CHAPTER

7

Towards a new generation of human development metrics for the Anthropocene

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Human development is dynamic. So the way we measure it must be, too. Over the years, new dashboards and indices have been introduced.

How do we measure human development in the Anthropocene?

In line with a central theme of the report, there is no one-size-fits-all tool or metric. Instead, this chapter introduces and explores a suite of possibilities, including an experimental Planetary pressures-adjusted Human Development Index.

One index to rule them all?

Confronting the Anthropocene calls for a new generation of human development metrics. The Human Development Index (HDI) introduced in 1990 was intended to be a general index for global assessment and critique based on a minimal listing of capabilities focused on enjoying a basic quality of life.[1] Clear and simple, and focused on income, education and health, it shaped public and political debate and reoriented objectives and actions. It has since been augmented by the Inequality-adjusted HDI, the Gender Development Index, the Gender Inequality Index and the Multidimensional Poverty Index (spotlight 7.1).

The inclusion of income in the HDI was intended only as a proxy for capabilities other than education and health, as something instrumentally important for achievements in those other capabilities. But gross national income (GNI) does not account for planetary pressures. So this chapter considers possible adjustments to the HDI's income component, subtracting the social costs of carbon from GNI and discussing options to account for changes in total wealth that include natural capital.

The chapter also presents an adjustment to the HDI that uses indicators of greenhouse gas emissions and material footprint. The adjustment is made by multiplying the HDI by an adjustment factor that accounts for planetary pressures. This adjustment factor is calculated as the arithmetic mean of indices measuring carbon dioxide emissions per capita—which speaks to the challenge of shifting away from fossil fuels for energy—and the material footprint per capita—which relates to the challenge of closing material cycles. This Planetary pressures–adjusted HDI provides a sense of the possibilities for achieving high HDI values with lower emissions and resource use.

The HDI was not meant to encompass the totality of the human development approach since no single measure can do that.[2] But it has served as a powerful device to shape public and political debate, encouraging a reorienting of objectives and action. Because supporting that reorientation remains vital, it is important to reaffirm the original intent of the HDI (spotlight 7.1). But as we confront the Anthropocene, the original reorientation is no longer enough. The transformational changes required to ease planetary pressures and redress social imbalances call for another reorientation of goals and choices like the one that the HDI encouraged 30 years ago.

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Confronting the Anthropocene calls for a new generation of human development metrics, guided by three considerations. First, as the 2019 Human Development Report argued, we need a revolution in metrics, going beyond averages to inequalities both across and within countries (part I).[3] The inequalities reflect the unequal consequences of dangerous planetary change and the differences in power that frame choices driving planetary pressures. And they are manifest not only in inequalities in income and wealth but also in enhanced capabilities—today's new necessities in a rapidly changing and increasingly digital world. Particularly important is to emphasize horizontal (intergroup) inequalities, since they often reflect longstanding patterns of exclusion and discrimination. And it is important to go beyond national averages more than ever—for even countries contributing little to total greenhouse gas emissions may have large individual emitters (spotlight 7.2).

Second, while longstanding debates on sustainability are crucial, we need to go beyond sustaining—meaning, aspiring for a better future for our descendants, not merely avoiding a decline as the objective—and beyond needs (chapter 1). Sustainability cannot be assessed without defining what is to be sustained. Different approaches suggest different indicators: No unique measure is applicable to all definitions of sustainability.[4] Nor can sustainability be assessed without forecasting the future, for what will matter then is not necessarily what matters for us today, but what will matter for future generations.[5] These are not mere technical challenges. If the metrics are to influence those making choices in the real world, these challenges are consequential and cannot be brushed aside.[6] And there simply is no way of assessing any notion of sustainability based on past or current indicators without making assumptions about the future.[7] Going beyond "sustaining," and consistent with the findings of this Report, measuring

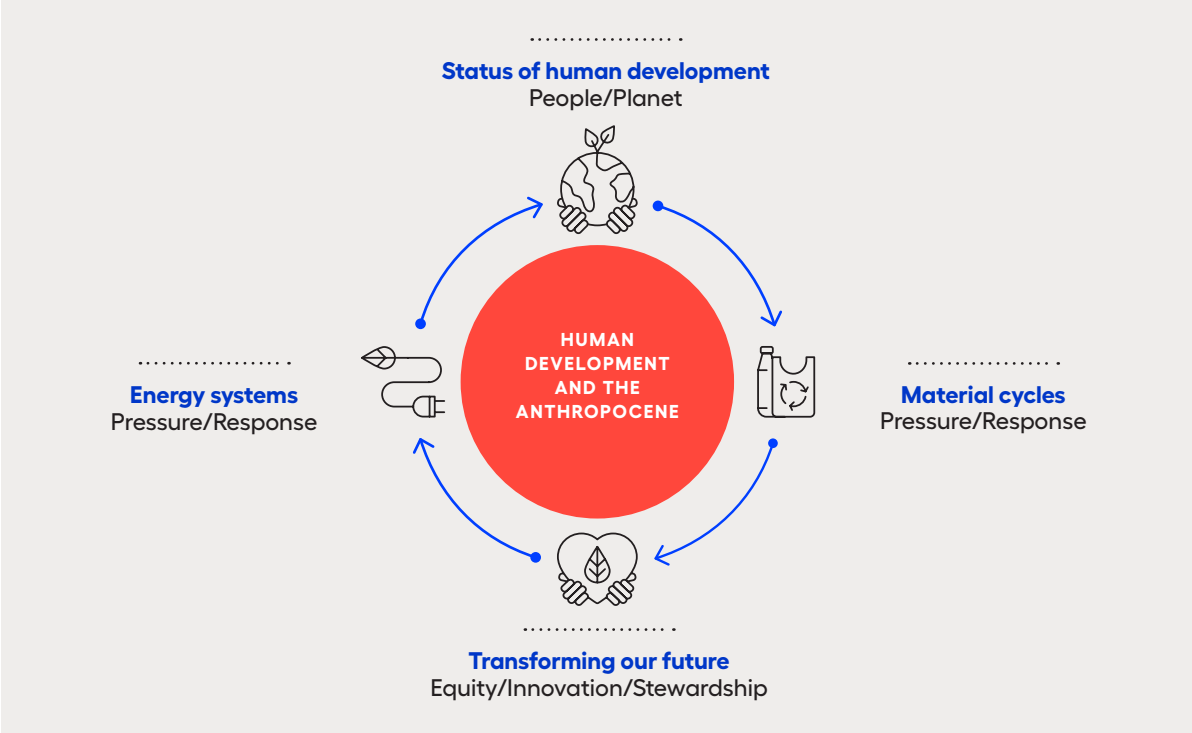
human development in the Anthropocene should be guided towards measures of planetary pressures and those that incorporate human agency.[8]

Third, although composite indices are powerful political signalling devices, relying on them exclusively can be misleading. The shortcomings of relying only on GDP were emphasized by Joseph Stiglitz, Amartya Sen and Jean Paul Fitoussi's *Report of the Commission on the Measurement of Economic Performance and Social Progress*[9] and further strengthened in more recent work by Stiglitz, Fitoussi and Martine Durand.[10] Dashboards can complement single indicators, including composite indices,[11] particularly when thinking about measures of current and future well-being (with the latter meant in some sense to reflect sustainability). Sen, Fitoussi and Stiglitz used the analogy of a driver relying on a car's dashboard for information on speed and on how much fuel is in the tank.[12] Both pieces of information are valuable separately, but it is difficult to see how they could be combined in a way that warns the driver of both whether he or she is speeding or running out of fuel.

These considerations define a broad framework for the evolution of metrics of human development in the Anthropocene, and this chapter makes an initial and partial contribution. To take the third consideration first, a new dashboard of indicators can be organized according to the findings of this Report.[13] Composite indices impose normative assumptions for the choice and aggregation of the indicators, including the weights for different components. They are rarely transparent or even explicit.[14] Dashboards, by contrast, make it possible to inspect different dimensions simultaneously, recognizing that different people can give different weights to each dimension depending on context and aspiration.[15]

This chapter suggests a new dashboard on human development and the Anthropocene, with indicators aimed at capturing the complex interactions between people and ecosystems and at monitoring individual country progress towards easing planetary pressures and social imbalances. The information is organized in four dimensions: status of human development, energy systems, material cycles and transforming our future (figure 7.1). An initial implementation of this dashboard is available online, with the choice of indicators guided in part by data availability.[16]

Figure 7.1 New dashboard on human development and the Anthropocene



Source: Human Development Report Office.

Also important is presenting the information in a way that helps decisionmakers and the public, and harnessing the power of digital data platforms provides an opportunity to innovate. The Covid-19 Dashboard of the Center for Systems Science and Engineering at Johns Hopkins University presents data from multiple sources and combines spatial data visualizations and data modelling.[17] With a real-time tracking map of Covid-19 cases and deaths, it uses open data principles, offering data downloads with transparent explanations of its sources and documentation. Our World in Data, a University of Oxford initiative, combines data and research to inform global audiences and inspire change. It presents in a transparent and engaging way data and knowledge that would be otherwise hidden in databases and scientific papers.[18]

"The chapter concludes by proposing a new index to adjust the HDI for planetary pressures. It is a crude but simple way of bringing together a central theme of this Report—reimagining the human development journey as one in which the expanding human freedoms also eases planetary pressures.

The chapter next explores how the analysis of human development in the Anthropocene in parts I and II can inform adjustments to the income component of the HDI. These adjustments are informed by recent developments in comprehensive wealth accounting (which includes natural capital, reviewed in more detail in spotlight 7.3) and by advances in the measurement of sustainability and environmental degradation (spotlight 7.4). Both open a new perspective for metrics of human development in the Anthropocene. The chapter concludes by proposing a new index to adjust the HDI for planetary pressures. It is a crude but simple way of bringing together a central theme of this Report—reimagining the human development journey as one in which the expanding human freedoms also eases planetary pressures.

Broadening the vista on the Human Development Index: The income component and planetary pressures

This section builds on proposals to add environmental and sustainability dimensions to the HDI (spotlight 7.4) but explores metrics guided by the importance of going beyond sustaining.[19] It focuses on the implications of accounting for planetary pressures[20] by adjusting the income component of the HDI (box 7.1 shows and discusses an adjustment to the HDI through the health component that could be linked to the drivers and impact of planetary pressures).[21]

Since the HDI presents an alternative to GDP, its income component has been a source of controversy.[22] Including income in the HDI has been criticized as encouraging unaimed opulence—that is, "attempting to maximize economic growth without paying any direct attention to the transformation of greater opulence into better living conditions. Unaimed opulence generally is a roundabout, undependable and wasteful way of improving the living standards of the poor."[23] But including income in the HDI was intended as a proxy for capabilities other than health and education (spotlight 7.1). It does not represent human thriving directly but something instrumentally important to enable achievements in other capabilities. And it is included in the HDI in a way that recognizes that such instrumentality declines as income rises.[24]

Thus, this apparent difficulty would be resolved if the original intent of including income as an index of nonhealth and noneducation capabilities were retained. A more fundamental issue is that GNI does not account for planetary pressures. So this section considers possible adjustments to the income component of the HDI. First, by subtracting from GNI the social costs of carbon. Second, by discussing recent developments in wealth accounting that open the possibility of replacing GNI with measures that account for changes in total wealth, inclusive of natural capital, representing net changes in a more comprehensive measure of capital than the gross investment in physical capital that goes into GNI.

Accounting for the social cost of carbon

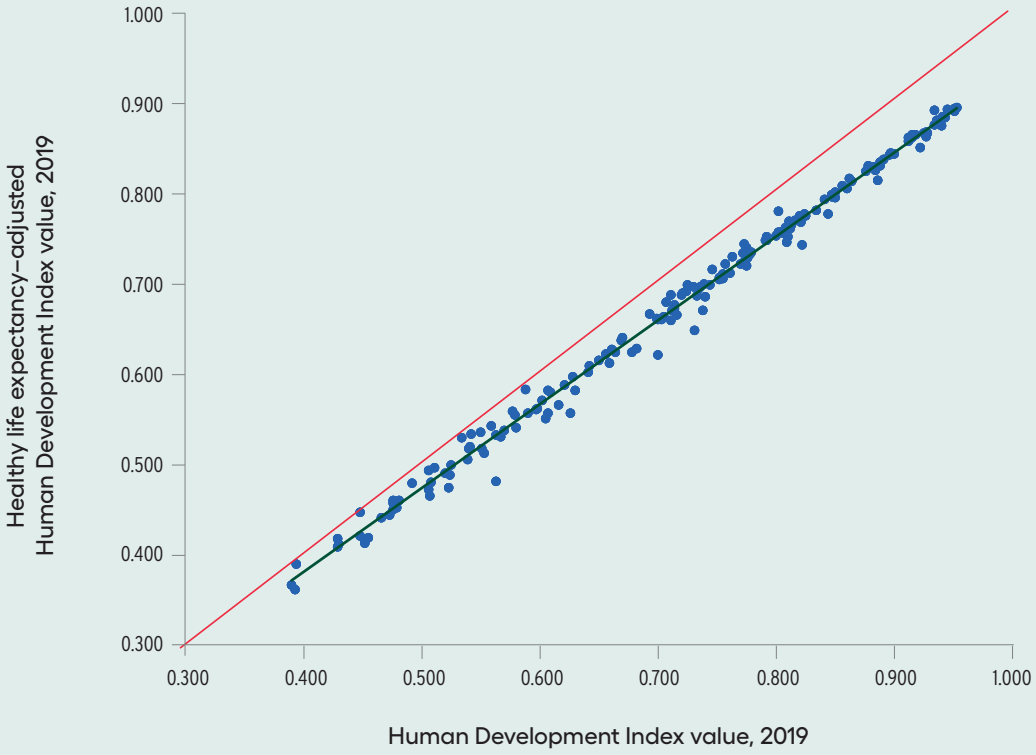
The HDI's indicator for the income dimension is GNI. "Gross" is the rogue word in this concept because it fails to account for the depreciation of capital assets[25] and ignores natural capital (spotlight 7.2) and the social costs (borne by everyone) of environmental damage.[26] Other income-based indicators take a

Box 7.1 Would health-adjusted longevity better reflect the impact of planetary pressures?

The Human Development Index (HDI) includes a measure of length of life—life expectancy at birth—but not how healthy people are when they are alive. Environmental pressures are important determinants of health inequalities, and the very consumption patterns that are ecologically damaging (such as meat consumption, discussed in the 2019 Human Development Report[1]) may also relate to deteriorating health in noncommunicable diseases.[2]

The determinants of morbidity are complex and multifaceted, but if the focus is on the capability to live a long and healthy life, this capability might be better captured by healthy life expectancy, an indicator that looks at both the length of life and the quality of health during life. It adjusts life expectancy to account for illness or disability. Using healthy life expectancy instead of life expectancy at birth lowers HDI values for all countries.[3] But the HDI and the healthy life expectancy–adjusted HDI are highly correlated, suggesting only very small changes in rank (see figure).

Healthy life expectancy broadly preserves the ranking of countries by Human Development Index value



Correlation coefficient = 0.997

Note: Covers 186 countries with Human Development Index (HDI) values. Healthy life expectancy is not available for Liechtenstein and Hong Kong Special Administrative Region, China; Nigeria is excluded because the value for healthy life expectancy (produced by the Institute for Health Metrics and Evaluation) is higher than the value for life expectancy (produced by the United Nations Department of Economic and Social Affairs and included in the HDI).
Source: Human Development Report Office calculations based on HDI values from table 1 in the statistical annex and healthy life expectancy data from IHME (2020).

Notes
1. UNDP 2019c. **2.** Springmann and others 2016. We are grateful to Marc Fleurbaey for this suggestion. The education component could also be adjusted to reflect more directly not only learning but also innovation. And the income component could be adjusted by deducting the social cost of greenhouse gas emissions—something explored later in this chapter. **3.** Given that healthy life expectancy is lower than life expectancy. The slope of the green line depends on the choice for the maximum goalpost in the health dimension—these results assume the same maximum goalpost as the one used for life expectancy in the HDI.

broader view of net flows from capital and adjust for natural resource depletion and damage from emissions and pollution.[27] Here we explore a simpler and more direct adjustment to GNI by subtracting the social costs of carbon dioxide emissions.[28] Again, this is driven by the importance of encouraging a transformation in energy use to lower greenhouse gas emissions. This is not meant to accurately capture the full social costs of environmental damage or the overuse of resources not in GNI. For simplicity the adjustment considers emissions from each country, not the actual damages to each country caused by global aggregate emissions.[29]

The social cost of carbon is the economic cost attributable to an additional tonne of carbon dioxide emissions or its equivalent. Estimates of this cost depend on several assumptions and parameter choices and span a wide range.[30] Here we consider two estimates.[31] One proposed by the International Monetary Fund sets the cost of carbon in 2030 at $75 per tonne of carbon dioxide—in 2017 US dollars and covering all fossil fuels (spotlight 5.1). It is based on a model showing that the impact of a global carbon tax at this level would be consistent with countries meeting their Paris Agreement pledges. The other estimate is from a recent application of the Dynamic Integrated Climate-Economy integrated assessment model.[32] It includes the latest climate science and reflects a broad range of expert recommendations on social discount rates—a key parameter in the model that weighs the value today of future benefits and costs.[33] The median expert view on discount rates gives a carbon social cost of around $200 per tonne of carbon dioxide in 2020 (in 2010 international dollars).[34]

The adjustment to the income component of the HDI subtracts the social cost of carbon dioxide emissions (measured as the product of the country's carbon dioxide emissions per capita and the social cost of carbon) from GNI per capita (and so does not account for the costs of other greenhouse gases). With the social cost set at $75 per tonne of carbon dioxide,[35] the adjustment to the income component would not change a country's HDI value substantially. The changes are generally small, even with the higher social price of carbon of $200 per tonne (figure 7.2). The small changes also suggest that an HDI adjusted only for the social costs of carbon in these price ranges would not send strong enough signals to encourage behaviour change. Something more comprehensive may be required. The next section explores changes in comprehensive wealth that involve natural capital, which more inclusively accounts for the social costs of the depletion of natural capital than carbon dioxide emissions alone does.

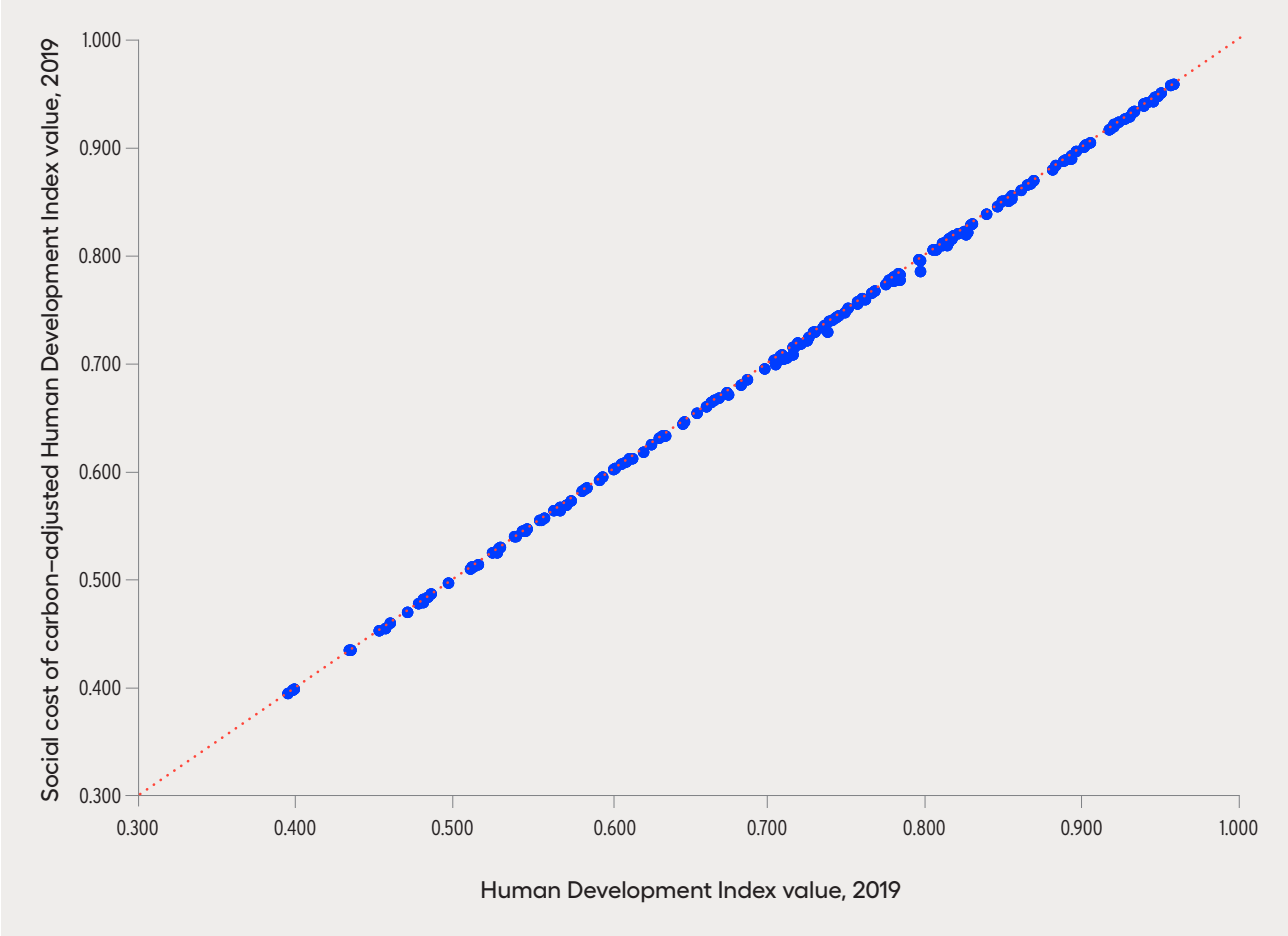
Accounting for changes in comprehensive—and natural—wealth

Recent analytical and empirical advances in wealth accounting offer exciting new avenues to explore human development metrics. Measures of economic activity and social welfare are becoming available that include contributions from nature, the costs of extraction from it and how pollution depreciates capital.[36] They relate to the measurement of comprehensive wealth (sometimes called inclusive or total wealth), which includes natural capital[37] along with produced and human capital.[38] Natural capital comprises nature's assets.[39] These approaches have a long tradition in economics.[40] Irving Fisher started his 1906 book on the nature of capital and income by using fisheries in the Newfoundland Banks as an example of a stock.[41] But the pace picked up from the late 1960s, fuelled in part by debates on how to link social welfare to measures of economic activity and consumption[42] as well as by growing awareness and concerns over ecological degradation.[43]

"Recent analytical and empirical advances in wealth accounting offer exciting new avenues to explore human development metrics.

Partha Dasgupta and Karl-Göran Mäler have built on this tradition, proposing a model in which changes in comprehensive wealth are equivalent to changes in social welfare (meaning that the changes encompass the social welfare of the current generation and all future ones).[44] This is the foundation for much conceptual and empirical work. On the conceptual front, Dasgupta extends the model to include both the values and ethics of population levels and growth and empirical estimates of the planet's human carrying capacity under different normative and parametric assumptions.[45] Empirical estimates of comprehensive

Figure 7.2 The changes to Human Development Index values after subtracting the social costs of carbon at $200 per tonne of carbon dioxide emissions are generally small



Source: Human Development Report Office calculations based on Human Development Index values from table 1 in the statistical annex and data on production-based carbon dioxide emissions from GCP (2020).

wealth were informed by pioneering work on genuine savings[46] and have evolved to encompass not only cases for some countries[47] but also estimates for several countries. The United Nations Environment Programme (UNEP) and the World Bank now issue country-level estimates.[48] Table 7.1 describes the measures of inclusive wealth released by the UNEP and the measures of total wealth estimated by the World Bank. Both organizations emphasize that their approaches likely greatly underestimate natural capital. A separate but related development is the growing interest in directly measuring wellbeing (box 7.2).

The various components that make up inclusive wealth show different trends (figure 7.3). For most countries and for the world at large, inclusive wealth grows more slowly than GDP. Although the increase in physical capital is on par with GDP, the growth of human capital is slower. More troubling, these estimates suggest that natural capital has been steadily declining over time (spotlight 7.3).

Changes in inclusive wealth offer a more comprehensive approach than simply subtracting the social costs of carbon dioxide emissions discussed above. Explorations could include adjusting the income component of the HDI by replacing GNI with measures that account for changes in comprehensive wealth. But given that changes in comprehensive wealth reflect broader implications for human wellbeing than just the effect of planetary pressures, how to introduce this broader concept in an index of capabilities like the HDI requires further analysis. These explorations remain under study also because of empirical challenges. To begin with, estimates of inclusive wealth are likely lower bounds, as noted

Table 7.1 Estimates of comprehensive wealth

Measure	Institution	Data	Description
Inclusive wealth	United Nations Environment Programme	140 countries 1990–2014	Inclusive wealth aims to measure wellbeing by monitoring the productive base for future generations. A country's inclusive wealth is the social value of all its capital assets (valued through shadow prices[a]). These include natural capital (fossil fuels, minerals, forests, agricultural land, fisheries), human capital (health, education) and produced capital (equipment, machineries, roads). Of importance for analysis is the change in wealth. In 2014 about 20 percent of global inclusive wealth was accounted for by produced capital, 60 percent by human capital and 20 percent by natural capital. Even though 135 of 140 countries showed growth in inclusive wealth in 2014, natural capital declined in 127 of the 140 countries.
Total wealth	World Bank	141 countries 1995–2014	World Bank wealth accounts include the following asset categories: produced capital and urban land (machinery, buildings, equipment, residential and nonresidential urban land—measured at market prices), natural capital (energy and minerals, agricultural land, forests, terrestrial protected areas—measured as the discounted sum of the value of the rents generated over the lifetime of the asset), human capital (disaggregated by gender and employment status—measured as the discounted value of earnings over a person's lifetime) and net foreign assets (for example, foreign direct investment, reserve assets). In 2014 about 27 percent of total wealth was produced capital, 64 percent was human capital and 9 percent was natural capital, with natural capital accounting for 47 percent of the wealth in low-income countries and 27 percent in lower-middle-income countries.

a. The shadow price or value of a capital asset is the monetary measure of the contribution a marginal unit of that asset is forecast to make to human wellbeing (UNEP 2018b).
Source: UNEP 2018b; World Bank 2018.

above. For instance, the social cost of carbon used to estimate the damages from carbon emissions in inclusive wealth is $50—using the $200 value as above would multiply the change in inclusive wealth due to this factor by four. And the information on changes in comprehensive wealth from the UNEP and World Bank estimates often vary greatly for some countries, not only in magnitude but also on whether there was a decrease or increase over some time periods. Still the ongoing advances in wealth accounting hold great potential to explore new avenues to incorporate into human development metrics the challenges that we confront in the Anthropocene.

Adjusting the Human Development Index as a whole

The HDI is an example of what James Foster has called "intentional measurement."[49] Its construction was driven by its intended purpose and desired characteristics. The purpose was to shift objectives and action towards a view of development that put people at the centre. Two of its main desired characteristics were clarity and simplicity. A criterion for the validity of such indices is whether they are actually used and adopted over time. And by that standard—despite the modifications made over the years—the HDI has stood the test of time (spotlight 7.1).

So now is the chance to step back and reflect on the intent of adjusting the HDI. Put simply the intent is to have a measure that accounts for how people are doing and for the unprecedented pressures people are imposing on the planet. To account for capabilities, the HDI is the obvious choice. And for the other component, the biophysical and socioeconomic processes that produce planetary pressures should inform the choice. We consider two summary measures: carbon dioxide emissions and material footprint, both on a per capita basis, informed by the discussion in chapter 1. It is crucial to keep in mind the clarity of message and simplicity of understanding.

The adjustment to the HDI is a signalling device for positive change, encouraging the expansion of capabilities while reducing planetary pressures.[50] The focus on greenhouse gases and material flows does not imply that all other environmental concerns are less important or urgent—as is the case for losses in biosphere integrity and several other urgent concerns, as reflected in the Sustainable Development Goals. But reductions in the flows of greenhouse gases and more efficient material use would eventually reflect the outcomes of the broader economic and societal transformation to ease planetary pressures.[51]

The Planetary pressures–adjusted Human Development Index

The adjustment corresponds to multiplying the HDI by an adjustment factor, creating the Planetary

Box 7.2 Measuring wellbeing

Efforts to measure societies' wellbeing have involved government, civil society, academia and international organizations, often working in collaboration. Though some initiatives have sought to measure wellbeing, others have assessed related concepts, including progress, quality of life or sustainable development. For the purposes here, there is little to choose among the measures used for these themes—each initiative has sought to provide an index, or set of indicators, that paints a broader picture of national wellbeing than GDP provides.

Official statistical offices have often been at the forefront of this work, keen to see a richer, fact-based debate about key aspects of life. An early effort came from the United Kingdom, which produced Quality of Life Accounts in 1999.[1] In 2002 the Australian Bureau of Statistics produced "Measuring Australia's Progress."[2] Ireland's Central Statistics Office followed a year later with "Measuring Ireland's Progress."[3]

In 2005 the Organisation for Economic Co-operation and Development (OECD) began its Global Project on Measuring the Progress of Society[4] to catalyse growing interest in going beyond GDP. In 2007 the OECD, along with the European Commission, the United Nations, the United Nations Development Programme (UNDP), the World Bank and others, cosigned a declaration on the importance of measuring the progress of societies.[5] Later that year the European Union held a conference—Beyond GDP—on developing indicators that are as clear and appealing as GDP but more inclusive of environmental and social aspects of progress.[6]

There has been much work since then. Some, such as the 2009 Commission on the Measurement of Economic Performance and Social Progress,[7] has been driven by political leaders. Others, such as the Canadian Wellbeing Index, have been driven by civil society and academia.[8]

International organizations have also been active. UNDP aside—many would argue that the Human Development Index is a measure of wellbeing—the OECD began compiling its Better Life Index in 2011 to bring together internationally comparable measures of wellbeing.[9]

Bhutan's Gross National Happiness work is a well known project from the Global South. What began as a remark by Bhutan's King—"Gross national happiness is more important than GNP"—gained traction as a policy goal, and the Centre for Bhutan Studies developed a survey to measure the population's overall wellbeing that covers four pillars: promotion of sustainable development, preservation and promotion of cultural values, conservation of the natural environment and establishment of good governance. These four pillars consist of nine general contributors to happiness, including psychological wellbeing, health, education, cultural diversity and resilience, time use, community vitality, living standard, and ecological diversity and resilience. And these ideas are embedded into national policy.[10]

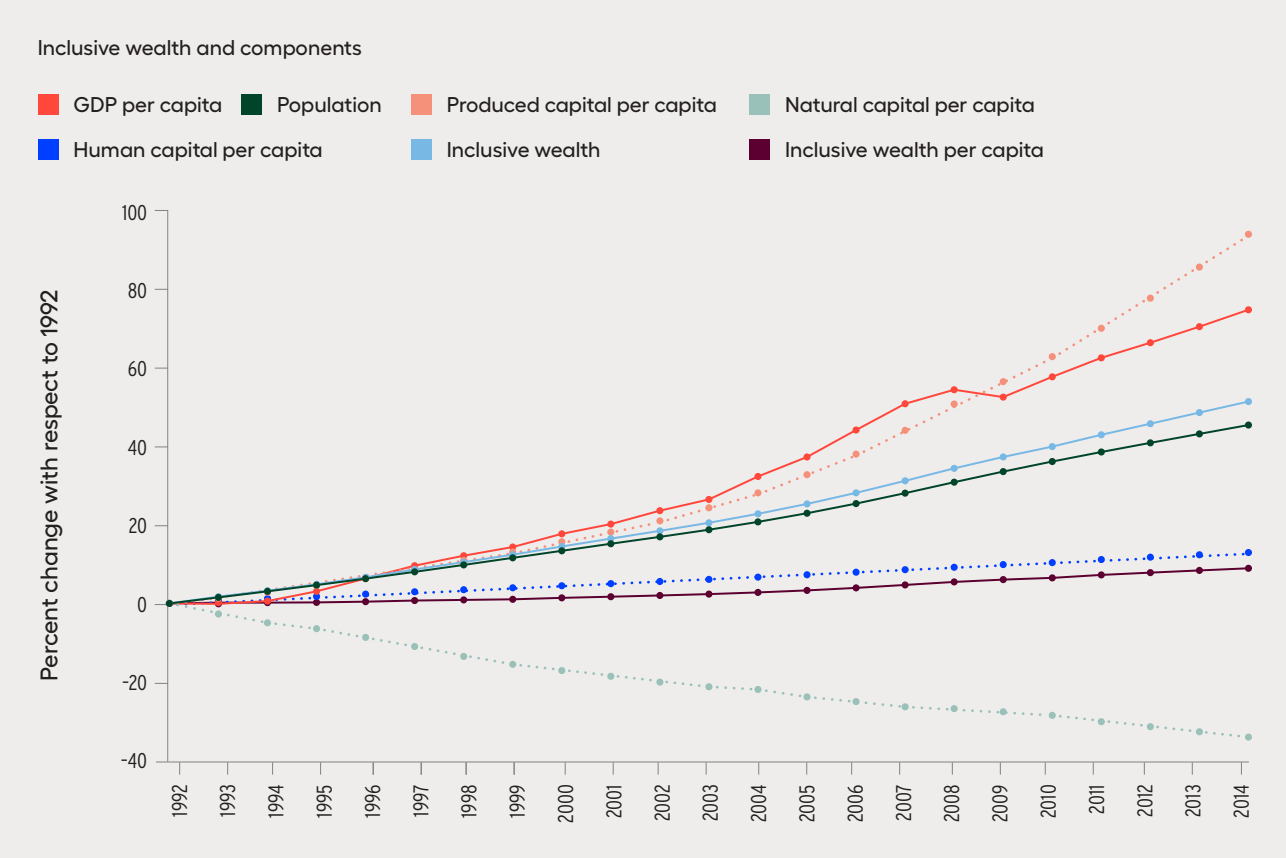
Central government agencies are also becoming interested in wellbeing. For example, the government of New Zealand recently made a strong political commitment to go beyond GDP, with its Treasury using the OECD's Living Standard Framework, which measures wellbeing, capital stocks, and risk and resilience to inform budget decisions.[11] Its commitment to engaging with diverse communities within Aotearoa, New Zealand, will help transformation towards an even richer conceptualization and measure of wellbeing.

Around the world the development of wellbeing indicators for children,[12] older people,[13] people with disabilities[14] and indigenous communities[15] is ongoing, sometimes building on a long tradition of work. So too are wellbeing initiatives undertaken by local communities, such as indigenous communities, that are also undertaking socioenvironmental wellbeing surveys.[16] These and other communities are developing wellbeing indicators to understand the needs and aspirations of their communities in the widest sense.[17]

Notes

1. UK Department of the Environment, Transport and the Regions 1999. **2.** Trewin 2002. **3.** Ireland Central Statistics Office 2004. **4.** OECD 2020a. **5.** OECD 2007. **6.** European Commission 2009. **7.** Stiglitz, Sen and Fitoussi 2009. **8.** CIW 2020. **9.** OECD 2020b. **10.** Centre for Bhutan Studies and GNH Research 2016. **11.** New Zealand Treasury 2020. **12.** Biggeri, Ballet and Comim 2011. **13.** ICECAP-O 2020. **14.** Trani and others 2011. **15.** Breslow and others 2016; Durie 1995; Yap and Yu 2016a. **16.** Durie 1995; Yap and Yu 2016a. **17.** Kukutai and Taylor 2016.

Figure 7.3 The steady decline in natural capital



Source: UNEP 2018b.

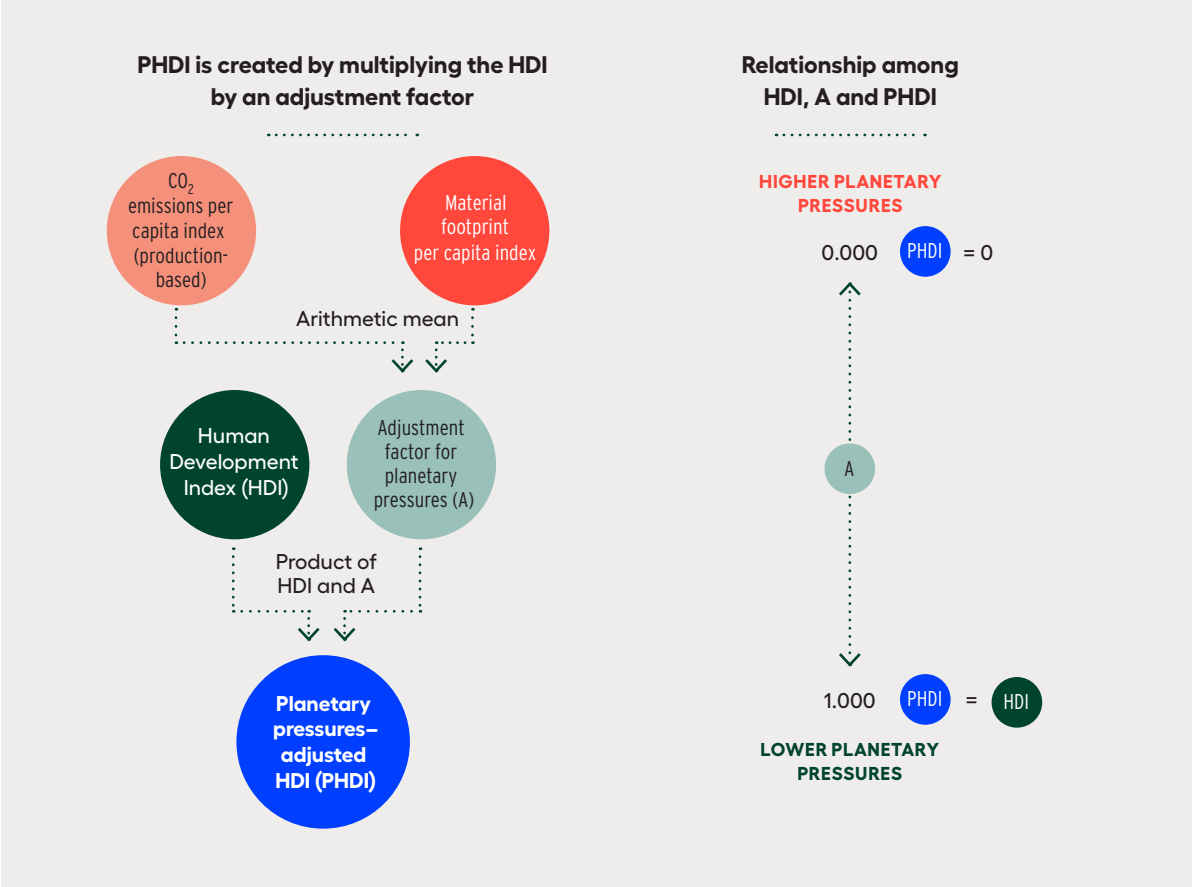
pressures–adjusted HDI (PHDI; figure 7.4).[52] If a country puts no pressure on the planet, its PHDI and HDI would be equal, but the PHDI falls below the HDI as pressure rises. The adjustment factor is calculated as the arithmetic mean of indices measuring carbon dioxide emissions per capita, which speaks to the energy transition away from fossil fuels, and material footprint per capita, which relates to closing material cycles.[53] A country's material footprint measures the amount of material extracted (biomass, fossil fuels, metal ores and nonmetal ores) to meet domestic final demand for goods and services, regardless of where extraction occurs. It is a consumption-based measure that accounts for international trade. It also indicates pressures on the biosphere exerted by socioeconomic activities, since it includes the use of biomass—thus indirectly reflecting impacts of actions such as land use change on the loss of biosphere integrity.[54]

The literature has often justified adjustments to the HDI of this type as a penalty for pollution,[55] as in proposals to multiply the HDI by a loss function associated with carbon dioxide emissions above a country's "fair share."[56] Discounting the HDI could be interpreted as similar to the adjustments in the Inequality-adjusted HDI (IHDI).[57] The IHDI adjustment is motivated by intragenerational inequality, lowering each component of the HDI by the inequality in that component. By analogy, discounting the HDI for planetary pressures could be interpreted as reflecting a concern for intergenerational inequality.

> "If a country puts no pressure on the planet, its PHDI and HDI would be equal, but the PHDI falls below the HDI as pressure rises.

But "one should be careful not to interpret [this type of adjustment] in terms of moral appraisal of countries, because some may have little choice but to deplete their capital."[58] The interpretation proposed here for the adjustment for planetary pressures is

Figure 7.4 Visual representation of the Planetary pressures–adjusted Human Development Index



Source: Human Development Report Office.

intended to incentivize change by providing a metric for countries to assess their own progress over time and highlighting countries that are moving in the right direction so that others can learn from them.[59] It provides a sense of possibility for how to achieve high HDI values with lower emissions and resource use. This approach also avoids imposing what will always be ultimately arbitrary constraints on each country, blind to their historic responsibilities, within-country inequalities—which often reflect longstanding patterns of racial, gender and other types of discrimination—and resource and economic circumstances.[60]

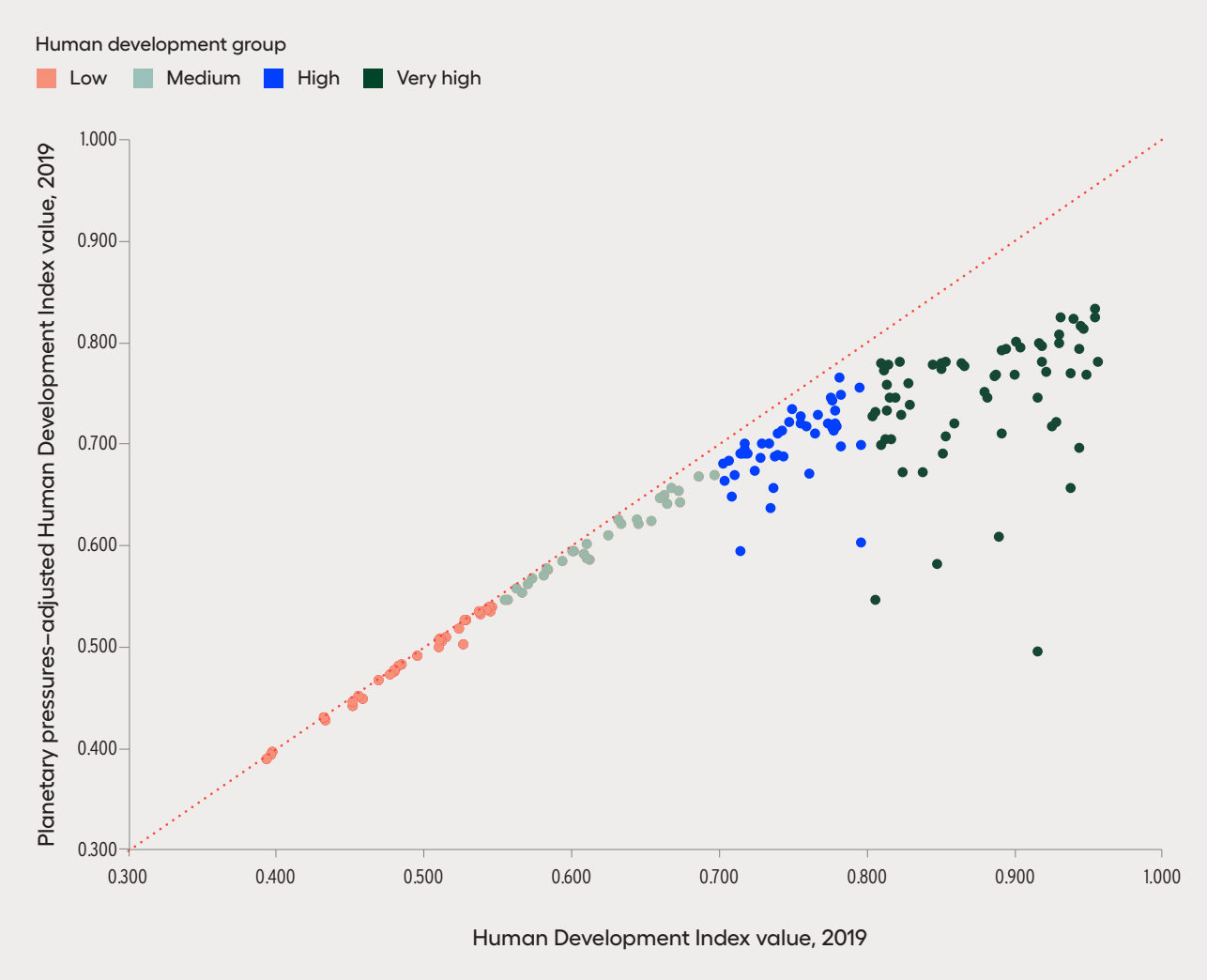
PHDI values are very close to HDI values for countries with an HDI value of 0.7 or lower (figure 7.5). Differences start to open up at higher HDI values, with wider divergence at very high HDI values. But caution must be used in interpreting these numbers because the adjustment does not account for individual country responsibilities—current or historical.[61]

Annex table A7.1 at the end of the chapter presents the values and ranks of countries on the PHDI. Costa Rica has a very large increase in rank from the HDI to the PHDI, while the opposite is true for countries that depend heavily on hydrocarbons. Luxembourg and Singapore demonstrate this more sharply, in large part reflecting their exceptional circumstances, given that both are small, highly open economies with high income per capita and a structural dependence on hydrocarbons for energy.[62]

Human development progress based on the Planetary pressures–adjusted Human Development Index: A new lens

The global PHDI offers a summary view of the evolution in human development and the associated planetary pressures—the world has consistently increased planetary pressures per capita over the

Figure 7.5 Planetary pressures–adjusted Human Development Index values are very close to Human Development Index values for countries with a Human Development Index value of 0.7 or lower



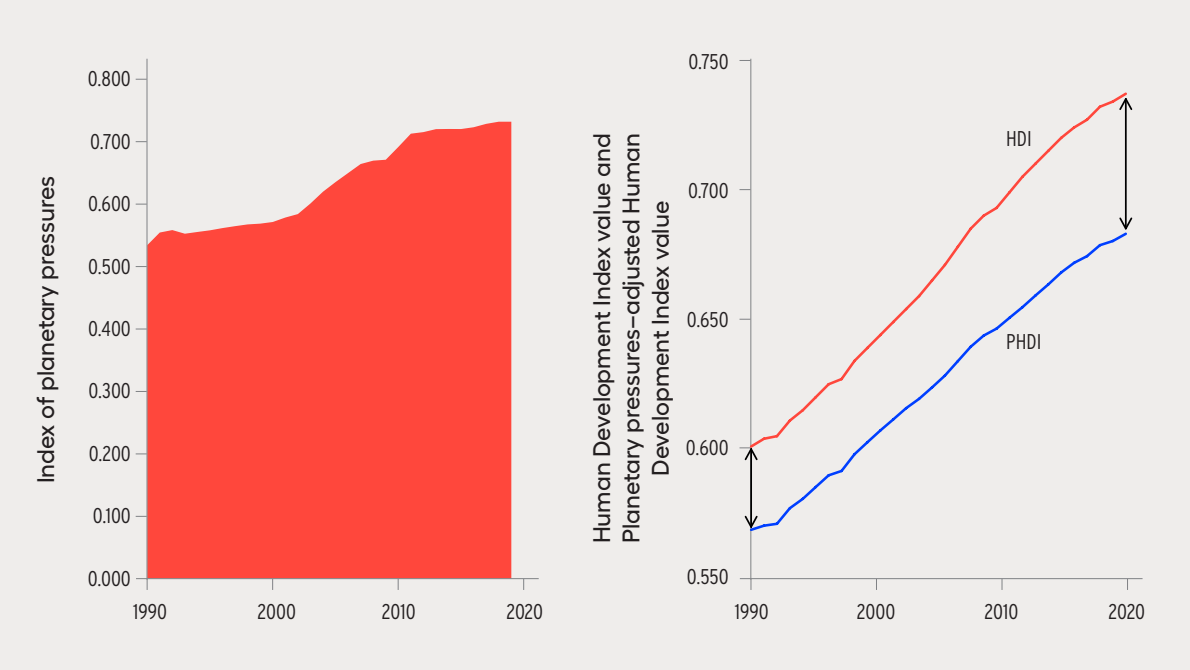
Note: The Planetary pressures–adjusted Human Development Index covers 169 countries with Human Development Index (HDI) values. Data on material footprint are not available for 19 countries with HDI values, and Guyana is excluded from the analysis due to unrealistically high values for material footprint.
Source: Human Development Report Office calculations based on HDI values from table 1 in the statistical annex, data on carbon dioxide emissions from GCP (2020) and data on material footprint from UNEP (2020d).

past three decades (figure 7.6, left panel).[63] The PHDI is not only lower than the HDI; it is also growing more slowly (figure 7.6, right panel). The gap between the conventional assessment of development (the HDI) and the new perspective to navigate the Anthropocene (the experimental PHDI) has been widening.

From an evaluative perspective these trends reflect both gains in the space of basic capabilities and general material conditions and the increasing anthropogenic planetary pressures. As discussed in chapter 2, the negative effects of climate change and losses in biosphere integrity are starting to emerge in different aspects of human development not captured in the HDI.

From a policy perspective the PHDI provides a guiding metric towards advancing human development while easing planetary pressures—a combination that today corresponds to an "empty corner" when human development is contrasted with indicators of planetary pressures, as chapter 1 highlighted.[64] In figure 7.7 the horizontal axis shows the HDI, and the vertical axis shows the index of planetary pressures (which is one minus the adjustment factor for

Figure 7.6 Planetary pressures have increased with gains on the Human Development Index

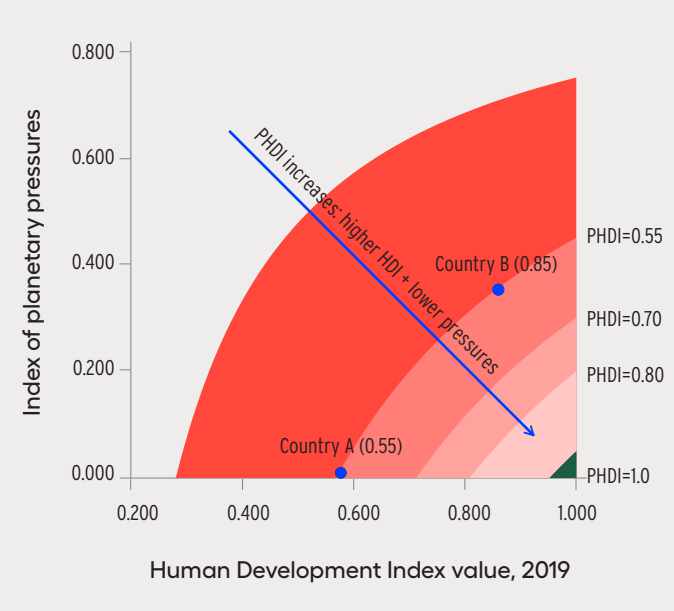


Note: The Planetary pressures–adjusted Human Development Index (PHDI) values for 2018 and 2019 use material footprint data for 2017, the most recent year for which data are available, and the PHDI value for 2019 uses carbon dioxide emissions per capita data for 2018, the most recent year for which data are available. The index of planetary pressures is equal to 1 – A, with A defined in figure 7.4
Source: Human Development Report Office calculations based on Human Development Index values from table 2 of the statistical annex, data on carbon dioxide emissions from GCP (2020) and data on material footprint from UNEP (2020d).

planetary pressures that is multiplied by the HDI to generate the PHDI). Also plotted are contour lines corresponding to the same PHDI values that result from different combinations of the HDI and the index of planetary pressures (isoquants). PHDI values increase as these lines move towards the bottom right corner. This corner (highlighted in green in the figure) is the "empty space" identified in chapter 1 as the aspirational destination of the human development journey in the Anthropocene. For instance, countries in positions A and B have very different HDI values (0.55 and 0.85) but the same PHDI value (0.55) because the greater progress in HDI in country B has been coupled with much greater planetary pressures. This simple example shows the importance of a joint assessment of socioeconomic and planetary pressure indicators as part of a single framework.

Figure 7.8 shows how human development (in its traditional interpretation, characterized by the HDI) is intimately connected with planetary pressures. Of the more than 60 very high human development countries, only 10 are still classified as very high

Figure 7.7 Contrasting progress in human development with planetary pressures



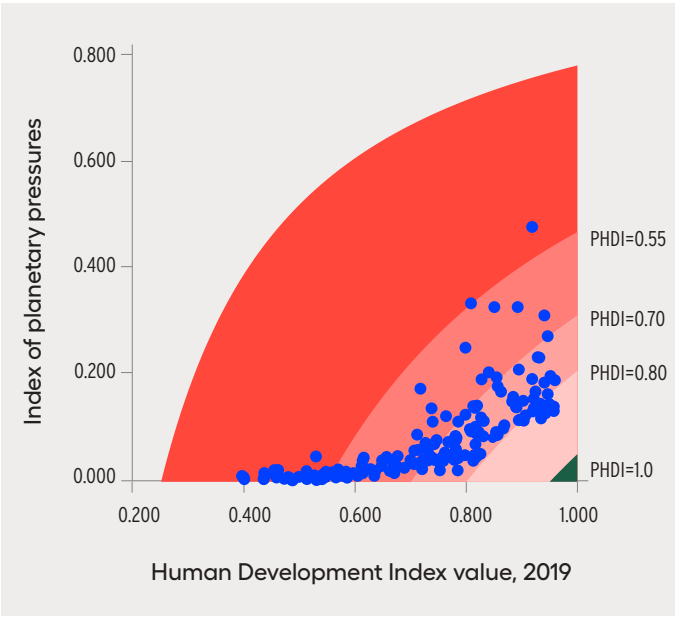
Note: The index of planetary pressures is equal to 1 – A, with A defined in figure 7.4
Source: Human Development Report Office.

human development on the PHDI. And even in those 10 countries the PHDI is still far from the aspirational bottom-right corner.

Looking at the trajectory of countries over the past three decades shows different paths across human development groups. Low and medium human development countries have been able to improve social and economic conditions substantially without a high burden on planetary pressures. But in high and very high human development countries, improvements on the HDI have been coupled with rising planetary pressures (figure 7.9, left panel).

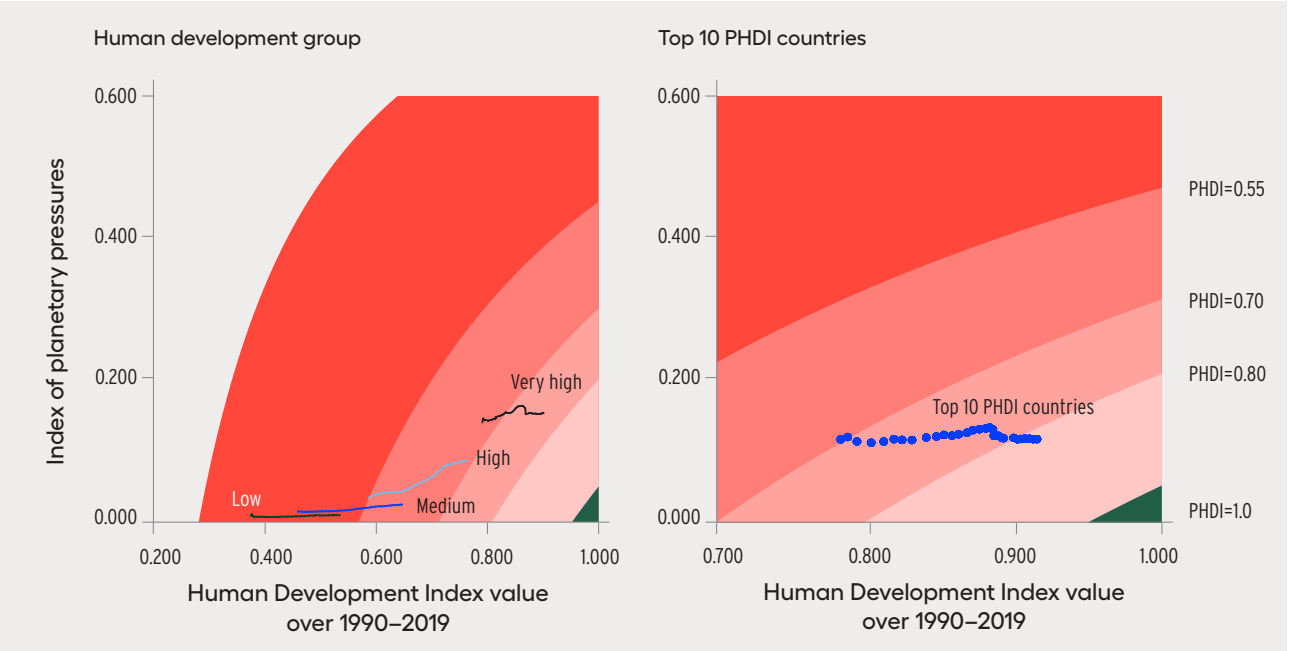
Although absolute planetary pressures have been growing, two aspects reflect some progress. First, after the 2008 global financial crisis a few developed countries have shown some decoupling of human development gains from planetary pressures.[65] For instance, on average, the top 10 countries on the PHDI have increased their HDI value and reduced their planetary pressures over the last decade (figure 7.9, right panel).[66] Second, there is some evidence more broadly of relative decoupling.[67] The curve corresponding to the average performance on the HDI and planetary pressures for all countries moved slightly

Figure 7.8 Of the more than 60 very high human development countries in 2019, only 10 are still classified as very high human development on the Planetary pressures–adjusted Human Development Index



Note: The index of planetary pressures is equal to 1 – A, with A defined in figure 7.4
Source: Human Development Report Office calculations based on Human Development Index values from table 1 of the statistical annex, data on carbon dioxide emissions from GCP (2020) and data on material footprint from UNEP (2020d).

Figure 7.9 Human Development Index and Planetary pressures–adjusted Human Development Index trajectories are coupled in very high human development countries

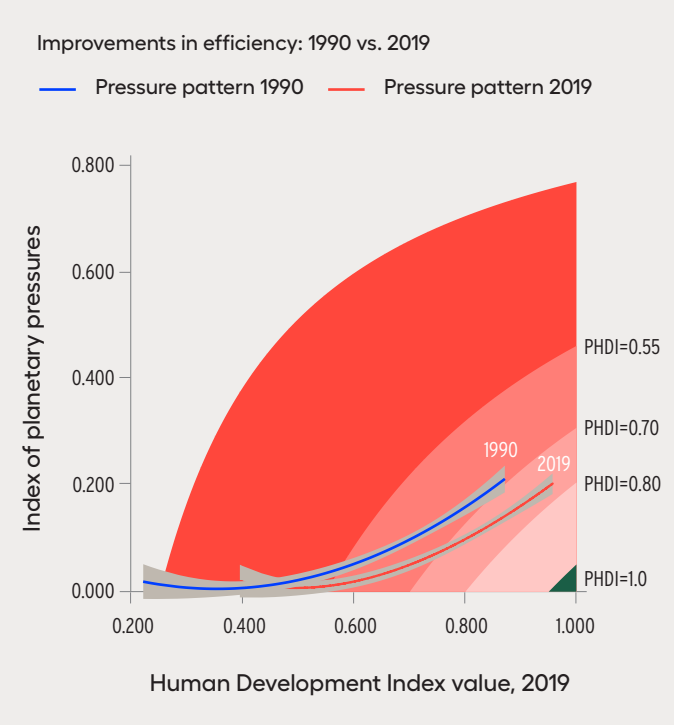


Note: The index of planetary pressures is equal to 1 – A, with A defined in figure 7.4. The lines on the left panel and the dots on the right panel represent the evolution of the two indices over 1990–2019.
Source: Human Development Report Office calculations based on Human Development Index values from table 2 of the statistical annex, data on carbon dioxide emissions from GCP (2020) and data on material footprint from UNEP (2020d).

towards the bottom right-hand corner between 1990 and 2019 (figure 7.10).

But the movement has been far too slow and modest. Further progress will require all countries to rapidly shift substantially towards the bottom-right corner. The PHDI and the HDI can help assess and, more important, encourage choices towards a human development journey in the Anthropocene that move us all in the direction of advancing human development while easing planetary pressures.

Figure 7.10 The world is moving far too slowly towards advancing human development while easing planetary pressures



Note: Cross-sectional pressure patterns for 1990 and 2019 were calculated using a polynomial regression model. Shaded areas are confidence intervals. The index of planetary pressures is equal to 1 – A, with A defined in figure 7.4
Source: Human Development Report Office calculations based on Human Development Index values from table 2 of the statistical annex, data on carbon dioxide emissions from GCP (2020) and data on material footprint from UNEP (2020d).

ANNEX TABLE A7.1

Planetary pressures-adjusted Human Development Index

HDI RANK		Human Development Index (HDI) Value 2019	Planetary pressures–adjusted HDI (PHDI) Value 2019	Difference from HDI value (%) 2019	Difference from HDI rank 2019[a]	Adjustment factor for planetary pressures Value 2019	SDG 9.4 Carbon dioxide emissions per capita (production) (tonnes) 2018	Carbon dioxide emissions (production) index Value 2018	SDG 8.4, 12.2 Material footprint per capita (tonnes) 2017	Material footprint index Value 2017
Very high human development										
1	Norway	0.957	0.781	18.4	-15	0.816	8.3	0.881	37.9	0.752
2	Ireland	0.955	0.833	12.8	1	0.872	8.1	0.884	21.5	0.859
2	Switzerland	0.955	0.825	13.6	0	0.864	4.3	0.938	32.1	0.790
4	Hong Kong, China (SAR)	0.949	..	..	..	..	5.9	0.916	..	..
4	Iceland	0.949	0.768	19.1	-26	0.809	10.8	0.846	34.8	0.772
6	Germany	0.947	0.814	14.0	-1	0.859	9.1	0.869	23.0	0.849
7	Sweden	0.945	0.817	13.5	1	0.865	4.1	0.941	32.2	0.789
8	Australia	0.944	0.696	26.3	-72	0.737	16.9	0.758	43.4	0.716
8	Netherlands	0.944	0.794	15.9	-6	0.842	9.5	0.864	27.7	0.819
10	Denmark	0.940	0.824	12.3	5	0.876	6.1	0.913	24.6	0.839
11	Finland	0.938	0.770	17.9	-19	0.821	8.5	0.878	36.1	0.763
11	Singapore	0.938	0.656	30.1	-92	0.700	7.1	0.898	76.1	0.501
13	United Kingdom	0.932	0.825	11.5	10	0.885	5.6	0.919	22.7	0.851
14	Belgium	0.931	0.800	14.1	4	0.859	8.7	0.876	24.1	0.842
14	New Zealand	0.931	0.808	13.2	6	0.867	7.3	0.895	24.5	0.840
16	Canada	0.929	0.721	22.4	-40	0.776	15.3	0.781	34.9	0.771
17	United States	0.926	0.718	22.5	-45	0.775	16.6	0.763	32.5	0.787
18	Austria	0.922	0.771	16.4	-11	0.837	7.7	0.889	32.9	0.784
19	Israel	0.919	0.797	13.3	7	0.867	7.7	0.890	23.9	0.843
19	Japan	0.919	0.781	15.0	2	0.850	9.1	0.869	25.9	0.830
19	Liechtenstein	0.919	..	..	..	..	4.0	0.942	..	..
22	Slovenia	0.917	0.800	12.8	11	0.873	6.9	0.901	23.7	0.845
23	Korea (Republic of)	0.916	0.746	18.6	-19	0.814	12.9	0.816	28.6	0.813
23	Luxembourg	0.916	0.495	46.0	-131	0.541	15.9	0.773	105.6	0.308
25	Spain	0.904	0.795	12.1	11	0.880	5.7	0.918	24.1	0.842
26	France	0.901	0.801	11.1	16	0.889	5.2	0.926	22.5	0.853
27	Czechia	0.900	0.768	14.7	-5	0.853	9.9	0.858	23.0	0.849
28	Malta	0.895	0.794	11.3	13	0.887	3.6	0.948	26.5	0.826
29	Estonia	0.892	0.711	20.3	-40	0.797	14.8	0.788	29.6	0.806
29	Italy	0.892	0.792	11.2	12	0.888	5.6	0.920	21.9	0.857
31	United Arab Emirates	0.890	0.609	31.6	-87	0.685	21.3	0.694	49.6	0.675
32	Greece	0.888	0.768	13.5	0	0.865	7.0	0.899	25.8	0.831
33	Cyprus	0.887	0.767	13.5	-2	0.865	6.3	0.910	27.5	0.820
34	Lithuania	0.882	0.746	15.4	-8	0.846	4.8	0.931	36.3	0.762
35	Poland	0.880	0.752	14.5	-5	0.855	9.1	0.870	24.5	0.839
36	Andorra	0.868	..	..	..	..	6.1	0.912	..	..
37	Latvia	0.866	0.777	10.3	9	0.897	3.7	0.947	23.2	0.848
38	Portugal	0.864	0.780	9.7	15	0.903	5.0	0.929	18.7	0.878
39	Slovakia	0.860	0.720	16.3	-21	0.837	6.6	0.905	35.3	0.769
40	Hungary	0.854	0.781	8.5	21	0.915	5.1	0.926	14.9	0.903
40	Saudi Arabia	0.854	0.707	17.2	-33	0.827	18.4	0.736	12.4	0.919
42	Bahrain	0.852	0.691	18.9	-42	0.811	19.8	0.717	14.4	0.906
43	Chile	0.851	0.774	9.0	14	0.910	4.6	0.934	17.5	0.885
43	Croatia	0.851	0.779	8.5	19	0.916	4.5	0.936	16.0	0.895
45	Qatar	0.848	0.581	31.5	-84	0.685	38.0	0.456	13.2	0.913
46	Argentina	0.845	0.778	7.9	20	0.920	4.4	0.937	14.7	0.904
47	Brunei Darussalam	0.838	0.672	19.8	-49	0.802	18.5	0.735	20.0	0.869
48	Montenegro	0.829	0.738	11.0	-1	0.890	3.2	0.954	26.7	0.825
49	Romania	0.828	0.760	8.2	11	0.917	3.8	0.946	16.9	0.889
50	Palau	0.826	..	..	..	..	13.2	0.811	..	..
51	Kazakhstan	0.825	0.672	18.5	-46	0.815	17.6	0.749	18.1	0.881
52	Russian Federation	0.824	0.728	11.7	-4	0.883	11.7	0.832	9.9	0.935
53	Belarus	0.823	0.781	5.1	33	0.949	6.9	0.901	0.4	0.997
54	Turkey	0.820	0.746	9.0	10	0.910	5.2	0.926	16.2	0.894
55	Uruguay	0.817	0.704	13.8	-20	0.862	2.0	0.971	37.7	0.753
56	Bulgaria	0.816	0.745	8.7	9	0.913	6.3	0.910	12.8	0.916
57	Panama	0.815	0.778	4.5	30	0.955	2.6	0.963	8.0	0.947
58	Bahamas	0.814	0.733	10.0	6	0.900	4.7	0.933	20.2	0.868
58	Barbados	0.814	0.758	6.9	18	0.932	4.5	0.936	11.1	0.927

Continued →

HDI RANK		Human Development Index (HDI)	Planetary pressures–adjusted HDI (PHDI)			Adjustment factor for planetary pressures	SDG 9.4 Carbon dioxide emissions per capita (production)	Carbon dioxide emissions (production) index	SDG 8.4, 12.2 Material footprint per capita	Material footprint index
		Value	Value	Difference from HDI value (%)	Difference from HDI rank	Value	(tonnes)	Value	(tonnes)	Value
		2019	2019	2019	2019[a]	2019	2018	2018	2017	2017
60	Oman	0.813	0.704	13.4	-15	0.866	13.9	0.801	10.4	0.932
61	Georgia	0.812	0.772	4.9	30	0.951	2.6	0.962	9.1	0.940
62	Costa Rica	0.810	0.779	3.8	37	0.961	1.6	0.977	8.3	0.946
62	Malaysia	0.810	0.699	13.7	-18	0.863	8.1	0.884	24.2	0.842
64	Kuwait	0.806	0.547	32.1	-74	0.678	23.7	0.661	46.5	0.696
64	Serbia	0.806	0.732	9.2	10	0.908	5.2	0.926	16.7	0.891
66	Mauritius	0.804	0.727	9.6	9	0.904	3.8	0.945	20.8	0.864
High human development										
67	Seychelles	0.796	0.699	12.2	-13	0.879	6.7	0.903	22.3	0.854
67	Trinidad and Tobago	0.796	0.603	24.2	-54	0.758	31.3	0.552	5.6	0.963
69	Albania	0.795	0.756	4.9	28	0.951	1.6	0.977	11.4	0.925
70	Cuba	0.783	0.749	4.3	27	0.957	2.5	0.964	7.8	0.949
70	Iran (Islamic Republic of)	0.783	0.698	10.9	-12	0.891	8.8	0.874	14.1	0.908
72	Sri Lanka	0.782	0.765	2.2	34	0.979	1.1	0.984	4.1	0.973
73	Bosnia and Herzegovina	0.780	0.718	7.9	8	0.920	6.5	0.907	10.2	0.933
74	Grenada	0.779	..	..	..	..	2.4	0.965	..	..
74	Mexico	0.779	0.733	5.9	22	0.941	3.8	0.946	9.8	0.936
74	Saint Kitts and Nevis	0.779	..	..	..	..	4.6	0.934	..	..
74	Ukraine	0.779	0.720	7.6	13	0.924	5.1	0.927	12.1	0.920
78	Antigua and Barbuda	0.778	0.713	8.4	7	0.917	5.9	0.916	12.5	0.918
79	Peru	0.777	0.743	4.4	28	0.956	1.7	0.975	9.6	0.937
79	Thailand	0.777	0.716	7.9	9	0.921	4.2	0.941	15.0	0.902
81	Armenia	0.776	0.745	4.0	32	0.960	1.9	0.973	8.2	0.947
82	North Macedonia	0.774	0.720	7.0	19	0.930	3.5	0.950	13.8	0.910
83	Colombia	0.767	0.729	5.0	26	0.951	2.0	0.972	10.7	0.930
84	Brazil	0.765	0.710	7.2	10	0.927	2.2	0.969	17.4	0.886
85	China	0.761	0.671	11.8	-16	0.881	7.0	0.899	20.9	0.863
86	Ecuador	0.759	0.718	5.4	19	0.947	2.5	0.965	11.0	0.928
86	Saint Lucia	0.759	..	..	..	..	2.3	0.967	..	..
88	Azerbaijan	0.756	0.720	4.8	24	0.953	3.7	0.947	6.3	0.959
88	Dominican Republic	0.756	0.727	3.8	28	0.962	2.3	0.967	6.6	0.957
90	Moldova (Republic of)	0.750	0.734	2.1	36	0.979	1.3	0.982	3.8	0.975
91	Algeria	0.748	0.721	3.6	29	0.963	3.7	0.947	3.1	0.980
92	Lebanon	0.744	0.688	7.5	-2	0.924	3.5	0.949	15.4	0.899
93	Fiji	0.743	0.713	4.0	21	0.959	2.4	0.966	7.2	0.953
94	Dominica	0.742	..	..	..	..	2.5	0.964	..	..
95	Maldives	0.740	0.689	6.9	1	0.931	3.0	0.958	14.5	0.905
95	Tunisia	0.740	0.710	4.1	19	0.960	2.7	0.961	6.3	0.959
97	Saint Vincent and the Grenadines	0.738	..	..	..	..	2.0	0.971	..	..
97	Suriname	0.738	0.687	6.9	1	0.931	3.1	0.956	14.2	0.907
99	Mongolia	0.737	0.657	10.9	-10	0.891	8.9	0.873	13.9	0.909
100	Botswana	0.735	0.637	13.3	-18	0.867	3.0	0.958	34.1	0.776
101	Jamaica	0.734	0.700	4.6	18	0.954	2.8	0.960	7.9	0.948
102	Jordan	0.729	0.700	4.0	19	0.961	2.4	0.965	6.7	0.956
103	Paraguay	0.728	0.686	5.8	5	0.943	1.1	0.985	15.1	0.901
104	Tonga	0.725	..	..	..	..	1.3	0.981	..	..
105	Libya	0.724	0.673	7.0	3	0.929	8.1	0.884	3.9	0.974
106	Uzbekistan	0.720	0.691	4.0	15	0.960	2.8	0.960	6.0	0.960
107	Bolivia (Plurinational State of)	0.718	0.695	3.2	17	0.968	2.0	0.972	5.5	0.964
107	Indonesia	0.718	0.691	3.8	16	0.963	2.3	0.967	6.3	0.959
107	Philippines	0.718	0.701	2.4	24	0.977	1.3	0.982	4.4	0.971
110	Belize	0.716	0.690	3.6	16	0.964	1.5	0.979	7.8	0.949
111	Samoa	0.715	0.690	3.5	17	0.965	1.3	0.981	7.9	0.948
111	Turkmenistan	0.715	0.595	16.8	-18	0.832	13.7	0.805	21.5	0.859
113	Venezuela (Bolivarian Republic of)	0.711	0.670	5.8	7	0.942	4.8	0.931	7.3	0.952
114	South Africa	0.709	0.648	8.6	-1	0.914	8.1	0.884	8.5	0.945
115	Palestine, State of	0.708	..	..	..	..	0.7	0.991	..	..
116	Egypt	0.707	0.684	3.3	15	0.967	2.4	0.965	4.8	0.968
117	Marshall Islands	0.704	..	..	..	..	2.6	0.963	..	..
117	Viet Nam	0.704	0.664	5.7	7	0.943	2.2	0.969	12.7	0.917
119	Gabon	0.703	0.680	3.3	16	0.967	2.5	0.964	4.5	0.971
Medium human development										
120	Kyrgyzstan	0.697	0.669	4.0	11	0.960	1.6	0.977	8.7	0.943
121	Morocco	0.686	0.668	2.6	11	0.974	1.8	0.974	3.9	0.975
122	Guyana	0.682	..	..	..	..	3.1	0.955	..[b]	..
123	Iraq	0.674	0.642	4.7	3	0.953	5.3	0.924	2.8	0.982
124	El Salvador	0.673	0.654	2.8	8	0.972	1.1	0.984	6.3	0.959
125	Tajikistan	0.668	0.657	1.6	12	0.984	0.6	0.991	3.7	0.976

Continued →

HDI RANK	Human Development Index (HDI)	Planetary pressures–adjusted HDI (PHDI)			Adjustment factor for planetary pressures	SDG 9.4 Carbon dioxide emissions per capita (production)	Carbon dioxide emissions (production) index	SDG 8.4, 12.2 Material footprint per capita	Material footprint index
	Value	Value	Difference from HDI value (%)	Difference from HDI rank	Value	(tonnes)	Value	(tonnes)	Value
	2019	2019	2019	2019[a]	2019	2018	2018	2017	2017
126 Cabo Verde	0.665	0.641	3.6	5	0.964	1.2	0.983	8.6	0.944
127 Guatemala	0.663	0.650	2.0	10	0.980	1.1	0.985	3.9	0.975
128 Nicaragua	0.660	0.647	2.0	9	0.980	0.9	0.988	4.3	0.972
129 Bhutan	0.654	0.624	4.6	4	0.954	1.6	0.977	10.4	0.932
130 Namibia	0.646	0.621	3.9	4	0.961	1.7	0.975	8.2	0.946
131 India	0.645	0.626	2.9	8	0.971	2.0	0.972	4.6	0.970
132 Honduras	0.634	0.621	2.1	6	0.980	1.0	0.985	4.0	0.974
133 Bangladesh	0.632	0.625	1.1	9	0.988	0.5	0.992	2.4	0.985
134 Kiribati	0.630	..	..	..	..	0.6	0.991	..	..
135 Sao Tome and Principe	0.625	0.610	2.4	6	0.976	0.6	0.992	5.9	0.961
136 Micronesia (Federated States of)	0.620	..	..	..	..	1.3	0.981	..	..
137 Lao People's Democratic Republic	0.613	0.586	4.4	-2	0.956	2.7	0.961	7.5	0.951
138 Eswatini (Kingdom of)	0.611	0.587	3.9	0	0.961	1.1	0.985	9.6	0.937
138 Ghana	0.611	0.601	1.6	5	0.984	0.6	0.991	3.6	0.977
140 Vanuatu	0.609	0.592	2.8	3	0.971	0.5	0.992	7.6	0.950
141 Timor-Leste	0.606	..	..	..	..	0.4	0.994	..	..
142 Nepal	0.602	0.595	1.2	7	0.988	0.3	0.995	2.8	0.982
143 Kenya	0.601	0.594	1.2	6	0.988	0.4	0.995	3.0	0.980
144 Cambodia	0.594	0.584	1.7	3	0.984	0.6	0.991	3.6	0.976
145 Equatorial Guinea	0.592	..	..	..	..	4.3	0.938	..	..
146 Zambia	0.584	0.576	1.4	1	0.986	0.3	0.996	3.5	0.977
147 Myanmar	0.583	0.578	0.9	3	0.992	0.5	0.993	1.4	0.991
148 Angola	0.581	0.570	1.9	2	0.981	1.1	0.984	3.4	0.978
149 Congo	0.574	0.567	1.2	2	0.988	0.6	0.991	2.2	0.986
150 Zimbabwe	0.571	0.562	1.6	2	0.983	0.8	0.988	3.2	0.979
151 Solomon Islands	0.567	..	..	..	..	0.3	0.996	..	..
151 Syrian Arab Republic	0.567	0.554	2.3	1	0.977	1.7	0.976	3.4	0.978
153 Cameroon	0.563	0.558	0.9	3	0.991	0.3	0.995	1.9	0.987
154 Pakistan	0.557	0.547	1.8	2	0.982	1.1	0.985	3.2	0.979
155 Papua New Guinea	0.555	0.547	1.4	3	0.985	0.9	0.987	2.6	0.983
156 Comoros	0.554	..	..	..	..	0.3	0.996	..	..
Low human development									
157 Mauritania	0.546	0.539	1.3	1	0.987	0.6	0.991	2.5	0.984
158 Benin	0.545	0.535	1.8	-1	0.981	0.6	0.991	4.4	0.971
159 Uganda	0.544	0.539	0.9	3	0.991	0.1	0.998	2.5	0.983
160 Rwanda	0.543	0.537	1.1	2	0.989	0.1	0.999	3.1	0.980
161 Nigeria	0.539	0.532	1.3	0	0.987	0.6	0.991	2.7	0.982
162 Côte d'Ivoire	0.538	0.535	0.6	3	0.995	0.3	0.995	0.9	0.994
163 Tanzania (United Republic of)	0.529	0.526	0.6	1	0.994	0.2	0.997	1.4	0.991
164 Madagascar	0.528	0.526	0.4	2	0.996	0.2	0.998	0.8	0.994
165 Lesotho	0.527	0.503	4.6	-4	0.954	1.3	0.982	11.4	0.925
166 Djibouti	0.524	0.518	1.1	2	0.988	0.7	0.990	2.3	0.985
167 Togo	0.515	0.509	1.2	2	0.989	0.4	0.994	2.5	0.984
168 Senegal	0.512	0.505	1.4	0	0.987	0.7	0.989	2.4	0.984
169 Afghanistan	0.511	0.508	0.6	3	0.994	0.3	0.996	1.2	0.992
170 Haiti	0.510	0.507	0.6	3	0.994	0.3	0.996	1.4	0.991
170 Sudan	0.510	0.500	2.0	0	0.980	0.5	0.993	5.0	0.967
172 Gambia	0.496	0.491	1.0	0	0.990	0.3	0.996	2.3	0.985
173 Ethiopia	0.485	0.483	0.4	0	0.997	0.1	0.998	0.8	0.995
174 Malawi	0.483	0.481	0.4	0	0.996	0.1	0.999	1.2	0.992
175 Congo (Democratic Republic of the)	0.480	0.477	0.6	0	0.993	0.0	1.000	2.0	0.987
175 Guinea-Bissau	0.480	..	..	..	..	0.2	0.997	..	..
175 Liberia	0.480	0.476	0.8	-1	0.993	0.3	0.995	1.6	0.990
178 Guinea	0.477	0.473	0.8	0	0.991	0.3	0.996	2.3	0.985
179 Yemen	0.470	0.467	0.6	0	0.994	0.4	0.995	1.1	0.993
180 Eritrea	0.459	0.449	2.2	-1	0.978	0.2	0.997	6.2	0.959
181 Mozambique	0.456	0.452	0.9	1	0.992	0.3	0.996	2.0	0.987
182 Burkina Faso	0.452	0.446	1.3	0	0.986	0.2	0.997	4.0	0.974
182 Sierra Leone	0.452	0.442	2.2	-1	0.978	0.1	0.998	6.4	0.958
184 Mali	0.434	0.427	1.6	-2	0.984	0.2	0.997	4.6	0.970
185 Burundi	0.433	0.431	0.5	1	0.994	0.0	0.999	1.6	0.990
185 South Sudan	0.433	0.430	0.7	0	0.993	0.2	0.998	1.6	0.989
187 Chad	0.398	0.396	0.5	0	0.994	0.1	0.999	1.5	0.990
188 Central African Republic	0.397	0.393	1.0	0	0.991	0.1	0.999	2.6	0.983
189 Niger	0.394	0.390	1.0	0	0.989	0.1	0.999	3.2	0.979
Other countries or territories									
Korea (Democratic People's Rep. of)	..	..	..	..	0.988	1.2	0.983	1.0	0.993
Monaco	..	..	..	..	..	..	..	..	..

Continued →

HDI RANK	Human Development Index (HDI) Value 2019	Planetary pressures–adjusted HDI (PHDI) Value 2019	Difference from HDI value (%) 2019	Difference from HDI rank 2019[a]	Adjustment factor for planetary pressures Value 2019	SDG 9.4 Carbon dioxide emissions per capita (production) (tonnes) 2018	Carbon dioxide emissions (production) index Value 2018	SDG 8.4, 12.2 Material footprint per capita (tonnes) 2017	Material footprint index Value 2017
Nauru	..	..	..	..	..	4.7	0.933	..	..
San Marino	..	..	..	..	..	..	..	..	..
Somalia	..	..	..	..	0.992	0.0	0.999	2.3	0.985
Tuvalu	..	..	..	..	..	1.0	0.986	..	..
Human development groups									
Very high human development	0.898	0.760	15.4	–	0.846	10.4	0.851	24.2	0.841
High human development	0.753	0.688	8.6	–	0.914	5.1	0.927	15.2	0.900
Medium human development	0.631	0.615	2.5	–	0.975	1.6	0.977	4.0	0.974
Low human development	0.513	0.508	1.0	–	0.990	0.3	0.996	2.2	0.985
Developing countries	0.689	0.651	5.5	–	0.944	3.4	0.952	9.6	0.937
Regions									
Arab States	0.705	0.666	5.5	–	0.944	4.8	0.931	6.5	0.958
East Asia and the Pacific	0.747	0.676	9.5	–	0.905	5.5	0.921	16.9	0.890
Europe and Central Asia	0.791	0.728	8.0	–	0.920	5.5	0.921	12.2	0.920
Latin America and the Caribbean	0.766	0.720	6.0	–	0.940	2.8	0.960	12.4	0.919
South Asia	0.641	0.622	3.0	–	0.971	2.0	0.972	4.6	0.970
Sub-Saharan Africa	0.547	0.539	1.5	–	0.985	0.8	0.988	2.8	0.982
Least developed countries	0.538	0.533	0.9	–	0.990	0.3	0.995	2.3	0.985
Small island developing states	0.728	0.680	6.6	–	0.935	3.2	0.954	12.9	0.915
Organisation for Economic Co-operation and Development	0.900	0.766	14.9	–	0.851	9.5	0.864	24.8	0.838
World	**0.737**	**0.683**	**7.3**	**–**	**0.927**	**4.6**	**0.934**	**12.3**	**0.919**

Notes

a Based on countries for which a Planetary pressures–adjusted Human Development Index value is calculated.

b Not reported.

Definitions

Human Development Index (HDI): A composite index measuring average achievement in three basic dimensions of human development—a long and healthy life, knowledge and a decent standard of living. See *Technical note 1* at http://hdr.undp.org/sites/default/files/hdr2020_technical_notes.pdf for details on how the HDI is calculated.

Planetary pressures–adjusted HDI (PHDI): HDI value adjusted by the level of carbon dioxide emissions and material footprint per capita to account for excessive human pressures on the planet. It should be seen as an incentive for transformation. See *Technical note* at http://hdr.undp.org/sites/default/files/phdi_tn.pdf for details on how the PHDI is calculated

Difference from HDI value: Percentage difference between the PHDI value and the HDI value.

Difference from HDI rank: Difference in ranks on the PHDI and the HDI, calculated only for countries for which a PHDI value is calculated.

Adjustment factor for planetary pressures: Arithmetic average of the carbon dioxide emissions index and the material footprint index, both defined below. A high value implies less pressure on the planet.

Carbon dioxide emissions per capita (production): Carbon dioxide emissions produced as a consequence of human activities (use of coal, oil and gas for combustion and industrial processes, gas flaring and cement manufacture) divided by midyear population. Values are territorial emissions, meaning that emissions are attributed to the country in which they physically occur.

Carbon dioxide emissions (production) index: Carbon dioxide emissions per capita (production-based) expressed as an index using a minimum value of 0 and a maximum value of 69.85 tonnes per person. A high value implies less pressure on the planet.

Material footprint per capita: Material footprint is the attribution of global material extraction to domestic final demand of a country. The total material footprint is the sum of the material footprint for biomass, fossil fuels, metal ores and nonmetal ores. Material footprint is calculated as raw material equivalent of imports plus domestic extraction minus raw material equivalents of exports. Material footprint per capita describes the average material use for final demand.

Material footprint index: Material footprint per capita expressed as an index using a minimum value of 0 and a maximum value of 152.58 tonnes per person. A high value implies less pressure on the planet.

Sources

Column 1: Human Development Report Office calculations based on data from UNDESA (2019b), UNESCO Institute for Statistics (2020), United Nations Statistics Division (2020b), World Bank (2020g), Barro and Lee (2018) and IMF (2020d).

Column 2: Calculated as the product of the HDI and the adjustment factor presented in column 5.

Column 3: Calculated based on data in columns 1 and 2.

Column 4: Calculated based on PHDI values and recalculated HDI ranks for countries for which a PHDI value is calculated.

Column 5: Calculated based on data in columns 7 and 9.

Column 6: GCP 2020.

Column 7: Calculated based on data in column 6.

Column 8: UNEP 2020d.

Column 9: Calculated based on data in column 8.

SPOTLIGHT 7.1

The Human Development Index at 30: Ageing well?

Amartya Sen argued that presenting an alternative to the exclusive concentration on utility (and its "younger brother," real income) in the evaluation of wellbeing and development was key for the success of the first 10 years of the Human Development Report. The genius of Mahbub Ul Haq, Sen argued, was to confederate "large armies of discontent" with the single-minded focus on income and to put forward a "broad and permissive framework for social evaluation" open to multiple concerns—a framework that makes it possible "to have many different things as being simultaneously valuable."[1] The approach came with proposals on accounting for differences and progress in human development that reflected this spirit and were informed by the capability approach.

The Human Development Index (HDI) was introduced to account for a basic set of capabilities—longevity, education and "command over resources to enjoy a decent standard of living."[2] Proxied by income per capita, this third component of the HDI was to be interpreted "strictly as a residual catch-all, to reflect something of other basic capabilities not already incorporated in the measures of longevity and education."[3] Thus, while the indicators for health and education directly reflect capabilities, income is included as something with instrumental value, as a "causal antecedent for basic human capabilities" to account for other "basic concerns that have to be captured in an accounting of elementary capabilities."[4] Those concerns could include freedom from hunger, having shelter, mobility or Adam Smith's notion that "the clothing and other resources one needs 'to appear in public without shame' depends on what other people standardly wear, which in turn could be more expensive in rich societies than in poor ones."[5]

Before starting the Human Development Report, Haq was an influential voice in framing the sustainability debate in terms that reflected the perspective of developing countries.[6] This evolved towards the more recent formulations that tie environmental sustainability with social and economic sustainability, culminating in the 2030 Agenda for Sustainable Development. But as chapter 1 argued, the Report has integrated concerns with environmental degradation and sustainability from the very beginning. Over the years the Report has followed a dual approach in implementing Haq's vision of enhancing human lives through more freedom and opportunity—presenting alternative human development metrics and applying the human development approach to a development theme.[7]

With its visibility and relevance, the HDI has been subjected to its own dose of critical scrutiny. A perennial observation is that the HDI does not include important dimensions of development. The list is long but includes poverty, human rights, happiness, governance, security, environment, wellbeing and social cohesion, among many others.[8] Motivated in part by these "missing" dimensions and in part by the proven success of composite indices and country rankings, the HDI is now released among a plethora of other measures that purport to serve as alternative focal points of measurement either for development or for some particular dimension.

Adding something would inevitably dilute the significance of the constitutive dimensions of human development of the HDI. Additions would thus also diminish its distinctiveness in the now fairly well populated ecosystem of composite indices.[9] It is unclear which missing dimensions could be characterized as a capability.[10] Many, if not most, have been addressed in the narrative parts of Human Development Reports.[11] Thus the HDI has been retained over the years as it was initially intended—an index of basic capabilities, with health and education at their core and income used instrumentally as a residual that accounts for other elemental capabilities.

While the three dimensions have been retained, several modifications have been made. Some were simple changes to the indicators, aimed at better

reflecting achievements in the capabilities accounted for in the index. For instance, the literacy rate was dropped as an indicator of education, replaced by a combination of mean years of schooling and expected years of schooling.[12] The Sustainable Development Goals have further shifted education aims away from enrolment rates towards targets related to learning. While that is also the relevant capability that years of schooling meant to capture, more direct measures of learning achievements would take us closer. But data availability remains a challenge.[13] This example is not meant to be settled here but to illustrate the dynamic and iterative process involved in the choice of indicators included in the HDI. This process reflects advances in measurement that better capture capabilities, improvements in our empirical understanding of the real achievement (and shortfalls) that are relevant and the data availability that allows for reasonably comprehensive coverage of countries over time.[14]

In debates over sustainability and environmental pressure, including income in the HDI is seen by some as particularly problematic.[15] But as noted, income should be understood as an index of other basic capabilities beyond health and education. It is crucial to reiterate that the production and command over commodities are seen as instrumental—one of the contributions of the Human Development Report has been to document the very different ways societies make use of their ability to produce commodities to yield very different achievements in capabilities. Furthermore, conversion rate of income into basic capabilities decreases as income rises—which is one reason why income per capita enters into the HDI in logarithmic form.[16] Conversely, additional income is likely to make a big difference in enabling capabilities at low incomes. In fact, the first version of the HDI gave zero weight to income per capita above a certain threshold—defined for the 1990 Report as the mean of the poverty lines in a few high-income countries.[17]

This first version of the HDI could also be interpreted as an expression of the ethical concern for those who have the least, which permeates not only the human development approach but also has broad ethical appeal. It is reflected in the aspiration to "leave no one behind and reach the furthest behind first" of the 2030 Agenda for Sustainable Development, and in Sustainable Development Goal 10, for which one target is having the bottom 40 percent of the population increase its income at a rate greater than the average. But by the second Human Development Report, the constraint of giving zero weight to incomes above the poverty line of rich countries was relaxed because it implied that human development gains above that poverty line were essentially worthless, which was inconsistent with the broader framing of striving for longer and better lives for everyone.[18] There are thus good reasons to include income with logarithmic transformation in the HDI.

The HDI has been complemented over the years with other indices, statistical tables and statistical dashboards to provide a more comprehensive perspective of the relevant data to assess countries on human development. To shine a spotlight on poverty, the Human Development Report introduced in 2010 the Multidimensional Poverty Index, which measures deprivations without including income. In the same year it introduced the Inequality-adjusted HDI, which addresses another criticism of the HDI—it is based on average achievements and does not consider disparities across the population. The Inequality-adjusted HDI discounts the average achievement in each dimension by the level of inequality in that dimension. Building on the pioneering 1995 Human Development Report on gender, which also proposed indices to measure gender inequalities in both wellbeing and agency, the Report now includes two indices on gender, one accounting for differences between men and women on the HDI dimensions, the other a composite of inequalities in empowerment and wellbeing.

In practical terms the Human Development Report has always considered the single index versus dashboards a false dichotomy. Since the beginning, the Report has presented both composite indices (often several) and dashboards (initially in the form of statistical tables aggregated by topics relevant for human development, now complemented by full-fledged dashboards).[19] Improving the metrics of human development implies continuing work on both fronts.

Thus the HDI at 30 years is ageing well. It remains effective as a partial index of basic capabilities essential for wellbeing to be complemented by a broader set of indices and statistics that give a fuller account of the state and prospects of human development.

NOTES

1 This paragraph is based on Sen (2000), with direct quotations from this work. See also Stewart, Ranis and Samman (2018).

2 UNDP 1990, p. 1.

3 Anand and Sen 2000b, p. 86.

4 Anand and Sen 2000b, p. 86.

5 Sen 2005, p. 154. Of course, clothing is used as an example of a broader point: The experience of not living in poverty includes a dimension of social inclusion, of dignity, for which the level of command over commodities is higher in countries with higher income. People may have reasons to value higher incomes far beyond what is required to meet basic subsistence needs.

6 Fukuda-Parr and Muchhala 2020.

7 Haq 1995. Ironically, the success of the HDI may have generated its very own dominance, of the sort that Mahbub Ul Haq rebelled against in the form of income, often overshadowing the narrative component of many Human Development Reports and in the process partially obscuring the critical scrutiny of the human development approach to a wide range of policies, practices and features in areas ranging from the international financial and economic system to intellectual property rights that stand in the way of enhancing human lives and freedoms.

8 See, for instance, Ranis, Stewart and Samman (2006).

9 Kanbur 2020.

10 For a discussion in the context of sustainability, see Malik (2020).

11 Sometimes accompanied by introducing innovative measures of human development related to them.

12 Differences across countries in literacy rates had shrunk considerably by the time this change was implemented in 2010, which partially motivated the drop of literacy, but even a change as simple as this inevitably implies that something is lost. In this case there is no information on learning achievements—for which literacy, however imperfectly, provided some. Recent evidence suggests that as many as 53 percent of 10-year-olds in low- and middle-income countries—and as many as 80 percent in some of the lowest income countries—cannot read and understand a simple written paragraph (World Bank 2019a).

13 Even if there have been some recent advances in the direct measurement of literacy and numeracy, such as those used in the measure of quality of education in producing the World Bank's Human Capital Index (World Bank 2020a). But data are available only for recent years and for a limited number of countries, and the measures used contested.

14 The modification of the way the three components are combined into a single index was more substantial. One strand of critical scrutiny targets the assumption of equal weights across the three dimensions of the HDI. Another persistent line of argument was that the assumption of perfect substitutability, as reflected in the use of the arithmetic mean to aggregate the HDI in the 1990–2010 Human Development Reports allowed for perfect substitutability across the three dimensions. The shift from an arithmetic mean to a geometric one to aggregate the three components of the index was meant, in part, to address this line of concern (Klugman, Rodríguez and Choi 2011; UNDP 2010c). But it generated its own rebuttals, with a debate that continues today (Ravallion 2012). For a recent perspective on the debate, see Rodriguez (2020). Anand (2018) provides a forceful argument for the advantages of the arithmetic mean, showing that using the geometric mean suggests that improvements in life expectancy in lower income countries are "worth" less—when evaluated in terms of income, as implied by the geometric mean aggregation—than in richer countries. This goes against the fundamental human development principle of equality of life claims. Fleurbaey (2019) counters that it is possible to look at this result with a different ethical lens, suggesting that the lower value of life expectancy in a poorer country simply reflects that an impartial observer would rather live a year more of life in a rich country than in a poorer country. As a matter of empirical fact, however, differences in rankings of countries obtained with either method—or with some of the other alternatives proposed—are not very significant (Klasen 2018). But the objections to the geometric mean deserve careful consideration as we think about the future of the HDI, bearing in mind the original objective to have a measure that was simple to communicate and understand by the public, a rough and ready indicator, which the use of the geometric mean does not help with. And worrying too much about substitutability goes against the idea of having many different things as being simultaneously valuable. As Basu and Lòpez-Calva (2011) argue, the capabilities approach compels us to think about sets and to move away from framing welfare evaluation as the maximization of a single variable that is a function of factors that are subject to tradeoffs and marginal rates of substitution.

15 Chhibber 2020.

16 One consequence of this—more than the use of the geometric mean to aggregate the different components of the HDI—is the very low implicit valuation of life expectancy at low income levels (and very high implicit valuation at high income levels). Thus, proposals have been made to use a different transformation of income, such as x to the power of a, where $0 < a < 1$ (see Rodriguez 2020), but those transformations would imply a constant marginal rate of contribution of income to the HDI.

17 Anand and Sen 2000a.

18 The income component has been treated in different ways over the years, with a transition phase in which different weights were used at different levels of income (Anand and Sen 2000a), but the logarithmic transformation now in use represents a balance between a plausible index for basic capabilities beyond health and education (which includes income-relative notions of social standing and dignity), while incorporating the idea that the rate at which incomes can reasonably be seen as indexing those capabilities decreases as incomes go up.

19 The Human Development Report now publish several dashboards, including a dashboard on environmental sustainability and a dashboard on socioeconomic sustainability. The main distinction of these dashboards is the partial ordering and the colour-coding of tercile groups in each indicator for easy visualization and comparison of the country's achievements. The Report's dashboards allow partial grouping of countries by indicator —rather than complete ranking by a composite measure, such as the HDI —that combines multiple indicators after making them commensurable. A complete ranking depends on how component indicators are combined; in contrast, a partial grouping does not require assumptions about normalization, weighting or the functional form of the composite index. Generally, a partial grouping may depend on the predefined values used as thresholds for grouping, expressing what is considered good performance or a target to be achieved. The dashboards divide countries into three groups of approximately equal size (terciles) for each indicator in the dashboard: the top third, the middle third and the bottom third. The intention is not to suggest thresholds or target values for the indicators but to allow a crude assessment of a country's performance relative to others. Three-colour coding is used to visualize the partial grouping of countries by indicator—a simple tool to help users immediately discern a country's performance.

SPOTLIGHT 7.2

Global inequality in carbon emissions: Shifting from territorial to net emissions by individuals

Lucas Chancel, World Inequality Lab, Paris School of Economics

From territorial emissions to net national emissions

Global carbon emissions from human activities —energy, transport, agriculture, industry, waste, deforestation—today amount to about 56 gigatonnes of carbon dioxide equivalent, or about 7 tonnes per capita a year.[1] Where do these emissions come from? Emissions can be seen in terms of territorial emissions, which include all emissions happening within national boundaries, and net emissions (or carbon footprint), which include emissions produced abroad and incorporated in the goods and services consumed at home.[2] Net emissions provide a more reliable picture of each country's responsibilities for carbon dioxide emissions.[3]

At the global level territorial emissions must by definition equal net emissions, since the world does not trade with another planet. But gaps between territorial and net emissions at the regional and national levels are meaningful, and shifting from one representation to the other might reveal significantly different trends depending on a region's integration into global value chains and economic development.

To what extent does moving from territorial emissions to net emissions reveal different regional trends in greenhouse gas emissions? Today, total territorial emissions are 7.2 gigatonnes of carbon dioxide equivalent for North America, about 15 percent of the world total,[4] and 4.8 gigatonnes of carbon dioxide equivalent for Europe, 10 percent of the world total (figure S7.2.1). Taking into account imported emissions, net emissions are 8 percent above territorial emissions in North America and 27 percent above territorial emissions in Europe.

While territorial emissions show a relatively clear downward trend in Europe since 1990, net emissions associated with Europeans' lifestyles have actually been stable over the past 30 years. In the United States the apparent stability of territorial emissions also masks important variations and a slight increase overall in net emissions over the past 30 years. This focus on net emissions therefore invites us to reconsider regions' effectiveness at curbing emissions.

Unlike rich countries, which import more carbon than they export, large emerging countries are net exporters (figure S7.2.2). China's net emissions (8 gigatonnes) are 34 percent below its territorial emissions (12.5 gigatonnes) compared with 19 percent in India and 15 percent in Sub-Saharan Africa. Although in China and India net emissions are lower than territorial emissions, the two measures have followed a similar trend over the past three decades—a sharp increase in the 1990s and 2000s followed by relative stability.

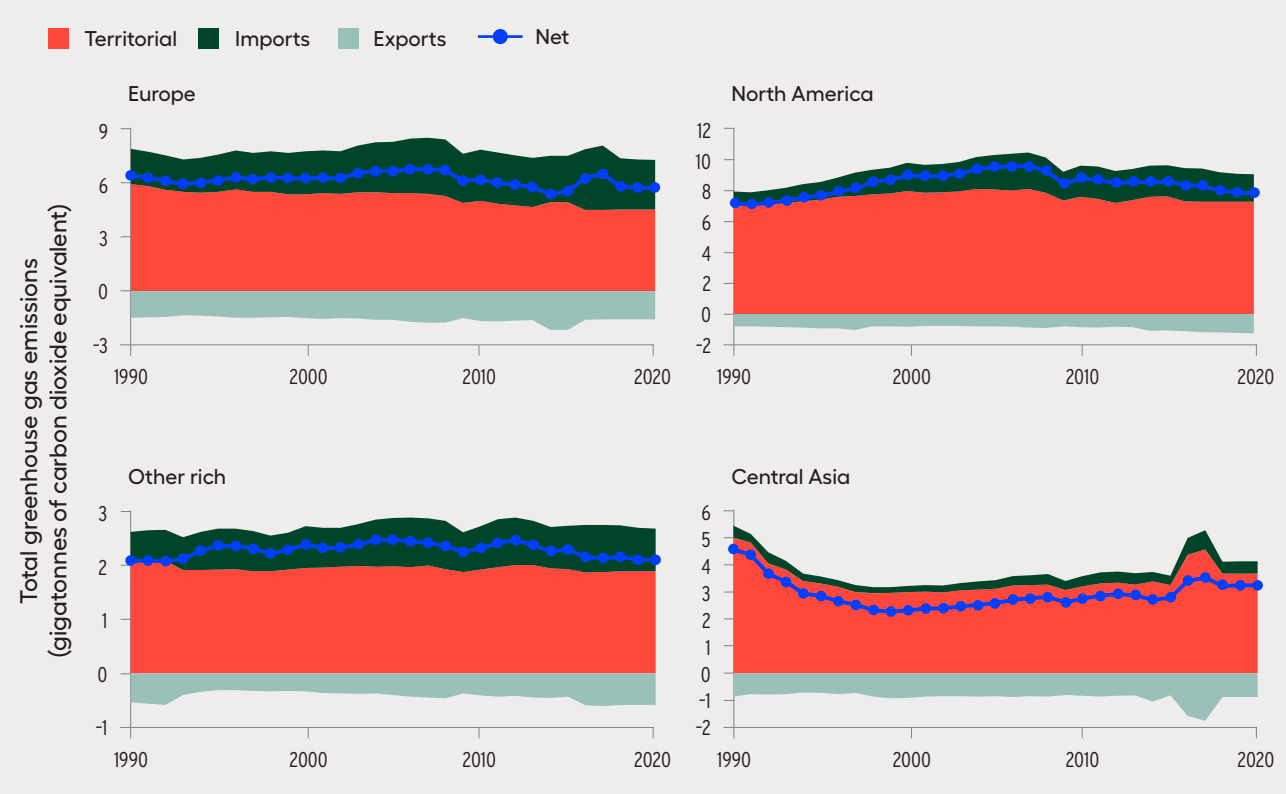
Factoring in international trade has implications for global climate policy discussions, as it might change representations of countries' responsibilities in the face of climate change. A better understanding of imported emissions can also be key for domestic policy: In July 2020 EU countries agreed to a carbon tax on emissions imported from abroad (also known as "carbon border adjustment") to finance the Covid-19 recovery package.[5]

While extremely useful, aggregate net emissions figures remain incomplete measures of carbon emissions, just as GDP is insufficient as an indicator of a country's income and wealth dynamics. Ultimately, all carbon flows serve an economic function, which in turn serves individuals when they consume goods and services—whether privately or collectively—or when they invest in the economy. In designing global or national climate mitigation policies, it is thus necessary to go beyond national or regional totals and averages[6] to focus on individuals' emissions and the inequality of those emissions.

Attributing net carbon emissions to individuals

Researchers and statistical offices have combined total net emissions figures such as those presented

Figure S7.2.1 Greenhouse gas emissions and international trade: Europe, North America, Central Asia and other rich countries, 1990–2019



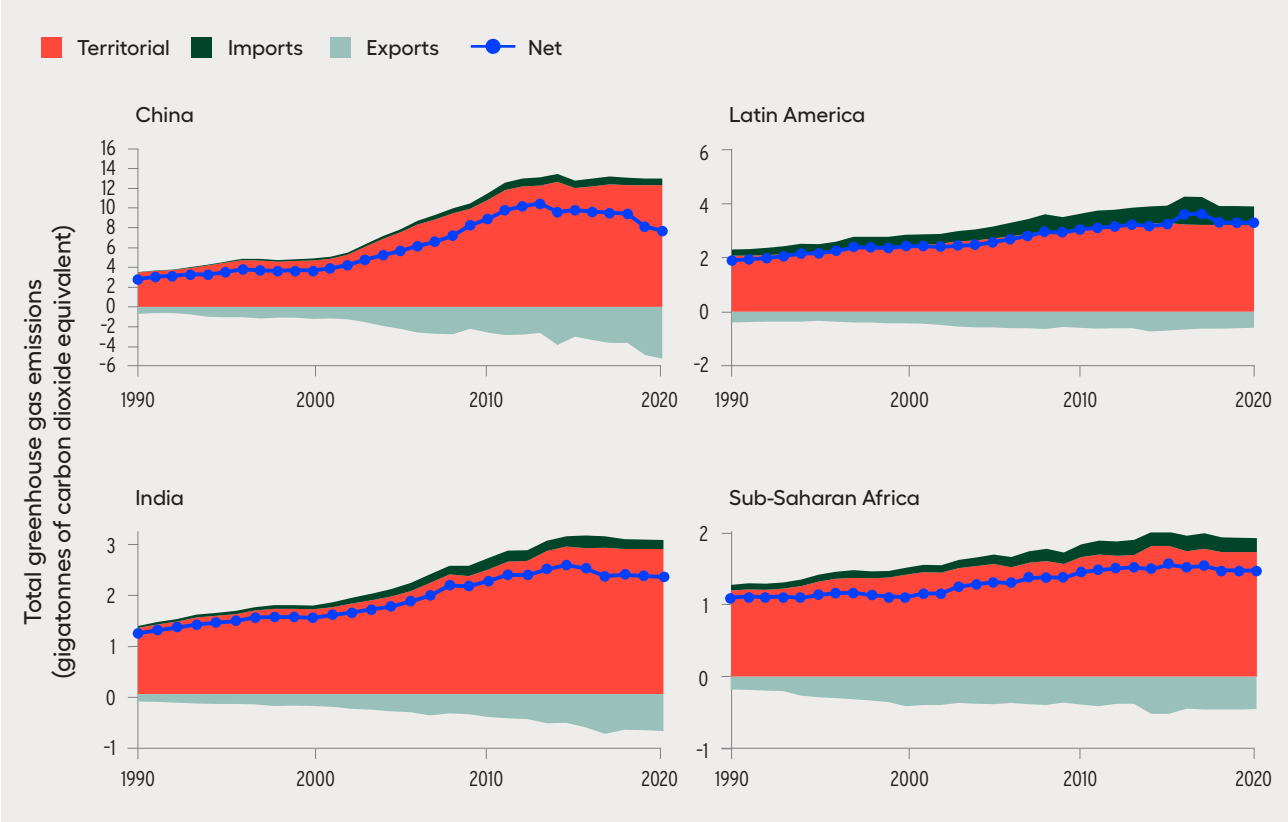
Note: Emissions exclude land use change (about 6 gigatonnes of carbon dioxide equivalent a year in 2015–2020).
Source: World Inequality Lab and Human Development Report Office using the Eora Global Supply Chain Database.

above with inequality statistics to determine emissions levels associated with individuals' consumption.[7] Recent research has found, for instance, that the richest 1 percent of EU households have an annual carbon footprint of 55 tonnes of carbon dioxide equivalent per capita, and only 5 percent of EU households live within sustainable climate targets, estimated at 2.5 tonnes of carbon dioxide equivalent per capita a year. But this analysis focuses on a subset of net emissions because it excludes government and investment-related emissions, which ultimately accrue to individuals. Government and investment-related emissions (called "institutional sectors" in the language of national accounting) account for 35–45 percent of emissions throughout the world. Investment-related emissions have surged over the past two decades in China while remaining broadly stable in Europe and the United States.

To assess individuals' responsibilities associated with climate change, and to design fair and politically sustainable climate mitigation policies, it also seems critical to factor in investment-related emissions, as much as government expenditure emissions. The emissions associated with investments in machines, buildings and factories, for instance, are the result of decisions by individuals (or groups of individuals) who have power over how capital is invested. So, it seems only logical to attribute the resulting emissions to the individuals who make those decisions rather than to consumers.

If a government or an institution wanted to determine individuals' emissions based on what they consume and how they invest in stocks, for example, they would first need information on those individuals' asset ownership. In a handful of countries such information on the ultimate beneficiaries of asset ownership is available (Norway), while in most it remains extremely opaque after decades of financial deregulation and disinterest in financial transparency matters. This highlights the importance of data transparency in the fight against both tax evasion and extreme inequality on the one hand and climate change on the other.

Figure S7.2.2 Large emerging countries are net exporters of carbon



Note: Emissions exclude land use change (about 6 gigatonnes of carbon dioxide equivalent a year in 2015–2020).
Source: World Inequality Lab and Human Development Report Office using the Eora Global Supply Chain Database.

While governments need to move towards more transparency, it is already possible to develop methods to approximate how different income or wealth groups emit carbon dioxide, taking into account consumption, government spending and investment.[8]

Global inequality in individual net carbon emissions

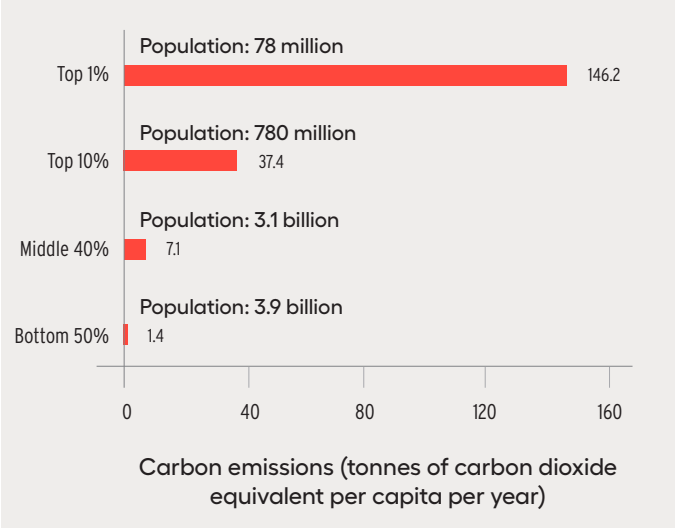
Using net emissions data and the World Inequality Database on global income and wealth inequality, we obtain net emission totals, related both to investment and to private and public consumption for different income groups across countries and world regions. Such numbers should indeed be read with care given the various underlying scenarios.[9]

Emissions at the top of the income distribution may be quite substantial once emissions associated with wealth ownership and investment are factored in. In the benchmark scenario the annual emissions of the wealthiest 1 percent of individuals in 2019 averaged 146 tonnes of carbon dioxide equivalent per capita, up from 110 in 1980 (figure S7.2.3). This group is responsible for more than 20 percent of global emissions.

At the other end of the income distribution, the global poorest 50 percent emits on average 1.4 tonnes of carbon dioxide equivalent per capita a year, a hundredth of what the wealthiest 1 percent emit and just 9 percent of global emissions. Over the past 50 years this group's emissions have remained stable. The world's poorest individuals emit about as much today as they did in 1980, whereas the annual emissions of the richest 1 percent of individuals has increased by 35 tonnes per capita on average.

In 2020 individuals in the middle 40 percent of the income distribution emitted 7 tonnes of carbon dioxide equivalent per capita on average, or about 41 percent of global emissions. The top wealthiest 10 percent emitted 37 tonnes per capita, or 51 percent of global emissions. The top 0.1 percent emits

Figure S7.2.3 The wealthiest 1 percent of individuals worldwide emit 100 times as much carbon dioxide each year as the bottom 50 percent



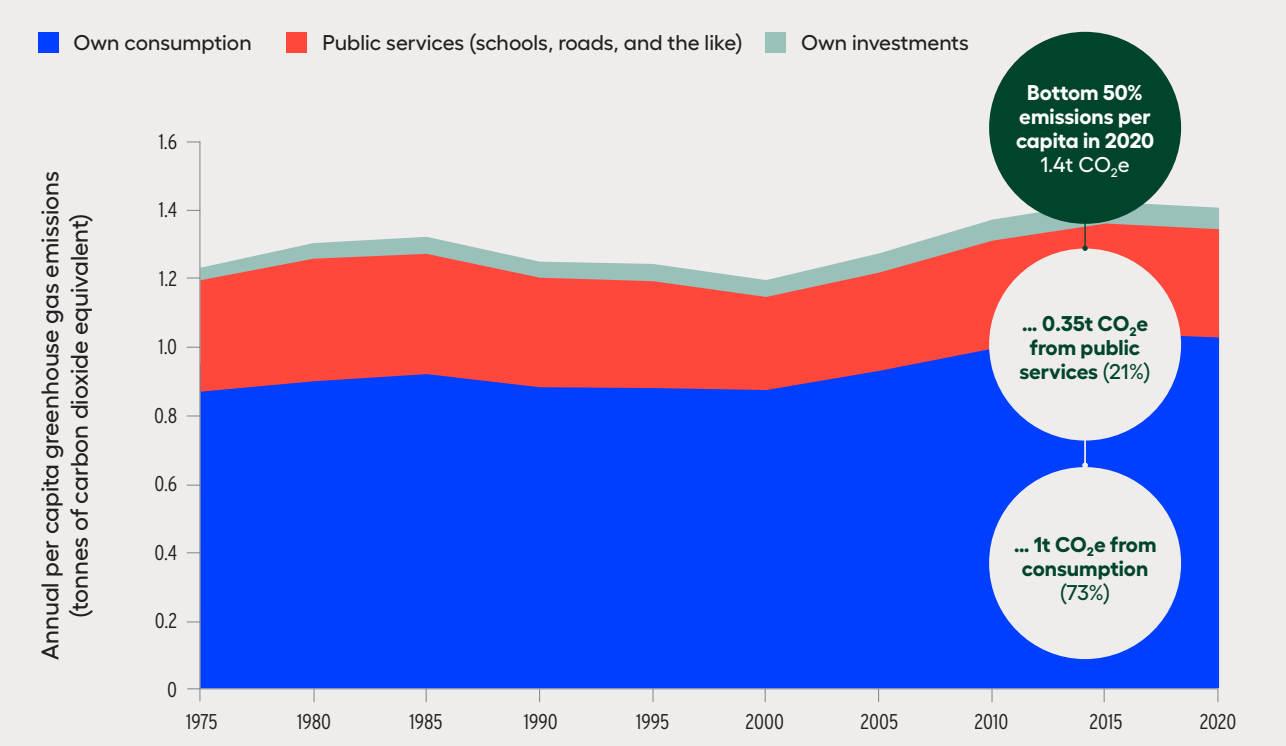
Source: World Inequality Lab and Human Development Report Office based on the World Inequality Database and the Eora Global Supply Chain Database.

an average of 687 tonnes a year, or 9 percent of global emissions.

While the emissions of the bottom 50 percent can essentially be traced to fossil fuels for heating, cooking, transportation and the consumption of goods, this is not the case higher on the income distribution. The richer individuals are, the more their emissions are embedded in the assets they own and the investments they make. Investment-related emissions totalled 73 tonnes of carbon dioxide equivalent per capita among the wealthiest 1 percent of individuals, or about half of their total emissions. This share has been rising over the past four decades; hence the focus on emissions from investments and not only from consumption (figures S7.2.4 and S7.2.5).

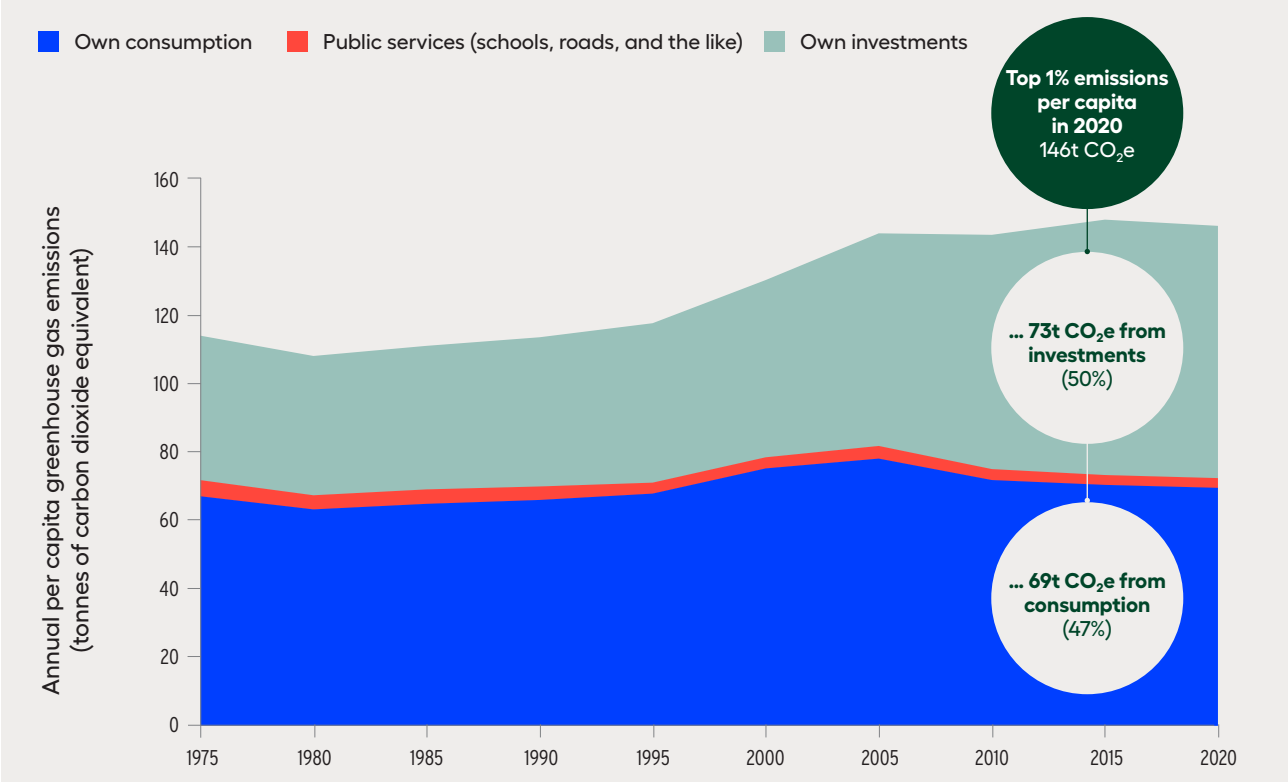
The rise of the middle class in emerging countries has increased that group's emissions. At the same time greater energy efficiency and sluggish income growth among the working and middle classes in rich

Figure S7.2.4 Emissions from the bottom 50 percent over 1975–2020: Small and linked predominantly to consumption



Source: World Inequality Lab and Human Development Report Office based on the World Inequality Database and the Eora Global Supply Chain Database.

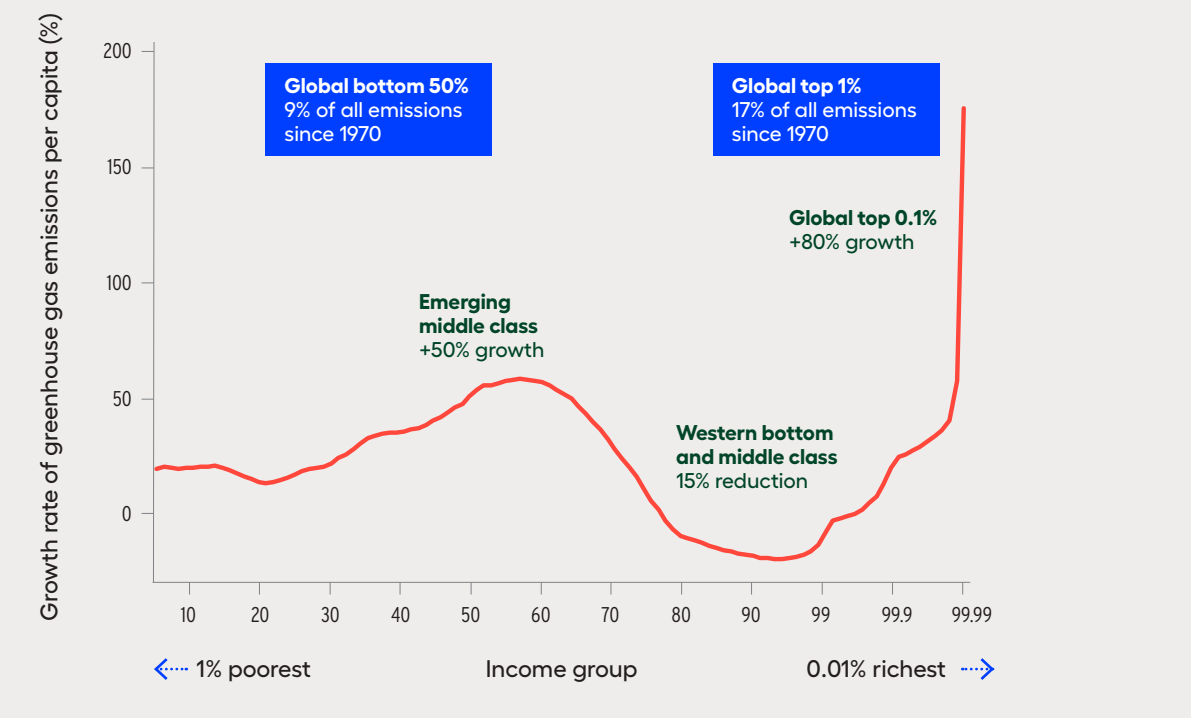
Figure S7.2.5 For the wealthiest 1 percent of individuals, the share of investment-related emissions in total emissions has been rising over the past four decades



Source: World Inequality Lab and Human Development Report Office based on data from the World Inequality Database and the Eora Global Supply Chain Database.

countries has reduced emissions per capita among these groups. The top 1 percent of earners worldwide have recorded substantial growth in emissions because of increased consumption as well as increased emissions from their wealth and investments (figure S7.2.6). While rising emissions among the poorest 50 percent worldwide represent a challenge from a global sustainability perspective, the importance of emissions among wealthiest 1 percent should not be downplayed.

Figure S7.2.6 The highest income earners worldwide have recorded substantial growth in emissions because of increased consumption as well as increased emissions from their wealth and investments



Source: World Inequality and Human Development Report Office based on the World Inequality Database and the Eora Global Supply Chain Database.

NOTES

1 Including land use change, (such as deforestation), the global total is close to 56 gigatonnes of carbon dioxide equivalent today—that is, an extra tonne per capita per year.

2 The underlying method, based on the pioneering work of Nobel Prize–winning economist Wassily Leontief (1936). Leontief (1970) starts from territorial emissions and subtracts all the carbon exported and adds the carbon imported from abroad, by each sector of the economy, to obtain net national emissions, also known as national carbon footprint or consumption-based emissions. See also Bullard and Herendeen (1975) and Krey and others (2014).

3 There is no single standard source of net national emissions, but there exist a few providers of multiregion input output tables, which provide results with similar trends and order of magnitudes but which can differ slightly among each other, because of different methodological choices, imputation methods or raw data. Such providers include the Global Trade Analysis Project, the Eora Global Value Chain Database, the World Input-Output Database, the Organisation for Economic Co-operation and Development Inter-Country Input-Output database and the EXIOBASE database (Lenzen and others 2013). Below, international trade and emissions data are mobilized from the Eora Global Value Chain Database (the only database providing global coverage of all countries between 1990 and today) and from the World Inequality Database.

4 These values do not include emissions associated with deforestation and land use change.

5 European Council 2020.

6 UNDP 2019c.

7 Ivanova and Wood 2020; Wiedenhofer and others 2017.

8 Net emissions related to investments in a country can be attributed in proportions to individuals' share of wealth in the country, for instance. Put simply, if person A owns 1 percent of the wealth in her country, she will be attributed 1 percent of all private investment–related emissions. This is imperfect, but when focusing on anonymized groups of individuals (top 0.1 percent, middle 40 percent and the like), it can provide valuable insights into who is actually responsible for emissions. The allocation of government related emissions also poses several questions. Certain forms of government interventions can be individualized, but others cannot. In which case, who benefits from government emissions associated with defence or justice? As a first approximation, one can assume that these emissions are shared equally across the population.

9 See Chancel (2020) for details on the methodology.

SPOTLIGHT 7.3

Wealth accounting and natural capital

Planetary pressures are weakly reflected in the incentive structure of societies, and progress on easing pressures depends in part "on understanding ecosystem dynamics and on relying on appropriate indicators of change."[1] The standard economic framework is premised on the idea that environmental degradation and unsustainable use of resources have implications for others, today and in the future, not considered in economic decisions with current institutions and norms. These implications (externalities) operate outside the market—prices do not fully signal either benefits or costs. This happens even when people are very aware of the damage they are inflicting on the environment but are reluctant to change their behaviour for fear others will not do so (a collective action problem).

Viewed from the perspective in which individuals pursue their self-interest and behave rationally, the social costs of degrading nature (essentially those shared by everyone) are not borne by the individuals deriving personal benefits from its use, leading to the tragedy of the commons.[2] This is the foundation for a vast literature on environmental and resource economics that considers how to structure economic incentives to avoid or mitigate the tragedy of the commons (through prices, regulation and assigning property rights to common resources). But market prices cannot fully account for many decisions that put pressure on the environment.[3] So, in the spirit of Elinor Ostrom[4] and as argued in parts I and II of the Report, different institutions and norms as well as assumptions on what drives human behaviour can lead to the identification of mechanisms other than markets to encourage individual consumers and producers to consider, and incorporate in their decision-making, the damage they do to nature and the full benefits they derive from it.

Advances in wealth accounting and measurement of natural capital can shift incentives and open new perspectives for human development metrics.[5] The foundations for natural capital and comprehensive wealth are well established, and their applicability in practice has been clearly demonstrated.[6] But uncovering the accounting prices required to construct wealth indices does not happen in a vacuum. It is informed by economic goals and resource allocation mechanisms.[7]

Marc Fleurbaey argues that in assessing sustainability, uncovering accounting prices has to somehow embody projections of future paths and how they vary with components of wealth.[8] And for the social cost of carbon, estimates can cover a wide range, due to different model assumptions and parameter choices, as well as uncertainties over the underlying geophysical processes modelled.[9] The role of economic inequalities (typically ignored) in estimating the social cost of carbon can have implications as great as those that relate to differences around the discount rate.[10] Ethical stances on future population growth can also have implications of the same order of magnitude,[11] showing the relevance of ethical discussions beyond those related to discount rates.[12] And even migration policy can influence the exposure and vulnerability to climate change that are used to inform climate damages in integrated assessment models.[13]

Part of the limitation in uncovering prices is the representation of the complexity of natural systems, given that the loss or even substantial reduction in the stocks of a species can have dramatic implications for overall ecosystem functioning. Natural systems are rife with bifurcations when critical thresholds or tipping points are reached.[14] Still, these challenges are less important when pricing natural capital to consider changes in value at the margin.[15] Recent climate models have incorporated nonlinear tipping points, such as the melting of the Greenland ice sheet.[16]

Sudhir Anand and Amartya Sen have argued that nondeclining wealth—and understanding sustainability as preserving the opportunity for a certain standard of living—may be relevant from a human

development perspective. They do not reject or exclude the concepts but find them lacking for two reasons: "(i) in terms of the limitation of the means-ends relations, and (ii) in terms of the inadequacy of the notion of overall living standards as the thing to be sustained."[17] The limitation of the means-ends relations is due to the nonuniqueness of wealth as a means to the end of human development (even if it can have an important instrumental role) and the contingent nature of its effectiveness as a means (which depends on distribution and the uses to which wealth is put).

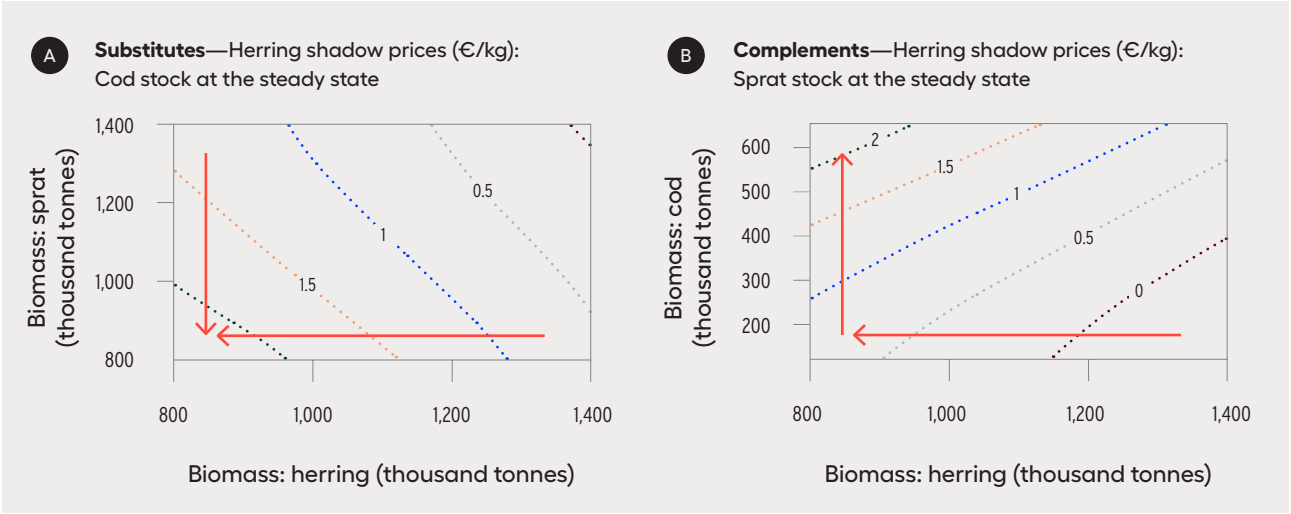
While some of the work on natural capital and comprehensive wealth is a collaboration between economists and ecologists, there are critical views, even from within these disciplines. A central objection is that even when the concept of natural capital is accepted, the substitutability of different forms of capital implicit in the notion of preserving comprehensive wealth as the criterion for sustainability settles for a notion of "weak sustainability." That is, it is acceptable to draw down nature's assets as long as the buildup of other forms of capital compensates for those losses.[18]

But the prices considered in building a comprehensive wealth index are not market prices; rather, they reflect the social value of the asset given its current stock level.[19] So prices would increase as stocks decline, admitting different degrees of substitutability and even complementarity—an extreme form of nonsubstitutability—across different assets (it is even possible to use the framework to incorporate into an asset's price how its stock depends on the interactions across stocks). As an illustration, Seong Do Yun and others calculated the wealth stored in Baltic Sea fisheries, incorporating into the prices of three species of fish the way they interact in the ecosystem.[20] While the two prey species (sprat and herring) were substitutes, they were each complements with cod, the predator species (figure S7.3.1). Moreover, the shadow prices of sprat and herring adjusted when the stock of one species went down, so that the decline in one could compensate for the other, but not at a fixed ratio.[21]

One possible approach to strong versus weak sustainability is to consider the issue an empirical matter and try to determine the degree of substitutability empirically. Francois Cohen, Cameron J. Hepburn and Alexander Teytelboym report a bias in the economic literature towards considering that substitutability is high, but that is based on strong assumptions (perhaps reflecting initial priors on the potential for substitutability) that are subject to challenge or methodological approaches that are far from robust.[22] But the disagreements appear to run deeper.

Consider an exchange reflecting different views on the evolution of modern agriculture. Kenneth Arrow and others cite modern agriculture as an example of

Figure S7.3.1 Contours of shadow prices for different species of fish in the Baltic Sea



Note: Contours of shadow prices calculated by fixing the cod stock in A and the sprat stock in B. Red arrows are the increasing direction of shadow prices. Downward sloping curves show substitute relationships, and upward sloping curves show complementary relationships.
Source: Yun and others 2017.

how deploying knowledge and capital has enabled agricultural productivity to more than keep up with population growth since the middle of the 20th century.[23] As a result the Malthusian concern (that population growth would run ahead of agricultural production) that re-emerged in more comprehensive formulations in the limits to growth[24] and "population explosion"[25] warnings did not come to pass. But Herman E. Daly and others write: "We, on the contrary, consider modern agriculture a case of substituting one resource base (nonrenewable fossil fuels and fertilizers) for another (renewable sunlight and soil)—not a case of substituting capital funds for resource flows."[26]

The reality for many is that it is simply not possible in the limit to substitute the services provided by ecosystems. The difference between ecological and economic perspectives may be due to ecologists focusing on limit behaviour and economists emphasizing a marginal concept.[27] And if one conceives of strong sustainability as "insisting on preserving every detailed component of natural capital, this would make sustainability totally impossible, in an uninteresting way."[28] In the end, both notions might be relevant, depending on how close one is from critical thresholds or tipping points in natural systems, if we know how close we are.[29]

NOTES

1 Arrow and others 1995, p. 521.

2 A term coined by Hardin (1968), but the idea really harks back to Gordon (1954). We are grateful to Eli Fenichel for this reference.

3 Dietz, Shwom and Whitley 2020; Dietz and Whitley 2018; Nielsen and others 2020; Stern 1986; Stern and others 2016.

4 Ostrom 1990.

5 They are underpinned by clear analytical frameworks and theory—which is not the case for some estimates, such as those presented in Costanza and others 1997 (in fact, Toman 1998 quipped that those estimates seriously underestimate infinity).

6 Fenichel and Abbott 2014; Fenichel, Abbott and Yun 2018.

7 Arrow, Dasgupta and Mäler 2003; Fenichel and Hashida 2019.

8 Fleurbaey 2020; Scovronick and others 2019.

9 Palmer and Stevens 2019.

10 Dennig and others 2015.

11 Scovronick and others 2017.

12 Fleurbaey and others 2019.

13 Benveniste, Oppenheimer and Fleurbaey 2020.

14 A much studied example is the collapse in the population of cod in the Baltic Sea, attributed to passing a threshold linked to the equilibrium between predator (cod) and prey (sprat; Lade and others 2015). Reusch and others (2018) suggest that this could be a model to understand marine systems more broadly. For a conceptual visualization, see Millennium Ecosystem Assessment (2003).

15 As shown in Fenichel and Abbott (2014).

16 Nordhaus 2019.

17 Anand and Sen 2000a, p. 2037.

18 See, for instance, Daly and others (2007), who also pose the question more generally, if neoclassical economics is able to account for physical limits of the scale of production imposed by the natural world. These questions are at the heart of ecological economics, with Daly (1992), arguing that scale should be a key objective of economic analysis and policy, along with efficient allocation and equitable distribution.

19 Fenichel and Abbott 2014; Fenichel, Abbott and Yun 2018.

20 Yun and others 2017.

21 Maher and others (2020) extend this type of analysis to a system with caribou, wolves, deer and oil production.

22 Cohen, Hepburn and Teytelboym 2019.

23 Arrow and others 2007.

24 Such as those presented in Meadows and others (1972).

25 Ehrlich 1968.

26 Daly and others 2007, p. 1362.

27 As argued in Fenichel and Zhao (2015).

28 Fleurbaey 2020, p. 16.

29 Barbier and Hochard 2019.

SPOTLIGHT 7.4

Evolving metrics to account for environmental degradation and sustainability

How best to reflect concerns with environmental degradation and sustainability in indicators of development? The wealth accounting and natural capital measurement reviewed in chapter 7 and spotlight 7.3 provide an answer, but several other approaches have been considered: dashboards, composite indices, indices that adjust GDP or other existing metrics and indices that focus on measuring how much we overconsume our resources.[1]

An obvious argument for a dashboard approach is to recognize that no single indicator or index can provide a good and comprehensive enough measure. The Sustainable Development Goals implicitly reflect this assumption, proposing 169 targets and more than 230 indicators. Still, having many indicators in a dashboard is always a challenge because it makes interpretation and policy use difficult and because of the high risk of missing values for many countries. For example, of the 93 Sustainable Development Goal indicators related to the environment, 30 percent lack an agreed methodology, and most that have one lack sufficient data to assess progress.[2]

So interest in composite indices seeks to complement dashboards by providing comprehensible summary indicators that combine relevant information. Some composite indices combine economic, social and environmental dimensions. Much innovation is being applied subnationally, with estimates of a gross ecosystem product, which summarizes the value of the contributions of nature to economic activity, already informing investments in conservation and restoration across China, but it is designed to be applied at the national level and thus could have global applicability.[3] Table S7.4.1 presents an illustrative set of

Table S7.4.1 Composite indices that combine economic, social and environment dimensions

Index	Institution	Data coverage	Description and comments
Green Economy Progress Index[a]	United Nations Environment Programme and Partnership for Action on the Green Economy	105 countries	The Green Economy Progress Index measures progress in improving the wellbeing of current generations relative to economic opportunities, social inclusiveness and environmental protection. It comprises 13 indicators that capture critical issues faced in achieving an inclusive green economy transition (material footprint, energy use, air pollution, protected areas, gender inequality, green trade, renewable energy, Palma ratio, environmental patents, life expectancy, mean years of schooling, pension coverage and access to basic services). It focuses on country progress towards a target set for each individual indicator. A companion dashboard of sustainability includes six indicators (inclusive wealth index, freshwater withdrawals, greenhouse gas emissions, nitrogen emissions, land use, ecological footprint) that track the sustainability of any progress achieved by the index.
Sustainable Society Index[b]	Sustainable Society Foundation	154 countries	The Sustainable Society Index depicts countries' current level of sustainability. It is built up by 21 indicators clustered in seven categories (basic needs, health, personal and social development, natural resources, climate and energy, transition, economy) and finally in three dimensions (human, environmental and economic wellbeing).
Environmental Performance Index[c]	Yale and Columbia Universities	180 countries	The 2020 edition of the Environmental Performance Index ranks 180 countries and is based on 32 indicators—7 cover environmental health and 25 cover ecosystem vitality. The indicators establish how close countries are to established environmental policy goals.
Red List Index	International Union for Conservation of Nature	195 countries	The Red List Index, based on the International Union for Conservation of Nature's Red List of Threatened Species, measures the changing state of global biodiversity. It defines the conservation status of major species groups and measures trends in extinction risk, reporting under Sustainable Development Goal indicator 15.5.1.

a. PAGE 2017.
b. World Bank 2020f.
c. https://epi.yale.edu.
Source: Human Development Report Office.

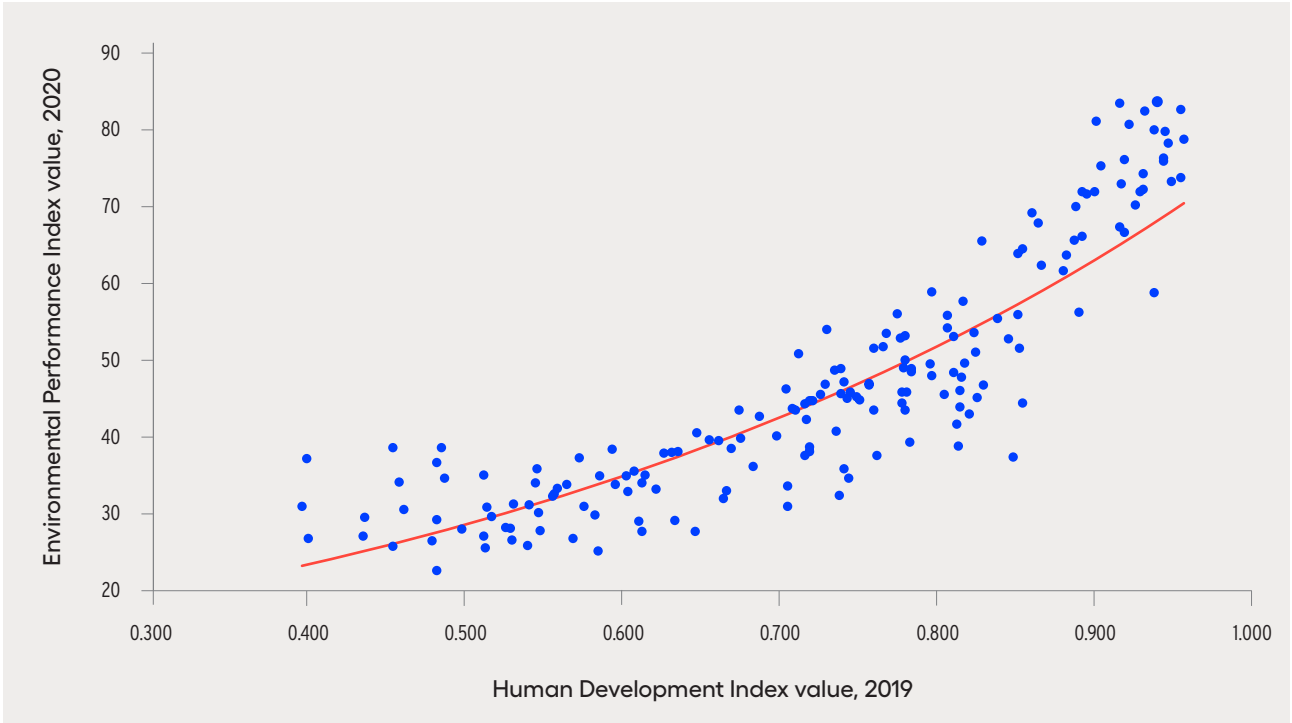
composite indices at the national level for more than 100 countries.

The HDI is positively associated with some of these indices (figure S7.4.1), perhaps reflecting that higher human development enhances the ability to invest in both people and ecosystems. But for the most part these indices inform about a mix of current environmental quality or pressure on resources but do not indicate whether a country is actually on a sustainable path.

A related approach is adjusting GDP (or GNI) to account for environmental degradation and natural resource depletion.[4] The System of Economic and Environmental Accounts proposes doing so as an extension of the concept of net domestic product. Just as GDP (gross) is turned into net domestic product by accounting for the consumption of fixed capital (depreciation of produced capital), an environmentally adjusted GDP considers the flow of damages to the environment. Adjusted net savings, also known as genuine savings or genuine investment, builds on these concepts but reformulates them as stocks of wealth rather than flows of income or consumption. It is computed as net national savings plus education expenditure and minus energy depletion, mineral depletion, net forest depletion and carbon dioxide and particulate emissions damage (table S7.4.2).

An accounting shortcoming of adjusted net savings is that the adjustment for environmental degradation is limited to a restricted set of pollutants. The calculations do not include other important sources of environmental degradation, such as underground water depletion, unsustainable fisheries, soil degradation or biodiversity loss. And the World Bank adds current education spending to indicate investment in human capital but not health expenditures.[5] If the logic is that education spending improves education, then if human capital is depreciating through morbidity and mortality, health spending that potentially increases life expectancy could also be seen as increasing human capital.[6] Similarly, as discussed in spotlight 7.3, pricing environmental degradation is tricky because the relevant prices are not necessarily those provided by current market valuations, which undervalue nature and are myopic relative to the future. Shadow prices that fully account for the social value of capital could be used, and these can adjust unboundedly when some stock approaches a critical value.

Figure S7.4.1 The Human Development Index is positively associated with the Environmental Performance Index



Source: Human Development Report Office calculations based on Human Development Index values from table 1 in the statistical annex and Environmental Performance Index data from Wendling and others (2020).

Table S7.4.2 Indicators of national savings

Index	Institution	Data coverage	Description and comments
Adjusted net savings (current $, percent of GNI)	World Bank, Organisation for Economic Co-operation and Development	More than 150 countries	Adjusted net savings equals net national savings plus education expenditure and minus energy depletion, mineral depletion, net forest depletion, and carbon dioxide and particulate emissions damage.
Net national savings (current $, current local currency unit, percent of GDP)	World Bank, Organisation for Economic Co-operation and Development	Up to 194 countries	Net national savings equals gross national savings minus consumption of fixed capital.
Gross savings (current $, current local currency unit, percent of GDP)	World Bank, Organisation for Economic Co-operation and Development	Up to 194 countries	Gross national savings equals GNI minus final consumption expenditure (former total consumption) plus net transfers.
Gross domestic savings (current $, current local currency unit, percent of GDP)	World Bank, Organisation for Economic Co-operation and Development	Up to 194 countries	Gross domestic savings equals GDP minus final consumption expenditure.
Adjusted net national income (current $, current local currency unit)	World Bank	Up to 194 countries	Adjusted net national income equals GNI minus consumption of fixed capital and natural resources depletion.

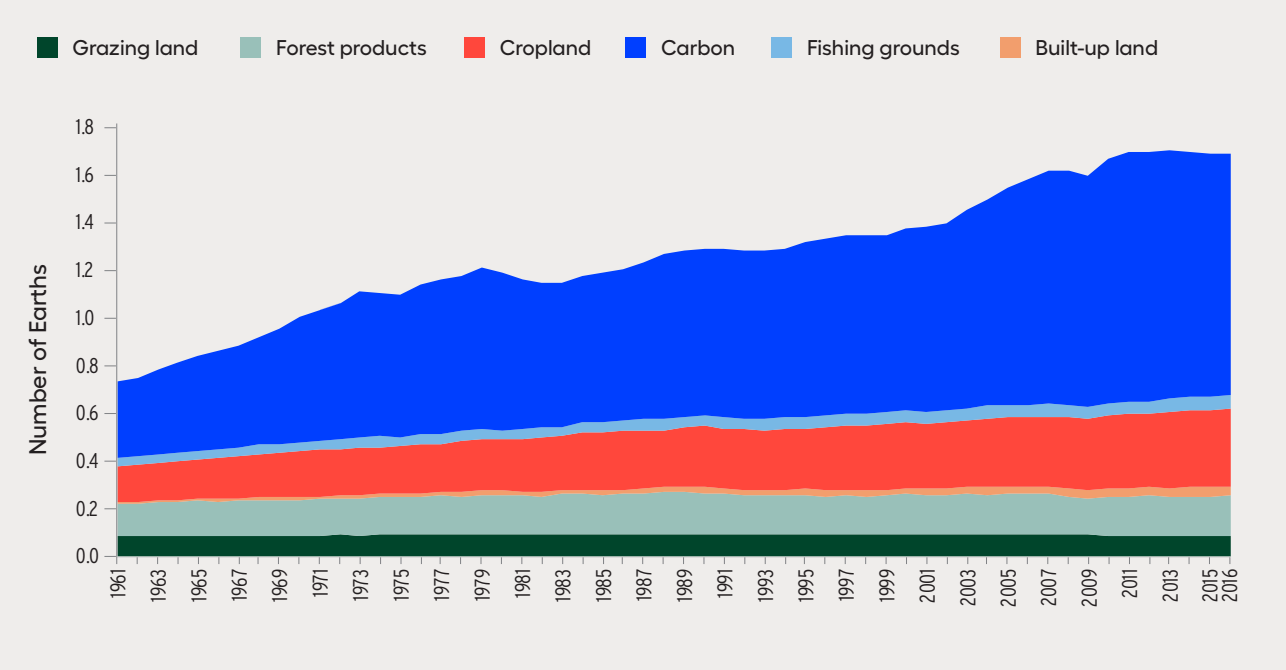
Source: Compiled by the Human Development Report Office based on metadata available at World Bank (2020f).

Indices that measure how much we are overconsuming our resources include estimates of footprints as indicators of the pressure of human activities on the environment. The ecological footprint tracks demand for biocapacity compared with availability of biocapacity.[7] It measures how much "area" of biologically productive land and water that human activities require in order to produce all the resources consumed and to absorb the waste generated.[8] Put another way, the ecological footprint measures human appropriation and the biosphere's supply of ecosystem products and services as the bioproductive land and sea area needed to supply these products and services.[9] Biocapacity is a measure of the amount of biologically productive land and sea area available to provide ecosystem services.

Global demand for biocapacity, as measured by the ecological footprint, is largely explained by carbon dioxide emissions, expressed in hectares of forest needed for carbon sequestration (figure S7.4.2).[10] These are conservative accounts: biocapacity is overestimated because it does not consider land degradation and long-term sustainability of resource extraction. In turn, the ecological footprint might be underestimated because it does not measure human demand of freshwater consumption, soil erosion or emissions of greenhouse gases other than carbon dioxide.[11] However, the aggregate magnitude of ecological footprint is sensitive to the methodology used to estimate the effect of carbon emissions.[12]

Measures of carbon footprint are designed to account for greenhouse gas emissions that are caused directly and indirectly by an activity or accumulated over the lifecycle of a product.[13] It has become a widely referenced environmental protection indicator, benefiting mostly from the work of the Intergovernmental Panel on Climate Change and the climate change community. The carbon footprint considers emissions of the seven greenhouse gases framed by the Kyoto Protocol (carbon dioxide, methane, nitrous oxide, perfluorocarbons, hydrofluorocarbons, sulphur hexafluoride and nitrogen trifluoride).[14] Emissions are typically accounted for through a lifecycle perspective, including all stages—from raw material extraction to the end of production. The carbon footprint is quantified using global warming potential,[15] which represents the quantities of greenhouse gas emissions that contribute to climate change. A specific time horizon is usually considered, such as 100 years.[16] The carbon footprint also has an interesting feature of being computable at any level of disaggregation. This makes it a powerful instrument for monitoring the behaviour of individual actors.

Figure S7.4.2 Global demand for biocapacity as measured by the ecological footprint is largely explained by carbon dioxide emissions



Source: Global Footprint Network 2019.

NOTES

1 For a recent review, see Dizdaroglu (2017).

2 UNEP 2019d.

3 Ouyang and others 2020. This is part of the broader efforts to draw on the value of natural capital to inform sustainable development in China (Guerry and others 2015; Ouyang and others 2016; Zheng and others 2019). See also D'Odorico and others (2020) for estimates of the value of water. See Mohan and others (2020) for an alternative approach.

4 See, for instance, Muller, Mendelsohn, and Nordhaus (2011).

5 Kraay 2018.

6 Although this is challenging to do, as illustrated also in Jones (2016).

7 Wackernagel and Rees 1996; Wackernagel and others 2019.

8 Lin and others 2018; Wackernagel and Rees 1996.

9 Borucke and others 2013.

10 Extracted from Global Footprint Network 2019.

11 Borucke and others 2013.

12 Blomqvist and others 2013.

13 Fang, Heijungs and De Snoo 2015. One example is the carbon footprint computed by the Global Footprint Network as an input for the ecological footprint (https://www.footprintnetwork.org/our-work/climate-change/).

14 WRI 2013.

15 Høgevold 2003.

16 These greenhouse gases, weighted by their global warming potential value, are expressed in carbon dioxide equivalents. See explanations in Our World in Data (2020a, b). "The GWP [global warming potential] measures the relative warming impact of one molecule or unit mass of a greenhouse gas relative to carbon dioxide over a given timescale—usually over 100 years. For example, one tonne of methane would have 34 times the warming impact of a tonne of carbon dioxide over a 100-year period. GWP100 values are used to combine greenhouse gases into a single metric of emissions called carbon dioxide equivalents (CO2-eq). CO2-eq is then derived by multiplying the mass of emissions of a specific greenhouse gas by its equivalent GWP100 factor. The sum of all gases in their CO2-eq form provides a measure of total greenhouse gas emissions."

SPOTLIGHT 7.5

Adding environmental and sustainability dimensions to the Human Development Index

Proposals to adjust the Human Development Index (HDI) by adding environmental dimensions include the variant proposed by Casilda Lasso De La Vega and Ana Marta Urrutia, who replaced the standard of living term with a harmonic mean of income and an environmental behaviour indicator, defined as 1 minus a normalized measure of carbon dioxide emissions per capita.[1] The harmonic mean is a special case of the constant elasticity of substitution function, which introduces imperfect substitutability but no complementarity between income and the environment indicator. This adjustment penalizes uneven patterns of economic development (those where progress in environmental behaviour far outstrips progress in economic growth).

An alternative approach added a fourth component to the index to account for air pollution, water pollution, soil pollution from agriculture and energy consumption.[2] The authors also suggested modifying the health index by adding a measure of employment, which they argue allows the health component to work as a proxy for social stability. Similarly, Ajay Chhibber and Rachid Laajaj's Global Development Index included a fourth dimension, environment, with four indicators in the HDI.[3] They distinguished two aspects of environmental costs—those related to damages that the country inflicted on its own nature and people through unsustainable development, such as air pollution, soil erosion or poor water quality, and those related damages to other countries through carbon dioxide emissions, ocean acidification or biodiversity loss. Two indicators in the first environmental subdimension related to local impact are sulphur dioxide emissions and water scarcity (measured by water withdrawal as a share of renewable water resources), and two indicators in the global impact subdimension are carbon dioxide emissions per capita and share of renewable energy in total energy consumption. A simple average with equal weights allowed perfect substitutability between four dimensions. Chhibber and Laajaj also suggested replacing life expectancy with health-adjusted life expectancy.

Another proposal involved simply adding carbon dioxide emissions per capita to the HDI using the territorial allocation of the production-based carbon emissions as a summary measure of all other degradation of environment, including loss of biodiversity and pollution.[4] The justification for this simplicity parallels one usually given for using life expectancy as a representative of healthy longevity in the HDI. The authors interpreted the addition of carbon emissions as accounting for the cost of one country's quality of life to another's, because the high quality of life enjoyed in a country with high carbon emissions comes at a price for the quality of life in other countries, particularly developing countries, and for future generations.

Giangiacomo Bravo's critical review of this index found a very high correlation with the HDI (.98)[5] and its components but a low correlation with environmental indices and indicators. Bravo concluded that "a little is better than nothing" but that it is adding little to distinguish between ecosystem destruction and welfare.

More recent research has further explored adding an environmental dimension—carbon dioxide emissions per capita—and the freedom dimension based on human and political rights.[6] For an environmentally-centred sustainable HDI the authors suggested a novel method of aggregation implying that the degree of substitutability is linked directly to a country's general level of wellbeing. This form penalizes heterogeneity, so the environmentally-centred sustainable HDI heavily penalized countries with high carbon dioxide emissions. It was calculated using data for 2013 and resulted in substantial changes in country ranks compared with the HDI.

Eric Neumayer suggested leaving the HDI as it is and adding sustainability concerns as an external

qualification to the achieved level of human development.[7] His proposal is to complement the HDI with one or preferably two pieces of additional information on sustainability—one that he considered to reflect weak sustainability, the other strong sustainability.

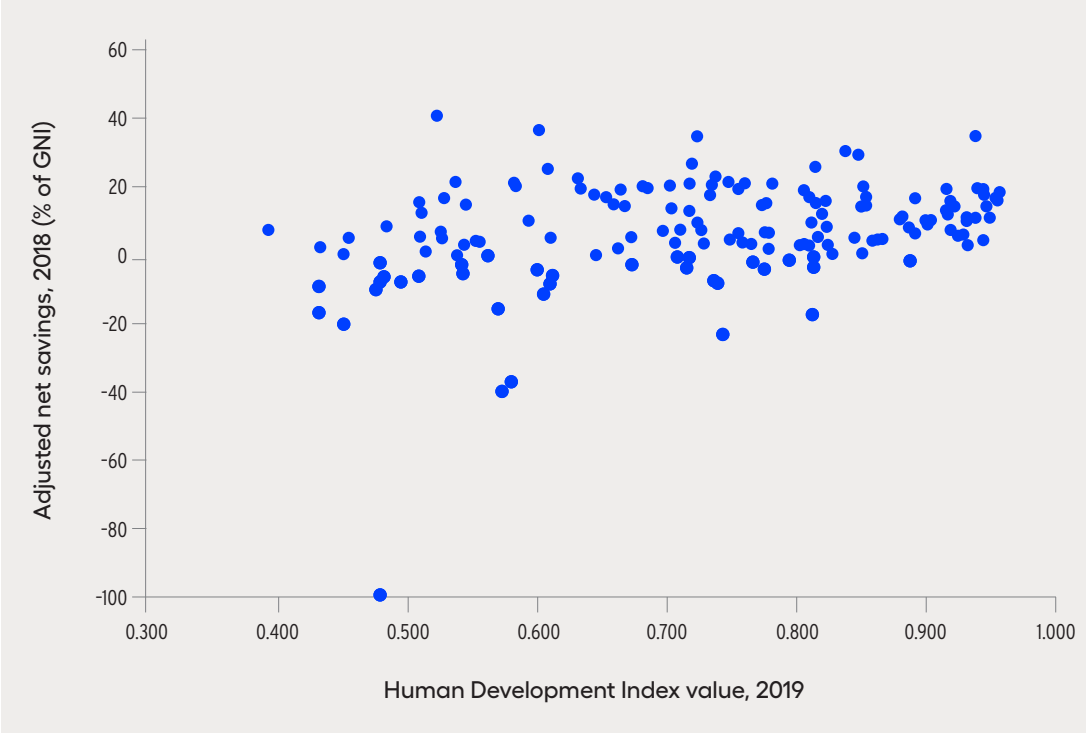
As a weak measure of sustainability, Neumayer suggested genuine savings (adjusted net savings) because it is available for a large sample of countries over a long period.[8] Some of its notable weaknesses were mentioned in spotlight 7.4: The coverage of both nonrenewable and renewable resources is limited.[9] High and very high human development countries typically have high net saving rates (figure S7.5.1), but if more pollutants were taken into account, the picture would likely change. And adjusted net savings is based on a social cost of carbon of $30 per tonne, far below other estimates, as discussed in chapter 7.

As a measure for what he considered strong sustainability, Neumayer suggested the ecological footprint. Although the ecological footprint uses land area instead of money as a yardstick, there is possible substitutability within the considered natural capital, which may be problematic in the strong sustainability sense.[10] The focus of the ecological footprint is consumption, so the consumer rather than the producer is "billed" for the impact on nature.[11] Neumayer suggested constructing a table with values of the HDI, ecological footprint and adjusted net savings. He then suggested that the sustainability measures to partially rank countries in two groups—sustainable and unsustainable. This proposal can be further developed by considering the individual gaps of countries from the available biocapacity or from a 0 value of the adjusted net savings. Countries could also be partially ranked by each sustainability measure (table S7.5.1).

Planetary boundaries

This spotlight concludes with an exploration built on the planetary boundary framework described in chapter 2. An index of planetary pressure is proposed here that can be compared with the HDI in the same way that Neumayer proposed.[12] Planetary boundaries are interdependent, but two of them, climate change and biodiversity, are considered core boundaries in part because action aimed at addressing

Figure S7.5.1 High human development index values go along with positive adjusted net savings



Note: Data for adjusted net savings refer to 2018 or the most recent year available.
Source: Human Development Report Office calculations based on Human Development Index values from table 1 in the statistical annex and adjusted net savings data from World Bank (2020e).

Table S7.5.1 Gaps from sustainable values of the ecological footprint and adjusted net savings

HDI rank, 2019	Country	Adjusted net savings		Ecological footprint		
		Value	Rank[a]	Global hectares per person	Rank[a]	Ecological reserve[b]
1	Norway	18.2	31	5.5	152	-3.9
2	Ireland	16.1	41	5.1	147	-3.5
2	Switzerland	16.9	36	4.6	142	-3.0
6	Germany	14.4	52	4.8	145	-3.2
7	Sweden	17.8	32	6.5	164	-4.9
8	Australia	4.4	98	6.6	165	-5.0
8	Netherlands	19.2	28	4.8	144	-3.2
10	Denmark	19.4	25	6.8	167	-5.2
11	Finland	10.8	64	6.3	162	-4.7
11	Singapore	34.7	4	5.9	157	-4.3
13	United Kingdom	3.0	109	4.4	136	-2.8
14	Belgium	11.1	62	6.3	161	-4.7
14	New Zealand	10.1	69	4.7	143	-3.1
16	Canada	6.0	86	7.7	170	-6.1
17	United States	5.6	87	8.1	171	-6.5
175	Congo (Democratic Republic of the)	-7.9	141	0.7	6	0.9
175	Guinea-Bissau	-2.2	128	1.5	46	0.1
175	Liberia	-99.4	154	1.1	28	0.5
178	Guinea	-10.2	145	1.6	50	0.0
181	Mozambique	5.1	91	0.8	10	0.8
182	Burkina Faso	0.6	116	1.2	33	0.4
182	Sierra Leone	-20.3	150	1.2	32	0.4
184	Mali	2.5	112	1.6	51	0.0
185	Burundi	-16.9	148	0.7	3	0.9
185	South Sudan	-9.2	144	1.5	45	0.1
189	Niger	7.2	78	1.7	55	-0.1

a. Calculated by the Human Development Report Office.
b. Biocapacity minus ecological footprint. Measured in global hectares per person.
Note: Among the top and bottom countries by Human Development Index (HDI) rank, the most unsustainable countries according to each measure are in red. Data for adjusted net savings refer to 2018 or the most recent year available since 2008. Data for ecological footprint accounts refer to 2016.
Source: Human Development Report Office based on HDI values from table 1 of the statistical annex, adjusted net savings data from World Bank (2020e) and ecological footprint data (consumption-based) from Global Footprint Network (2019).

them would also alleviate pressure on others—as reducing carbon dioxide emissions would reduce the risk of ocean acidification.[13] One challenge with the planetary boundary approach is its validity at scales other than global, as is the case for nitrogen and phosphorus cycles (chapter 2). Thus proposals to bring the boundaries from the global to the national level have limitations and must be interpreted with some caution. Still, assessing the extent to which planetary boundaries are being transgressed when global boundaries are brought to the national level provides useful information on countries' contribution to planetary pressures: avoiding the transgression of regional and national boundaries "would thus contribute to an aggregate outcome within a planetary-level safe operating space."[14] The definition of national boundaries follows proposals in the literature,[15] and excessive pressure is measured by the extent to which the values of component indicators exceed each planetary boundary.[16] The index of excessive pressure on the planet proposed here combines indicators of carbon dioxide emissions, nitrogen use, land use, freshwater withdrawals and material footprint—the last of which is not part of the planetary boundaries framework. Table S7.5.2 summarizes planetary boundaries and their expressions per capita or per area unit.[17] It also shows the number of countries within boundaries for these indicators. Only four countries are within boundaries for all five indicators—Gambia, Ghana, Republic of Moldova and Rwanda.

The indicator values are standardized by the corresponding boundary expressed per capita or per area unit. The standardized value represents the order of transgression by which the country's emissions, environmental degradation or overconsumption exceed the boundaries.[18] Among the 142 countries with information on all five index of excessive pressure on the planet indicators, the index equals the quadratic mean order of overshooting across all considered indicators (table S7.5.3).

When ranked by index of excessive pressure on the planet value (the quadratic mean order of transgressions), 6 of the 10 countries in the table would be

Table S7.5.2 Planetary boundaries per capita or per area unit

Biophysical indicator	Planetary boundary	Per capita or per area unit boundary	Countries with data	Countries within boundaries[a]
Carbon dioxide emissions (production)	2 degrees Celsius warming	1.61 tonnes per year	193	74
Nitrogen as fertilizer nutrient	62 teragrams per year	39.4 tonnes per 1,000 hectares of cropland per year	152	71
Freshwater withdrawals	4,000 cubic kilometres per year	565 cubic metres	179	122
Change in forest area	47.9 million square kilometres by 2050	Annual average growth of forest area by 0.25 percent since 1990	187	53
Material footprint[b]	50 gigatonnes per year	7.2 tonnes per year	172	72

a. Data refer to 2018 or the most recent year available.
b. Material footprint is not part of the planetary boundaries framework, so this is a maximum sustainable value.
Source: Human Development Report Office calculations based on Human Development Index values from table 1 in the statistical annex, carbon dioxide emissions data from GCP (2020), nitrogen and freshwater withdrawals data from FAO (2020a), forest area data from World Bank (2020e) and material footprint data from UNEP (2020d).

Table S7.5.3 Balance sheet of transgressions of the top 10 Human Development Index–ranked countries with information on all five index of excessive pressure on the planet indicators

	Human Development Index, 2019		Order of transgression					Index of excessive pressure on the planet		
Country	Value	Rank	Carbon dioxide emissions (production)	Nitrogen as fertilizer nutrient	Freshwater withdrawals	Change in forest area	Material footprint	Value	Rank	Number of transgressed boundaries
Norway	0.957	1	5.2	3.2	1.1	2.0	5.3	3.7	121	5
Switzerland	0.955	2	2.7	2.7	0.0	0.0	4.5	2.6	84	3
Iceland	0.949	4	6.7	2.5	1.4	0.0	4.8	3.9	122	4
Germany	0.947	6	5.7	2.9	0.0	1.8	3.2	3.3	109	4
Sweden	0.945	7	2.6	1.8	0.0	2.0	4.5	2.6	83	4
Australia	0.944	8	10.5	1.1	1.2	2.4	6.0	5.6	135	5
Denmark	0.940	10	3.8	2.0	0.0	0.0	3.4	2.4	73	3
Finland	0.938	11	5.3	1.6	2.2	1.8	5.0	3.6	118	5
United Kingdom	0.932	13	3.5	4.3	0.0	0.0	3.2	2.9	95	3
Belgium	0.931	14	5.4	4.9	0.0	1.6	3.3	3.7	120	4

Note: Covers 142 countries with data for all five indicators. A value of 0 indicates no transgression.
Source: Human Development Report Office calculations based on Human Development Index values from table 1 in the statistical annex, carbon dioxide emissions data from GCP (2020), nitrogen and freshwater withdrawals data from FAO (2020a), forest area data from World Bank (2020e) and material footprint data from UNEP (2020d).

ranked below 100, and all of them would be ranked below 70. Other important information provided by the index is the number of boundaries that each country transgressed. Six of the 10 countries in the table have their largest transgression in carbon dioxide emissions, three have their largest transgression in material footprint and one (United Kingdom) has their largest in nitrogen.

NOTES

1 de La Vega and Urrutia 2001.

2 Costantini and Monni 2005.

3 Chhibber and Laajaj 2008.

4 Bravo 2014; Togtokh 2011; Togtokh and Gaffney 2010.

5 Bravo 2014.

6 Biggeri and Mauro 2018.

7 Neumayer 2013.

8 Neumayer 2013.

9 For example, forests are an important renewable resource that are included in adjusted net savings, but water, soil and biodiversity are also important renewables and should be included into the calculation. Similarly, loss of natural capital due to environmental pollution is underestimated, since only two pollutants are included. Ideally, damage from emissions of, for example, sulphur oxides, nitrogen oxides, faecal coliforms and particulate matter should also be included.

10 Neumayer 2013.

11 This is quite different from adjusted net savings, which attributes natural capital depreciation from resource extraction to the extracting, not the consuming country, according to the capital maintenance principle. Recently, the economic footprint has been produced, accounting for the impact of production as well. But perhaps, more importantly, the economic footprint measures a country's contribution to global strong unsustainability rather than how a country is affected by strong unsustainability of others. A good example is the Maldives, a country that is likely to become a victim of the strong unsustainability of others in the future, although it does not have an unsustainably high ecological footprint. What matters to countries like the Maldives is whether globally there is strong unsustainability in the form of, for example, unsustainably high greenhouse gas emissions, not so much their own contribution to it. So the reasoning is that by identifying contributors to the global unsustainability, the progress towards strong sustainability can be made globally if the high contributors reduce their own contributions.

12 The framework identifies nine critical boundaries related to essential planetary processes at the global scale. Only seven boundaries are currently measured: climate change (carbon dioxide concentration in the atmosphere less than 350 parts per million), ocean acidification (mean surface seawater saturation state with respect to aragonite at least 80 percent of preindustrial levels), stratospheric ozone (less than 5 percent reduction in ozone concentration from preindustrial level of 290 Dobson units), biogeochemical nitrogen cycle (limit industrial and agricultural fixation of N_2 to 35 teragrams per year) and phosphorus cycle (annual phosphorus inflow to oceans not to exceed 10 times the natural background weathering of phosphorus), global freshwater use (less than 4,000 cubic kilometres per year of consumptive use of runoff resources), land system change (less than 15 percent of the ice-free land surface under cropland) and the rate at which biological diversity is lost (less than 10 extinctions per million species per year). The two additional planetary boundaries for which scientists have not yet been able to determine a boundary level are chemical pollution and atmospheric aerosol loading.

13 Steffen and others 2015.

14 Steffen and others 2015, p. 2.

15 O'Neill and others 2018; Steffen and others 2015.

16 This work is inspired and based on works of Hickel (2019a, 2020b) and O'Neill and others (2018).

17 For carbon dioxide emissions we adopt the approach by O'Neill and others (2018) and consider the planetary boundary derived from the target of limiting global warming to 2 degrees Celsius, as emphasized in the Paris Agreement. This target roughly translates to emissions per capita of 1.61 tonnes of carbon dioxide per year. In Steffen and others (2015) the planetary boundary for nitrogen is set at 62 teragrams per year. O'Neill and others (2018) expressed this quantity as 8.9 kilograms per capita per year. Because nitrogen is an active compound in the fertilizers used in agriculture, it seems that it would be better to express it per area unit of agricultural land than per capita. However, not all types of agricultural land require fertilizers, so we opted to look at the planetary boundary expressed in tonnes per 1,000 hectares of cropland—that is, arable land plus permanent cropland. In 2016 the size of cropland at the global level was 1,575,238,243 hectares, so the planetary boundary for the nitrogen can be expressed as 39.4 tonnes per 1,000 hectares of arable land.

Rockström and others (2009a) specified the planetary boundary for freshwater use as a maximum global withdrawal of 4,000 cubic kilometres per year of blue water, which is water from rivers, lakes, reservoirs and renewable groundwater stores. Despite thorough debates, research findings and proposed revisions in the literature, the practical implications on assessment of the planetary boundaries were, overall, minor (O'Neill and others 2018). Although we recognized that the research is still in progress, we decided to follow the originally established global boundary of 4,000 cubic kilometres per year. Data on annual freshwater withdrawal available from the Food and Agriculture Organization of the United Nations AQUASTAT database cover many countries, but the most recent available year of data is scattered in a large time interval, from 1990 to 2017. Using the global population of 2012 (median year of the latest data on withdrawal available) of 7.086 billion, we arrived at a per capita boundary of 565 cubic metres per year. This is slightly lower than the 574 cubic metres used by O'Neill and others (2018).

The area of forested land that is maintained on the ice-free land surface is expressed as a percentage of the potential area of forested land in the Holocene. Based on previous research, the planetary boundary was set at 75 percent of potential forest cover, meaning that approximately 47.9 million square kilometres of the ice-free land surface of Earth should be maintained as forest. This boundary has been constructed as a weighted aggregate of three individual biome boundaries. For tropical and boreal forests the boundary was set at 85 percent of potential forest cover, while for temperate forests the boundary was proposed as 50 percent of the potential forest cover. A challenging issue is how to determine the national share of the planetary boundary so that it is possible to identify countries that are transgressing. With the idea to increase the global forest to the extent of 47.9 million square kilometres by 2050, it means that the average annual growth rate of area under forest should be about 0.25 percent since 1990.

Material footprint is an indicator of strong sustainability that does not link directly to a planetary boundary. However, we include it in the index of excessive pressure on the planet analysis because material use is an important indicator of the environmental pressure exerted by socioeconomic activities.

Following O'Neill and others (2018), we adopt a global target of 50 gigatonnes per year, although we caution that the literature is not very mature in this area. This value leads to a per capita target of 7.2 tonnes per year, assuming a world population of 7 billion people.

18 For each indicator, except for change in forest area, the standardized value equals the observed value divided by the boundary. For change in forest area, the standardized value equals 2 minus the ratio between the observed value and the boundary.