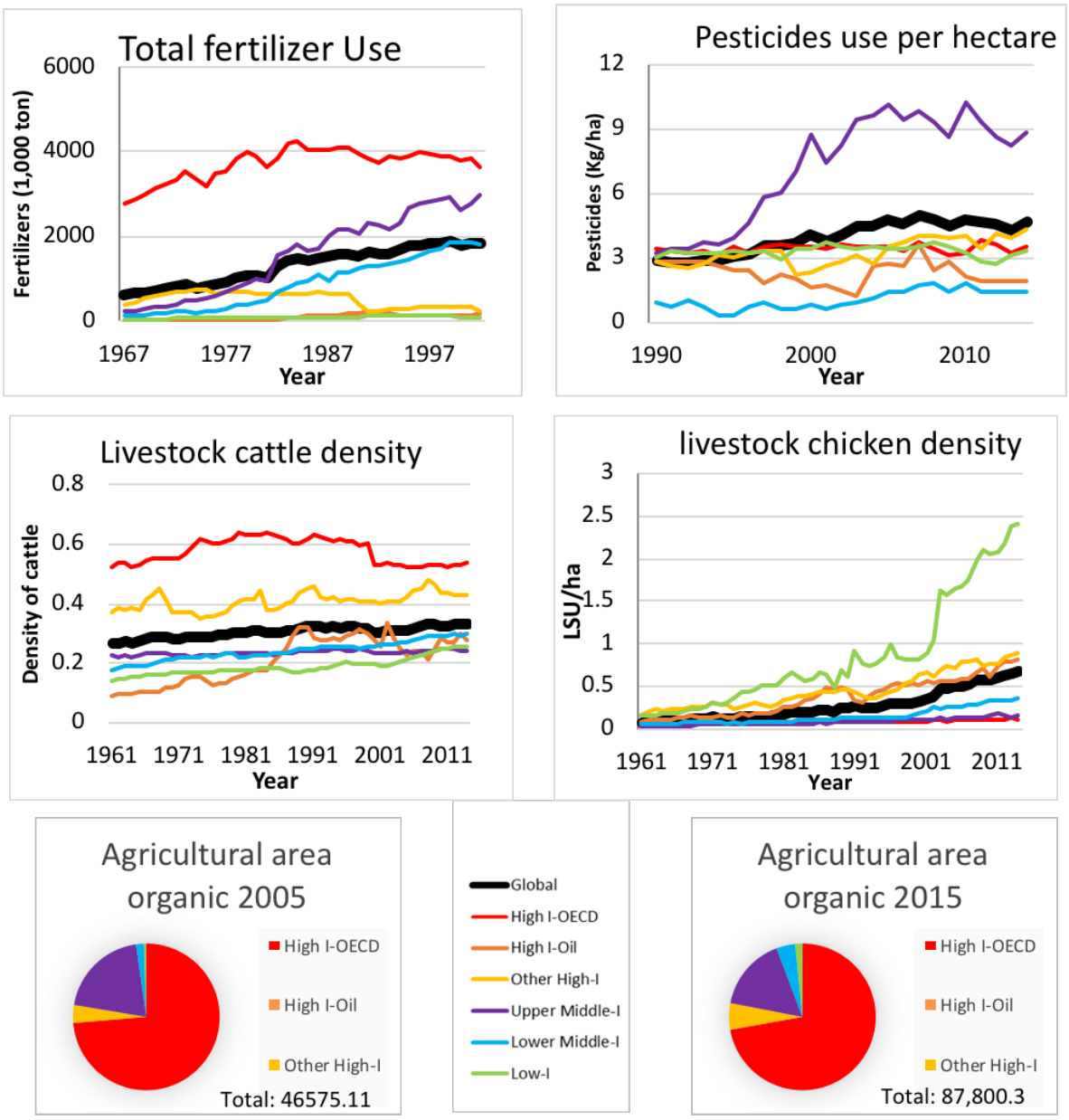


Fig. S21. Temporal trends in selected indicators of agriculture 1960-2015 for countries with different income level. Values shown are averages among countries for World Bank income levels. A) Fertilizer use: in thousands of tons, b) Pesticides use: in kg per ha, c) Livestock density of cattle: in livestock unit per ha, d) Livestock density of chickens: livestock unit per ha, e) Total area under organic agriculture: calculated in square kilometer in 2005; f) Total area under organic agriculture: calculated in square kilometer in 2015. Source: FAO, 2018e, 2018b; OECD, 2018a

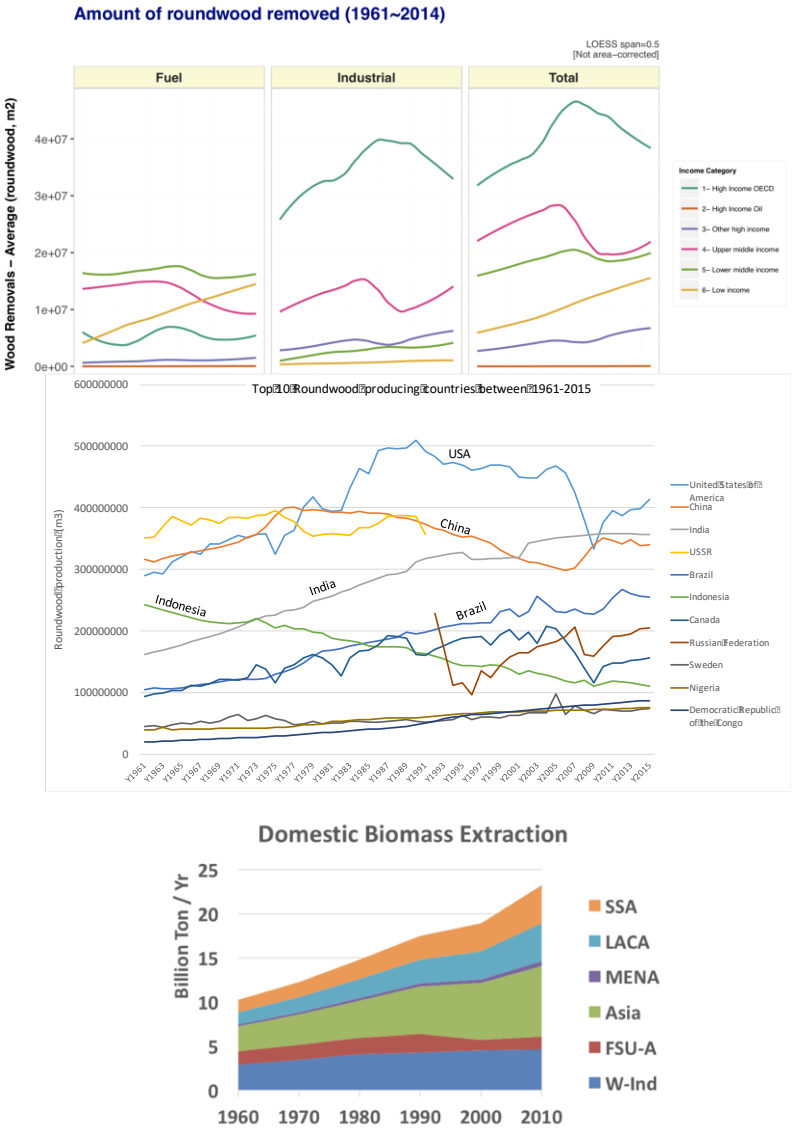


Figure S22. Trends in wood and biofuel extraction. **a)** Trend in the amount of roundwood removed for fuel, industrial and the total (1961~2014). The data were calculated as the sum of reported and/or estimated data on industrial roundwood removals and woodfuel removals; the latter with weak data for many countries, where estimates were made using models for woodfuel consumption. Average values per country using world bank income categories. **b)** Trend of top 10 roundwood producing different countries (1961~2015). **c)** Worldwide trend of domestic biomass extraction across various regions (1960~ 2010). Abbreviations: SSA: Sub-Saharan Africa; LACA: Latin America and The Caribbean; MENA: Middle East and North Africa; FSU-A: Former Soviet Union and its allies; W-Ind: Western Industrial countries; Asia: excl. countries included in FSU-A, W-Ind and MENA. Sources: FAO, 2018c; Schaffartzik et al., 2014.

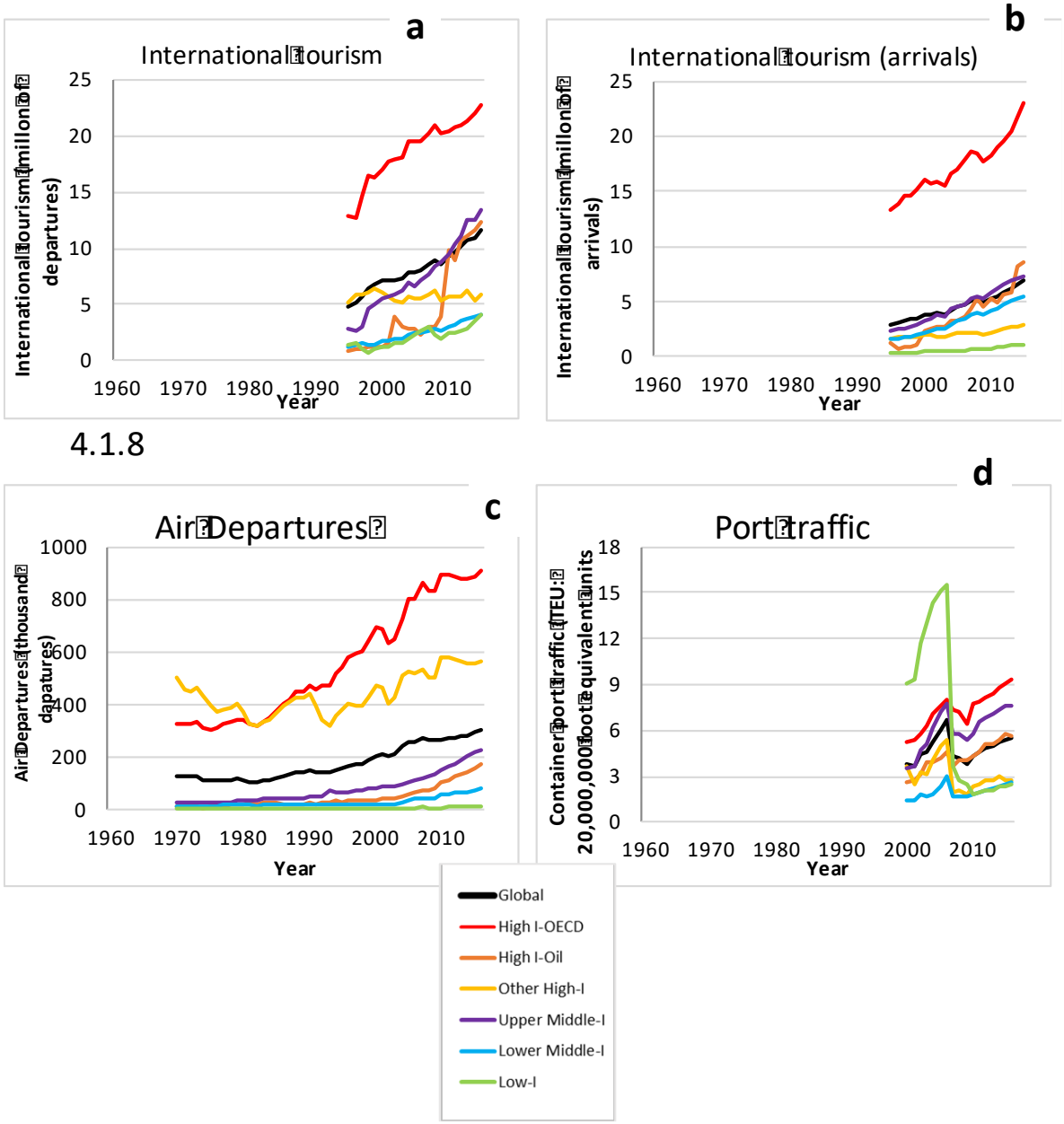
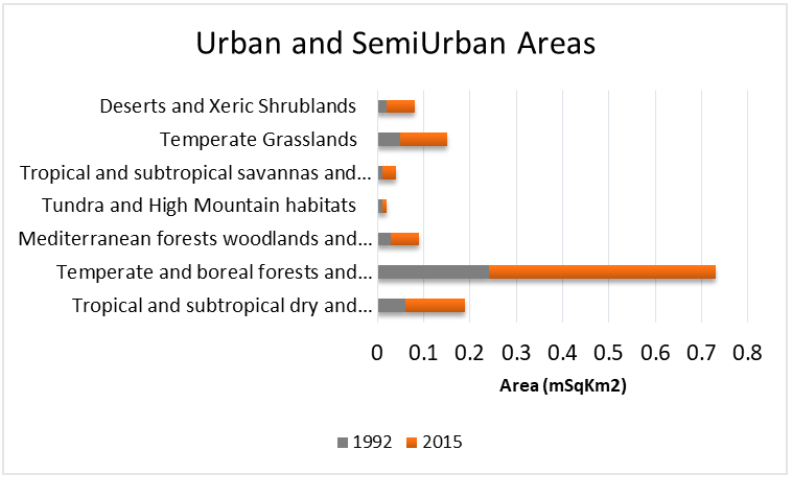
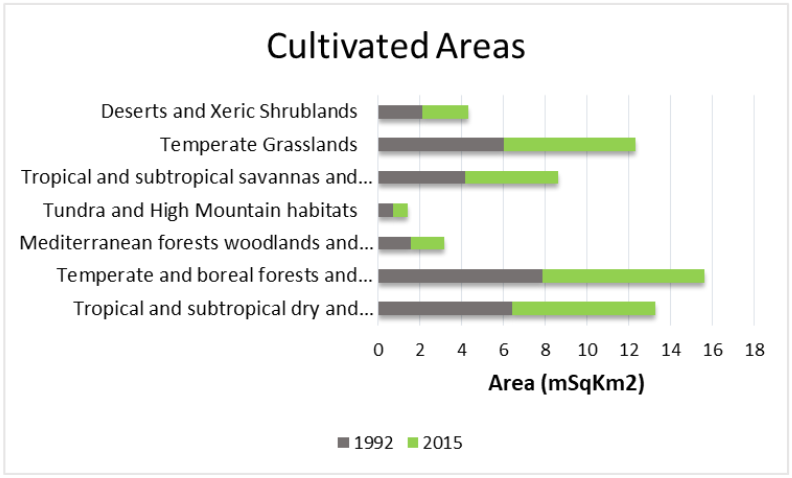


Figure S23. Temporal trends in selected indicators of relocations of goods and people. Data shown are averages per country for World Bank Income level A) International tourisms arrivals b) departures from 1960 to 2010, c) Total air departures from 1970 to 2015 and d) Average Port traffic represent to container port traffic in 2,000,00-foot equivalent units. Sources: (World Bank, 2018a, 2018h, 2018i)



a



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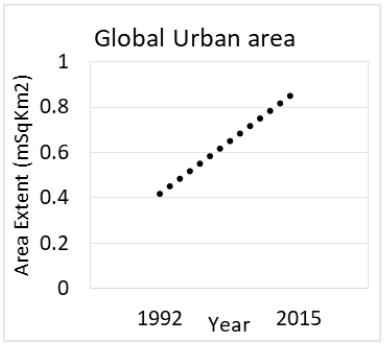

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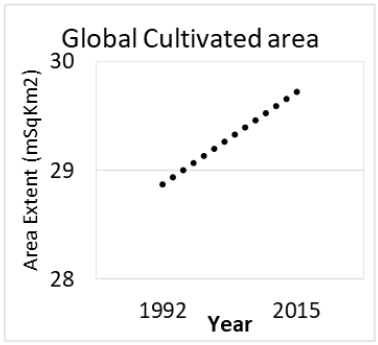
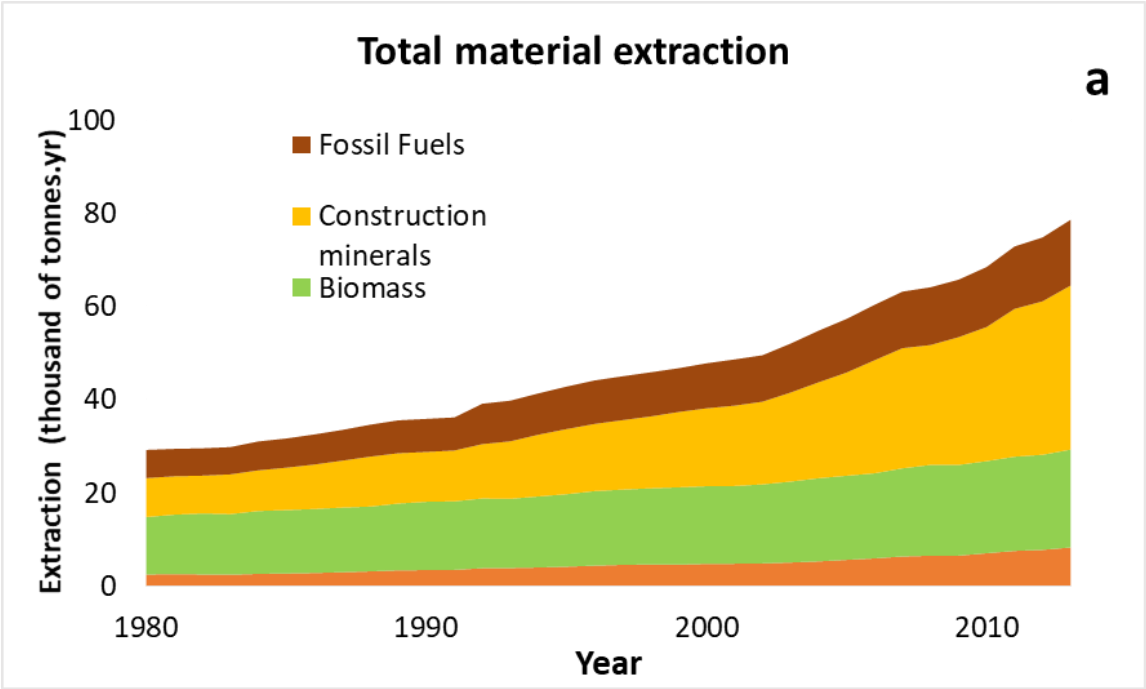


d

Figure S24. Land use changes 1992-2015. a) Units of analysis showing changes in urban and Semi urban areas, b) and changes in cultivated areas, and Global extent of c) urban and d) cultivated areas. Changes in the proportion of land cover in Urban and Cultivated Areas between year 1992 and year 2015 were calculated using the changes in the proportion of ESA CCI Land Cover in Urban (class value 190) and Cultivate Areas (Class values 10, 20, 30, and 40) in gradients of white (no change) to dark red (100%). The proportion calculated based on the number of Urban and Cultivated 300m cells within a grid of 10km (ESA CCI, 2017).


Total material extraction
a
Extraction (thousand of tonnes.yr)
100
80
60
40
20
0
Fossil Fuels
Construction minerals
Biomass
1980
1990
2000
2010
Year

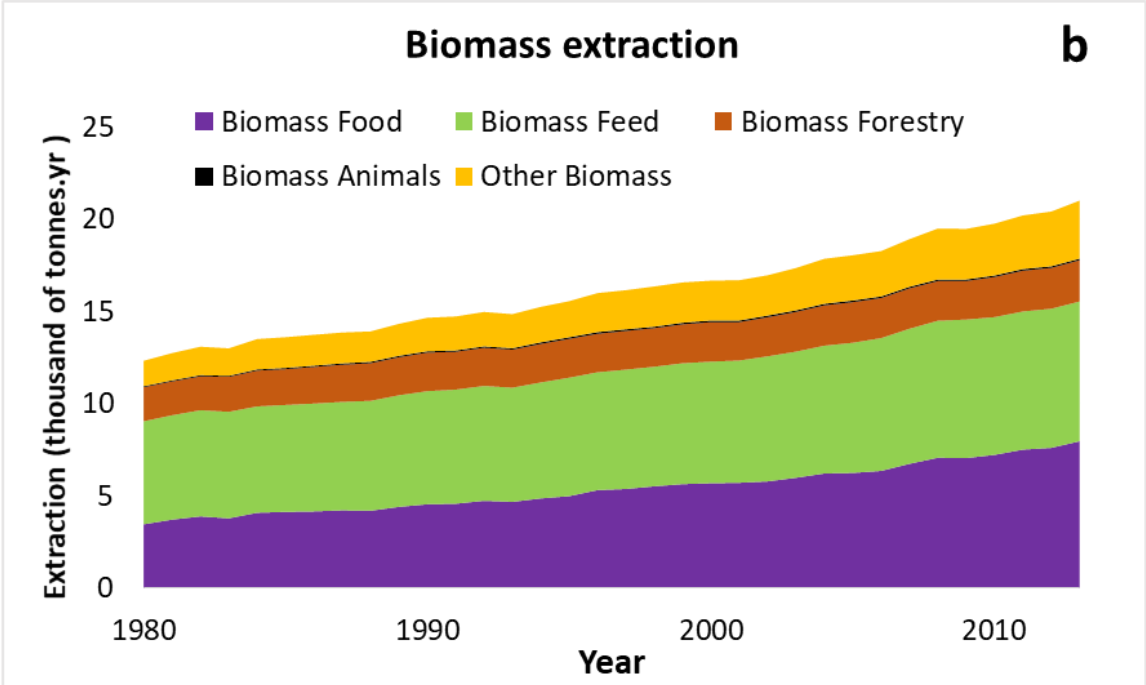

Biomass extraction
b
Extraction (thousand of tonnes.yr)
25
20
15
10
5
0
Biomass Food
Biomass Feed
Biomass Forestry
Biomass Animals
Other Biomass
1980
1990
2000
2010
Year

Figure S25 Temporal trends in total material extraction in thousands of tonnes (1980~2015). a) Extraction of fossil fuels, construction minerals, biomass and ores, and b) Extraction of biomass of food, feed, forestry, animals and other. Source: (WU, 2015) .

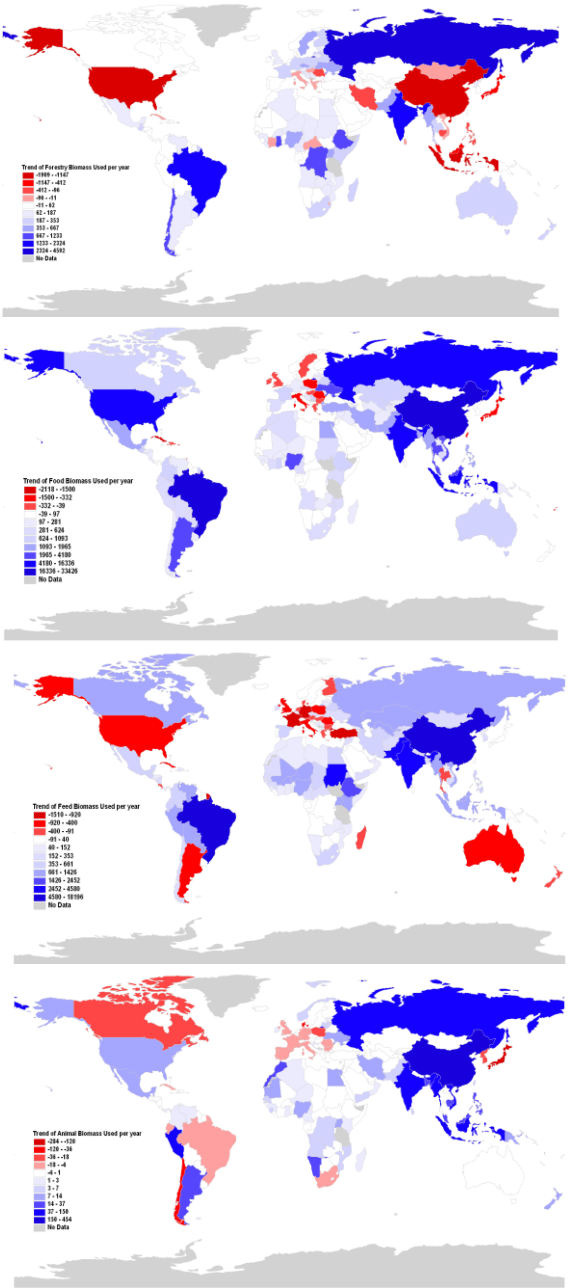


Figure S26. Spatial patterns of temporal trend in total extraction of biomass categories. Data shown is change expressed in thousands of tonnes 1980 to 2010. A) Biomass from forestry. B) Food biomass C) Feed biomass D) Animal biomass. Source: (WU, 2015).

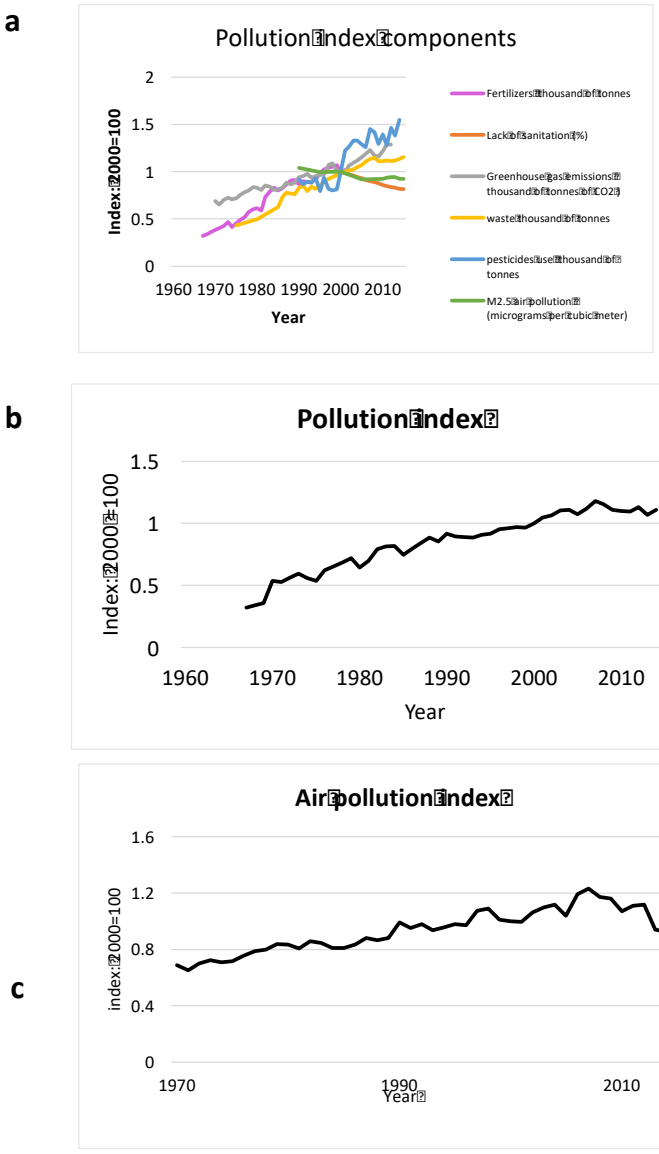


Figure S27. Temporal trends in pollution 1970-2000. A) the components of the pollution index include best available data on emissions of pollutants into the air, water and soil: fertilizer use, lack of sanitation, greenhouse gas emission, municipal waste production (per capita*population), pesticides use, air pollution by PM2.5 particles. b) trends in pollution based on a synthesis indicator for which each of the above variables are standardized using a value of 1 for the year 2000. C) trends in air pollution, using only data on greenhouse gas emissions and PM2.5 particles. Sources: (FAO, 2018e, 2018b; OECD, 2018c; World Bank, 2018q, 2018c, 2018r)

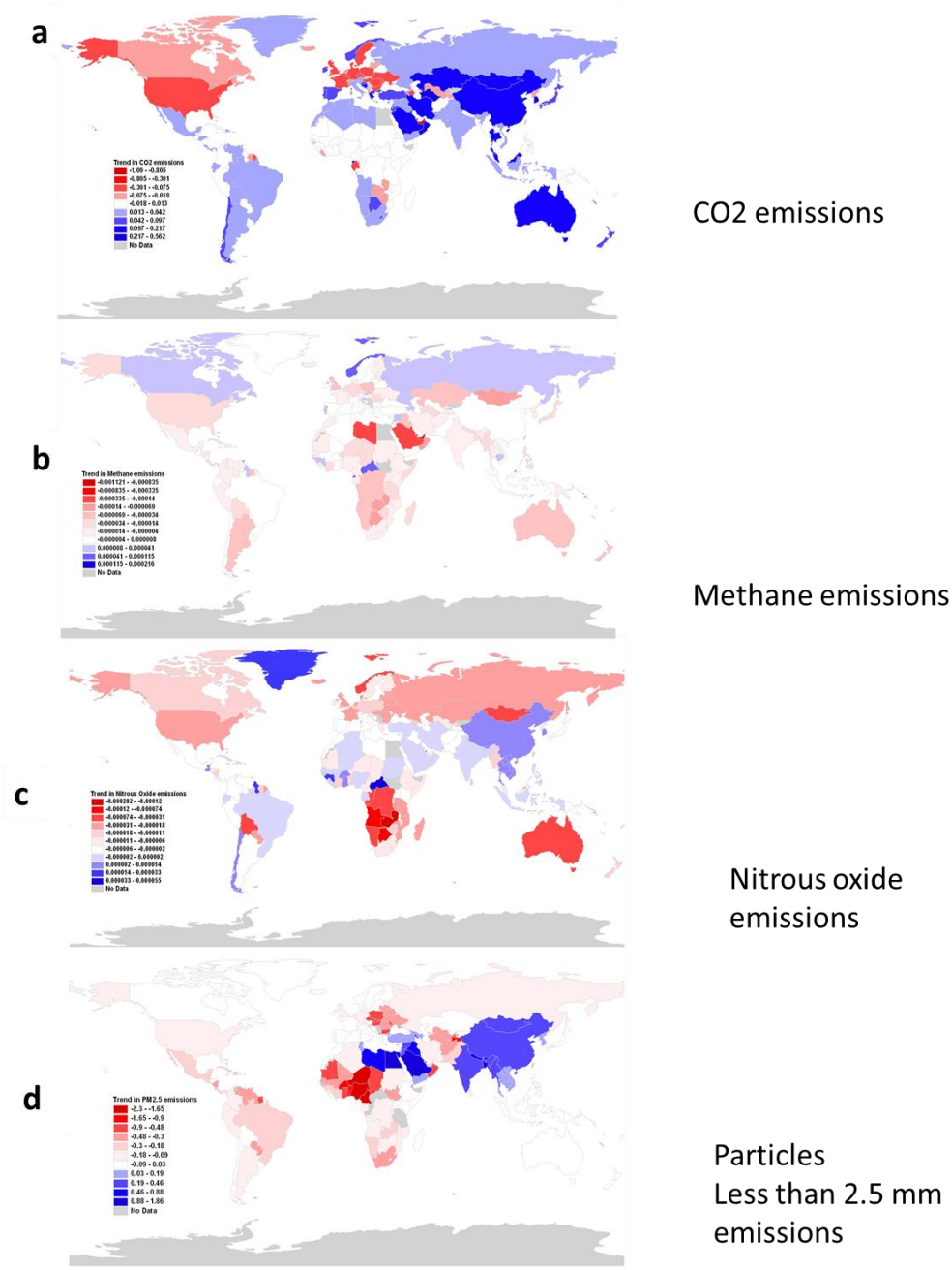


Figure S28. Spatial patterns of temporal trend of in air pollution. Trends for individual contries were assessed separately, then standardized. a) CO_2, b) Methane, c) Nitrous oxide, and d) Particles Less than 2.5 mm emissions. Values shown are the rate of change derived from a linear regression of individual country values through time. Source: Own calculations from (World Bank, 2018o, 2018l, 2018c, 2018r)

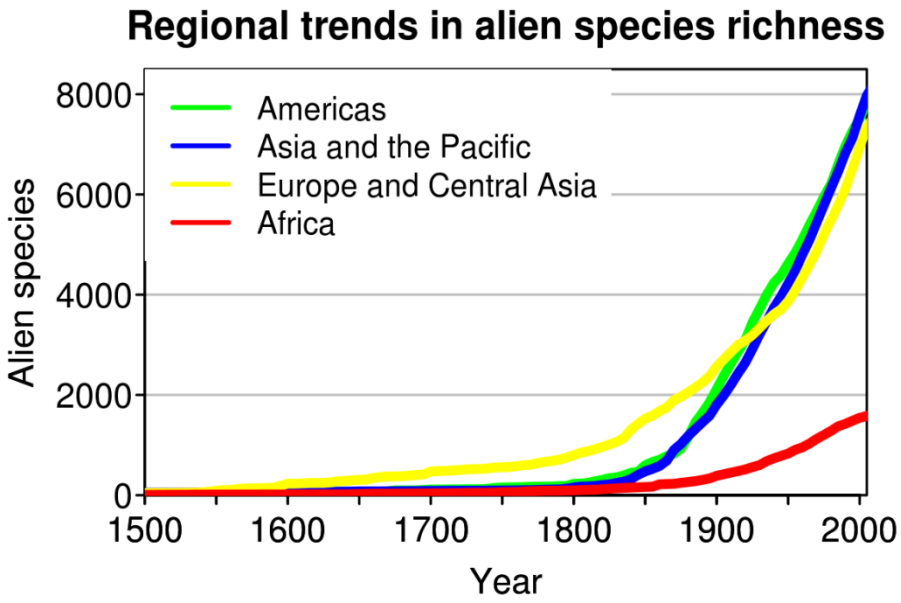


Figure S29. Temporal trends in alien species richness per IPBES region (1500~2000). The years of first record of an alien species in a country or on an island are obtained from the recent version of the Alien Species First Record Database (Seebens et al., 2018).

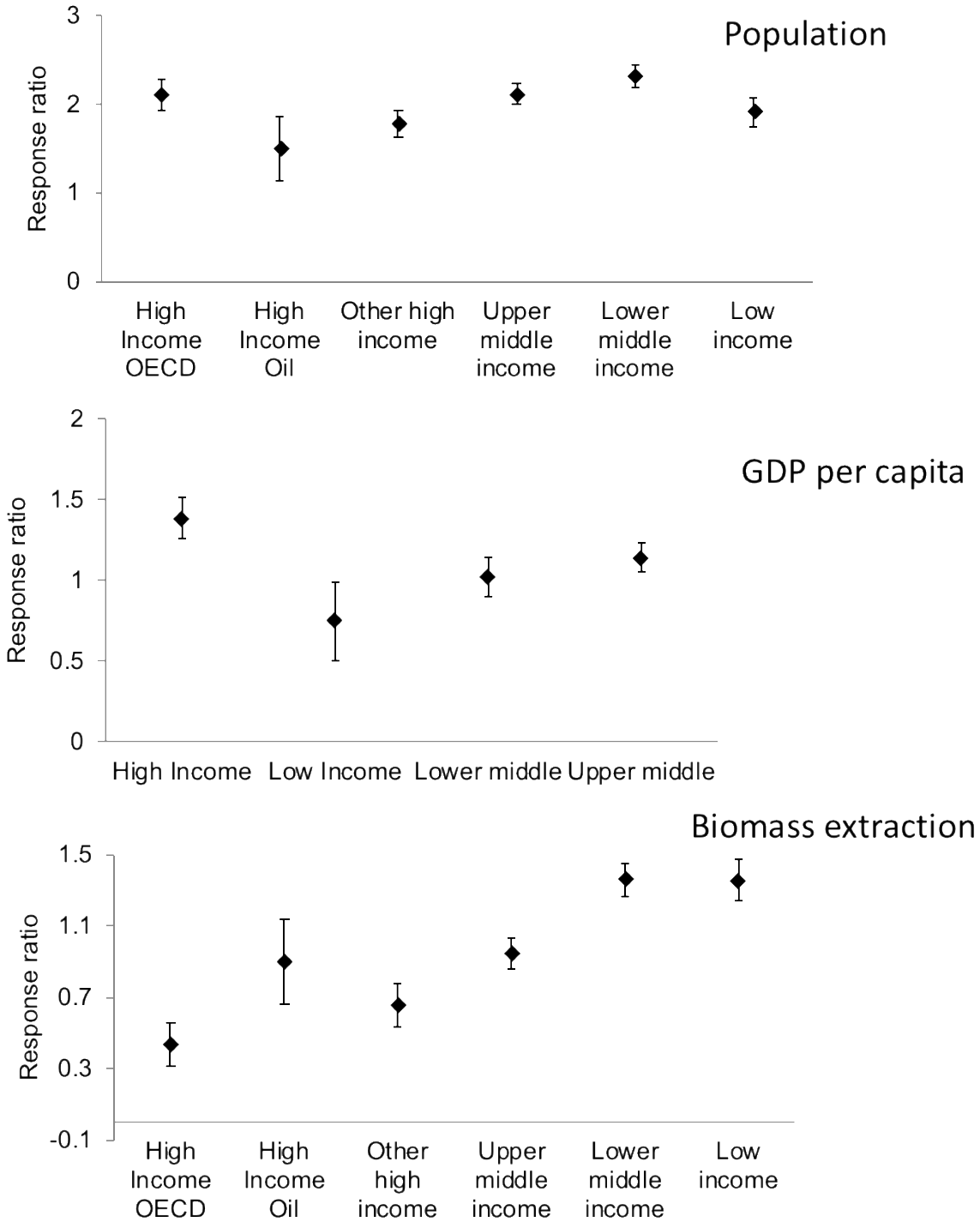


Figure S30. Differences in rates of change from 1980-2010 for 3 selected response variables between countries group using world bank income categories. Based on the raw mean of each variable in each country we estimated the average annual rate, and significant differences among income country groups were identified (see Below for further details). Sources: (Koricheva et al., 2013; World Bank, 2018e, 2018s; WU & Dittrich, 2014)

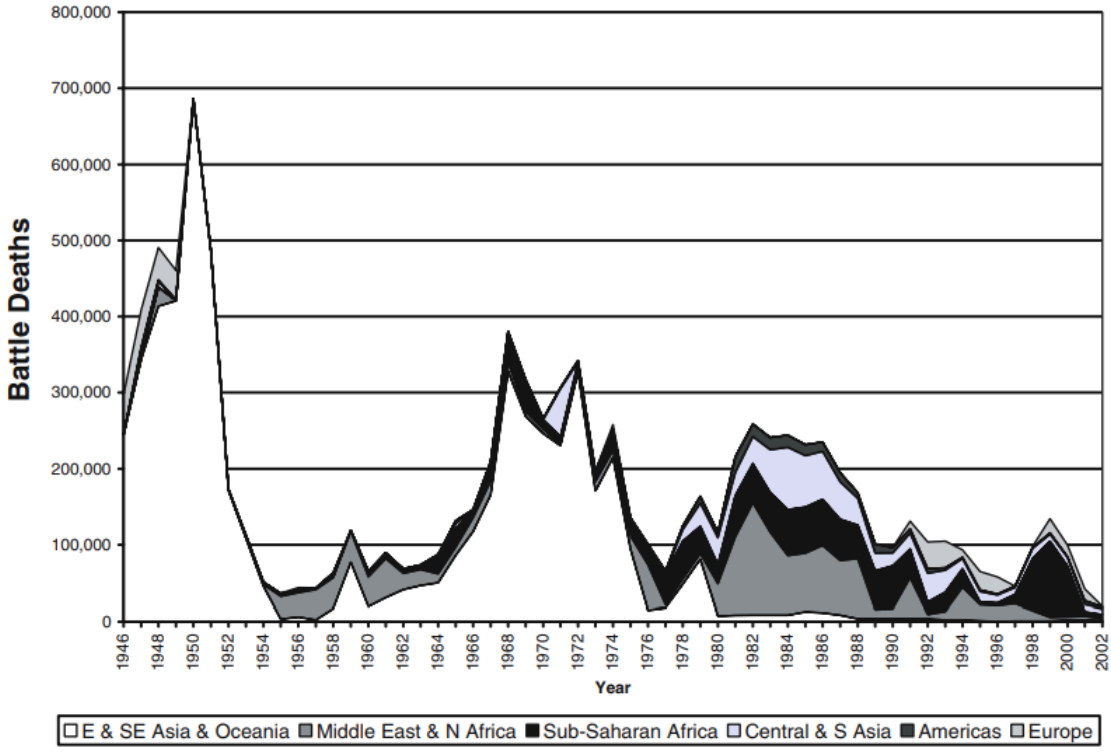
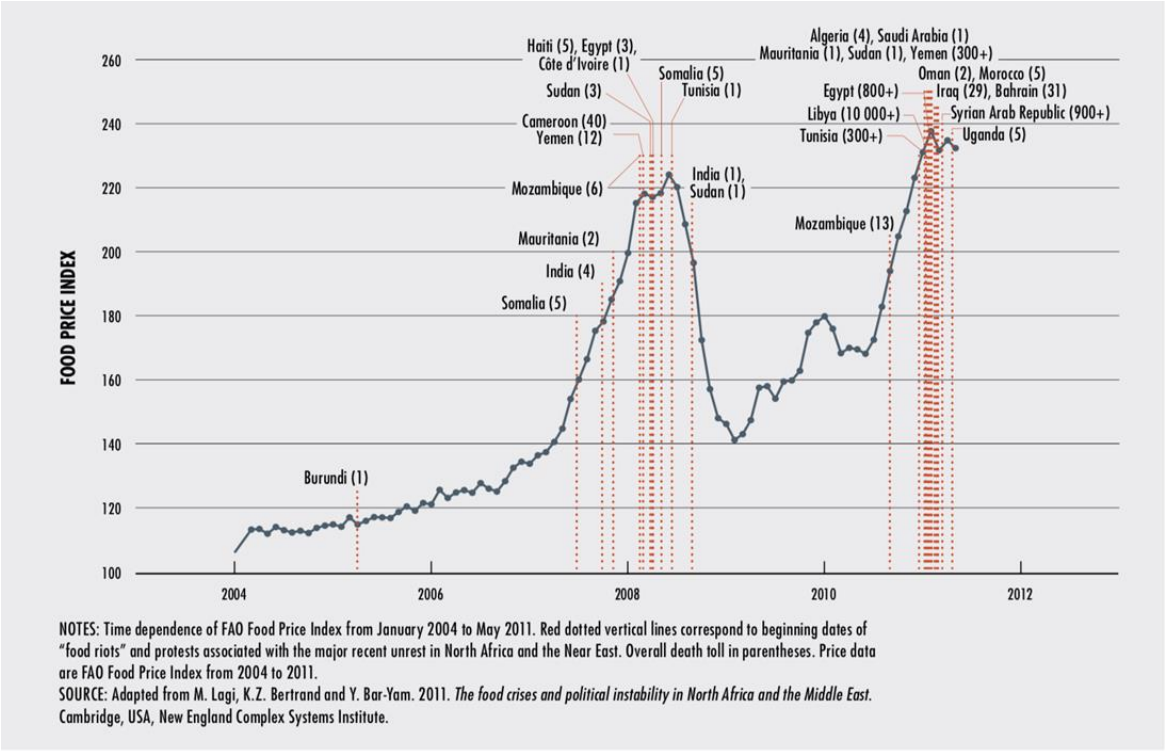


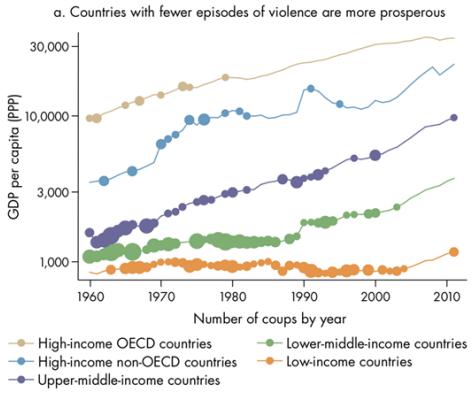
Figure S31: Total number of people dead in battles worldwide, 1946-2002 (Lacina & Gleditsch, 2005)



NOTES: Time dependence of FAO Food Price Index from January 2004 to May 2011. Red dotted vertical lines correspond to beginning dates of "food riots" and protests associated with the major recent unrest in North Africa and the Near East. Overall death toll in parentheses. Price data are FAO Food Price Index from 2004 to 2011.
SOURCE: Adapted from M. Lagi, K.Z. Bertrand and Y. Bar-Yam. 2011. *The food crises and political instability in North Africa and the Middle East.* Cambridge, USA, New England Complex Systems Institute.

Fig. S32. Water scarcity and food riots. Time dependence of FAO Food Price Index from January 2004 to May 2011. Red dashed vertical lines correspond to beginning dates of "food riots" and protests associated with the major recent unrest in North Africa and the Middle East. The overall death toll is reported in parentheses [26–55]. Blue vertical line indicates the date, December 13, 2010, on which we submitted a report to the U.S. government, warning of the link between food prices, social unrest and political instability [56]. Inset shows FAO Food Price Index from 1990 to 2011. Source: FAO et al., 2017, adapted from Lagi et al., 2011.

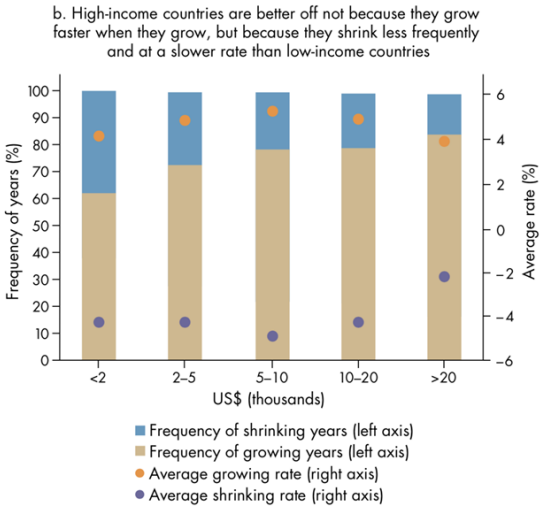
a



Sources: WDR 2017 team, based on data from Archigos database (Goemans, Gleditsch, and Chiozza 2009) for number of coups and Penn World Table, version 8.1 (Feenstra, Inklaar, and Timmer 2015), for level of GDP per capita.

Note: The size of the circles on each time series is relative to the number of coups per country for each income group in a given year. GDP = gross domestic product; OECD = Organisation for Economic Co-operation and Development; PPP = purchasing power parity.

b



Sources: WDR 2017 team, based on Wallis 2016, with data from Penn World Table, version 8.1 (Feenstra, Inklaar, and Timmer 2015).

Note: The figure shows real GDP per capita (constant prices: chain series). Countries were first sorted into income categories based on their income in 2000, measured in 2005 U.S. dollars. Average annual growth rates are the simple arithmetic average for all the years and all the countries in the income category, without weighting. The sample underlying the figure comprises 141 countries, which have data available from at least 1970 onward. GDP = gross domestic product.

Figure S33. Economic growth requires security. **a)** Countries with fewer episodes of violence are more prosperous. The size of the circles on each time series is relative to the number of coups per country for each income group in a given year. GDP = gross domestic product; OECD = Organisation for Economic Co-operation and Development; PPP = purchasing power parity, and **b)** High-income countries are better off not because they grow faster when they grow, but because they shrink less frequently and at a slower rate than low-income countries. Note: The figure shows real GDP per capita (constant prices: chain series). Countries were first sorted into income categories based on their income in 2000, measured in 2005 U.S. dollars. Average annual growth rates are the simple arithmetic average for all the years and all the countries in the income. Source: World Bank, 2017

Figure A70. Regime shifts documented on the regime shifts database

Figure S34. Regime shifts documented to date across the planet. Interactions between drivers of change in nature can lead to non-linear and even dramatic change in the functioning of ecosystems, which are considered regime shifts. Source: Stockholm Resilience Centre, 2018

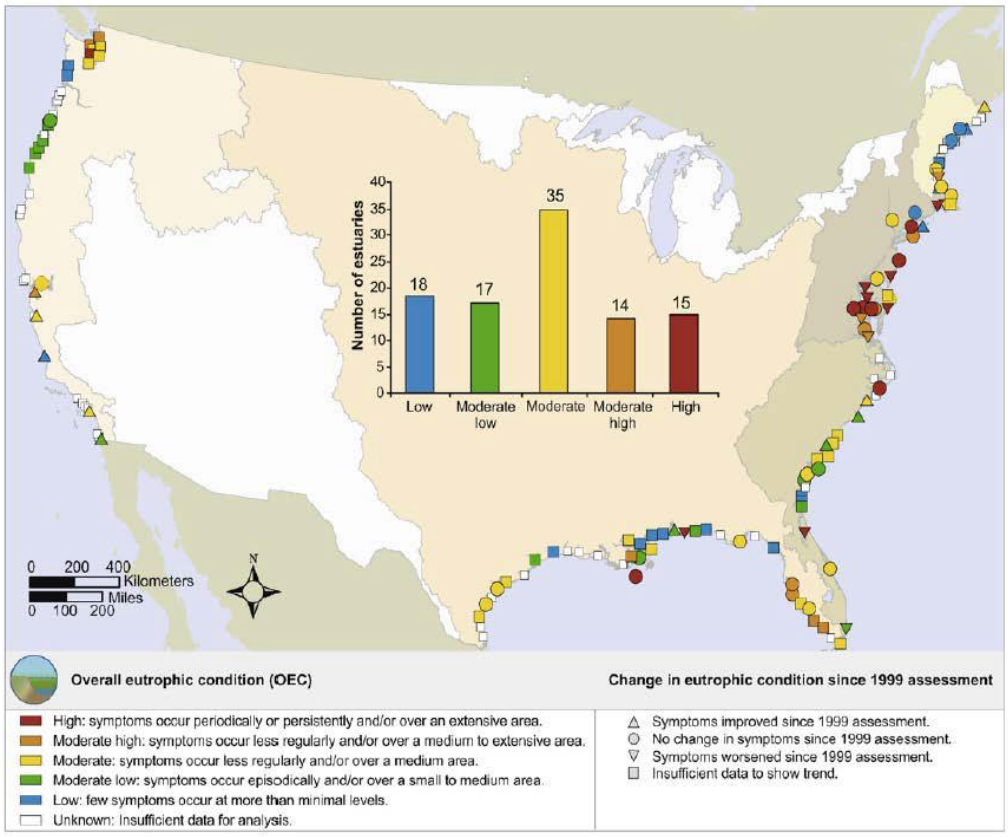


Fig. 4. Overall eutrophic condition on a national scale (from Bricker et al., 2007).

Figure S35. Eutrophication, regime shifts in coastal systems, documented for one developed country. Source: Bricker et al., 2008

2. Additional text

2.1. Maintain nature or meet society's many short-run goals? (SECTION 2.1.2.1)

Globalization or interconnectedness is highly correlated with GDP. The set of connections among countries, which are created and mediated through all the flows of people, capital, goods and information (Dreher et al., 2008), has increased over the last five decades (Fig. 4). Globalization is higher in high-income countries, with OECD countries exhibiting the highest level of globalization, followed by the Upper Middle, Lower Middle, and low-income countries. Between 1970 and 2013, on average, there has been a trend of increase in the globalization index among all income groups (Fig.S), while individual countries exhibited positive or negative trends.

2.2. Inequalities (SECTION 2.1.2.2)

Just as there are many views of well-being, there are also many metrics developed to measure it. For instance, there are indices that describe the material conditions for life, following an economic development perspective, such as the GDP. While this index is a measure of production that integrates the quantities of goods produced with their prices, aggregated across all goods, it is commonly associated with well-being (Agarwala et al., 2014), although it ignores non-market transactions and any distinctions between groups (Fig. 4).

Other indices (Hilmi et al., 2015)(Fig. S4) incorporate different perspectives such as the Human Development Index (HDI), which in addition to income (using a log that imposes diminishing returns to income) also incorporates health (in the form of life expectancy at birth) and education (in the form of average number of years of schooling) (UN, 2016a). There also exist indices which focus instead on different aspects of the environment. For example, the Happy Planet Index (HPI) incorporates 'ecological footprint' metrics with indicators of 'the well-being experience of individuals' (HPI, 2016a). The well-being component of the Sustainable Society Index (SSI.H) integrates the use of renewable energy with biodiversity (SSI, 2016). The Inclusive Wealth Index (IWI) integrates metrics of social and natural capital (UNU-IHDP & UNEP, 2014).

Some integrated indices aim to highlight management actions by people and communities (Fig. S4). For example, the Economic component (SSI.E) of the Sustainable Society Index accounts for land area dedicated to "organic farming" (SSI, 2016), while the Environmental Performance Index (EPI) includes metrics for managing ecosystem services and environmental policy (EPI, 2018). Other indices aim for integrated and relational perspectives upon well-being. Social Progress Index (SPI) utilizes measures of access, equality, tolerance, and the inclusion of minorities (SPI, 2017), while the World Happiness Index (WHI) focuses on 'freedoms' in terms of life options (WHI, 2017). Recent initiatives add additional perspectives such as linguistic diversity (Maffi, 2005) and cultural identity including the retention of indigenous ecological knowledge and practice over time (Sterling et al., 2017), and the list goes on.

Total biocapacity has nearly doubled for upper middle-income countries as a result of the expansion in their agricultural area and technological intensification, but their total footprint has increased 6-fold between the 1980s and the 2010s (Fig.S7). Similarly, although lower, increases are found in Lower Middle-Income countries. Yet, when analyzed per capita, the biocapacity of all types of countries is dramatically decreasing, being highest for Low-Income countries, and the per capita footprint is slowly increasing, except for the case of High-Income Oil producing countries for which it has increased ten-fold.

Assessing overall water footprint of production, it remained quite stable over the last five decades (Fig. S7). It is highest for High-Income OECD, Upper Middle-Income, and Low Middle-Income countries, but dropped after 2000. Conversely total water withdrawals in Upper Middle-Income countries have been escalating close to ten-fold.

2.3. Fisheries, and aquaculture and mariculture (SECTION 2.1.11.1)

Aquaculture has an expanding list of species with differential regional and economic value importance. 575 aquatic species, including freshwater, seawater and brackish species, contribute to aquaculture. Two-thirds (44.2 million tons) of total fish production were finfish species grown from inland aquaculture (38.6 million tonnes) and mariculture (5.6 million tons) (FAO, 2014), followed by mollusks (30% of animals grown), and crustaceans (4%) (FAO, 2006). Nearly 40% of the farmed species are carps and about 4% salmon or tilapia. In OECD countries, aquaculture is predominantly dominated by high economic value marine species such as salmon and oysters, while lower-value freshwater species such as carp and catfish predominate in Asian production. Aquatic plants, mostly seaweeds, are increasingly contributing to providing jobs (US$6.4 billion in 2014), largely in developing and emerging economies, and are emerging as an ecologically friendly alternative to the use of coastal and marine ecosystems (Cottier-Cook et al., 2016).

The production of aquafeed has increased 4 times to 29.2 million tons in 2008 (UN, 2016b), though no comprehensive information on farm-made aquafeeds and/or on the use of low-value fish with low market value as fresh feed is available. Fishmeal and fish oil are produced mainly from harvesting stocks of small, fast reproducing fish (e.g., anchovies, small sardines and menhaden). This use was promoted in the 1950s by FAO as a means to add value to the massive harvesting of small pelagic fish. Fishmeal is increasingly being used as a strategic ingredient fed in stages of the growth cycle when its unique nutritional properties can give the best results or in places where price is less critical. The most commonly used alternative to fishmeal is soymeal.

2.4. Agriculture & Grazing (crops, livestock, agroforestry) (SECTION 2.1.11.2)

Several studies have shown the extensive and successful use of agroforestry, as a key practice in agroecological approaches (Prabhu et al., 2015), to alter structural complexity of coffee for increased functional diversity of avian insectivores, with increased removal of about 50% of coffee berry borer (*Hypothemus hampei*) and improved management of fungal pathogens (Avelino et al., 2016; Karp et al., 2013; Perfecto et al., 2014). Other studies show agroforestry and soil conservation techniques at landscape level through various incentive schemes have enabled improved soil erosion management, sediment control and as a result more reliable power supply dams (DeClerck et al., 2010; Estrada-Carmona & Declerck, 2012).

2.5. Forestry (logging for wood & biofuels) (SECTION 2.1.11.3)

Solid biofuel from woody plants, crop residue and dung is a primary source of energy. The energy ladder suggests that poorest people use dung, agricultural waste, fuelwood and charcoal as main sources of energy and that as affluence increases they replace these gradually by wood, charcoal or kerosene stoves, and then by LPG and finally by electricity (Masera et al., 2000). While bioenergy is starting to shift from a traditional and indigenous energy source to a modern and globally traded commodity (GEA, 2012; IEA, 2016; World Energy Council, 2016), solid biofuel is still the number one source of energy used by

households, contributing to 9.2% of world's total energy supply in 2014 (IEA, 2017b). Developing countries produced and use ~85% of biofuels in 2014, which are usually burned in open fires or in inefficient and polluting stoves that typically emit smoke into the indoor environment (IEA, 2016). Wood fuel, mainly firewood and charcoal, accounts for the majority of solid biofuel used globally, while about half the wood extracted worldwide from forests is used to produce energy. Crop residue and dung are also important solid biofuels used by households in some rural developing regions, but no comprehensive global statistics exist. Solid biofuel, especially wood fuel, is the primary source of residential energy for around 2.7 billion people around the world, particularly in developing countries in Sub-Saharan Africa and South Asia (De Stercke, 2014; IEA, 2016). More than 90% of households in Sub-Saharan Africa depend on wood fuel for their daily cooking needs (Cerutti et al., 2015). Africa accounted for only 5.6% of the world's total primary energy supply in 2014, but accounted for 29.3% of the world's solid biofuels supply (IEA, 2017a) and has always maintained the highest per capital bioenergy consumption (Chum et al., 2011).

From 1961 to 2015, global wood fuel production increased by 25% from 1.5 billion m^3 to about 1.87 billion m^3, mostly contributed by African countries (FAOSTAT, 2016). Asia-Pacific was the largest producer (40%), followed by Africa (32%), Latin America and the Caribbean (14%), Europe (8%) and North America (4%). The rates of global wood fuel production peaked during the mid-1970s and since the 1980s the global increase in wood fuel production slowed down for Upper Middle-Income countries (Fig. S17). Deforestation and forest degradation in tropical regions and wood fuel extraction in Sub-Sahara Africa were the main drivers (Rademaekers, Eichler, Berg, Obersteiner, & Havlik, 2010). Between 27 and 34% of the global wood fuel harvest in 2009 was deemed unsustainable, with large geographical variations, and ~275 million rural people living in wood fuel scarcity "hotspots," mostly in South Asia and East Africa (Masera, Bailis, Drigo, Ghilardi, & Ruiz-Mercado, 2015).

Charcoal is a transitional fuel, which is cleaner and easier to use than firewood and often cheaper and more readily available than gas or electricity (van Dam & FAO, 2017). Global charcoal production increased by more than 3-fold between 1961 and 2015 (FAOSTAT, 2016), due to population growth, poverty, urbanization and the relatively high prices of alternate energy sources for cooking (van Dam & FAO, 2017). Of all the wood used as fuel worldwide, about 17 percent is converted to charcoal. Africa currently accounts for 62% of the global charcoal production, mostly in Sub-Saharan Africa. In many developing countries across Southeast Asia and South America, wood for charcoal production is sourced mainly from natural forests and woodlands, and usually produced using simple technologies with low efficiency, resulting in substantial losses of wood and energy (van Dam & FAO, 2017). Wood pellets production and consumption is the main wood fuel used in Europe and North America (Schlesinger, 2018).

2.6. Mining: minerals, metals, oils and fossil fuels (SECTION 2.1.11.5)

Fossil fuel extraction has been marked by changes in fuel sources, fuel demand and fuel

prices. Accessibility to shale oil and gas has increased (Joskow, 2013) and many factors regulate the fossil fuel markets (Baumeister & Kilian, 2016; Hamilton, 2009b; Kilian, 2009). Low gas prices brought on by the boom in shale gas production (Hausman & Kellogg (2015), and oil price fluctuations are more driven by demand factors than supply ones (Baumeister & Kilian 2016). Kilian (2016a, 2016b, 2017) found little effect on Brent crude oil prices (although the surge in tight oil did contribute to the spread between the prices of WTI and Brent crude oil during 2011-2014).

2.7. Infrastructure (dams, cities, roads) Urbanization and infrastructure (SECTION 2.1.11.6)

Urban expansion and economic growth are imposing major management challenges around the world as illustrated here with the case of water (Liu & Yang, 2012; McDonald et al., 2014). For instance, megacities (cities with populations over 10 million) constitute hotspots of water use and face enormous water sustainability challenges (Engel et al., 2011; UN, 1998, 2010). Of 28 megacities that currently exist, 22 rely on distant water transfers (UN, 2014). These require development of large water infrastructure projects, with socioeconomic and environmental effects across some large regions. The Three Gorges Dam and the South-to-North Water transfer project constitute two of the largest such projects, in the world, with consequences including biodiversity loss and human displacement, among others, including land-use change (Fu et al., 2010; Liu, Yang, et al., 2016). While these mega-projects benefit people in distant urban centers, their socioeconomic burdens fall completely on rural areas that locally are directly affected, with not only displacement but also drastic changes in livelihoods including negative economic (e.g., loss of income, debt increase) and social (e.g., loss of social ties) impacts (Moore, 2014; Tilt & Gerkey, 2016; Wilmsen, Webber, & Duan, 2011; Wilmsen, 2017). Project impacts also increase the vulnerability of rural people to any further external shocks (Wilmsen et al., 2011)

2.8. Illegal activities with direct impacts on nature (SECTION 2.1.11.10)

IUU is highly lucrative for the high value of fishing demersal species (e.g. cod), as well as salmon, trout, lobster and prawns, which are already overexploited by legal fishing or subjected to restrictions for fisheries management, even if the quantities are small but the prices are very high. Also, IUU does not pay taxes or duties on the catches. Interactions between IUU and legal catch quotas in the maritime region and marine protected areas, where a total fishing ban is imposed, are complex to asses. IUU fishing (http://www.dfo-mpo.gc.ca/international/isu-iuu-drvrs-eng.htm) is promoted by weak governance of the global commons. Efforts to enhance international fisheries and oceans governance have come a long way in the last decade, resulting in significant improvements in the management of high seas and highly migratory fish stocks. Yet, not all regions on the high seas are overseen by a regional fishery management organization (RFMO), and not all RFMOs are as effective in monitoring, controlling and surveilling their regulatory area to prohibit IUU fishing. The Agreement on Port State Measures to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing (FAO, 2016), came into force in June 2016, with 54 parties, all 28 members EU counted as one. The Marine Resources

Assessment Group (2005) states that the most obvious impact of IUU fishing is direct loss of the value of the catches that could be taken by the coastal State otherwise. Vessels operating without licenses and licensed vessels misreport catches (quantity, species, fishing area, etc.) and illegal trans-shipment of catches (not much quantitative data on this one). Secondary economic impacts from the loss of fish to IUU vessels include reduced revenue from seafood exports and reduced employment in the harvest and postharvest sectors, and conflicts and IUU fishing generally occur between vessels of any size. The endorsement of 170-member states of the FAO Code of Conduct for Responsible Fisheries (CCRF) in 1995, has contributed to decreases in IUU fishing. It was endorsed by around 170-member states- and is voluntary and non-binding- countries. Australia, Malaysia, Namibia, Norway and South Africa, have incorporated some of its provisions into national law.

Due to recent improvements in technology and affordability, vessel monitoring systems (VMS) are increasingly available for both large- and small-scale fishing vessels, and thus can provide geo-referenced data that accurately describe fishing areas on geographic scales applicable to MSP (Global Fishing Watch, 2018; Kroodsma et al., 2018; Mccauley et al., 2016). Such data can be combined with validated logbook data, rich time-series data are potentially available from intensely fished and monitored sea areas, though largely for developed countries. The data situation is slowly improving in developing countries. Land tenure systems that extend to parcels of seabed and water for aquaculture also provide clear boundaries. Superimposed on these spaces are increasingly sophisticated layers of information on the interactions among fisheries, and between aquaculture and fisheries. Although not all fisheries conflicts concern spatial use, or can be managed through MSP, many are potential candidates for spatial conflict management.

2.9. Evolving economic & Environmental tradeoffs (SECTION 2.1.18.2)

Environmental justice focuses on “how the burdens of environmental harms and regulations are allocated among individuals and groups within our society” (Salzman & Thompson, 2003, p. 38). The concept was developed in the United States, in struggles against waste dumping in North Carolina in 1982. Activist-authors such as Robert Bullard, civil rights activists with no academic affiliation, and members of Christian churches, like Benjamin Chavis, saw themselves as militants of environmental justice (Martinez-Alier et al., 2014). In a seminal work *Dumping in the Dixie*, (Bullard & Wright, 1990) examined the environmental inequities that exist in the United States, particularly in the South: Texas, Louisiana, West Virginia, and Alabama. He identified that polluting industries follow the “path of least resistance” by locating their landfills, power plants, chemical plants, and hazardous waste dumps in minority areas that are economically poor and politically powerless. Although many interpret that environmental justice goes hand in hand with environmental equity, in reality the concept of environmental justice is more politically charged in the sense that it connotes some remedial action to correct an injustice imposed on a specific group of people (Cutter, 1995).

During the last 3 decades, scholars, activists, social movements and even government agencies, have produced extensive literature and evidence on the dimensions of differential environmental risks based on race and low-income (Brulle & Pellow, 2006). One of the

first studies to perform a systematic meta-analysis of empirical studies shedding light on race and class was Bryant & Mohai (1992). They analyzed 16 studies and found that race was a more important predictor than income of where environmental hazards are located. However, the multiple evidence (Bowen et al., 1995; Morello-Frosch et al., 2001; Pastor Jr et al., 2002) show that environmental inequities in this context are a result of racism or class barriers or a combination of both.

In other parts of the world, although the reality is different because people of color and poor people are not minorities, environmental inequities reveal the same patterns. For instance, in India caste has been an important aspect when analyzing disproportionate amounts of pollution and other environmental stressors (Demaria, 2010; Parajuli, 1996). As well, tribal affiliation often counts in many other countries in the struggles against resource extraction. In Nigeria, Shell and other oil companies have shifted the social and environmental costs of oil extraction onto indigenous, poor local communities (Martinez-Alier et al., 2014).

Negative shocks to the economy and nature clearly also may occur e.g., from climate change (regardless of cause), paraphrasing the IMF World Economic Outlook: Economic costs of warming include: 'market' impacts upon climate-sensitive sectors (agriculture, forestry, fisheries and tourism); damage to coastal areas from sea-level rise; higher expenditures for heating or cooling; changes in water resources; and non-market impacts such as the spread of infectious diseases, increases in water shortages, greater pollution and damages to ecosystems. Prominent prior studies (Mendelsohn et al., 2000; Nordhaus & Boyer, 2000; Tol, 2002) and literature covered in the *Stern Review* (2006) point to losses between 0% and 3% percent of the world's GDP, for a 3°C warming from 1990–2000 levels. Yet these estimates of damages rarely cover non-market damage, or the risk of local extreme weather or large temperature increases and global catastrophes. Further, such estimates of total global damages mask quite large variations − e.g., more damage for the countries with higher initial temperatures, greater climate change, and lower levels of development, which often implies greater dependence on climate-sensitive sectors and in particular agriculture. The regions that are likely to experience the greatest negative effects include Africa, south and southeast Asia (especially India), Latin America and the European OECD. In contrast, China, North America, OECD Asia and all the transition economies (especially Russia) should suffer smaller impacts and may even benefit. Uncertainty plagues such damage estimates, however, starting from our limited scientific knowledge concerning the physical and ecological processes that underlie climate change and including how best to quantify economic impacts. The losses will depend on how well people, firms and other institutions adapt − including the extent to which technological innovations reduce impacts. Any such quantification of the aggregate losses across generations involves some use of a specific welfare measure and it raises questions about how changes in welfare in the future should be discounted (that is related to the return on capital as a higher rate implies wealthier futures that we might worry less about per equity). Weitzman (2007) argues that the most important source of variation is uncertainty about catastrophes.

Such negative shocks to the economy and nature can, critically, affect health, usually exacerbating existing inequalities and, as noted, potentially affecting growth. A myriad of

health impacts can occur from environmental transformations due to land-use change, climate change, water scarcity, biodiversity loss, changing biogeochemical cycles (Whitmee et al., 2015) and varied alterations of ecosystems and their services will disproportionately affect poor populations in the developing world (Myers et al., 2013), accentuating existing health inequities. Increasing carbon dioxide in the atmosphere will reduce the micronutrient content of food crops (Myers et al., 2014), while a sea-temperature rise will move fish polewards away from the food-insecure equatorial belt of nations; Golden et al. (2016; 2017) note that aquaculture and mariculture can help with these challenges but their production and distribution patterns are not designed for nutritionally vulnerable nations. Deforestation and fragmentation in the Amazon could increase malaria (Vittor et al., 2006) and, perhaps, also other devastating diseases such as Ebola and HIV thought to have been released from African forests, while forest burning in Indonesia generates severe air pollution and haze, driving increases in respiratory infections, maternal mortality and cognitive deficits (Marlier et al., 2015).

Oil Palm

Palm oil production has been growing immensely in the last few decades. Production grew from 37 Million Metric Tons in 2006 to 65 Million Metric Tons in 2016, and it is projected to reach 85 Million Metric Tons in 2024. The global market value for palm oil and its derivatives was estimated at 65.7 Billion USD in 2015 and estimated to reach 90 Billion in 2021.

This is fuelled by increasing demand for multiple uses. Most of the palm oil is used in the food industry. It is widely used in frying and cooking oils, bakery, biscuit and pastry fats, margarines, animal feed, confectionery filling, coffee whiteners, ice creams etc. More traditional /non-food use has been in oleochemicals as a replacement for petroleum products in soaps, detergents, greases, lubricants and candles. Fatty acid derivatives are also used in producing pharmaceuticals, water-treatment products and bactericides. More recently, it has been used as feedstocks for biodiesel production and as alternative to mineral oils in power stations.

This global demand has been driven from emerging centers of international capital in the Southern Hemisphere (Borras et al., 2016). This is being encouraged also by institutions such as the World Bank (Deininger et al., 2011) and UNEP (Segura-Moran, 2011), under the assumption that there are marginal (unpopulated) lands apt for cultivation and that promoting the development of oil palm plantations as crops can help solve manifold energy, climate, economic and financial crises. Governments envisage jobs and revenues that could help mitigate high unemployment in developing countries and help supplement declining revenues due to extended periods of falling commodity prices worldwide. Other stakeholders especially private actors see an opportunity as a feedstock for biofuels.

About 80% of palm oil production happens in Indonesia and Malaysia, with the rest distributed across Latin America (Colombia, Guatemala, Ecuador, Honduras and others) and West Africa (Nigeria, Ghana, Cote D'Ivoire and others). However, palm oil production area has been growing in Africa over the last few years, with Nigeria, Democratic Republic

of Congo (DRC), Ghana and Cote D' Ivoire being lead producers. In the Congo Basin, in Cameroon the production increased from 21,000 tons in 1994 to 53,000 tons in 2010 (FAO, 2009; Hoyle and Levang, 2012), while the production in Gabon increased from 5,000 tons in 1994 to 12,000 tons in 2007 (FAO, 2009). Top ten consumers include India, Indonesia, EU, China, Pakistan, Nigeria, Thailand, Bangladesh and USA.

There is growing evidence that palm oil production (*Elaeis guineensis*), alongside soy, beef, wood, cocoa, coffee and other cash crops account for a great deal of tropical deforestation (up to 65%), alongside a number of other environmental and ecosystems degradation challenges (Borras et al., 2011; Gibbs et al., 2010). In Latin America and Southeast Asia this expansion has reduced soil fertility, increased water and air pollution (caused by major fires) and biodiversity loss; and prevented communities from accessing their main sources of livelihoods (water, fertile soil, food). The intensive use of pesticides has caused ecological disasters such as the “ecocidio” (thousands of fish death) (EJAtlas, 2015). The fires and deforestation have increased the number of human infections and premature death (Fornace et al 2016; Burrows 2016).

In Guatemala, cultivated lands with palm oil plantations increased almost 600% from 2000 to 2010 at the expense of the country’s tropical forests, wetlands and subsistence agricultural land. The expansion has been driven by states, international institutions and corporations and is controlled by five elite Guatemalan families allied to several transnational groups (Alonso-Fradejas, 2012).

The deforestation and ecosystems degradation (such as peatlands in Indonesia) and other environmental, and rights issues around oil palm production has triggered a number of policy responses at multiple levels. The Roundtable for Sustainable Palm Oil (RSPO) created in 2008 is probably the most well-known response (www.rspo.org). RSPO pioneered a multistakeholder platform between producers, the consumer-oriented industry, environmental and social NGO's and stakeholder groups and governments. This resulted in a set of principles, criteria and indicators and a certification scheme aimed at regaining trust between consumers and producers. The two main producer countries, Indonesia and Malaysia, have followed these voluntary standards, and developed their own mandatory system to enforce stronger compliance with the existing rules and regulations. RSPO has so far certified about 11.7 Million Metric Tons (19% of global production) and currently has membership from 91 countries.

The European Union has also taken specific measures given its position as the second largest market of Indonesia’s palm oil after India. The EU instituted an Anti-dumping Initiative regarding biodiesel from Indonesia and Argentina. EU lawmakers voted a law in January 2018 to ban palm oil-based biofuels by 2021. Under the 2030 sustainable development agenda, the EU is committed to halting deforestation, restoring degraded forests and promoting sustainable procurement by 2020.

At national the top producing country, Indonesia is also considering other measures. Proposed direct actions include a Peatland Restoration Agency for the purpose of restoring two million hectares of fire-hit peatland and, while freezing new concessions, working

closely with other significant consumers of palm oil to raise awareness and to explore common solutions to the problem of tropical deforestation and forest degradation.

It has been argued that the implementation of RSPO rules especially in Indonesia and Malaysia and policy shifts in the EU demanding sustainable palm oil where rigorous conditions, regulations and demands are forcing major plantation companies to shift investments to Africa, where conditions are less stringent at the moment. This increased production for export has been linked to disruption of the local values, nutrition, culture and markets for palm oil in Congo Basin countries. Palm oil is the main edible oil in the region, and is widely used for multiple medicinal uses. With rising global demand, the price of palm oil has more than doubled in the region, increasing cost of living in the region. The higher prices have in turn fueled local investments in oil palm. For instance, there is evidence of growth and the establishment of medium-sized 5 - 50-hectare plantations in the southern Cameroon forest areas due to return of urban investments by the Cameroonian elite that increasingly see palm oil as a reliable and profitable investment (Yemefack et al., 2005). These medium-sized producers largely target the local market, but prospects for integrating out-grower schemes of large producers are very good.

The growth of palm oil in Africa has been associated with land grabbing in the Congo Basin and the Guinea forest ecosystem, where several land acquisition deals for palm oil production by multinationals have been reported (see www.landmatrix.org). While several of the acquisitions remain undeveloped due to local community resistance and land claims, where developments have proceeded as planned, the employment envisaged and high revenues have been mixed because jobs are mostly low paid jobs and often short lived. Tax exemptions, limited local financing opportunities and poor infrastructure sometimes limits the economic gains envisaged by governments (Cotula, 2016).

It is evident that demand for palm oil will continue to grow and consequently, its production will continue to increase. Several developing countries continue to see its expansion as an opportunity to bring marginally profitable lands under palm oil production, create jobs and improve revenues in the midst of a poor global outlook for commodities. Likely negative impacts on nature and its benefit to people would continue if current policies are not reinforced. Current certification efforts in oil palm only covers 19% of global production with prospects for expansion limited by poor governance, capacity and cost challenges in producing countries (Mithöfer et al., 2017). Consumer country measures such as EU bans on imports of palm oil-based biodiesel only targets a small segment of market. Hence, more far reaching policy responses are needed.

Managing landscapes in which palm oil is grown for multiple ecosystems services as well as production is imperative given failed efforts to stop its growth. One key option could be agroecological approaches- i.e. implementing ecological principles in the management of agricultural lands. Agroecology applications to oil palm, especially agroforestry show potential for simultaneously increasing productivity, profitability and maintaining or enhancing ecosystem services. This might require multiple incentives including monetary investments, subsidies, technical training and others (Minang, 2018) to enhance the abilities of farmers and stakeholders manage working landscapes.

Estonia, the Soviet Union and the European Union

Active exploration of oil-shale deposites from Estonia did not occur until World War I when there were fuel shortages.

After World War II, annual shale-oil production increased reaching its highest rates in 1980 (Dyni, 2003). As a result, Estonian oil shale gas was used in Saint Petersburg (then Leningrad) and in northern cities in Estonia as a substitute for natural gas. With ongoing industrial growth, there was increased need for electricity in the north-west of the Soviet Union. This led to the construction of three large, oil-shale-fired power stations is Estonia and oil-shale extraction peaked in 1980 at more than 30 million tonnes per year. A shift in Soviet priority, though, involving the launch of nuclear reactors in Russia (particularly Sosnovyi Bor), reduced demand for electricity produced from oil shale.

Post-Soviet function was quite different in key dimensions. For instance, the post-Soviet restructuring of the electricity industry in the 1990s, led to a decrease in oil shale mining. More recently, after decreasing for two decades, oil-shale mining started to increase again at the beginning of the 21st century, implying a serious impact on the environment including water and air pollution from extraction and processing. The combustion and thermal processing generate waste requiring disposal, and atmospheric emissions including carbon dioxide. In 2015, it produced about 70% of Estonia's ordinary waste, 82% of its hazardous waste and more than 70% of its greenhouse gas emissions while lowering groundwater levels and water quality

European governance brings yet another twist to this tale. While the Estonian National Development Plan for the Utilisation of Oil Shale 2008–2015 prioritises oil shale as a resource for ensuring Estonia's electricity supply and energy security, the share of oil shale in Estonia's electricity and heat production is set to decrease due to the European Union's climate policy and the country's recognition of the environmental impacts and a need to diversify the national energy balance. While Estonia has the right to allocate a gradually decreasing limited number of emission allowances free of charge, this will be phased out by 2020.According to the International Energy Agency, Estonia shou reduce the share of oil shale in the primary energy supply by improving the efficiency of shale-fired power stations and increasing the use of renewable energy and natural gas. All this involves other countries in other ways as well. About 29% of produced electricity was exported to Finland, Latvia, and Lithuania and during the 1990s Finland supported processes of political and economic transition in neighbouring areas. Co-operation developed in particular with those regions of Russia bordering on Finland and with Estonia, Latvia, Lithuania and Poland. At the end of 2001, renovation of power plants began, with the introduction of a new combustion technology – circulating fluidized bed (CFB) process. Concentrations of SO2 and NOx in the flue gas from CFB power units are more than 100 and 2 times lower, respectively, fulfilling EU Directive 2001/80/EEC. Decline in SO2 emissions from oil-shale power in Estonia is an important factor in decreasing acidification of lake water and forest soil in southern Finland as well as in Leningrad District in Russia situated to the east from the town of Narva. Fiscal measures with an impact on GHG emissions in Estonia include excise duties and pollution charges. As a Member State, Estonia must comply with EU Directive 2003/96/EC for the taxation of fuels and energy.

While Estonia was granted a transitional period for the introduction of relevant taxes, e.g., regarding shale oil it was eligible for a transitional period until 1 January 2010 to adjust the national level of taxation for district heating purposes, nevertheless Estonia had already introduced the tax on shale oil by that date.

3. Selected recent critical references included in this report beyond the May 2018 threshold

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4. Methods for literature review

4.1. Key messages, outline and iterative literature review steps

The outline of the First Order Draft (FOD) was largely built through the analysis of the outlines of the drivers sections of the Second Order Drafts (SOD) of the four regional IPBES assessments (Americas, Africa, Europe and Central Asia, Asia Pacific).
The outline of the SOD was first built from FOD, comments from reviewers, the drivers typology as well as revisions by the team of authors, and co-chairs. Then, it was revised iteratively from the identification of key messages as they were iteratively identified and refined.
The literature review was undertaken iteratively from three different complementary processes that ran in parallel with the development of the outline of the FOD and the SOD: 1- identification of global policy relevant issues, 2- the in-depth analysis of the different subsections, 3- global overview.

4.2. Global policy relevant issues

In order to identify the most salient global issues relevant to the Drivers sub-chapter we revised the last ten years of the reports of relevant global organizations. These included: FAO, UN, UNESCO, UNEP, World Bank, World Economic Forum, World Health Organization, World Resources Institute. Within these reports we targeted the key policy relevant messages as well as the supporting information (figures and tables).

4.3. In-depth analysis of the different subsections

Each of the subsections of the outline (e.g. 4.1.1.) was led by one of the CLAs or LAs, based on their previous knowledge on the specific topic. The aim was to produce a short and critical, analysis of the most relevant issues and their complex interlinkages, based on an assessment of the available literature. To support this task, we invited a wide range of contributing authors (CAs) from different disciplines and countries. This wide team of CAs would be able to convey a diversity of approaches and perspectives. We targeted scholars with well-known experience on these topics, as well as early career academics that were deeply familiar with the corresponding literature and issues.
The in-depth analysis was based on a wide range of literature sources, including those not easily accessible through systematic literature review such as that associated to relevant study cases, books and reports in several languages beyond English.

4.4. Global overview

To complement the in-depth analysis, we also searched for literature that would provide a global overview of the different subsections, when needed. To do so we piloted a systematic review per subsection using Publish or Perish

(http://www.harzing.com/resources/publish-or-perish) for the case of each of the activities with direct impacts on nature (4.1.1 to 4.1.9). The search retrieved a very large number of papers (100-200) per subsection (e.g. 4.1.1), but of which very few (< 5) provided the global overview we expected to build to complement the in-depth analysis.
Instead, we dissected the literature search task into the specific topics that were identified from the in-depth analysis and from the outline development, within each subsection (1-3 paragraphs). For that purpose we used google scholar. We targeted either of the following papers: reviews, most recent, highly cited, global coverage, in high impact factor journals (e.g. Science, Nature, PNAS).
Relevant books and reports were also retrieved from this exercise. Most reports were easily downloadable, and complemented the identification of global policy relevant issues. Books, which contributed to the global overview and to the in-depth analysis, were not always accessible, depending on the respective online library subscriptions of the team of CLAs and LAs.

4.5. Systematic assessment of the amount of literature available on interactions between indirect drivers, actions and direct drivers

Articles retrieval. Bibliographic data were extracted from the Web of Science (http://apps.webofknowledge.com/WOS_GeneralSearch_input.do?product= WOS&search_mode= GeneralSearch&SID= C62QZMbzHJ59XeiWLnq&preferencesSaved=; retrieved 5 October 2018). We extracted 206,956 articles from 38 leading interdisciplinary journals between January 2017 and October 2018 (with 2017 impact factor > 3.16). We used a filter of 166 keywords that referred to nature and reduced the total number of analyzed papers to a sample of 48,892 articles. For these articles we obtained information on keywords, authors, title, abstract, year of publication and journal. All bibliographic data were imported into a database in R using the bibliometrix package (http://www.bibliometrix.org/).

Articles classification. Journal articles were classified into five direct drivers (climate change, land/ seascape change, pollution, resource extraction, invasive alien species) and in eight indirect drivers (actions, economic, development pathways, institutions and governance, demographic, lifestyle and inequalities, technological and values). Articles were classified based on the occurrence of direct and indirect drivers-specific words with their respective title, keywords and abstract (Mazor et al., 2018)

The set of drivers-specific keywords (see tables below) was determined by extracting the 1,429 most frequently used keywords from all considered articles and assigning each word to each direct and indirect driver. The set of driver search words was determined based on the top 100 keywords of articles containing the explicit driver (for example, “climate change”) in either the title, abstract or keywords. Each set of 100 words was filtered, using only those words that >50% of the current authors agreed related to a driver. A total of 167,852 articles (81%) were assigned to one or more drivers.

Validation. We corroborated our procedure by manually inspecting 2.8% of the articles across driver’s classification. 84% of the human-reviewed articles were successfully categorized.

Analysis. We used social network analysis (Wasserman & Faust 1994) to assess the contributions of indirect drivers to direct drivers of biodiversity and ecosystem services loss. We built a network data set where $n \times n$ matrix **S**, where n equals the number of nodes in the analysis and s_{ij} is the measured relation between specific nodes i and j. The node is the unit of analysis. In this study, nodes represent direct and indirect drivers. Links are based on the number of articles addressing the respective two connected drivers.

Table 1. Set of 1,429 keywords used to classify the literature addressing the indirect and direct drivers

Topic	Keywords
Direct drivers: Pollution	"pollution", "eutrophication", "ecotoxicology", "contamination", "pollute", "pollutes", "pollutant", "polluting", “municipal waste”, “nitrogen deposition”, “chemical pollution”, “hazardous substances”, “poor air quality”, “waste water dumps”, “wastewater”, “asbestos”, “pesticides”, “open waste dumps”, “dump sites”, “solid waste management”. “controlled waste disposal facilities”, “heavy metals”, “persistent organic pollutants”, “endocrine-disrupting chemicals”, “micro-pollutants”, “waste landfills”, “hazardous chemicals”, “e-waste”, “food waste”, “organic waste”, “construction waste”, “demolition waste”, “hazardous waste”, “, “sulfur dioxide”, “nitrogen oxides”, particulate matter 2.5”, “carbon monoxide”, “volatile organic compounds”, “ammonia”, “plastic debris”, “fumaric acids”, “phthalic acids”, “nitrates”, “phosphates”, “leachates”, “PCBs”, “floating plastic debris”, “GCC”, “greenhouse gases”, “GHGs”, “greenhouse gas”, “GHG”, "carbon dioxide"
Direct drivers: Land/ seascape change	"habitat change", "habitat-change", "habitat loss", "habitat-loss", "deforestation", "fragmentation", "land-use change" “land use”, "forest fragmentation", "habitat fragmentation", "habitat modification", "landscape change", , “urbanisation”, “urbanization”, “agricultural expansion”, “urban expansion”, “crop lands expansion”, “grazing lands expansion”, “infrastructure development”, “intensified land management systems”, “tree plantation”, “tree plantations”, “industrial development”, “agroforestry”, “human encroachment”, “managed forest”, “transformation of natural ecosystems”, “human use-dominated ecosystems”. “anthromes”, “anthropic biomes”, “road construction”, , “road expansion”, “dam construction”, “port construction”, “sea-ice change”, “seascape change”, “change in seascape”, “changes in seascape patterns”, “loss of coastal habitats”, “degradation of coastal habitats”, “loss of coral reefs”, “loss of seagrasses”, “loss of mangroves”, “loss of salt marshes”, “changes in seascape structure”, “fragmentation of seascape”, “loss of wetlands”, “large-scale conversion of coastal wetlands”, “loss of inland natural wetlands”, “land use and land use change” “LULUC”, “changes in sediment flows”, “reduction in sediment inputs”, “urban land expansion”, “monoculture plantations”, “land degradation”, “degraded land”, “soil degradation”, “surface sealing”, “soil compaction”, “soil acidification”, “soil fertility loss”, “organic matter depletion”, “rangeland degradation”, “freshwater degradation”, “soil erosion”, “forest degradation”, “loss of wetlands”, “loss of hydrological functions”, “irreversible land degradation”,)
Direct drivers: Resource extraction	“biomass extraction”, “biomass materials extraction”, “resource extraction”, “raw material extraction”, “domestic extraction”, “harvested biomass”, “grazed biomass”, “animal biomass extraction”, “plant-based biomass extraction”, “metallic minerals extraction”, “gold extraction”, “non-metallic minerals extraction”, “sand extraction”,

	“gravel extraction”, “limestone extraction”, “clays extraction”, “non-metallic minerals extraction”, “fossil energy carriers extraction”, “coal extraction”, “crude oil extraction”, “natural gas extraction”, “shale gas extraction”, “hydrated gas extraction”, “shale oil extraction”, “timber extraction”, “construction materials extraction”, “fossil fuels extraction”, “groundwater extraction”, “surface water extraction”, “fuelwood collection”, “non-timber natural resource extraction”, “extractive industry”, “wood extraction”, “charcoal extraction”, “ecosystem-derived fuels extraction”, “fuelwood extraction”, “material footprint”, "overfishing", "overexploitation", "overgrazing", "overhunting", "overharvesting", "over fishing", "over exploitation", "over grazing", "over hunting", "over harvesting", "over-fishing", "over-exploitation", "over-grazing", "over-hunting", "over-harvesting", "over fished", "over exploited", "over hunted", "over grazed", "over harvested", "over-fished", "over-exploited", "over-hunted", "over-grazed", "over-harvested", "overfished", "overexploited", "overhunted", "overgrazed", "overharvested"
Direct drivers: Climate change	"climate change", "global warming", "ocean acidification", "climate warming", “global climate change”, “glacier retreat”, “extreme weather events and climate change”, “LST” ,“sea-level rise”, “SLR”, “sea level rise”, “climate change effects”, “impacts of climate change”, “black carbon”, “ocean acidification”
Direct drivers: Invasive alien species	"invasive species", "biological invasion", "invasive", "invasion", "invasion ecology", "alien species", "introduced species", "invasive plants", "invasions”, “non-native species", "invasiveness", "invasibility", “emerging alien species”
Indirect drivers: Actions	“fisheries”, “aquaculture”, “industrial fishing”, “fish stocks”, “marine fisheries”, “shrimp farming”, “salmon farming”, “agriculture”, “crop production”, “fertilization”, “agricultural expansion”, “cattle”, “agricultural intensification”, “livestock”, “pasture”, “food crops”, “grazing lands”, “agricultural systems”, “logging”, “wood fuel harvest”, “firewood”, “charcoal”, “bioenergy”, “non-timber forest products”, “timber”, “sustainable community forestry”, “mining”, “fossil fuel production”, “small-scale mining”, “large mining multinationals”, “surface mining”, “gold mining”, “shale oil”, “shale gas”, “offshore oil”, “offshore gas”, “seabed mining”, “marine mining”, “dams”, “reservoirs”, “hydropower generation”, “illegal activities”, “illegal fishing”, “unreported and unregulated fishing”, “illegal forestry”, “illegal logging”, “illegal logging”, “illegal poaching”, “tourism”, “ecotourism”, “nature-based tourism”, “sustainable tourism”, “wildlife-base tourism”, “adventure tourism”, “community based ecotourism”, “ecosystem management”, “ecosystem conservation”, “restoration”, “air flights”, “goods transportation”
Indirect drivers: Economic	"international trade", “globalization”, “economy”, “economic”, “production of goods”, “GDP”, “markets”, “economic assets”, “income”, “import of goods”, “export of goods”, “socioeconomic”, “socio-economic”, “financial flows”, “structural changes in economies”, “economic transitions”, “production of goods”, “environmental kuznets curve”, “materials flow”, “goods flow”, “land grabbing”, “water grabbing”
Indirect drivers: Demographic	"human migration", “human population”, “population growth”, “education”, “human capital”, “megacities”, “decline of fertility”, “survival rates”, “death rates”, “size of global population”, “global population”, “international migrants”, “international migration”, “refugees”, “net migration”, “aging population”, “aged population”, “urban

	population", "rural population", "growth in the urban population", "urban dwellers", "settlements", "urban growth", "cities", "urban development", "rural-urban migration"
Indirect drivers: Technological	"technological innovation", "technologies", "technology", "green revolution", "genetically modified organisms", "genetic engineered crops", "genetically modified seeds", "insect resistance", "herbicide tolerance", "Big data", "The internet of things", "IoT", "artificial intelligence", "3D printing", "biotechnology", "nanotechnology", "renewable energy", "drones", "satellite", "frontier technologies", "automation", "digital automation", "data visualization", interactive mapping", "synthetic biology", "research and development", "R&D" "patent", "patent applications", "technology clusters", "Science Technology and Innovation", "STI", "science, technology engineering and mathematics", "STEM", "smart specialization, "technology parks", "PEDs", "Global collaboration in scientific research", "biotech", "digital technologies", "nano-tech", "green technologies", "smart agriculture", "smart electricity grids", "solar energy", "smart grids", "solar desalination", "energy efficiency"
Indirect drivers: Institutions and governance	"common-pool resource", "collective property", "local institutions", "local natural resources", "social networks", "collective tenure", "corruption", "revolving doors", "political stability", "state take-over by corporations", "Voluntary Partnership Agreements", "VPAs", "co-management", "common rights", "human communities", "local human communities" , "collective rights", "informal governance", "collective action", "collaboration", "coordination", "community lands", , "common-property regimes", "land rights", "land tenure", "community-based management", "social capital", "local institutions", "collective ejido tenure", "governance", "small scale fisheries", "public participation", "forest certification", "FSC", "Stewardship", "certification", "Market-based certification", "Marine Stewardship Council", "FSC Certified Forest Area", "certification principles", "certification standards", "environmental policy", "conservation policy", "local government", "national government", "policy choices", "policies", "political decisions", "climate-change policy", "environmental policies", "natural resource policies", "policy solutions", "environmental regulations", "environmental laws", "Payments for Ecosystem Services", "Payments for Environmental Services" "biodiversity offset", "environmental taxes", "policy spillovers", "policy instruments", "carbon taxes", "carbon tax", "cap-and-trade", "natural gas taxes", "trade tariffs", "agricultural subsidies", "Global North", "Global South", "world heritages sites", "international convention", "CITES", "CBD", "IPCC", "global coordination", "global resource domains", "Ramsar sites", "United Nations Framework Convention on Climate Change", "Montreal Protocol", "Convention Biological Diversity", "Conservation of Antarctic Marine Living Resources", "Nagoya Protocol", "International cooperation", "Ramsar Convention on Wetlands of International Importance", "Wetland Convention", "global treaties", "global agreements", "The Helsinki Rules on Uses of the Waters of International Rivers", "International Law Association", "Johnston Agreement", "Indus Waters Treaty", "Convention on the Protection and Use of Transboundary Watercourses and International Lakes", "International Council for the Exploration of the Sea", "Regional Fisheries Management Organizations", "RFMOs", "United Nations Conference on the Law of the Sea", "United Nations Convention on Fishing and Conservation of Living Resources of the High Seas", "Convention on the

	Conservation of Antarctic Marine Living Resources", "Kyoto Protocol", "CITES", "program to monitor the illegal killing of elephants", "IUCN", "International Union for Conservation of Nature", "Roundtable for Sustainable Palm Oil", "RSPO", "REDD+", "REDD", "Reducing emissions from deforestation and forest degradation", "Indigenous Peoples and Local Communities, IPLC"
Indirect drivers: Lifestyles and inequalities	"human well-being", "well-being", "wellbeing", "human wellbeing", "quality of life", "consumption lifestyles", "Western-style diets", "waste generation", "multidimensional poverty index", "MPI", "poverty", , "livelihoods", "food security", "access to water", "access to safe drinking water", "maternal mortality", "child mortality", "death of children under five", "access to sanitation", "access to electricity", "local livelihoods", "inequality", "social inequality", "environmental justice", "environmental inequities", "environmental hazards", "human footprint", "human footprint index", "water footprint", "GDP per capita", "the Human Development Index", "HDI", "OECD's Better Life Index", "GPI", "Genuine progress indicator", "least developed countries", "LDCs", "access to reproductive health care services", "life expectancy", "under-five mortality rate", "physical security", "food security", "water security", "energy security"
Indirect drivers: Values	"multiple values of nature", "nature contributions to people", "nature's benefits", "nature's benefits to people", "good quality of life", "instrumental values", "monetary value", "materialist view", "environmental values", "nature-based spiritualities", "inherent values", "intrinsic values", "relational values", "biocultural diversity", "biophilia", "sense of place", "sense of community", "self-determination", "sacred sites", "totemic beings", "spiritual well-being", "intra-generational equity", "inter-generational equity", "plural values", "sacred space", "worldviews", "expressions of value preferences", "moral judgments", "cosmocentric", "biocentric", "biocentrism", "ecocentric", "good quality of life" "animal welfare", "animal rights", "anthropocentric values", "non-anthropocentric values" "human thought", "human emotion", "human expression", "human behavior", "cultural heritage", "economic potential", "biological uniqueness", "ecotourism", "psychological benefits", "bequest value" "rights to nature", "indigenous and local knowledge", "ILK", "cultural diversity", "traditions", "rituals", "mother earth rights", "living well", "ecological solidarity", "systems of life", "customary uses", "social capital", "indigenous peoples", "indigenous communities", "shared norms", "stewardship", "community cohesion", "social resilience",).
Indirect drivers: Development pathways	"feedbacks", "negative loop holes", "integrated approaches", "integrated decision making", "multiple sources of uncertainty", "regime shifts", "interactions drivers", "negative loop holes", "abrupt changes", "persistent changes", "algae dominated reefs", "productivity decline", "hypoxia", "arctic sea ice", "tipping point", "tipping points", "lifeless zones", "non-linear change", "arctic regime shifts", "loss of ecosystem services", "biodiversity loss", "cultural identity loss", "loss of species richness", "local knowledge loss", "land abandonment", "biodiversity degradation", "violent conflict", "environmental conflicts", "mining conflicts", "unsustainable land management", "water depletion", "eutrophication", "hypertrophication", "resistance to antibiotics", "chronic diseases", "epidemic outbreaks", "infectious diseases", "cardiovascular diseases", "respiratory diseases", "pneumonia", "diarrheal diseases", "health impacts", "global health threats", "vulnerability", "human appropriation", "human appropriation of net primary production", "HANPP", "anthropogenic

	impacts", "water shortages", "water scarcity", "cumulative environmental impacts", "transboundary use of resources", "social-ecological resilience", "sustainability", "social sustainability", "economic sustainability", "ecological sustainability", "tele coupling", "teleconnections", "embedded flows"

5. Data acquisition

5.1. Core and highlighted IPBES indicators

We worked closely with the Knowledge and Data Technical Support Unit of IPBES (K&DTSU) to gather data on all relevant core and highlighted indicators for which data was readily available https://www.ipbes.net/indicators. Through the K&DTSU we requested the data that was not readily available from data providers with no success.

5.2. Publicly available data

We identified additional publicly available data from globally recognized resources: World Bank, OECD, FAO, UNDP, NASA. Additionally, we identified particularly relevant public data sources supported by Universities or well-known organizations on specific topics such as the material flows data base http://www.materialflows.net/materialflowsnet/data/data-download/.

5.3. Data bases contributed by contributing authors

Some CAs provided data bases that were supported by their publications.

6. Data analysis

6.1. Trends

Temporal trends within 1960 and 2015 where calculated for all the available variables for the available dates. Global averages or totals, as well as averages among countries grouped into World Bank Income Levels (see 6 below https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups), and IPBES regions (see 6 below and https://www.ipbes.net/dataset/ipbes-regions-subregions).

Two different procedures were applied to individual country data. We only included countries with more than 5 years of temporal data onwards.

Doted lines in trends figures represent periods for which either no data is available between the two extremes of the dotted line, or those for which the data presents very large variability respective to that found in other periods within the same figure.

Synthesis figures with multiple variables with the same axis were prepared by standardizing the response variables relative to a same shared year, for which a value of 1 (or 100) was used as reference for all the variables.

The pollution indicators uses best available data on emissions of pollutants into the air, water and soil: fertilizer use, lack of sanitation, greenhouse gas emission, municipal waste production (per capita*population), pesticides use, air pollution by PM2.5 particles. Trends in pollution were based on a synthesis indicator for which each of the above variables are standardized using a value of 1 for the year 2000. Trends in air pollution, using only data on greenhouse gas emissions and PM2.5 particles

6.2. Maps

6.2.1. Static

Selected variables were represented into maps for most recently available year.

6.2.2. Trends

Temporal trends of different metrics (i.e., variables of economic development, globalization, air pollution, material extraction) were calculated for each country, using linear regression against time (measured in years). Countries with insufficient data to calculate the regressions were excluded. The slopes of these regressions were binned among countries using natural breaks and the resultant bins were displayed in choropleth maps. To aggregate different variables into a single metric, the slopes of the regressions for each variable were first standardized across countries and then averaged among the variables to be aggregated. These averages (in units of standard deviation) were then binned among countries using natural breaks and the resultant bins were displayed in choropleth maps.

The speed of temperature change (km yr-1) was calculated based on 30-arcsec WorldClim Version 1.4 Annual Mean Temperature and Total Annual Precipitation bioclimatic variable using the methods described in (Loarie et al., 2009).

Changes in the proportion of land cover in Urban and Cultivated Areas between year 1992 and year 2015 were calculated using the changes in the proportion of ESA CCI LandCover in Urban (class value 190) and Cultivate Areas (Class values 10, 20, 30, and 40) in

gradients of white (no change) to dark red (100%). The proportion calculated based on the number of Urban and Cultivated 300m cells within a grid of 10km.

The increase in total numbers of established alien species from 1950 to 2000. Species numbers are indicated by color and additionally by circle size for islands with small land areas. The years of first record of an alien species in a country or on an island are obtained from the recent version of the Alien Species First Record Database (Seebens et al., 2018).

6.3. Meta-analysis

A preliminary meta-analysis was undertaken to compare among countries, classified into income categories or into IPBES regions, the rate of change from 1980 to 2015 of the response variables assessed, measured in some quantitative scale. We used in this pilot analysis the total biomass extraction, GDP and air departures.

From the raw mean for each quantitative variable in each country we estimated the annual rate. We thus included these values in a random-effects mixed model to evaluate differences among income country groups (Koricheva et al., 2013). Models assumed a normal distribution of data and a constant annual rate, through time. Each variable was analyzed through its corresponding period of time (which varies among 1960 – 2016, 1980 – 2013, and other periods).

Figures show the predicted annual rates by the meta-analytic model. All figures show mean values and standard errors. The dotted line represents global values. Standard errors that not overlap mean statistical differences with $p < 0.05$. We used the metaphor package in R (Viechtbauer, 2010).

We must further check for ratio scale measurements for nonlinear variables (many could be nonlinear. For ratio scale measurements, the log transformed mean or the log transformed coefficient of variation (with bias correction) may also be of interest (Nakagawa et al., 2017). We also need checking by sample size (number of countries in each income category), but at least at this point results are strong evident.

6.4. Synthesis pathways

All the quantitative and qualitative information gathered along the chapter was summarized in two synthesis figures. They emphasize the mains contrasts in development pathways and consequences for nature among higher income and lower income countries.

7. Data sources

Table 2. The indicators used and the data sources

Indicator	Data source	Description of the indicator
GDP	https://data.worldbank.org/indicator/NY.GDP.MKTP.CD	GDP at purchasers prices is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. Data are in current U.S. dollars. Dollar figures for GDP are converted from domestic currencies using single year official exchange rates. For a few countries where the official exchange rate does not reflect the rate effectively applied to actual foreign exchange transactions, an alternative conversion factor is used.
Globalization index	https://www.kof.ethz.ch/en/forecasts-and-indicators/indicators/kof-globalisation-index.html	The KOF Globalization Index measures the economic, social and political dimensions of globalization. Globalization in the economic, social and political fields has been on the rise since the 1970s, receiving a particular boost after the end of the Cold War.
Poverty gap	https://data.worldbank.org/indicator/SI.POV.GAPS	Average of Poverty headcount ratio at $1.90 a day is the percentage of the population living on less than $1.90 a day at 2011 international prices. As a result of revisions in PPP exchange, from 1986 to 2015
Food Security Index	http://foodsecurityindex.eiu.com/	The Global Food Security Index considers the core issues of affordability, availability, and quality across a set of 113 countries. The index is a dynamic quantitative and qualitative benchmarking model, constructed from 28 unique indicators, that measures these drivers of food security across both developing and developed countries. This index is the first to examine food security comprehensively across the three internationally established dimensions. Moreover, the study looks beyond hunger to the underlying factors affecting food insecurity. This year the GFSI includes an adjustment factor on natural resources and resilience. This new category assesses a country's exposure to the impacts of a changing climate; its susceptibility to natural resource risks; and how the country is adapting to these risks.
Depth of the food deficit (kcal/capita/day) (3-year average)	https://landportal.org/book/indicators/indfaofsec6	The depth of the food deficit indicates how many calories would be needed to lift the undernourished from their status, everything else being constant. The average intensity of food deprivation of the undernourished, estimated as the difference between the average dietary energy requirement and the average dietary energy consumption of the undernourished population (food-deprived), is multiplied by the number of undernourished to provide an estimate of the total food deficit in the country, which is then normalized by the total population.

Indicator	Data source	Description of the indicator
Access to improved sanitation facilities	https://data.worldbank.org/indicator/SH.STA.SMSS.ZS	The percentage of people using improved sanitation facilities that are not shared with other households and where excreta are safely disposed of in situ or transported and treated offsite. Improved sanitation facilities include flush/pour flush to piped sewer systems, septic tanks or pit latrines: ventilated improved pit latrines, compositing toilets or pit latrines with slabs
Domestic Material Consumption	http://www.materialflows.net/materialflowsnet/data/data-download/	This category refers to the origin and/or destination of material flows, as materials used by the economy can either be extracted from the domestic territory or imported from other countries. Note that for the categories of unused and indirect material flows related to internationally traded products, the terms „ecological rucksacks" and „hidden flows" are also used.
per capita calorie intake	https://ourworldindata.org/food-per-person	The Coefficient of Variation (CV) of the per capita caloric intake in a given population. The coefficient variation (CV)measures the inequality of caloric intake across a given population. It represents the a statistical measure of the dataspread around the mean caloric intake. Higher CV values represent larger levels of dietary inequality. The CV of caloricintake is reported only for developing countries within the Food Security Indicators
Prevalence of obesity in the adult population (18 years and older)	https://ourworldindata.org/obesity	Percentage of adults aged 18+ years old who are defined as obese based on their body-mass index (BMI). BMI is aperson's weight in kilograms (kg) divided by his or her height in metres squared. A BMI >30 is defined as obese.
Energy use (kg of oil equivalent per capita)	https://data.worldbank.org/indicator/EG.USE.PCAP.KG.OE?view=chart	Energy use refers to use of primary energy before transformation to other end-use fuels, which is equal to indigenous production plus imports and stock changes, minus exports and fuels supplied to ships and aircraft engaged in international transport
Mobile cellular subscriptions	https://data.worldbank.org/indicator/IT.CEL.SETS.P2?	Mobile cellular telephone subscriptions are subscriptions to a public mobile telephone service that provide access to the PSTN using cellular technology. The indicator includes (and is split into) the number of postpaid subscriptions, and the number of active prepaid accounts (i.e. that have been used during the last three months). The indicator applies to all mobile cellular subscriptions that offer voice communications. It excludes subscriptions via data cards or USB modems, subscriptions to public mobile data services, private trunked mobile radio, telepoint, radio paging and telemetry services.

Indicator	Data source	Description of the indicator
Fossil fuel energy consumption (% of total)	https://data.worldbank.org/indicator/EG.USE.COMM.FO.ZS?view=chart	Fossil fuel comprises coal, oil, petroleum, and natural gas products
Renewable electricity consumption (% of total electricity output)	https://data.worldbank.org/indicator/EG.ELC.RNEW.ZS?view=chart	Renewable electricity is the share of electrity generated by renewable power plants in total electricity generated by all types of plants
Electric power consumption (kWh per capita)	https://data.worldbank.org/indicator/EG.USE.ELEC.KH.PC?view=chart	Electric power consumption measures the production of power plants and combined heat and power plants less transmission, distribution, and transformation losses and own use by heat and power plants.
Access to electricity	https://data.worldbank.org/indicator/EG.ELC.ACCS.ZS?view=chart	Access to electricity is the percentage of population with access to electricity. Electrification data are collected from industry, national surveys and international sources.
Alternative and nuclear energy (% of total energy use)	https://data.worldbank.org/indicator/EG.USE.COMM.CL.ZS?view=chart	Clean energy is noncarbohydrate energy that does not produce carbon dioxide when generated. It includes hydropower and nuclear, geothermal, and solar power, among others.
Protein intake per country per person	http://chartsbin.com/view/1155	This map shows dietary protein consumption per person. The dietary protein consumption per person is the amount of protein in food, in grams per day, for each individual in the total population.
Energy supply derived from cereals, roots and tubers	http://www.fao.org/faostat/en/#data/FS	For detailed description of the indicators below see attached document: Average Dietary Supply Adequacy; Average Value of Food Production; Share of Dietary Energy Supply Derived from Cereals, Roots and Tubers; Average Protein Supply; Average Supply of Protein of Animal Origin; Percent of paved roads over total roads; Road Density (per 100 square km of land area); Rail lines Density (per 100 square km of land area); Domestic Food Price Level Index; Percentage of Population with Access to Improved Drinking Water Sources; Percentage of Population with Access to Sanitation Facilities; Cereal Import Dependency Ratio; Percent of Arable Land Equipped for Irrigation; Value of Food Imports in Total Merchandise

Indicator	Data source	Description of the indicator
		Exports; Political stability and absence of violence; Domestic Food Price Volatility Index; Per capita food production variability; Per capita food supply variability; Prevalence of Undernourishment; Share of Food Expenditures of the Poor; Depth of the Food Deficit; Prevalence of Food Inadequacy; Children aged <5 years wasted (%); Children aged <5 years stunted (%); Children aged <5 years underweight (%); Percentage of adults underweight in total adult population; Prevalence of anaemia among children under 5 years of age; Prevalence of Vitamin A deficiency in the population; Prevalence of Iodine deficiency; Prevalence of anaemia among pregnant women; Number of people undernourished; Minimum Dietary Energy Requirement (MDER); Average Dietary Energy Requirement (ADER); "Minimum Dietary Energy Requirement (MDER) - PAL 1.75"; Coefficient of variation of habitual caloric consumption distribution (CV); Skewness of habitual caloric consumption distribution (SK); Incidence of caloric losses at retail distribution level; Dietary Energy Supply (DES); Average Fat Supply
People per ouletlet McDonal´s	https://en.wikipedia.org/wiki/List_of_countries_with_McDonald%27s_restaurants	This is a listing of countries with McDonald's restaurants. McDonald's is the largest chain of fast food restaurants in the world. It has more than 35,000 outlets worldwide. The majority of McDonald's outlets outside of the United States are franchises. The biggest temporary McDonald's restaurant in the world was opened during 2012 Summer Olympics in London, which had 3,000 square metres (32,000 sq ft) The biggest still standing one is probably that at Will Rogers Turnpike. The list of countries follows the company's own calculation, and contains several non-sovereign territories.
Population growth (annual %)	https://data.worldbank.org/indicator/SP.POP.GROW?view=chart	Annual population growth rate for year t is the exponential rate of growth of midyear population from year t-1 to t, expressed as a percentage . Population is based on the de facto definition of population, which counts all residents regardless of legal status or citizenship
Population density	https://data.worldbank.org/indicator/EN.POP.DNST	Population density is midyear population divided by land area in square kilometers. Population is based on the de facto definition of population, which counts all residents regardless of legal status or citizenship--except for refugees not permanently settled in the country of asylum, who are generally considered part of the population of their country of origin. Land area is a countrys total area, excluding area under inland water bodies, national claims to continental shelf, and exclusive

Indicator	Data source	Description of the indicator
		economic zones. In most cases the definition of inland water bodies includes major rivers and lakes
Child mortality rate	https://data.worldbank.org/indicator/SH.DYN.MORT	Mortality rate, under-5 (per 1,000 live births) Under-five mortality rate is the probability per 1,000 that a newborn baby will die before reaching age five, if subject to age-specific mortality rates of the specified year.
Urban Population Total	https://data.worldbank.org/indicator/SP.URB.TOTL.IN.ZS?view=chart	Urban population refers to people living in urban areas as defined by national statistical offices. The data are collected and smoothed by United Nations Population Division.
International migrant stock	https://data.worldbank.org/indicator/SM.POP.TOTL?view=chart	International migrant stock is the number of people born in a country other than that in which they live. It also includes refugees. The data used to estimate the international migrant stock at a particular time are obtained mainly from population censuses. The estimates are derived from the data on foreign-born population--people who have residence in one country but were born in another country. When data on the foreign-born population are not available, data on foreign population--that is, people who are citizens of a country other than the country in which they reside--are used as estimates. After the breakup of the Soviet Union in 1991 people living in one of the newly independent countries who were born in another were classified as international migrants. Estimates of migrant stock in the newly independent states from 1990 on are based on the 1989 census of the Soviet Union. For countries with information on the international migrant stock for at least two points in time, interpolation or extrapolation was used to estimate the international migrant stock on July 1 of the reference years. For countries with only one observation, estimates for the reference years were derived using rates of change in the migrant stock in the years preceding or following the single observation available. A model was used to estimate migrants for countries that had no data.
Refugee population	https://data.worldbank.org/indicator/SM.POP.REFG?view=chart	Refugee population by country or territory of origin. Refugees are people who are recognized as refugees under the 1951 Convention Relating to the Status of Refugees or its 1967 Protocol, the 1969 Organization of African Unity Convention Governing the Specific Aspects of Refugee Problems in Africa, people recognized as refugees in accordance with the UNHCR statute, people granted refugee-like humanitarian status, and people provided temporary protection. Asylum seekers--people who have applied for asylum or refugee status and who have not yet received a decision or who are registered as asylum seekers--are excluded. Palestinian refugees are people (and

Indicator	Data source	Description of the indicator
		their descendants) whose residence was Palestine between June 1946 and May 1948 and who lost their homes and means of livelihood as a result of the 1948 Arab-Israeli conflict. Country of origin generally refers to the nationality or country of citizenship of a claimant.
Migration Net	https://data.worldbank.org/indicator/SM.POP.NETM	Net migration is the net total of migrants during the period, that is, the total number of immigrants less the annual number of emigrants, including both citizens and noncitizens. Data are five-year estimates.
Population in the largest city	https://data.worldbank.org/indicator/EN.URB.LCTY.UR.ZS?view=chart	Population in largest city is the percentage of a country's urban population living in that country's largest metropolitan area.
Population in megacities	https://data.worldbank.org/indicator/EN.URB.MCTY.TL.ZS?view=chart	Population in urban agglomerations of more than one million is the percentage of a country's population living in metropolitan areas that in 2000 had a population of more than one million people.
GDP per capita	https://data.worldbank.org/indicator/NY.GDP.MKTP.CD	GDP per capita is gross domestic product divided by midyear population. GDP is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. Data are in current U.S. dollars.
Agrucultural land	https://data.worldbank.org/indicator/AG.LND.AGRI.ZS	Agricultural land refers to the share of land area that is arable, under permanent crops, and under permanent pastures. Arable land includes land defined by the FAO as land under temporary crops (double-cropped areas are counted once), temporary meadows for mowing or for pasture, land under market or kitchen gardens, and land temporarily fallow. Land abandoned as a result of shifting cultivation is excluded. Land under permanent crops is land cultivated with crops that occupy the land for long periods and need not be replanted after each harvest, such as cocoa, coffee, and rubber. This category includes land under flowering shrubs, fruit trees, nut trees, and vines, but excludes land under trees grown for wood or timber. Permanent pasture is land used for five or more years for forage, including natural and cultivated crops.
livestock indigenous animals	http://www.fao.org/faostat/en/#data/TA	The food and agricultural trade dataset is collected, processed and disseminated by FAO according to the standard International Merchandise Trade Statistics Methodology. The data is mainly provided by UNSD, Eurostat, and other national authorities as needed. This source data is checked for outliers, trade partner data is used for non-reporting countries or missing

Indicator	Data source	Description of the indicator
		cells, and data on food aid is added to take into account total cross-border trade flows. The trade database includes the following variables: export quantity, export value, import quantity and import value. The trade database includes all food and agricultural products imported/exported annually by all the countries in the world
livestock density of cattle	http://www.fao.org/faostat/en/#data/TA	The food and agricultural trade dataset is collected, processed and disseminated by FAO according to the standard International Merchandise Trade Statistics Methodology. The data is mainly provided by UNSD, Eurostat, and other national authorities as needed. This source data is checked for outliers, trade partner data is used for non-reporting countries or missing cells, and data on food aid is added to take into account total cross-border trade flows. The trade database includes the following variables: export quantity, export value, import quantity and import value. The trade database includes all food and agricultural products imported/exported annually by all the countries in the world
livestock density of animals (chickens)	http://www.fao.org/faostat/en/#data/TA	The food and agricultural trade dataset is collected, processed and disseminated by FAO according to the standard International Merchandise Trade Statistics Methodology. The data is mainly provided by UNSD, Eurostat, and other national authorities as needed. This source data is checked for outliers, trade partner data is used for non-reporting countries or missing cells, and data on food aid is added to take into account total cross-border trade flows. The trade database includes the following variables: export quantity, export value, import quantity and import value. The trade database includes all food and agricultural products imported/exported annually by all the countries in the world
agricultural organic area	http://www.fao.org/faostat/en/#data/RL	Total agricultural area organic calculated in square kilometer from 2005 and the change in 2015
Agricultural land	https://data.worldbank.org/indicator/%20AG.LND.AGRI.ZS	Agricultural land refers to the share of land area that is arable, under permanent crops, and under permanent pastures. Arable land includes land defined by the FAO as land under temporary crops (double-cropped areas are counted once), temporary meadows for mowing or for pasture, land under market or kitchen gardens, and land temporarily fallow. Land abandoned as a result of shifting cultivation is excluded. Land under permanent crops is land cultivated with crops that occupy the land for long periods and need not be replanted after each harvest, such as cocoa, coffee, and rubber. This category includes land under flowering shrubs, fruit trees, nut trees, and

Indicator	Data source	Description of the indicator
		vines, but excludes land under trees grown for wood or timber. Permanent pasture is land used for five or more years for forage, including natural and cultivated crops.
International tourism, number of departures	https://data.worldbank.org/indicator/ST.INT.DPRT?view=chart	International outbound tourists are the number of departures that people make from their country of usual residence to any other country for any purpose other than a remunerated activity in the country visited. The data on outbound tourists refer to the number of departures, not to the number of people traveling. Thus a person who makes several trips from a country during a given period is counted each time as a new departure.
International tourism, number of arrivals	https://data.worldbank.org/indicator/ST.INT.ARVL	International inbound tourists (overnight visitors) are the number of tourists who travel to a country other than that in which they have their usual residence, but outside their usual environment, for a period not exceeding 12 months and whose main purpose in visiting is other than an activity remunerated from within the country visited. When data on number of tourists are not available, the number of visitors, which includes tourists, same-day visitors, cruise passengers, and crew members, is shown instead. Sources and collection methods for arrivals differ across countries. In some cases data are from border statistics (police, immigration, and the like) and supplemented by border surveys. In other cases data are from tourism accommodation establishments. For some countries number of arrivals is limited to arrivals by air and for others to arrivals staying in hotels. Some countries include arrivals of nationals residing abroad while others do not. Caution should thus be used in comparing arrivals across countries. The data on inbound tourists refer to the number of arrivals, not to the number of people traveling. Thus a person who makes several trips to a country during a given period is counted each time as a new arrival.
Container port traffic (TEU: 20 foot equivalent units)	https://data.worldbank.org/indicator/IS.SHP.GOOD.TU?view=chart	Port container traffic measures the flow of containers from land to sea transport modes., and vice versa, in twenty-foot equivalent units (TEUs), a standard-size container. Data refer to coastal shipping as well as international journeys. Transshipment traffic is counted as two lifts at the intermediate port (once to off-load and again as an outbound lift) and includes empty units.
Air passengers	https://data.worldbank.org/indicator/IS.AIR.PSGR	Air passengers carried include both domestic and international aircraft passengers of air carriers registered in the country.
Air departures	https://data.worldbank.org/indicator/IS.AIR.DPRT	Registered carrier departures worldwide are domestic takeoffs and takeoffs abroad of air carriers registered in the country.

Indicator	Data source	Description of the indicator
Deaths from air pollution	https://ourworldindata.org/air-pollution	Population-weighted exposure to ambient PM2.5 pollution is defined as the average level of exposure of a nation's population to concentrations of suspended particles measuring less than 2.5 microns in aerodynamic diameter, which are capable of penetrating deep into the respiratory tract and causing severe health damage. Exposure is calculated by weighting mean annual concentrations of PM2.5 by population in both urban and rural areas.
GHG emissions (in tonnes CO2 eq and tonnes per capita)	https://data.oecd.org/air/air-and-ghg-emissions.htm	Greenhouse gases refer to the sum of seven gases that have direct effects on climate change : carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), chlorofluorocarbons (CFCs), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluoride (SF6) and nitrogen trifluoride (NF3). The data are expressed in CO2 equivalents and refer to gross direct emissions from human activities. CO2 refers to gross direct emissions from fuel combustion only and data are provided by the International Energy Agency. Other air emissions include emissions of sulphur oxides (SOx) and nitrogen oxides (NOx) given as quantities of SO2 and NO2, emissions of carbon monoxide (CO), and emissions of volatile organic compounds (VOC), excluding methane. Air and greenhouse gas emissions are measured in thousand tonnes, tonnes per capita or kilogrammes per capita except for CO2, which is measured in million tonnes and tonnes per capita
Pesticides used per unit area	http://www.fao.org/faostat/en/#data/EP	The indicator is defined as the annual agricultural use of total pesticides (Fungicides & Bactericides, Herbicides, Insecticides, Plant Growth Regulators, Seed Treatment Fungicides, Seed Treatment Insecticides, Mineral Oils, Rodenticides, and Disinfectants) divided by the area of croplands (arable and permanent crops)
Fertilizers used per unit area	https://data.worldbank.org/indicator/AG.CON.FERT.ZS?view=chart	Fertilizer consumption measures the quantity of plant nutrients used per unit of arable land. Fertilizer products cover nitrogenous, potash, and phosphate fertilizers (including ground rock phosphate). Traditional nutrients--animal and plant manures--are not included. For the purpose of data dissemination, FAO has adopted the concept of a calendar year (January to December). Some countries compile fertilizer data on a calendar year basis, while others are on a split-year basis. Arable land includes land defined by the FAO as land under temporary crops (double-cropped areas are counted once), temporary meadows for mowing or for pasture, land under market or kitchen gardens, and land temporarily fallow. Land abandoned as a result of shifting cultivation is excluded.

Indicator	Data source	Description of the indicator
Air pollution	https://ourworldindata.org/air-pollution	Air pollution is perceived as a modern-day curse: a by-product of increasing urbanization and industrialization. It does, however, have a long and evolving history with interesting transitions in line with economic, technological and political change. This entry presents a global-level overview of air pollution: trends in emissions from historical through to the present day, the health and mortality burden and risk from air pollution, and discussion of some of the key correlations and determinants of the severity of pollution and its impacts. Air pollution occurs in indoor (e.g. household) contexts and outdoor environments—this data entry focuses on ambient outdoor pollution. The data entry for indoor pollution can be found here. Air pollution can be defined as the emission of harmful substances to the atmosphere. This broad definition therefore encapsulates a number of pollutants, including: sulphur dioxide (SO2), nitrogen oxides (NOx), ozone (O3), particulate matter (small suspended particles of varying sizes), carbon monoxide (CO) and volatile organic compounds (VOCs).
Nitrogene n deposition trends	https://www.sciencedirect.com/science/article/pii/S1352310140050007	Atmospheric deposition to forests has been monitored within the International Cooperative Programme on Assessment and Monitoring of Air Pollution Effects on Forests (ICP Forests) with sampling and analyses of bulk precipitation and throughfall at several hundred forested plots for more than 15 years. The current deposition of inorganic nitrogen (nitrate and ammonium) and sulphate is highest in central Europe as well as in some southern regions.
GHG emissions change	https://data.worldbank.org/indicator/EN.ATM.GHGT.ZG	Total greenhouse gas emissions are composed of CO2 totals excluding short-cycle biomass burning (such as agricultural waste burning and Savannah burning) but including other biomass burning (such as forest fires, post-burn decay, peat fires and decay of drained peatlands), all anthropogenic CH4 sources, N2O sources and F-gases (HFCs, PFCs and SF6). Each year of data shows the percentage change to that year from 1990.
Extraction ores	http://www.materialflows.net/materialflowsnet/data/data-download/	The category of used materials is defined as the amount of extracted resources, which enters the economic system for further processing or direct consumption. All used materials are transformed within the economic system. Unused extraction refers to materials that never enter the economic system and comprises overburden and parting materials from mining, by-

Indicator	Data source	Description of the indicator
		catch from fishing, wood and agricultural harvesting losses, as well as soil excavation and dredged materials from construction activities.
Extraction all of biomass	http://www.materialflows.net/materialflowsnet/data/data-download/	The category of used materials is defined as the amount of extracted resources, which enters the economic system for further processing or direct consumption. All used materials are transformed within the economic system. Unused extraction refers to materials that never enter the economic system and comprises overburden and parting materials from mining, by-catch from fishing, wood and agricultural harvesting losses, as well as soil excavation and dredged materials from construction activities.
Extraction of ind. & const. minerals	http://www.materialflows.net/materialflowsnet/data/data-download/	The category of used materials is defined as the amount of extracted resources, which enters the economic system for further processing or direct consumption. All used materials are transformed within the economic system. Unused extraction refers to materials that never enter the economic system and comprises overburden and parting materials from mining, by-catch from fishing, wood and agricultural harvesting losses, as well as soil excavation and dredged materials from construction activities.
Extraction biomass food	http://www.materialflows.net/materialflowsnet/data/data-download/	The category of used materials is defined as the amount of extracted resources, which enters the economic system for further processing or direct consumption. All used materials are transformed within the economic system. Unused extraction refers to materials that never enter the economic system and comprises overburden and parting materials from mining, by-catch from fishing, wood and agricultural harvesting losses, as well as soil excavation and dredged materials from construction activities.
Extraction Biomass Forstry	http://www.materialflows.net/materialflowsnet/data/data-download/	The category of used materials is defined as the amount of extracted resources, which enters the economic system for further processing or direct consumption. All used materials are transformed within the economic system. Unused extraction refers to materials that never enter the economic system and comprises overburden and parting materials from mining, by-catch from fishing, wood and agricultural harvesting losses, as well as soil excavation and dredged materials from construction activities.
Extraction biomass feed	http://www.materialflows.net/materialflowsnet/data/data-download/	The category of used materials is defined as the amount of extracted resources, which enters the economic system for further processing or direct consumption. All used materials are transformed within the economic system. Unused extraction refers to materials that never enter the economic system and

Indicator	Data source	Description of the indicator
		comprises overburden and parting materials from mining, by-catch from fishing, wood and agricultural harvesting losses, as well as soil excavation and dredged materials from construction activities.
Extraction biomass animals	http://www.materialflows.net/materialflowsnet/data/data-download/	The category of used materials is defined as the amount of extracted resources, which enters the economic system for further processing or direct consumption. All used materials are transformed within the economic system. Unused extraction refers to materials that never enter the economic system and comprises overburden and parting materials from mining, by-catch from fishing, wood and agricultural harvesting losses, as well as soil excavation and dredged materials from construction activities.
Extraction other biomass	http://www.materialflows.net/materialflowsnet/data/data-download/	The category of used materials is defined as the amount of extracted resources, which enters the economic system for further processing or direct consumption. All used materials are transformed within the economic system. Unused extraction refers to materials that never enter the economic system and comprises overburden and parting materials from mining, by-catch from fishing, wood and agricultural harvesting losses, as well as soil excavation and dredged materials from construction activities.
Extraction fossil fuel	http://www.materialflows.net/materialflowsnet/data/data-download/	
Water withdrawal	https://data.oecd.org/water/water-withdrawals.htm	Water withdrawals, or water abstractions, are defined as freshwater taken from ground or surface water sources, either permanently or temporarily, and conveyed to a place of use. If the water is returned to a surface water source, abstraction of the same water by the downstream user is counted again in compiling total abstractions: this may lead to double counting. The data include abstractions for public water supply, irrigation, industrial processes and cooling of electric power plants. Mine water and drainage water are included, whereas water used for hydroelectricity generation is normally excluded. This indicator is measured in m^3 per capita (a cubic meter is the equivalent of one thousand 1-liter bottles).
Renewable internal freshwater resource	https://data.worldbank.org/indicator/ER.H2O.INTR.K3?view=chart	Renewable internal freshwater resources flows refer to internal renewable resources (internal river flows and groundwater from rainfall) in the country.
Agricultural water	http://www.fao.org/nr/water/aquastat/data/query/results.html?regionQ	FAO works to promote coherent approaches to sustainable land and water management.

Indicator	Data source	Description of the indicator
withdrawal	uery=true&yearGrouping=SURVEY&showCodes=false&yearRange.fromYear=1958&yearRange.toYear=2017&varGrpIds=4250%2C4251%2C4252%2C4253%2C4257&cntIds=&regIds=9805%2C9806%2C9807%2C9808%2C9809&edit=0&save=0&query_type=WUpage&lowBandwidth=1&newestOnly=true&_newestOnly=on&showValueYears=true&_showValueYears=on&categoryIds=-1&_categoryIds=1&XAxis=VARIABLE&showSymbols=true&_showSymbols=on&_hideEmptyRowsColoumns=on&lang=en	FAO's work in land and water is relevant to several dimensions of sustainable development, such as the governance and management of food production systems; the provision of essential ecosystem services; food security; human health; biodiversity conservation; and the mitigation of, and adaptation to, climate change.
The Ramsar Sites	https://rsis.ramsar.org/ris-search/?solrsort=area_off_d%20desc&pagetab=3&f%5B0%5D=regionCountry_en_ss%3AEurope&f%5B1%5D=regionCountry_en_ss%3ALatin%20America%20and%20the%20Caribbean	The Ramsar List was established in response to Article 2.1 of the Convention on Wetlands (Ramsar, Iran, 1971), which reads: "Each Contracting Party shall designate suitable wetlands within its territory for inclusion in a List of Wetlands of International Importance, hereinafter referred to as 'the List' which is maintained by the bureau [secretariat of the Convention] established under Article 8."
Certified Forest Area	http://www.fao.org/faostat/en/#data/EL	The statistics from the Agri-environmental indicator – Land Use domain are calculated based on the data taken from FAOSTAT Inputs – Land domain (http://www.fao.org/faostat/en/#data/RL). The indicator describes shares of different land use categories at national, regional and global levels over time for the following elements (in %): i) Share in Land area; ii) Share in Agricultural area and iii) Share in Forest area. The indicators were co-developed by FAO, OECD and EUROSTAT. The time-series coverage of the indicators depends on the land use category used to compute them. For the agricultural area, data are available for

Indicator	Data source	Description of the indicator
		subcategories: arable land, permanent crops, permanent meadows and pastures, total area equipped for irrigation, in time series from the year 1961 onwards. Data for agricultural area actually irrigated are provided from 2001 onwards. For forest, data are available in time series from the year 1990 onwards for subcomponents: primary forest, other naturally regenerated forest, planted forest.
United Nations Framework Convention on Climate Change	https://treaties.un.org/Pages/ViewDetailsIII.aspx?src=IND&mtdsg_no=XXVII-7&chapter=27&Temp=mtdsg3&clang=_en	United Nations, Treaty Series , vol. 1771, p. 107; and depositary notifications C.N.148.1993.TREATIES-4 of 12 July 1993 (procès-verbal of rectification of the original texts of the Convention); C.N.436.1993.TREATIES-12 of 15 December 1993 (corrigendum to C.N.148.1993.TREATIES-4 of 12 July 1993); C.N.247.1993.TREATIES-6 of 24 November 1993 (procès-verbal of rectification of the authentic French text); C.N.462.1993.TREATIES-13 of 30 December 1993 (corrigendum to C.N.247.1993.TREATIES-6 of 24 November 1993); C.N.544.1997.TREATIES-6 of 13 February 1997 (amendment to the list in annex I to the Convention); and C.N.1478.2001.TREATIES-2 of 28 December 2001 (amendment to the list in annex II to the Convention); C.N.237.2010.TREATIES-2 of 26 April 2010 (adoption of amendment to the list in the Annex I to the Convention); C.N.355.2012.TREATIES-XXVII.7 of 9 July 2012 (adoption of amendment to Annex I to the Convention) and C.N.81.2013.TREATIES-XXVII.7 of 14 January 2013 (entry into force of amendment to Annex I to the Convention).
Convention of fishing and conservation of the living resources of the high seas	https://treaties.un.org/pages/ViewDetails.aspx?src=TREATY&mtdsg_no=XXI-3&chapter=21&clang=_en	This database contains: All multilateral treaties deposited with the Secretary-General (presently over 560 treaties); The Charter of the United Nations, in respect of which certain depositary functions have been conferred upon the Secretary-General (although the Charter itself is deposited with the Government of the United States of America); Multilateral treaties formerly deposited with the Secretary-General of the League of Nations, to the extent that formalities or decisions affecting them have been taken within the framework of the United Nations;1 and Certain pre-United Nations treaties, other than those formerly deposited with the Secretary-General of the League of Nations, which were amended by protocols adopted by the General Assembly of the United Nations.
Montreal Protocol	http://www.environment.gov.au/protection/ozone/montreal-	The Montreal Protocol is widely considered as the most successful environment protection agreement. The Protocol sets out a mandatory timetable for the phase out of ozone depleting

Indicator	Data source	Description of the indicator
	protocol/register-montreal-protocol-countries	substances. This timetable has been reviewed regularly, with phase out dates accelerated in accordance with scientific understanding and technological advances. The Montreal Protocol sets binding progressive phase out obligations for developed and developing countries for all the major ozone depleting substances, including CFCs, halons and less damaging transitional chemicals such as HCFCs.
Convention on Biological Diversity	https://www.cbd.int/information/parties.shtml	Signed by 150 government leaders at the 1992 Rio Earth Summit, the Convention on Biological Diversity is dedicated to promoting sustainable development. Conceived as a practical tool for translating the principles of Agenda 21 into reality, the Convention recognizes that biological diversity is about more than plants, animals and micro organisms and their ecosystems – it is about people and our need for food security, medicines, fresh air and water, shelter, and a clean and healthy environment in which to live.
Convention on the Conservation of Antarctic Marine Living Resources	https://www.ats.aq/devAS/ats_parties.aspx?lang=e	The original Signatories to the Treaty are the twelve countries that were active in Antarctica during the International Geophysical Year of 1957-58 and then accepted the invitation of the Government of the United States of America to participate in the diplomatic conference at which the Treaty was negotiated in Washington in 1959. These Parties have the right to participate in the meetings provided for in Article IX of the Treaty (Antarctic Treaty Consultative Meetings, ATCM). Since 1959, 41 other countries have acceded to the Treaty. According to Art. IX.2, they are entitled to participate in the Consultative Meetings during such times as they demonstrate their interest in Antarctica by "conducting substantial research activity there" . Seventeen of the acceding countries have had their activities in Antarctica recognized according to this provision, and consequently there are now twenty-nine Consultative Parties in all. The other 24 Non-Consultative Parties are invited to attend the Consultative Meetings but do not participate in the decision-making.
Credit to Agriculture, Forestry and Fishing	http://www.fao.org/faostat/en/#data/IC	The Credit to Agriculture dataset provides national data for over 100 countries on the amount of loans provided by the private/commercial banking sector to producers in agriculture, forestry and fisheries, including household producers, cooperatives, and agro-businesses. For some countries, the three subsectors of agriculture, forestry, and fishing are completely specified. In other cases, complete disaggregations are not available. The dataset also provides statistics on the total credit to all industries, indicators on the share of credit to

Indicator	Data source	Description of the indicator
		agricultural producers, and an agriculture orientation index (the agriculture share of credit, over the agriculture share of GDP).
Political stability and absence of violence/terrorism	https://landportal.org/book/indicator/wb-pvest	Political stability and absence of violence measures perceptions of the likelihood that the government will be destabilized or overthrown by unconstitutional or violent means, including politically-motivated violence and terrorism.

Table 2. Country typology used in the chapter. Data sources: UN development categories (https://www.un.org/en/development/desa/policy/wesp/wesp_current/2014wesp_country_classification.pdf), World Bank Income Levels (https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups), and IPBES regions (https://www.ipbes.net/ipbes-regions-subregions).

Country	UN development categories	World Bank Income Category	IPBES region
Afghanistan	Least Developed	6- Low income	Asia-Pacific
Albania	Developing Economies	4- Upper middle income	Europe-Central Asia
Algeria	Developing Economies	4- Upper middle income	Africa
American Samoa	Developing Economies	4- Upper middle income	Asia-Pacific
Andorra	Developing Economies	3- Other high income	Europe-Central Asia
Angola	Least Developed	4- Upper middle income	Africa
Antigua and Barbuda	Developing Economies	3- Other high income	Americas
Argentina	Developing Economies	4- Upper middle income	Americas
Armenia	Developing Economies	5- Lower middle income	Europe-Central Asia
Aruba	Developing Economies	3- Other high income	Americas
Australia	Developed Economy	1- High Income OECD	Asia-Pacific
Austria	Developed Economy	1- High Income OECD	Europe-Central Asia
Azerbaijan	Developing Economies	4- Upper middle income	Europe-Central Asia
Bahamas, The	Developing Economies	3- Other high income	Americas
Bahrain	Developing Economies	2- High Income Oil	Asia-Pacific
Bangladesh	Least Developed	5- Lower middle income	Asia-Pacific
Barbados	Developing Economies	3- Other high income	Americas
Belarus	Developing Economies	4- Upper middle income	Europe-Central Asia
Belgium	Developed Economy	1- High Income OECD	Europe-Central Asia
Belize	Developing Economies	4- Upper middle income	Americas
Benin	Least Developed	6- Low income	Africa
Bermuda	Developing Economies	3- Other high income	Americas
Bhutan	Least Developed	5- Lower middle income	Asia-Pacific
Bolivia	Developing Economies	5- Lower middle income	Americas
Bosnia and Herzegovina	Developing Economies	4- Upper middle income	Europe-Central Asia
Botswana	Developing Economies	4- Upper middle income	Africa
Brazil	Developing Economies	4- Upper middle income	Americas
British Virgin Islands	Developing Economies	3- Other high income	Americas
Brunei Darussalam	Developing Economies	3- Other high income	Asia-Pacific
Bulgaria	Developed Economy	4- Upper middle income	Europe-Central Asia
Burkina Faso	Least Developed	6- Low income	Africa
Burundi	Least Developed	6- Low income	Africa
Cabo Verde	Developing Economies	5- Lower middle income	Africa
Cambodia	Least Developed	5- Lower middle income	Asia-Pacific
Cameroon	Developing Economies	5- Lower middle income	Africa

Canada	Developed Economy	1- High Income OECD	Americas
Cayman Islands	Developing Economies	3- Other high income	Americas
Central African Republic	Least Developed	6- Low income	Africa
Chad	Least Developed	6- Low income	Africa
Channel Islands	NA	3- Other high income	Europe-Central Asia
Chile	Developing Economies	3- Other high income	Americas
China	Developing Economies	4- Upper middle income	Asia-Pacific
Colombia	Developing Economies	4- Upper middle income	Americas
Comoros	Least Developed	6- Low income	Africa
Congo, Dem. Rep.	Least Developed	6- Low income	Africa
Congo, Rep.	Developing Economies	5- Lower middle income	Africa
Costa Rica	Developing Economies	4- Upper middle income	Americas
Cote d'Ivoire	Developing Economies	5- Lower middle income	Africa
Croatia	Developed Economy	3- Other high income	Europe-Central Asia
Cuba	Developing Economies	4- Upper middle income	Americas
Curacao	Developing Economies	3- Other high income	Americas
Cyprus	Developed Economy	3- Other high income	Europe-Central Asia
Czech Republic	Developed Economy	3- Other high income	Europe-Central Asia
Denmark	Developed Economy	1- High Income OECD	Europe-Central Asia
Djibouti	Least Developed	5- Lower middle income	Africa
Dominica	Developing Economies	4- Upper middle income	Americas
Dominican Republic	Developing Economies	4- Upper middle income	Americas
Ecuador	Developing Economies	4- Upper middle income	Americas
Egypt, Arab Rep.	Developing Economies	5- Lower middle income	Africa
El Salvador	Developing Economies	5- Lower middle income	Americas
Equatorial Guinea	Developing Economies	4- Upper middle income	Africa
Eritrea	Least Developed	6- Low income	Africa
Estonia	Developed Economy	3- Other high income	Europe-Central Asia
Ethiopia	Least Developed	6- Low income	Africa
Faroe Islands	NA	3- Other high income	Europe-Central Asia
Fiji	Developing Economies	4- Upper middle income	Asia-Pacific
Finland	Developed Economy	1- High Income OECD	Europe-Central Asia
France	Developed Economy	1- High Income OECD	Europe-Central Asia
French Polynesia	Developing Economies	3- Other high income	Asia-Pacific
Gabon	Developing Economies	4- Upper middle income	Africa
Gambia, The	Least Developed	6- Low income	Africa
Georgia	Developing Economies	4- Upper middle income	Europe-Central Asia
Germany	Developed Economy	1- High Income OECD	Europe-Central Asia
Ghana	Developing Economies	5- Lower middle income	Africa
Gibraltar	NA	3- Other high income	Europe-Central Asia
Greece	Developed Economy	1- High Income OECD	Europe-Central Asia

Greenland	NA	3- Other high income	Europe-Central Asia
Grenada	Developing Economies	4- Upper middle income	Americas
Guam	Developing Economies	3- Other high income	Asia-Pacific
Guatemala	Developing Economies	5- Lower middle income	Americas
Guinea	Least Developed	6- Low income	Africa
Guinea-Bissau	Least Developed	6- Low income	Africa
Guyana	Developing Economies	4- Upper middle income	Americas
Haiti	Least Developed	6- Low income	Americas
Honduras	Developing Economies	5- Lower middle income	Americas
Hungary	Developed Economy	3- Other high income	Europe-Central Asia
Iceland	Developed Economy	1- High Income OECD	Europe-Central Asia
India	Developing Economies	5- Lower middle income	Asia-Pacific
Indonesia	Developing Economies	5- Lower middle income	Asia-Pacific
Iran, Islamic Rep.	Developing Economies	4- Upper middle income	Asia-Pacific
Iraq	Developing Economies	4- Upper middle income	Asia-Pacific
Ireland	Developed Economy	1- High Income OECD	Europe-Central Asia
Isle of Man	NA	3- Other high income	Europe-Central Asia
Israel	Developing Economies	3- Other high income	Europe-Central Asia
Italy	Developed Economy	1- High Income OECD	Europe-Central Asia
Jamaica	Developing Economies	4- Upper middle income	Americas
Japan	Developed Economy	1- High Income OECD	Asia-Pacific
Jordan	Developing Economies	4- Upper middle income	Asia-Pacific
Kazakhstan	Developing Economies	4- Upper middle income	Europe-Central Asia
Kenya	Developing Economies	5- Lower middle income	Africa
Kiribati	Least Developed	5- Lower middle income	Asia-Pacific
Korea, Dem. People's Rep.	NA	6- Low income	Asia-Pacific
Korea, Rep.	Developing Economies	1- High Income OECD	Asia-Pacific
Kuwait	Developing Economies	2- High Income Oil	Asia-Pacific
Kyrgyz Republic	Developing Economies	5- Lower middle income	Europe-Central Asia
Lao PDR	Least Developed	5- Lower middle income	Asia-Pacific
Latvia	Developed Economy	3- Other high income	Europe-Central Asia
Lebanon	Developing Economies	4- Upper middle income	Asia-Pacific
Lesotho	Least Developed	5- Lower middle income	Africa
Liberia	Least Developed	6- Low income	Africa
Libya	Developing Economies	4- Upper middle income	Africa
Liechtenstein	NA	3- Other high income	Europe-Central Asia
Lithuania	Developed Economy	3- Other high income	Europe-Central Asia
Luxembourg	Developed Economy	1- High Income OECD	Europe-Central Asia
Macao SAR, China	NA	3- Other high income	Asia-Pacific
Macedonia, FYR	Developing Economies	4- Upper middle income	Europe-Central Asia
Madagascar	Least Developed	6- Low income	Africa

Malawi	Least Developed	6- Low income	Africa
Malaysia	Developing Economies	4- Upper middle income	Asia-Pacific
Maldives	Developing Economies	4- Upper middle income	Asia-Pacific
Mali	Least Developed	6- Low income	Africa
Malta	Developed Economy	3- Other high income	Europe-Central Asia
Marshall Islands	Developing Economies	4- Upper middle income	Asia-Pacific
Mauritania	Least Developed	5- Lower middle income	Africa
Mauritius	Developing Economies	4- Upper middle income	Africa
Mexico	Developing Economies	4- Upper middle income	Americas
Micronesia, Fed. Sts.	Developing Economies	5- Lower middle income	Asia-Pacific
Moldova	Developing Economies	5- Lower middle income	Europe-Central Asia
Monaco	NA	3- Other high income	Europe-Central Asia
Mongolia	Developing Economies	5- Lower middle income	Asia-Pacific
Montenegro	Developing Economies	4- Upper middle income	Europe-Central Asia
Morocco	Developing Economies	5- Lower middle income	Africa
Mozambique	Least Developed	6- Low income	Africa
Myanmar	Least Developed	5- Lower middle income	Asia-Pacific
Namibia	Developing Economies	4- Upper middle income	Africa
Nauru	Developing Economies	4- Upper middle income	Asia-Pacific
Nepal	Least Developed	6- Low income	Asia-Pacific
Netherlands	Developed Economy	1- High Income OECD	Europe-Central Asia
New Caledonia	Developing Economies	3- Other high income	Asia-Pacific
New Zealand	Developed Economy	1- High Income OECD	Asia-Pacific
Nicaragua	Developing Economies	5- Lower middle income	Americas
Niger	Least Developed	6- Low income	Africa
Nigeria	Developing Economies	5- Lower middle income	Africa
Northern Mariana Islands	Developing Economies	3- Other high income	Asia-Pacific
Norway	Developed Economy	1- High Income OECD	Europe-Central Asia
Oman	Developing Economies	2- High Income Oil	Asia-Pacific
Pakistan	Developing Economies	5- Lower middle income	Asia-Pacific
Palau	Developing Economies	4- Upper middle income	Asia-Pacific
Panama	Developing Economies	4- Upper middle income	Americas
Papua New Guinea	Developing Economies	5- Lower middle income	Asia-Pacific
Paraguay	Developing Economies	4- Upper middle income	Americas
Peru	Developing Economies	4- Upper middle income	Americas
Philippines	Developing Economies	5- Lower middle income	Asia-Pacific
Poland	Developed Economy	3- Other high income	Europe-Central Asia
Portugal	Developed Economy	1- High Income OECD	Europe-Central Asia
Puerto Rico	Developing Economies	3- Other high income	Americas
Qatar	Developing Economies	2- High Income Oil	Asia-Pacific
Romania	Developed Economy	4- Upper middle income	Europe-Central Asia

Russian Federation	Developing Economies	4- Upper middle income	Europe-Central Asia
Rwanda	Least Developed	6- Low income	Africa
Samoa	Developing Economies	5- Lower middle income	Asia-Pacific
San Marino	NA	3- Other high income	Europe-Central Asia
Sao Tome and Principe	Least Developed	5- Lower middle income	Africa
Saudi Arabia	Developing Economies	2- High Income Oil	Asia-Pacific
Senegal	Least Developed	6- Low income	Africa
Serbia	Developing Economies	4- Upper middle income	Europe-Central Asia
Seychelles	Developing Economies	3- Other high income	Africa
Sierra Leone	Least Developed	6- Low income	Africa
Singapore	Developing Economies	3- Other high income	Asia-Pacific
Slovak Republic	Developed Economy	3- Other high income	Europe-Central Asia
Slovenia	Developed Economy	3- Other high income	Europe-Central Asia
Solomon Islands	Least Developed	5- Lower middle income	Asia-Pacific
Somalia	Least Developed	6- Low income	Africa
South Africa	Developing Economies	4- Upper middle income	Africa
South Sudan	Least Developed	6- Low income	Africa
Spain	Developing Economies	1- High Income OECD	Europe-Central Asia
Sri Lanka	Developing Economies	5- Lower middle income	Asia-Pacific
St. Kitts and Nevis	Developing Economies	3- Other high income	Americas
St. Lucia	Developing Economies	4- Upper middle income	Americas
St. Vincent and the Grenadines	Developing Economies	4- Upper middle income	Americas
Sudan	Least Developed	5- Lower middle income	Africa
Suriname	Developing Economies	4- Upper middle income	Americas
Swaziland	Developing Economies	5- Lower middle income	Africa
Sweden	Developed Economy	1- High Income OECD	Europe-Central Asia
Switzerland	Developed Economy	1- High Income OECD	Europe-Central Asia
Syrian Arab Republic	Developing Economies	5- Lower middle income	Asia-Pacific
Tajikistan	Developing Economies	5- Lower middle income	Europe-Central Asia
Tanzania	Developing Economies	6- Low income	Africa
Thailand	Developing Economies	4- Upper middle income	Asia-Pacific
Timor-Leste	Least Developed	5- Lower middle income	Asia-Pacific
Togo	Least Developed	6- Low income	Africa
Tonga	Developing Economies	5- Lower middle income	Asia-Pacific
Trinidad and Tobago	Developing Economies	3- Other high income	Americas
Tunisia	Developing Economies	5- Lower middle income	Africa
Turkey	Developing Economies	4- Upper middle income	Europe-Central Asia
Turkmenistan	Developing Economies	4- Upper middle income	Europe-Central Asia
Turks and Caicos Islands	Developing Economies	3- Other high income	Americas
Tuvalu	Least Developed	4- Upper middle income	Asia-Pacific
Uganda	Least Developed	6- Low income	Africa

Ukraine	Developing Economies	5- Lower middle income	Europe-Central Asia
United Arab Emirates	Developing Economies	2- High Income Oil	Asia-Pacific
United Kingdom	Developed Economy	1- High Income OECD	Europe-Central Asia
United States	Developed Economy	1- High Income OECD	Americas
Uruguay	Developing Economies	3- Other high income	Americas
Uzbekistan	Developing Economies	5- Lower middle income	Europe-Central Asia
Vanuatu	Least Developed	5- Lower middle income	Asia-Pacific
Venezuela, RB	Developing Economies	4- Upper middle income	Americas
Vietnam	Developing Economies	5- Lower middle income	Asia-Pacific
Virgin Islands (U.S.)	Developing Economies	3- Other high income	Americas
West Bank and Gaza	NA	5- Lower middle income	Asia-Pacific
Yemen, Rep.	Least Developed	5- Lower middle income	Asia-Pacific
Zambia	Least Developed	5- Lower middle income	Africa
Zimbabwe	Developing Economies	6- Low income	Africa

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