ENE425 Sustainable Energy and App Development

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Contents

Chapter 3

Metrics: Human development for the Anthropocene

The first Human Development Report, published 30 years ago, presented the concept and measurement of **human development**. Since then, the connection between the Gross domestic product (GDP) and the HDI has evolved, and proposals have been made to adjust or change human development metrics, including to **account for sustainability**.

In this section, we look at the new reality underpinning proposals for the Anthropocene and what that means for human development. We propose arguments for reimagining the human development journey as one in which people are embedded in the **biosphere**. We also explores **new metrics** for measuring human development taking into account our impact in the planet.

The **Human Development Report** can be downloaded in the (link).

To have access to the Human Development Index (HDI) **data** for every country visit: United Nations Development Program, Human Development Index (HDI)

To have access to the **methodology** to work out the HDI visit: Human Development Indices and Indicators: 2018 statistical update.

3.1 Renewing human development for the Anthropocene

"Most 'classic' writings on sustainability present people as the problem, not as a collective source of strength. [...They] frame the discourse in terms of the Earth's finite resources and rising population. [...] We have moved away from framing it exclusively around limits to growth and conserving natural resources. Instead, we emphasize the connections between communities, ecosystems and social justice." Harini Nagendra

The **Anthropocene**: the age of humans. For the first time in our history the most serious and immediate, even existential, risks are human made and unfolding at planetary scale. This section argues that this new reality calls for reimagining the human development journey and leveraging the human development approach to support transformational social changes to ease pressures on the planet. We study the evolution of the Human Development Index during the last thirty years, and how to frame it in the context of the Anthropocene.

The Anthropocene is a proposed geological epoch dating from the commencement of significant human impact on Earth's geology and ecosystems, including, but not limited to, anthropogenic climate change.

As of July 2020, neither the International Commission on Stratigraphy (ICS) nor the International Union of Geological Sciences (IUGS) has officially approved the term as a recognised subdivision of geologic time, although the Anthropocene Working Group (AWG) of the Subcommission on Quaternary Stratigraphy (SQS) of the ICS voted in April 2016 to proceed towards a formal golden spike (GSSP) proposal to define the Anthropocene epoch in the geologic time scale and presented the recommendation to the International Geological Congress in August 2016. In May 2019, the AWG voted in favour of submitting a formal proposal to the ICS by 2021, locating potential stratigraphic markers to the mid-twentieth century of the common era. This time period coincides with the start of the Great Acceleration, a post-WWII time period during which socioeconomic and Earth system trends increase at a dramatic rate, and the Atomic Age.

Various start dates for the Anthropocene have been proposed, ranging from the beginning of the Agricultural Revolution 12,000–15,000 years ago, to as recent as the 1960s. The ratification process is still ongoing, and thus a date remains to be decided definitively, but the peak in radionuclides fallout consequential to atomic bomb testing during the 1950s has been more favoured than others, locating a possible beginning of the Anthropocene to the detonation of the first atomic bomb in 1945, or the Partial Nuclear Test Ban Treaty in 1963.

For more information about the Anthropocene visit: The Anthropocene (wikipedia).

For the **documentary**, the **book**, the **art project** "The Anthropocene" visit: The Anthropocene project.

Two more documentaries that explains The Anthropocene:

- The Anthropocene: Has earth shifted out of its Holocene state?
- The Anthropocene: The age of mankind

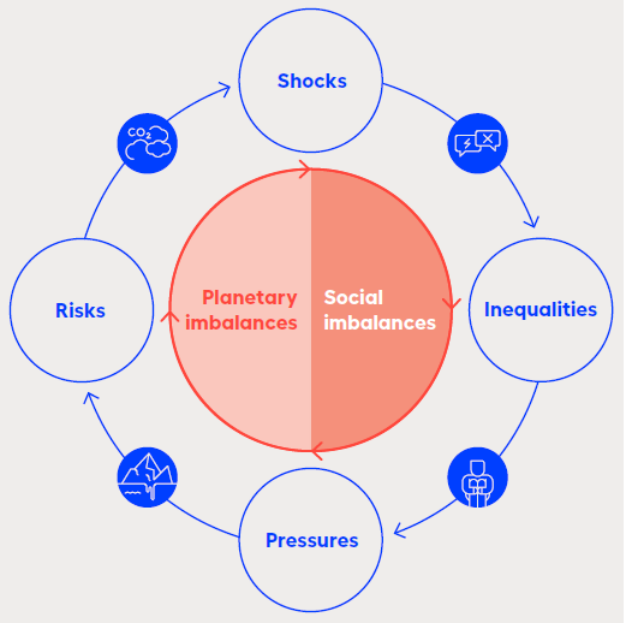
3.1.1 Confronting a new reality: People versus trees?

Unlike other concepts that have highlighted the impact of human pressures on the environment, the Anthropocene describes a state change in the Earth system, viewed as an interdependent, co-evolving social-ecological system, as well as a new way of thinking about our recent and current epoch. Anthropocene thinking takes us away from reductionist linear cause-effect analysis of equity and sustainability, to underline the fully intertwined character of human and ecological systems, and the co-evolving fates of sustainability and equity." Melissa Leach, Belinda Reyers and others

Our dependence on nature is not in question. Amartya Sen put it bluntly: "It is not so much that humanity is trying to sustain the natural world, but rather that humanity is trying to sustain itself. It is us that will have to 'go' unless we can put the world around us in reasonable order. The precariousness of nature is our peril, our fragility." But there are **two new elements to consider**.

1. First, the notion of the Anthropocene has forced a **reframing of thinking—from** stan-

Figure 3.1: Planetary and social imbalances reinforce each other



Source: UNDP (2020)

dalone environmental and sustainability issues, such as climate change, to the recognition of a set of interdependent challenges resulting from underlying processes of planetary change driven by human pressures.

As Sharachchandra Lele put it, we need to move beyond a "narrowed framing of the problem: **one value** (sustaining future generations), **one problem** (climate change), **one goal** (reduce carbon emissions) and **one solution** (renewables)." And that calls for a full understanding of the pressures we are putting on the planet and of our interdependence with nature.

2. Second, the notion of the Anthropocene emerges thanks to remarkable advances in **Earth system and sustainability sciences**. In addition to documenting and explaining the impacts of human activities, these new fields are stimulating interdisciplinary work, encompassing natural and social sciences and the humanities, providing insights into how to mitigate those impacts while improving people's lives.

A key insight emerging from this vast and rapidly growing body of work is that **social and natural systems are best seen not only as interacting and interdependent but also as embedded in each other**. Moving beyond the notion of sustainable development as separable human development targets constrained by environmental or natural resource limits, to an inseparable socio-ecological systems perspective on sustainable development, offers a fresh perspective on sustainable development. It further offer a novel and expanded opportunity space from which to address the challenges of the Anthropocene.

Considering the complex and interdependent relationship between people and planet, between socio-economic and natural systems, points to the links between dangerous **planetary and social imbalances**, which interact and often reinforce each other. As long as planetary imbalances persist, they engender risks that can materialize in shocks to human development, just as the Covid-19 pandemic has done (figure 3.1).

Reframing the human development journey in the Anthropocene has the potential to break this cycle. **What does this mean for human development?**

1. First, it presents a challenge as to how to imagine and pursue human development. Addressing social imbalances, the hemisphere on the right in figure 3.1, has always been at the core of the human development journey. But until now the other hemisphere, planetary imbalances, has not been systematically brought into the human development journey.

2. Second, the human development approach has not yet been fully leveraged to inform how to address the challenges in the hemisphere on the left in figure 3.1. It can offer fresh perspectives on making expanded capabilities and human agency central to easing pressures on the planet.

3.1.2 Reimagining the human development journey: Bringing the planet back in

Decoupling economic growth from emissions and material use is key to easing pressures on the planet while improving living standards. The debate on the extent to which this is sufficient and feasible provides a natural starting point to explore whether decoupling helps rearticulate the human development journey in the Anthropocene.

Decoupling what?

The dominant view on decoupling is that green growth or green economy approaches hold promise by shifting towards more resource-efficient and less emission-intensive production and consumption, allowing for relative or absolute decoupling.

Roughly speaking, human development comprises capabilities that relate to wellbeing and agency.

1. Improvements in human development as measured by the HDI (which accounts only partially for agency) were fuelled by using resources that generated today's ecological crises (countries in **rectangle B** of figure 3.2.

2. So a reimagined human development journey cannot occur along the same path for low human development countries (in **rectangle A**), and high human development countries cannot remain where they are.

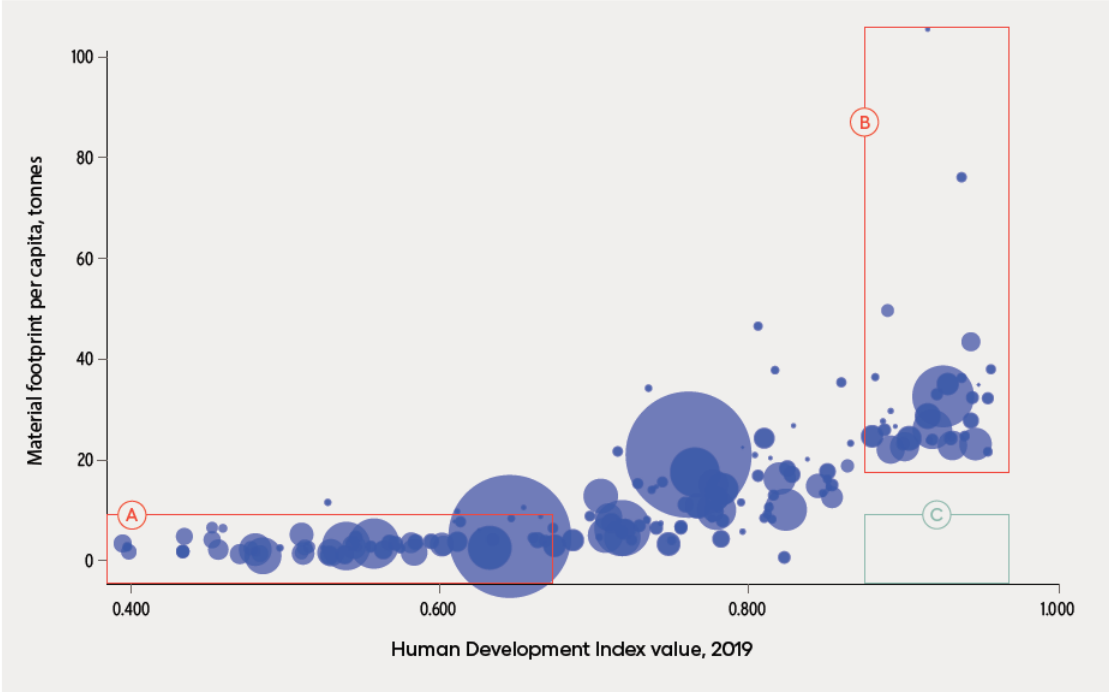
3. A reimagined human development journey thus calls on all countries to improve wellbeing equitably while easing pressures on the planet (moving to the empty **rectangle C**).

Mapping human societies' embeddedness in the biosphere: Energy and material flows.

Human societies are embedded in the biosphere and depend on it. But by extracting from it for economic activities that shape consumption and production patterns, they have also been depleting it. Much of this happens in the background and seems invisible to social and individual choices, similar to forgetting our dependence on the air we breathe. To make the interactions between social and ecological systems more visible, it is useful to look at material and energy flows in our societies and their impact on planetary processes (figure 3.3).

Transitions in human history have been driven by technological and institutional innovations, resulting in new forms of social and economic organization that have progressively expanded energy and material use. The intentional use of fire first allowed people to generate energy outside the human body but increased energy input above human physiological needs only by a factor

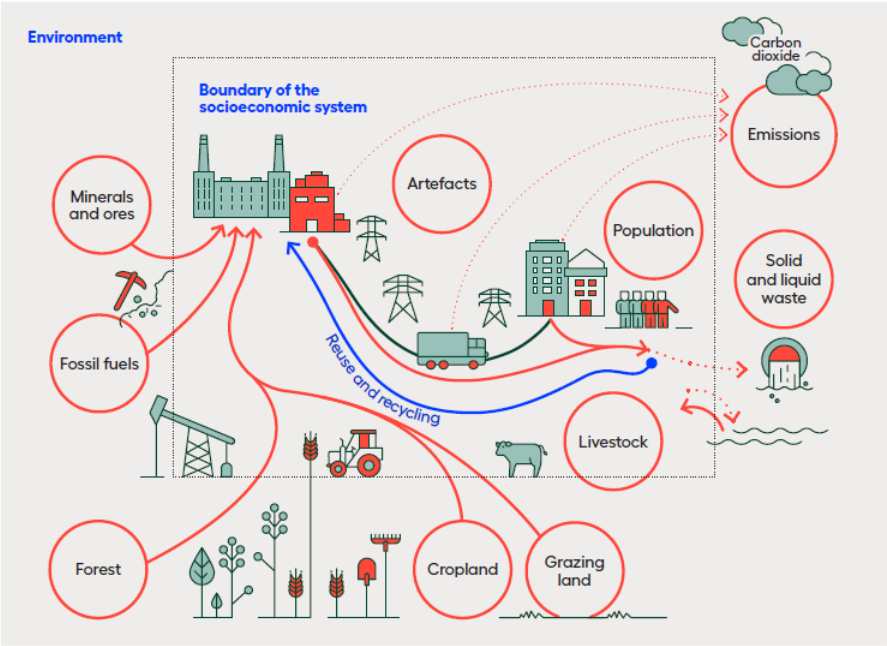
Figure 3.2: Footprint and Human Development Index



Note: Includes only countries with more than 1 million inhabitants. Bubble size is proportional to population.
Source: Human Development Report Office based on data from the United Nations Environment Programme.

Source: UNDP (2020)

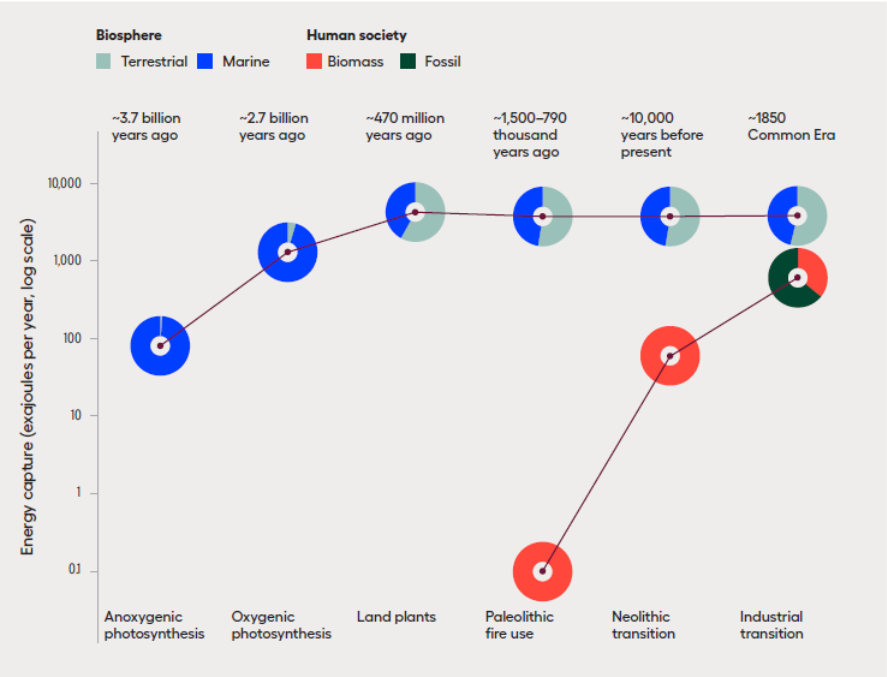
Figure 3.3: Human societies are embedded in the biosphere



Source: Haberl and others 2019.

Source: UNDP (2020)

Figure 3.4: Energy captured in the biosphere and human society



Note: Dates indicate the approximate beginning of each transition, with energy estimates for when energy regimes have matured.
Source: Lenton, Pichler and Weisz 2016.

Source: UNDP (2020)

of 2–4 (figure 3.4). The transition to agriculture represented a fundamentally new stage that raised human energy capture by three orders of magnitude (in around 1850, when it was the dominant mode of subsistence and the global population was around 1.3 billion). The higher flows of energy and population linked to farming boosted societies' material inputs and waste products and led to substantial local (and possibly global) ecological impacts due in part to the large-scale changes in forest cover often associated with fire regimes that spread and managed fire.

As some societies increased economic demands and evolved social structures to sustain those demands, the limiting conditions could be overcome by using fossil fuels for energy and through industrialization. This decoupled energy use from land and human labour. As a result, global human energy capture rose 10-fold between 1850 and 2000, as the population grew by a factor of 4.6 and GDP per person by a factor of 8.3. The total global energy flux through human societies is already one-third above the total that flows through all nonhuman and nonplant biomass.

3.1.3 Leveraging the human development approach for transformation: Beyond needs, beyond sustaining

The Brundtland approach to defining **sustainable development** as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" was a watershed moment (WCED, 1987). It brought together the ethical imperative of fulfilling the basic subsistence requirements of people today—putting poverty eradication squarely at the centre of the concept—with an obligation to our descendants rooted in **intergenerational justice**. It put people at the core, instead of defining what needed to be sustained for consumption or production. And rather than asking for the preservation of a pristine state of nature, it emphasized the ability of each generation to use resources, allowing for some fungibility across resources.

Where to go **beyond needs**? What can we expand, beyond focusing on sustaining? How to account for persistent inequalities that feeds social imbalances? The human development approach offers a path to address these questions.

Human development takes us beyond notions of sustainability based on needs fulfilment and away from notions based on instrumental objectives such as consumption or economic activity (measured by growth in GDP, for instance).

A focus on **needs** may lead to prioritizing social or economic floors, providing a minimum foundation to be shared by everyone, but it does not fully account for inequalities, and it downplays the potential of people as agents. For instance, the inspired and influential framework proposed by Kate Raworth sets a floor of essential human and social needs as a circle inside the planetary boundaries framework described in the next section. The resulting **"doughnut"** defines an operating space that is not only safe, from the Earth system sciences perspective, but also socially just.

There may not be a clear blueprint of what human development is and will be in the decades to come. Human development is permanently under construction, and the approach is open to new and emerging challenges and opportunities. This section has attempted to sketch a vision of the **human development journey in the Anthropocene** in order to navigate towards a better planet for people and the rest of life.

Brundtland Commission. Formerly known as the **World Commission on Environment and Development (WCED)**, the mission of the Brundtland Commission is to unite countries to pursue **sustainable development** together. The Chairperson of the Commission, Gro Harlem Brundtland, was appointed by United Nations Secretary-General Javier Pérez de Cuéllar in December 1983. At the time, the UN General Assembly realized that there was a heavy deterioration of the human environment and natural resources. To rally countries to work and pursue sustainable development together, the UN decided to establish the Brundtland Commission. Gro Harlem Brundtland was the former Prime Minister of Norway and was chosen due to her strong background in the sciences and public health. The Brundtland Commission officially dissolved in December 1987 after releasing Our Common Future, also known as the Brundtland Report, in October 1987.

The Report of the World Commission on Environment and Development: Our Common Future can be downloaded from the United Nations webpage (link).

For more information about the Brudtland Commission visit the Brundtland Commission (wikipedia).

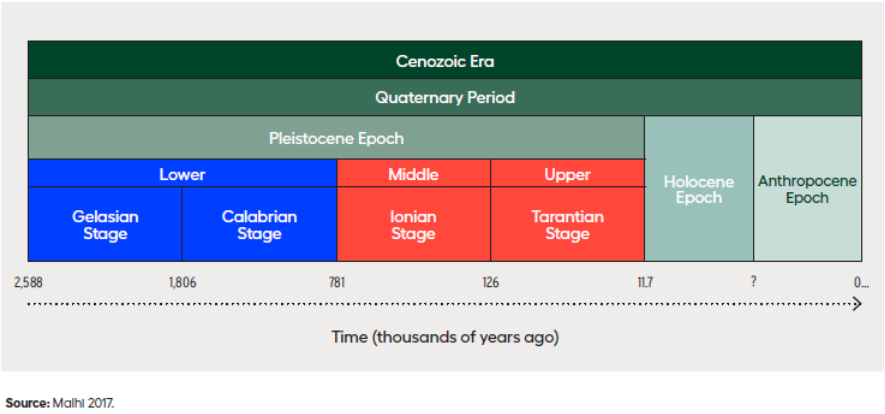
3.2 Unprecedented—the scope, scale and speed of human pressures on the planet

3.2.1 Enter the Anthropocene

"[T]he world is a complex, nonlinear system, in which the living and non-living components are tightly coupled [... with] important tipping points." Timothy M. Lenton (Lenton, 2019)

The story of the planet over time is told in the Geological Time Scale (figure 3.5). It records distinct periods in the Earth's history over timescales spanning thousands to millions of years, differentiated by characteristics ranging from climate to the emergence of life and stages in its

Figure 3.5: Geological Time Scale



Source: UNDP (2020)

evolution. Earth system scientists introduced the term Anthropocene at the turn of the 21st century. They confronted a range of observations of recent changes to the planet that contrasted with the palaeoenvironmental record of the Holocene (which is estimated to have started about 11,700 years ago) and indicated that the planet was operating in a no analogue state—that is, without precedent in the history of the planet.

The Anthropocene is not yet formally established as a new geological epoch, but several geologists and Earth system scientists propose dating its beginning to the mid-20th century with the growth in new anthropogenic materials as part of the evidence be hind their proposal. That would correspond to the Great Acceleration of human pressures on the planet that have the potential to leave a geological imprint (figure 3.6.

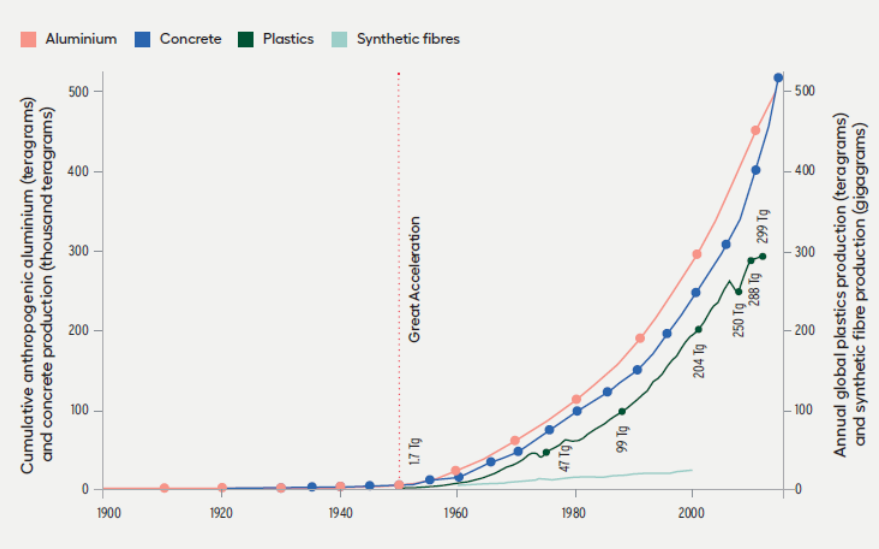
Drawing on interdisciplinary evidence and analysis, Earth systems science, geology and ecology characterize the Anthropocene from distinct perspectives (figure 3.7). Each brings something different, showing that considering diverse perspectives and approaches reveals the complexity and reach of the concept.

3.2.2 Learning from Earth system science: Something new under the sun

Over the past 2.6 million years the planet's temperature has oscillated sharply, leading to alternating warmer and colder periods. But the Holocene has been both warmer and more stable in temperature. The climate system has also been more stable, despite massive hydrological variability that has had radical implications at the regional scale. For instance, the Sahara has not always been the dry desert we see today, and the Amazon had to confront severe droughts earlier in the Holocene. In fact, an important characteristic of the climate system during the Holocene is the tight link between the whole web of life on the planet and in the atmosphere, regulating the carbon cycle. For instance, about a fifth of annual average precipitation falling on land is linked to plant-regulated water cycles, with many places now receiving half the precipitation from this type of cycle that they received before.

A prominent framework to summarize how changes in the Earth system and the biosphere underpin human prosperity in fundamental ways is the **planetary boundaries approach** 3.8. In 2009 Johan Rockström and colleagues identified what they denoted a **safe operating space for humanity**. This space is define. by several Earth system boundaries that, if transgressed, could undermine life-supporting conditions on our planet. This notion, refined over the years,

Figure 3.6: Beginning of the Anthropocene



Source: Waters and others 2016.

Source: UNDP (2020)

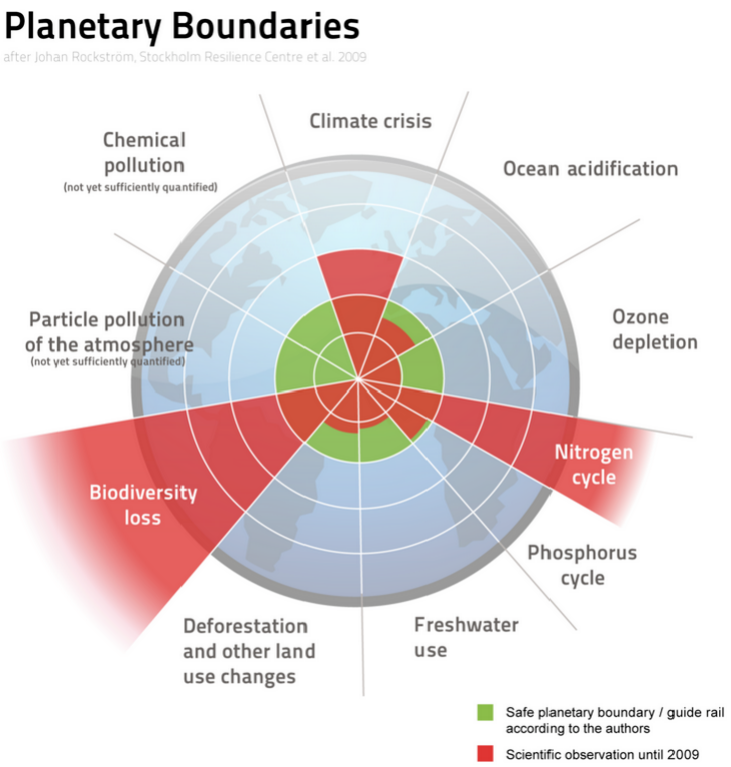
Figure 3.7: Perspectives from the natural sciences on the Anthropocene

Field	Focus	Evidence	Approaches and metrics
Earth system science	Planetary functions	Moving outside the range of variability of the Holocene → Climate change → Biogeochemical cycles disrupted (especially nitrogen and phosphorus) → Ocean acidification → Land use change → Biodiversity loss	→ Earth system tipping points and tipping elements → Planetary boundaries
Geology	Earth history	Identifying a contemporary change that is significant and detectable over Earth history timescales → Abundance of new materials of pure anthropogenic origin (aluminium, concrete, plastics) → Presence of radionuclides linked to atmospheric nuclear weapons testing	
Ecology	Biosphere	Altering the diversity, distribution, abundance and interactions of life on Earth → Conversion of ecosystems into agricultural or urban anthromes → Increasing species extinction rates → Habitat losses, overharvesting → Invasive species, global harmonization of flora and fauna	→ Biophysical reserve accounting (such as ecological footprint) → Human appropriation of net primary productivity → Rates of species extinction → Ecosystem services, nature's contributions to people

Source: Human Development Report Office based on Malhi (2017) and other sources in the text.

Source: UNDP (2020)

Figure 3.8: Planetary boundaries



Source: Wikipedia

remains one of the most influential framings for the challenges of the Anthropocene. Though the framework was designed explicitly for the **global level** only, there have been attempts to apply it at **lower scales**, even though that is neither encouraged nor supported by the original proponents.

Planetary boundaries.

Planetary boundaries is a concept involving Earth system processes that contain environmental boundaries. It was proposed in 2009 by a group of Earth system and environmental scientists, led by Johan Rockström from the Stockholm Resilience Centre and Will Steffen from the Australian National University. The group wanted to define a "safe operating space for humanity" for the international community, including governments at all levels, international organizations, civil society, the scientific community and the private sector, as a precondition for sustainable development. The framework is based on scientific evidence that human actions since the Industrial Revolution have become the main driver of global environmental change.

According to the paradigm, "transgressing one or more planetary boundaries may be deleterious or even catastrophic due to the risk of crossing thresholds that will trigger non-linear, abrupt environmental change within continental-scale to planetary-scale systems." The Earth system process boundaries mark the safe zone for the planet to the extent that they are not crossed. As of 2009, two boundaries have already been crossed, while others are in imminent danger of being crossed.

For more information about planetary boundaries visit: Planetary boundaries (wikipedia).

Doughnut (economic model).

The Doughnut, or Doughnut economics, is a visual framework for sustainable development – shaped like a doughnut or lifebelt – combining the concept of planetary boundaries with the complementary concept of social boundaries. The name derives from the shape of the diagram, i.e. a disc with a hole in the middle. The centre hole of the model depicts the proportion of people that lack access to life's essentials (healthcare, education, equity and so on) while the crust represents the ecological ceilings (planetary boundaries) that life depends on and must not be overshot. The diagram was developed by Oxford economist **Kate Raworth** in the Oxfam paper A Safe and Just Space for Humanity and elaborated upon in her book Doughnut Economics: Seven Ways to Think Like a 21st-Century Economist.

For more information about **Doughnut (economic model)** visit:

- https://www.kateraworth.com/
- Doughnut (economic model) (wikipedia).

For a video about **Doughnut (economic model)** visit: Kate Raworth (TED talk).

3.2.3 Understanding geological and ecological change

To specify the Anthropocene as a new geological epoch, geologists must identify a contemporary human-induced change that is significant and detect able over the timescales of Earth's history. Mining, landfills, construction and urbanization have resulted in the greatest expansion of new minerals that do not exist in the natural world as rocks (in the geological sense of having the potential for long-term persistence). Pure elemental aluminium is one of these materials, and as much as 98 percent of the aluminium on Earth has been produced since 1950. Another is plastics, whose current annual production equals the global human biomass. The disruptions of the global biogeochemical cycles of carbon and nitrogen also leave detectable signals visible in ice cores, reflecting rapid increases in the concentrations of carbon dioxide and methane. A unique and globally dispersed geological signature corresponds to the radioactive fallout from **atmospheric nuclear weapons** tested in the mid-20th century.

Geologists also consider **changes in flora and fauna**, both extinctions and the mixing of species across previously isolated continents and islands. Changes in periods in the geological timescale are often linked to sudden changes in the fossil record. While difficult to use as a marker for the Anthropocene with the precision of radionuclides, the magnitude and scale of the changes by humans to life on Earth may be the most enduring and obvious over the long term.

While Earth system science emphasizes the role of the biosphere on planetary functions and geologists look for markers, **ecologists and sustainability scientists** provide additional insights on human pressures by considering other fundamental changes to the diversity of life on the planet. **The Anthropocene biosphere corresponds to a third and fundamentally new stage in the evolution of life on Earth**. The first was dominated by simple single-cell microbial organisms —from approximately 3.5 billion to 650 million years ago. In the second stage complex multicellular life emerged, becoming widespread and diverse after the Cambrian explosion 540 million years ago. **Four characteristics make the Anthropocene biosphere unlike anything that has ever existed on the planet**:

- Homogenization of flora and fauna through deliberate or accidental transfer of species across the globe.

- One species (humans) consuming 25–40 percent of land net primary productivity (that is, the biomass and energy made available by plants to all life on Earth).
- Human-directed evolution of plants and animals, marginalizing natural biomes—something unprecedented in the last 2.4 billion years.
- Increasing impact of new technologies as the biosphere interacts with the technosphere.

3.2.4 Bringing the Anthro into the Anthropocene

Along with the physical evidence this added dimension of the Anthropocene is essential to framing a new human development narrative. It places people's interactions with nature in historical, social and economic contexts, informed by insights from the natural sciences. This is reflected in new fields such as the climate-economy literature and in the resurgence of interest in environmental history.

Historical analysis places the current moment of the Anthropocene in perspective but also shows how much of human history has been influenced by occurrences in the natural world. In the words of historian Kristina Sessa, "The idea that objects, animals, and other non-human entities (volcanoes, oak trees and solar radiation, for instance) shape the development of human affairs, that they possess historical agency in some form, has forced scholars to **rethink** some of their basic assumptions about **government**, **power**, and **culture**." (Sessa, 2019)

Thus, many argue that rather than looking at the Anthropocene as a precisely dated geological period, it would be better to consider it a process, or a continuous Holocene/Anthropocene, in order to understand the long (and ongoing) transition of the dialectical relationship between cultural, political and economic systems and the natural world. Others reject the notion altogether, criticizing a narrative that lumps humanity together without attending to either existing inequalities or historical asymmetries in power and overexploitation of resources. One common line of criticism is that the notion of the Anthropocene, especially the more science-based formulations such as planetary boundaries, do not strike at the heart of the problem, which is seen as capitalist modes of production as well as longstanding historical legacies of colonization. Although Edward Barbier documents that the environmental record of centrally planned and collectivized economies has been no better than that of capitalist ones.

Some of these differences in perspective reflect differences between the social sciences and the humanities, on the one hand, and the natural sciences, on the other. The humanities see society and the economy as complex systems, with nature at best a contextual backdrop or something that can be analytically separated from societies, even if they are physically interdependent. The natural sciences take the reverse perspective, with natural systems as interdependent and complex and human agency de scribed in aggregate terms as causing generalized impacts or disturbances. Others oppose conceptualizing the Anthropocene as a process because they view the concept's power as signifying a rupture with the past, thus indicating a contemporary state of the world that urgently needs fundamental changes at the risk of catastrophic consequences for nature.

Where does this leave us? With the **notion that the Anthropocene is something novel in two ways**.

1. First, "the Anthropocene is an encapsulation of the concept that modern human activity is large relative to planetary processes, and therefore that human social, economic, and political decisions have become entangled in a web of planetary feedbacks. This global planetary entanglement is something new in human history and Earth history."

2. Second, the Anthropocene is a catalyst for systematic thinking about the interdependence of people and nature, including the Earth system. It is informed by a diversity of disciplines, going beyond linear and simplified narratives of progress, and invites framing the options that face us today as more than a choice between impending catastrophe or an easy decoupling of economic activity from planetary pressures.

One implication of this understanding of the relationship between people and nature is the recent reframing of the conceptual approach of ecosystems as providers of services to acknowledge nature's contributions to people. This reframing also presents anthropogenic drivers of changes in nature as being embedded in institutions and governance systems. It recognizes the intrinsic value of preserving nature.

3.3 Towards a new generation of human development metrics for the Anthropocene

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 this section, there is no one-size-fits-all tool or metric. Instead, this subsection introduces and explores a suite of possibilities, including an experimental **Planetary pressures adjusted Human Development Index**.

3.3.1 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. 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**.

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 section 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 section 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**.

3.3.2 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 but explores **metrics** guided by the importance of going beyond sustaining. It focuses on the implications of accounting for planetary pressures by adjusting the income component of the HDI.

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 be cause it fails to account for the depreciation of capital assets and ignores **natural capital** and the **social costs** (borne by everyone) of environmental damage. **Other income-based indicators** take a broader view of net flows from capital and adjust for natural resource depletion and damage from emissions and pollution. Here we explore **a simpler and more direct adjustment to GNI by subtracting the social costs of carbon dioxide emissions**. 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.

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. The UNDP (2020) consider **two estimates**:

1. 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. 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.
2. The other estimate is from a recent application of the **Dynamic Integrated Climate-Economy integrated assessment model**. 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. 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).

Dynamic Integrated Climate-Economy model (DICE model).

The Dynamic Integrated Climate-Economy model, referred to as the DICE model or Dice model, is a neoclassical integrated assessment model developed by 2018 Nobel Laureate William Nordhaus that integrates in the economics, carbon cycle, climate science, and impacts allowing a weighing of the costs and benefits of taking steps to slow climate change.

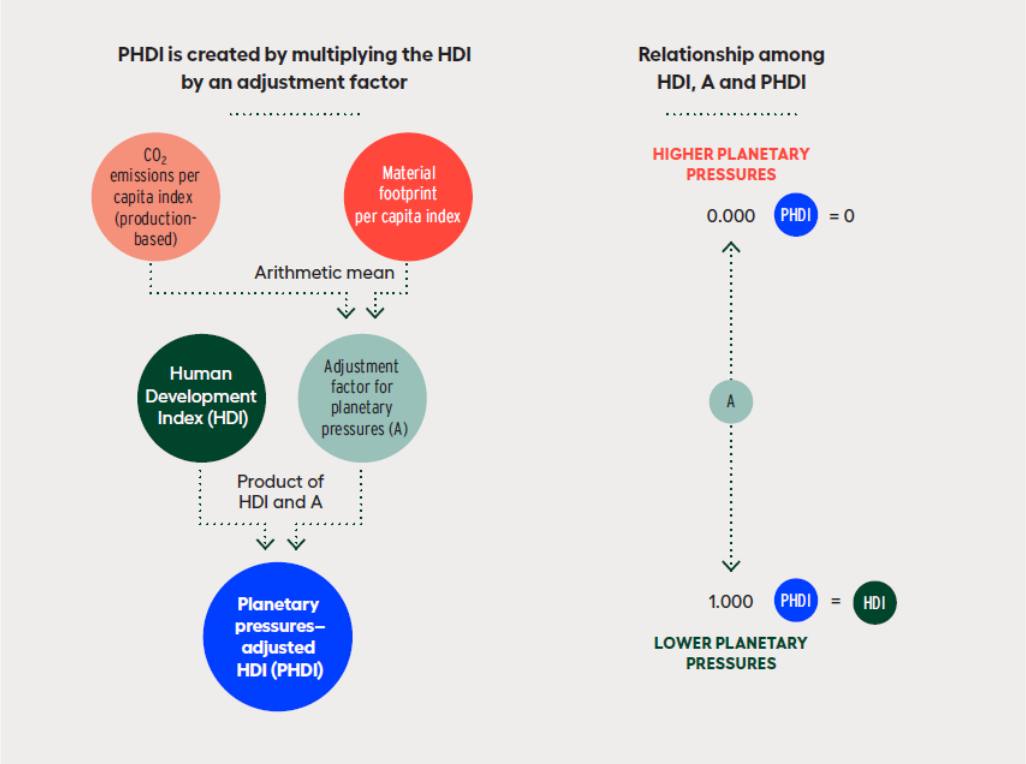
For more information about **Dynamic Integrated Climate-Economy model (DICE model)** visit:

- Pedagogy in Action.
- (Wikipedia).

3.3.3 Adjusting the Human Development Index as a whole

The HDI is an example of what James Foster has called "intentional measurement." Its construction was driven by its intended purpose and desired characteristics. The purpose was to **shift**

Figure 3.9: Visual representation of the Planetary pressures–adjusted Human Development Index



Source: UNDP (2020)

objectives and action towards a view of development that put people at the centre. Two of its main desired characteristics were clarity and simplicity.

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**.

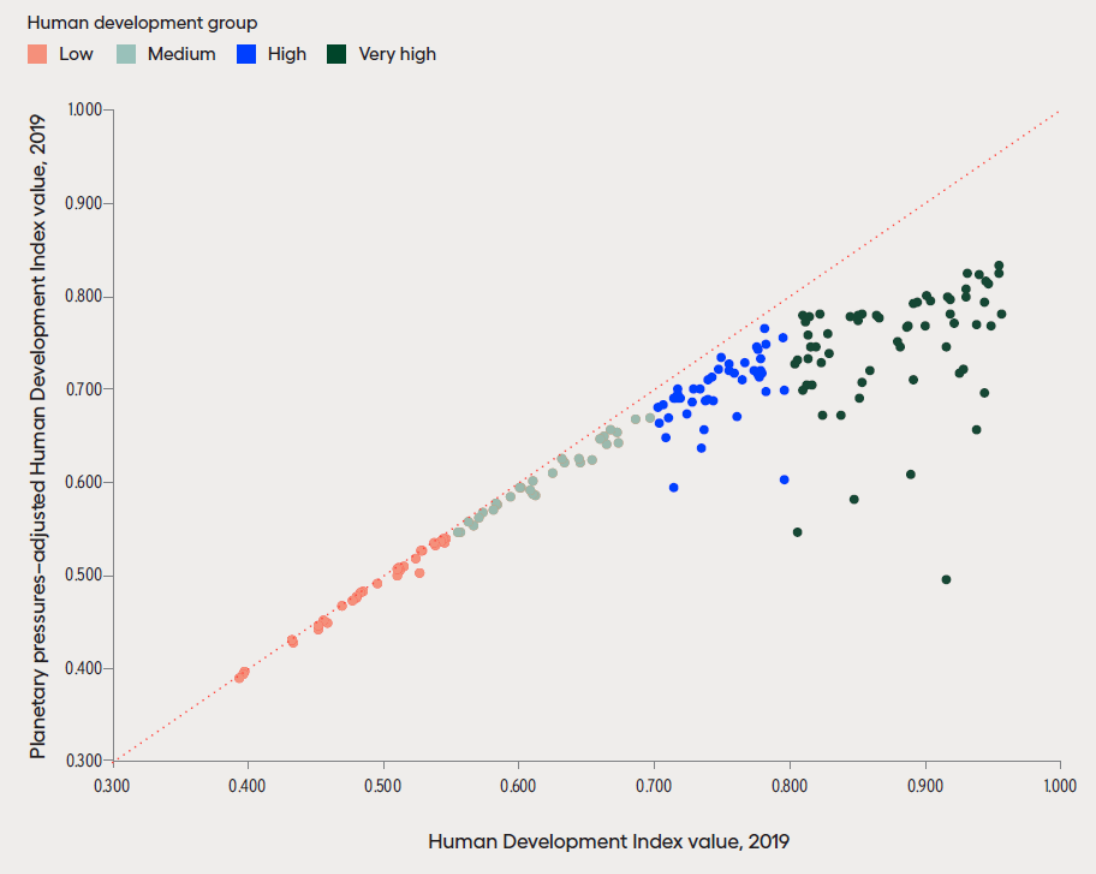
- To account for **capabilities**, the HDI is the obvious choice.
- And for the other component, the **biophysical and socioeconomic processes** that produce planetary pressures should inform the choice. We consider **two summary measures**:
  - **Carbon dioxide emissions**.
  - **Material footprint**, both on a per capita basis.

The adjustment to the HDI is a **signalling device** for positive change, encouraging the expansion of capabilities while reducing planetary pressures. 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.

The Planetary pressures–adjusted Human Development Index

The adjustment corresponds to multiplying the HDI by an adjustment factor, creating the Planetary pressures–adjusted HDI (PHDI) (figure 3.9). If a country puts no pressure on the planet,

Figure 3.10: Human Development Index vs. Planetary pressures–adjusted Human Development Index



Source: UNDP (2020)

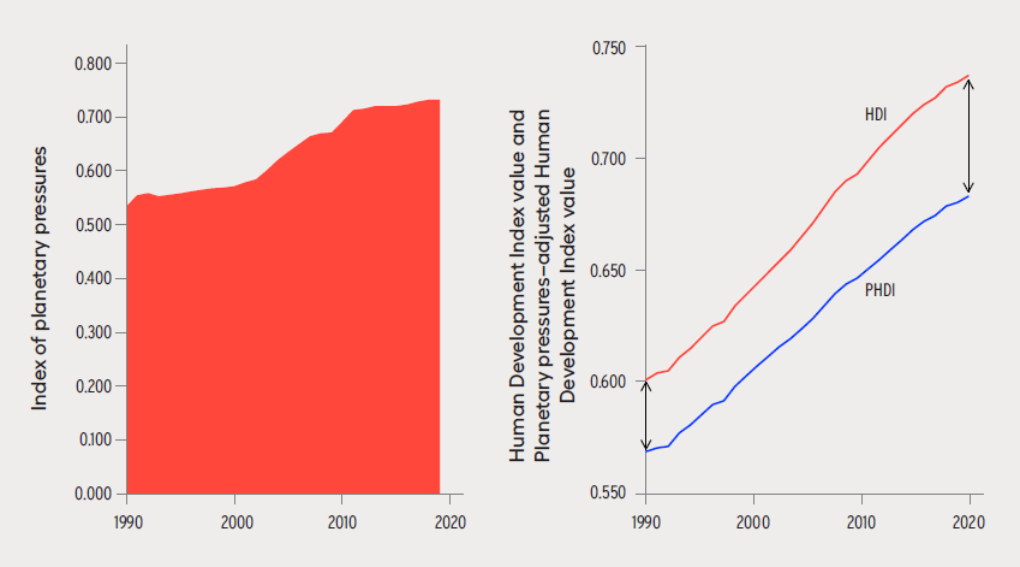
its PHDI and HDI would be equal, but the PHDI falls below the HDI as pressure rises. The **adjustment factor** is calculated as the arithmetic mean of indices measuring **carbon dioxide emissions per capita**, which speaks to the energy transition away from fossil fuels, and **material footprint per capita**, which relates to closing material cycles. A country's material footprint measures the amount of material extracted (biomass, fossil fuels, metal-ores (minerals) 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.

PHDI values are very close to HDI values for countries with an HDI value of 0.7 or lower (figure 3.10). Differences start to open up at higher HDI values, with wider divergence at very high HDI values.

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 past three decades (left-hand side panel, figure 3.11). The PHDI is not only lower than the HDI; it is also growing more slowly (right-hand panel, figure 3.11). The gap between

Figure 3.11: Planetary pressures have increased with gains on the Human Development Index



Source: UNDP (2020)

the conventional assessment of development (the HDI) and the new perspective to navigate the Anthropocene (the experimental PHDI) has been widening.

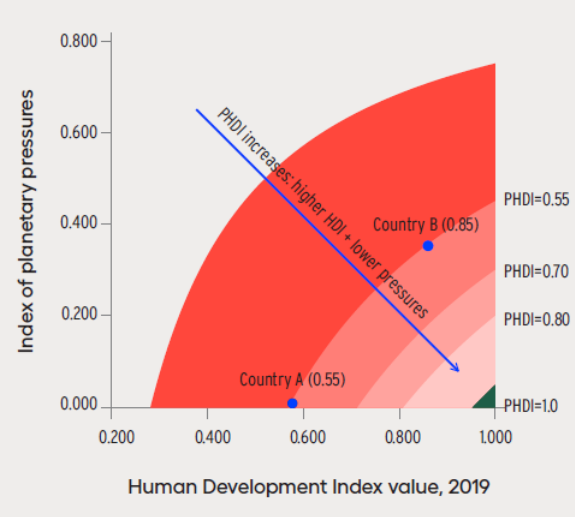
From a policy perspective the PHDI provides a guiding metric towards advancing human development while easing planetary pressures—a combination that today corresponds to an "empty corner" when human development is contrasted with indicators of planetary pressures (figure 3.2).

In figure 3.12 the horizontal axis shows the HDI, and the vertical axis shows the index of planetary pressures (which is one minus the adjustment factor for 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 section 3.1 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 3.13 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 human development on the PHDI**. And even in those 10 countries the PHDI is still far from the aspirational bottom-right corner.

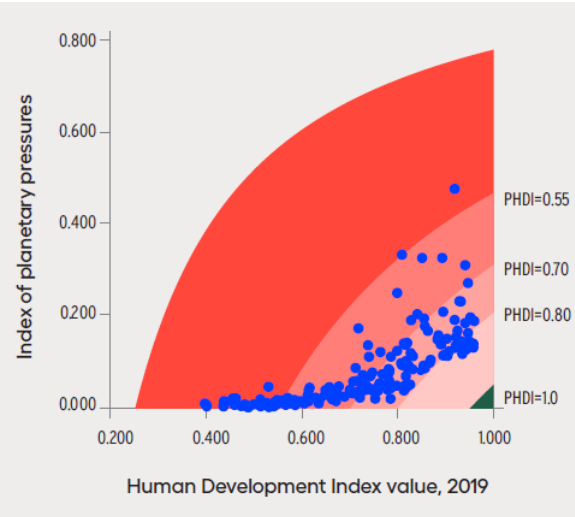
Looking at the trajectory of countries over the past three decades shows different paths across human development groups. Low and medium human development countries have been able to improve social and economic conditions substantially without a high burden on planetary pressures. But in high and very high human development countries, improvements on the HDI have been coupled with rising planetary pressures (left-hand side panel, figure 3.14).

Figure 3.12: Contrasting progress in human development with planetary pressures



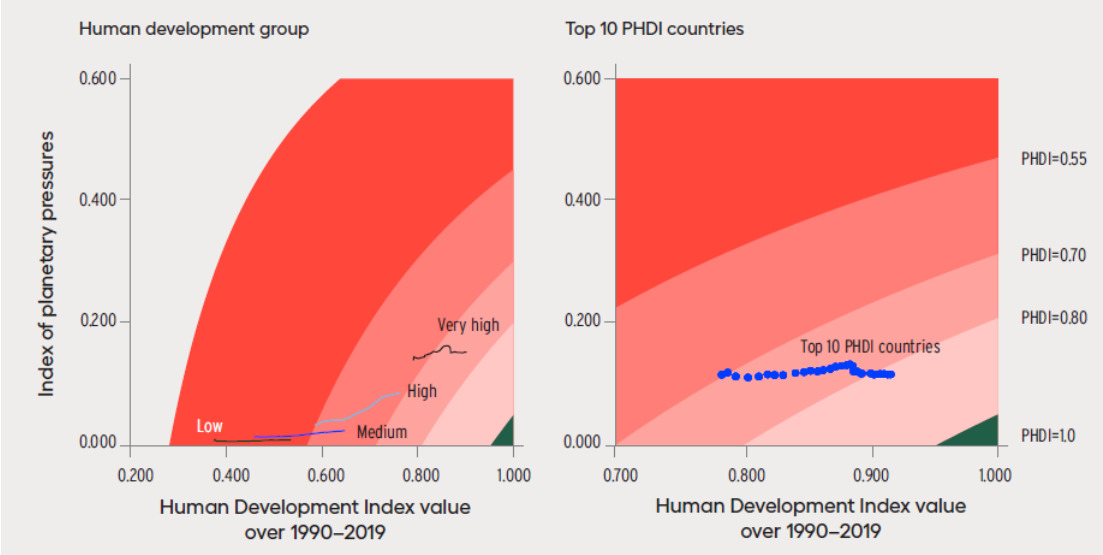
Source: UNDP (2020)

Figure 3.13: Planetary pressures and Human Development Index by country



Source: UNDP (2020)

Figure 3.14: Planetary pressures and Human Development Index (time evolution)



Source: UNDP (2020)

Although absolute planetary pressures have been growing, **two aspects reflect some progress**:

1. First, after the 2008 global financial crisis a few developed countries have shown some **decoupling of human development gains from planetary pressures**. 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 (right-hand side panel, figure 3.14).

2. Second, there is some evidence **more broadly of relative decoupling**. The curve corresponding to the average performance on the HDI and planetary pressures for all countries moved slightly towards the bottom right-hand corner between 1990 and 2019 (figure 3.15.

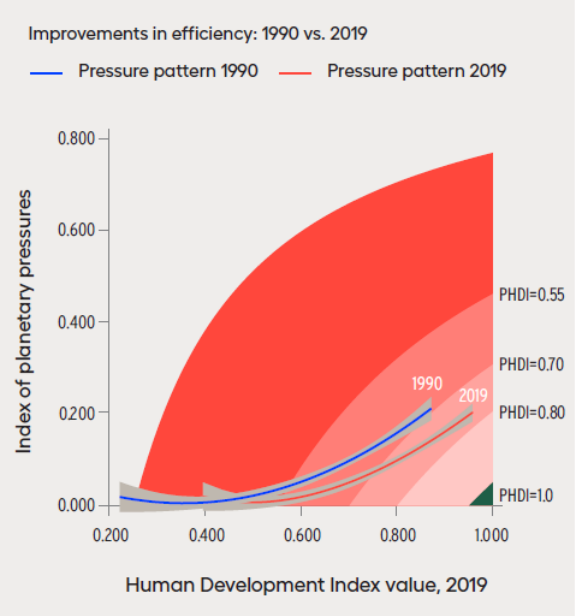
But the movement has been far too slow and modest. Further progress will require all countries to rapidly shift substantially towards the bot tom-right corner. The PHDI and the HDI can help assess and, more important, encourage choices towards a human development journey in the Anthropocene that move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

3.4 Other measures of 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.

In 2005 the **Organisation for Economic Co-operation and Development (OECD)** began its Global Project on Measuring the Progress of Society 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

Figure 3.15: Planetary pressures and Human Development Index (trends)



Source: UNDP (2020)

declaration on the importance of measuring the progress of societies. 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.

The OECD began developed the **Better Life Index** in 2011 to bring together internationally comparable measures of wellbeing.

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.
- Establishment of good governance.

These four pillars consist of **nine general contributors to happiness**:

- Psychological wellbeing
- Health
- Education
- Cultural diversity and resilience
- Time use
- Community vitality

- Living standard
- Ecological diversity
- Resilience.

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. 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**, **older people**, **people with "disabilities" (special capacities)** and **indigenous communities** 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. These and other communities are developing wellbeing indicators to understand the **needs and aspirations of their communities in the widest sense**.

Better Life Index.

This index allows you to compare well-being across countries, based on topics the OECD has identified as essential, in the areas of material living conditions and quality of life.

For more information about the Better Life Index visit: Better Life Index (link).

Global Green Economy Index.

This index combines in-depth analysis of national green performance with perception of that performance. The index evaluates the green reputations of countries as judged by expert practitioners and benchmarks these perceptions against measures of national green performance.

For more information and data about the Global Green Energy Index visit: Global Green Energy Index, Dual Citizen (link).

For more information about sustainable lifestyles visit: The SPREAD Sustainable Lifestyles 2050 Project (link).

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