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Rapid economic valuation of ecosystem services in man and biosphere reserves in Africa: A review

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ABSTRACT

Ecosystem services (ESs) include the benefits people receive from ecosystems that support the socio-economic requirements and human well-being. The Man and Biosphere (MAB) programs are a scientific plan in the African context that is linked to governments and attempts to create a systematic ground to enhance the relationship between individuals and their environments. Using economic valuation methods, the main objective of this study was to perform a systematic review on studies undertaken in African countries in order to expose the role of MAB programs in conserving ESs in these countries. Based on the results, MAB programs offer both the protection of cultural ecosystem services and the improvement of livelihoods. Moreover, the MAB programs enable biosphere reserves to help national governments find solutions to the pressing challenges in Africa. In conclusion, policymakers should be aware of the main goal of ESs valuation approaches. In other words, the main goal should focus on the creation of prevention rather than rehabilitation activities in order to avoid the loss of ecosystem services mainly at the cost of users. Overall, the findings of this study underlined that economic valuation methods should provide evidence to underpin the development of policy instruments for the conservation of ESs in African countries. More importantly, ESs conservation strategies should consider various measures to reduce human impacts while also considering their well-being. In this context, the study's main implication is that human well-being is determined not only by the quantity but also by the quality of ESs.

1. Introduction

A great deal of policy movement and research efforts are currently focusing on ecosystem services, which have been clarified as the benefits of ecosystems for everyone (Fisher et al., 2014; Iqbal, 2020; Rosa et al., 2020). This evolutionary approach to nature encourages a new mindset on the environmental contribution to human well-being (Bolzonella et al., 2019; Daily and Matson, 2008; Prentice et al., 2019). Ecosystem services (ESs) are defined generally as services provided by the natural environment that benefit people in all societies. ESs produce outputs or effects that have a direct and indirect impact on human well-being, culture, and the global economic system (Feng et al., 2018; Ma et al., 2020).

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While ESs are important for everyone's comfort, their help to economic growth is difficult to be measured in monetary terms. As they are not exchanged in trading markets, they are usually considered less important or unimportant in policy-making. The key factor in achieving the desired economic results and the probability of sustainable economic benefits for a project is economic analysis. Therefore, the last choices may favor the results that ESs really have marketing importance, replacing the unsuitable use of ecosystems with more cost-effective ones in a limited amount of time (GIZ, 2012; Ma et al., 2020).

The valuation of ESs is an approach to support decision making that involves the environment (trade-offs between production and environmental conservation). It measures the advantages presented by ecosystems and the effect of ecosystem adjustments on the comfort of everyone. Thus, monetary values must be taken into account when creating economic decisions. The supporters of ecosystem service estimation believe that estimations can: (i) enhance our perception of difficulties and possible arrangements, (ii) be applied precisely to make choices, (iii) show profit allocation and thus help cost-sharing administrative actions, and (iv) encourage making creative organizational and market devices that support viable ecosystem administration (Arowolo et al., 2018).

As discussed above, economic analysis and monetary valuations can have an impact on a wide range of policymaking decisions. However, it is not always clear whether a cost-benefit analysis leads to different and better social choices or is only used to justify policy-driven decisions, opportunism, or non-economic justification (Moore et al., 2011). In the 1960s, UNESCO, as the UN organization responsible for research, created new Man and the Biosphere (MAB) programs to address human-biosphere interactions. It was a revolutionary initiative that aimed to use UNESCO's convening power in education, natural and social sciences, culture, and communication to establish a new understanding of the natural world. MAB created a biosphere reserve by combining a new scientific direction with a creative site-based approach (Bridgewater, 2016). The areas of strategies and programs that are most relevant to the Reserve Program for Man and Biosphere (MAB) include socio-economic development, natural resource use, and biodiversity conservation priorities (AfriMAB, 2013; Bonnin and Jardin, 2009). The AfriMAB network expressed a need to document ESs for MAB reserves in 2013, and the idea of documenting ESs for MAB reserves was born. The lessons learned from the MAB program are all about program creation and management, stakeholder engagement, and systemic failure, according to a review of related studies (e.g., Ishwaran, 2012; UNESCO, 2017). The program has many potentials if it takes the advantage of the changing the landscape of biodiversity research and policy. Because of incoherent perimeters and zoning of protected areas, the concept of biosphere reserve is frequently misunderstood by local populations and ecology professionals. As a result, given the threatened environmental, economic, and social resources of African countries, there is a constant need to prioritize where these resources should be distributed using the MAB programs (Pool-Stanvliet et al., 2018).

In 2017, new guidelines called "global MAB programs" were announced. The importance of biosphere reserves in achieving the global sustainable development goals (SDGs) as well as other multilateral environmental agreements, such as the Aichi Biodiversity Targets were highlighted in the global MAB programs (Pool-Stanvliet and Coetzer, 2020). Currently, new biosphere reserve sites in Africa are nominated at random, resulting in selecting the areas that are not always optimally protected. The lack of any clear objectives or key measures makes it impossible for the concept of biosphere reserve to truly take shape and offer players perspectives. The idea of ESs was unfamiliar to the participants during a general assembly on "Green Economy and Ecosystem Services". They needed to learn more about these ESs issues to be better equipped to handle the MAB sites (AfriMAB, 2017). As a result, it is important to respond to this need by reviewing successful evaluation methods in a number of African MABs (Reed, 2019).

In addition to the need for sustainable socio-economic growth, the need for sustainable use of natural resources, the critical role of ESs, and the need for security are recognized as heterogeneous in the search of longer-term solutions (DEA Biosphere Reserve Programme, 2010; Elbakidze et al., 2013). Moreover, based on TEEB's (2010) study, monetary valuation of the natural environment has increasingly been linked to the concept of ecosystem services. The assessment of ESs, as illustrated by Costanza et al. (1997a, 1997b), Pittini (2011), and Mangi (2016), includes assessing improvements in quality and quantity and their impact on human well-being. Economic valuation aims to meet the monetary public expectations to achieve environmental conversation goals (Defra, 2007; Wangai et al., 2016). As a result, economic valuation approaches' primary goal is to provide sufficient evidence for cost-benefit analysis (Muthee et al., 2017).

ESs include the benefits that people receive from ecosystems (Vilà and Hulme, 2017). They include and socio-cultural programs as well as supporting services required to keep the other services running (Otto et al., 2017). Human health and well-being are dependent on these facilities, which range from the provision of sufficient food and water to disease regulation. Since the causal connections between environmental change and human health are often indirect, displaced in space and time, and based on a variety of modifying forces, they are difficult to understand (Otto et al., 2017; Bogardi et al., 2020). If ESs are no longer sufficient to meet social needs, significant direct human health effects can occur (Dressler et al., 2017). Changes in ESs have an indirect impact on livelihoods, jobs, local migration, and even political and social conflict (WHO, 2018; Rodríguez-Robayo et al., 2020). In this way, ESs contribute to economic well-being in two ways: first, by making contributions to income and well-being generation, and second, by preventing human-made damages. Ultimately, the evaluation of ESs using monetary valuation methods can help: 1) determine whether a policy intervention (which alters the ecosystem condition) provides net benefits to society, and 2) assess liability for the damage to the environment. Furthermore, the use of economic terms (such as economic and monetary valuation methods) has helped us determine the environmental effects of human activities in Africa. Several studies based on African case studies (e.g., Pool-Stanvliet, 2014; Muthee et al., 2017; Hugé et al., 2020) have assessed the efficacy of ESs management and the variables that can be correlated with its success or failure. These studies, on the other hand, are not systematic because they only look at particular management activities or because their conclusions are focused solely on managers' and researchers' opinions. As a result, there is a need to integrate the available studies in order to gain a more comprehensive understanding of the economic valuation methods (monetary and non-monetary techniques) associated with the role of MAB programs in ESs conservation. Using economic valuation methods, the main objective of this study was to perform a systematic review on studies undertaken in African countries in order to expose the role of MAB

programs in conserving ESs in these countries. Accordingly, the second section explains two different views (optimist and pessimist) of MAB programs in Africa as well as two different views (optimistic and pessimistic) of ESs valuation methods. The third section discusses the methods used to characterize ESs. In Section 4, the economic valuation studies of the ecosystem in MAB reserves are discussed followed by monetary and non-monetary techniques. In the end, the last section outlines the main conclusions and guidelines on the ESs evaluation in the African context.

2. Theoretical background

2.1. ESs in Africa linked with Man and Biosphere Reserves (MAB): Optimistic view

The MAB program established by UNESCO in 1971 has played a pioneering role in supporting and enforcing interdisciplinary research to tackle local and global conservation and sustainable utilization challenges (Ishwaran, 2012). The MAB program is the main tool used to support 'science for sustainable use' sites, including local communities and scientists, that involves collaboration with a suitable range of stakeholders (Schultz et al., 2011; United Nations Educational, Scientific, and Cultural Organization, 2016).

UNESCO (2017) defines Man and Biosphere Reserve as areas in which it aims, by means of management practice and sustainable growth, to find an equilibrium between social and ecological systems (UNESCO, 2017). The present management of the reserve is considering different measures to reduce human impacts. Such strategies include widening the protected area and thereby growing the population's access to ESs, toughening restrictions, and increasing awareness. The policies are meant to have a positive effect on the ecological environment, but the effects on human lives should not be ignored and the implications should be considered carefully. The main question here is which approach or policy best aligns with the values and needs of the population while achieving the desired conservation outcome.

As an example, in South Africa, the applicable regional and sub-regional networks are respectively the African Biosphere Reserve Network (AfriMAB) and the Southern African Biosphere Reserve Network (Fig. 1). The WNBR currently has 651 locations in 120 countries, including 15 transboundary locations (UNESCO, 2015a, 2015b).

Countries are encouraged to use the reserves of biosphere (to promote sustainable development) and support healthy and equitable societies, economies, and prosperous human settlements through the new MAB strategy and the Lima Action Plan (LAP) (UNESCO, 2017). These underlying features of the MAB programs enable biosphere reserves to help national governments find landscape solutions to the pressing challenges of South Africa (DSD, 2017).

Long-term persistence, efficiency, and biodiversity of biosphere reserves should be ensured by optimal locations. These sites must represent that biodiversity is managed efficiently and persisted in the long term. Currently in South Africa, with the support of the

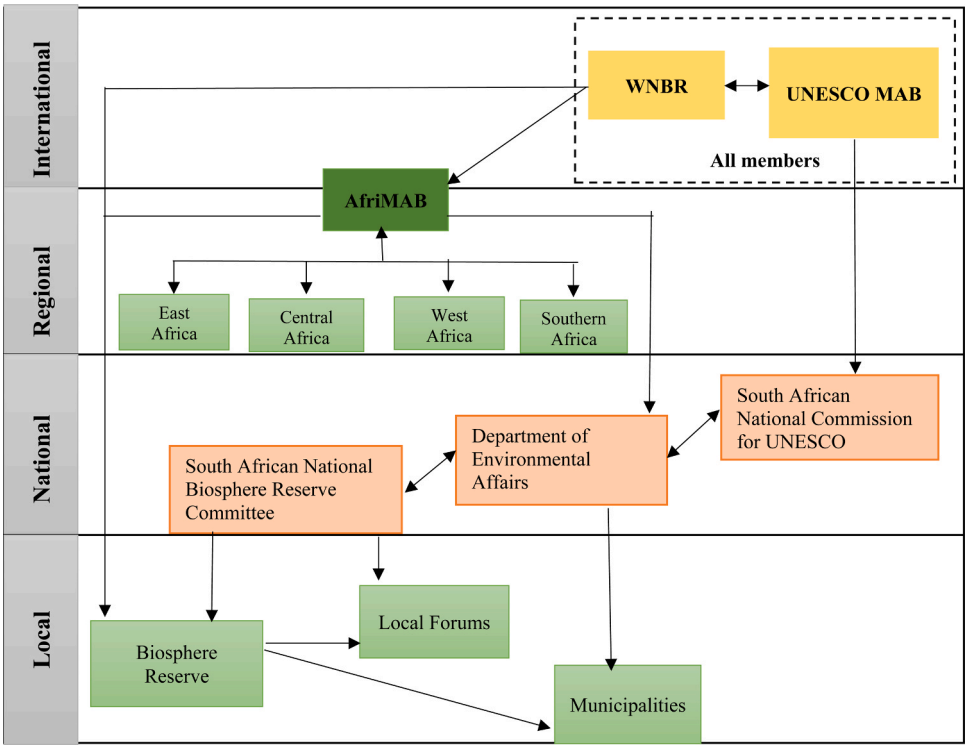

Fig. 1. The Biosphere Reserve program working structure in the African context.
(Adapted from the Government of South Africa (2015)).

relevant provincial governors, the national government submits to UNESCO ad hoc nominations for new biosphere reserves, broadly in response to inquiries from interested community groups (Pool-Stanvliet, 2014).

Overall, MAB programs can contribute to encourage societally important interdisciplinary and transdisciplinary studies. Biosphere reserves are rooted in the dynamic relationship between humans and the natural world, and it is the interconnectedness that drives sustainability research. MAB projects are thus suitable, scientifically sound platforms for understanding social-ecological processes, putting biosphere reserves firmly at the center of research, policy, and society (Pool-Stanvliet and Coetzer, 2020).

2.2. ESs in Africa linked with Man and Biosphere Reserves (MAB): pessimistic view

The current state of ecosystem degradation in Africa is comparable to which occurred in Europe during the industrial revolution in the 19th century (AEO, 2013). Urbanization-related economic activities draw a significant number of people, resulting in high population densities. Previous research (Boafo et al., 2014; Inkoom et al., 2017) has highlighted that the obstacle to ESs studies in Africa is due not only to insufficient scientific research, but also the African governments' lack of commitment to enact key policies. These policies will result in sustainable land management for efficient ESs delivery, giving scientists the ability to investigate current state-of-the-art and forecast potential changes. In the case of West Africa, for example, the problem can be divided into two groups. First, there is a lack of public involvement, institutional resources, and qualified manpower in terms of ESs expertize, as well as insufficient logistics to carry out planning activities (Fuseini and Kemp, 2015). Second, there is a lack of understanding and education on the ESs definition and its underlying concepts, despite the growing resources and information system beyond the subregion's borders. In addition, resources and methods for mapping, evaluating, tracking, and practically incorporating ESs to support planning are not available (Inkoom et al., 2017).

Taking into account the above explanations on MAB programs, it is not clear how biosphere reserves fulfill their commitment to an inclusive environmental management approach. Kothari et al. (2014) criticize the idea of "oxymoron" sustainable development because it offers an insufficient solution to unsustainability and inequity. Authentic worldviews and life forms should also be highly respected and completely incorporated into the biosphere reserves since they embody many of the values promoted by the UNESCO MAB Program. Different strategies can be tailored to various Biosphere reserves, depending on the local, regional, or national context. For policymakers in general, as well as for Biosphere Reserve managers in particular, consistent policies and strategies demand: "a framework for systematically thinking about multiple interactions, beyond synergies and trade-offs, in order to quickly define which groups might become their allies and which ones they should negotiate with" (Nilsson et al., 2016). It is clear that the MAB programs are facing a range of obstacles, both familiar and fresh, and that the problem of sustainable use will have to be tackled more aggressively in action and not merely in principle (e.g., through knowledge centers or other environmental awareness events coordinated by the biosphere reserve staff). To resolve these obstacles, biosphere reserve management calls for a political tailwind by providing sufficient human and financial resources to accomplish the range of its tasks, together with brave political support (Asara et al., 2015).

As discussed in the previous section, MAB program was chosen as the best fit for a holistic conservation approach. However, the national governments of Africa's funding for biosphere reserves through this program is still very small. Due to some financial management systems, dedicated funding support for biosphere reserves is almost impossible. A few types of protected areas listed in South Africa's National Environmental Management Act No. 107 of 1998 are nature reserves, special nature reserves, national parks, and protected environments. A biosphere reserve was not identified as a distinct category of protected area since it can be included in several different types of protected areas within its borders. Therefore, the legal standing of biosphere reserves remains a challenge (Pool-Stanvliet, 2013). Another weakness linked with MAB programs is the low-qualified biosphere reserves agents. Biosphere reserve agents must strengthen their skills in ecology, regional planning, and governance as they face an increasing number of environmental, financial, political, and technical challenges. Beyond assisting them in their daily missions, strengthening agents' capabilities should allow them to have a better handle on local issues and more power in dealings with authorities, industrial groups, and other influential players, who often benefit from strong strategies and qualified personnel to protect their interests (Pool-Stanvliet, 2013). As a result, these agents must be able to: propose alternative solutions for projects (that may have an impact on their sites), provide examples of solutions, identify legal provisions, and construct formal ESs conservation models. Strengthening the capabilities of these agents will enable national authorities and local communities to establish stable MAB programs and make informed decisions (Ajavon, 2017).

2.3. Ecosystem services' valuation methods: optimistic view

There are a number of methods to valuate ESs. Each has strengths and weaknesses, and certain methods are best suited to specific situations, depending on the type of information. There are two main types of valuating approaches including "revealed preference" and "stated preference" (Vallecillo et al., 2019). Choices may only be differentiated by the nature of the environment or the products and services offered by the ecosystem, and therefore, the importance of those qualities is exposed to specific choices. The stated preference suggests focusing on individuals to find out what they consider as the importance of ecosystem resources, goods, and services. In the defined preference system, the most common measures of value are willingness to pay and willingness to accept (Gallai et al., 2009). To highlight other classifications of ESs, the Millennium Ecosystem Assessment (MEA, 2005) classified ESs as: i) services availability (e.g., food); ii) regulating services (e.g., coping with extreme events, climate regulation, waste treatment, maintaining the populations of species and erosion protection); iii) supporting services (e.g., primary production and nutrient cycling); and iv) cultural services (e.g., recreation, esthetics, spiritual experience, and information for cognitive development). The Common International Classification of Ecosystem Services (CICES, Haines-Young and Potschin, 2013) was created by the United Nations Statistical Division

(UNSD) with the goal of assisting citizens in determining what constitutes a final ESs, navigating between various typologies that have formed around the ESs definition, and reporting in a standardized manner.

2.3.1. Revealed preference approaches

2.3.1.1. Market price method. This method uses the prices of products and services bought and sold in commercial markets to assess the value of ESs. This approach measures either the quantity or the price of a good or service. The value can be calculated by calculating the difference in producer and consumer surplus after the increase in output or price has been applied. In order to assess the product and customer surplus, the demand feature must be measured and the normal market price should be subtracted from the amount demanded (Muthee et al., 2017).

2.3.1.2. Productivity method. This method estimates a non-market ESs contribution to a commercialized commodity. That approach is most effective in cases where the resource is a good substitute for other output inputs and, therefore, in situations where only suppliers benefit from changes in the quantity or quality of the resource and customers are not influenced (La Notte et al., 2015).

2.3.1.3. Hedonic pricing method. This method estimates the non-market value of ESs by comparing the market prices of two products or services, which differ only from the features and services of the ecosystems. The price difference must be the value of that feature or service of the ecosystem, where the only difference between goods or services is the characteristic of the ecosystem (Liebelt et al., 2018).

2.3.1.4. Travel cost method. This method attempts to calculate the ESs benefit based on the amount of money spent on getting to the destination. This is used for assessing the value of sites used for recreation. This may measure the benefits or costs associated with changes in the admission fees to leisure areas, the elimination of an existing site, or the introduction of a new site or improvements in the site's environmental quality (Vallecillo et al., 2019).

2.3.2. Stated preference methods

2.3.2.1. Contingent valuation method. This approach is used to assess the ESs value by determining how much survey respondents are willing to pay for particular assets or services in the ecosystem. This method is the only one capable of incorporating the non-use values into the ecosystem's total economic value. The approach is called contingent valuation because it seeks people's answers on how they would behave if they were put in a particular situation (Carson, 2012).

2.3.2.2. Conjoint analysis. This method is used for determining specific preferences between different levels of an ecosystem attribute's characteristics. This allows people to choose between two hypothetical worlds, land plots or homes, etc., based on a list of features that make them from each other on the basis of a ranking system of each attribute. This method enables researchers to see which of the two choices the respondent prefers to teach and what features they value the most (Gallai, 2009).

2.3.2.3. Factor income method. This method uses income changes which result from environmental quality changes as the determinant of an ecosystem's value. By determining that there is a direct connection between the quality of the environment and the income level for certain jobs, the income factor test will assess the value of the environment and the income level for certain jobs (De Groot et al., 2000; Boerema et al., 2017).

2.4. Ecosystem services' valuation methods: pessimistic view

There have been great improvements in ESs valuation methods. However, uncertainty has some effects on the valuation methods in general, and on the stated preference methods in particular. The key explanation for this is a lack of ecosystem dynamics understanding, human needs, and valuation process technical issues. It is important to include uncertainty problems in valuation studies and recognize the drawbacks of valuation approaches in cases where there is a great deal of ambiguity or ignorance regarding ESs (Pandeya et al., 2016). Economic valuations of ESs are subject to a number of constraints. Certain simplifications are required in order to deliver global valuation, such as the most well-known project counting the value of 17 ecosystem services for 16 biomes (Fisher et al., 2011a, 2011b). Another aspect of economic valuation is to include as many services as possible, because failing to do so may result in underestimating certain ecosystems, which lead to making poor decisions about ESs conservation methods. The next point to consider is the monetary valuation's limitations (Fisher et al., 2011a, 2011b). While monetary valuation has disadvantages that have yet to be resolved, it may provide useful information about changes in welfare that will be achieved as a result of ecosystem management activities. The limitations of monetary valuation become even more important when ecosystems hit critical thresholds and ecological change is irreversible or only reversible at prohibitive cost (Muthee et al., 2017). Market valuation methods primarily rely on production or cost data, which are generally easier to determine the demand for ESs. However, when it comes to valuing ESs, these methods have serious limitations. These are primarily due to the lack of or distorted markets for ecosystem services. As a result, estimated ecosystem service values will be skewed and will not provide reliable data on which to base policy decisions (Muthee et al., 2017). When using specified preferences methods, market imperfections and policy failures will distort the expected monetary value of

ESs. High-quality transaction data, large data sets, and sophisticated statistical analysis are needed by scientists. As a result, approaches based on specified preferences are both expensive and time-consuming. These approaches have the advantage of relying on actual/observed activity, but they have many drawbacks, including the inability to estimate nonuse values and the reliance on technical assumptions about the relationship between the environmental good and the surrogate consumer good (Carson, 2012).

3. Methodology

3.1. Overview of the systematic review

This study conducted a systematic review to explore cross-cutting studies in Africa on different economic valuation methods of ESs and MAB programs. The systematic review aims to bring evidence together to answer the defined research questions. This method involves identifying all primary relevant materials to define the research question, exploring gaps in the literature, and synthesizing the findings (Aromataris and Pearson, 2014; Pollock and Berge, 2018). In this study, the main research question was to explore how MAB programs find solutions to the pressing challenges of ESs degradation in Africa using ESs valuation methods. Furthermore, the systematic review seeks to find appropriate primary articles, collect the necessary data, evaluate, and discuss the findings in order to achieve a deeper and broader understanding of the domain under investigation (Tawfik et al., 2019). This is also falling within the scope of the current study, as the main approach was to first collect all relevant materials from valid sources and then, discuss them further by presenting several tables and figures.

The systematic review contributes to minimizing subjectivity and bias by conducting a comprehensive literature reviewed to create a new conceptual framework or evaluate an existing one (Siddaway et al., 2019). Focusing on the current study, the main purpose of this paper was to evaluate and investigate the MAB programs' contributions to the ESs conversation practices in Africa to find out its weak and strong points. Overall, by conducting a systematic review, it is possible to draw clear conclusions and recommendations at the end.

3.2. Data collection

Before conducting the systematic review to have a clear focus on the research topic, "valuation of ecosystem services" and "Man and Biosphere Program (MAB)" terms have been chosen as the main keywords to obtain the best relevant results. The first step of data collection was to select the databases and main types of literature to be included. The data were collected from broad and most valid scholarly databases such as ISI Web of Science, Google Scholar and Science Direct. Although reducing the initial large number of papers published from various databases, the analysis concentrated on literature explaining particular issues related to the above-mentioned keywords.

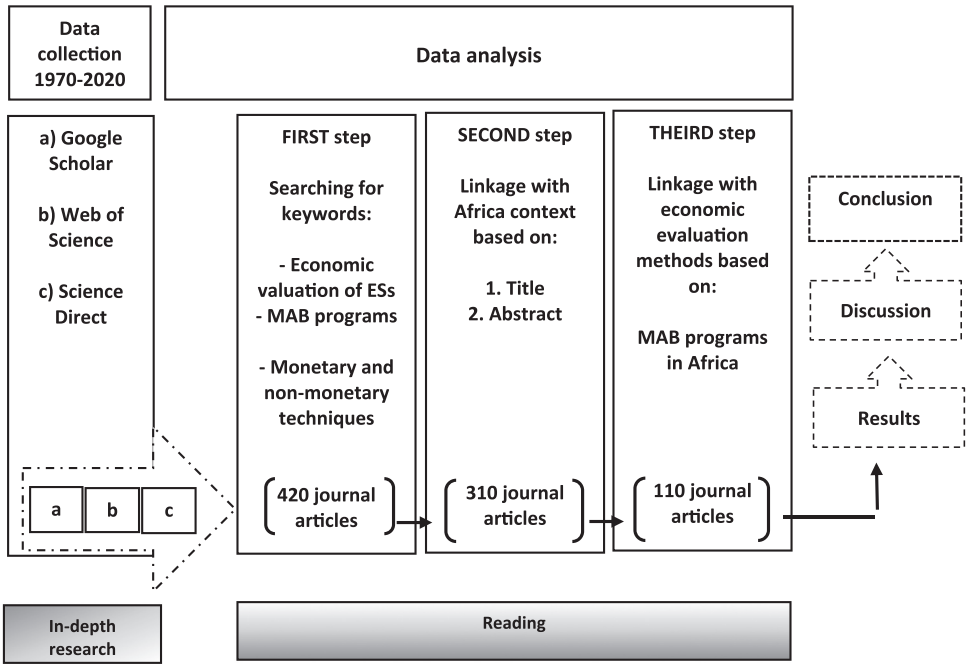

Fig. 2. Three steps of data collection and qualitative assessment.

3.3. Qualitative assessment

A qualitative assessment analysis based on a systematic evaluation is presented in this paper. The review was carried out in three stages. The first phase was to collect 420 original articles. Some inclusion criteria were used to select relevant papers in order to observe the various phases of the systematic analysis. To prevent bias in our literature collection, a careful articulation of the inclusion criteria is critical and may affect the outcome of the review process (Munn et al., 2018). This study's inclusion criteria are as follows: 1) date and source: the related papers were collected from five of the most well-known and well-respected scholarly databases; 2) Language and time period: only English-written literature published between 1970 and 2020 was included in this review. 3) Geographic position of the studies: Given the linkage to MAB projects, the current paper focused on African studies, including Sub-Saharan Africa, Kenya, Uganda, and others. 4) Type of publication: while peer-reviewed publications were the primary focus, this analysis also gathered technical reports (such as perspective reports and policy briefs) and web-based recommendations; 5) type of study: empirical, review papers, and cross-sectional research were all considered in this paper.

About 310 original articles, which have applied monetary and non-monetary techniques in the second step, were re-sorted according to their title and abstract. In the final step, using Endnote software, papers were further re-sorted based on the different economic valuation methods of ESs and MAB programs, which resulted in 110 journal articles. This selected literature has been critically reviewed to extract data, summarize, synthesize and interpret the results. Three stages of our data collection and qualitative assessment are depicted in Fig. 2. The qualitative analysis was carried out in three stages, as seen in the diagram.

4. Methods to characterize ESs

As shown in Table 1, the concept of ESs includes the transmission, arrangement, creation, support, or the act of keeping goods and services that humans consider to be essential (Chee, 2004; Daryanto et al., 2019). ESs involve goods like seafood, animal food, trees, biomass fuels, natural fibers, medicines, industrial products; services like keeping biodiversity; and life supporting actions such as waste absorption, sanitization, restoration, renewal, and abstract, artistic, and cultural profits (Aerts and Honnay, 2011; Hicks et al., 2014).

The several services discussed above are to be found all over the world. Although all ecosystems cannot provide all the mentioned services, a few services are more widespread in special instances. For management and programming, it is important to have information about the essential services that are supplied by regional ecosystems (Hawkins et al., 2003). Accordingly, the most important services provided by each ecosystem should be identified. Once ESs are recognized, each form of service should be paralleled with a suitable estimation approach (MEA, 2005).

Data relevant to decisions that are useful at the regional level should be produced by quantification methods. These diagnostics services should be feasible and accessible in terms of experience, facilities, and time and they should be obtainable to policymakers. To show the great development in the measurement of the ESs, a variety of tools have been developed. However, some issues remain unanswered, especially regarding site-scale evaluations (Table 2 represents an overview of ESs assessment techniques). They generally rely on costly methods or approaches and the application of models and collected data (Turner et al., 2012).

Table 1
Models and grouping of ecosystem services.

Manufacturing goods
Food: earthly animal and plant products, animal food, seafood, and spice
Pharma: medicines and artificial medicines precursors
Long-lasting fabrics: natural fiber and timber
Energy: renewable fuel and low hydropower sediment water
Machine made products: waxes, oils, perfumes, dyes, rubber, and forerunners of artificial products
Genetic resources: the foundation for making other goods
Transformation services
Cycling and filtration services: waste detoxification, soil fertility recovery, and water and air cleaning
Transformation services: distribution of seeds required for vegetation and crop pollens
Balancing services
Limited balancing of the weather condition
Tempering weather extremes such as temperature and wind
Adjusting the hydrological cycle
Keeping the coastal and river channels balanced
Rectification and placement of one group of animals for another when environments change
Managing the most possible pest groups
Life conforming services
Supplying artistic beauty and cultural, mental, and unphysical motivation
The cost of being present
Technological finding
Peace
Maintaining the choices
Keeping ecological parts and mechanisms ready for future years
Providing goods/services counting on discovery

Source: Chee (2004)

Table 2
An overview of ESs assessment techniques.

Approach/tool	Description	Scope
Toolkit for Ecosystem Service at Site-based Assessment (TESSA)	A constructive set of measurement and monitoring tools for on-site ecosystem services	Landscape
Assessment and Research Infrastructure for Ecosystem Services (ARIES)	A modeling approach to quantify ecosystem services and elements that affect their values in a geographical area, in accordance with users' requirements and priorities	Landscape–Global
Corporate Ecosystem Services Review (ESR)	A number of arguments for the development of risk management strategies and opportunities resulting from the reliance of the company on natural resources	Landscape – Global
Integrated Valuation of Ecosystem Services and Tradeoffs (InVEST)	An artificial-based platform to assess how different scenarios can lead to different scenarios of ecosystem service and how human-wellbeing is linked with the outcomes in a geographical area	Landscape–Global
Multi-Scale Integrated Models of Ecosystem Services (MIMES)	A set of models to evaluate how different management scenarios could lead to different ecosystem services and human well-being results	Landscape–Global
ECOPALN toolbox	A tool that can be used flexibly to provide answers to typical questions (e.g., Actor analysis, Social appreciation, Quick Scan, and the Monitor Geoportal) emerging from projects for spatial planning, where the development of multifunctional landscapes is a key objective	Landscape–Global

Although decision-makers need the right information at the right time, much of the information produced in developing countries (especially Africa) is too expensive and unsatisfactory (Owolabi et al., 2020). The challenge in ESs valuation studies is to find ways in which decision-makers can learn about more cost-effective rural conditions that lead to comprehensive knowledge and understanding (Alamanos and Papaioannou, 2020). While many of the methods investigated in the studies were commonly used in the field, not all of them were used in biosphere reserves, and not all of them were subjected to scientific scrutiny (Beeri et al., 2020).

Ruckelshaus et al. (2013) reviewed the applications of the INVEST tool and their impacts at different decision-making levels. TESSA generates information that can help decision-making. It requires no computer modeling but the involvement of stakeholders and encourages primary data collection (Hugé et al., 2015; Peh et al., 2016). As mentioned by Nelson et al. (2013), InVEST is a set of service models that convert land use and land cover maps, land management, and biophysical conditions into service supply maps using production functions. Thus, the software has an important generalization feature for different landscapes and situations. An extended range of ecosystem goods and services are provided by wetlands, but they are increasingly at the risk of unsustainable use (Hugé et al., 2020). The many advantages of wetlands often lead to competing priorities for the use of wetlands. Competing needs of different uses and users should be balanced by management.

5. ESs assessment using economic valuation methods

The valuation methods can aid a manager or decision-maker in making a decision based on the relative value of various ecosystems and their social consequences (Kermagoret and Dupras, 2018). Fig. 3 shows the assessment used to derive ESs valuation through three steps of valuation methods.

The first step is to understand the drivers for changes in ESs through the development of appropriate key performance indicators

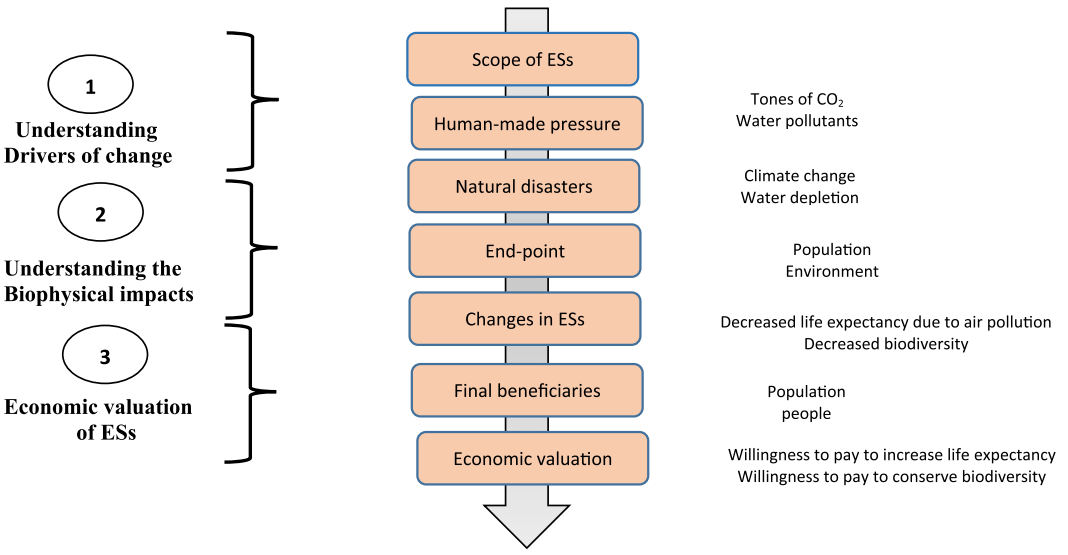

Fig. 3. The framework for assessment used to derive ESs valuation.
(Adapted from Keeler et al. (2012)).

that measure the extent of their impact on the end-point. The end-point is the primary impact receptor – the society, the environment. The impacts are quantified in terms of biophysics. Definitions of metrics are increases in life expectancy or shifts in species resources attributable to pollutant emissions. The selection of the valued attribute is informed by both the study's scope and requirements and, most crucially, how it feeds the development economic valuation in step 3. The third step is to convert the biophysical metrics into monetary terms that reflect the costs and benefits to the particular beneficiaries of the change in ESs. It may also be beneficial to incorporate both quantitative and qualitative approaches for a more comprehensive understanding of the ESs. The qualitative assessment can be used during scoping to classify the related programs and beneficiaries (Fig. 3). The specified collection of services can then be quantified or modeled in either biophysical or monetary terms using quantitative assessment in a spatial context. The combination of qualitative and quantitative analyses at all levels of an ESs evaluation may, therefore, be effective. While the aim of the evaluation will drive the choice of both qualitative and/or quantitative methods, the evaluation team's capacity and resources are often a major driver.

6. ESs researches in Africa

The results of an in-depth literature review showed that the first ESs investigations in Africa happened in 2005 in South Africa in a study done by Van Jaarsveld et al. (2005). They utilized various measures (local, regional, and national) of ESs in 19 Southern African areas. They recognized that with regard to the different spatial and temporal contexts of ESs mapping, accurate regional programming and operation are needed. According to them, the capacity to estimate and assess features in ecosystem services is yet an expanding field that is at various phases of expansion and recognition. Information on the MEA was published in that same year (MEA, 2005). After the publications of the Millennium Ecosystem Assessment, the interest in the ESs increased considerably. Moreover, the results of the literature review revealed that until July 2014, six more studies were conducted.

Other recent reviews (e.g., Vihervaara et al., 2010, Seppelt et al., 2011, Martínez-Harms and Balvanera et al., 2012, and Crossman et al., 2013) conducted 17 ESs studies in Africa, and to date, this number is increasing. ESs arrangement is dimensionally different according to various land views and is made clear by many social, political, and ecological synergies among human beings. Assessment services in big rates are entirely dependent on the modeling methods that are frequently restricted by raw determination of input information. The proposed framework in this study is intended to be a tool for decision-making and communication on the importance of ecosystems to human well-being, with a focus on economic and social benefits derived from them.

To communicate regional decision-making, there is an increasing demand to assess ESs at every station at a suitable dimensional grain, since it is the rate at which several land-use directions are usually made and is required to be announced. Such data are important for creating suitable safeguards for ESs if there are functional and basic debates supporting the special area's maintenance. The information is also important for informing decision-makers if preserving (apart from changing) or recovering a station has bigger profits for people (Turner et al., 2003).

The value of numerous environmental and non-environmental benefits from biosphere reserves to reduce poverty and income inequality has been extensively investigated in many developing countries, including South Africa (e.g., Ethiopia, Cambodia, Zimbabwe, and Nicaragua) (Thondhlana and Muchapondwa, 2014; Gatiso and Wossen, 2015; Nguyen et al., 2015). The findings of the case studies have been quite varied due to the homogeneity of social, economic, environmental, and political contexts in these

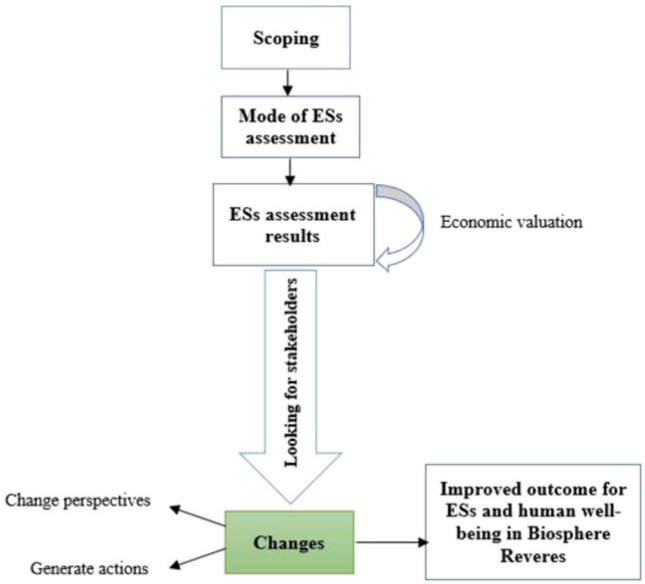

Fig. 4. Achieving outcomes on the basis of the ESs assessment.
Source: Study findings.

countries. Moreover, ecological incomes have been shown to have positive impacts on poverty reduction and the elimination of income inequality.

As illustrated in Fig. 4, the scope phase may provide an overview of the full range of ESs sites and associated recipients at local, regional, national, and global levels. Although it is possible to choose only some of these ESs for further review, scoping helps to ensure that all the advantages are recognized and accounted for. More specifically, all processes for assessing ESs will require some degree of stakeholder involvement. Stakeholders can: 1) define the appropriate ESs for on-site evaluation; 2) include sources of data, information, and expertize that could contribute to a more comprehensive evaluation; 3) assist in validating the ESs evaluation results; and 4) ensure that the evaluation results are properly used for management or policy decisions.

The analyzed ESs researches in Africa are presented in Table 3. The column of country/study area is related to the country/countries where the research was performed. Type of ecosystems refers to the kind of ecosystems raised in the examined researches, and the category of explored ESs refers to ESs regulations. The measurement of ESs refers to measurement/qualification, planning, and economic values. Quantification/qualification, planning, and financial values are three frequently utilized methods in ESs measurements which were employed by almost all the researchers whose investigations were examined in this study. Finally, the last column refers to procedures, foundations, and devices utilized in the research.

Table 3
Ecosystem services studies in Africa.

Author (s)	Country/study area	Type of ecosystem	Category of ES studied	Mode of ES assessment	Methodology/tools
Swallow et al. (2009)	Kenya	Wetland & catchment ecosystems	Regulating services	Economic valuation	U SWAT model, Interviews, GIS
Reyers et al. (2009)	South Africa	Grassland & semi-arid ecosystems	Regulating services, supporting services, cultural services	Mapping and monetary valuation	GIS mapping Value Matrix formulation
Elisa et al. (2011)	Tanzania	Wetland & catchment ecosystems	Provisioning services	Quantification/qualification	Use of satellite altimetry derived H2O levels Observations & interviews
Davenport et al. (2012)	South Africa	Urban ecosystems	Provisioning services	Monetary valuation	Direct-use value Household incomes
De Wit et al. (2012)	South Africa	Urban ecosystems	Regulating services, supporting services, cultural services	Monetary valuation	Six-step valuation methodology
Handmer et al. (2012)	Sub-Saharan Africa	Mixed ecosystems	Regulating services, supporting services, cultural services	Economic valuation	Data collection
Cools et al. (2013)	Uganda	Urban ecosystems	Urban water supply and wastewater treatment, wetland agriculture, biodiversity	Mapping and monetary valuation	Numerical modeling and spatial mapping
Silvestri et al. (2013)	Kenya	Wetland & catchment ecosystems	Provisioning services, advocating aids, cultural aids	Economic valuation	Trade-offs approach
Hicks et al. (2013)	Kenya, Tanzania, Madagascar	Marine ecosystems	Supplying aids, supporting aids, cultural aids	Economic valuation	Cost-benefit analysis Trade-offs approach
Willemen et al. (2013)	Congo	Mixed ecosystems	Supplying aids, organizing aids, advocating aids	Economic valuation	Survey Payment of ecosystem services
Schäffler and Swilling (2013)	South Africa	Urban ecosystems	Supplying services, organizing services	Monetary valuation	Carbon pricing Replacement Cost Hedonic pricing
Namaalwa et al. (2013)	Uganda	Wetland & catchment	Regulating services, supporting services, cultural services	Quantification/qualification	Driver-Pressure-State-Impact-Response (DPSIR) Stakeholder analysis
Cavan et al. (2014)	Ethiopia/ Tanzania	Urban ecosystems	Regulating services	Mapping and monetary valuation	GIS mapping Urban Morphology Types (UMTs) Field Surveys
De Leeuw et al. (2014)	Kenya	Mixed ecosystems	Supporting services	Economic valuation	Willingness-to-pay (WTP)
Bayliss et al. (2014)	Tanzania	Wetland & catchment ecosystems	Cultural services	Economic valuation	Field Survey Expressed valuation method (WTP)
Dickens (2015)	South Africa	Mixed ecosystems	Provision of water regulating services	Mapping	GIS coverage
Wangai et al. (2016)	South Africa, Kenya, and Tanzania	Mixed ecosystems	Review	Economic valuation, quantification/ qualification, and mapping	Data collection
Muthee et al. (2017)	West Africa	Sahelian ecosystem	Provisioning, regulatory, supportive, and cultural services	Mapping	ArcGIS and CRiSTAL
Turpie et al. (2017)	South Africa	Mixed ecosystems	Provisioning, regulatory, supportive, and cultural services	Mapping and economic valuation	GIS mapping and field survey

Table 3 shows that South Africa, Kenya, and Tanzania are the countries with the greatest ESs measurement publications. The type of ecosystem in the context of the case studies is represented by five different types of ecosystems, including grassland and semi-arid ecosystems, wetland and catchment ecosystems, city ecosystems, marine ecosystems, and combined ecosystems.

7. Discussion

7.1. MAB's contribution to environmental management applications

Based on the results, there have been a number of conducted ESs studies in Africa. However, a few MAB reserves have been conducted; studies at large scales are rare, and they are insufficient for applications in environmental management. More importantly and as discussed in the previous sections, the MAB program was already implemented in African countries and seems to offer both the protection of ESs and the improvement of livelihoods. Africa has the expertise to develop a strong ESs research program that can deal with environmental degradation. Based on the findings, in South Africa, the ESs researches are ideally conducted while simultaneously building capacity in other African countries.

Therefore, it could be understood that ESs researches in Africa are conducted in a harmonious manner. Given the form of ESs measurement, the studies were divided into two studies for ESs quantification/qualification, two studies for ESs mapping, and nine studies for economic valuation of ESs. As shown in Table 3, it is clear that the three forms of ESs research are not similarly utilized, and "provisioning" and "regulating" services are the major categories of ESs considered in different case studies. Furthermore, "economic valuation" has been applied to most parts of both "wetland and catchment" as well as "urban" ecosystems. Asset-based methods are useful for ESs assessments in Africa, as many local people and tribes in Africa still exchange their properties in a non-monetary currency. In addition, demand and supply were not adequately defined by ES studies and led to a limited management of flows, synergies, and trade-offs between different types of ESs. Nevertheless, the diversity in applying different methodologies and tools is high, from simple interviews and surveys to more complex techniques such as SWAT and GIS models. Accordingly, one could conclude that to gain a complete recognition of outcomes and promising uses, ESs studies in Africa require more concentration on different ESs measurement/qualification, ESs planning, and economic evaluation of ESs.

7.2. ESs quantification/qualification, mapping, and economic valuation

In order to obtain a multidiscipline platform and potential benefits, African studies of ESs must focus on the quantification/qualification of ESs, mapping of ESs, and economic valuation. Based on the findings, the least number of ES quantification/qualification studies were conducted. The results in this mode of valuation show that the majority of studies have been conducted at the regional level, and ESs researchers have paid less attention to the national level. The evaluation of biophysical ESs is accurate and verifiable as it is based on measurements. Such procedures, however, are costly and, as such, less data is available for the quantification of ESs (Seppelt et al., 2011). This absence of data can be explained by the few studies on the assessment method of quantification/qualification. However, this study's findings clearly point to the significance of the quantity and quality of ESs. In other words, human well-being (as characterized by an individual's social, physical and psychological needs) is influenced not only by the quantity but also by the consistency of ESs. Due to their long-term human well-being, the amount and quality of ESs are closely connected to the well-being of human beings.

To describe visualized ESs spatial information, the term 'ESs mapping' has been used (Willemen et al., 2013). The country with the most ESs mapping publications is South Africa. For example, Van Jaarsveld et al. (2005) recognized the need for careful local planning and action due to the diverse nature of ES mapping. It is also noted that multiple (temporary) scales should be adopted in cases where many countries undergo a single study.

According to the findings, at the regional and local levels, ESs economic valuations are necessary measures to contribute directly to policy development at the local level. Since Africa has a uniqueness of cultural and social capital, a list of allies for cultural ESs is needed to increase their significance and the potential for applications for future case studies. Although national recognition has been raised, and problem identification studies are useful, regional and local decision-making cannot be promoted. Information about ESs supply, ESs demand, natural conditions, resource management regimes, and societal value is highly required in local decision-making. In future, ecosystem changes and vulnerability could be major issues in ESs research considering the current population growth trends and land use stresses. To approach a sustainable future, it is required to increase cooperation among multidisciplinary researchers and motivate new international policy processes. Therefore, there is a need for a great deal of additional research and also shows the specific areas that need more attention. Furthermore, the emphasize should be on the relative importance of ESs and the potential impact of continued squandering on our welfare.

8. Conclusion

The results show that rapid economic evaluation of ESs and biosphere reserves requires accurate information on the supply and demand of natural conditions, energy systems and social values in local management. To fill the gap on the interrelation of MAB programs and ESs valuation, our findings showed that MAB programs offer both the protection of ESs and improvement of livelihoods. Moreover, the MAB programs enable biosphere reserves to help national governments find solutions to the pressing challenges of ESs in Africa. As a result, regional and local ESs assessments are required to contribute directly to local policymaking. In order to combine knowledge with long-term environmental and socioeconomic experience and thus, provide practical solutions, African scientists must

engage in ESs evaluation immediately. Reviewing the findings of previous studies can assist researchers to apply a relevant tool/approach (e.g., TESSA, ARIES, InVEST, etc.) for the economic valuation of ESs. These tools/approaches should be capable of quantifying the conservation strategies, which are derived from the environment and related ESs. Considering the suggested tools/approaches by different studies, the following questions have been addressed in the current study:

8.1. Recognizing and measuring the way ecosystems present services

1) What are the major signs and criteria to measure the scope of an ecosystem to present services, and what are the highest viable application levels?
   This study shows that decisions on alternative investments, criteria, or policy measures for ESs are often based on weighing and comparing multiple cost and benefit measures in various metrics at different locations and times. Internationally, the concept has been promoted and used as a guiding framework to restore and monitor viable applications in protected areas. For instance, establishing a new protected area could include expenses related to land purchasing, local communities' compensation, and continuous costs for maintenance, enforcement, and benefits related to the conservation of biodiversity.
2) How can ecosystem roles and services be dimensionally explained (planned) and envisioned?

The result estimates the value and role of the ESs on a monetary basis according to the economic assessment. These estimations for all people affected by service change can be used to determine the total social impact of the ESs service transformation Nevertheless, in monetary terms, the values of some ESs are difficult to measure. The decision-making process does not require the monetary calculation of all ESs. This study sought to fill the gap in the current literature and refine and develop new and innovative approaches to assess ESs in Africa.

8.2. Valuation of ESs

1) How the role of financial importance of ESs in society could be defined?
   As noted earlier, ecosystems provide society with a wide range of resources and processes. The financial importance, which could be classified as provisioning services (e.g., material goods such as food, feed, fuel, and fiber), affects human well-being. Coastal ecosystems, for example, provide fish and shellfish, recreational opportunities, esthetic beauty, species habitat, storm protection, sequestration of carbon, and other services.
2) What is the way to plan values (ecological, social, and financial) in order to simplify the application of ESs in programming?

The use of an ESs evaluation method raises a potential issue about what it means to consider "the environment and the public as a whole". Policymakers should thus, be aware that the objective of an ESs reorientation approach is not to substitute a lost natural system for the lost ESs value for the user by a set of constructed replacements or a long-term payment period. With three planning values in mind (ecological, social, and financial), the applications of ESs which restore the lost services should be publicly acceptable, rather than denying compensation simply because it cannot be completed.

8.3. Investing in viable employment of ESs

1) What is the adequacy level for contemporary financing approaches to investing in ESs? How can it be enhanced?
   The adequacy level of financing approaches for ESs valuations must be generally greater than the returns to ecosystem conversion. To enhance funding approaches, it is necessary to fully recognize the role of well-defined property rights in the management of ecosystems. Most ecosystems are public goods linked to the classic open access and overuse problems. The role of economic data in the value of ESs will provide the optimal provision of ecosystem services where preservation balances the use of ecosystem services. Improved understanding of ecosystem dynamics and the integration of ecosystem and contemporary funding models are integral to this level of use.
2) Why do we need to involve all stakeholders in ESs and their social and economic value?

It is important for managers and stakeholders to understand and operate the scientific foundations of the socio-economic integrity of ESs in a way that captures the complexity of the valuation concept. They should be informed that the social and economic value of ESs is measurable, relevant to managers, and can be understood and supported by the public.

However, in some cases, the ecosystem values are not properly addressed in natural resource decisions. In this context, the evaluation of ESs provides a significant opportunity to create a framework to support the wise use of biodiversity and other natural resources. Although the value of using ESs to frame MAB programs assessments in Africa has been demonstrated, it is still necessary to explore frameworks for more sustainable socio–ecological systems. Accordingly, the main implication of our findings is to provide a more holistic and systematic understanding of biosphere reserve management in the context of Africa. The proposed biosphere reserve requirements for African countries, as shown by the results, have the potential to be useful in the selection of future productive and efficient biosphere reserves that will deserve their rightful position. Accordingly, this study suggests that future empirical research should address the multi-faceted nature of biosphere reserve criteria to provide some key elements for a valuation framework capable of dealing with ESs. If MAB programs and/or the ESs paradigm are to be implemented at the national level, it is critical to revise the concept of cultural services, and more broadly, practically define the more tangible ESs on which we rely.

Finally, future research could use the theoretical findings of the current study to examine the real changes in Africa by applying different ESs evaluation methods.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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