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Natural Capital

Humankind's existence on earth is based on natural resources, which constitute natural capital. Natural capital consists of natural resources that make human existence possible and that benefit human life and activities. As the stock of natural capital diminishes or deteriorates, opportunities to produce and consume goods and services dwindle, economic and human development are compromised, and general well-being erodes. Thus, if we are to promote sustainable well-being in Israel, we must manage, invest in, and efficiently utilize the stock of natural capital. Of particular importance in the Israeli context are land, ecosystems and the biodiversity present in them, water resources, air, mineral ores, and energy resources. Due to Israel's small land area relative to the intensity of human activity, it is particularly important that open spaces subject to heavy pressure be protected, and that institutional systems be established to manage the stock of resources from an intergenerational perspective.

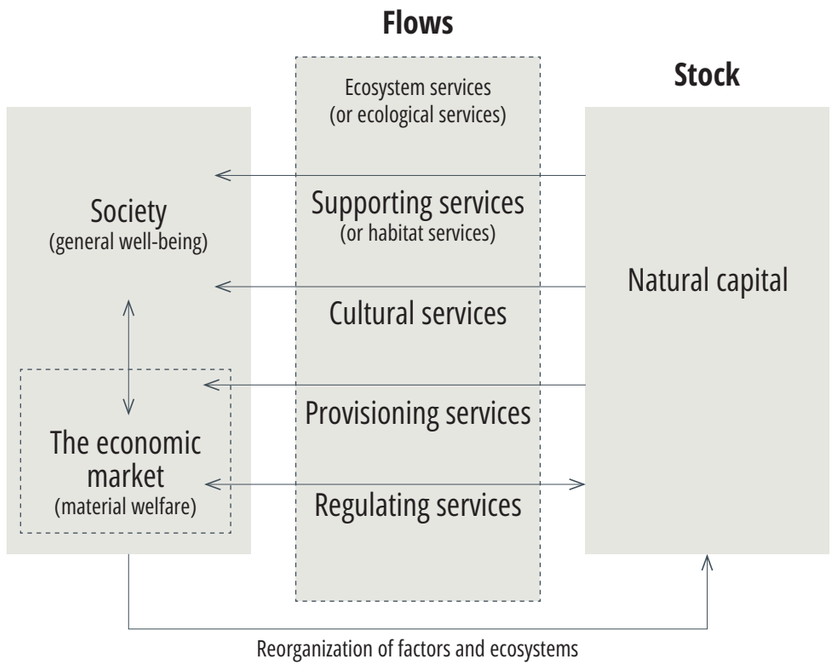
Definition of Natural Capital

Natural resources comprise the total sum of biotic and abiotic factors in nature: land, water, and air, ecosystems, flora and fauna, all of which are useful or necessary for human existence and well-being.[9] The most comprehensive definition of the benefits and services that ecosystems provide appears in the Millennium Assessment. According to this definition, there are four different kinds of services (see Figure 4 below):

1. **Supporting services:** Also known as habitat services, these include the basic processes that make life possible. These include biotic processes such as the initial production of elementary biological compounds (via photosynthesis and chemosynthesis), as well as abiotic processes such as the formation of land and atmospheric oxygen.
2. **Provisioning services:** These include the provision of raw materials from nature, such as water, energy, and food.
3. **Regulating services:** These include natural processes, such as waste decomposition, carbon fixation, air purification, water storage, and pollination of crops.
4. **Cultural services:** These include recreation and the direct production of positive experiences, as well as the provision of non-material benefits such as scientific and artistic inspiration.[10]

9 For further discussion of natural capital in general, and in Israel in particular, see the review of natural capital in the Digital Appendix to this report (Tzachor, 2021b).
10 For more on cultural services, see also the discussion in the chapter Cultural Capital.

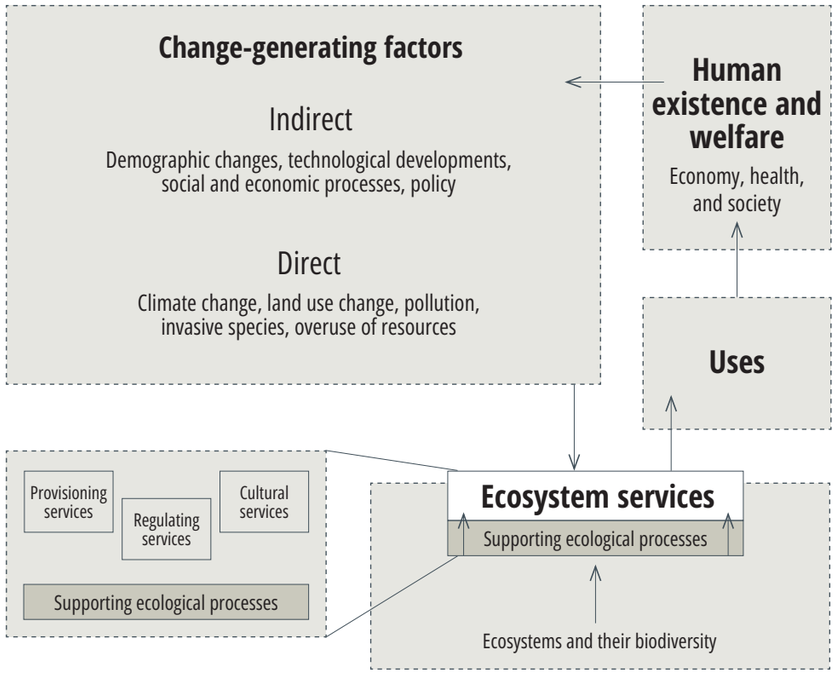
Figure 4. The Stock of Natural Capital, Ecosystem Service Flows, Market and Society



Source: Tzachor (2021b)

In the course of assessing Israel's ecosystem services, the service definitions were slightly altered. Supporting services were characterized as the basis for biodiversity, which is part of the natural capital that provides the three other services necessary for human well-being: provisioning services, regulating services, and cultural services. This model is shown in Figure 5. The figure's breakdown of services is the one that is proposed for the assessment of Israel's natural capital.

Figure 5. Ecosystem Services

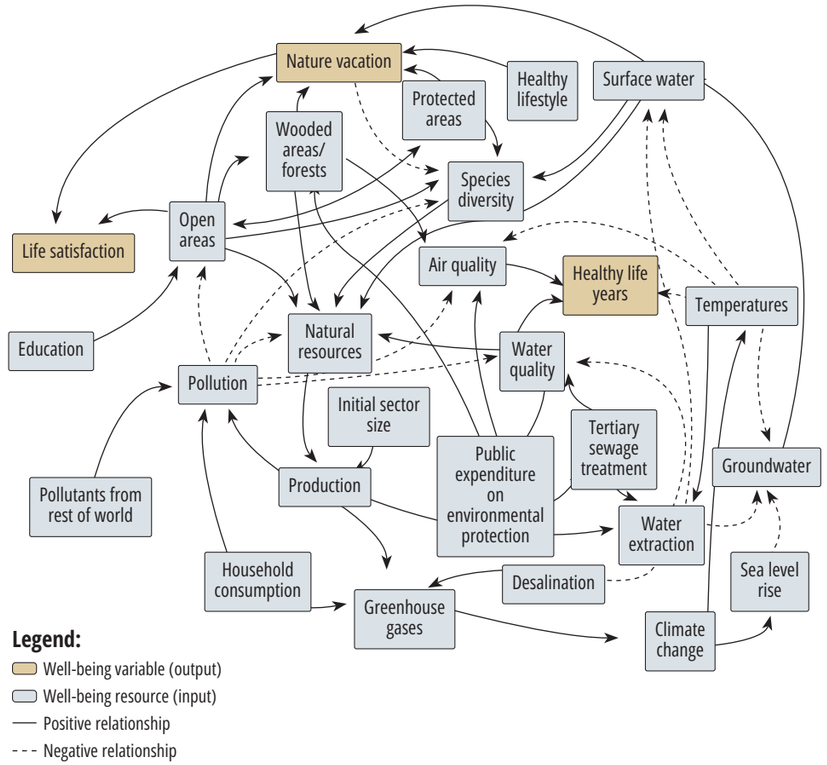


Source: Lotan, Safriel, & Feitelson (2017, p. 14)

Natural Capital and Well-being

Natural capital has several unique properties in comparison with other types of capital. At the most basic level, natural capital is what enables humankind to exist. It precedes humankind, is not produced by humans, but is affected by human activity. Natural capital is also subject to the principle of mass conservation, according to which matter is neither created nor destroyed. Human activity and, in particular, the creation of economic capital are therefore, in essence, transformations of natural capital. Economic activity cannot, in the material sense, produce an object ex nihilo. It involves the conversion

Figure 6. The Relationships between Natural Capital and Well-being in Israel



of natural materials that originate from natural systems. Moreover, natural capital's contribution to well-being is multidimensional, meaning that one natural capital resource can yield multiple services (regulating, cultural, and provisioning), and provide raw materials for different products, unlike manufactured and manmade capital assets that are of limited, unidimensional use. The ecosystem services approach underscores the importance of natural capital to well-being, and its relationship to it. In essence, different ecosystem services promote different aspects of well-being.

We can also learn about natural capital's contribution to well-being from the work of Ilmola-Sheppard et al. (2020), who mapped the relationships between the various natural systems or resources that promote well-being, as defined by the OECD. Figure 6 (see below) presents the mapping of the relationships between natural capital resources and well-being, adjusted to Israeli conditions. The figure focuses on two aspects of well-being as characterized by the OECD: healthy life years (HLY) and life satisfaction.[11] Added to these two is spending leisure time in nature, which is one of the main cultural services of natural systems and has special importance in a densely populated country such as Israel.

As we can see in Figure 6, HLY is affected by air and water quality. Air quality is an inverse function of pollution levels, which are determined by the volume of economic activity (production and consumption) and by pollutants transported from other parts of the world. Water quality is affected by the level of water treatment (a function of governmental investment) and, accordingly, by the level of wastewater treatment. It is also affected by the amount of water extracted from water sources, especially groundwater. The extraction levels themselves are determined by the amount of desalination that takes place, by wastewater reclamation levels, and by precipitation levels and weather (which in turn affect the amount of agricultural and urban irrigation). Water quality is also affected by pollution levels. It should be noted that, in order to adjust this mapping to Israel, two influencing variables were added – seawater desalination and tertiary, rather than primary, wastewater treatment – due to the scope of desalination and the widespread shift to tertiary wastewater treatment in Israel. Additionally, groundwater and surface water were separated, due to the centrality of groundwater to Israel's water supply, and the importance of surface water in terms of tourism patterns and biodiversity.

The importance of water resources and air quality to well-being also illuminates the degree to which well-being is affected by climate change. The amount of water available depends on the amount and nature of precipitation (frequency and intensity). These, in turn, are affected by climate, which is changing. Climate change is expected to increase the number of extreme climate events and to cause sea levels to rise – in addition to raising temperatures, a phenomenon already apparent today. Climate change can therefore be expected to influence the supply of water in several different ways. In addition to its direct impact on precipitation levels (among other things, more frequent and lengthy periods of drought are anticipated), climate change will lead to more flooding events, and salinization of the Coastal Aquifer as a result of rising sea levels, which will reduce Israel's usable water reserves. Higher temperatures are expected to increase the evaporation rate, another factor that will reduce the reserves of surface water sources, first and foremost the Sea of Galilee. Climate change is also expected to have ramifications for air quality and, indirectly, life expectancy.

The amount of available open space, and options for spending time in nature, are factors that influence life satisfaction. Such options are in turn affected by the amount of surface water and open space, including forests and protected areas. The latter have particular importance in the Israeli context, and were specially added to this mapping due to the current pressure on Israel's open space, which is intensifying in the wake of governmental plans to increase the housing supply. The amount of protected area and surface water also affects species diversity, which, as can be seen in Figure 5 (above), is the basis for ecosystem services. Alongside the amount of open space, surface water, and forested areas, these constitute the

11 In its well-being indices, the OECD refers to "life expectancy," but in the case in question this aspect differs from healthy life expectancy due to the importance attached not only to length of life but also to quality of life. For more on this topic, see the chapter Human Capital.

foundation for our natural resources (including abiotic resources), some of which are used in production (i.e., provisioning services).

As natural capital stocks are depleted or decline in quality, opportunities for the production and consumption of goods and services diminish, economic and human development processes are impaired, and general well-being erodes. Efficient management and utilization of natural capital are therefore crucial to sustainable well-being, all the more so with regard to those of its components that are not renewable or whose rate of renewal is very slow. Besides efficient use of limited natural resources, we need to invest in other natural resources whose stocks can be increased and developed. In this context, we should note that investment in one component of natural capital may sometimes adversely affect another component. For example, seawater desalination may help maintain high water levels in the aquifers, allowing for greater allocations of water to nature (thereby improving the status of desiccated aquatic systems and supplying cultural services), but at the cost of air pollution, greenhouse gas emissions, and adverse impacts on marine ecosystems.

Natural Capital Resources and Their Measurement

In accordance with the System of Environmental and Economic Accounting, or SEEA, an integrated framework jointly developed by the United Nations, the European Union, the International Monetary Fund, the OECD, and the World Bank, the present report highlights six natural resource categories that are critical to well-being in Israel: (1) land, (2) soil, (3) ecosystems and biodiversity, (4) water, (5) air, and (6) mineral ores and energy resources. A seventh category of "timber" is commonly added to this list, but there is a broad consensus that this is not a resource necessary to well-being in Israel (trees are important in terms of biodiversity, but they should be seen as an element of the ecosystem).

Land

Land is perhaps the most critical natural capital resource, due to its limited and depletable nature, as manifested in rezoning. There is currently great pressure on Israel's land resources, due to population growth, economic development, a rising standard of living, and the amount of infrastructure required by the above, as well as the massive use of land resources by the military and for security. The pressure on land resources is expected to increase, given an anticipated doubling of the Israeli population within forty years. The criticality of land is partly due to the fact that ecosystems and biodiversity are dependent upon it.

The most important distinction regarding land is that between developed and open spaces. Construction in open spaces is, for all practical purposes, a point of no return. Thus, the more open spaces that will be available to future generations, the better their quality of life will be, and the wider their range of opportunities. Open spaces will give future generations greater flexibility to meet their needs. Due to the effects of cultivation on biodiversity, it is also advisable to distinguish between open spaces that have been cultivated during the past generation or two and those that have not. Other issues of importance besides zoning are the quality of the ecosystems that exist on the land, the contiguity of open spaces, their distribution, the climatic differences between them, and their history. A comprehensive measurement of land resources should ideally take all of these matters into account. In particular, the degree to which open spaces are preserved and protected should be monitored by geographic breakdown, with the highest priority

given to nature reserves, national parks, and forests. However, other open spaces protected by district and national outline plans should be monitored as well, as they complement the network of open spaces and are vital to their contiguity, which is of great ecological importance.

Open space indicator: The total amount and contiguity of open space in different parts of the country should be measured. When analyzing the country's open spaces, we must distinguish between those that have been cultivated and those that have not. We must also identify their distribution in different ecological and geographical regions, by region and by ecosystem, following the breakdowns proposed by HaMaarag, Israel's National Ecosystem Assessment Program (Sorek & Shapira, 2018). To measure open space contiguity, one may use the method developed by Noam Levin et al. (2007), which can be applied on different spatial scales.

Planned open space indicator: Besides looking at the amount and contiguity of open space relative to the present land cover, we need to examine zoning. Zoning offers an outlook for the country's future land cover and changes anticipated in light of planning trends. An indicator along these lines would have to determine the amount of open space slated for construction, minus the amount of open space that currently exists. A negative value for this index would indicate the degree to which open space may be expected to dwindle.

Urban nature indicator: An internal breakdown of the built-up area category should be included, for purposes of monitoring intra-urban open space, including urban nature areas, as these also provide system services, particularly cultural and regulating services.

Protected open space indicator: The degree to which open areas are protected should be monitored by tracking tools to ensure that open areas are conserved as such, with an emphasis on nature reserves, national parks, forests, and other areas eligible for protection in national or district outline plans. It is also advisable to monitor the degree to which the protected areas conserve nature. HaMaarag's State of Nature report (Sorek & Shapira, 2018) may be used for this purpose.

Soil

"Soil" relates to land profile and land type, factors that substantially determine the soil's fertility and influence the flora (and hence fauna) that grow on it. In actuality, due to land profile variation from place to place, and the difficulty of gathering aggregative land profile data, we have little information about land profiles. There is more information about land types. The SEEA proposes employing the Harmonized World Soil Database, which offers a taxonomy and relevant assessment and classification methods. By means of this database one can monitor the degree to which different types of land remain open, but such assessments do not add information about land profiles. Thus, the adjustment and formulation of soil indicators for Israel will require additional research and development work that lies beyond the scope of this report.

Ecosystems

Ecosystems are a dynamic array of flora, fauna, microorganisms, and abiotic factors that function interactively as a single unit. They can be small or large, and can exist on land but also in bodies of water or in the sea. They constitute the basis for provisioning, regulating, and cultural services. They are highly complex, which makes it hard to understand how their components interact and how external factors affect them. Among other things, they are sensitive to irreversible processes, and small changes to them can produce large unforeseen effects.

Biodiversity is the basis for ecosystem monitoring and conservation, as ecosystems cannot exist without it. Particular attention must be paid to the number of species and to species' uniqueness and population size, and we must distinguish between natural diversity and alien and invasive species. All beneficial species should be monitored, including tiny ones whose presence in very large populations is an important part of an ecosystem[12].

12 Saltwater fish are also part of our natural capital, but it should be noted that they are only some of the fish available in Israel because some fish constitute manufactured (economic) capital.

Biodiversity indicator: Biodiversity measurement should be based on the stock of flora and fauna. For this purpose, use may be made of the biodiversity survey in HaMaarag's State of Nature report (Sorek & Shapira, 2018). In this context, we should distinguish between endemic, especially endangered, species, invasive/outbreak species, and synanthropic species. We must also differentiate between the various natural systems. The Central Bureau of Statistics monitors changes in biodiversity, based on species and land changes (in scope and contiguity) in natural land units. This kind of measurement provides an overview of change in the amount of natural capital, but does not represent the entire stock (i.e., the scarcity of the various units). HaMaarag data, as updated through monitoring and surveys, may prove helpful in bridging this gap.

Endangered species indicator: Measures the number of species that are extinct or are in danger of extinction. For this index, use can be made of HaMaarag's State of Nature report (Sorek & Shapira, 2018).

Invasive species indicator: Measures the number of invasive species, their population size, and their distribution. For this indicator, use can be made of HaMaarag's State of Nature report (Sorek & Shapira, 2018).

Water

Water's importance to human life is basic, direct, and critical. We need water to drink, for hygiene and cooking, and for growing food (much

of which is imported, meaning that it does not depend on local water).[13] Beyond this, water resources are also important to ecosystems, especially to terrestrial-aquatic natural systems, currently the most vulnerable in Israel. The dwindling of water resources could potentially harm ecosystems. While desalinated seawater and recycled wastewater may add to the total quantity of water available, the substitutability between natural water resources and desalinated water is limited, as the water types are not identical in character or quality, and substitution could harm biodiversity by encouraging the growth of invasive species. Thus, the contribution of desalinated water lies in its potential for home use, making it possible to leave more water in the natural systems.

In arid regions such as that in which Israel is located, the most important water resource component is the reservoirs (whose quality is also crucial), inasmuch as water has to be stored from winter to summer, and from years of abundance to years of drought. The amount of water in the reservoirs, and their quality, must therefore be monitored. Because the main reservoirs, the mountain aquifers, are shared with the Palestinians, it is necessary to monitor the reservoirs throughout Israel and the West Bank. Furthermore, we need to monitor the quantity of natural surface water flows, as that water is the basis for a significant proportion of recreational activity in Israel during the warm months, beyond its importance to aquatic biodiversity. A special problem in this sphere is that of the natural water that flows in the southern Jordan River, an international river that (together with its main tributary, the Yarmouk) is the Kingdom of Jordan's main water source. It should be noted that at present, Israel also has manufactured (desalinated and reclaimed) water available for household use: this water is not part of the nation's natural capital but rather is produced via economic investment. However, the country's large scale of desalination and high rate of wastewater reclamation are crucial in reducing pressure on the country's natural capital and allowing that capital to be conserved and even improved.

13 The water contained in imported food is called "virtual water." In Israel, most of the water used for growing food is actually virtual water. However, growing fresh food locally is important as well.

Water level and quality indicator: Measures the level and quality of water in the natural reservoirs, broken down by source. The Central Bureau of Statistics monitors these parameters based on data from the Israel Hydrological Service. Alternative proposals for measurement points were not considered, as that would fall outside the bounds of the Committee's work. However, the Israel Hydrological Service data enabled us to examine additional points.

Natural water flow indicator: In addition to reservoir water level and quality, it is important to monitor natural flows as manifested in groundwater elevation.

Water allocated to nature indicator: It is advisable to measure the amount of water allocated to the aquatic systems – the water that reaches nature. This parameter is not always identical to that of natural flows, as water sometimes reaches nature via extraction or artificial discharge of natural water.

In this sphere, regarding the amount of water both in the reservoirs and in the aquatic systems, red lines have already been drawn for use in situational assessment, based on Central Bureau of Statistics and Israel Hydrological Service data.

Air

Air is not traditionally considered a form of "capital" or "stock." However, it is still an aspect of the natural system that is crucial to human life and health. Air quality has two main components: dust concentration (some dust comes from natural sources), and the presence of pollutants (products of human activity that have health consequences). Human activity also has an impact in terms of greenhouse gas emissions. Pollutants are created mainly by production and consumption processes and transportation systems. Due to air's dynamic nature, the state often has limited control over air quality; dust and pollutants can, for example, arrive from other regions.

Air quality indicator: Air quality measurements are not estimates of capital, but it is important to monitor air quality for purposes of well-being assessment. Air pollution and air quality are measured in Israel today by the Ministry of Environmental Protection and the National Monitoring Program; some parameters are reported by the Central Bureau of Statistics, per pollutant. The air quality indicator could be the amount by which the various pollutants exceed air quality standards. A special issue of relevance here is that of dust concentration's impact on air quality. A substantial proportion of dust comes from natural sources outside the state's borders, but because of its health impact it is advisable to monitor the quantity and sources of dust.

Pollutant emission indicator: Pollutant emission levels should be monitored by source.

Greenhouse gas emission indicator: Greenhouse gas emission levels should be monitored by source. Such monitoring is of particular importance due to Israel's commitment, like that of other nations, to mitigating greenhouse gas emissions. Monitoring will make it possible to determine the extent to which Israel meets the targets it has set for itself.

Renewable energy indicator: Long-term impacts should be assessed by monitoring renewable energy as a share of total energy. This indicator is also important for determining the extent to which Israel meets international commitments in this sphere.

Climate change indicator: It is advisable to monitor how climate change affects Israel, with an emphasis on temperature, precipitation, and the number of extreme weather events (large-scale deviations from average values). This monitoring is an important means of assessing the impact of global climate change so that measures can be planned and taken for Israel's adaptation to them.

Mineral Ores and Energy Resources

Mineral ores and energy resources are depletable. Unlike other natural resources, they do not constitute life-supporting environments; rather, they are production inputs. Because most of these resources are underground, their stocks are not precisely known. When measuring minerals and energy resources, it is important to determine their concentration levels, as that will affect the cost of producing the resource.

The more critical resources are those that cannot be imported (or for which the cost of importing is very high). In Israel, these are

sand and other aggregates. However, some of these resources can be substituted for each other, for example by changing the style of construction or switching energy resources. On the energy side, gas resources are of the utmost importance to Israel at present. Although oil shale can be found in Israel as well, the cost of producing it is high and the environmental damage caused by its production process is extensive, making it doubtful whether the resource will be utilized. Israel also has minerals of great economic importance, some or most of which are exported; the most notable of these resources are phosphate and potash.

Concrete price per m³ (cubic meter) indicator: An earlier report (Feitelson, 2004) proposed monitoring the price of a cubic meter of concrete, which reflects the demand and supply of sand and construction aggregates. Aggregates are used primarily in the local market and are expensive to import; their price thus indicates their scarcity and the demand for them. As part of National Outline Plan – Mining and Excavation (NOP 14 and its various amendments), a survey was conducted of the various stocks. The stocks can be monitored via the plan updates, and with the aid of the Commissioner of Mines. However, the effective stock is also a function of production efficiency and regulation levels; regulation determines whether reserves can be realized (Ministry of Energy, Natural Resources Administration, March 2019). It is worth noting that the reserves available for utilization could be enlarged via underground mining, which is more costly. Currently identified stocks do not include aggregates that require underground mining.

Energy resources indicator: Measures the stock of local energy resources, gas and oil shale in particular, by type of resource.

Principal Challenges

Depletable Resources

Natural capital components cannot be produced, nor do they have perfect substitutes. Although treated effluents can be discharged into streams, they cannot replace natural water due to their composition and flow intensity differences. Similarly, urban green space, which provides many important ecosystem services, is no substitute for extra-urban open space – neither in terms of flora and fauna, nor in terms of the cultural, regulating, and provisioning services that extra-urban areas provide. The depletability of these resources can lead to market and regulation failures when policymakers rely on the indicators by which these resources are assessed. Due to the growing scarcity dictated by their depletable nature, these resources' future real value will exceed the values that can be estimated at present. The rise in real future value, which will continue over generations, is not reflected in the markets or in decision-making processes. It is therefore possible that the indicators will be designed as deficit indicators in terms of natural capital depletion, the emphasis being on those components that are considered to be life-supporting. Accordingly, we should abide by the precautionary principle and ensure optimal utilization and savings of natural capital resources. This is especially true regarding open spaces. Hence the great importance of protecting these spaces and thwarting attempts to weaken relevant planning regulation.

Utilization Efficiency

The scarcity of depletable natural capital components, and the scope of their loss, are functions of the efficiency with which such resources are utilized. For example, water conservation levels affect the amount of water extracted and diverted from

the natural systems. Similarly, the efficiency with which materials are mined and extracted affects the size of mining and quarrying sites, while building density affects the degree to which open spaces are rezoned for construction. Natural capital measurement should accordingly reflect not only depletion rates but also the efficiency with which the components of natural capital are utilized. Indicators of efficient use can drive policies to increase natural resource utilization efficiency, so that we can ensure sustainable well-being.

One means of improving efficiency is by recycling, per the circular economy approach. The circular economy promotes the extensive use and recycling of all materials, thereby encouraging servicizing, i.e., the provision of services (such as transportation services) instead of products (cars). A circular economy thus curbs natural capital erosion. It is therefore appropriate to monitor recycling and servicizing levels, and in particular the connection between economic expansion and natural capital erosion, so as to estimate the degree to which growth and resources are decoupled – decoupling being the goal of the circular economy.

Lack of Knowledge

Some components of natural capital are invisible, and so their true situation is unknown. Knowledge is notably lacking with regard to biodiversity; we do not know what the full stocks of species are. Mineral and energy resource stocks are also not fully known. Thus, we are liable to find ourselves in a situation where construction or development will come at the expense of these unknown stocks, or severely compromise diversity through harm to species whose existence at the relevant sites was unknown. To prevent such damage, surveys are conducted, sometimes as part of building plans. But the knowledge provided via ad hoc surveys is not necessarily preserved or amassed to the point of offering a comprehensive picture. Thus, the measures used to illuminate the status of natural capital component stocks are almost of necessity biased.