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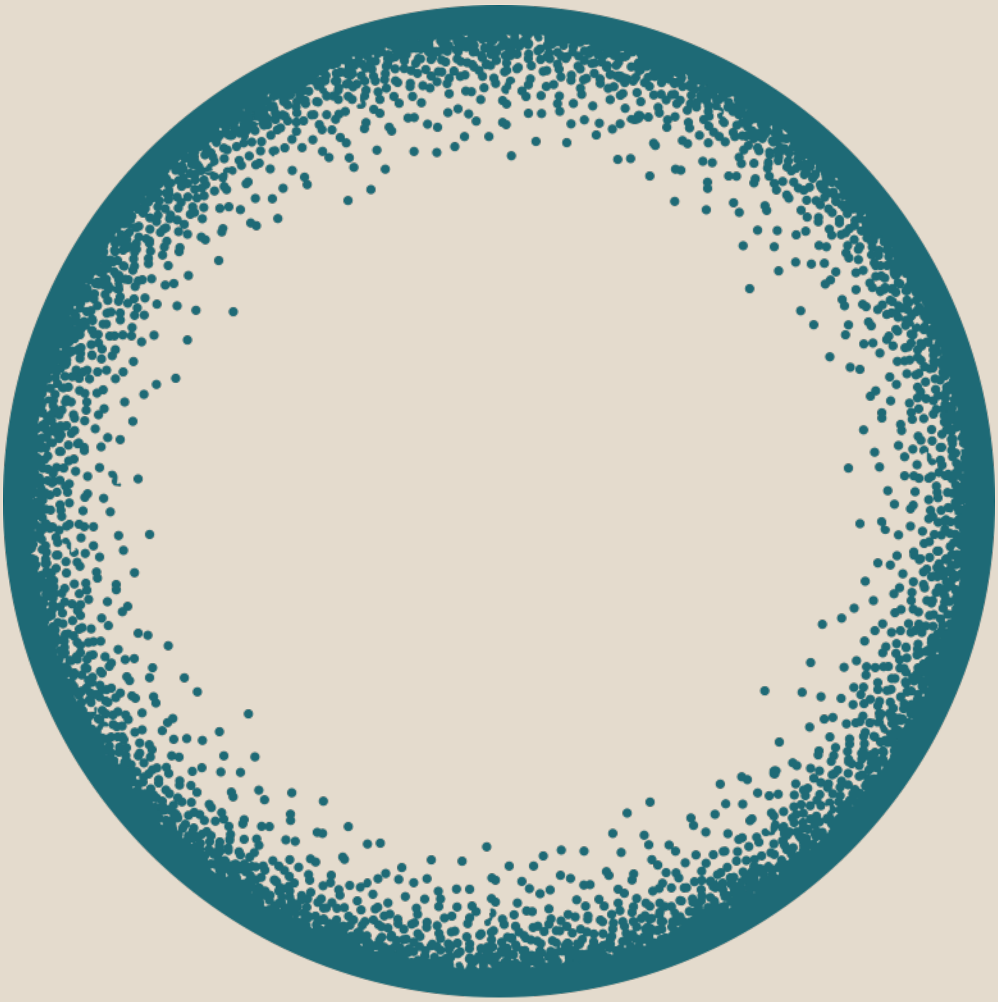

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FROM PLANETARY EMERGENCY TO REGENERATIVE ECONOMIES

Accounting for nature in measures of sustainable development

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Abstract

Starting from a world in which resources have become scarce and planetary boundaries have been reached or exceeded, the paper discusses how these changes affect our understanding of (economic) progress and sustainable development. In doing so, the paper addresses three important points in the discussion on sustainability. Firstly, the question of "means" and "ends", secondly, the visualization of this reality in the measurement of sustainable development, taking into account the specific characteristics of the environment/nature, and thirdly, the question of whether a concept that maps "regenerative development" could be suitable to account for the current state of natural systems that have already exceeded their (planetary) limits.

JEL codes: Q01, Q2, Q3, Q5

Keywords: Sustainable development, planetary boundaries, well-being, wealth, means and ends, social and economic progress, conservation & restoration, regeneration

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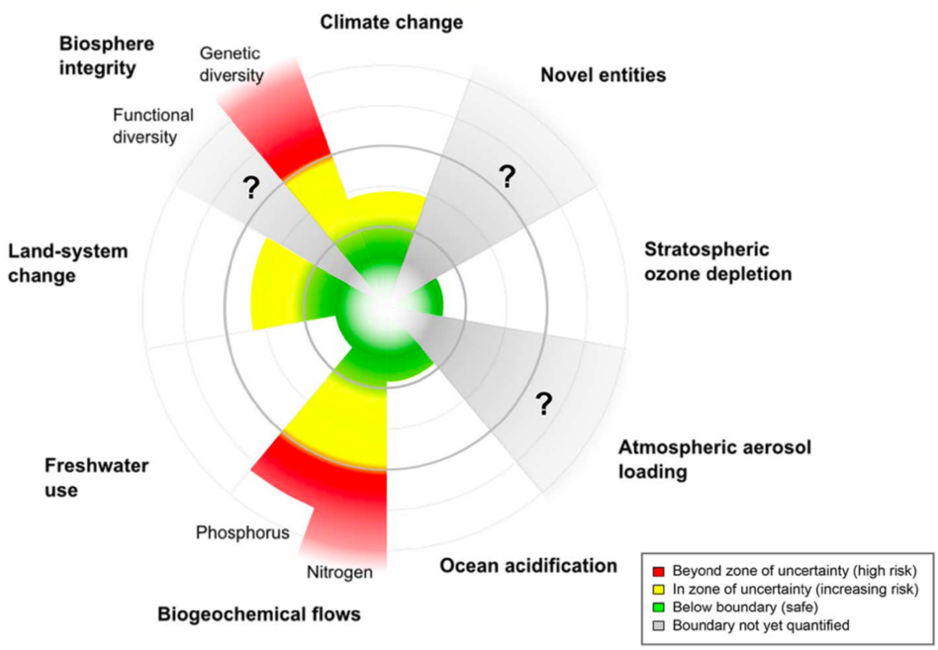
1. INTRODUCTION

The 2020s are the UN Decade on Ecosystem Restoration, aiming “to prevent, halt and reverse the degradation of ecosystems on every continent and in every ocean.”[1] According to its own definition, the UN understands ecosystem restoration as assisting in the recovery of ecosystems that have been degraded or destroyed, as well as conserving the ecosystems that are still intact. In choosing the term “restoration”, the idea of repairing and building back ecosystems is conjured as some kind of emergency procedure (Young and Schwartz 2019). This bears resemblance, on a conceptual level, to the notion of planetary boundaries, which in themselves comprise a limitational view of nature and its ecosystems (Rockström et al. 2009; Steffen et al. 2015).

Planetary boundaries connect to the older discussion on the limits to human economic activities within a wider ecological system that is understood to be finite. The relevance of the entropy law for the economic process (Georgescu-Roegen 1971; Bonaiuti 2010; Georgescu-Roegen 1971), the view of a “Spaceship Earth” economy (Boulding and Bernett 1966), the economic discipline of ecological economics (Daly 1996; Daly and Farley 2003; Zografos and Howarth 2008), and of course the first report to the Club of Rome, “Limits to Growth” (Meadows et al. 1972; Meadows, Randers, and Meadows 2004; Turner 2008), are intellectual predecessors of the current debate on planetary boundaries.

Figure 1: Planetary Boundaries



Source: Steffen et al. 2015

[1] Taken from https://www.decadeonrestoration.org/

Four of the nine planetary boundaries identified are already outside their “safe operating space” (see Figure 1). Human behavior has already impacted e.g. the climate system profoundly and further and more severe potentially irreversible changes are expected to happen (IPCC 2021b). The state of urgency can be summarized in that “we are currently damaging [the natural world] so profoundly that many of its natural systems are now on the verge of breakdown.“ (Attenborough 2021).

A common understanding of economics as the study of “human behavior as a relationship between given ends and scarce means”, which goes back to Robbins (1935), p.16)[2], implies that when scarcities and dynamics change in a significant way, economic models and approaches have to respond to these changed circumstances and be adapted. Against this background of the developments outlined above as well as the current state and perception of economic research, these changes urgently need to be integrated and implemented also beyond environmental and ecological economics, into the core of general economic frameworks, models and applications (Dasgupta 2021; Groom and Turk 2021)[3].

The need for restoration and preservation, the importance of physical limits and the embeddedness of the economic system in the environment have been highlighted prominently, also from an economics perspective, in recent publications and initiatives, such as the Dasgupta Report on the Economics of Biodiversity (Dasgupta 2021), the Report of the German Advisory Council on Global Change (WBGU - German Advisory Council on Global Change 2021). The Dasgupta Report identifies three key areas to proceed: The first is to address the imbalance between the demand of our current economic system and nature’s supply and to increase the latter, the second to change the measures of economic progress and the third to transform our institutions and systems accordingly (Dasgupta 2021). The focus of this article is on the second aspect, the measures.

In the debate on measuring social and economic progress, the measurement of sustainable development plays a central role (see e.g. OECD 2018 or Stiglitz, Sen, and Fitoussi 2009). This article discusses the measurement of sustainable development focusing on indicators. As the objectives of development and the means to reach them need to be identified before they are being measured, some main points of this discussion are outlined. We also present special characteristics of natural compared to anthropogenic capital, which have an influence on the measurement and inclusion into indicators, especially for forward-looking ones. Based on this, characteristics of frequently used indica-

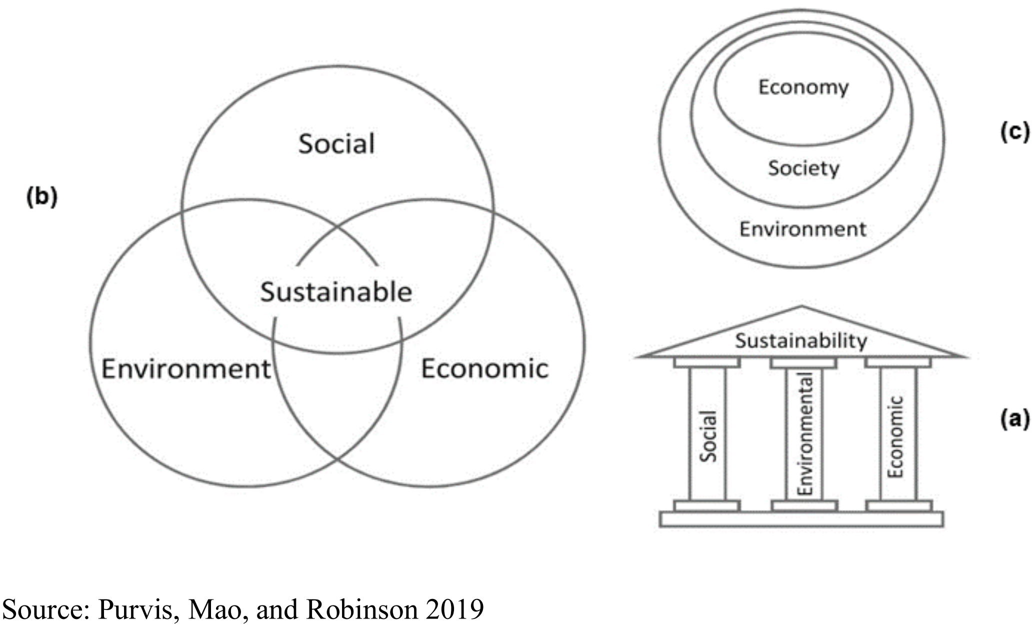
[2] This definition is being used widely both, within and outside economics (e.g. in Baumgärtner and Quaas (2010) and Eaton and Sheng (2019) or Shizgal (2012).
[3] While this call for inclusion has been considered “commonplace” by the same author 20 years ago, the understanding of how this could be done was less clear at that time (Dasgupta (2001), p.xviii).

tors are discussed, concentrating on how far they can contribute to a better understanding of sustainable development in the current situation. This is then related to the possibility of measuring regenerative development.

2. NATURE AND SUSTAINABLE DEVELOPMENT

The Brundtland Commission's definition of sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (United Nations 1987, chapter II) is the one, which is most often cited and serves as a basis for many discussions on sustainable development, although it was not the first attempt to conceptualize the term[4]. The Commission's definition prominently incorporates the two dimensions of intergenerational justice (between present and future generations) and intragenerational justice (the needs of the present) and drew attention to the focus on human needs. It also includes limitations of the environment's ability to meet these needs that are "imposed by the state of technology and social organization" (ibid.). Scarcities have been changing fundamentally since the Brundtland report and recent proposals for adjusted definitions of sustainable development often emphasize the dependence of the economy on nature and its implied existence of limits for economic activity more prominently. One example is the proposal by Griggs et al. (2013) to define SD as "[d]evelopment that meets the needs of the present while safeguarding Earth's life-support system, on which the welfare of current and future generations depends" (Griggs et al. 2013).

Figure 2: Graphical representations of sustainability / sustainable development

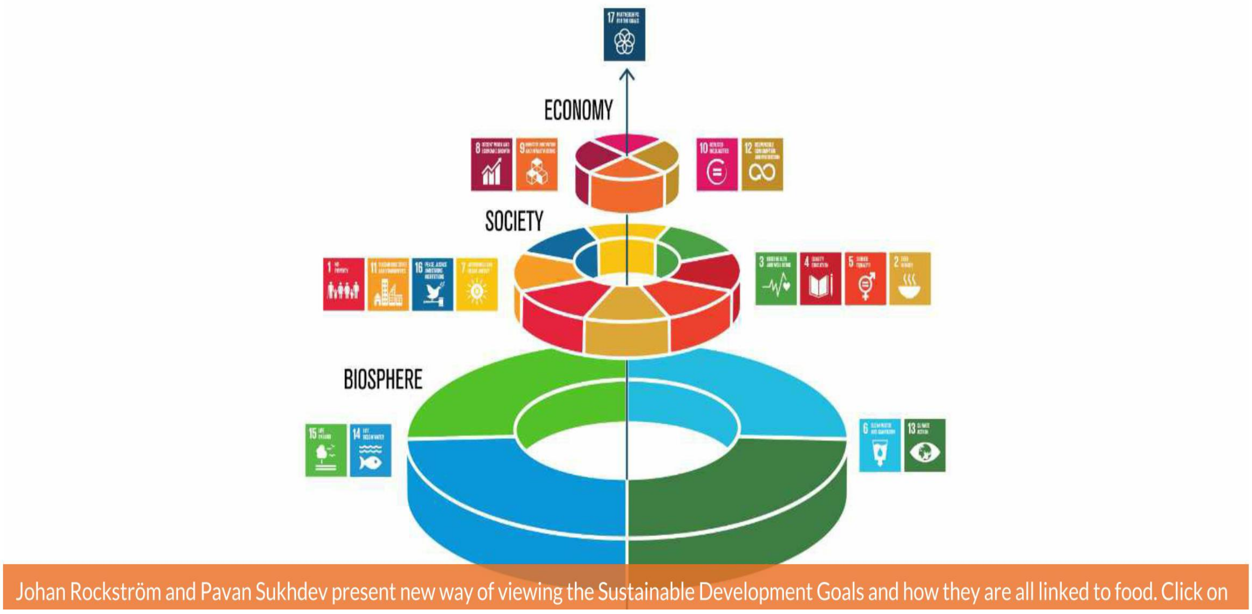


Source: Purvis, Mao, and Robinson 2019

[4] One of the earliest definitions of the term sustainable development is by Allen (1980) and „refers to a development process that is compatible with the preservation of ecosystems and species" (cited in Fleurbaey et al. (2014), p.292).

Sustainable development (SD) has often been conceptualized based on three pillars or spheres (social, economic and environmental), which have been expressed graphically in three types (Figure 2): From three distinct pillars next to each other (a), to three overlapping circles with SD in the overlapping area that emphasize trade-offs and interactions between the different spheres (b) to concentric circles, which depict the economy (and society) as embedded in the environment/the biosphere (c). This last type of representation is conceptually in line with the understanding of sustainable development that explicitly considers "the stable functioning of Earth systems — including the atmosphere, oceans, forests, waterways, biodiversity and biogeochemical cycles — [as] a prerequisite for a thriving global society" (Griggs et al. 2013) and which is applied to food for the Sustainable Development Goals (SDG) in Figure 3.

Figure 3: An application of sustainable development to the SDG, embedded



Source: Rockström and Sukhdev 2016

Economists have often interpreted sustainable development as a non-decreasing capacity to provide utility per capita that does not decline in the future (Neumayer 2013)[5]. A prominent approach demands for a development to qualify as sustainable it is necessary that "the per capita social value, adjusted for distribution, of the full array of resource stocks that constitute the productive base of the Anthropocene System" does not decline (Clark and Harley 2020). In other words, inclusive wealth does not decline.

[5] According to Sen (2013), "to ask for the maximization of sustainable consumption would replace an end-based objective with a means-based objective" as consumption should be considered as a means to other ends. This becomes relevant when consumption of different forms of capital is used as a proxy for utility (or well-being).

The Common International Classification of Ecosystem Services (CICES) can be seen as an example of how nature can be treated in practice as consisting of assets that provide benefits, which in turn increase the well-being of people and should therefore be positively valued (e.g. from a social welfare perspective) (European Environment Agency 2021). CICES distinguishes between three categories of how ecosystem services affect human well-being, directly or indirectly: (1) Provisioning Services, (2) Regulating and Maintenance Services, (3) Cultural Services. Note that restricting the services to those that affect human well-being still implies an anthropocentric perspective.

One way to conceptualize the environment and its role in the economy is as performing four functions in the economy, all of which have an impact on human well-being[6]. Besides serving as a resource base, a waste sink and providing amenity services, life-support services and system services are the fourth function the environment provides (graphically this function is often depicted as a box or circle around the economy)[7]. In that setting, the embeddedness of the economy in nature is thus acknowledged conceptually. A related and interdisciplinary, but different, structure can be found in the IPBES Report (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services 2019), which differentiates between material, non-material and regulating contributions of nature to people.

The OECD contrasts the so-called capital approach[8], where the allocation of resources or assets (i.e. different forms of capital) determines people's well-being today and in the future, with the systems approach that makes a distinction between the behavior of components in a system and the dynamics of the system itself (OECD 2018). It should however be noted that a focus on capital (or wealth) maintenance from a strong sustainability perspective, i.e. within certain components of natural capital, does not necessarily entail monetization of natural capital. This economic construction of ecological reality (Luks 2007; Luks and Siemer 2007) has severe limitations especially when we are faced with varying degrees of uncertainty e.g. about thresholds (Stirling et al., 1997; Temel et al., 2018) as in the planetary boundary concept[9]. Moreover, the existence of tipping points[10] renders marginal analysis largely inappropriate for the analysis of ecological systems (Cohen, Hepburn, and Teytelboym 2019).

[6] This is described e.g. in the environmental and resource economics textbook by Perman et al. (2011).
[7] This can be related to the outer circle of Raworth's doughnut or the systems approach in general.
[8] More on the theory and application of sustainable development in line with the capital approach can be found e.g. in Hamilton and Clemens (1999); Dasgupta and Mäler (2000); Lange et al. (2018) or Arrow et al. (2012); United Nations Environment Programme (2018).
[9] See Neumayer (2013), chapter (4) for an introduction on the role of risk and uncertainty for sustainability.
[10] A tipping point is understood as "the critical point at which the future state of the system is qualitatively altered by a small perturbation" (Lenton et al. (2008), p.1786) or the threshold beyond which „runaway change propels a system to a new state" (van Nes et al. (2016), p. 902).

3. ECONOMICS WITHIN PLANETARY BOUNDARIES

The fact that scarcities have changed fundamentally in recent years, as described e.g. by the IPCC (IPCC 2021a), makes it even more important to account for the environment in economic theory and approaches. The current imbalance between the current economic demand and what nature (can) supply needs to be acknowledged outside the realm of specific subfields (Dasgupta 2021). The dependence of the economy on nature can be modeled via a materials balance constraint in a model of natural resource extraction applied to the macro level, which sets limits to economic possibilities by including a minimum level (threshold) of the natural resource. Beyond this threshold, economic activity falters (presented in Dasgupta 2021, summarized e.g. in Groom and Turk 2021). Nature thus directly restricts the extent to which economic activities are possible and desirable.

The following section highlights some of the differences between natural and other forms of capital, which can be subsumed under the term anthropogenic capital. The latter aggregate includes for example physical and social capital. These differences have implications for the inclusion of nature in economic analyses and are mostly in addition to the general systemic aspects discussed in the preceding section.

Starting from a general classification of nature with respect to the type of goods it comprises of, its constituent parts often have public goods characteristics in the sense that there is no rivalry in their use/consumption and users cannot be excluded easily. For environmental goods and services, Figure 4 presents some examples with different characteristics in terms of rivalry and ease of exclusion. Environmental goods and services appear in all combinations of these two factors and hence fall into all categories available, from private goods in the upper left corner to public ones in the lower right corner. As different types of goods imply that potential policy measures need to address very different market failures, the corresponding analyses may thus differ substantially and can be more similar to analyses of non-environmental goods of the same type than to other parts of the environment. Consequently, to address the potential market failures resulting from these varying characteristics, policy measures need to vary accordingly.

Figure 4: Examples of goods and services classified by rivalry and excludability

Ease of exclusion

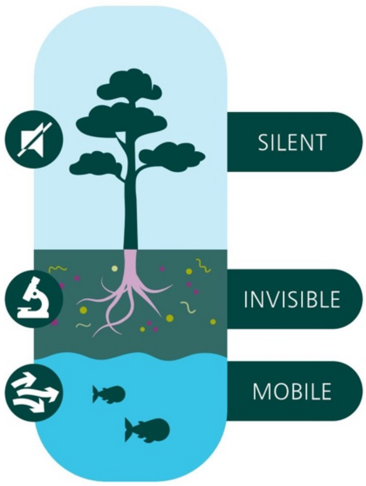
Rivalry	Easy	Difficult	Approaching impossible
Rival and scarce	Timber	Wild game	Fish in the open ocean
Rival & abundant	Parks	Regulating and cultural ecosystem services	Atmospheric oxygen
Non-rival	Flood protection	National security	Ozone protection

Source: based on Kubiszewski (2010) and Costanza et al. (2021), adapted by the authors

However, many environmental goods and services share certain properties; many parts of it are silent, invisible and/or mobile (cf Figure 5). These properties put nature especially at risk of being neglected in (economic) analyses. Fish are one example of mobile stocks, where this property makes it difficult e.g. to include them in national accounts; while the regulating and maintenance services that nature provides are often both invisible and silent and therefore ceteris paribus more likely to be neglected.

Timber on the other hand, the example for a private good in Figure 4, is less likely to be at risk of being excluded from analysis, as it is both visible and tangible as well as immobile. It is traded on markets as an input to production. People can be excluded from its use relatively easily and property rights can thus be established relatively easily (in principle), compared to other natural assets. Moreover, the benefits it generates are direct and easily attributable to the resource, compared e.g. to many provisional services an ecosystem provides[11].

Figure 5: Nature's properties



Source: Dasgupta 2021, p. 31.

When nature is conceptually treated as an asset, three main differences to reproducible capital are the irreversibility of many processes; the impossibility to replace (at least partly) and the possibility of abrupt system collapse (Dasgupta 2008; Barbier 2013 for ecosystems). Each of these structural differences has important implications for the application of economic models to nature and for measuring sustainable development.

It should be stressed here once more that treating nature as assets that generate well-being does not imply it can or should be marketized. But it can be argued that in order to integrate the

[11] This does not imply that other values a tree provides share these properties.

environment in economic analyses, to make it visible and possible to account for it in economic models and applications, it has to be valued using metrics that are compatible with these approaches[12].

When it comes to quantifying natural capital without the need of monetization, measures like the ecological footprint (Lin et al., 2018; Wackernagel et al., 2017) or the carbon budget (Messner et al., 2010; Rogelj et al., 2019) seem to be feasible applications to provide insights. The latter measure yields an alarming insight: to stay within the 1.5C-guardrail of the Paris Agreement, we would need emissions reductions by about 15% per year until 2040, given that this year we achieve peak emissions, unless we employ large-scale negative emissions technologies[13]. These measures, however, do not provide explicit estimates of the fulfillment of human needs.

4. MEASURING SUSTAINABLE DEVELOPMENT

Facing a planetary emergency, it is crucial to assess not only the development of natural assets per se, but in how far the resources available in the system are able to support human well-being over time[14]. This includes taking into account any negative externalities of extraction, processing as well as renewal (where possible) and maintenance. The crucial role of indicators to inform about these developments is evident, not only for decision-making in the context of policy measures. As a central feature of sustainability, indicators of sustainable development should then provide information about the ability of the resource base to keep human well-being at least at the current level.

The challenge of measuring sustainable development can be divided into two forms: the first aims at comparing objects when valuing past developments and states of affairs in terms of the quality of life they sustain. The second one aims at comparing the relative merits of actions, e.g. when evaluating the likely impact of (policy) interventions on future developments (Dasgupta 2001; Clark and Harley 2020). When applied to specific indicators, the conceptual differences between determinants and components of well-being should be kept in mind.

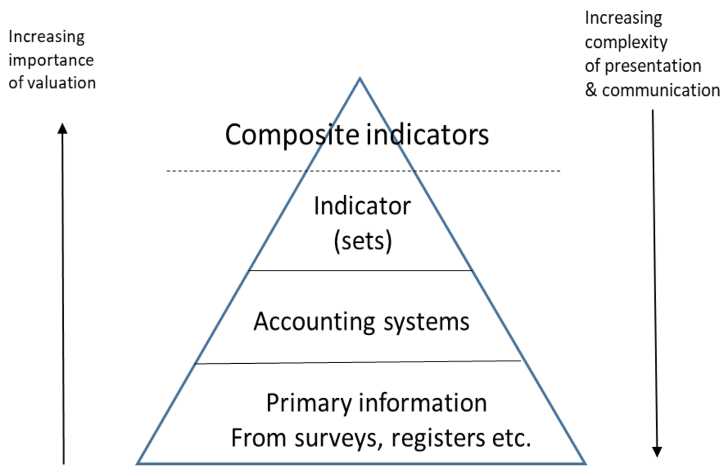
When constructing indicators that include nature, one challenge is their incommensurability, i.e. the difficulty of getting fundamentally different things into one common unit of measurement, which is often applied using monetary units. This is particularly relevant for non-marketed environmental goods and services, where no market price exists and where it may be more challenging or impossible to estimate the social worth using accounting prices.

[12] If this exercise should be conducted at all - this can still be opposed to for other reasons.
[13] https://ourworldindata.org/future-emissions gives a good overview of sources and visualizations of emissions reduction pathways.
[14] A summary of advances in the field is provided e.g. in Clark and Harley (2020). The authors consider the development of the capacity to measure this as “one of the strongest contributions of science to sustainable development over the past two decades” (Clark and Harley (2020), p.343).

However, in order to include the contribution nature makes to well-being and e.g. as a prerequisite for weighing alternative policy options, this needs to be made tractable. One way to do this is by constructing indicators that combine available information in such a way that they provide information on (non-)sustainable development. The concentration of information (focus) and the possibility to include data on development rather than (economic) growth are two main advantages of composite indicators compared to less aggregated data. The downside of aggregating data is the loss of information and the need for a sound theoretical base of the aggregation mechanism, plus the necessity of normative decisions.

Applied to (sustainability) indicators, the first and the last point can be shown as in Figure 6, which presents different forms in which a complex concept like sustainable development can be presented/expressed, increasing in the level of data aggregation from the bottom (little aggregation, survey data) to the top (most aggregation, composite indicators)[15]. While the ease of communication increases with every level of the pyramid, so does the importance of valuation. This trade-off in the level of aggregation remains in the construction of indicators and dashboards and needs to be carefully assessed for each individual case (Nardo et al. 2005), while it may have no strict first-best solution. There are examples of both decisions, to keep a dashboard of sub-components (as in the OECD's better life index or the UN's sustainable development goals) or to end up with a composite indicator such as the Human Development Index or the change in inclusive wealth.

Figure 6: The importance of valuation and the complexity of communication for different levels of aggregation



Source: Based on OECD (2011) and Eurostat (2017)

[15] A composite indicator compiles individual indicators into a single index, on the basis of an underlying model of the multi-dimensional concept that is being measured.

When assessing indicators, besides the level of aggregation, weighting the different components in the process of aggregation is another challenge. Which weights are added to different components has often large implications for the empirical results and needs a convincing theory-based reasoning, or - if absent - transparency of the procedure in addition to some robustness checks for alternative weights.

Many of the points that have been described and discussed in the preceding paragraphs apply equally to the discussion on measuring economic and social progress and well-being and to the measurement of sustainable development. The human-nature relationship, however, is one of the central elements of sustainability science and of sustainability economics (e.g. Baumgärtner and Quaas 2010). Sustainability indicators thus incorporate this as an essential part in their construction e.g. by addressing how far the resource base is able to maintain supporting current levels of well-being, especially with respect to the special characteristics of nature that have been discussed in the preceding section.

Assessing current well-being and the connection between well-being today and the future are both essential for the measurement of sustainable development. However, most indicators focus on one of the two, addressing both aspects equally remains challenging. The United Nation's Human Development Index (HDI)[16] for example combines the three dimensions of a long and healthy life (life expectancy at birth), knowledge (expected years of schooling and mean years of schooling) and a decent standard of living (GNI per capita, PPP $). It is thus an example of an indicator measuring (objective) current well-being that does not address other central features of sustainability, such as the possibility to maintain the status quo in the long term. As a response to this critique, adjustments have been made to the HDI to take the ecological base and its development into account[17]. One recent example is the Sustainable Development Index (SDI), which divides the HDI by an ecological impact index that consists of the average overshoot of CO2 emissions and the material footprint (Hickel 2020). Alternative approaches suggest linking the HDI to sustainability measures instead of adjusting the indicator itself, e.g. by using changes in comprehensive wealth (Neumayer 2001).

The World Bank's Adjusted Net Savings (ANS)[18] indicator measures the change in all forms of capital (natural, physical, human) over time and provides a measure of changes in the assets that have the capacity to fulfill the needs of current and future generations[19]. It indicates non-sustainable development if this change is negative. The ANS indicator is, however, silent on the current level of well-being (Neumayer 2007). Direct attempts to measure the assets (or wealth), which then generate

[16] United Nations Development Programme (2020).
[17] For an overview of main points of critique regarding the HDI, see e.g. Kovacevic (2011).
[18] Also referred to as Genuine Saving or GS.
[19] See also Hamilton and Naikal (2014) for an overview of the ANS indicator.

well-being are the World Bank's wealth estimates (World Bank 2011; Lange, Wodon, and Carey 2018) and the UN's Inclusive wealth estimates (Managi and Kumar 2018) share this focus.

That these two groups of indicators have developed somewhat in parallel is partly due to the different foci on either current well-being (social dimension) or the long-term perspective and future developments (environmental dimension). Approaches can also differ with respect to measuring either the ends (well-being) directly, or measuring the means of achieving them (the productive base that can be dawn own for that purpose), as the presented examples do. As the two can be shown to be formally equivalent in this framework, the approaches are, in principle, equally well-suited to measure sustainability (Clark and Harley 2020). It can be argued that due to the long-term nature of sustainability, it is generally easier to measure the means (i.e. the stocks of resources) than it is to measure the constituents of the end (i.e. flows of goods and services) (Dasgupta 2018).

These indicators are based on welfare economics and the economic theory of capital. Importantly, it is not necessary to assume that there is no relationship between different forms of capital. As Figure 7 illustrates for the fishing community, assets (resource stocks) of both types, natural and anthropogenic capital[20] are necessary as a productive base for human well-being (e.g. fish and boats and regulations on catch).

Figure 7: Resource stocks that constitute the productive base for human well-being, for the example of fishery

Resource group	Specific example of an ocean fishery	General list of representative resource stocks
Natural capital		
Ecosystems	Fish and their food	Biota, biomass, communities
Environment	Ocean temperature, pH	Climate, quality and quantity of land, air, water
Minerals	Fossil fuel for the boats	Fossil fuels, iron, sand, etc.
Anthropogenic capital		
Manufactured capital	Boats of the fleet	Roads, buildings, infrastructure
Human capital	Skilled fishers	Population; its health, education, distribution
Social capital	Regulations on catch	Institutions (including rules, norms, rights, culture, networks, etc.)
Knowledge capital	Maps of the seabed	Indigenous, practical, scientific

Source: Clark and Harley 2020

A third group of sustainability indicators focuses on the change in the natural resource stock in physical units. Prominent examples are the ecological footprint (e.g. Wackernagel and Beyers 2019) and the Environmental Performance Index (Wendling et al. 2020). The footprint approach contrasts the (physical) supply nature provides with the demand required for current levels of consumption. The

[20] Anthropogenic capital includes both, man-made and human capital, among others.

supply side depicts an entity's biocapacity, while the demand side reflects all ecological assets needed for consumption and the absorption of waste (Global Footprint Network 2021). The concept has the embeddedness of the economy in nature at its heart, while the translation of resources/assets into well-being is not its focus.

The second example for resource-focused sustainability indicators, the EPI, uses information on ecosystem viability and environmental health and aggregates them to one index of overall environmental performance, ranging from 0 (worst) to 100 (best). It is based on a mixture of measures of resource stocks and how they change over time (e.g. tree cover loss) and human-related measures (e.g. unsafe sanitation). While incorporating the resource base and its development, both examples refrain from establishing a firm link between nature and well-being that remains a central aspect when measuring sustainable development.

Likely the best-known attempt to measure sustainable development, the United Nations' Sustainable Development Goals (SDG), construct 17 different goals and measures progress towards them. The related SDG index (Sachs et al. 2021) applies equal weights to aggregate all individual goals in order to arrive at the resulting index. The SDG and the related SDG index both do not account directly for the embeddedness of the economy in nature. The large negative correlation between measures of per capita demand on nature (e.g. in footprints) and the SDG can be interpreted as reflecting the missing connection of the SDG to the resource base (Wackernagel, Hanscom, and Lin 2017). This missing link implies that it is possible that the SDG are reached at a certain point in time, but are not sustainable because this outcome has been achieved by irreversibly eroding natural assets (Dasgupta 2018).

A related second critique of using the SDG or the SDG index for measuring sustainable development, addresses the missing linkages and trade-offs between the different SDGs as suggested by the systems approach. This is of particular relevance in attempting to attain several or all SDG simultaneously (Barbier and Burgess 2017) and considering that social and biophysical processes are interdependent.

An important caveat of the present analysis is that the indicators are not assessed separately with respect to resilience, i.e. "the capacity of a system to remain in a given configuration of states [..] in systems where multiple regimes are possible" (Walker et al. (2010, p.184)). That is, the more resilient the system, the larger the shock it can absorb while remaining in the same system regime. Sustainability in general is, however, closely linked to resilience and vulnerability (Fleurbaey et al. 2014). While it is an important part of measuring sustainable development how to include changes in these risks, it is beyond the scope of this overview to address this issue comprehensively. However, for the inclusive wealth approach it can be shown that when resilience in a system is expressed as a capital stock, losses in wealth that may occur in the future can be included in this type of measure of sustainable development (e.g. Walker et al. 2010 or Mäler 2008).

5. DISCUSSION: REGENERATION AS A CENTRAL TENET OF DEVELOPMENT

The boundaries of our language are the boundaries of our world, and thus the terms we apply are crucial insofar as they enable us to see some things while making us blind to others. Instead of focusing on restoration, on repairing and building back, but also instead of focusing on sustaining or keeping our collective heads down in a safe operating space, we propose to focus on regeneration instead. While restoration focuses on reversing damage caused by human intervention and returning to an unspecified (and in principle unknowable) origin condition, regeneration represents a form of upgrade from that perspective. If restoration means "to make something well again,"[21] regeneration means "to make it better" than a (supposed) origin condition (Morseletto 2020). Both terms envision ecological systems return to and maintain a healthy state, but regeneration also encompasses the systemic ability to evolve beyond any origin condition.

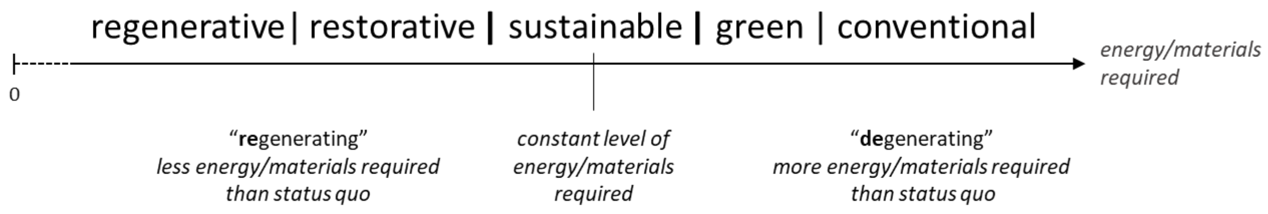
From a social systems perspective, the idea of regeneration as a social and economic paradigm can be traced back to two different lines of thought: a regenerative design approach from urban development, and regenerative economy approach. From a design perspective, regeneration is a process of involvement of everyone and everything that makes a system (a place, a country, an organization, the planet) healthy and viable, understanding these interconnections as the building blocks of a living system (Reed 2007). This perspective connects to more contemporary stakeholder approaches as well as to more indigenous understandings of sustainability e.g. Australian aboriginal law and the notion of living in "country", which is the complex interrelation of the living and non-living world, the totality of life (Kwaymullina 2005). The central ideas here are learning from place/context and designing within that place/context and its history.

In the regenerative economy approach, regeneration is used as a guiding principle, based on the observation that natural systems thrive because they are able to regenerate that is then extended to the overall economy. This results in an inclusive ecosystem economy that upgrades the capacity for collaboration and innovation across all sectors and systems (Fullerton 2015; Scharmer, 2010) should. The resulting regenerative economy is defined by the belief that economic vigor is a product of human and societal vitality, rooted in ecological health and the inclusive development of human capabilities and potential. The approach connects to the capability approach of international development in including capabilities in its ends (Lessmann and Rauschmayer 2013; Sen 2000). The approach can be framed as applying key development principles from natural to anthropogenic assets

[21] "Ecological restoration is the process of assisting the recovery of an ecosystem that has been degraded, damaged or destroyed." Society for Ecological Restoration International and IUCN Commission on Ecosystem Management (2004).

instead of the other way round, a criticism that is often raised at economic approaches. For nature, the approach is principally in line with the characteristics and special properties of nature compared to man-made assets discussed in previous sections.

Figure 8: Classification of economies, based on energy/materials required according to Fullerton 2015



Source: own representation.

Based on a categorization of different economies with respect to the energy/materials (means) required to achieve a certain status quo (Figure 8), Fullerton (2015) depicts a regenerative economy as the one with the smallest use of energy/materials, while a sustainable economy in this categorization is one that keeps the level constant. Following that line of reasoning, one can contrast sustainable development as development that keeps resource inputs constant from one period to the next with regenerative development as development that reduces the energy/materials required over time. As an adjusted constant capital rule, this would translate as an increase in capital (natural or overall) instead of the non-declining capital condition.

Note that this classification is a relational one, which compares two states of an economy with each other in terms of resource inputs and does not in itself address how far remaining resources are able to fulfill human needs. Accordingly, it does not establish an explicit relation between means (resources) and ends (well-being).

Applied to "regenerative development", main discussion points remain essentially similar to "sustainable development", as both share the normative concept of development. For example, the role of technology and necessary assumptions of potential technological possibilities in the future and the substitutability of different forms of capital for each other, remain as important as for the sustainable development debate.

However, due to the properties of natural capital outlined above, system dynamics and uncertainties will be even more important when applied to potential new states of systems, which are key to the idea of regenerative economies. It remains open for discussion in how far measures of resilience related to the capacity to regenerate can be useful in empirical applications of this kind. These that face challenges in estimating outcomes due to increased uncertainties about costs, risks and impacts on well-being in states not yet experienced.

6. CONCLUSION

This article focuses on measures of sustainable development and analyzed how some key aspects of the sustainability debate have been applied to frequently used indicators of sustainable development. The connection between well-being today and the future is essential for the measurement of sustainable development. However, it is not addressed prominently in all measures. The statement that indicators of well-being tend to ignore sustainability while many indicators of sustainability do not cover (current) well-being (Neumayer 2007) still bears some truth.

If one accepts the proposition that measuring ends (well-being) and ends to achieve those means are equivalent is valid under certain conditions, existing sustainability indicators based on wealth estimates can, in principle, cover current well-being and reflect the embeddedness of the economic system in nature.

The concepts of sustainable and regenerative development share many central features. However, an approach to measuring regenerative development empirically via indicators faces additional challenges. One major challenge of measurement is that it would be necessary to value states of affairs for systems that have not experienced those states yet. Due to the properties that many parts of nature share, a potential comprehensive indicator of regenerative development would be at risk of causing confusion instead of providing information and guidance.

REFERENCES

Allen, Robert. 1980. How to save the world. Strategy for World Conservation. London: Kogan Page Limited.

Arrow, Kenneth J., Partha Dasgupta, Lawrence H. Goulder, Kevin J. Mumford, and Kirsten Oleson. 2012. “Sustainability and the measurement of wealth.” Environment and Development Economics, 17(3): 317–53.

Attenborough, David. 2021. “Foreword.” In The Economics of Biodiversity: The Dasgupta Review, ed. HM Treasury, 1–2. London.

Barbier, Edward B. 2013. “Wealth accounting, ecological capital and ecosystem services.” Environment and Development Economics, 18(2): 133–61. https://www.jstor.org/stable/10.2307/26379168.

Barbier, Edward B., and Joanne C. Burgess. 2017. “The Sustainable Development Goals and the systems approach to sustainability.” Economics, 11(1).

Baumgärtner, Stefan, and Martin Quaas. 2010. “What is sustainability economics?” Ecological Economics, 69(3): 445–50.

Bonaiuti, Mauro, ed. 2010. From bioeconomics to degrowth. Georgescu-Roegen's "new economics" in eight essays. New York, NY: Routledge.

Boulding, Kenneth E., and Harold J. Bernett. 1966. “Resources development and the environment.” Environmental quality in a growing economy : [this book is based on papers given at the 1966 RFF Forum on Environmental Quality held in Washington, March 8 and 9]: 3–20.

Clark, William C., and Alicia G. Harley. 2020. “Sustainability Science. Toward a Synthesis.” Annual Review of Environment and Resources, 45(1): 331–86.

Cohen, François, Cameron J. Hepburn, and Alexander Teytelboym. 2019. “Is Natural Capital Really Substitutable?” Annual Review of Environment and Resources, 44(1): 425–48.

Costanza, Robert, Paul W. B. Atkins, Marcello Hernandez-Blanco, and Ida Kubiszewski. 2021. “Common asset trusts to effectively steward natural capital and ecosystem services at multiple scales.” Journal of environmental management, 280: 111801.

Daly, Herman E. 1996. Beyond growth. The economics of sustainable development. Boston, Mass.: Beacon Press.

Daly, Herman E., and Joshua C. Farley. 2003. Ecological economics. Principles and applications. Washington: Island Press.

Dasgupta, Partha. 2001. Human Well-Being and the Natural Environment: Oxford University Press.

Dasgupta, Partha. 2008. “Nature in Economics.” Environmental and Resource Economics, 39(1): 1–7. https://link.springer.com/content/pdf/10.1007/s10640-007-9178-4.pdf.

Dasgupta, Partha. 2018. “Foreword to Inclusive Wealth Report 2018.” In Inclusive Wealth Report 2018. Measuring Sustainability and well-being.

Dasgupta, Partha. 2021. “The Economics of Biodiversity: The Dasgupta Review.” HM Treasury.

Dasgupta, Partha, and Karl-Göran Mäler. 2000. “Net national product, wealth, and social well-being.” Environment and Development Economics, 5(1): 69–93.

Eaton, Derek, and Fulai Sheng, ed. 2019. Inclusive Green Economy: Policies and Practice. Dubai, Shanghai.

European Environment Agency. 2021. CICES. Towards a common classification of ecosystem services. Structure of CICES. https://cices.eu/cices-structure/ (accessed August 3, 2021).

Eurostat. 2017. “Towards a harmonised methodology for statistical indicators. Part 3 - Relevance of Indicators for Policy Making.” Eurostat. Manuals and Guidelines.

Fleurbaey, M., A. D. Kartha, S. Bolwig, Y. L. Chee, Y. Chen, E. Corbera, F. Lecocq, W. Lutz, M. S. Muylaert, and R. B. Norgaard, et al. 2014. “Sustainable Development and Equity.” In Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, ed. Edenhofer, O., R. Pichs-Madruga, Y. Sokona, E. Farahani, S. Kadner, K. Seyboth, A. Adler, I. Baum, S. Brunner, P. Eickemeier, B. Kriemann, J. Savolainen, S. Schlömer, C. von Stechow, T. Zwickel and J.C. Minx, 283–350. Cambridge, UK and New York, USA: Cambridge University Press.

Fullerton, John. 2015. “Regenerative Capitalism.” Capital Institute.

Georgescu-Roegen, Nicholas. 1971. The entropy law and the economic process. Cambridge, Mass.: Harvard University Press.

Global Footprint Network. 2021. Ecological Footprint. https://www.footprintnetwork.org/our-work/ecological-footprint/ (accessed August 16, 2021).

Griggs, David, Mark Stafford-Smith, Owen Gaffney, Johan Rockström, Marcus C. Ohman, Priya Shyamsundar, Will Steffen, Gisbert Glaser, Norichika Kanie, and Ian Noble. 2013. “Sustainable development goals for people and planet.” Nature, 495(7441): 305–07.

Groom, Ben, and Zachary Turk. 2021. “Reflections on the Dasgupta Review on the Economics of Biodiversity.” Environmental and Resource Economics, 79(1): 1–23.

Hamilton, K., and M. Clemens. 1999. “Genuine Savings Rates in Developing Countries.” The World Bank Economic Review, 13(2): 333–56.

Hamilton, Kirk, and Esther Naikal. 2014. “Genuine saving as an indicator of sustainability.” In Chapters, Handbook of Sustainable Development, ed. Giles Atkinson, Simon Dietz, Eric Neumayer, and Matthew Agarwala, 336–47: Edward Elgar Publishing.

Hickel, Jason. 2020. “The sustainable development index. Measuring the ecological efficiency of human development in the anthropocene.” Ecological Economics, 167(6): 106331.

Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. 2019. “The Global Assessment Report on Biodiversity and Ecosystem Services. Summary for Policy Makers.”

IPCC, ed. 2021a. Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate: Cambridge University Press.

IPCC. 2021b. “Summary for Policymakers. Approved Version: 7 August 2021 17:00 CEST.” In Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate, ed. IPCC: Cambridge University Press.

Kovacevic, Milorad. 2011. “Review of HDI Critiques and Potential Improvements.” UNDP. Human Development Research Paper 2010/33.

Kubiszewski, Ida. 2010. Graduate College Dissertations and Theses. Searching for the Sweet Spot: Managing Information as a Good that Improves with Use(129).

Kwaymullina, A. 2005. “Seeing the light. Aboriginal law, learning and sustainable living in Country.” Indigenous Law Bulletin, 6(11): 12–15.

Lange, Glenn-Marie, Quentin Wodon, and Kevin Carey. 2018. The Changing Wealth of Nations 2018: Washington, DC: World Bank. https://openknowledge.worldbank.org/bitstream/10986/29001/4/9781464810466.pdf.

Lenton, T. M., H. Held, E. Kriegler, J. W. Hall, W. Lucht, S. Rahmstorf, and H. J. Schellnhuber. 2008. “Tipping elements in the Earth's climate system.” Proceedings of the National Academy of Sciences, 105(6): 1786–93.

Lessmann, Ortrud, and Felix Rauschmayer. 2013. “Re-conceptualizing Sustainable Development on the Basis of the Capability Approach. A Model and Its Difficulties.” Journal of Human Development and Capabilities, 14(1): 95–114.

Luks, F. 2007. “Jenseits des Ökonomischen das Nachhaltige suchen.” Ökologisches Wirtschaften: 27–29.

Luks, F., and S. H. Siemer. 2007. “Whither sustainable development? A plea for humility.” GAIA–Ecological Perspectives for Science and Society, 16(3): 187–92.

Mäler, Karl-Göran. 2008. “Sustainable Development and Resilience in Ecosystems.” Environmental and Resource Economics, 39(1): 17–24.

Managi, Shunsuke, and Pushpam Kumar. 2018. Inclusive Wealth Report 2018: Routledge.

Meadows, Donella H., Dennis L. Meadows, Jørgen Randers, and William W. Behrens III. 1972. The Limits to Growth. A Report for the Club of Rome's Project on the Predicament of Mankind. 2nd ed. New York, NY: Universe Books.

Meadows, Donella H., Jørgen Randers, and Dennis L. Meadows. 2004. Limits to growth. The 30-year update. White River Junction, Vt.: Chelsea Green Publishing Company.

Morseletto, Piero. 2020. “Restorative and regenerative. Exploring the concepts in the circular economy.” Journal of Industrial Ecology, 24(4): 763–73.

Nardo, Michela, Michaela Saisana, Andrea Saltelli, Stefano Tarantola, Anders Hoffman, and Enrico Giovannini. 2005. “Handbook on Constructing Composite Indicators. Methodology and User Guide.” OECD Statistics Working Paper, 2005/03. http://dx.doi.org/10.1787/533411815016.

Neumayer, Eric. 2001. “The human development index and sustainability — a constructive proposal.” Ecological Economics, 39(1): 101–14.

Neumayer, Eric. 2007. “Sustainability and Well-being Indicators.” In Studies in development economics and policy, Human Well-being. Concept and Measurement, ed. McGillivray, and Mark, 193–213. Basingstoke: Palgrave Macmillan.

Neumayer, Eric. 2013. Weak versus strong sustainability. Exploring the limits of two opposing paradigms. Cheltenham, UK, Northampton, MA, USA: Edward Elgar.

OECD. 2018. “For Good Measure: Advancing Research on Well-being Metrics Beyond GDP.” OECD.

Perman, Roger, Yue Ma, Michael S. Common, David Maddison, and James McGilvray. 2011. Natural resource and environmental economics. Harlow, England, London, New York, Boston, San Francisco, Toronto, Sydney, Tokyo, Singapore, Hong Kong, Seoul, Taipei, New Delhi, Cape Town, Madrid, Mexico City, Amsterdam, Munich, Paris, Milan: Addison Wesley is an imprint of Pearson.

Purvis, Ben, Yong Mao, and Darren Robinson. 2019. “Three pillars of sustainability. In search of conceptual origins.” Sustainability Science, 14(3): 681–95.

Reed, Bill. 2007. “Shifting from ‘sustainability’ to regeneration.” Building Research & Information, 35(6): 674–80.

Robbins, Lionel. 1935. An Essay on the Nature and Significance of Economic Science. London: Macmillan and Co.

Rockström, Johan, Will Steffen, Kevin Noone, Asa Persson, F. S. Chapin, Eric F. Lambin, Timothy M. Lenton, Marten Scheffer, Carl Folke, and Hans J. Schellnhuber, et al. 2009. “A safe operating space for humanity.” Nature, 461(7263): 472–75.

Rockström, Johan, and Pavan Sukhdev. 2016. How food connects all the SDGs. https://www.stockholmresilience.org/research/research-news/2016-06-14-how-food-connects-all-the-sdgs.html (accessed August 3, 2021).

Sachs, Jeffrey D., Christian Kroll, Guillaume Lafortune, Grayson Fuller, and Finn Woelm. 2021. Sustainable Development Report 2021. The Decade of Action for the Sustainable Development Goals. Cambridge UK: Cambridge University Press.

Sen, Amartya. 2000. Development as freedom. 1st ed. New York: Anchor Books.

Sen, Amartya. 2013. “The Ends and Means of Sustainability.” Journal of Human Development and Capabilities, 14(1): 6–20.

Shizgal, Peter. 2012. “Scarce means with alternative uses. Robbins' definition of economics and its extension to the behavioral and neurobiological study of animal decision making.” Frontiers in neuroscience, 6: 20.

Society for Ecological Restoration International and IUCN Commission on Ecosystem Management. 2004. “ion International and IUCN Commission on Ecosystem Management. 2004. Ecological Restoration, a means of conserving biodiversity and sustaining livelihoods.”

Steffen, W., K. Richardson, J. Rockstrom, S. E. Cornell, I. Fetzer, E. M. Bennett, R. Biggs, S. R. Carpenter, W. de Vries, and C. A. de Wit, et al. 2015. “Planetary boundaries. Guiding human development on a changing planet.” Science, 347(6223): 1259855.

Stiglitz, Joseph E., Amartya Sen, and Jean-Paul Fitoussi. 2009. “Report of the commission on the measurement of economic performance et social progress.” www.stiglitz-sen-fitoussi.fr.

Turner, Graham M. 2008. “A comparison of The Limits to Growth with 30 years of reality.” Global Environmental Change, 18(3): 397–411. https://www.sciencedirect.com/science/article/pii/S0959378008000435.

United Nations. 1987. “Report of the World Commission on Environment and Development: Our Common Future.”

United Nations Development Programme. 2020. Human Development Index (HDI). http://hdr.undp.org/en/content/human-development-index-hdi (accessed August 12, 2021).

United Nations Environment Programme. 2018. “Inclusive Wealth Report 2018. Measuring Sustainability and well-being.”

van Nes, Egbert H., Babak M.S. Arani, Arie Staal, Bregje van der Bolt, Bernardo M. Flores, Sebastian Bathiany, and Marten Scheffer. 2016. “What Do You Mean, ‘Tipping Point’?” Trends in Ecology & Evolution, 31(12): 902–04.

Wackernagel, Mathis, and Bert Beyers. 2019. Ecological Footprint. Managing Our Biocapacity Budget: New Society Publishers.

Wackernagel, Mathis, Laurel Hanscom, and David Lin. 2017. “Making the Sustainable Development Goals Consistent with Sustainability.” Frontiers in Energy Research, 5: 518.

Walker, Brian, Leonie Pearson, Michael Harris, Karl-Göran Maler, Chuan-Zhong Li, Reinette Biggs, and Tim Baynes. 2010. “Incorporating Resilience in the Assessment of Inclusive Wealth. An Example from South East Australia.” Environmental and Resource Economics, 45(2): 183–202.

WBGU - German Advisory Council on Global Change. 2021. “Rethinking Land in the Anthropocene: from Separation to Integration. Flagship Report.”

Wendling, Z. A., J. W. Emerson, A. de Sherbinin, D. C. Esty, and et al. 2020. 2020 Environmental Performance Index. https://epi.yale.edu/ (accessed August 16, 2021).

World Bank. 2011. “The Changing Wealth of Nations. Measuring Sustainable Development in the New Millennium.” World Bank.

Young, Truman P., and Mark W. Schwartz. 2019. “The Decade on Ecosystem Restoration is an impetus to get it right.” Conservation Science and Practice, 1(12).

Zografos, Christos, and Richard B. Howarth, ed. 2008. Ecological economics and human well-being, Deliberative ecological economics. New Delhi: Oxford Univ. Press.