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## RETROSPECTIVE ANALYSIS OF THE CONCEPT OF ECOSYSTEM SERVICES

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**\*<sup>a</sup>Dr Oumar Plea, <sup>b</sup>Dr Amadou Touré**

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a. Department of Environment, Water and Sanitation at Ahmed Baba Private University in Bamako and Niamey. Associate Researcher at François Rabelais University of Tours, UMR Cities, Territories, Environment and Societies, Territorial and Environmental Dynamics and Action Team (DATE).

b. Department of Rural Engineering and Water and Forestry, Rural Polytechnic Institute for Training and Applied Research (IPR/IFRA) of Katibougou, Mali, BP: 224.

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**Article Received: 18 March 2026**

**Article Revised: 08 April 2026**

**Published on: 28 April 2026**

**\*Corresponding Author : Dr Oumar Plea**

Department of Environment, Water and Sanitation at Ahmed Baba Private University in Bamako and Niamey. Associate Researcher at François Rabelais University of Tours, UMR Cities, Territories, Environment and Societies, Territorial and Environmental Dynamic and Action Team (DATE).

DOI: <https://doi-doi.org/101555/ijrpa.3629>

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### ABSTRACT

The concept of ecosystem services, which emerged in the 1970s from the convergence of ecology and economics, refers to the benefits that human societies derive from ecosystems. Since its formalization within the framework of the Millennium Ecosystem Assessment (2005), it has become a central paradigm for nature management, integrating four main categories: provisioning, regulating, supporting, and cultural services. This article presents a synthesis of the concept, its historical emergence, different scientific perspectives, and associated assessment methods. It highlights the ongoing debates about its boundaries, particularly the distinction between ecological functions and services rendered, as well as the tensions between utilitarian, naturalist, and pluralist approaches.

**KEYWORDS:** Retrospective analysis, ecosystem service concept, method, function, use.

### 1. INTRODUCTION

The concept of ecosystem services emerged from the fusion of knowledge between scientific ecology and economic sciences (Gómez et al., 2010). It first appeared in public debates in 1970 through North American conservationists, who were ecologists and environmental

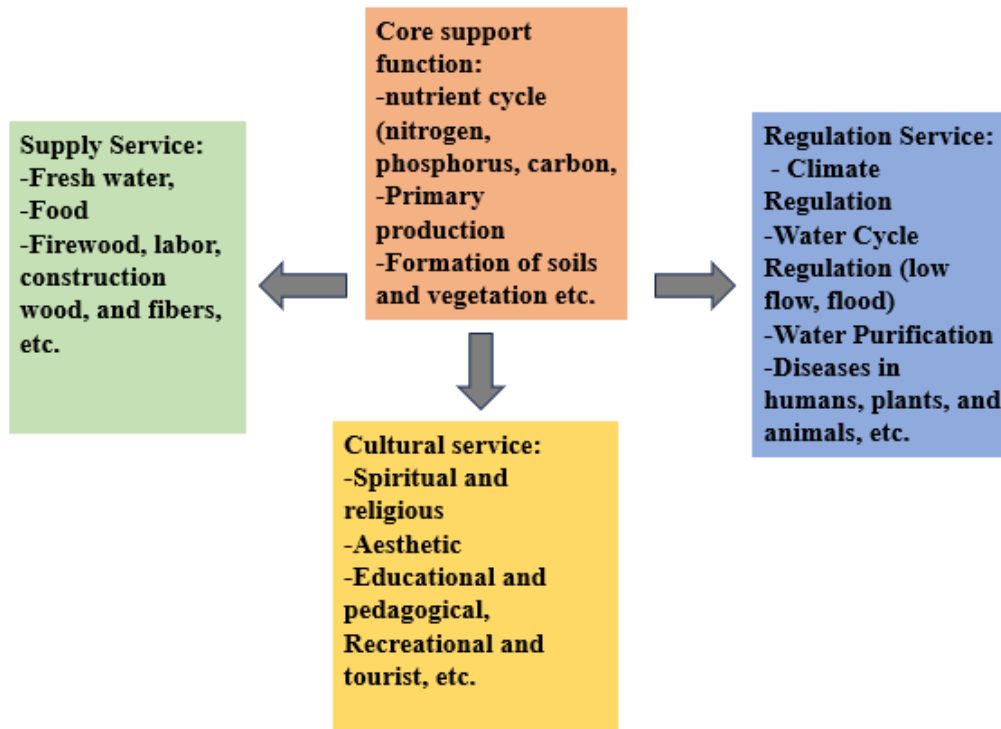
economists (Costanza, 1997; Dufour et al., 2016). In 1970, following observations of ecosystem degradation linked to industrial growth and the effects of climate change, researchers in ecology, environmental science, and physical geography introduced this systemic approach to conceptualize the challenges facing the biosphere (Aubertin, 2005; Méral, 2012). However, long before its appearance, concepts such as ecological thinking, ecological functions, or environmental services had preceded it (Dagenais, 2013). Due to its pedagogical value, the concept of ecosystem services attracted the attention not only of researchers but also of political decision-makers internationally. This is why it has superseded all the concepts that preceded it. Today, the question is no longer whether the ecosystem services paradigm is coherent with current ecosystem challenges. Instead, we must question the results of this paradigm in relation to the concepts that preceded it. We observe that the introduction of this systemic method for understanding the global problem of the biosphere has revealed the peril in our "common home" (Morin, 2009). Thus, the major alert was sounded in 1972 in the Meadows report (a study commissioned by the Club of Rome). In the chronology of events, this report was one of the first major efforts to consider the joint human and biological futures on a global scale. It predicted the limits of human and industrial growth worldwide. From then on, humanity was warned, and ecological awareness regarding environmental protection issues became established (Morin, 2009). After waves of movements by Anglo-Saxon activists and conservationists, researchers like Morin (2009) highlighted that the issue is not just the preservation of nature. It is now about human life. However, it was only from 1992, after the Rio Conference, that the preservation of natural resources (arable land and vegetation) in developing countries became a reality. This played a decisive role in the political agenda for nature management (Rodary et al., 2016). Subsequently, the publication of Daily's work (1997) and Costanza's article (1997) allowed the concept of ecosystem services to spread within the scientific and political spheres. To truly understand the emergence of the concept of ecosystem services, it is necessary to situate the discussion on the elements proposed for the conservation of nature and biological diversity from the 1970s onwards. As mentioned earlier, shortly after the alert given by the Club of Rome during the Stockholm Conference in 1972, the questions raised about the state of natural resources in the face of anthropogenic pressures combined with the adverse effects of climate change on a global scale led to the consideration of the concept of ecosystem services in the first ecosystem assessment programs, particularly the Millennium Ecosystem Assessment (MEA). Finally, the concept became popular after the publication of the Millennium Ecosystem Assessment report (MEA, 2005). The dynamic of the MEA caused

the concept to move in a few years from being confined to restricted scientific circles, mainly conservation biology and ecology, to a central position in international biodiversity and environmental policies (Bonin et al., 2012). Currently, the ecosystem services paradigm is clearly evident in international biodiversity policy and contributes significantly to the economic and monetary valuation of biodiversity (Méral et al., 2016). These elements explain our interest in questioning the relevance of the effects of such a notion in nature management within a tropical environment.

## **2. Ecosystem Services and Ecological Function**

Ecological functions and ecosystem services are intimately linked, and we cannot speak of one without speaking of the other. They are two different, complex notions, difficult to grasp in their respective entirety. In the geographical and spatial dimension, an ecosystem is a dynamic complex composed of plants, animals, microorganisms, and the surrounding non-living environment, acting in interaction as a functional unit (UN, 2004). It is characterized by its flora and fauna, their physical environment, and their interactions (biotic and abiotic). Through its characteristics and interactions, the ecosystem ensures the realization of ecological functions. These ecological functions are the origin of ecosystem services.

Indeed, ecosystem services and ecological functions are linked, although distinct. Through the bibliometric analysis conducted by Jeanneaux and his colleagues (2012) and in the work of Maris (2014), as well as that of Méral et al. (2016), we observe various ways of distinguishing ecosystem services and ecological functions. Ecological functions are defined as a biological process of functioning and maintaining ecosystems (Puydarrieux et al., 2014). It is within this process that ecological functions produce ecosystem services from which humans can derive direct or indirect benefits, goods, or products used or consumed by humans and having economic or social value for societies (Figure 1).



**Figure 1: Conceptual framework by Puydarrieux and Darses, (2014).**

Thanks to the works of Maris (2014) and Méral et al. (2016), we can understand that the genealogy of the concept leads to three possible appellations: environmental services, ecological services, and ecosystem services. These concepts have been the subject of numerous scientific debates held by economists, environmentalists, and ecologists. Thus, they remain in scientific approaches as a constellation of more or less interdependent sub-disciplines and sub-domains. In the context of this work, the interest lies particularly in the concept of ecosystem services. By the word "service," we mean the verb "to serve." In the Larousse dictionary, it means what is useful or beneficial to someone. Meanwhile, the adjective "ecosystemic" evokes the functioning of ecosystems (MEA, 2005). It refers to issues related to anthropogenic activities such as the overexploitation of natural resources (Hrabanski et al., 2016), hence our interest in the notion. Based on this foundation, we can understand that the ecosystem service approach or ecosystem approach is a management method that integrates land, water, and living resources to promote the conservation and sustainable use of natural resources based on human dependence. In most consulted works, to define ecosystem services, researchers such as Méral and his colleagues (2016), Maris (2014), and Walter and his colleagues (2009) refer to the definition given by the MEA, considered the guiding principle. Ecosystem services are defined as the benefits that humans derive from ecosystems (MEA, 2005). They are also considered as the set of services

provided by nature to humans (Maris, 2014). Furthermore, in the work of Méral and his colleagues (2016), the notion is considered a way of apprehending, in a more economic manner, the benefits that humans derive from nature (Méral, 2012). It focuses on the most useful components of ecosystems (water, soil, vegetation, animals) and not on the renewal processes of these components, nor on the regulation processes of water cycles or carbon storage, for example (Serpantié et al., 2012; Hrabanski et al., 2013). In summary, what needs to be understood about the concepts of ecosystem services and ecological functions lies in the relationship they maintain with each other. Environments, functions, and services are linked by a causal relationship. In this logic, the ecosystem is the foundation that determines the functions and subsequently the services (Figure 2).

Figure 2: Relationship between ecosystem services

### **3. The typology and use of ecosystem services**

#### **3.1 The typology**

The growing interest of researchers in the concept has led to the establishment of a typology of ecosystem services for the entire scientific community. The typology proposed by the MEA (2005) is the reference. It is extensively cited by researchers (Maris, 2014; Méral et al., 2016; Dufour et al., 2016; Yengué, 2017). Subsequently, another typology was proposed in the TEEB (The Economics of Ecosystems and Biodiversity) assessment, providing more precise details on the ecosystem services provided to humans (TEEB, 2010). In the Millennium Ecosystem Assessment, ecosystem services are classified into four categories: provisioning services, supporting services, regulating services, and cultural services (MEA, 2005). Figure 3 illustrates the typology of ecosystem services, inspired by the typology proposed by the MEA and TEEB.

#### **Support services**

Support services are considered basic ecological functions that ensure primary production, photosynthesis, soil formation, or nutrient cycling (De Groot, et al., 2002; Maris, 2014). They do not necessarily rely on services in the strict sense, but rather on functions necessary for the production of all goods derived from ecosystem functioning (Maris, 2014). They play a leading role thanks to ecological processes. These processes promote soil formation, plant species formation, and photosynthesis without human intervention. Furthermore, in the absence of these processes, there will be no regulation, provisioning, or cultural services.

#### **Regulation services**

Regulation services have been described as the indirect benefits we derive from the functioning of ecosystems (MEA, 2005; TEEB, 2008). They concern the regulation of pollution, diseases, the water cycle, and climate stabilization. However, by focusing on the different forms of classification of support and regulation services, we find that they are not so easy to distinguish from each other. For example, the carbon cycle is considered both a support service and a regulation service. On the one hand, carbon absorption in the soil is the main factor for underground and above-ground growth. On the other hand, the CO<sub>2</sub> content of surface plants not only promotes photosynthesis but also conditions precipitation factors in terms of regulation (Seguin, 2010). These two relationships are very important in our work, which is based on the assessment of provisioning ecosystem services.

### **Provisioning ecosystem services**

Provisioning ecosystem services have been interpreted in several ways in scientific discourse. Indeed, the qualifier "ecosystemic" has been much debated and is still confused, even in specialized scientific literature (Bonin et al., 2012). In the classification made by the MEA, provisioning ecosystem services rely entirely on the production of goods provided to humans. For example, water, food, wood, and fuel, etc. Through this distinction, we claim to consider the concept of provisioning ecosystem services as a conceptual tool for evaluating services derived from ecosystems and for accounting for the intrinsic value of nature. However, the inclusion of provisioning services in the list of ecosystem services is not always unanimous in the scientific sphere. According to Maris (2014), its inclusion raises two problems. The first problem lies in how they are classified. In her logic, the term "provisioning ecosystem service" is not appropriate. These are goods, not services (Maris, 2014). According to Maris (2014), goods are tangible and storable products (like wheat in kilograms). She believes that services are intangible and non-storable products (like green spaces, for example). The second problem lies in the fact that provisioning ecosystem services are imposed while trying to estimate the monetary or economic value of the services rendered by ecosystems. This is why Maris (2014) suggests that by considering the price per ton of wheat to inform or evaluate the economic value of a provisioning service, one aggregates without distinguishing between the benefits derived from ecosystem functioning (photosynthesis, primary production) and the benefits acquired through human effort or labor (planting, harvesting, transport), or even in another institutional context (agricultural input subsidies, markets, etc.) (Maris, 2014). Furthermore, in the bibliometric analysis by Jeanneaux et al. (2012), we observe a distinction between the notion of ecosystem services and the classification of the

categories of services to which they should belong. This scientific article provides valuable explanations on the notion as well as its application in the scientific agenda. Given all the uncertainties concerning this notion, this thesis is based on the term "provisioning ecosystem services" or "ecosystem services." They are defined as the set of goods that humans derive from ecosystems (MEA, 2005).

### **Cultural services**

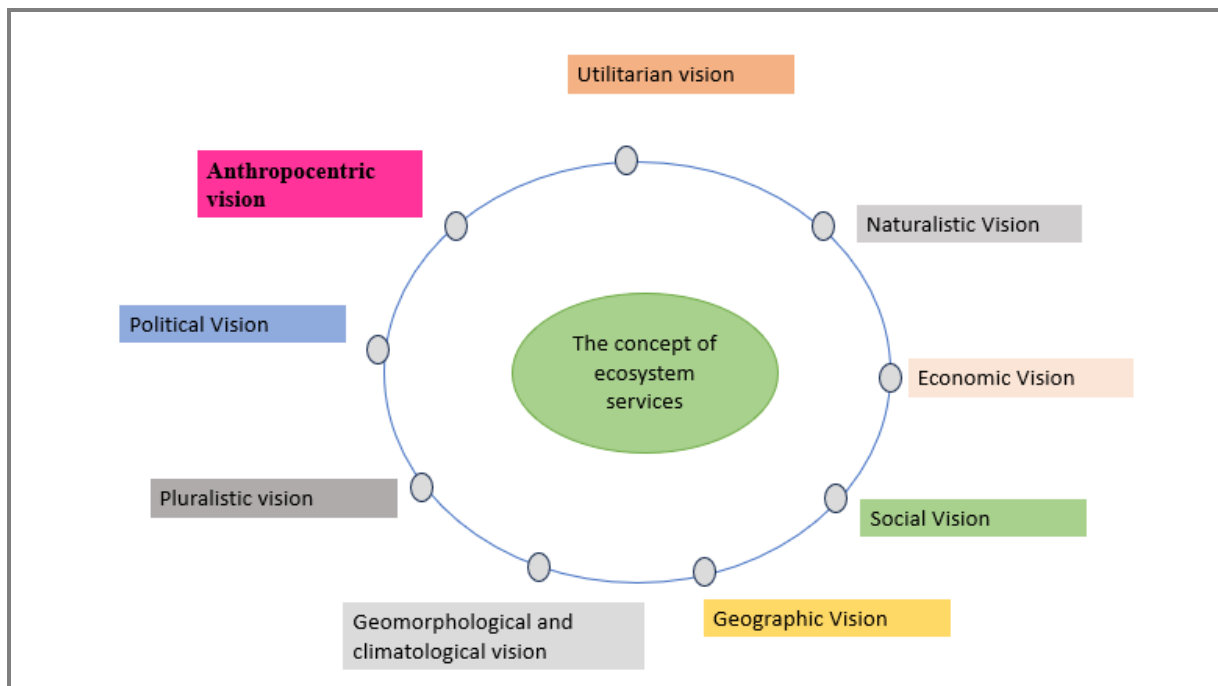
In addition to support, regulation, and provisioning services, there are cultural ecosystem services. In the Convention on Biological Diversity, in the Millennium Ecosystem Assessment report, as well as in the Economics of Ecosystems and Biodiversity report, cultural services refer to values that can be attributed to natural environments (MEA, 2005; TEEB, 2010). These values concern the human living environment, but also their conception of nature and its stakes (Couvet et al., 2010). Cultural services seek to account for the fact that the values of nature are not directly or indirectly linked to immediate benefits but rather to the intangible benefits that humans can derive from ecosystems (Daily, 1997; MEA, 2005; Maris, 2014; Méral, 2016). By definition, cultural services are essentially based on spiritual and religious, traditional, educational, aesthetic, ecotourism, and heritage orders (MEA, 2005). These include sacred natural sites in southern countries and green spaces or urban parks in the West. We hypothesize that they go beyond all these distinctions. Indeed, according to the meaning highlighted by Virginie Maris, Philippe Méral, and Jean L. Yengué, humans can establish a strong link with nature. Certain religious beliefs attach strong religious value to natural ecosystems.

### **3.2 The difficult interpretation of the use of ecosystem services**

According to the current state of knowledge, we have attempted to focus on the different schools of thought on ecosystem services (Figure 4). Our concern is to know: how to grasp the paradigm of ecosystem services through all these divergent and convergent visions? And how did it manage to establish itself in relation to all these concepts that preceded it?

Given the volume of work, the paradigm of ecosystem services has been interpreted in several fields, notably in sustainable development economics, ecology, environment, and geography, etc. Numerous methodological approaches have been developed and tested by the scientific community in different application fields regarding the assessment and management of biological diversity. These different approaches have shed light on the paradigm and its use in the scientific sphere.

By definition, a paradigm is the set of principles and methods shared by the scientific community, which for a time holds authority, while being able to be replaced by another paradigm whose explanatory power will be considered superior (Kuhn, 1962). It is by relying on this definition that we qualify ecosystem services as a paradigm. Consequently, we have focused our analysis on various viewpoints, notably the utilitarian, economic, anthropocentric or ecocentric viewpoints, and that of naturalists. The choice of these viewpoints is explained by the fact that we often recognize ourselves in their scientific logic.



**Figure 4: Scientific viewpoints relating to the concept of ecosystem services.**

### **From the utilitarian perspective**

The ecosystem services paradigm was born from the utilitarian perspective of ecosystems (Costanza, 1997). Utilitarians in sustainable development economics were the first to approach ecosystem services as a systemic approach. Pragmatically, they describe the concept of ecosystem services as a way to evaluate actions and their consequences in order to maximize well-being (Biénabe, Dutilly, Karsenty, and Coq, 2016). Furthermore, from this utilitarian perspective, the ecosystem services paradigm encompasses all the direct benefits provided by natural and semi-natural ecosystems to human society (Costanza, 1997). This school of thought emerged at a time when discussions around environmental issues or disorders were omnipresent on the political and scientific scene (Costanza, 1997; Daily, 1997). Despite criticisms and controversies regarding the coherence of the utilitarian vision

with environmental disorder, it has allowed for the attribution of moral and monetary value to ecosystems.

### **From the economic perspective**

Since its emergence, the concept of ecosystem services has been influenced by the vision of neoclassical economists. It relies entirely on the monetary perspective of anthropocentrists and ecocentrists (Norton, 1997). It draws its main reference from provisioning services. In this economic viewpoint, questions primarily concern nature's capacity to provide the foundations for economic production (Méral et al., 2016). The idea sought by economists was to give economic value to natural ecosystems. This was highly contested as it was considered inconsistent with the protection and management of natural resources in a naturalist context. Assigning a price to a service is no less reductionist than economic utilitarianism, when it explains and justifies varied consumer behaviors based on the satisfaction of industrial preferences (Blandin, 2009). In this logic, giving a monetary value to nature is very different from assigning a price. This is explained by the fact that it is difficult to conduct an exhaustive valuation of ecosystem services. It is rarely performed and complex (Yengué, 2017). Thus, we can only estimate an intrinsic value of nature, while this viewpoint was perceived as a process of commodification of natural ecosystems. This viewpoint is inconsistent. This is why Maris (2014) states that it is inconsistent with biodiversity management.

### **From the naturalist perspective**

The naturalist perspective is based on the reconquest of biodiversity, nature, and landscapes (Couvet D et al., 2010). According to this viewpoint, several important provisions of biodiversity knowledge have been proposed. One of the most important provisions concerns the consolidation and evaluation of ecosystem services of natural origin. It notably includes the consolidation of the natural heritage inventory. This constitutes the foundation of the naturalist perspective. Indeed, naturalist knowledge aims to highlight and prioritize conservation actions for species or the management of remarkable areas. This includes, for example, the protection of protected natural areas, the spatialization of issues like green and blue infrastructure, national or international strategies for creating protected areas, etc. This is a logic that was perceived as a response to international commitments regarding the conservation of ecosystem-based natural resources (Convention on Biological Diversity, 2011-2020). Moreover, the emergence of the concept was accompanied by ideologies of

preserving natural ecosystems, which were highly contested by naturalists. Indeed, they consider ecosystem services as a tool for commodifying nature and therefore inappropriate for the sustainable management of natural resources (Gomez et al., 2009). This partly explains the divergence of ideas between naturalists and utilitarians, and even with other schools of thought.

### **From the pluralist perspective**

Regarding the protection of natural and semi-natural ecosystems, Norton in Larrère (2010) emphasizes the need to adopt a pluralist perspective. This involves studying, analyzing, and developing approaches for the protection of natural and semi-natural ecosystems. It is not only about maintaining the ecosystem services provided to humans but also about understanding the ecological processes of such ecosystems, ensuring actions to maintain their regulatory conditions, and even their sustainability. It is from this perspective that the concept of ecosystem services has positioned itself as a tool to be seized for managing environmental disorders.

In summary, all these viewpoints have contributed in one way or another to the establishment of key tools for the protection of ecosystem diversity at the global and local levels. These tools still raise numerous issues that need to be examined in the scientific and political spheres. The first issue, in our opinion, is related to negotiations between political decision-makers and the beneficiaries (e.g., local populations) of ecosystem services. The main difficulty lies in the commitment and motivation of each party. For some, particularly political decision-makers, the protection of natural resources is vital, as it ensures the reproduction of plant species and promotes photosynthesis. For others, particularly consumers, the main motivation lies in socio-economic development. This is entirely explained by the satisfaction of human societies' needs for basic necessities. This is, for example, the main reason for the collection of firewood in Mali by the local population.

The second issue concerns the difficulty in articulating current knowledge systems (MEA, 2005; TEEB, 2010). For instance, the dynamics of the Millennium Ecosystem Assessment were intended to improve communication on biodiversity issues. It was contested within the scientific community as well as by some skeptical politicians because knowledge is scattered between theory and practical frameworks (Méral, 2012). Over 1300 researchers from 50 different countries responded to the UN's call for proposals. The dynamics of the MEA are also explained by the quantity of tools used to promote biodiversity protection (Méral et al.,

2016). In this context, we can understand a third issue related to the methodological approach: how to sort through all these viewpoints that each author considers relevant? We know that some approaches are not applicable to all environments. For example, the relationship between humans and nature in Southern countries differs from that between humans and nature in Northern countries (Méral et al., 2016).

#### 4. Synthesis of ecosystem service evaluation tools

As defined in the conceptual part, an ecosystem is a dynamic complex composed of plants, animals, microorganisms, and the surrounding non-living environment acting in interaction as a functional unit (UN, 2014). Thus, the ecosystem, as a whole, encompasses arable lands, deserts, tropical forests, boreal forests, grasslands, cultivated areas, water bodies, etc. Through this functional process of ecosystems and biotic interactions, ecosystem services are defined as the benefits that humans derive from natural ecosystems (MEA, 2005). They are also described by TEEB (2010) as the benefits that humans derive from ecosystems.

As mentioned in the typology, ecosystem services are described in four categories: provisioning services (production of food, firewood, construction timber or lumber, fibers, pharmaceutical ingredients, freshwater); supporting services (soil and vegetation formation, etc.); regulating services (climate regulation, water cycle regulation, flood protection, erosion control); and cultural services, etc. (MEA, 2005). Given anthropogenic pressures and climatic disorders, the balance of ecosystems has been altered, and certain animal and plant species have become extinct in recent decades (Living Planet, 2016; Couvet et al., 2010). As mentioned in the general introduction, this is where the problem of this thesis lies.

To evaluate ecosystem services, various methods have been considered since the early 1970s (Table 1). The list of methods presented in this table is not exhaustive. It groups those that are well-known in the scientific sphere, particularly in ecology, geography, and development economics. According to the current state of knowledge, these evaluation tools are ecological methods. They have been chosen to evaluate ecosystem services.

**Table 1: Summary of tools used to evaluate ecosystem services.**

Methods/Tools	Process	Indicators
<b>Specific richness</b>	-Estimate the number of species in the inventoried environment -Understand the link between the richness and functioning of ecosystems (Tucarti2011: p30)	Inventoried species/areas
	-Weight species of a population by	

<b>Specific diversity</b>	their relative abundance. (Blondel, 1997) -Take into account the regularity of species diversity and species richness (Goudard, 2007)	Types of rare and non-rare species determine the result (Barbault, 2008)
<b>Functional diversity</b>	-Analyze the diversity of functions by vegetation /scale/ community /or by ecosystem.	-Habitat/ecosystem -Aridity index -Meteorological or climatological record -Capacity for supplying essential services (arable land, firewood, and timber, etc.)
<b>Ecological integrity</b>	-Evaluate the ecopotentiality of an environment and its interpretation	-Habitat/Area or ecosystem -Ecological integrity index and/or biotic integrity

In Table 1, firstly, the specific richness evaluation technique is proposed and tested in biological biodiversity assessments. In the sense given by authors such as Vanpeene Bruhier, Moyne, and Brun (1998), the specific richness technique estimates the number of species present in the inventoried environment. It also seeks to understand the link between species richness and ecosystem functioning.

Specific richness S is formulated by the total or average number of species recorded per unit area:

$$S = \frac{\text{Number of species}}{\text{Inventoried area}}$$

The S indicator is used to analyze the species population of a given location. It broadly considers the distinction between spatial variations (areas rich in species population or areas poor in species) and temporal variations (according to seasons and environmental stations).

Secondly, the evaluation procedure focuses on specific diversity. This involves weighting species in a population by their relative abundance (Devineau, Lecordier et Marzin, 1984). It takes into account the regularity of species distribution and specific richness. In this procedure, only the type of species, rare or non-rare, can determine the result (Barnaud, Antona et Marzin, 2011).

Another evaluation technique is known as "functional diversity." It proposes a theoretical and experimental approach. It consists of analyzing the diversity of ecosystem functions through vegetation diversity at the scale of a plot, a community, or an ecosystem. As described by Tucarti (2011), an ecosystem is stable when its functional diversity is high. The advantage of

this method, unlike the previous two, lies on one hand in the articulation between theory and experimental practice. On the other hand, this process relies on the biodiversity index. This involves, for example, evaluating biodiversity by habitat or ecosystem type, by aridity index, precipitation, temperature, wind speed, or, in another dimension, by service provision capacity. This allows for an assessment of the habitat's current state while considering different scales in a nested logic (populations, communities, ecosystems, etc.). In this work, the method based on functional diversity may interest us due to its theoretical application. Furthermore, we have utilized some of its potentials, particularly the aridity index, to highlight the areas most impacted by reduced rainfall in the studied zone. We also attempted to cross-reference this index with dendrometric data to highlight the production capacity of forest ecosystems for fuelwood in the two regions.

Furthermore, there is a fourth method, called "ecological integrity," addressed and treated by (Weber, 2013). It is used to evaluate the eco-potentiality of an environment. Its objective is to question the health status of an ecosystem. It is a process defined as the capacity of an ecosystem to support and maintain ecological processes and to protect biotic and abiotic components (Weber et al. 2008). The health status of an ecosystem has been defined by Costanza (1997) based on three components: vigor estimated by productivity, organization based on the complexity of trophic interactions, and the resilience of the environment. The resilience of an environment is its capacity to maintain itself in the face of stress (Costanza, 1997). What should be retained from the ecological integrity evaluation approach is its particularity of combining field data (sampling) and spatial data (satellite images, aerial images). It relies on the characterization, observation, and spatialization of plant populations and implies a field monitoring approach (Selmi, 2014). In our context, this method seems very costly, even though it appears to be the most comprehensive of the four methods presented. We have synthesized a non-exhaustive list of ecological methods. It illustrates the most well-known methods currently in ecology and sustainable development economics. We wanted to provide this overview to truly understand the ecosystem services approach, discussed below.

## **5. Discussion on the ecosystem services approach**

As mentioned in the introduction to this section and in the framing of the research problem, this research work is primarily focused on the assessment of provisioning ecosystem services. The chosen method is currently experiencing a global surge in interest from researchers, territorial managers involved in environmental management, and political decision-makers

(Bonin et Antona, 2012). It is perceived here as a technique that is more concerned with the functional diversity of ecosystems. It is divided into two main branches. The first branch is based on the bottom-up ecosystem services approach, or the habitat approach, and the second branch follows the top-down ecosystem services approach. In its application through the case studies we have consulted so far, we observe that the choice between these two pathways for assessing ecosystem services is objectively made according to each party's interests. To facilitate understanding of the method, we first carried out a typology of the two application processes of the method in Table 2.

As described in Table 2, the bottom-up approach seeks to determine the distribution of ecosystem services by habitat and on a well-defined scale. From this perspective, the approach determines biophysical and socio-economic potential. It also characterizes the impact of anthropogenic pressures to understand the heterogeneity of the studied habitat (DeGroot, 2010).

**Table 2: Description of the bottom-up and top-down approach.**

	<b>Objectives</b>	<b>Study indicators</b>
<b>Bottom-up approach or habitat approach</b>	<ul style="list-style-type: none"> <li>_ Determine the distribution, at a local scale, of ecosystem services based on the previously defined habitat</li> <li>_ Understand the heterogeneity of habitats</li> <li>Evaluate and analyze anthropogenic pressures</li> <li>_ Understand the dynamics of land use and the production of ecosystem services</li> </ul>	<ul style="list-style-type: none"> <li>-Habitat by ecosystem/surfaces</li> <li>-Land occupation</li> <li>-Vegetation index</li> <li>-Vegetation type</li> </ul>
<b>Approche descendante ou par services écosystémiques</b>	<ul style="list-style-type: none"> <li>_ Identify plant formations capable of providing ecosystem services</li> <li>_ Identify and analyze the socio-political and economic determinants.</li> <li>_ Observe, question, and investigate the concerned local stakeholders</li> <li>_ Characterize motivations and identify practices</li> <li>_ Identify the most relevant ecosystem services for the population</li> </ul>	<ul style="list-style-type: none"> <li>-Habitat by ecosystem/surfaces</li> <li>-Land use</li> <li>-Vegetation index</li> <li>-Vegetation type</li> </ul>

The top-down approach to ecosystem services covers a set of processes. It consists of identifying the plant formations that provide ecosystem services. It also proposes to identify and analyze ecosystem services in a broader dimension with climatic, socio-political, and

economic determinants. For greater consistency in its application, the method has expanded its operationality. To this end, it proposes observing, interviewing, and surveying the local actors concerned. This allows for the characterization of motivations and the identification of practices through which local populations organize themselves to benefit from natural ecosystems. These characteristics are essential for proposing solutions to biodiversity erosion. The analysis of these elements can not only qualify the local population's perception of natural resources but also understand how they organize themselves to consume ecosystem services.

### **CONCLUSION:**

In this work, we have attempted to clarify the concept of ecosystem services as well as that of ecological functions since their emergence in the scientific field. As the state of the art shows, the concept of ecosystem services remains subject to numerous debates, particularly concerning the classification of services, their concrete use, and the evaluation methods employed. For our study, we focused our attention on provisioning ecosystem services. In order to specifically evaluate these services, particularly energy wood, we adopted an ecosystem services approach, combining two complementary pathways. On the one hand, the top-down pathway, which directly addresses the posed problem and relies on the recognized conceptual framework of soil-derived provisioning ecosystem services, highlighting climatic, socio-political, and economic determinants, in line with the work of Walter et al. (2009). This approach guided the construction of our data catalog organized according to these three dimensions. On the other hand, the bottom-up pathway allows for the collection of local perceptions of natural resource degradation from the populations concerned, thus providing valuable qualitative data. By confronting this method with other approaches and taking into account the specific advantages offered by the ecosystem services approach, we consider that this combination constitutes the most appropriate method for evaluating the capacity of ecosystems to produce services useful to humans, particularly provisioning services.

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