Chapter 1
Ecosystem services

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Contents

Salt production in Djégbadji village, in a coastal lagoon of South Benin
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RELEVANCE FOR AFRICAN BIOSPHERE RESERVES

The concept of ecosystem services **links the conservation of biodiversity and human development**. This concept is central to the Man and the Biosphere (MAB) Programme, which aims to combine conservation of ecosystems and sustainable development through the zonation of biosphere reserves and other approaches.

Biosphere reserves are excellent learning sites to study the interactions between people and nature, especially how people benefit from nature (ecosystem services), stakeholders' perceptions and use of nature, important anthropogenic pressures, etc. The concept of ecosystem services helps to structure and study all of these interactions.

Biosphere reserves would benefit from **incorporating the concept of ecosystem services into their management**. A better knowledge and integration of ecosystem services into management plans is a key priority for African biosphere reserves, which face high anthropogenic pressures such as rapid population growth, high dependence on natural resources for livelihoods, weak institutions and competing stakeholder interests under challenging governance conditions (German Federal Agency of Nature Conservation, 2011).

Africa, in particular, hosts multiple biodiversity hotspots and has a **high level of direct dependency on ecosystem services**. Economies and a large proportion of the population depend on goods and services provided by local ecosystems (IPBES, 2018a). The well-being of people is directly dependent on ecosystem services and access to the benefits provided by a steady flow of ecosystem services, which contribute to poverty alleviation (Fisher et al., 2014).

WHAT IS BIODIVERSITY?

Biodiversity is the variability among living organisms and encompasses terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part. It includes diversity within species, between species and of ecosystems (CBD, 1992) (**Figure 3**).

HUMANS AND NATURE

Ecosystems

The ecosystem concept can help us better study and understand nature. Ecosystems are physically defined environments consisting of abiotic components (water, soil, temperature, etc.) and living organisms (e.g. plants and animals), which interact with each other. These populations form communities of species that thrive in a given habitat. By studying ecosystems at different levels, we can analyse ecological interactions, production of biomass, prey-predation dynamics, migration, and many more spatial and temporal interactions (**Figure 4**).

The more you zoom out from an individual to a community level, the more complex the interactions between biotic and abiotic elements. Nowadays, management of natural resources leans towards the more holistic **Ecosystem Approach**, a 'strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way' (CBD, 2000). This approach stands at the meeting point between sustainable ecosystem management and enhanced livelihood security, thereby encompassing both conservation and development concerns (Beaumont et al., 2007; Shepherd, 2008).

A related methodology is the **Landscape Approach**, which aims to balance 'competing land use demands in a way that is best for human well-being and the environment. It means creating solutions that consider food and livelihoods, finance, rights, restoration and progress towards climate and development goals' (Global Landscapes Forum, 2020).

FIGURE 3. THE THREE LEVELS OF BIOLOGICAL DIVERSITY

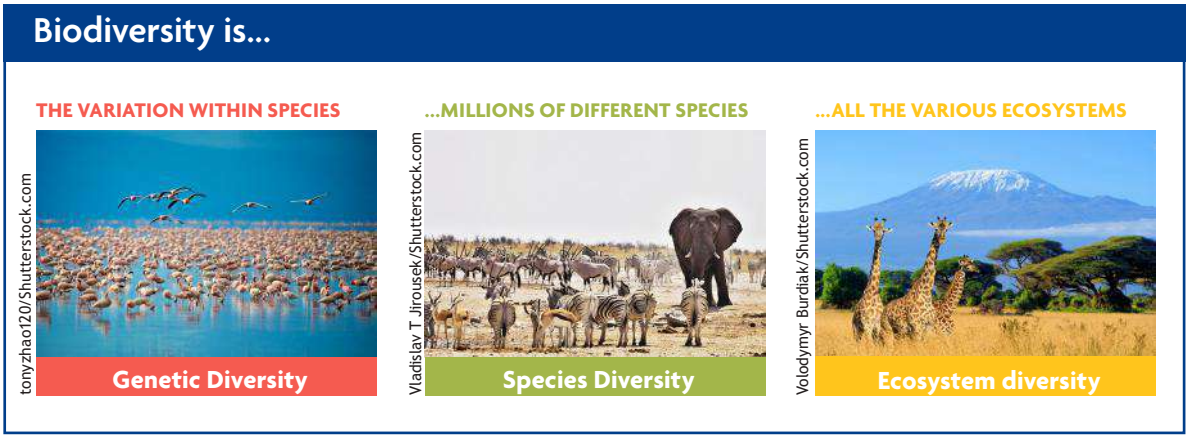

FIGURE 4. DIFFERENT LEVELS OF COMPLEXITY WITHIN AN ECOSYSTEM (A TO C)

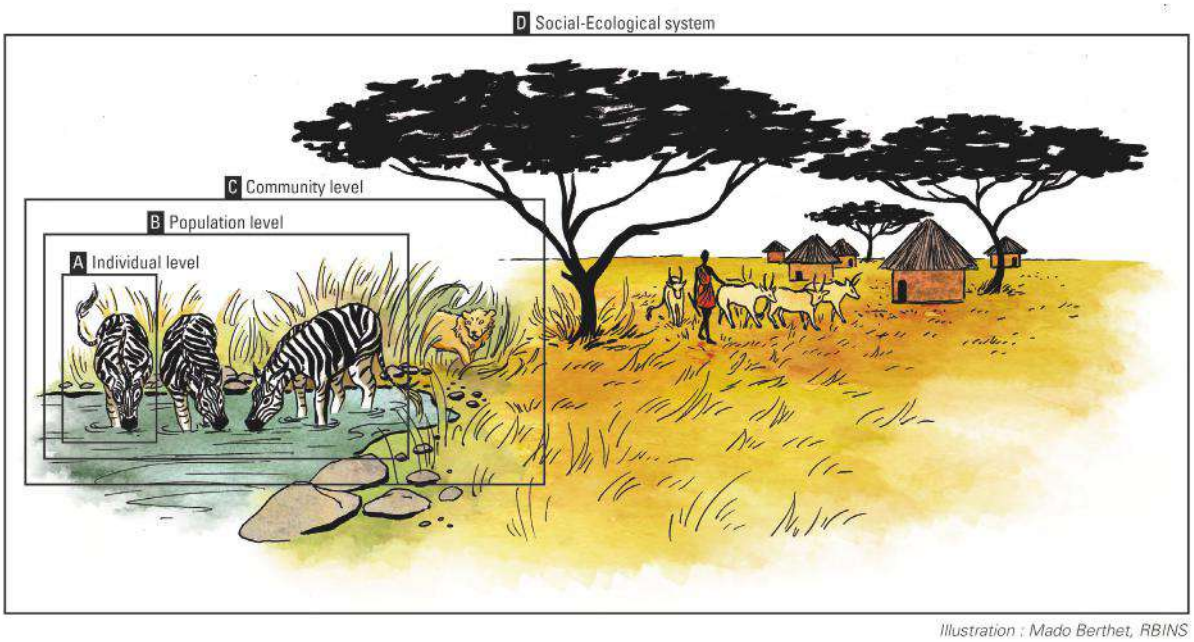

Illustration : Mado Berthet, RBINS

FIGURE 5.
EXAMPLES OF DIFFERENT ECOSYSTEM SERVICES PROVIDED BY A SINGLE TREE

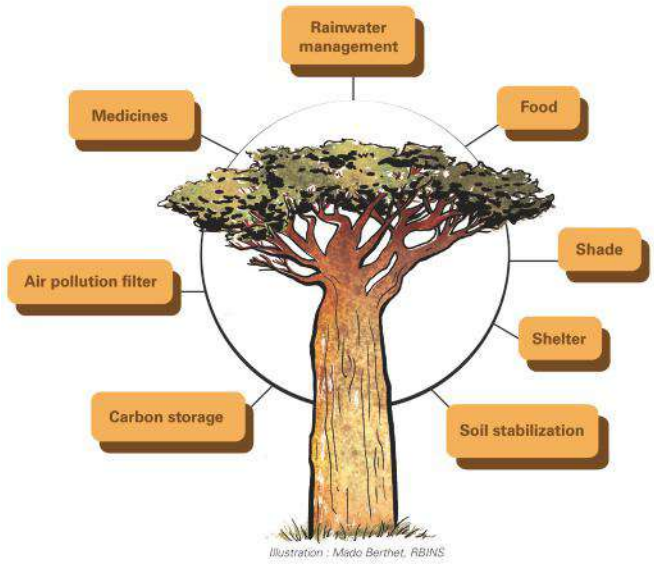

FIGURE 6.
DIFFERENT TYPES OF VALUES PEOPLE CAN ASCRIBE TO NATURE: a) instrumental value, b) relational value, and c) intrinsic value

Social-ecological system

We as **humans** are part of this complex web of interactions referred to as the 'social-ecological system'. We influence nature and depend on it for our survival, sustenance and well-being.

The **direct or indirect benefits** provided by ecosystems are called 'ecosystem services' (MEA, 2005). One single tree, for example, can provide multiple ecosystem services (ES) (**Figure 5**). These services can directly benefit people, for example through shade and food, or more indirectly via soil stabilization and carbon storage.

WHY DO WE PROTECT NATURE?

We protect nature because of its value for us. What this value entails differs among people (**Figure 6**):

- Nature can be valued for itself, independent from humans. This is its '**intrinsic value**'.
- Nature can be valued because of its utility to humans. This is what we refer to as **'instrumental value'**. Ecosystem services are an example of this approach, where nature provides certain services that benefit us and our well-being.
- Nature can be valued based on the relationship established with it. This '**relational value'** of nature can be linked to individual and/or collective preferences and norms. Nature can be meaningful to humans, for example, because of the memories it evokes, the sense of identity it provides, or the sense of responsibility and connection it triggers. When nature is endangered, the special meaning that part of nature has in our lives is also threatened. Caring for nature is thus understood as a moral and social responsibility, and as essential to meeting our needs and those of future generations. These relational values are often associated with traditional and indigenous communities, but can be important to anyone.

For example, farmers may value the food they produce in different ways, such as a pure market commodity producing a financial benefit, or as an integral part of their continued cultural identity and self-determination. Furthermore, the same farmers may hold conflicting and evolving values about the food they produce. Hence, the ways in which values are understood, acknowledged and addressed in practice are complex and have an impact on decisions that may affect both present and future outcomes (Pascual et al., 2017).

This multidimensional valuation of nature should ideally inform environmental management and policy, with particular attention to the kinds of relationships that people already have with nature. Any conservation initiative should be seen as a collective negotiated action towards good stewardship (Chan et al., 2016). The upcoming Thematic Assessment on the multiple values of nature and its benefits, produced by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), is expected to provide an in-depth synthesis of the multidimensional valuation of nature.

What are ecosystem services?

Ecosystem services were first defined as the multiple benefits that ecosystems provide to humans. They are typically categorized into four types (MEA, 2005) (**Figures 7 and 8**):

- **supporting services** such as nutrient cycling, primary production (photosynthesis) and soil formation;
- **provisioning services** such as providing food, fresh water, wood and fibre, fuel, etc.;
- **regulating services** such as the regulation of climate, flood, diseases and water purification; and
- **cultural services** such as aesthetic, spiritual, educational and recreational uses.

Further details of recent evolutions in the concept of ecosystem services can be found in **Box 4**. **Figure 8** provides some concrete examples of ecosystem services.

The global economic value of Earth's ecosystem services for the entire biosphere was estimated to amount to US$125 trillion/year, highlighting their importance in our society and in decision-making processes (Costanza et al., 2014).

FIGURE 7. FOUR TYPES OF ECOSYSTEM SERVICES AND EXAMPLES FOR EACH CATEGORY
(Source: WWF)

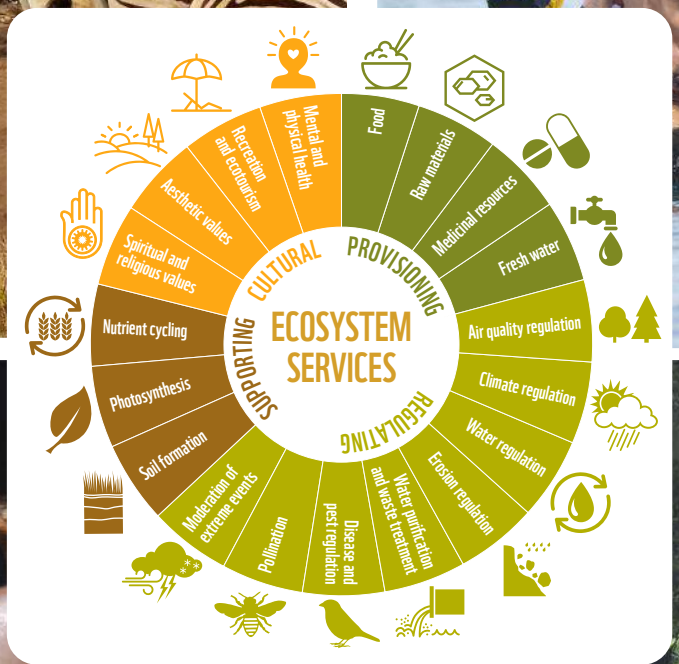

FIGURE 8.
EXAMPLES OF ECOSYSTEM SERVICES
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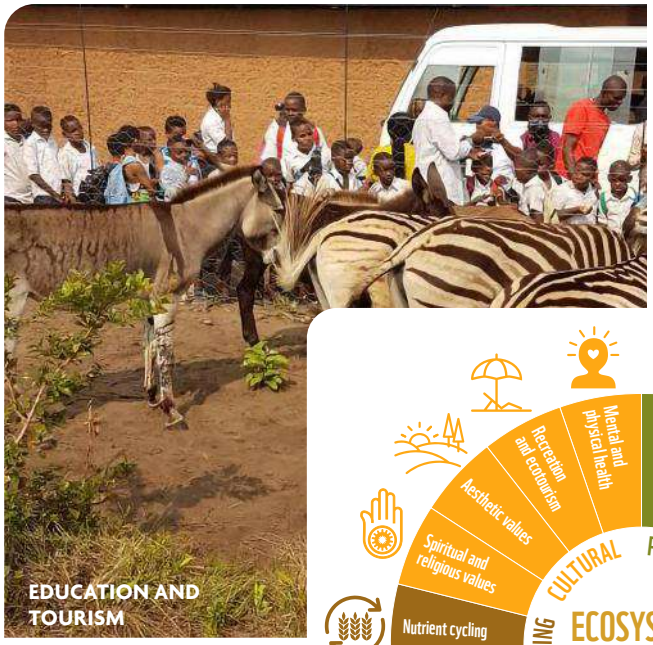
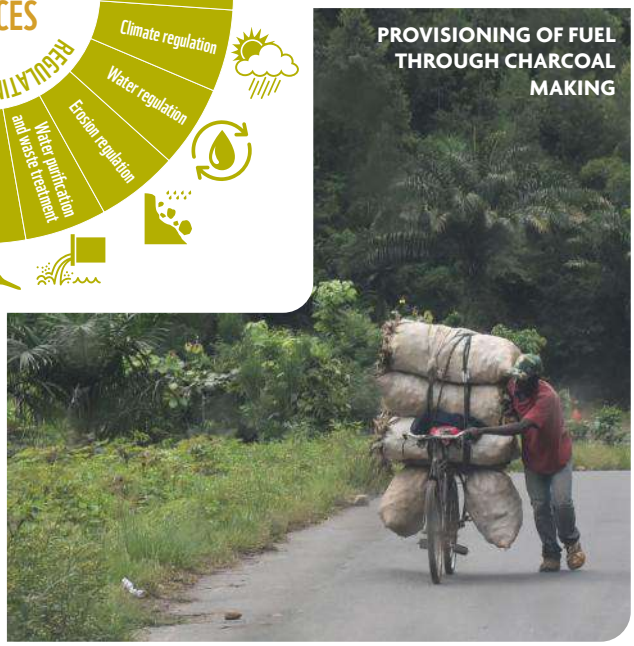




Services provided by ecosystems are essential to human well-being

There is a growing consensus among conservationists that nature conservation should aim to preserve biodiversity and improve long-term human well-being through sustainable development. 'Human well-being' refers to the state of physical and mental health of individuals (Díaz et al., 2015), and is an essential component of a good quality of life, which depends on multiple factors including access to food, water, health, education and security, as well as cultural identity, material prosperity, spiritual satisfaction and freedom of choice (Ngo et al., 2019). All of these dimensions are closely interlinked with ecosystem services.

Figure 9 demonstrates the importance of ecosystem services as a crucial link between nature and a good quality of life. In order to maintain or even improve our current level of well-being, we need to be able to sustain the delivery of ecosystem services. Other parameters such as direct and indirect drivers, further detailed in **Figure 12**, also have a crucial role to play.

The rest of this manual uses the term 'ecosystem services' but recognizes the concepts embraced by NCP associated with other worldviews on human–nature relations and knowledge systems (e.g. 'nature's gifts' in many indigenous cultures).

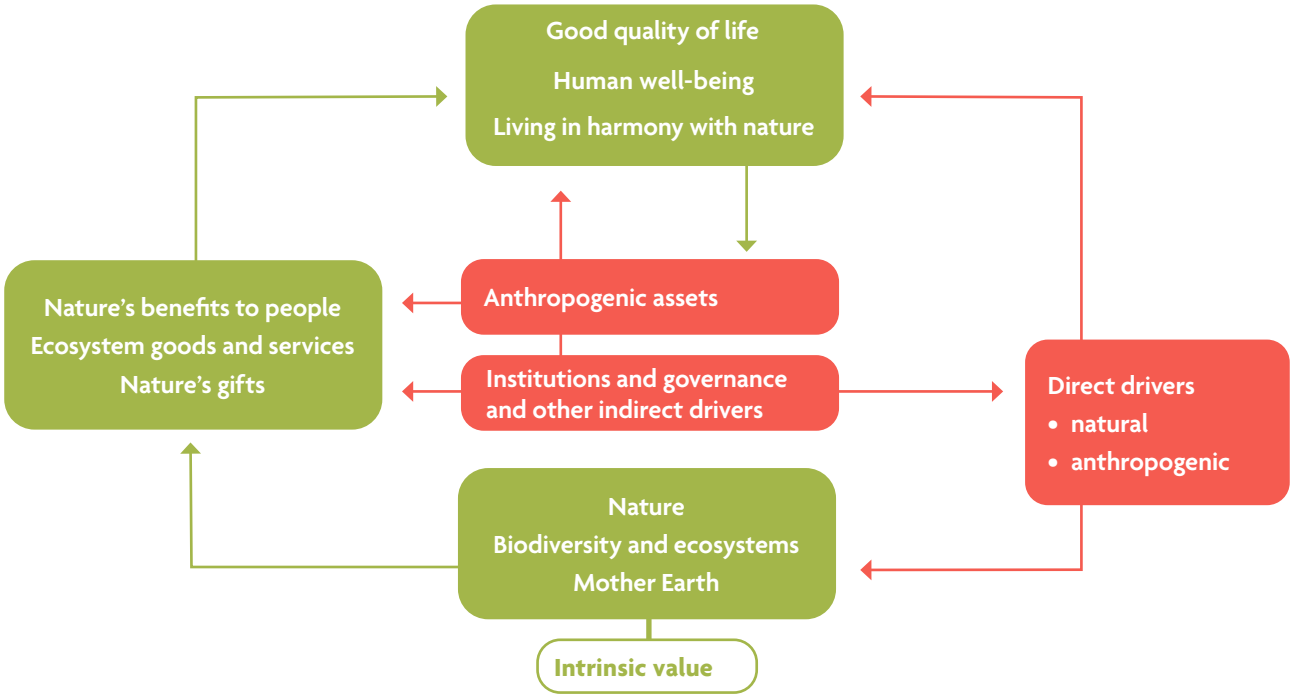
Figure 10 shows how NCPs influence quality of life, and places them on a value gradient from instrumental to relational. The grading of green and brown colours indicates whether NCPs are associated more with natural (green) or with cultural (brown) systems.

BOX 4.
NATURE'S CONTRIBUTIONS TO PEOPLE: ANOTHER LENS FOR CONSIDERING ECOSYSTEM SERVICES

Ecosystem services can be classified in several ways and the concept itself is constantly evolving. According to the Millennium Ecosystem Assessment (MEA) (2005), four types of services provided by ecosystems may be distinguished (see **Figure 7**). The Common International Classification of Ecosystem Services (CICES, 2019) recognizes three types of ecosystem services, merging the MEA categories of supporting and regulating services into one. In this manual, we use the MEA classification which recognizes four types.

IPBES has recently introduced the term **Nature's Contributions to People (NCP)** (Pascual et al., 2017), which embodies the concept of ecosystem goods and services and notions of nature's gifts from indigenous and local knowledge systems. It emphasizes the cultural aspects and considers the importance of social sciences while assessing the interaction between people and nature, thereby recognizing the central role that culture plays in defining all links between people and nature (Díaz et al., 2018). NCP consists of 18 categories including regulation of climate, food and feed, learning and inspiration, and is organized into three partially overlapping groups: regulating, material and non-material contributions (see **Figure 10**) (IPBES, 2019). IPBES assumes that some contributions can be detrimental for humanity, such as pests in crops (IPBES, 2018a; Pascual et al., 2017).

FIGURE 9.
THE IPBES CONCEPTUAL FRAMEWORK PROVIDES A SIMPLIFIED MODEL OF THE COMPLEX INTERACTIONS BETWEEN THE NATURAL WORLD AND HUMAN SOCIETIES



Source: adapted from Díaz et al. (2015), IPBES

Who benefits from ecosystem services?

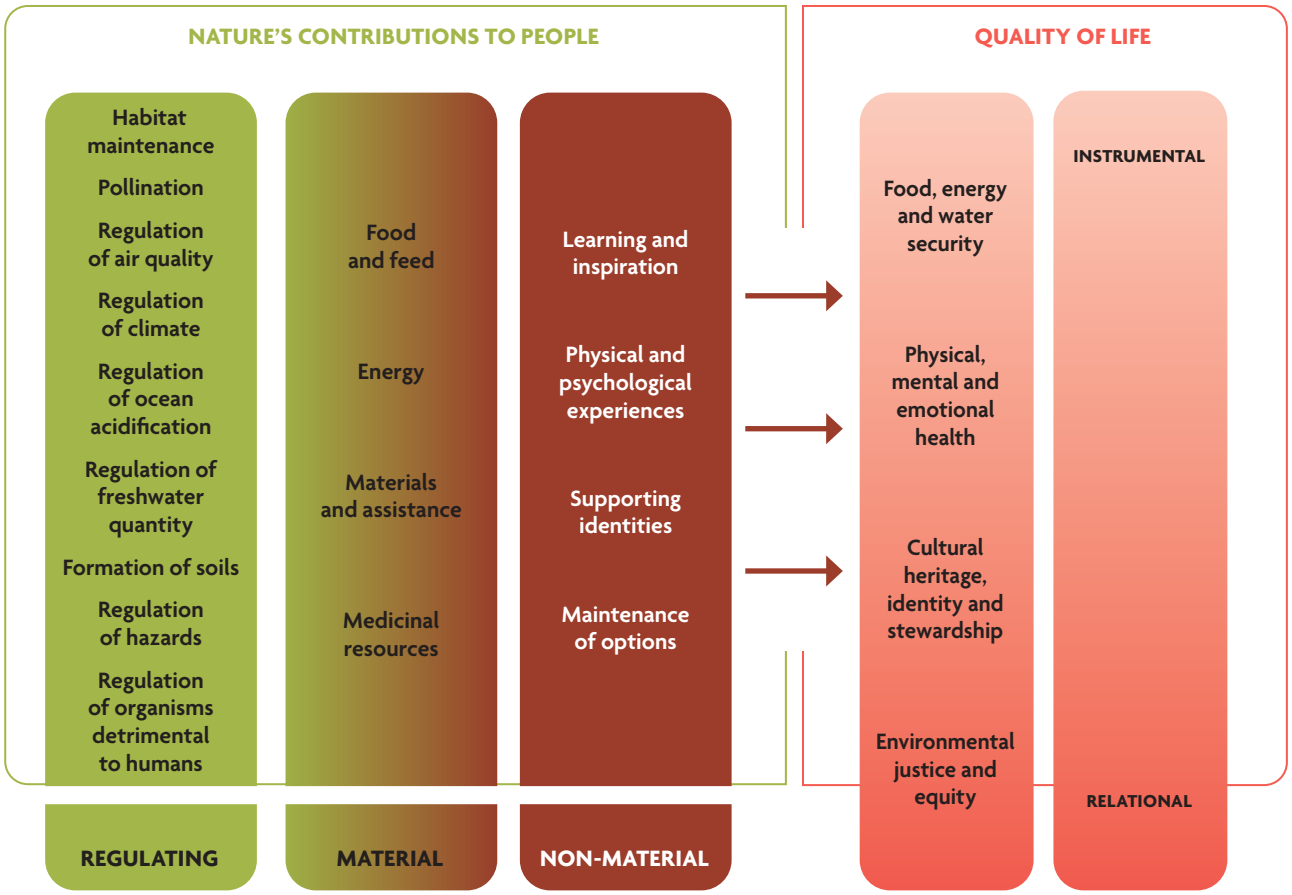
The services provided by an ecosystem extend beyond the ecosystem itself. Ecosystems provide services at different geographical scales, and human activity can benefit from ecosystem services that are sometimes very distant. Take the example of forest ecosystems (see **Figure 11**):

- **Locally produced benefits.** At the local level, the forest influences the formation of soils (e.g. by providing litter), among others.
- **Omnidirectional neighbourhood benefits.** Forest ecosystems can play an important role for neighbouring ecosystems, for example by hosting a number of pollinating species. These species will pollinate neighbouring fields.
- **Directional neighbourhood benefits.** A forest may protect against external disturbances. For instance, mangroves protect coasts from storms.
- **Long distance directional benefits.** The forest ecosystem plays a role at the regional level, in particular by regulating the flow of rivers in the surrounding watershed.
- **Globally distributed benefits.** Finally, large forest ecosystems can provide a global climate regulation service.

People benefiting from the ecosystem services provided by an area (the beneficiaries) often depend significantly on these services, which sometimes come from far away, as shown in **Table 1**.

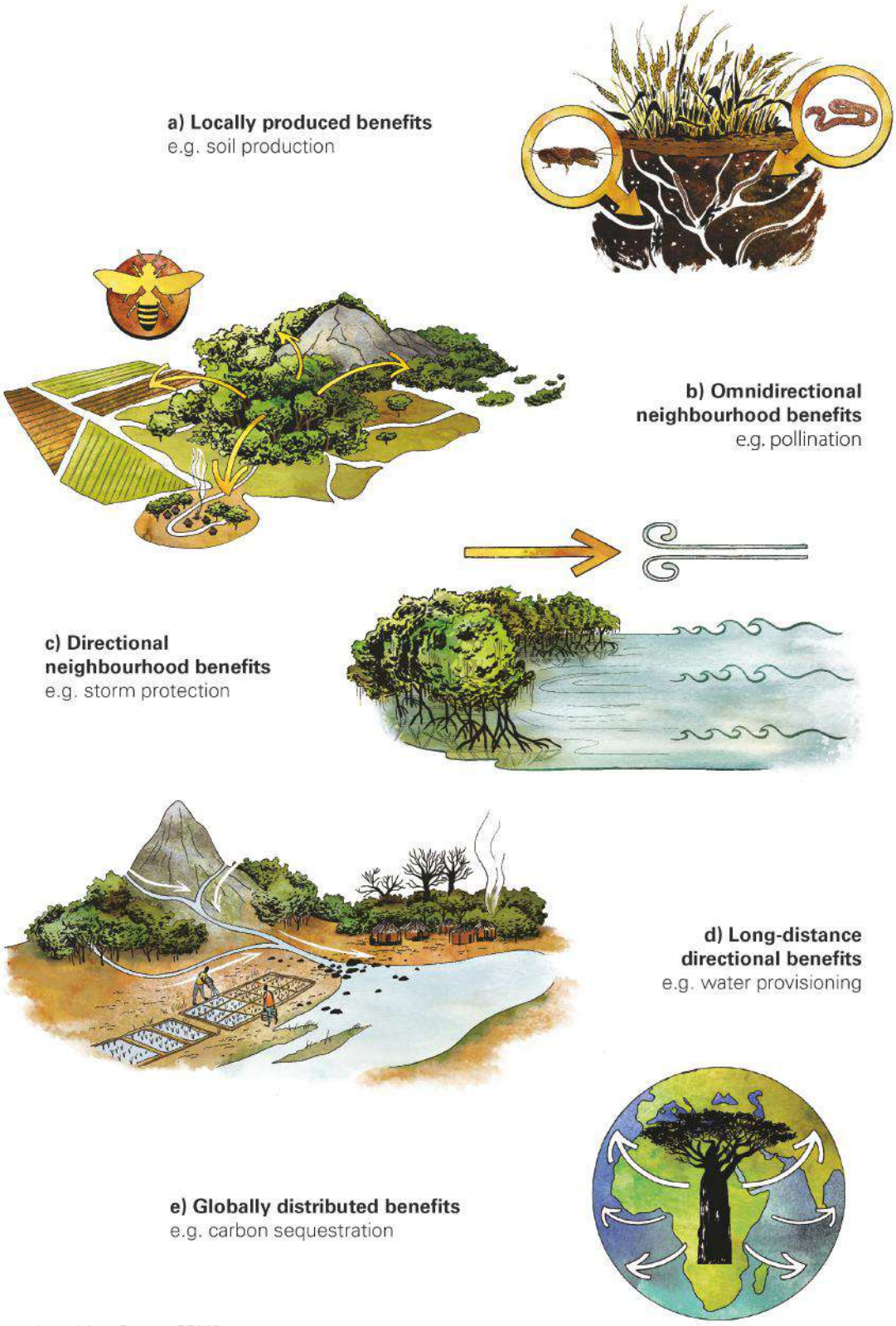
Different stakeholders will have different priorities and vary in the level of their dependency on ecosystem services. People living in and around biosphere reserves are usually **more visibly and directly dependent** on ecosystem services for their livelihood compared to those living in cities or further from natural areas. Therefore, it is essential to consider ecosystem services across different scales when targeting sustainable development and human well-being in biosphere reserves.

FIGURE 10.
NATURE'S CONTRIBUTIONS TO PEOPLE AND THEIR RELATION TO QUALITY OF LIFE IN TERMS OF INSTRUMENTAL AND RELATIONAL VALUES



Source: IPBES (2018b).

FIGURE 11.
CATEGORIES OF ECOSYSTEM SERVICE FLOW IN RELATION TO THEIR SPATIAL CONFIGURATION



Source: adapted from Fisher, Turner and Morling (2009).

TABLE 1.
EXAMPLES OF ECOSYSTEM SERVICES AND THEIR BENEFICIARIES IN THE PENDJARI BIOSPHERE RESERVE, BENIN

Ecosystem service	Beneficiaries	Scale	More information
TOURISM AND RECREATION	Local population of riparian villages	Local	Local population involved in tourism activities (e.g. local guides) may receive incomes, or park benefits if these are redistributed to the population, or benefit from job creation by the national park.
	People from Natitingou	Neighbourhood	Pendjari National Park attracts tourists to northern Benin, thereby developing the tourism industry in Natitingou, the closest town.
	Tourists	Global	Tourists can enjoy beautiful scenery and wildlife, or participate in trophy hunting.
WATER SUPPLY	Local population	Local	The local population uses water for drinking, for cattle and agriculture, and for laundry.
	Benin	Long distance	Northern Benin, including the Pendjari Biosphere Reserve, is the source of water for a large part of the country.
FODDER	Local population	Local	Livestock keeping is the second economic activity around Pendjari National Park.
	Pastoralists	Long distance	Pendjari Biosphere Reserve is an important transhumance route, with livestock keepers stopping around the National Park for grazing (and to sell water and cheese to the locals).
CARBON SEQUESTRATION	People at the global scale	Global	Forest ecosystems contribute to global climate regulation services.
COTTON	Local communities	Local	Cotton is as an important cash crop around the Pendjari Biosphere Reserve, providing substantial income to farmers.
	The state, and outside Benin	Long distance	Cotton is produced around the biosphere reserve, is sold to the state and is exported outside Benin.
CULTURE	Local communities	Local	The sacred baobabs are linked to the Voodoo religion.

Source: EVAMAB

Ecosystem services at risk

Biodiversity is declining drastically both at the global and local scale. Human actions have been driving biodiversity loss and ecosystem deterioration, as illustrated in **Figure 12** (Díaz et al., 2019; IPBES, 2019).

IPBES (2019) has identified the five most important direct drivers behind nature degradation (see **Figure 13**).

Those five direct drivers are the result of an array of underlying causes – indirect drivers of change – which are in turn underpinned by societal values and behaviours that include production and consumption patterns, human population dynamics and trends, trade, technological innovations and various governance structures (see **Figure 12**, IPBES, 2019). Key drivers of biodiversity change in Africa, per subregion and ecosystem type, are shown in **Figure 17** (**Box 5**).

The ability of ecosystems to provide services to society and thus support human well-being is decreasing (**Figure 14 and 15**).

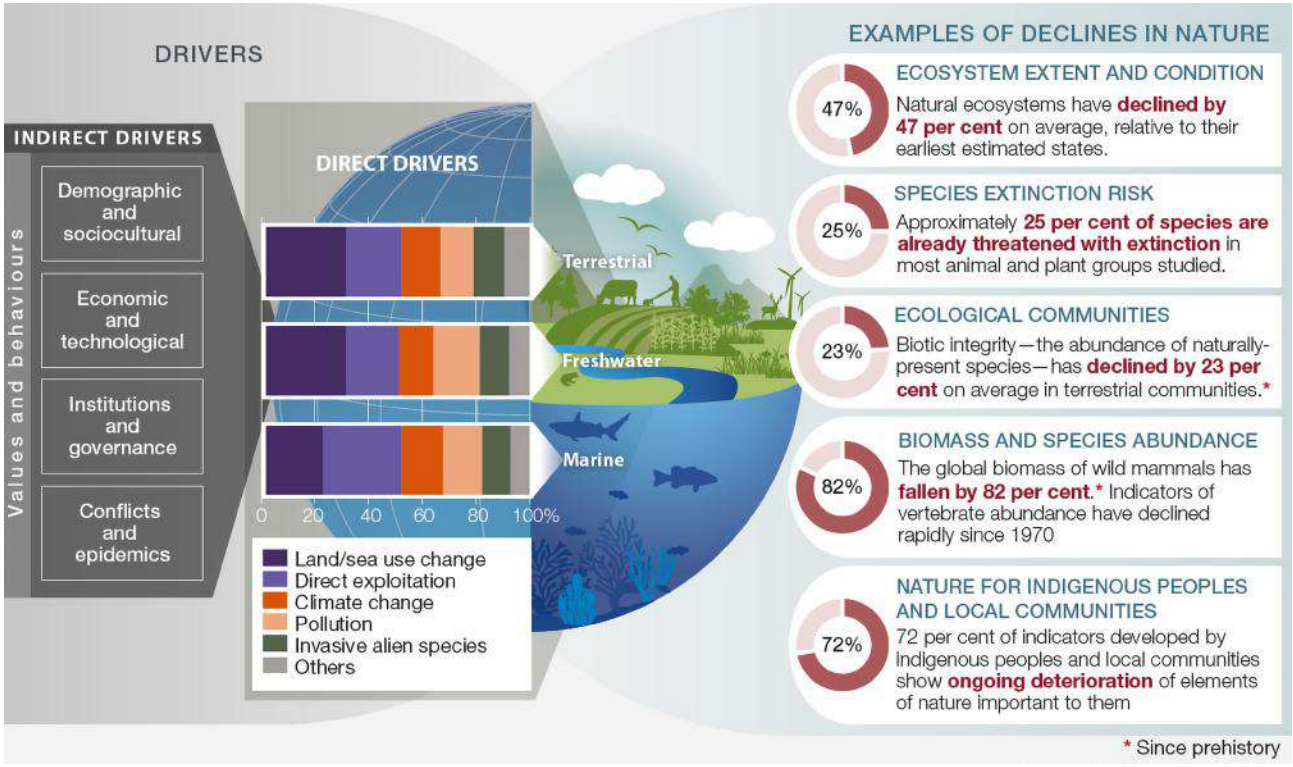
The cultural and natural richness of Africa in terms of biodiversity and ecosystem services, and indigenous and local knowledge, is extraordinary. Across the continent, more than 62% of the rural population is directly dependent on ecosystem services for their survival. Today, 14% of its land and 2.6% of its sea surface are designated as protected areas (IPBES, 2018a).

The true value of ecosystem services is still underappreciated in decision-making. It is therefore essential to transform agricultural practices, improve land-use planning and protect existing natural areas, in order to guarantee food security and human well-being for current and future generations (Tilman et al, 2017). In Africa, where threats to biodiversity are significant owing to a growing population and unsustainable economy, sustainable development is key for the continued delivery of ecosystem services.

'Africa is the last place on earth with a significant assemblage of large mammals'

IPBES (2018a)

FIGURE 12.
EXAMPLES OF GLOBAL DECLINES IN NATURE CAUSED BY DIRECT AND INDIRECT DRIVERS OF CHANGE



Source: IPBES (2019).

FIGURE 13.
MAIN DIRECT DRIVERS BEHIND NATURE DEGRADATION

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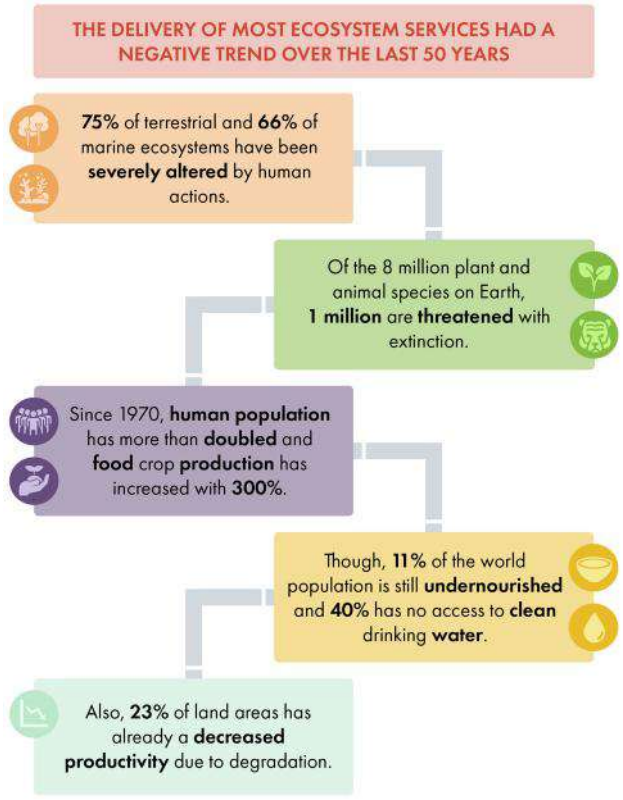
FIGURE 14.
THE DEGRADATION OF NATURE AND ITS VITAL CONTRIBUTIONS TO PEOPLE WORLDWIDE



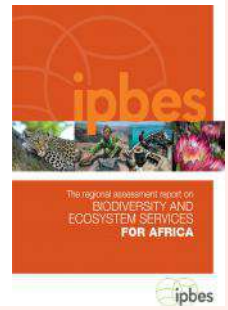
Source: IPBES (2018a).

BOX 5.
IPBES REGIONAL ASSESSMENT REPORT ON BIODIVERSITY AND ECOSYSTEM SERVICES FOR AFRICA

The Africa regional assessment is the first of its kind for the continent and constitutes one of four regional assessments conducted under the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES). The assessment is a synthesis of the state of knowledge on biodiversity and ecosystem services. It aims to provide the foundation for a meaningful dialogue across the full range of stakeholders involved in African development.

A number of key thematic challenges are considered by the assessment, including the food-energy-water-livelihood nexus, climate-related risks, land degradation, invasive alien species, sustainable use and technological innovations. By focusing on biodiversity and nature's contributions to people, this regional assessment is critical to African policy-makers, all constituents of African communities, civil society, the private sector and other stakeholders involved in environmentally sensitive investments and land-use decisions.

Two key figures address the economic value of ecosystem services in Africa (**Figure 16**) and key drivers of biodiversity change in Africa (**Figure 17**).



The report is composed of a Summary for Policymakers and six chapters, all of which can be accessed at https://ipbes.net/assessment-reports/africa.

FIGURE 15.
DEGRADING THE ECOSYSTEM AND ITS SERVICES CAN HAVE MAJOR IMPACTS, SUCH AS LANDSLIDES RISKS OWING TO DEFORESTATION – A COMMON ISSUE IN MOUNT ELGON BIOSPHERE RESERVE, UGANDA

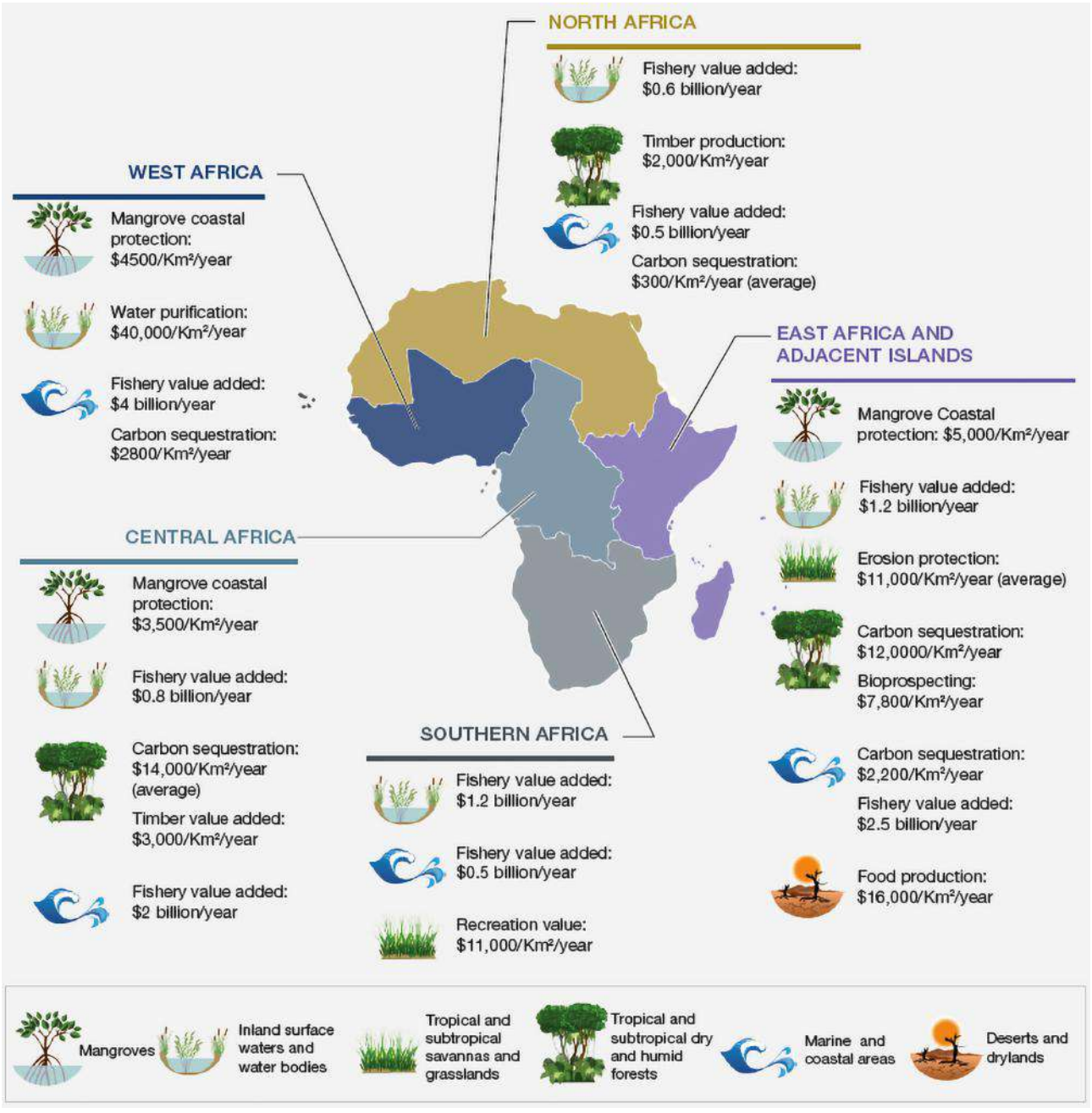
Illustrations: Mado Berthet, RBINS

'Disrespect ecosystem services, and they will punish you'

A MAB manager present at the EVAMAB closing workshop

Figure 16 provides sample values of some ecosystem services in selected ecosystems (freshwater, marine and coastal areas, and forests) in Africa. One of the key messages is that the true value of biodiversity and nature's contributions to human well-being tends to be underappreciated in decision-making processes in Africa, in particular for non-material and regulating contributions.

FIGURE 16.
INDICATIVE LISTS OF THE ECONOMIC VALUE OF NATURE'S CONTRIBUTIONS TO PEOPLE IN AFRICA



Source: IPBES (2018a).

Figure 17 presents a general qualitative assessment of the various drivers of change of biodiversity and nature's contributions to people in Africa. It assesses the trend of the impact (high, moderate or low increase) of respective drivers on the various ecosystem types. The thickness of the arrows indicates the level of agreement for the countries sampled for the report (IPBES, 2018a).

FIGURE 17.
KEY DRIVERS OF BIODIVERSITY CHANGE IN AFRICA SHOWN PER SUBREGION AND ECOSYSTEM TYPE

SUBREGIONS	ECOSYSTEM TYPE	DRIVERS OF BIODIVERSITY CHANGE							
		Direct drivers						Indirect drivers	
		Climate change	Habitat conversion	Over harvesting	Pollution	Invasive alien species	Illegal wildlife trade	Demographic change	Protected areas
Central Africa	Terrestrial/Inland waters	↗	↑	↑	↑	↑	↑	↑	↗
	Coastal/Marine	↗	↑	↑	↗	↗	↑	NI	↔
East Africa and adjacent Islands	Terrestrial/Inland waters	↑	↗	↑	↗	↗	↑	↑	↗
	Coastal/Marine	↑	↗	↗	↗	↗	↑	↑	↔
North Africa	Terrestrial/Inland waters	↑	↗	↗	↗	↑	↔	↗	↗
	Coastal/Marine	↗	↗	↗	↗	↑	NI	↗	↗
Southern Africa	Terrestrial/Inland waters	↗	↗	↑	↗	↑	↗	↗	↗
	Coastal/Marine	↗	↗	↗	↗	↑	↗	↗	↗
West Africa	Terrestrial/Inland waters	↑	↑	↑	↗	↗	↑	↗	↗
	Coastal/Marine	↑	↗	↗	↗	↗	↑	↗	↗

Width of an arrow = level of agreement for countries sampled
Arrow = Trend of the respective impact of the driver

↑ High Increase ↗ Moderate Increase ↗ Low Increase ↓ Decrease **NI** No information available ↔ Unchanged/Under control

Source: IPBES (2018a).

MORE INFORMATION

Online courses

- Ecosystem Services: a Method for Sustainable Development, Université de Genève, Switzerland
  www.mooc-list.com/course/ecosystem-services-method-sustainable-development-coursera.
- Environmental Challenges: Rights and Values in Ecosystem Services, University of Leeds
  www.futurelearn.com/courses/environmental-challenges-rights-values.

Other sources

- The IPBES Regional Assessment Report on Biodiversity and Ecosystem Services for Africa
  https://ipbes.net/assessment-reports/africa.
- The Ecosystem Approach: Learning from Experience. G. Shepherd. 2008. Gland, Switzerland, IUCN
  www.cbd.int/doc/external/iucn/iucn-ecosystem-approach-en.pdf.
- The comparison between the concepts of nature's contribution to people and Ecosystem Services: Disentangling 'ecosystem services' and 'nature's contributions to people'. Kadykalo et al., 2019 .
  www.tandfonline.com/doi/full/10.1080/26395916.2019.1669713.
- Ecosystem services in Lake Manyara Biosphere Reserve, Tanzania (video).
  www.youtube.com/watch?v=s1bUmMxwGcU&list=UUp9IYI9IsQjYugUFddS9O4Q&index=10.
- 'Social-ecological assessment of Lake Manyara basin, Tanzania: A mixed method approach'. Janssens de Bisthoven et al., 2020
  www.sciencedirect.com/science/article/pii/S0301479720305272.