Supplementary Information

"Climate-smart" conservation must be coupled with development in Africa

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This supplementary information article describes the selection and use of 11 variables related to environmental, energy production and use, as well as socioeconomic development for Sub-Saharan Africa and the rest of the world. These variables were selected based on their relevance for evaluating conservation efforts, the extent to which natural capital stocks are being liquidated or converted for economic purposes as well as human development and well-being. The World Bank's World Development Indicators database was a key data source, providing over half of the variables described below. Additional variables came from the Global Footprint Network as well as the United Nations Human Development Report. The radar plot is the primary graphical representation used for this article. All variables are shown on the axis, point data for each variable is connected to form two polygons, one for Sub-Saharan Africa and the other for the world. This categorization allows for a visual comparison between the region and the world, across variables and with the identification of weaknesses and strengths.

1. Radar chart and data pre-processing

Radar variables are shown on the axis of the plot and each point shows the magnitude of each variable and the overall shape of the polygon represents trends and performance between environmental and socioeconomic sub-indicators. Environmental impact and climate change is represented by Ecological Footprint, CO2 emissions and renewable energy consumption. Sub-indicators for evaluating resource use are total natural resources rents, arable land and forest area. Socioeconomic indicators evaluating development, income inequality and vulnerability included the Human Development Index, access to basic sanitation services, Gini index and vulnerable employment. Data pre-processing of the selected variables involved normalizing those which were not given on a percent scale to a ratio ranging from 0-1. Since most of the variables were given in percentages, only two variables were normalized to a 0-1 scale. The ecological footprint which was originally given in *global hectares per capita* and C02 emissions which were expressed in *metric tons per capita.* The final plot was generated using the *fmsb::ggradar* package and associated functions on RT as well as *scales::rescale* to normalize some of the variable on a 0-1 scale, all variables are given equal weighting.

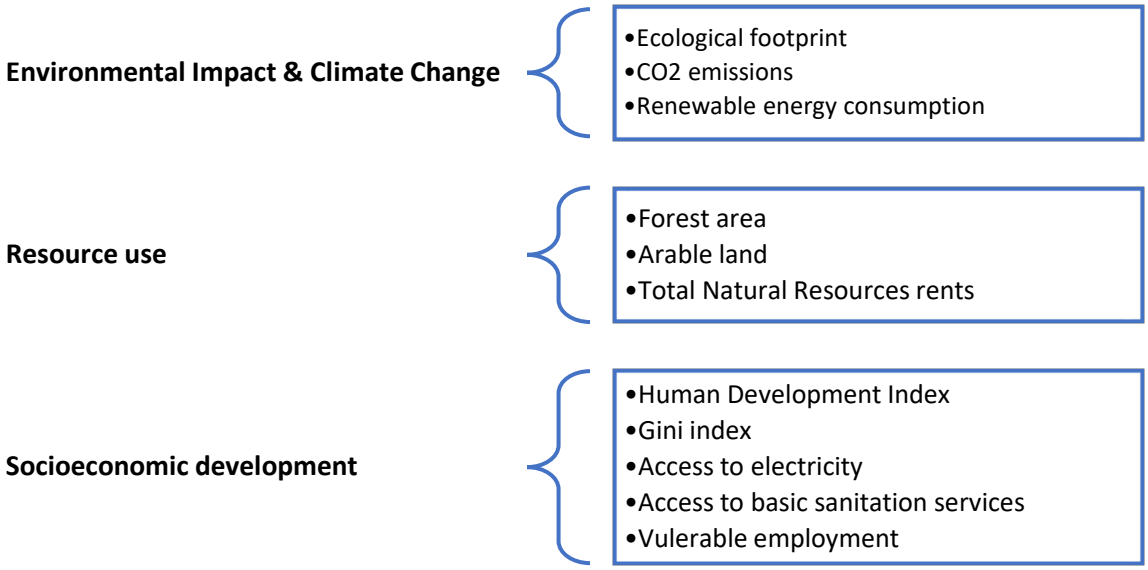
2. Radar variables

a. Environmental indicators & Energy production and use

Ecological footprint *(global hectares per capita)*: The Ecological Footprint is a resource accounting tool that measures the amount of biologically productive land and sea resources used to meet society's needs and to absorb the waste generated. It is expressed in global hectares to account for needs met using "land or sea imported" from other parts of the world. It is used to measure the extent to which anthropogenic activities are exceeding the capacity of earth's ecosystem. Ecological overshoot can lead to ecosystem degradation, biodiversity loss and climate change. This data was sourced from the Global Footprint Network.

Carbon Dioxide (CO2) emissions *(metric tons per capita)*: Carbon dioxide emissions are those stemming from the burning of fossils fuels and biomass for energy generation and transportation, as well as generated from anthropogenic activities related to land use changes and industrial processes like cement production. This data is used as an indicator of regional and country activities on global environmental change. Reductions in carbon dioxide emissions could indicate increased adoption of renewable energy, improvements in energy efficiency and environmental regulation. Emission data is

collected through a variety of sensors, surveys and models targeted at monitoring and estimating energy consumption, generation and carbon sequestration. Data on C02 emissions was accessed through the World Bank open databank platform which cites Climate Watch as the primary source. Emissions data are used in this study as an environmental and energy production sub-indicator evaluating regional and global performance low-carbon development.



Forest area *(% of land area)***:** This is the percentage of a country or region's land under natural or planted stands of trees, excluding tree stands in agricultural production systems (such as fruit plantations and agroforestry systems) or trees in urban parks and gardens. Natural forest stands or primary forests consist of native species with no clear indications of human activities such as clearance for agriculture, logging or built environment. Primary tropical forests are critical ecosystems often characterized by high biodiversity and carbon sequestration. Populations located near forested areas can also benefit from forest ecosystem services like food such as access to fishing or wild fruit harvesting, medicine and fuel. Data for forest area was accessed through the World Bank open databank which cites Food and Agriculture Organization (FAO) as the original data source.

Access to electricity *(% of population)***:** Access to electricity is the percentage of the population with access to electricity. Electrification data are collected from industry, national surveys, and international sources. This data was used as an indicator of the level of development and quality of life in Sub-Saharan Africa and the world as electricity access is essential for improved lighting, heating and using communication technologies such as televisions and the internet with positive implications on increased access to information, educational opportunities and economic productivity. Improvements in electricity access could indicate increased investments in electricity infrastructure and generation. Used together with renewable energy consumption, the two variables capture aspects of the SDG 7: Affordable and clean energy for all. The dataset was accessed from the World Bank open data

Renewable energy consumption (*% of total final energy consumption***)***:* This is the share of the total energy consumption sourced from renewable energy like hydro, solar, wind or bioenergy rather than

traditional and carbon-intensive sources like fossil fuels. Although increased renewable energy consumption could indicate increased investments in clean energy sources, in some developing countries it can reflect the lack of access and grid connected infrastructure of more traditional energy sources rather than a shift to renewables as a result of strategic decarbonization objectives. This data was accessed via the World Bank open data bank which cites the World Bank, Sustainable Energy for All (SE4ALL) database. In this study, it is used as an energy production and use sub-indicator for assessing the progress of countries and regions in the use and availability of sustainable energy sources.

b. Socioeconomic development indicator

Vulnerable employment *(% of total employment | modeled ILO estimate):* The working definition of vulnerable employment as proposed by the International Labour Organization (ILO) refers to the subset of the self-employed that are own-account workers (self-employed workers without employees) or contributing family workers (unpaid family workers). It is characterized by factors like inadequate earnings, precarious and difficult working conditions, as well as job insecurity. Vulnerable employment can also exist within both informal and formal sectors. High levels of vulnerable employment could indicate low growth in the formal and waged labour market, or large agricultural sector and rural economy. This data was estimated based on data obtained from International Labour Organization and accessed through the World Bank data bank's World Development Indicators database.

People using at least basic sanitation services *(% of population)***:** The percentage of the population that has access to basic sanitation services such as flush toilets, septic tanks or pit latrines, piped sewer systems and hand-washing facilities. Sanitation has crucial implications for development, health and the environment. Diseases caused by poor sanitation such as cholera, diarrhea and dysentery often disproportionately affect children, the poor and those living in rural areas. Improved access to basic sanitation services requires significant investments in infrastructure, public health education and changes in behavioural practices. Data on regional and global access to basic sanitation services was accessed from the World Bank open data platform. In this study, access to basic sanitation services is categorized and used as a socioeconomic development sub-indicator.

Total Resource Rents *(10 % of GDP)* **:** The surplus earnings (calculated as a difference between market price and the average cost of production of a commodity) from the extraction of minerals, natural gas, coal, and the sale of timber, reported as a % of a state's GDP. They can show the extent to which natural resources contribute to an economy and may be useful for identifying resource-dependent economies. Increases in total natural resources rents could indicate accelerating liquidation of the natural resources stock, while decreases could suggest improved resource management. In addition, revenue earned from resource rents could fund socioeconomic development objectives such as poverty reduction, education, health and infrastructure investments. The 2015 data for total natural resources rents for Sub-Saharan Africa and the world was sourced from the World Bank open data bank.

Human Development Index: Is calculated as a composite index that evaluates the development of a country by focusing on three components or dimensions related to the population's capabilities and standards of living; A long and healthy life, access to knowledge and a decent standard of living. Life expectancy at birth is used to measure a long and healthy life. Mean years of schooling for adults aged 25 years and more as well as expected years of schooling for children is used to measure education or the knowledge dimension. Standards of living are measured using gross national income per capita (GNI per capita) based on purchasing power parity and the final score (HDI) is calculated as a geometric mean of

the normalized indices for each dimension. At a regional level, aggregate HDI values are calculated using the weighted group averages of component indicators. The HDI does not consider issues of inequality, gender disparities and poverty which could affect a country's overall extent of development and distributional outcomes. Regional HDI data for Sub-Saharan Africa and the global HDI for 2015 were sourced from the United Nations – Human Development Reports (HDR).

Gini index: The Gini index measures the extent of income inequality within a country, where higher values reflect higher levels of inequality and lower values indicate lower levels of inequality, where 0 is the case of perfect economic equality or where every resident has the same income. The index is calculated using lumped income and population size without taking into account individual factors such as gender, age and education levels. It is ideal for comparing extent of income inequality between countries but does not explain within country dynamics. As a socioeconomic sub-indicator the Gini index is used in this study to supplement the HDI which does not account for income inequality. Data for the Gini index was accessed from the World Inequality Database (WID).

Arable land (*% of land area*): Arable land is defined by the FAO as land under temporary crops, land for pasture, gardens or under temporary fallow. This data can be useful for determining food production and food security. In rural areas, arable land area can indicate the extent of agriculture and its significance for local development. Understanding land tenure and the extent of commercial versus subsistence agriculture can also provide context for understanding the political economy of the area. It is used in this study as a socioeconomic sub-indicator that captures agricultural activity in terms of land-use as well as potential contributions to the economy. Data for arable land was accessed through the World Bank open data platform which cites the FAO as the primary source of the dataset.

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