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## Research Article

# Current status, Threats and Strategic solutions for Ethiopia's Biosphere Reserves

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### Article Info

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### Abstract

The biosphere is where all life forms and biotic environments live and interact. Biosphere reserves have different ways in which people live, work and interact with each other and with nature. The main objective of this paper was to assess the current status, risks and develop plans to ensure the longevity of Ethiopia's biosphere reserves. These reserves, recognised by UNESCO's Man and the Biosphere (MAB) programme, are designated areas that promote and showcase the balanced coexistence of humans and nature. Since 2010, Ethiopia has established five biosphere reserves, which are monitored globally by UNESCO. Sheka, Majang, Kafa, Yayu and Lake Tana are home to a wide variety of biological species, with 779,381ha representing just 0.1% of the world's biosphere reserves. These reserves play a key role in resolving conflicts between different stakeholders in a particular landscape through their involvement, participation and cooperation. They are also places where people can access information on sustainable development. Ethiopia's biosphere reserves face challenges such as land use change, deforestation, degradation, logging, agricultural expansion, investment, overgrazing, fuelwood, charcoal and other impacts. The sustainability problems in Ethiopia's biosphere reserves stem from the lack of an effective management strategy and insufficient ownership by the various stakeholders. The government and the community should prioritise the promotion and development of biosphere reserves and establish a management plan for each one. Ethiopia's biosphere reserves play a crucial role in conserving biodiversity. It is important that the government and local communities work together to promote development, establish management plans, involve local people, balance conservation and sustainable use, and provide incentives. In the future, institutional restructuring will need to address issues related to lack of ownership.

**Keywords:** Biosphere, Biosphere Reserves, Man and the Biosphere, Sustainable Development

## 1 Introduction

A biosphere reserve is defined as a place where humans and nature coexist and interact for mutual benefit (Verlag and Jentzsch-Cuvillier, 2009). The biosphere refers to all living things on Earth, the space they inhabit and the life-supporting systems (atmosphere,

hydrosphere) necessary for sustainable life as we know it (Huggett, 1999; Levit, 2011). The biosphere is where living organisms exist and interact. People live, work and interact within biosphere reserves, influencing resource use and future prospects. Cultural di-

iversity is linked to biodiversity (Bridgewater and Babin, 2017; Article, 2017; Pool-Stanvliet and Coetzer, 2020). Ethiopia is rich in biodiversity resources, traditional knowledge and centres of origin and diversity of many biodiversity crops and others. Some of the reasons for diversity are found in Ethiopia's altitude range (116m to 4,620m asl).

The biosphere reserve is a legally protected area where limited human activities are allowed, designated by UNESCO's Man and the Biosphere Programme (MAB). In 1974, a task force of the UNESCO MAB programme developed the concept of biosphere reserves, and the networks were established and launched in 1976 (Kennea, 1975; UNESCO, 2020). The MAB International Coordinating Council (MAB ICC) designates biosphere reserves (Hedden-dunkhorst and Schmitt, 2020). Under UNESCO's Man and Biosphere (MAB) programme, the first biosphere reserves were designated in eight countries in 1976 (Van Cuong et al., 2017). The biosphere is the part of the Earth occupied by living organisms, where living systems use and transform non-living or abiotic materials, forming a regenerative unit (Danilov-Danil'yan et al., 2009). Several biosphere reserves around the world are currently being studied from different perspectives. Today, the global number of biosphere reserves has doubled to 738 reserves in 134 countries (UNESCO, 2020; Pool-Stanvliet and Coetzer, 2020).

The biosphere reserve protects biodiversity and genetics and supports ecological and environmental research and education (Wehrden, 2020). International guidelines for biosphere reserves have also been established (Raszka and Heldak, 2023). The conservation objectives of biosphere reserves include biodiversity and cultural richness, economic and social development, and logistical support for research and education, all of equal importance (UNESCO, 2020). Ethiopia is a key hub of rich biodiversity hotspots worldwide, with diverse physiographic, attitudinal, climatic and edaphic systems that support a wide variety of habitats and indigenous flora and fauna (Kelbessa, 2005; Sewale and Mammo, 2022); due to its extensive geographical range, Ethiopia stands as a core of biological diversity (Kelbessa, 2005).

Interdisciplinary approaches to understanding and managing change and interactions between social and ecological systems are being tested in different locations. Different strategies for conflict prevention and biodiversity management are being explored. However, many challenges have been encountered in all of Ethiopia's biosphere reserves. These include unclear land use policies related to natural resource management and conservation, deforestation, degradation, logging, agricultural expansion, investments, mega-projects, overgrazing, firewood, charcoal and other factors. It is essential that government and communities prioritise the promotion and development of biosphere reserves and develop specific management plans for each one. The main objectives of this review paper are to assess the current status, threats and strategic solutions in the biosphere reserve area of Ethiopia.

## 2. Methods

The literature review methods included reading, analysing, evaluating and summarising scientific literature (journals and articles) on the current status, threats and strategic solutions for Ethiopia's biosphere reserves. A systematic approach was adopted for this study to ensure a comprehensive understanding of the key issues surrounding Ethiopia's biosphere reserves. The literature review was conducted using various academic databases and search engines to gather relevant information published in different years. The identified literature was then carefully reviewed to extract valuable insights and perspectives on the topic. This process helped to identify the current status, prominent threats and potential strategic solutions for enhancing the conservation and sustainable management of Ethiopia's biosphere reserves.

## 3. Results and discussion

### 3.1 The Status of Biosphere Reserve Area

#### 3.1.1 Global history of biosphere reserves

The United Nations Educational, Scientific and Cultural Organisation (UNESCO) initiated the Man and the Biosphere (MAB) programme in 1971 with the aim of improving the relationship between people and their natural environment. The programme focuses on a human-centred approach to conservation, emphasising the interaction, cooperation and trade-offs between 'conservation' and 'use' of the environment. It also establishes links between people and nature to achieve development goals, implemented in areas designated as biosphere reserves (Pool-Stanvliet and Coetzer, 2020).

The first country to establish and register biosphere reserves was the Democratic Republic of Congo in 1976, and the first biosphere reserve was established at Yangambi, home to 32,000 species of trees and endemic species such as forest elephants (*Loxodonta cyclotis*) and red river dolphins (*Potamochoerus porcus*). The Yangambi Biosphere Reserve supports activities such as sustainable agriculture, hunting and mining. One of the newest biosphere reserves is the Yayu Coffee Forest Biosphere Reserve in Ethiopia. The area is mainly used for agriculture, where crops such as honey, timber and fruit are regularly cultivated, and covers 243,755 hectares (Mammadova et al., 2022; Alborzi Manesh et al., 2023). UNESCO designated 11 new biosphere reserves in 9 countries in 2023, including Chad, Georgia and Zambia for the first time. Spain also extended two existing reserves. This action brings the total number of biosphere reserves in the global network to 738 sites in 134 countries (Ishwaran, Persic and Tri, 2008).

There has been an almost linear increase in the establishment of biosphere reserves from 1976 to 2018. Due to the desire to achieve sustainable development, countries understand the benefits of biosphere reserves in the conservation and sustainable management of forest

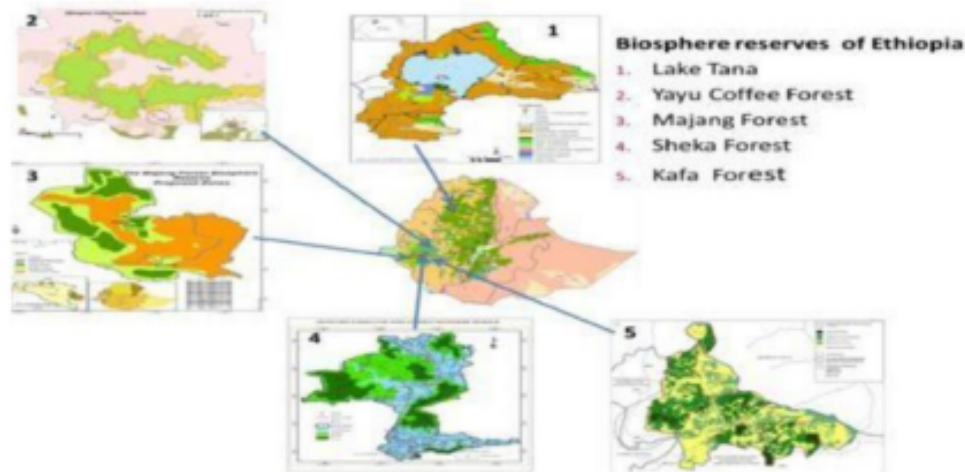


Figure 1: The Global History of Biosphere Reserves. Source: UNESCO, 2021.

resources (Reed, 2016). Different studies around the world have reported different statistical figures for biosphere reserves (Figure 1).

There are currently 738 biosphere reserves in 134 countries, with 22 transboundary sites designated at the global level (Bridgewater and Babin, 2017; Article, 2017; Pool-Stanvliet and Coetzer, 2020). The reported differences between 2002 (411 biospheres and 94 countries) and 2021 indicate an increase of 327 biosphere reserves (79.5%) and 40 countries (42.5%).

### 3.1.2 Biosphere reserves and other protected areas

Biosphere reserves are large areas that include national parks and wildlife sanctuaries. They create a high proportion of natural habitats with constitutional protection under specific policies and arrangements (Table 2) (Reed, 2016).

### 3.1.3 History of Ethiopia's Biosphere Reserves

A biosphere reserve is a collection of ecosystems (Bridgewater and Babin, 2017; Article, 2017). It is a place where people live, work and interact with each other (and with nature) in many ways (König et al., 2022). Biosphere reserves are a much broader concept than protected areas; they act as living laboratories for sustainable development (Wehrden, 2020). The biosphere reserve is a special region; not only the wildlife, but also the landscape, culture and people living there make the region deserving of the UNESCO designation (Vaňová et al., 2023). The biosphere reserves balance environmental protection and sustainable development (Bridgewater and Babin, 2017); and are learning places for sustainable development (Ayalew and Alemu, 2021; Clüsener-Godt, 2016).

Ethiopia's biosphere reserves are established and recognised by UNESCO's Man and the Biosphere (MAB) programme to promote and demonstrate balanced relationships between people and nature.

Ethiopia has five globally recognised sites, namely Kafa Biosphere Reserve, nominated in 2010, Yayu Biosphere Reserve, nominated in 2010, Sheka Biosphere Reserve, designated in 2015, and Majang Biosphere Reserve, designated in 2017 (Tadese et al, 2021), on plant diversity, challenges and conservation efforts in the Majang, Kafa, Sheka and Yayo Biosphere Reserves in southwestern Ethiopia (Dresen, 2011; Ayalew and Alemu, 2021; Tadese et al., 2021; chuit et al., 2021; Birhanu and Faris, 2022). Ethiopia's biosphere reserves cover approximately 779,381 hectares, representing 5.6% of Africa and 0.7% of the world.

#### 3.1.3.1 Majang forest biosphere reserve

The Majang Forest Biosphere Reserve is located in the Majang Zone of the Gambella National Regional State, which was established in June 2017. The size/area of the biosphere reserve is 225,490 hectares (Ayalew & Alemu, 2021). It comprises four ecological zones: wet afro-montane forest, transitional rainforest, cocoprete-terminalia forest, wetlands, a lake and numerous rivers (Dresen, 2011). The biosphere reserve is home to a wide variety of plant and animal species. It plays a crucial role in conserving the genetic diversity of many useful plants, especially ensete (*Ensete ventricosum*) and yam (*Dioscoria bulbifera*). More than 130 bird species have been recorded in the region. Notable mammal species found here include leopard (*Panthera pardus*), caracal (*Felis caracall*), colobus monkey (*Colobus guereza*) and anubis baboon (*Papio anubis*). It is home to 39 threatened species on the IUCN Red List, including 5 birds, 3 mammals, 3 amphibians and 28 plant species. The Kafa Coffee Biosphere Reserve (Dresen, 2011) faces challenges such as illegal logging, urbanisation, commercial interests and lack of public awareness.

Table 1: The difference between biosphere reserves and other protected areas

Protected Areas	Biosphere Reserves
<p>One type of land</p> <ul style="list-style-type: none"> <li>• A single category of land, usually relatively small in size and managed for a single purpose (e.g., nature conservation)</li> </ul> <p>One type of objective and function conservation</p> <p>One main category of interests</p> <ul style="list-style-type: none"> <li>• Natural</li> <li>• Landscape</li> <li>• Cultural</li> <li>• Historical</li> </ul> <p>One manager</p> <p>Well identified, directly in charge of the management of the territory</p>	<p>A mosaic of different types of land</p> <ul style="list-style-type: none"> <li>• Several categories of land, generally managed for different purposes (conservation, development, etc.)</li> </ul> <p>Overlapping of different types of objectives and functions • conservation, development, logistical support</p> <p>Multitude of interests</p> <ul style="list-style-type: none"> <li>• Often conflicting: farming, forestry, fisheries, tourism, science, local and national government</li> </ul> <p>Several managers</p> <p>Working more or less independently without consultation</p>
<p>Simple zonation</p> <p>Protection through regulation</p> <p>Management plan</p> <ul style="list-style-type: none"> <li>• Single planning scenario applied to a well-defined land area</li> </ul> <p>Single ecosystem approach</p> <p>Populations, ecosystem functioning</p> <p>Manager</p>	<p>Complex zonation</p> <ul style="list-style-type: none"> <li>• Three zones, transition area without demarcated outer limit</li> </ul> <p>Various means of protection</p> <ul style="list-style-type: none"> <li>• Regulation limited to the core areas, existence of management agreements or contracts</li> </ul> <p>Guide to Biosphere Reserve coordination harmonization of different planning scenarios for different areas in line with Biosphere Reserve concept; emphasis on local participation</p> <p>Landscape approach</p> <p>Complex of ecosystems</p> <p>Coordinator</p>

Table 2: \*

Source: (Bioret, 2001)

### 3.1.3.2 Kafa forest biosphere reserve

In 2010, the Kafa Biosphere Reserve was established in the Kafa Zone. The reserve covers an area of 540,631 hectares (Ayalew & Alemu, 2021). It is home to Ethiopia's remaining moist evergreen montane forests and lies within the Eastern Afromontane Biodiversity Hotspot. The wild coffee tree, *Coffea arabica*, grows naturally in the understorey of Kafa's montane forests and is occasionally harvested without proper management (Leßmeister et al., 2017). It is a biodiversity hotspot in the eastern mountains, with cultural and historical significance, caves and waterfalls, and a genetic pool for coffee arabica (Dresen, 2011; Fashing et al., 2022). The Institute for Biodiversity Conservation claims that the biosphere reserve contains a variety of habitat types. The distribution of these categories in the Kafa Biosphere Reserve is as follows. In 2009, an application for the Kafa Biosphere Reserve was submitted.

### 3.1.3.3 Yayu coffee biosphere reserve

Yayo (161,021 ha) is the largest area covered by a biosphere reserve in Ethiopia. Located in the Oromia Regional State, Ilu Abba Bora in southwestern Ethiopia was designated a biosphere reserve in 2010 (Birhanu and Faris, 2022). It is a biodiversity hotspot of cultural and

historical significance, home to Arabica coffee, caves, waterfalls and an Arabica coffee genetic pool. The Biosphere Reserve nomination form indicates that a total of 450 higher plant species, 50 mammals, 200 birds and 20 amphibian species have been reported. More than 100 species of plants, birds and mammals are endemic to the area (Tadese et al., 2021). Challenges in the area include lack of integration between institutions and sectors, changes in land use such as mining, logging and fertiliser industries, and unsustainable demand and exploitation of natural resources by local communities surrounding the biosphere (Fashing et al., 2022).

### 3.1.3.4 Sheka forest biosphere reserve

The Sheka Forest Biosphere Reserve, located in the Sheka Zone of the Southwestern Regional State of Ethiopia, was established in 2012 and covers an area of 238,750 hectares. The forest in Sheka, which is also part of the Southwest Highlands Forests of Ethiopia, is important for the conservation of Afromontane forest vegetation types, particularly Afromontane rainforest and alpine bamboo thickets. Afromontane forest vegetation has long been considered one of the most threatened ecoregions in the world. There are two types of ecosystems found there: the wet atofontane forests and environments, alpine bamboo thickets, wetlands, 300 higher plant species,



Table 3: Biosphere Reserves in Ethiopia

Name of BR	Year of Nominated	Region	characterize
Kafa	2010	SWERS	Forest
Yayu	2010	Oromia	Forest
Sheka	2012	SWERS	Forest
Lake Tana	2015	Amhara	Lake
Majang	2017	Gambella	Forest

Table 4: \*

Source: (Tadese et al., 2021). NB: SWERS=Southwest Ethiopia Regional State

50 animal species, 200 bird species, 20 amphibian species and 55 endemic plant species (Tadese et al., 2021). It is under significant pressure from increasing changes in plantations, settlements and agriculture (Birhanu & Faris, 2022).

### 3.1.3.5 Lake tana biosphere reserve

The lake's great biodiversity has led to its inscription on the UNESCO World Heritage List (Anteneh, 2020). Lake Tana, the largest biosphere reserve in Ethiopia, is located in northeastern Ethiopia in the Amhara region (Ayalew and Alemu, 2021a). The presence of 67 different fish species was confirmed in 2015, 70% of which are endemic. It is one of the biodiversity hotspots of the East African Mountains. This area is known for its biodiversity and is globally recognised as an important bird area, as well as being of global importance for agricultural genetic diversity (Fashing et al., 2022; Ayalew and Alemu, 2021). Invasive species such as water hyacinth could pose a threat to the Biosphere Reserve.

Lake Tana and Kafa are the two largest biosphere reserves among Ethiopia's five biosphere reserves in terms of size, covering 695,885ha (37.3%) and 540,631ha (28.9%), respectively (Fig. 3).

### 3.1.4 The objectives of biosphere reserve

Biosphere reserves aim to increase capacity, conserve biodiversity and promote sustainable development (Wehrden, 2020). These reserves also aim to protect and conserve various unique systems that are essential for biodiversity. They include developing and adapting management strategies for biosphere reserve areas, stabilising and promoting rural areas by ensuring economic, social and demographic stability, promoting sustainable tourism, enhancing inclusive participation of all people, promoting and strengthening cultural identity, and maintaining and enhancing conservation activities of biosphere reserve areas (Hedden-Dunkhorst and Schmitt, 2020).

UNESCO biosphere reserves exemplify sustainable development by protecting biodiversity, promoting regional marketing, encouraging low-impact tourism and promoting environmentally friendly agriculture. They also prioritise education, research and global interaction (Ishwaran, Persic and Tri, 2008). The common goal of conservation and positive development in biosphere reserves serves economic, social, political, environmental and cultural objectives.

Through the promotion of ecotourism, ecosystem services, cultural identity, network development, research, statistics and education for sustainable development (Clüsener-Godt, 2016).

### 3.1.5 Biosphere reserves' functions

Biosphere reserves are essential for the conservation of larger areas surrounding national parks (Society and Cooperation, 2015). They offer hope to local communities and indigenous peoples by providing opportunities to improve their livelihoods (Ishwaran, Persic and Tri, 2008). These reserves aim to address conflicts between different stakeholders in a given environment through stakeholder participation, engagement and cooperation (Hedden-dunkhorst and Schmitt, 2020). The key functions of biosphere reserves include conserving culture and biodiversity, promoting economic and human development, and supporting research, monitoring and information exchange related to conservation and development at local, national and global levels (Tadese et al., 2021). The three basic functions of biosphere reserves are

- Protective function:** The dynamics of natural ecosystems (largely unaffected by human intervention) and habitats close to natural habitats (cultural landscapes with traditional land use) are kept intact by a biosphere reserve (Tian et al., 2016).
- Development function:** Ecological and human development within biosphere reserves is ensured to be socio-culturally and environmentally sustainable through the implementation of exemplary approaches to environmentally sound land use with the local population. Development objectives are adapted to ecological and socio-economic conditions and opportunities for sustainable development are provided that are appropriate to the region (Hedden-dunkhorst and Schmitt, 2020).
- Logistical support:** Logistics functions include support for demonstrations, environmental education, training and research related to local, regional, national and global development (Tian et al., 2016; Hedden-dunkhorst and Schmitt, 2020; Ayalew and Alemu, 2021b; Items et al., 2022). It also supports sustainable development based on local community initiatives and robust research (UNESCO, 2020).

Table 5: Size of Ethiopia's biosphere reserve zones

Name of BRs	Core (ha)	Buffer (ha)	Transition (ha)	Total (ha)
Yayu	27,733	21,552	117,736	167,021
Majang	43,878	73,400	108,212	225,490
Sheka	55,255	76,395	107,100	238,750
Kafa	41,319	161,427	337,885	540,631
L.Tana	22,841	187,567	485,477	695,885
total	96,574	237,822	444,985	779,381

Table 6: \*

Source: Ayalew and Alemu, (2021)

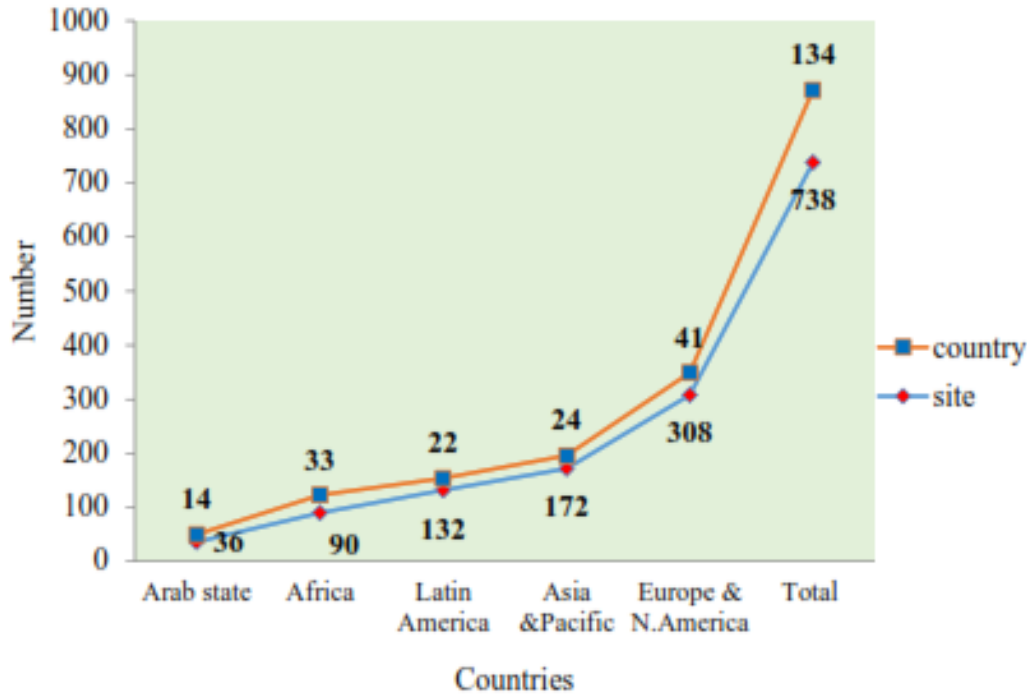


Figure 2: Size of Ethiopia's Biosphere reserves (%). Source: Birhanu and Faris, (2022)

### 3.1.6 Zones of Biosphere Reserve Area

A biosphere reserve is a legally established core area dedicated to the long-term protection of biodiversity. These reserves protect and serve as a place for environmental experts, decision-makers, scientific societies, management practitioners and stakeholder communities to work together (Tian et al., 2016). Landscape conservation is achieved by preserving ecosystems, endemic species, genetic diversity, biodiversity and cultural diversity in the three biosphere reserves (Deutsches Nationalkomitee MAB. and Unesco., 2005). Each part of the landscape in a biosphere reserve has its own conservation, management and development functions, categorised according to the level of human activity.

a) Core Zone: A core or national zone is an intact and legally protected ecosystem that serves as the most secure area within a biosphere reserve (Ayalew and Alemu, 2021). It is a key component of the biosphere reserve where all forms of human activity are prohibited, except for scientific research and monitoring of natural vege-

tation changes, typically within a national park where natural processes can unfold without human interference (Tian et al., 2016).

b) Buffer Zone: The area surrounding the core zone is typically affected by human activities, but still serves as a habitat for animal and plant species unique to the region. The core zone itself allows limited human involvement, with land use carefully regulated to prioritise biodiversity conservation (Birhanu and Faris, 2022). Scientific management is used to improve resource use strategies and to conduct research on various aspects of conservation ecology and education in the area (Ayalew and Alemu, 2021).

c) Transition zone: The transition zone is the outermost area of a biosphere reserve where reserve management establishes a positive relationship of activity and cooperation with local communities and tribes. This allows for activities such as settlement, agriculture, grazing, forestry and other economic activities, as well as recreation. It is also a place where traditional forest coffee production systems, garden coffee, agricultural practices and human settlements are allowed. The promotion of environmentally and socially sustainable

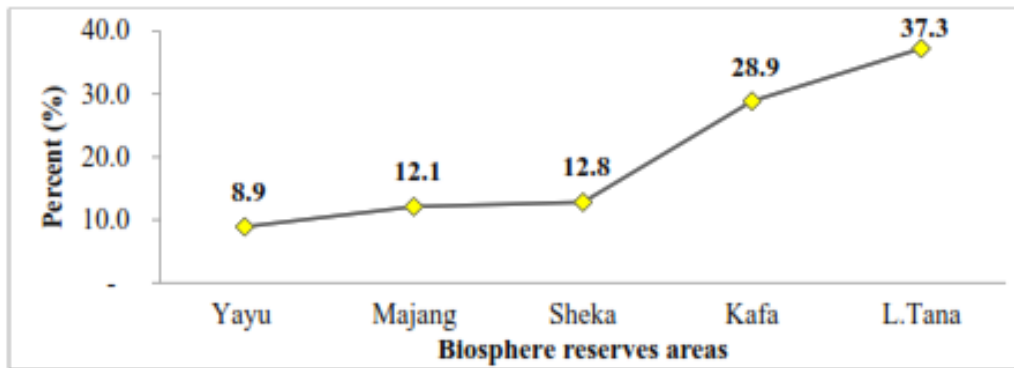


Figure 3: size of Ethiopia's Biosphere reserves (%). Source: Birhanu and Faris, (2022)

Table 7: Biosphere Reserve Designation Objectives

Designation	Objectives
Biosphere Reserve	Fostering the harmonious integration of people and nature for sustainable development through participatory dialogue, knowledge sharing, poverty reduction, human well-being improvements, respect for cultural values, and by improving society's ability to cope with climate change Biosphere reserves represent a unique tool for international cooperation through the exchange of experiences and the promotion of best practices.
World heritage site	International recognition of sites that have outstanding cultural, historical, scientific, or other international significance and universal value
UNESCO Global Geo-park	promotion and conservation of the planet's geological heritage, as well as encouragement of sustainable research and development by the communities concern
Ramsar site	Provision of national action and international cooperation regarding the conservation of wetlands of international importance (especially those providing waterfowl habitats and wise sustainable use of their resources).

Table 8: \*

Source: Pool-Stanvliet and Coetzer, (2020)

forms of production and consumption is at the forefront (Tian et al., 2016.; Birhanu and Faris, 2022).

The management policy or plan of biosphere reserves must consider zonation and address all zones equally and appropriately. They play a crucial role in poverty reduction and the implementation of Sustainable Development Goals (SDGs) due to their significant impact on socioeconomic issues (Birhanu and Faris, 2022).

### 3.2 Ethiopia's Biosphere Reserves in Managing Biodiversity

Biodiversity is essential to the processes that support all life on Earth, including humans. Without a wide variety of animals, plants and micro-organisms, we would not have the healthy ecosystems we rely on to provide the air we breathe and the food we eat. Humans also value nature, and forests contribute to climate change mitigation as important carbon stores (Tadese et al., 2021).

In Ethiopia, tropical biosphere reserves such as Sheka, Majang, Kafa, Yayo and Lake Tana are rich in biodiversity (Tadese et al.,

2021). They contain a wide variety of plants, including coffee, spices and medicinal plants. Protecting the entire ecosystems of biosphere reserves is key to ensuring in situ biodiversity conservation (Verlag and Jentzsch-Cuvillier, 2003). Biosphere reserves reconcile nature conservation with economic development, facilitate ecosystem services such as the provision of clean water, and maintain agricultural microclimates (Wehrden, 2020).

Governments around the world are increasingly promoting measures to protect biodiversity. In addition to securing economic prosperity and various facets of human wellbeing such as health, social connectedness and cultural values, it is crucial to protect and maintain natural ecosystems. Conserving biodiversity requires effective human management of the biosphere to maximise benefits for the present generation and enhance its capacity to meet the needs of future generations (Mackinnon et al., 2020). Forests promote an integrated approach and are well placed to contribute to the implementation of biodiversity (Biodiversity, 1996). Forest ecosystems play a role in biodiversity conservation. In other words, they are biodiversity hotspots of global interest (Manley et al., 2006).

The Biosphere Reserve Programme promotes sustainable development, integrated science and conservation of biological and cultural

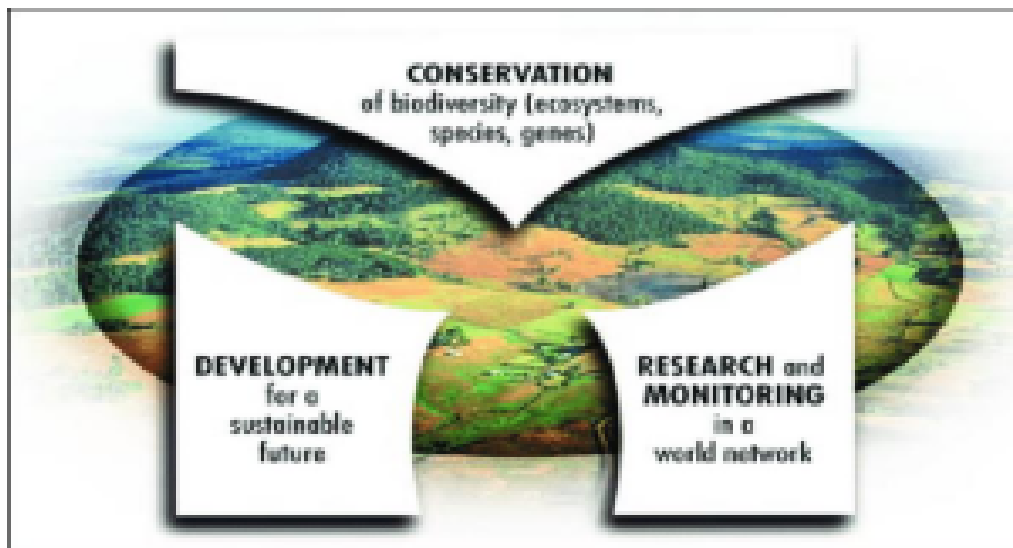


Figure 4:

diversity through partnerships between people and nature (Hedden-dunkhorst and Schmitt, 2020). Biosphere reserves protect cultural diversity by supporting local and indigenous forms of production and consumption, educating us about how human interventions affect ecosystems and habitats and vice versa, providing opportunities for organic agriculture and ecologically adapted forest management, assisting in peace-building, especially across borders, connecting ecologically significant areas for biodiversity, and acting as educational centres for regional, national and international exchange to promote sustainable development and bridge cultural and biological diversity for the betterment of nature and humanity (Clüsener-Godt, 2016). Majang (550), Yayu (450), Sheka (300), Kafa (224) and Lake Tana (179) were identified as the areas with the highest number of plant species, showing a diversity of plant life based on various research studies (Table 2).

### 3.3 Threats /challenges towards the sustainable management of Biosphere Reserves

Biosphere reserves are threatened by a variety of human-induced factors. The traditional approach of forest-based or in situ conservation, which depends on zoning, is inappropriate due to limited government resources. The control of local communities' activities has a poor track record (Amogne, 2014). Biosphere reserves work towards a natural harmony between man and nature (Hedden-dunkhorst and Schmitt, 2020).

Conservation efforts have been significantly hampered by a lack of administrative focus, the absence of integrated natural resource management strategies and programmes, and insufficient commitment by the relevant authority to implement natural resource goals and strategies (Verlag and Jentzschcuvillier, 2009; Bires and Raj, 2019). Changes in land use, influenced by climate change and social factors, pose a significant threat to sustainable land use and ecosystem functionality worldwide (König et al., 2022). Human activities can

have negative impacts on ecological diversity if not managed sustainably (Tesfu et al., 2018). The main direct threats to biodiversity in Ethiopia include habitat conversion, unsustainable exploitation of biodiversity resources, invasive species, displacement of local varieties and breeds, climate change and pollution (Tesfu et al., 2018). Unstable security and demographic conditions, expansion of large-scale agricultural plantations, weak governance structures and integration, inadequate control of corruption in management, mining and conflicts between local communities have significant impacts on biosphere reserves (Gesellschaft und Zusammenarbeit, 2015). Land use, deforestation and degradation, agricultural expansion, investment, overgrazing, fuel wood and charcoal production all contribute to the condition of Ethiopia's biosphere reserves (Ayalew and Alemu, 2021; Mammadova et al., 2021).

Most biosphere reserves have indicated that their budgets are insufficient, yet they need to be protected (Ali et al., 2022). Currently, a large number of species are threatened with extinction as a result of unsustainable resource use (Society and Cooperation, 2015). Deforestation and forest degradation in the southwestern biosphere reserves have led to a rapid decline in forest cover, mainly due to various factors. Investors have leased forest land for coffee, tea and spice plantations, resulting in heavy exploitation through logging and agriculture. This has led to a lack of focus on sustainable resource use in the biosphere reserves (Tadese et al., 2021; Ayalew and Alemu, 2021).

Deforestation leads to the loss of wild populations or the isolation of populations (Verlag and Jentzsch-Cuvillier, 2003). Agricultural expansion is ignored in the development of management strategies to mitigate its impact on ecosystems or biosphere reserves (Connelly and Shapiro, 2006); however, the causes of deforestation in all biosphere reserves have been largely subordinated to investment and agricultural expansion (Birhanu and Faris, 2022). Changes in land cover and land use lead to biodiversity loss or ecosystem degradation; production systems often threaten natural biodiversity due to their high land use intensity (Ali et al., 2022). Furthermore, climate



Table 9: Species composition of the Ethiopia Biosphere Reserve

Species	Yayo	Lake Tana	Majang	Kafa	Sheka
Higher Plants	450	179	550	224	300
Mammals	50	16	33	300	50
Birds	30	300	180	474	246
Reptiles	10	35	20	10	8
Amphibians	20	19	20	7	20
Fishes	0	67	0	6	0

Table 10: \*

Source Birhanu and Faris, (2022), Tadese et al., (2021; Ayalew and Alemu, 2021, Pool-Stanvliet and Coetzer, (2020))

change is now one of the world's greatest challenges, affecting all aspects of life as well as biosphere reserves; it affects all areas (Mack et al., 2021); and human encroachment is at its doorstep (Tesfu et al., 2018).

### 3.4 Sustainable Management Measures of Biosphere Reserves

The biosphere reserve can reduce threats by collaborating, coordinating and integrating with different actors in the area through cross-sectoral cooperation. This improves the livelihoods of communities and contributes to the sustainable management of the biosphere reserve (Tadese et al., 2021). Implementation strategies can preserve ecological knowledge, protect local culture, facilitate community-based learning and research, and adopt a scale of social organisation and governance that is appropriate for ecological learning and local adaptation, integrating conservation with the improvement of local livelihoods (Hedden-dunkhorst and Schmitt, 2020).

Sustainable development aims to find solutions for managing the resources of this planet to ensure a decent or clothed life, both globally and for centuries to come (Ishwaran, Persic and Tri, 2008). The biosphere reserve uses conservation as an open system as its primary approach to conservation. Monitoring, awareness raising and training of people in biosphere reserves are necessary to sustain the use of researchers, research and impact assessment of research, which requires both residents and managers (Ayalew and Alemu, 2021). Conserving biosphere reserves, reducing human pressure on ecosystems, and restoring ecological structures and processes are necessary to improve the overall functionality and health of the system (Mack et al., 2021). The establishment of a protected area is one of the conservation mechanisms used by the government to reduce forest conversion and a biosphere reserve is controlled and managed by both the community and the government (Tadese et al., 2021).

An image of the UNESCO World Biosphere Reserve designation will be known or famous to the local community and visitors who value this global award. The strategy of the biosphere reserve has been supported by a change in behaviour due to the strong brand of the area (German National Committee MAB. and Unesco., 2005). Monitoring, awareness raising and training of people in biosphere reserves can be beneficial for both the population and the administrators (Birhanu and Faris, 2022). UNSECO's Man and Biosphere

Reserve is considered a good conservation strategy for the sustainable use and conservation of plant genetic resources. This approach allows for the classification of the forest landscape where the target genetic resources are found in different management zones.

To achieve conservation goals, people should allow non-damaging uses in certain areas while protecting core areas of the reserve (Verlag and Jentzsch-Cuvillier, 2003). The government and communities should establish conservation mechanisms to maintain a protected area and biosphere reserve while reducing forest conversion (Tadese et al., 2021). Sustainable landscape governance and management of biosphere reserves should be achieved through the use of governance, adaptive management, information, communication and capacity building elements, together with multi-stakeholder participation and engagement components (Hedden-dunkhorst and Schmitt, 2020).

## 4 Conclusion and Recommendations

Biosphere reserves are areas where life forms and biotic environments interact, with the aim of protecting biodiversity and sustainable use of land and natural resources. Established in 1976 by UNESCO's Man and the Biosphere Programme, they promote human involvement and enhance conservation efforts. Challenges include lack of government focus, inadequate natural resource management policies, security issues and conflicts between local communities. Conservation strategies include sustainable conservation, research and impact assessment, with effective coordination between stakeholders. Efforts to address these challenges include capacity building for local communities, education programmes on sustainable practices, and partnerships with non-governmental organisations. By engaging with stakeholders and implementing innovative solutions, biosphere reserves can continue to play a vital role in safeguarding our planet's biodiversity for future generations.

Government and communities must prioritise the promotion and development of biosphere reserves. A strong management plan should be developed for each group to promote stakeholder ownership. It is essential to involve local communities and stakeholders in planning and management. Sites should implement strategies that balance conservation and sustainable use. Providing incentives for conservation and sustainable practices can help reduce pressure on protected

areas. Supporting communities through employment opportunities, agriculture and increased productivity is essential. The management of biosphere reserves involves dealing with multiple institutional mandates. Inadequate management often results from a lack of ownership. Institutional restructuring will be needed in the future.

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