Chapter 2
Biosphere reserves
Living laboratories for sustainable development

I. Janssens, E. Bocquet, J. Hugé, L. Janssens de Bisthoven and A-J. Rochette

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Lake Manyara Biosphere Reserve, Tanzania
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RELEVANCE FOR AFRICAN BIOSPHERE RESERVES

- For biosphere reserves stakeholders, this chapter functions as a good reminder of the objectives of the MAB Programme and the role and structure of biosphere reserves.
- This chapter also emphasizes the extensive range and diversity of the World Network of Biosphere Reserves (WNBR) in terms of ecosystems, social contexts and management types, and highlights its promotion of North-South and South-South collaboration as a unique tool for international cooperation through sharing knowledge, exchanging experiences, building capacity and promoting best practices.
- The chapter further underlines the importance of stakeholders and notes that other biosphere reserves both in Africa and worldwide face similar challenges and share common objectives.
- For non-MAB stakeholders, this chapter can help better understand the **MAB Programme** and its network of biosphere reserves, as well as their specificities.

THE MAN AND THE BIOSPHERE (MAB) PROGRAMME

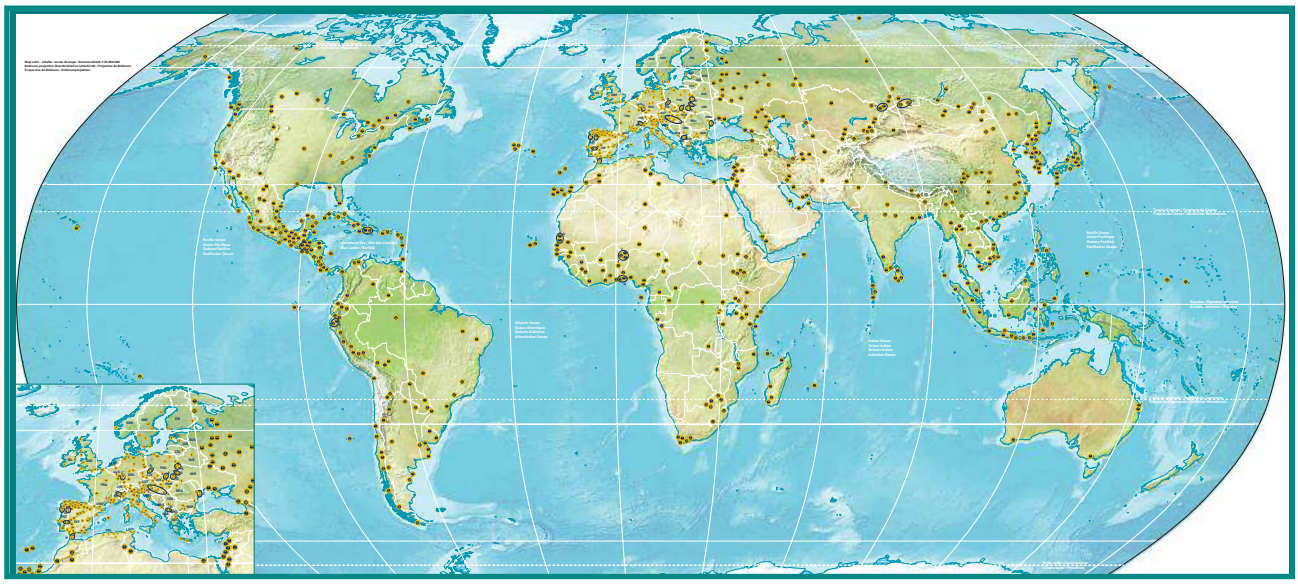
The Man and the Biosphere (MAB) Programme was created in 1971. It focuses on studying **interactions between human populations and ecosystems**, in order to ensure both human well-being and the sustainable management of natural resources.

The MAB network in 2022

The World Network of Biosphere Reserves (WNBR) promotes North-South and South-South collaboration and represents a unique tool for international cooperation through sharing knowledge, exchanging experiences, building capacity and promoting best practices.

- 738 biosphere reserves
- They cover 134 countries, including 90 sites located in 33 African countries (since June 2022).

FIGURE 18. WORLDWIDE LOCATION OF BIOSPHERE RESERVES IN 2020-21



*The 2022 map was not available at the time of the publication.

Biosphere reserves

While recognized internationally, biosphere reserves fall under the sovereign jurisdiction of the states in which they are located. The aim of these sites is to combine the conservation of ecosystems with the sustainable use of natural resources for the benefit of local communities.

They also serve as a model for solutions to promote sustainable development at the regional level, showcasing the possibilities for combining protection of nature with the sustainable development of local communities.

In order to become part of the MAB Programme, biosphere reserves should fulfil **three main integrated functions**:

- **Conservation of diversity** – maintaining the natural diversity of ecosystems and species, genetic diversity and cultural diversity of languages and ethnicities.
- **Sustainable development** – promoting human and economic growth in a sustainable way (fulfilling the current generation's needs without compromising those of the future) (United Nations, 1987).
- **Logistics** – using education, tourism and communication tools like social media, as well as scientific activities such as research and monitoring, to reach all parts of society.

Why are biosphere reserves important?

'They are important because they enable managers of biosphere reserves to balance the consumption and the protection of biodiversity. If they were any other national park, we wouldn't even be able to touch the natural resources. This enables sustainable harvesting of the resources by the communities.'

Fredric Kizza, Chief Warden, Mount Elgon Conservation Area, Uganda

What are some of the advantages of joining the World Network of Biosphere Reserves?

'What is unique with this network is that all those people are struggling to implement sustainable development solutions in their sites. So, we have a common framework, and a ten-year plan on how to improve sustainable development in these sites. Since it's a huge area, if we manage to establish sustainable development approaches in those sites, we believe it will have a huge impact worldwide.'

Noëline Raondry Rakotoarisoa, UNESCO-MAB

BOX 6.
UNESCO MAB: MORE THAN BIOSPHERE RESERVES

The World Network of Biosphere Reserves (WNBR) works to implement the UNESCO MAB Programme in the field. Achieving this involves the efforts of several different but linked entities at the international, national and regional levels.

At the international level:

- The **International Coordinating Council** is the main governing body of the MAB Programme. It comprises 34 Member States and defines the agenda of the MAB Programme.
- The **MAB Bureau** consists of a Chair and five vice-chairpersons from each of UNESCO's geopolitical regions, one of which functions as a rapporteur.
- The **MAB Secretariat** is part of UNESCO Secretariat and is located at UNESCO's Headquarters in Paris. The Secretariat works closely with the different UNESCO Field Offices around the world to coordinate the work of the MAB Programme at national and regional levels.
- Two international bodies provide advice to the MAB Programme: the **International Advisory Committee for Biosphere Reserves** and the **International Support Group (ISG)**.

At the regional level:

- **UNESCO Field Offices** implement the UNESCO's MAB Programme at the regional level. They work in coordination with the MAB Secretariat and serve as focal points for all issues relating to the Programme both at regional and national levels.
- **Regional MAB Networks** have a key role to play in the exchange of information and experience regionally. The MAB regional network in Africa[1] is called AfriMAB, the African Biosphere Reserves Network. It aims at promoting regional cooperation in the fields of biodiversity, conservation and sustainable development through transborder projects, which are based primarily in biosphere reserves.

At the national level:

- **MAB National Committees** ensure maximum national participation in the international programme, defining and implementing each country's activities. Every Member State is invited to establish a permanent and fully functioning national committee.
- Biosphere Reserves.

1 At UNESCO, AfriMAB is the regional group of sub-Saharan countries. Arab States are members of ArabMAB.

Three zones for different activities

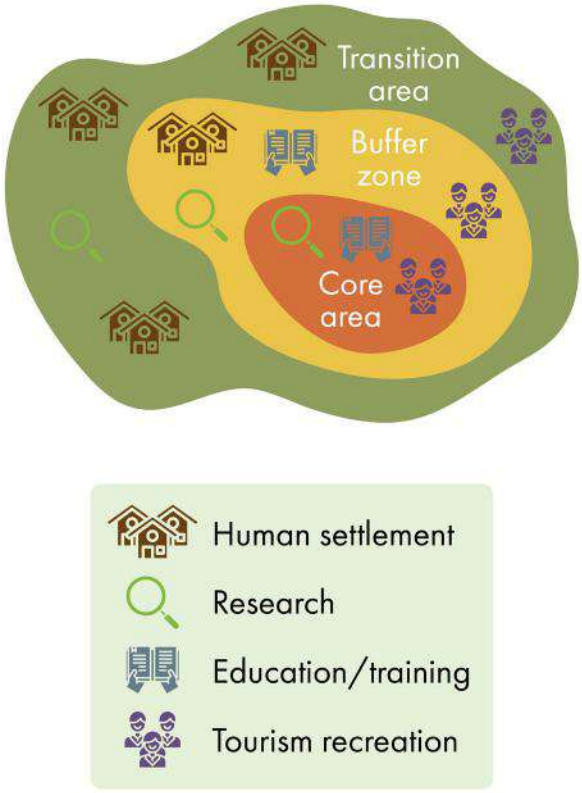
A biosphere reserve is composed of **three zones** (UNESCO, 2017). A zonation plan is mandatory and should be the spatial reference for the management plan of each biosphere reserve.

In order to be designated as biosphere reserve, a site must fulfil certain **general criteria** which can be found back in the Statutory Framework (UNESCO, 1996). The site must:

- contain all representative ecosystems of the region with a gradation of human occupation;
- be of significance for biological diversity conservation;
- provide an opportunity to explore and demonstrate approaches to sustainable development on a regional scale;
- have an appropriate size to serve the three functions of biosphere reserves;
- include these functions through appropriate zonation (see **Figure 19**);
- involve different stakeholders, including local populations and public authorities;
- make provision for
  - **mechanisms to manage human use and activities in the buffer zone(s),**
  - **a management policy or plan for the area as a biosphere reserve,**
  - **a designated authority or mechanism to implement this policy or plan,**
  - **programmes for research, monitoring, education and training.**

Every ten years, the biosphere reserve is subjected to submit a self-assessment known as the **periodic review**. This report is reviewed by the MAB International Coordinating Council in order to assess whether or not the biosphere reserve meets the criteria of the Statutory Framework of the WNBR. The periodic review should detail changes in the biosphere reserve during the reporting period and provide a detailed description of human, physical and biological characteristics, as well as institutional aspects. **Economic valuation and quantification of ecosystem services can serve to show quantifiable changes and trends in their provision.**

FIGURE 19.
ZONATION OF BIOSPHERE RESERVES



One - or several - core area(s)

- **all human activities are prohibited - except non-destructive research and other low-impact uses (education, tourism)**

The buffer zone surrounding or adjacent to the core area(s)

- **activities in harmony with the conservation goals are allowed: scientific research, education and low impact tourism**
- **important connectivity function**

The transition area

- **focus on the co-living relationship between people and nature (people often live there)**
- **sustainable economic and human development: stakeholders work together to manage and sustainably develop the area's resources**

BOX 7.

HOW TO TAKE ECOSYSTEM SERVICES INTO ACCOUNT WHEN ESTABLISHING A NEW BIOSPHERE RESERVE

CATEGORIZING ECOSYSTEM SERVICES IN THE NOMINATION FORM

Ecosystem services assessment tools help to identify the state of ecosystem services in a biosphere reserve, as well as threats and trends (increasing, decreasing, stable). This knowledge can also be translated into a simple categorization of ecosystem services, in order to highlight which services should be priority targets for management and conservation.

These priorities can then be used to make a case for why an area should be nominated as a biosphere reserve, and can be used to help complete the 'Ecosystem Services' section of the nomination form.

LINKING PRIORITY ECOSYSTEM SERVICES TO BIOSPHERE RESERVE ZONATION

Linking key ecosystem services to the three different zones of the biosphere reserve may help to set zone-specific management goals in the biosphere reserve. For example, in the Pendjari Biosphere Reserve (**Table 1**), key ecosystem services relate to specific zones, suggesting that management should reflect this zonation:

- **Core area** – water provision, safari tourism and research.
- **Buffer zone** – trophy hunting, religious worshipping (e.g. voodoo fetishes) and fodder gathering.
- **Transition area** – agriculture (cotton, food, etc.).

ASSIGNING KEY ECOSYSTEM SERVICES TO THE THREE BIOSPHERE RESERVE FUNCTIONS MAY ALSO HELP STRUCTURE DESCRIPTIONS OF THESE FUNCTIONS:

- **Conservation function** – the importance of the site for the conservation of biological and cultural diversity at regional or global scales.
  - The main ecosystem services concerned are cultural (e.g. sacred sites) and supporting services (habitats for wildlife).
- **Development function** – this implies securing flows of ecosystem services from the biosphere reserve to foster sustainable economic and socio-cultural development. Knowledge of key ecosystem services is essential to accurately describe this function.
  - Any ecosystem service identified as a priority in the area (ideally following the application of an assessment tool, see **Chapter 3**) may be linked to this function, for example, food and water provision, climate regulation and recreational use (tourism).
- **Logistical support:** support for demonstration projects, environmental education and training, research and monitoring
  - The main ecosystem services concerned are cultural (educational use and research).

FIGURE 20.

EXAMPLE OF A THREAT CATEGORIZATION FRAMEWORK FOR ECOSYSTEM SERVICES: CATEGORIZING ECOHYDROLOGICAL THREATS TO ECOSYSTEM SERVICES, THE ASSESSMENT FRAMEWORK

CATEGORY	DEFINITION	THRESHHOLD
Functionally extinct	Ecohydrological conditions characterising the region are such that ESs are no longer supplied and are practically unrecoverable.	LOST
Dormant	Ecohydrological conditions characterising the region are such that ESs are no longer supplied in the region but are potentially recoverable.	
Critically endangered	Current levels of demand exceed what the ecohydrology of a region can supply and the ratio of natural capital supply to demand is declining or is expected to decline.	UNDERSUPPLIED
Endangered	Current levels of demand exceed what the ecohydrology of a region can supply and the ratio of natural capital supply to demand is stable but supply is declining.	
Stable but undersupplied	Current levels of demand exceed what the ecohydrology of a region can supply but neither supply of natural capital nor the ratio of supply to demand is declining.	
Vulnerable	Ecohydrological conditions characterising the region are such that the ratio of natural capital supply to demand is declining or expected to decline such that supply is likely to be insufficient to meet demand within a set time horizon.	AT RISK
Least Concern	Ecohydrological conditions characterising the region are such that natural capital supply currently meets or exceeds demand, and does not meet the criteria for Vulnerable.	SECURE

Source: Adapted with modifications from Maron et al. (2017:243) and IUCN Red List Classification System

Gondo et al., 2019

BOX 8. HOW TO ADDRESS ECOSYSTEM SERVICES IN PERIODIC REVIEWS

Every ten years, biosphere reserves must undertake a periodic review. These reports are submitted to the MAB Secretariat where they are evaluated resulting in a 'satisfactory' or 'unsatisfactory' judgment regarding the state of the site.

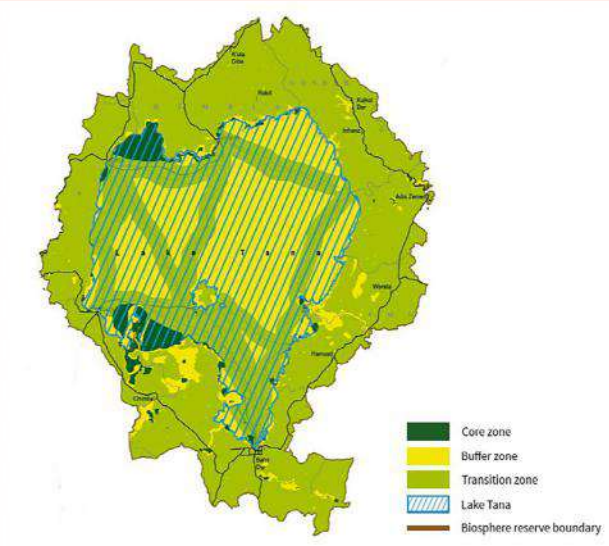
As a soft evaluation tool, the periodic review report has led to improvement in the implementation of the biosphere reserve concept, with a particular focus on design and planning aspects. However, it lacks results-based indicators to measure delivery of objectives linked to the three functions of biosphere reserves: conservation, sustainable development and logistical support.

The periodic reviews consist of ten chapters describing the biosphere reserve, its functions, governance and management, and so on. **Chapter 3** of the review concerns the ecosystem services in the biosphere reserve, their beneficiaries, trends and assessment, as well as their utility in relation to the management plan.

The ecosystem services assessment tools summarized in **Chapter 3** of this manual can help to address all these elements.

BOX 9. ZONATION OF LAKE TANA BIOSPHERE RESERVE

Each biosphere reserve can determine the activities that are allowed or not allowed in each zone. **Table 2** presents a list of activities that are permitted and prohibited in the different zones of Lake Tana Biosphere Reserve, Ethiopia.



Carte: UNESCO, Photo : S. Van Passel

TABLE 2. ACTIVITIES THAT ARE PERMITTED AND PROHIBITED IN THE THREE ZONES OF LAKE TANA BIOSPHERE RESERVE (2019)

	PERMITTED	PROHIBITED
CORE AREA	**Let nature take care of itself** Entering the core area(s) is allowed only for non-destructive activities, such as research (with a special permit from the biosphere reserve authorities).	**Destructive and economic activities** • hunting and removal of wild animals (including their eggs); • cutting, collecting or damaging plants/trees; • lighting fires, smoking, or slash and burn practices; • picking up, taking away or damaging any items, natural or humanmade; • fishing, farming, and livestock grazing; • mineral exploration, digging or sand extraction; • any disposal of waste or other humanmade materials; • any type of construction works; and • damaging, changing or removing any boundary marks of a core area.
BUFFER ZONE	**Sustainable use of natural resources (e.g. traditional fishing and organic farming)** • Traditional (seasonal) fishery, organic farming, beekeeping and similar activities; • environmental research and education; • recreation and eco-tourism; and • limited human activity (allowed and often guarded by community management systems and governed by utilization bylaws).	**Harmful and destructive practices** • use of chemical fertilizer and pesticides; • washing of clothes and vehicles near water sources; • (infrastructure) construction (buildings, roads); • mining, drilling and other large-scale earth movement; and • over-use of water and plants (e.g. for grazing).
TRANSITION AREA	**All other legal human activities** A focus on sustainable and ecologically sound practices should be favoured and promoted to ensure Lake Tana Biosphere Reserve becomes model region for sustainable development.	**Purely destructive and damaging activities** Activities illegal according to Ethiopian law.

CHALLENGES AND STAKES IN BIOSPHERE RESERVES, AND LINKS WITH ECOSYSTEM SERVICES

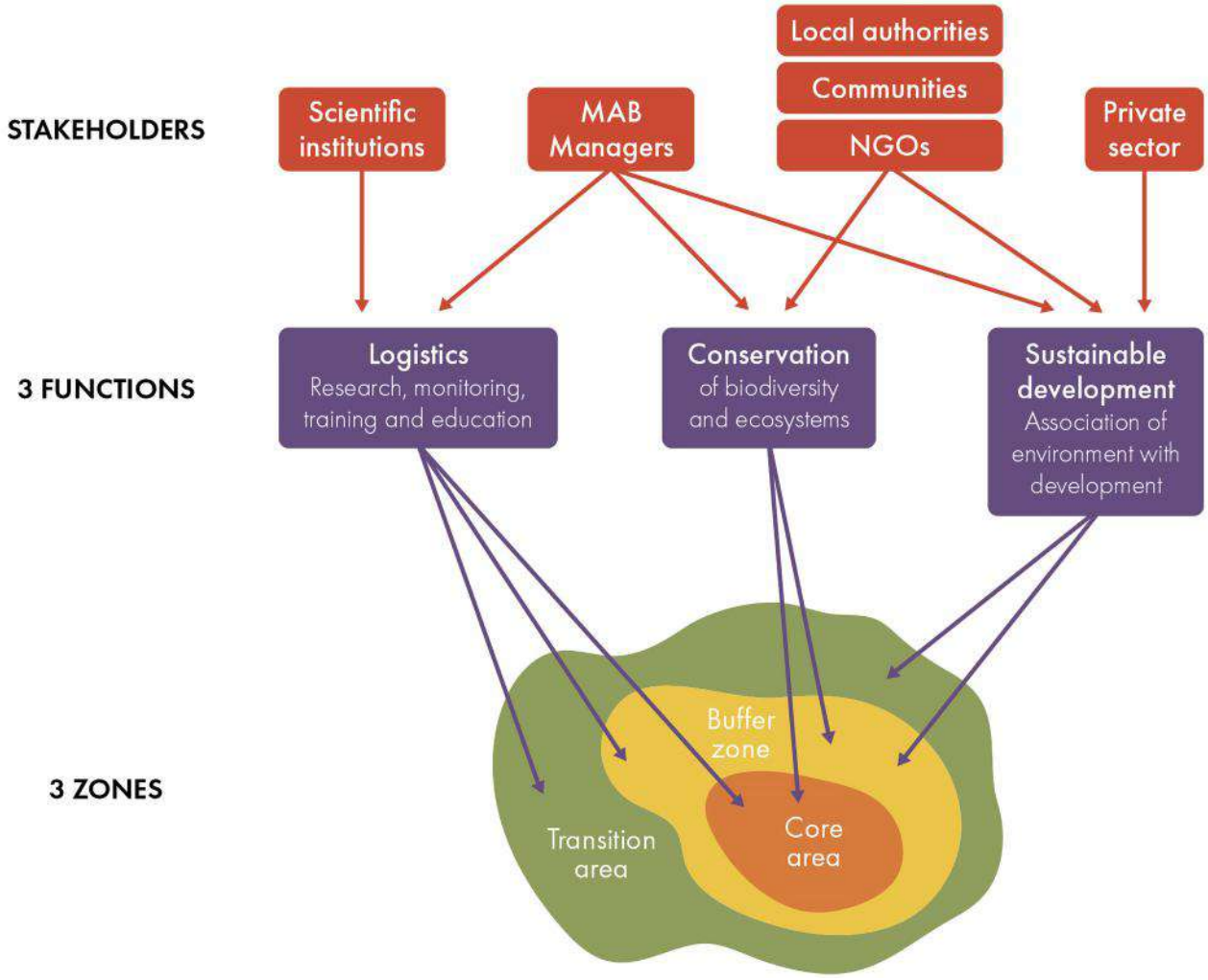
Biosphere reserves may be regarded as 'Sites supporting Science for Sustainability' – learning sites for testing interdisciplinary approaches to understanding and managing changes and interactions between social, cultural and ecological systems, including those related to climate change, ecosystem services and green economies.

The central role of stakeholders

Conservation only works with people. The people that have a 'stake' in and around a biosphere reserve whether locally or at a distance are the relevant stakeholders – the actors who will conceive and implement this dual purpose of conservation and sustainable development. Stakeholders must therefore be the 'owners' of conservation processes as well as the main beneficiaries and service providers in any conservation effort (see also **Chapter 5**). Many different stakeholders are involved in the varying functions of a biosphere reserve (**Figure 20**).

The ways in which stakeholders interact and influence the functioning of biosphere reserves can be appreciated by examining the different categories of governance and management (**Box 10** and **Table 3**).

FIGURE 21.
ZONATION, THE THREE FUNCTIONS OF A BIOSPHERE RESERVE AND THE STAKEHOLDERS ASSOCIATED WITH EACH OF THESE FUNCTIONS



Note: Main links are indicated but may differ from one biosphere reserve to another.

BOX 10: DIFFERENT TYPES OF GOVERNANCE AND MANAGEMENT

Biosphere reserves can be managed in different ways. Management categories and governance types provide substantial information about the characteristics of any area.

Management is about...	• What is done in pursuit of given objectives • The means and actions to achieve such objectives
Governance is about...	• Who decides what the objectives are, what to do to pursue them and with what means • How those decisions are taken • Who holds power, authority and responsibility • Who is (or should be) held accountable

Worboys et al. (2015)

Four main governance types are usually proposed for protected areas, according to the IUCN matrix (see **Table 3**), and may apply to biosphere reserves.

Top-down governance describes an approach where governments establish a management board that takes decisions without necessarily involving all stakeholders. This allows for clear and efficient management, but risks not representing the vision of all stakeholders. Conversely, when governance is spread among a plethora of ministries and other institutions, the management vision may become blurred resulting in lower efficiency.

Public-private partnerships are established when a government determines the policy but mandates a non-governmental organization to execute day-to-day management. These governance systems are more open than a top-down governance system. In addition, they can provide long-term financial and technical help – a critical issue for African protected areas with underfunding and lack of capacity. However, critics have raised questions about the ethics of delegating law enforcement, the loss of sovereignty of the state and the perception of protected areas being 'sold' to foreigners (Baghai et al., 2018).

Participatory management theoretically allows for better representation of local communities on the management board, which can improve the attitude of these communities towards conservation (Mutanga et al, 2015). In their global assessment, IPBES (2019) found protected areas that engage with local communities in management to be on average less degraded. However, a participatory approach with too many stakeholders, or not representative of the community, risks diluting conservation goals and increasing corruption and conflict (Sterling et al., 2017).

Different governance and management structures show varying degrees of success in different areas. The local situation will therefore dictate which structure should be applied.

TABLE 3.
CLASSIFICATION SYSTEM FOR MANAGEMENT CATEGORIES AND GOVERNANCE TYPES

	Governance by government	Shared governance	Private governance	Governance by indigenous peoples and local communities
MANAGEMENT	Federal or national ministry or agency in charge	Transboundary governance	Conserved areas established and run by individual landowners	Indigenous peoples' conserved areas and territories - established and run by indigenous peoples
	Sub-national ministry or agency in charge	Collaborative governance (various forms of pluralist influence)	...by non-profit organisations	Community conserved areas and territories - established and run by local communities
	Government-delegated management (e.g. an NGO)	Joint governance (pluralist governing body)	...by for-profit organisations (e.g., corporate land owners)	

Source: adapted from Worboys et al. (2015).

What is the strategy for biosphere reserves at the global level?

There are a number of key documents on historical implementation, monitoring, evaluation and improvement of the Man and the Biosphere Programme (**Figure 22**).

FIGURE 22.
KEY DOCUMENTS, STRATEGIES AND ACTION PLANS OF THE MAN AND THE BIOSPHERE PROGRAMME

The first action plan established the basics of what it means to be a biosphere reserve.

Approved by the General Conference of UNESCO.

Implemented the Statutory Framework of the World Network of Biosphere Reserves, presenting - among others - the criteria that need to be met to become a biosphere reserve.

Aimed to re-establish biosphere reserves as the main internationally designated areas dedicated to sustainable development in the twenty-first century.

Identified three key challenges of the twenty-first century: urbanization, climate change and biodiversity degradation.

Presented a set of actions aimed at ensuring the effective implementation of the MAB Strategy 2015-2025.

Placed a strong emphasis on thriving societies in harmony with the biosphere for the achievement of the Sustainable Development Goals (SDGs).

Main challenges in African biosphere reserves

BOX 11.
WHAT ARE THE MAIN MANAGEMENT CHALLENGES IN AFRICAN BIOSPHERE RESERVES?

During the 2017 meeting of AfriMAB in Nigeria, 22 participants were asked to complete a two-round Delphi survey (following Mukherjee et al., 2015), in order to identify the main management challenges in African biosphere reserves. The results are presented in **Table 4**.

TABLE 4.
MAIN MANAGEMENT CHALLENGES IN AFRICAN BIOSPHERE RESERVES

CHALLENGE	CONSENSUS LEVEL
Inadequate financial resources	90%
Pressure from human activities	70%
Limited capacity (e.g. human resources)	55%
Unavailability of data to support management	55%

'The main one is that some of **the land is privately owned**, but it's under the national park's authority. The other land is owned by big investors, so making everyone respect the policies in place is difficult. There are contradictions between one operator, and the other. So it becomes very complicated to manage the natural resources.'

Dr Noelia Myonga, Senior Assistant Conservation Commissioner, Lake Manyara National Park (Lake Manyara Biosphere Reserve, Tanzania)

'Institutional challenges like **capacity and institutional organizations**. For example, in Ethiopia, the MAB National Committee is established to communicate with UNESCO and to decide on issues of biosphere reserves such as nominations or action plans. The challenge is that, so far, in Ethiopia, there is no formalized institutional structure within the government sector. The MAB Committee alone won't be successful in managing the biosphere reserve unless sectorial offices have their own structure at the federal and regional governments.'

Motuma Didita, Ethiopian MAB Committee

'There is no proper **land use system** around the biosphere reserves. People are in a hurry to develop, so they end up encroaching on areas that should have been conserved. This is coupled with high population density and poverty around these biosphere reserves.'

Fredric Kizza, Chief Warden, Mount Elgon Conservation Area (Mount Elgon Biosphere Reserve, Uganda)

BOX 12.
CHALLENGES IN THE LAKE TANA BIOSPHERE RESERVE, ETHIOPIA

Lake Tana is the largest aquatic resource of Ethiopia and the source of the Blue Nile River. The Lake Tana basin and the Blue Nile River also provide economic, social, political, environmental, ecological and religious benefits for downstream eastern Nile countries. However, they face many challenges, especially related to food security and environmental sustainability.

AERIAL VIEW OF LAKE TANA BIOSPHERE RESERVE AND THE BLUE NILE OUTFLOW, ETHIOPIA

© L. Janssens de Bisthoven

The various ecosystems and services are under severe pressure from the following processes:

- soil erosion and land degradation due to overgrazing, deforestation, unsustainable agricultural practices and wetland degradation;
- uncontrolled agricultural expansion to the lake's zone;
- illegal fishing and unregulated overfishing;
- increased trend of eutrophication due to increasing use of fertilizers;
- risk of toxic bioaccumulation in plants and animals of pesticides from agriculture and construction materials;
- environmental pollution, especially domestic and industrial wastes from the growing urban population (Bahir Dar), leading to reduced water quality and diminished possibilities of irrigation with freshwater from the lake during the dry season;
- increasing rainfall variability causing droughts and floods; and
- invasive plants such as the Water Hyacinth.

Root causes of threats include:

- socio-economic and environmental shortcomings such as poverty and population pressures;
- shortage of agricultural land derived from increased human and livestock populations;
- low awareness among communities of ecosystem conservation;
- institutional shortcomings (i.e. giving high priority to short-term economic benefits rather than sustainability issues, including the construction of buildings in the Lake shore areas, which are natural breeding and feeding grounds for certain fish and bird species);
- poor legal enforcement;
- poor organizational and institutional linkages; and
- lack of action research and knowledge building.

Source: Michael Succow Foundation (2012); Berihun (2019); Goshu and Aynalem (2017)

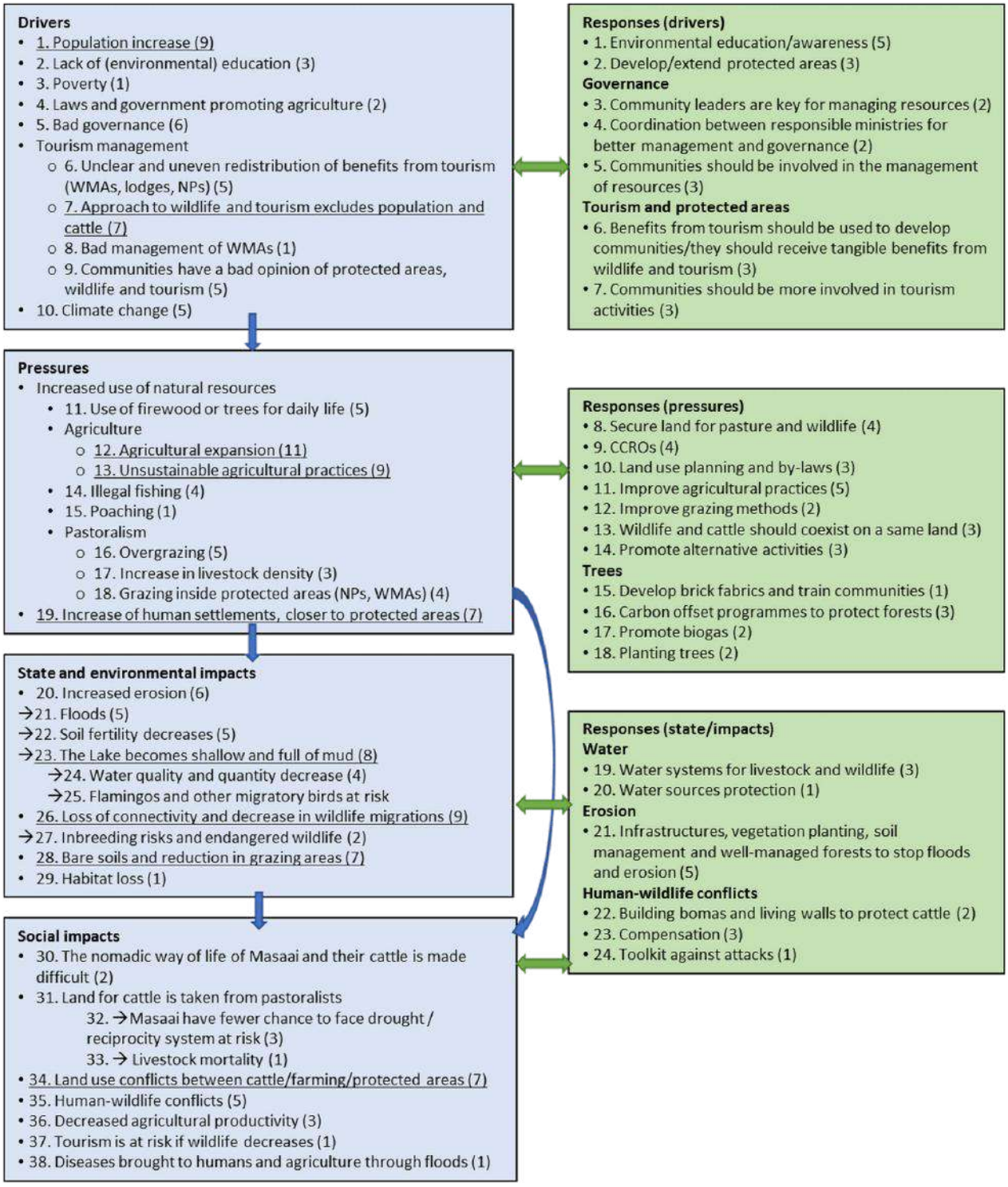
BOX 13.
VISUALIZING THE CAUSE-EFFECT CHAIN OF ENVIRONMENTAL CHALLENGES IN BIOSPHERE RESERVES: THE DPSIR FRAMEWORK

Structuring the challenges that occur in a biosphere reserve into an organized framework may help to better understand their cause-effect chain and existing or potential solutions. The Drivers-Pressures-State-Impact-Response (DPSIR) framework is an analysis approach that describes the interactions between society and the environment. It consists of five interrelated factors:

- **Drivers** – changes in the social, economic and institutional system that directly and indirectly trigger pressures on the environmental state
- **Pressures** – anthropogenic factors inducing environmental change
- **State** – this may range from the characteristics of ecosystems, the quantity and quality of resources, living conditions for humans, to even larger socio-economic issues
- **Impact** – changes in environmental functions affecting social, economic and environmental dimensions, which are caused by changes in the state of the system
- **Response** – actions attempting to prevent, eliminate, compensate or reduce the impacts.

The DPSIR framework may help to identify important relationships and reveal underlying problems. **Figure 23** shows an example for Lake Manyara Biosphere Reserve, based on answers from interviews about environmental challenges in the area (Janssens de Bisthoven et al., 2020).

FIGURE 23.
RESPONSES FROM INTERVIEWS ABOUT ENVIRONMENTAL CHALLENGES IN LAKE MANYARA BIOSPHERE RESERVE, TANZANIA, STRUCTURED USING THE DPSIR FRAMEWORK



Note: The numbers represent responses. Arrows refer to a causality relationship. Green double arrows link responses ('R') to a corresponding 'DPSI' category.

MORE INFORMATION

- Biosphere reserve nomination form
  www.unesco.org/new/fileadmin/MULTIMEDIA/HQ/SC/pdf/biosphere_reserve_nomination_form_2013_en.pdf.
- For official UNESCO MAB documents such as nomination forms, periodic review form, MAB guidance and policies, see
  www.unesco.org/new/en/natural-sciences/environment/ecological-sciences/related-info/publications/mab-official-documents.
- Charter of the African Biosphere Reserves Network (AfriMAB)
  www.unesco.org/new/fileadmin/MULTIMEDIA/HQ/SC/pdf/Final_Charter_AfriMAB_en.pdf.
- MAB Governance https://en.unesco.org/mab/governance.
- An example of a completed periodic review
  www.keskkonnaamet.ee/sites/default/files/periodic_review_2015_toim2017.pdf.
- Protected Areas Governance and Management (IUCN compendium textbook)
  https://press.anu.edu.au/publications/protected-area-governance-and-management.
- Protected area governance and management A resource book for practitioners in development cooperation (GIZ publication)
  https://www.snrd-africa.net/protected-area-governance-and-management.
- ENVISION project: developing an inclusive approach to the management of protected areas, known as 'inclusive conservation', with the aim of improving biodiversity and human well-being
  https://inclusive-conservation.org.
- 'UNESCO–MAB Biosphere Reserves already deal with ecosystem services and sustainable development' (PNAS)
  www.pnas.org/content/pnas/114/22/E4318.full.pdf.
- The World Network of Biosphere Reserves (WNBR)
  https://en.unesco.org/biosphere/wnbr.
- Video about the importance of biosphere reserves:
  www.youtube.com/watch?v=RDVsJJmjUsk&t=20s.