Chapter 20

A Long-Term Vision for 2050

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Executive summary

To assess future progress towards achieving the Sustainable Development Goals (SDGs) and related Multilateral Environmental Agreements (MEAs), their underlying targets need to be translated into a more concise and quantitative set of targets (*well established*). The SDGs cover a wide range of issues, with the environment represented in most of them, including in non-environmental goals. A range of challenges exists when interpreting the targets of the SDGs and related MEAs for an assessment of future progress. First, to make the assessment focused, a selection of the targets needs to be identified. Next, these targets need to be quantitative, using clear indicators accompanied by target values. {20.2; 20.3}

SDGs can be structured into groups based on how they address human well-being, sustainable consumption and production, and the natural resource base (*established, but incomplete*). The 2030 Agenda for Sustainable Development emphasizes that the goals and targets are integrated and indivisible and aimed at contributing to coherent sustainability policies. How the SDGs can be implemented synergistically is not apparent from the 2030 Agenda. To reveal potential trade-offs and synergies between achieving multiple SDGs and to point to ways these interlinkages can be governed, they can be grouped into goals focusing on social objectives or more broadly human well-being, goals addressing sustainable consumption and production with respect to resource use and access, and goals that address the protection and management of natural resources. These groups are bidirectionally connected in the sense that the environment provides the natural resource base on which human development and ultimately human well-being, including human health, are built. Unsustainable resource use can adversely impact both people and the planet, calling for policies that specifically focus on sustainable consumption and production as well as equitable distribution of natural resources and their benefits. The benefits to human health thus depend on the SDGs as a whole, not just those explicitly relating to health or well-being. {20.3}

Environment-related SDG targets can be further quantified based on internationally agreed targets from Multilateral Environmental Agreements (MEAs) and the scientific literature (*established, but incomplete*). Although many SDG targets have been formulated in clear and quantitative terms, for many environment-related ones, this is much less the case, both quantitatively and qualitatively. For several issues, such as climate change and biodiversity loss, the targets in MEAs are more concrete. Quantification of SDG targets can thus build on related MEAs. When internationally agreed environmental targets are lacking, so-called science-based targets can be used that are based on biophysical limits established in the scientific literature. {20.4}

The scenario assessment of GEO-6 centres around the food-water-energy nexus, linked to the five GEO-6 environmental themes and related multidimensional poverty and health. The selection of targets for the GEO-6 scenarios assessment, puts the use of natural resources central, focusing on the challenges addressed by, and linked to, the SDGs on food and agriculture (SDG 2), water (SDG 6) and energy (SDG 7). The use of natural resources is on the one hand linked to social objectives for people's access to food, water and energy, and subsequently to related health impacts (SDG 3). On the other hand, the use of natural resources is linked to the quality and quantity of the natural resource base that is required for, or impacted by, this use (SDG 13, SDG 14 and SDG 15). This focus and further quantification provide an integrated perspective on the environmental dimension of the SDGs and related agreements. The resulting set of targets is not an alternative to what is globally agreed, but a subset, and sometimes a proxy, to be used for the analysis in subsequent chapters. {20.4}

20.1 Introduction

An analysis of pathways towards sustainable development needs a long-term vision. Ideally, such a vision is summarized in a quantitative set of globally agreed key objectives or targets. The 2030 Agenda for Sustainable Development, adopted in September 2015, conceptualizes sustainable development through 17 SDGs and is further operationalized through 169 targets and 232 indicators (United Nations 2015a; see Annex 4-1). The Agenda formulates an ambitious and transformational vision for 2030. The SDGs address a broad range of issues, including eradicating poverty, transforming towards sustainable and resilient societies, and protecting and managing the natural resource base. Furthermore, the SDGs and its targets are related to several Multilateral Environmental Agreements (MEA). Together, the SDGs and related MEAs provide a globally agreed set of targets to guide the transformation towards long-term sustainability.

In this chapter, we define the vision used for the scenario analysis of GEO-6, taking a long-term perspective, beyond 2030. This vision uses the SDGs as an overarching, integrated set of goals and targets to start from, selecting key environment-related targets, and, where relevant, further quantifying these with targets from related MEAs or the scientific literature. This long-term vision addresses the theme of GEO-6 – Healthy Planet, Healthy People – by focusing on global environmental targets linked to the five themes discussed in Part A (State of the Global Environment), and related multidimensional poverty and health targets. In Chapters 21 and 22 the existing scenario literature is assessed, to allow discussion of future developments with respect to these targets and the pathways towards achieving them.

20.2 The environmental dimension of the SDGs

In 1972, as part of the United Nations Conference on the Human Environment, countries worldwide agreed that natural resources should be safeguarded, and pollution should not exceed the environment's capacity to clean itself (United Nations 1972). Since 1972, a proliferation of United Nations conferences, summits and international agreements have set targets for environmental protection and sustainable human development (Jabbour *et al.* 2012). The years 2015 and 2016 were a landmark for environmental multilateralism, thanks in large part to the formulation and adoption of five global frameworks, including the Paris Agreement (United Nations Framework Convention on Climate Change [UNFCCC] 2015) and the 2030 Agenda for Sustainable Development (United Nations 2015a).

The 2030 Agenda for Sustainable Development is explicit about the integrated nature of its goals and targets. The SDGs cover a wide range of environmental issues (see Section 1.5), with the environment represented in most of them (Organisation for Economic Co-operation and Development [OECD] 2015; United Nations Environment Programme [UNEP] 2015; Lucas *et al.* 2016; Reid *et al.* 2017) including their non-environmental goals (Elder and Olsen 2019).

More than half of the SDGs have an environmental focus and/or address the sustainability of natural resource use, while most include at least one target concerning environmental sustainability (United Nations Environment Assembly of the United Nations Environment Programme [UNEA] 2016). These targets link to the quality of the physical environment either directly (i.e. air, climate, biodiversity, oceans, land and freshwater) or indirectly (e.g. via health, education, agriculture, drinking water and sanitation, energy, and governance and institutions). Twelve SDGs promote human well-being through the sustainable use of natural resources, and ten can be achieved only if the efficiency of natural resource use is substantially improved (UNEP 2015). However, although many SDG targets have been formulated in clear and quantitative terms, many environment-related ones are not (Gupta and Vegelin 2016; Elder and Olsen 2018). This makes it more difficult to define a set of environment-related targets to be assessed in a quantitative scenario analysis.

20.3 An integrated view on the SDGs

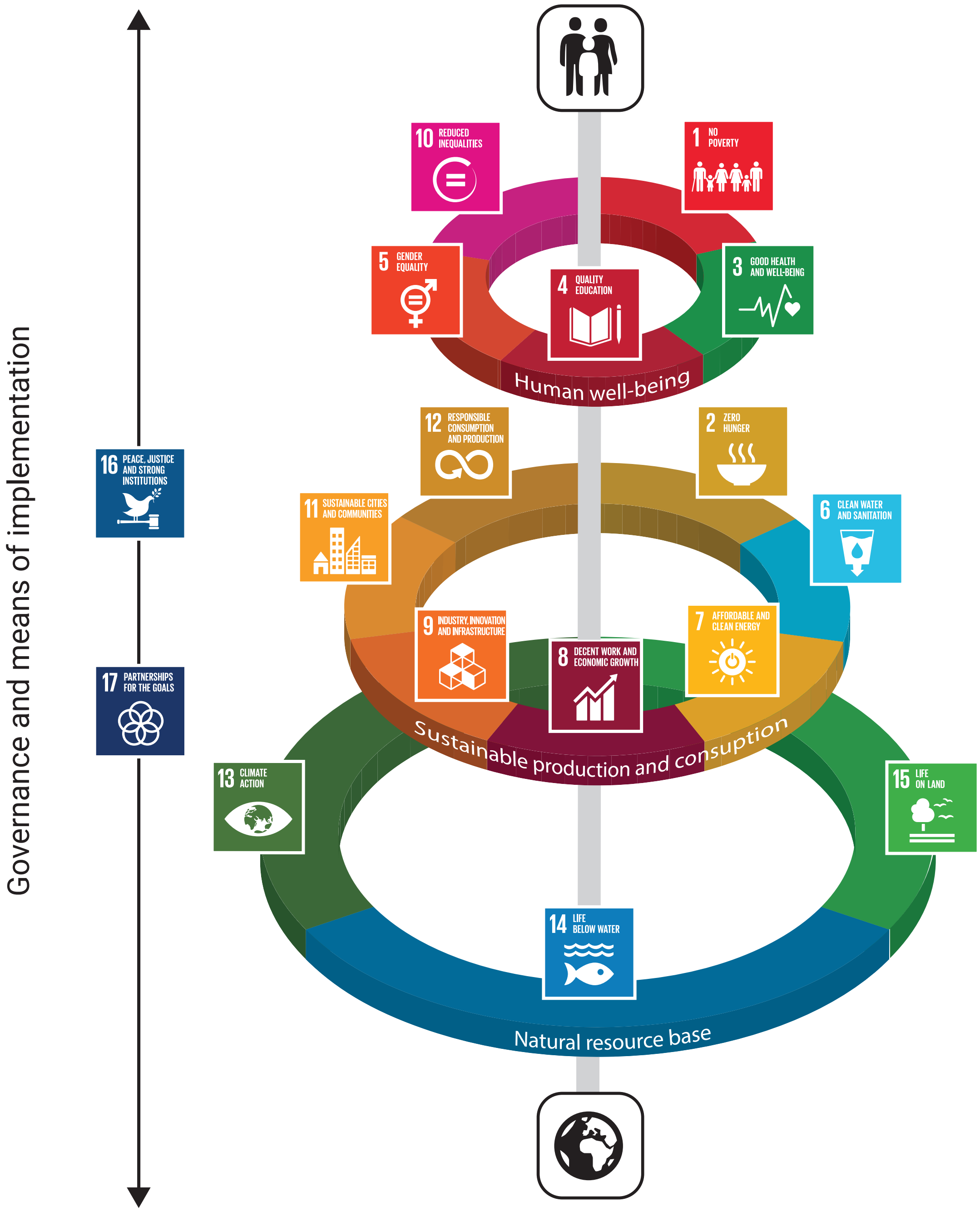
The 2030 Agenda for Sustainable Development emphasizes that the goals and targets are integrated and indivisible, and aim to contribute to coherent sustainability policies (United Nations 2015a) – meaning that they depend on each other in different ways (Nilsson, Griggs and Visbeck 2016). Greater focus on the interlinkages and synergies among the SDGs could enhance the effectiveness of their implementation and reduce the total burden and cost of pursuing the goals and targets individually (Elder, Bengtsson and Akenji 2016; UNEA 2016). However, while the SDGs and their associated targets are fairly straightforward, how they can be integrated is not apparent from the 2030 Agenda (International Council for Science and International Social Science Council 2015). The systemic properties of an integrated and holistic approach are also poorly understood (Weitz *et al.* 2017). Nevertheless, the scientific community at large has called for an integrated approach for SDG implementation (Weitz, Nilsson and Davis 2014; United Nations 2015b; Boas, Biermann and Kanie 2016; Lucas *et al.* 2016; Yillia 2016; Stafford-Smith *et al.* 2017). Frameworks have been proposed that allow the interactions between the goals and targets to be mapped and scored (Nilsson *et al.* 2016; Nilsson, Griggs and Visbeck 2016; International Council for Science 2017; Weitz *et al.* 2017; Zhou, Moinuddin and Xu 2017; Singh *et al.* 2018).

Various studies have analysed the interlinkages between the goals and targets, from different perspectives and using different methodologies, for example, by looking at the goals and targets as a network in which links among goals exist through targets that refer to multiple goals (International Science Council and International Social Science Council 2015; Le Blanc 2015; UNEP 2015; Zhou and Moinuddin 2017) and are based on quantitative modelling (United Nations 2015b; van Vuuren *et al.* 2015; Collste, Pedercini and Cornell 2017). Furthermore, researchers have created frameworks to structure the goals, to reveal potential trade-offs and synergies, and to point to ways their interactions might be governed (Griggs *et al.* 2013; Nilsson, Lucas and Yoshida 2013; Lucas *et al.* 2014; Waage *et al.* 2015a; Waage *et al.* 2015b; Elder, Bengtsson and Akenji 2016; Folke *et al.* 2016; Gupta and Vegelin 2016; Reid *et al.* 2017).

Overall, these frameworks reveal a nested structure of goals **(Figure 20.1)**. Some focus on social objectives, related to lives and livelihoods or *human well-being* (SDGs 1, 3, 4, 5, 10); others address *sustainable consumption and production* from a resource use or security perspective (SDGs 2, 6, 7) or more broadly, such as in the context of industry or cities (SDGs 8, 9, 11, 12); and some goals address global public goods from an environmental perspective or the *natural resource base* (SDGs 13, 14, 15). Finally, these goals are supported by a goal on governance (SDG 16) and one addressing means of implementation (SDG 17).

The way of structuring links to the central theme of GEO-6, with Healthy People at the top (being part of human well-being) and Healthy Planet at the bottom (natural resource base). The groups of SDGs are bidirectionally connected in the sense that a healthy planet is the foundation for the economy, human development and, ultimately, human well-being, including healthy people. Unsustainable resource use, waste and pollution can impact adversely on both the natural resource base and on human well-being. A key role is thus played by the goals in the middle, addressing sustainable production and consumption and the equitable distribution of goods and services.

Figure 20.1: A framework for the classification and grouping of the SDGs



Source: PBL Netherlands Environmental Assessment Agency (2017).

The structure in **Figure 20.1** loosely follows the five areas of critical importance mentioned in the preamble of the 2030 Agenda for Sustainable Development – people, prosperity and planet, underpinned by peace and partnership (United Nations 2015a). It also shows similarities with the doughnut model proposed by Raworth (2012; 2017); a doughnut-shaped area between two boundaries: a social floor (human well-being) and an environmental boundary (the natural resource base). The doughnut model highlights the dependence of human well-being on a healthy environment and stresses the need for improved equity in incomes and resource use, and greater efficiency in the latter (Raworth 2017). Finally, the structuring also relates to the triangle or pyramid originally proposed by Herman Daly, which moves from a base of ultimate means to a tip of ultimate ends, and integrates human well-being, economic development and the state of natural resources into a holistic framework (Daly 1973; Meadows 1998; Pinter *et al.* 2014). According to this framework, ultimate means refer to the underlying natural resource base and the life-support system of the planet (equivalent to the bottom circle in **Figure 20.1**, the natural resource base); intermediate means involve the material economy (middle circle, sustainable consumption and production); intermediate ends represent the capacities of individuals and the condition and functioning of institutions (top circle; human well-being); and ultimate ends indicate human well-being or happiness (Pinter *et al.* 2014).

It should be noted that most SDGs can be classified within different groups, since each SDG is operationalized by multiple targets. SDG 2, for example, includes targets related to human well-being (such as reducing hunger and malnutrition), to sustainable resource use (such as promoting sustainable agriculture), and to the natural resource base (such as maintaining agricultural biodiversity). The structuring of the SDGs in **Figure 20.1** follows from an interpretation from the environmental perspective. In the case of SDG 2, this is sustainable agriculture.

Although it is not stated explicitly, the 2030 Agenda for Sustainable Development and the SDGs suggest sustainable development to be the overarching goal, while emphasizing poverty eradication (Elder, Bengtsson and Akenji 2016). As such, many SDGs are means or intermediate steps towards achieving the goal of poverty eradication (i.e. human health, well-being and security). The top circle therefore contains the people-centred or social goals that aim to deliver individual and collective well-being through improved health and education, ensuring equitable distribution within and between individuals and countries (Waage *at al.* 2015a). These goals can be considered minimum standards for human well-being, while there are also synergistic opportunities for implementation, between education, health and gender equality for example.

Achieving these people-centred goals depends strongly on the realization of goals that address sustainable consumption and production, and equitable distribution of goods and services, including food, water and energy, and more broadly the economy, infrastructure, cities and industries. Food, water and energy security are important resources needed to achieve social objectives such as poverty reduction and good health. The goals addressing these resource needs encompass two distinct resource aspects: (i) access to resources, relevant for poverty reduction, and (ii) sustainable use of resources, relevant for the long-term security of supply. At the same time, production of food, water and energy is highly interlinked. Water is needed for food and energy production, for example, and energy is needed to produce water and food. This is the so-called food-water-energy nexus (Hoff 2011; (Food and Agriculture Organization of the United Nations [FAO] 2014)). These resource goals are accompanied by economy-focused goals that address the production of goods and services more broadly for achieving social objectives. These latter goals focus on the economic system (economic growth and jobs), infrastructure and sustainable industrialization, human settlements, and sustainable consumption and production in general. From an environmental perspective, these goals address the decoupling of efforts to improve human well-being from negative effects on the natural resource based in different contexts.

Realization of these second-level resource and economy goals depends on conditions in the biophysical systems or the natural resource base, including climate, oceans, land and biodiversity (parts of SDG 6 on freshwater also fit here). These goals address protection, conservation, restoration and sustainable use of critical parts of the Earth system. They directly relate to the biophysical limits to ensuring long-term environmental sustainability, or planetary boundaries (Rockström *et al.* 2009; Steffen *et al.* 2015).

The goals in the middle circle connect environmental issues (such as biodiversity loss, climate change and ocean acidification) and social themes (such as health, equal opportunities and labour conditions) to economic activities, products and markets. The challenge of these goals is to seize the synergies and reduce the potential trade-offs between those goals aiming to eradicate poverty and improve human well-being versus those addressing the natural resource base. In other words, improving human well-being should not be achieved at the expense of the natural resource base, while safeguarding the planet should benefit all people and not interfere with poverty eradication. In addition, these goals in the middle are faced with the competition for resources needed to serve multiple goals, e.g. land, water and energy resources. A major transformation to more sustainable consumption and production is needed to address these challenges. From a production perspective, this requires a decoupling of economic growth from environmental degradation, including cleaner production processes, and improved resource efficiency and corporate responsibility. From a consumption perspective it requires changes in lifestyles, consumption preferences and consumer behaviour (Bizikova *et al.* 2015).

20.4 A long-term vision: selected targets and indicators

A range of challenges exist when interpreting SDG targets and related indicators with regard to their values. Assessing future developments and potential pathways for achieving all SDG targets is not possible because of limited data and time. Furthermore, such an analysis is limited by the scope of the existing scenario literature and the integrated assessment models that these studies are built on (see Chapter 21). A selection of targets should thus be made. Next to the challenge of selecting targets, many environment related SDG targets are broadly defined and/or phrased in non-quantitative terms (Lucas *et al.* 2016). In order to assess pathways towards achieving the environmental dimension of the SDGs, the selected targets need to be quantitative, requiring clear indicators accompanied by target values.

The grouping of SDGs in **Figure 20.1** was used to select and organize the SDG targets. Quantitative targets from related MEAs and the scientific literature (science-based targets) were used to quantify these targets, where relevant. The selection is centred around the so-called food-water-energy nexus, focusing on the challenges addressed by, and linked to, the SDGs on food and agriculture (SDG 2), water (SDG 6) and energy (SDG 7). The selection puts natural resource use at the centre (*sustainable consumption and production*), linked with social objectives concerned with people's access to these resources and related health impacts (*human well-being*), and environmental objectives related to the quality and quantity of environmental resources required for or impacted by human use (*natural resource base*). The selected SDG targets for *human well-being* **(Table 20.1)** and the *natural resource base* **(Table 20.2)** are endpoint targets, aiming for a healthy planet with healthy people. The selected SDG targets for *sustainable consumption and production* **(Table 20.3)** are effort- or activity-related targets that are relevant to achieving the endpoint targets.

The selected targets addressing the natural resource base link to the five environmental themes discussed in Part A of GEO-6 (air, biodiversity, oceans, land and freshwater), supplemented by climate change. Furthermore, the targets link to a range of GEO-6 cross-cutting issues (see Chapter 4), most prominently health, climate change, energy, and food systems. Chemicals, and waste and wastewater are two other GEO-6 cross-cutting issues, identified as issues of global concern and addressed under multiple SDGs. There is a general lack, however, of future chemicals and waste flow studies and scenarios in the scientific literature **(see Box 21.1)**. Therefore, chemicals, and waste and wastewater are not discussed as separate issues. More in-depth analysis of these two issues in the context of the SDGs can be expected in UNEP's upcoming Global Chemicals Outlook II and Global Waste Management Outlook, to be released in 2019.

For each target selected, one indicator (and where relevant, two) is selected to track progress. In the context of the SDGs, the United Nations General Assembly adopted an SDG indicator framework that consists of 232 indicators (United Nations 2017). Each indicator is being developed in order to provide accurate and reliable data from now until at least 2030. UNEP is the custodian agency for several SDG indicators related to water (SDG 6), sustainable consumption and production (SDG 12), conservation and sustainable use of ocean resources (SDG 14) and of terrestrial ecosystems (SDG 15) (United Nations 2018). In addition to being custodian agency for these SDG indicators, UNEP is involved in most other SDG indicators that have an environmental dimension. The selected indicators link as much as possible to these globally agreed indicators.

It should be noted that the selected indicators are meant to track progress at the global level and that they are not always relevant at the national or subnational scale. Moreover, many indicators, especially those related to *sustainable consumption and production* and the *natural resource base*, cover only part of what the goals and targets try to accomplish. For air quality in cities, for example, the proposed indicator tracks progress for only one kind of air pollutant (i.e. fine particulate matter [PM] of diameter less than 2.5 μm and 10 μm; $PM_{2.5}$ and PM_{10}) – yet there are several others, with some interacting with each other (e.g. ozone, volatile organic compounds, sulphur dioxide etc.). With respect to health, only one indicator was selected (the under-five mortality rate), which only partly reflects the interconnectedness of planet, society and human health that the SDGs, and GEO-6, are trying to represent. Focusing on a single indicator to track progress for such targets should thus be done with care. To keep the analysis focused however, a limited set of targets is selected to cover, as much as possible, the food-water-energy nexus, while the selected indicators are based mostly on the official SDG indicator set.

Next to the indicator and target levels presented in **Tables 20.1, 20.2** and **20.3**, additional indicators are used in Chapters 21 and 22 to discuss future development of the respective targets, including relevant underlying developments, as well to discuss the potential of specific measures and important synergies and trade-offs across these measures and the selected targets.

20.4.1 Human well-being

For *human well-being*, five SDG targets are selected **(Table 20.1)**. Overall, the SDGs express a strong commitment, both quantitatively and qualitatively, to eradicating poverty and improving human well-being. Among other relevant issues, they aim to end all forms of poverty, including ending hunger, and to achieve access for all to safe drinking water, adequate sanitation, modern energy services, health care, education, work, housing and more.

Despite the centrality of human health to the GEO-6 theme of Healthy Planet, Healthy People, only one target (3.2) and one indicator (3.2.1, under-five mortality rate) has been selected for the scenario analysis. Under-five mortality is generally seen as a good indicator of quality of life, is influenced by numerous environmental determinants, is strongly related to other targets selected for human well-being. And the SDGs set a quantitative target for 2030. Scenario projections, although limited, also exist in the scientific literature that link future developments in under-five mortality to underlying environmental risk factors (see Section 21.3.6). The under-five mortality rate also has

Table 20.1: Selected targets and indicators for human well-being

SDG target	Target for GEO-6	Related MEA	Indicator *	Target level	Based on	Cluster in Chapters 21 and 22
2.1 By 2030, end hunger and ensure access by all people, in particular the poor and people in vulnerable situations, including infants, to safe, nutritious and sufficient food all year round	End hunger	–	2.1.1 Prevalence of undernourishment	0 in 2030	SDGs	Agriculture, food, land and biodiversity
3.2 By 2030, end preventable deaths of newborns and children under 5 years of age, with all countries aiming to reduce neonatal mortality to at least as low as 12 per 1,000 live births and under-five mortality to at least as low as 25 per 1,000 live births	End preventable deaths of children under 5	–	3.2.1 Under-five mortality rate	< 25 in 2030	SDGs	Human health
6.1 By 2030, achieve universal and equitable access to safe and affordable drinking water for all	Achieve universal access to safe drinking water and adequate sanitation	–	6.1.1 Proportion of population using safely managed drinking water services	100 per cent in 2030	SDGs	Freshwater
6.2 By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations		–	Proportion of population using safely managed sanitation services (6.2.1)	100 per cent in 2030	SDGs	Freshwater
7.1 By 2030, ensure universal access to affordable, reliable and modern energy services	Achieve universal access to modern energy services	–	7.1.1 Proportion of population with access to electricity	100 per cent in 2030	SDGs	Energy, air and climate
		–	7.1.2 Proportion of population with primary reliance on clean fuels and technology	100 per cent in 2030	SDGs	Energy, air and climate

* Indicators different from official SDG indicator are in italics, with related SDG indicators shown in brackets
MEA = multilateral environmental agreement

significant limitations, however. It excludes measures of morbidity, for example, including psychosocial aspects of childhood well-being (e.g. a sense of safety and of being loved) and other aspects of childhood health that may affect health and survival in later life (see Section 4.2.1). However, these latter data could not be gathered routinely and reliably worldwide, let alone for inclusion in a scenario context. Finally, by being age-limited, the under-five mortality rate does not account for other vulnerable populations, such as older people or pregnant women. As a result, child mortality only partly represents the effect on human health of the many and varied policies and measures, whether business-as-usual ones or transformative scenarios, that are discussed in the following chapters.

SDG target 3.9 is more specific on particular environment-related health risk factors, targeting a substantial reduction in the number of deaths and illnesses from hazardous chemicals and from air, water and soil pollution and contamination. The specific indicators associated with this target involve the mortality rate attributable to household and ambient air pollution, deaths due to unsafe water, sanitation and hygiene and mortality from unintentional poisoning. These rates are largely a reflection of the pollution levels themselves. In effect, control of mortality implies control of pollution itself, which is the focus of several of the targets here, as well as that of several of the SDG targets selected for the *natural resource base*. And so, achievement of all of these targets is an essential part of the GEO-6 vision of Healthy Planet, Healthy People.

20.4.2 Natural resource base

For the *natural resource base*, nine SDG targets are selected that relate to the quality and quantity of environmental resources (i.e. air, climate, biodiversity, oceans, land and freshwater) **(Table 20.2)**. Compared with human well-being, none of these targets has clear quantitative target levels that could be used in a scenario analysis. Each aims to "halt" or "combat" a specific type of environmental degradation and to "restore" the natural system as much as possible.

Several natural resource targets link explicitly or implicitly to specific MEAs that have more explicit quantitative targets and/or take a longer-term perspective, beyond 2030. For these targets, the target levels can be based on quantitative measures given by the agreements. SDG 13 on climate change includes only process- or activity-based targets, but explicitly refers to the United Nations Framework Convention on Climate Change (UNFCCC) as the primary international intergovernmental forum for negotiating the global response to climate change. The target for climate change is thus based on the globally agreed target of the Paris Agreement: that is, "Holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels" (UNFCCC 2015). The World Health Organization (WHO) established an air-quality guideline of 10 $\mu g/m^3$ for annual mean $PM_{2.5}$ concentrations (WHO 2006), but also defined interim targets of 15 $\mu g/m^3$, 25 $\mu g/m^3$ and 35 $\mu g/m^3$. Here, we focus on the long-term effects of $PM_{2.5}$ and use the percentage of the population exposed to annual mean $PM_{2.5}$ concentrations above the highest interim target of 35 $\mu g/m^3$ as the indicator for achieving the target for air quality. For biodiversity loss, the SDG target does not include a target year for ending biodiversity loss. We derived the target from the Convention on Biological Diversity's strategic plan for biodiversity 2011-2020, and more specifically Aichi biodiversity target five: "By 2020, the rate of loss of all natural habitats, including forests, is at least halved and where feasible brought close to zero…" (Convention on Biological Diversity 2010). This target was translated by Kok *et al.* (2018, p. 138) into halting "biodiversity loss by 2020 for developed countries and from 2030 onwards for developing countries". Kok *et al.* (2018) use mean species abundance as a biodiversity-impact indicator to track progress on this target (Alkemade *et al.* 2009). Mean species abundance is a measure of the intactness of an ecosystem relative to its undisturbed state. Specifically, it is the mean change in the abundance of the species that were present in the original, undisturbed state. Although it is different from the Living Planet Index (the SDG indicator for target 15.5), it shares some important conceptual similarities.

When related MEAs do not exist or lack quantitative target levels, target levels could also be based on scientific literature. The planetary boundaries framework is one example (Hoff and Alva 2017; Lucas and Wilting 2018) – it proposes global quantitative limits for human disturbance of nine critical Earth-system processes (Rockström *et al.* 2009; Steffen *et al.* 2015). Crossing any of the boundaries at the global scale increases the risk of large-scale, and possibly abrupt or irreversible, environmental change. The planetary boundary framework thus provides a quantification of safe levels of global environmental change, based on Earth-system science.

The global limits from the planetary boundaries literature are used for targets related to freshwater quality (de Vries *et al.* 2013; Steffen *et al.* 2015), and ocean acidification (Steffen *et al.* 2015). As already noted, studies and scenarios for chemicals and waste flow are largely missing from the scientific literature. The selected targets for freshwater quality and marine pollution therefore focus on nutrient losses (of nitrogen and phosphorus), for which scenario literature, although limited, is available. Excessive nutrient losses through run-off and erosion can cause the eutrophication of freshwater and coastal ecosystems (de Vries *et al.* 2013; Steffen *et al.* 2015). While recognizing that regional distribution is critical to impacts, the two targets for freshwater quality are global averages. There are several other limitations in using these target levels. They do not account for future trends in the efficiency of nutrient use and do not include other relevant sources of pollution, primarily untreated sewage. Ocean acidification lowers the saturation state of aragonite, a form of calcium carbonate, making it more difficult for marine organisms to form shells and skeletons, which can also run the risk of dissolving as a result of the acidification. Taking into account geographic heterogeneity, the global target for ocean acidification is set for the average global surface aragonite saturation level (Steffen *et al.* 2015).

It should be stressed that the planetary boundaries are not politically endorsed and are subject to ongoing scientific debate. In the end, defining safe levels of global environmental changes and getting consensus on them is a political process, involving subjective elements such as risk acceptance, solidarity and precaution (Lucas and Wilting 2018). Here, the global limits defined by the planetary boundaries framework are used as a set of science-based targets. It should further be noted that there is large geographic heterogeneity underpinning these Earth-system processes that should also be monitored.

For the selected targets for water scarcity, marine nutrient pollution, ocean resources and land degradation, no globally agreed or scientific quantitative target level is available. Therefore, for these targets no quantitative target level is set. The SDG indicator for water scarcity is freshwater withdrawal as a proportion of available freshwater resources (SDG indicator 6.4.2). As this indicator is only relevant at the local level, the total global population living in water scarce areas is used as an indicator. For marine nutrient pollution, the SDG indicator is an index of Coastal Eutrophication (ICEP) and Floating Plastic Debris Density. The indicator is still under development. Here, the focus is on coastal eutrophication, using nutrient runoff into oceans (N and P) as indicator to track progress. For sustainable management of ocean resources, trends in the proportion of fish stocks within biologically sustainable levels, the SDG indicator, are used to track progress. The SDG indicator for land degradation is the proportion of land that is degraded over total land area, based on three sub-indicators, namely trends in land cover, land productivity and carbon stocks (United Nations Convention to Combat Desertification [UNCCD] 2017; van der Esch *et al.* 2017). Also this indicator is still under development. Recognizing that all three sub-indicators are important for assessing land degradation, trends in soil organic carbon stock are selected to track progress.

Table 20.2: Selected targets and indicators for the natural resource base

6.3 By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally	Improve water quality	–	Nitrogen fertilizer use and biological nitrogen fixation	62 TgN/yr	(de Vries *et al.* 2013)	Freshwater
			Fertilizer use with phosphorus	6.2TgP/yr	(Steffen *et al.* 2015)	Freshwater
6.4 By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity	Reduce water scarcity	–	*Population living in water scarce areas (6.4.2)*	Not quantified	-	Freshwater
11.6 By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management	Improve air quality in cities	WHO guidelines	*Percentage population exposed to* $PM_{2.5}$ *above 35* μg/m^3 *(11.6.2)*	0 per cent in 2050	(World Health Organization [WHO] 2006)	Energy, air and climate
SDG13 Take urgent action to combat climate change and its impacts	Limit global warming	Paris Agreement	*Global mean temperature increase*	2.0/1.5°C warming by 2100	(UNFCCC 2015)	Energy, air and climate
14.1 By 2025, prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution	Reduce marine nutrient pollution	Aichi biodiversity targets	*N and P flow from freshwater systems into oceans (14.1.1)*	Not quantified	-	Oceans
14.3 Minimize and address the impacts of ocean acidification, including through enhanced scientific cooperation at all levels	Minimize ocean acidification	–	*Average global surface aragonite saturation level (14.3.1)*	Stay above 2.75 Ωarg	(Steffen *et al.* 2015)	Oceans
14.4 By 2020, effectively regulate harvesting and end overfishing, illegal, unreported and unregulated fishing and destructive fishing practices and implement science-based management plans, in order to restore fish stocks in the shortest time feasible, at least to levels that can produce maximum sustainable yield as determined by their biological characteristics	Sustainably manage ocean resources	Aichi biodiversity targets	14.4.1 Proportion of fish stocks within biologically sustainable levels	Not quantified	–	Oceans
15.3 By 2030, combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land degradation-neutral world	Achieve land degradation neutrality	UNCCD and Aichi biodiversity targets	*Loss in soil organic carbon (15.3.1)*	Not quantified	–	Agriculture, food, land and biodiversity
15.5 Take urgent and significant action to reduce the degradation of natural habitats, halt the loss of biodiversity and, by 2020, protect and prevent the extinction of threatened species	Halt biodiversity loss	Aichi biodiversity targets	*Loss in Mean Species Abundance (MSA) (15.5.1)*	Less than 36 per cent from 2030 onwards	(Kok *et al.* 2018)	Agriculture, food, land and biodiversity

* Indicators different from official SDG indicators are in italics, with related SDG indicators shown in brackets
MEA = multilateral environmental agreement

20.4.3 Sustainable consumption and production

For *sustainable consumption and production*, five SDG targets are selected that address the decoupling of economic growth from environmental degradation (see **Table 20.3**: Selected targets and indicators for sustainable production and consumption). These SDG targets are mostly not quantitative – aiming to increase efficiency substantially without defining a specific target level. They address efforts or activities that help to achieve the endpoint targets. Their absolute level depends on specific overarching objectives. Yield improvements, for example, are important for achieving targets on hunger and biodiversity (SDG targets 2.1 and 15.5). Improvements in water-use efficiency are important for achieving the target on water stress targets (SDG target 6.4). And improvements in energy efficiency and the renewable energy share are important for achieving the target on climate change (SDG 13). The level of decoupling required thus depends on these endpoint targets. Therefore, for the selected SDG targets for *sustainable consumption and production*, no quantitative target levels are defined. Also not for SDG target 7.3, to "double the global rate of improvement in energy efficiency". Instead, the pathways analysis of Chapter 22 provides ranges for the efforts required to achieve the selected SDG targets that address human well-being and the natural resource base, taking into account the interdependencies across these efforts.

Table 20.3: Selected targets and indicators for sustainable consumption and production

SDG target	Target for GEO6	Related MEA	Indicator *	Target level	Based on	Cluster in Chapters 21 and 22
2.3 By 2030, double the agricultural productivity and incomes of small-scale food producers, in particular women, indigenous peoples, family farmers, pastoralists and fishers, including through secure and equal access to land, other productive resources and inputs, knowledge, financial services, markets and opportunities for value addition and non-farm employment	Increase agricultural productivity	–	Yield improvement	required effort results from the pathways analysis in Chapter 22		Agriculture, food, land and biodiversity
2.4 By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality	Increase nutrient use efficiency	–	*Total N inputs to crop N yields (2.4.1)*	required effort results from the pathways analysis in Chapter 22		Agriculture, food, land and biodiversity
6.4 By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity	Increase water-use efficiency	–	6.4.1 Change in water-use efficiency over time	required effort results from the pathways analysis in Chapter 22		Freshwater
7.2 By 2030, increase substantially the share of renewable energy in the global energy mix	Increase the share of renewable energy	–	7.2.1 Renewable energy share in the total final energy consumption	required effort results from the pathways analysis in Chapter 22		Energy, air and climate
7.3 By 2030, double the global rate of improvement in energy efficiency	Increase energy efficiency	–	7.3.1 Energy intensity measured in terms of primary energy and GDP	required effort results from the pathways analysis in Chapter 22		Energy, air and climate

* Indicators are different from official SDG indicators in are italics, with related SDG indicator shown in brackets
MEA = multilateral environmental agreement

20.5 Conclusions

The SDGs and related MEAs provide a long-term vision for sustainable development to influence policies at the global, regional, national and local levels. This chapter makes a selection of SDG targets, linked to targets from related MEAs and the scientific literature (science-based targets) where relevant, accompanied by clear indicators and quantitative target values, at the global level. The resulting target set provides an integrated perspective on the environmental dimension of the SDGs, focusing on the GEO-6 environmental themes in Part A (air, biodiversity, oceans, land and fresh water) and related multidimensional poverty (access to food, water and energy, and under-five mortality). Unlike the SDGs and related MEAs, the science-based targets selected when there are no globally agreed quantitative targets - are not politically endorsed. They provide a proxy for the related SDG ambitions. Finally, for some selected targets no quantitative globally agreed or science-based target is currently available.

The selection of targets is analysed further in subsequent chapters: Chapter 21 discusses the implementation gap if no new policies are formulated, and Chapter 22 discusses pathways towards achieving the targets, including relevant interrelations (synergies and trade-offs) between different measures and targets. The two chapters do not address regional, national or local differences in developments for these targets and the implementation of measures for achieving them. Chapter 23 discusses implementation from a bottom-up perspective, thereby explicitly taking into account the local situation, different actors and cultural perspectives.

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