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Identifying the Ecosystem Services of Biodiversity on the Island of Martinique for Society

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Abstract

The subject focuses on the biotic ecosystem services provided to Martinique society. How do humans exploit the natural world around them? What are the specific environmental and cultural characteristics of Martinique? To achieve these objectives, the preferred method was first to carry out spatio-temporal research by immersing ourselves in the Martinique region over a period of several years. Secondly, a systemic analysis of the data was carried out to gain an overall view of ecosystem services in Martinique. This enabled us to highlight the richness and diversity of the services offered by nature to society. This holistic research into ecosystem services in Martinique lays the foundations for a more specific investigation into each of the services identified.

Keywords

Ecosystem Services, Martinique, Environmental Protection, Biodiversity, Cultural Identity, Traditional Medicine, Sylvotherapy, Food Self-Sufficiency, Natural Risk Prevention, Systemic Analysis

1. Introduction

The economic aspect is much in evidence when defining the term ecosystem services. We even talk about green Gross Domestic Product (green GDP) [1]. However, if we are committed to sustainable development, we must also consider the social dimension of ecosystem services. In other words, the well-being that nature brings to people. This is more in line with the definition given by the Millennium Ecosystemic Assessment (MEA or MA): ecosystem services are the goods and services that people can obtain from ecosystems, directly, to ensure their well-being. These services are derived from ecosystems. Ecosystems are complex natural sys-

tems whose biotic (fauna and flora) and abiotic (physico-chemical elements) components interact to adapt to perpetual changes in the environment. Ecosystems are constantly evolving, responding to disturbances with resilience [2]. Disturbances can be caused by society using ecosystem services. Hence the importance of identifying these services, which could help in public decision-making. Maintaining a balance between urbanized and natural areas has become a major concern in land-use planning, especially in terms of the well-being of the population. With this mind, our research will focus on the following problem: "What are the current and past ecosystem services of biodiversity used by the population of Martinique?". Our subject is therefore limited to biotic services (fauna and flora) and will not deal with abiotic services (physico-chemical elements) of Nature. Another limitation of the subject is that this research does not go so far as to give economic values to Nature [3]. We will remain focused on the qualitative values of ecosystem services.

To answer this question, we will first look at the international and national efforts to identify and safeguard ecosystem services. We will then look at the characteristics that make Martinique a unique territory, before describing the research carried out in Martinique's ecosystems. Finally, a typology of current and past biodiversity ecosystem services used by Martinique society will be presented. Each element of this typology will be developed from the point of view of their interest in society.

2. International and National Mobilization to Recognize and Safeguard Ecosystem Services

The Convention on Biological Diversity (CBD) [4] has established two typologies of ecosystem services, one very specific to urban environments and the other more general. Let's start with urban ecosystem services [5], which contribute to the well-being of cities in terms of cultural value (*i.e.* social cohesion, recreation and cognitive development), aesthetic value, health benefits, economic cost and resilience. Examples include noise reduction, food production, pesticide regulation, pollination and seed dispersal, carbon assimilation, air purification and urban temperature regulation.

The Convention on Biological Diversity, through the Millennium Ecosystem Assessment, has produced a more general typology. The Millennium Ecosystem Assessment distinguishes four types of ecosystem services [6] [7]:

- Supply services: food; drinking water; firewood; fiber; biochemicals; and genetic resources;
- Regulation services: climate regulation; disaster regulation; water regulation and pollination;
- Cultural services: spiritual and religious; recreation and ecotourism; aesthetics; inspiration; education; meditation; and cultural heritage;
- Support services: soil formation; nutrient cycles; production.

These two typologies are part of an international and national scheme to iden-

tify and protect ecosystems and their associated services (Figure 1).

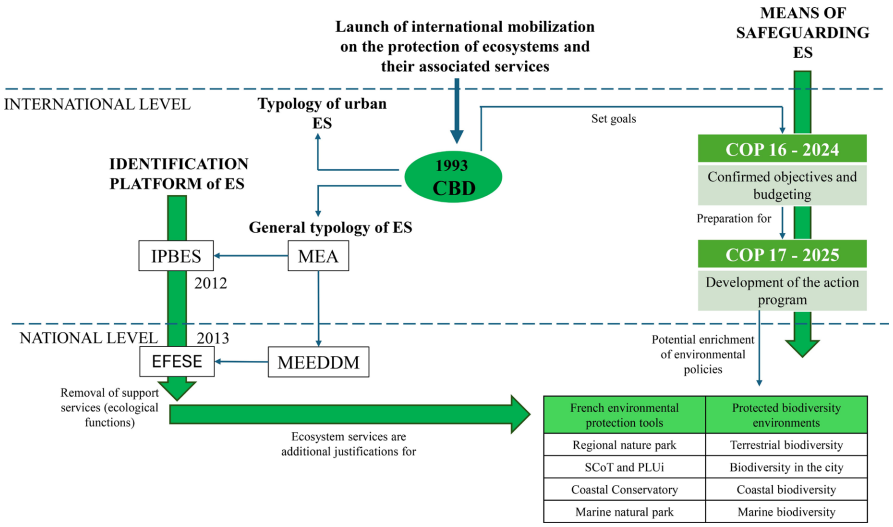

Figure 1. International and national mobilization to recognize and safeguard ecosystem services (Source: Hirep L. M., 2024). ES (Ecosystem Services); IPBES (Intergovernement Panel on Biodiversity and Ecosystem Services); EFESE (French Evaluation of Ecosystems and Ecosystem Services); CBD (Convention on Biological Diversity); COP (Conference of the Parties); MEA (Millennium Ecosystemic Assessment); MEEDDM (French Ministry of Ecology, Energy, Sustainable Development and the Sea); SCoT (Territorial Coherence Scheme); PLUi (Intercommunal Local Urban Planning Plan).

Indeed, it was the 1993 Convention on Biological Diversity that launched international mobilization on this subject. It initially established the two typologies we have just seen. Then, in 2012, the Millennium Ecosystem Assessment continued its work by creating a platform for identifying ecosystem services at international level, the Intergovernmental Panel on Biodiversity and Ecosystem Services (IPBES) [8]. This initiative was taken up at French national level by the Ministry of Ecology, Energy, Sustainable Development and the Sea (MEEDDM) [9]. Subsequently, a French program was created in 2013, the French Evaluation of Ecosystems and Ecosystem Services (EFESE). It retained three of the four types of ecosystem services identified by the Intergovernmental Panel on Biodiversity and Ecosystem Services (IPBES). It removed support services because it considered them to be ecological functions rather than direct services (Source: French Ministry of Territories, Ecology and Housing, 2019).

In addition, the Convention on Biological Diversity set targets for safeguarding ecosystems and their associated services. Follow-up has subsequently been carried out at various Conferences of the Parties (COPs). In particular, this year's Conference of the Parties (COP) and next year's in Canada. The sixteenth Conference of the Parties (COP 16) in 2024 confirmed the safeguard objectives and raised the question of funding for safeguard projects. The next, the seventeenth Conference of the Parties (COP 17) in 2025, will work on developing action programs to be integrated into national environmental policies.

French environmental policies already include several tools for preserving nature. Regulatory tools have been allocated to each natural area. For nature in the city, one of the objectives, which is becoming increasingly important in the Territorial Coherence Schemes (SCoT) and Intercommunal Local Urban Planning (PLUi), is to guarantee a balance between urban development and the preservation of natural areas [10]. Local authorities should try as far as possible to maintain ecological continuity by incorporating a strategic environmental assessment into their town planning documents. For terrestrial biodiversity, we have the regional nature parks. Their aim is to conserve the natural capital of an area as part of a collective approach [11]. For coastal biodiversity, the Coastal Conservatory (in French: le Conservatoire du Littoral) was given responsibility for preserving the coastline in 1975. It was set up to protect the coast against the privatization and artificialization of soils caused by the explosion in mass seaside tourism. However, the regulations governing the Coastal Conservatory are more flexible than those governing the nature reserves managed by the regional nature parks. It does not exclude man from exploiting the coastline. Instead, we are moving towards sustainable coastal development [12]. What's more, even though this program is driven at national level, elected representatives and local authorities are involved in implementing this environmental policy [13]. And for marine biodiversity, we still have marine nature parks. This increased protection of natural marine areas is fairly recent. The parks provide additional legal means for preserving certain marine environments. These marine protected areas will be able to reduce human pressure as much as possible. They will therefore be sanctuary zones for marine biodiversity [14].

If we return to the notion of ecosystem services, it is an additional justification for maintaining and developing all these regulatory tools for environmental protection [15]. This is why scientists are increasingly working with local, national and international authorities on this issue. The number of articles dealing with ecosystem services has increased exponentially over the last 40 years [16]. We have entered a virtuous circle. Ecosystem services are well identified. Their qualitative and quantitative values are made known to institutions. Which take decisions to conserve and safeguard the very ecosystems the provide us with these services. Emphasis is therefore placed on the interests offered by ecosystems when public decisions are made [17] [18].

3. Material: Martinique, a Land of Biodiversity

With a view to identifying and safeguarding ecosystem services, Martinique's biodiversity is an asset. Its exclusive economic zone boasts a high level of marine biodiversity. Here, we can find a wide variety of pelagic species (tuna, marlin, swordfish, sea bream), benthic species (snapper, conch, lobster), sea crabs in the mangroves and white sea urchins. This marine resource is an economic advantage for a tropical island. In Martinique, there are 850 companies fishing 1,000 tons a year (Source: Martinique Sea Direction, 2023). Martinique's rich biodiversity is

also marked by the fact that it is part of a global biodiversity hot spot, the Caribbean. A hot spot is characterized by its high level of endemic species, around 1500 or more than 0.5% of the endemic species present on Earth [19]. Martinique's terrestrial biodiversity is mainly the result of a combination of two phenomena, apart from the fact that it is in the intertropical zone. Firstly, there is Martinique's particular topography, with a duality between a wet windward slope and a drier leeward slope caused by the presence of high reliefs, the "Montagne Pelée" and the "Pitons". Precipitation in Martinique is mainly orographic [20]. The other factor is the fact that Martinique was built on an assemblage of several geological structures: Le Lamentin quaternary plain; Montagne Pelée active volcanism; Pitons du Carbet and Morne Pavillon volcanism; La Caravelle and Sainte-Anne oligocene deposits [21]. These two main factors are at the origin of a vegetation gradient that runs from the North-Central of the island, with very humid mountain vegetation, to a coastline with dry vegetation, even very dry vegetation on the Sainte-Anne peninsula [22]. And to this we must add the marine ecological diversity for an overall view of the ecology of Martinique. A wide variety of pelagic and benthic species evolve in different marine ecosystems such as mangroves, seagrass beds, coral communities, algal communities and communities of sponges and gorgonians [23]. Food self-sufficiency is supported by fishing for some of these marine species, but also by agricultural activities in Martinique. Self-sufficiency in agricultural food is fairly low. Today, only 20% of the island's surface area is devoted to agriculture. Of this 20%, half is used for export. If we add together banana (22% of the Useful Agricultural Area (UAA)) and sugar cane (17% of UAA) plus fallow land (16% of UAA), we have 55% of the Useful Agricultural Area for export. That leaves just 10% for local production. This is broken down as follows: livestock farming, 31% of the UAA; vegetable crops, 6% of the UAA; and fruit crops, 4% of the UAA (Source: Directorate of Food, Agriculture and Forestry (DAAF) of Martinique, 2022). Organic farming in Martinique is still very underdeveloped. According to data for 2021 from the "Agence Bio", it accounts for just 3% of the Useful Agricultural Area.

All these factors make Martinique an area rich in biodiversity and an attractive tourist destination. In fact, Martinique has seen a spectacular upturn in its tourism figures. In one year, it has gained 39.1% more tourists (Source: French National Institute of Statistics and Economic Studies (INSEE), 2023). Tourism's carrying capacity (number of tourists divided by the resident population) is therefore very high. It increases to 2.54 times more tourists than inhabitants on the island. The aera is therefore suffering from tourism overload. This anthropic pressure must be monitored to avoid causing significant environmental damage. The public authorities have put in place several measures to protect the environment. In Martinique, we have a wide range of protection tools: a regional nature park; land and marine ZNIEFFs (Natural Area of Ecological, Faunal and Floral Interest); a wetland of international importance, a Ramsar site; classified sites; "Conservatoire du Littoral" land; nature reserves; and a natural marine park, the "Précheur" marine

reserve (Source: Martinique Department of the Environnement, Planning and Housing (DEAL), 2024). Very few marine nature parks have been created in France, just eight. The one for Martinique was created in 2027 [24]. We could say that we that we are in an experimental and trial-and-error phase. Maritime practices are being organized to protect and preserve the natural marine environment as best we can.

However, insularity has an impact not only on an area's ecology, but also on its economy. There are several factors that limit human activity and the economy, such as isolation, remoteness, the small size of the territory, the fragility of the ecosystem and vulnerability to natural disasters. All these factors make it difficult for small islands to grow. There is little diversification of the production base, high trade costs and a limited local market. However, these major handicaps are mitigated by the many ecosystem services provided by Martinique's ecosystems.

4. Method: A Holistic Approach to Ecosystem Services

We are going to draw up a topology of these ecosystems through immersion research in Martinique's ecosystems to analyze their services to the population. This consisted of interviews with people over 60 years of age to find out about their use of past ecosystem services, and with people under 25 years of age to find out whether they knew about these past services; fieldwork to observe nature by touring the Martinique coastline and going on several hikes; and finally, immersion research over several years in Martinique to find out "How do people use their natural resources?".

The questions in the interviews with people over 60 focused on the natural remedies they had previously used. But more broadly, how did they use natural elements in their everyday lives? And were there any recreational activities they did with plants and trees? The data collection technique was cumulative. The information gathered from the first interviewer was confirmed by the second interviewer. The second interviewer also provided us with additional information of his own. In this way, the subsequent contributors gradually added to the database on the various past uses of ecosystem services. In a second phase, the interviews focused on people under the age of 25. The aim was to identify the transmission channels of past ecosystem services to the younger generation. The information collected from people over 60 was therefore submitted to people under 25. We asked about their knowledge of the following topics: old-fashioned games and toys made from natural elements; which plants were used to treat which illnesses; and how certain natural elements were used in everyday life. If they knew of old-fashioned games, natural utilities and medicinal plants, they were then asked from whom and where they had learned such information. These interviews with young people under the age of 25 will enable us to identify the ways in which old knowledge is passed on.

Field observation was based on identifying the flora and fauna and the various human activities practiced in the various ecosystems of Martinique. The following

index enabled us to focus our research on certain sites. The Doumenge index (the length of coastline divided by the surface area of the island) [25] applied to Martinique gives a result of 0.31. 0.31 is much higher than 0.05, so Martinique is a very maritime island. Hence the interest in concentrating on coastal ecosystems, so the research was carried out by touring the Martinique coastline. A few hikes were also added to study inland ecosystems and their uses. All this gave us an overall view of human exploitation of ecosystems in Martinique.

This research also involved immersion in both space and time. In terms of spatial immersion, the studies carried out in Martinique covered the North, Centre and South of the island. The ecosystems observed were inland forests, agricultural areas, beaches, backshore forests, mangroves and the petrified savannah of Sainte-Anne. Temporal immersion was spread over several years. It enabled us to assess the role played by biodiversity at different times of the year. In particular, the role it plays in Martinique's religious and cultural events.

This database of ecosystem services in Martinique is then processed using a systems approach. It is inspired by Bertalanffy's General System Theory [26], emphasized the fact that both natural and anthropogenic elements are interrelated. We therefore need to favor a global analysis of the research object to be able to study all the issues it raises. A holistic analysis of society is also necessary to find out how natural flows benefit the development of society [27]. This approach could be an aid to decision-making. Political decision-makers will then know the different parameters to be considered during a development project.

5. Result: Typology of Ecosystem Services in Martinique

It is thanks to this research work that we can begin to identify a typology of the current and past use of biodiversity ecosystem services by Martinique society.

Past uses are presented in three sub-categories: games of yesteryear; utilitarian elements; and traditional medicine. Then, for current uses, we have: the prevention of natural risks; leisure and discovery activities; the well-being of the population; food subsistence services; cultural services; and the worldwide recognition of a territory (**Figure 2**). For each of these categories, we will look at a few examples of ecosystem services.

We will therefore explore how Nature supports the Societal system. At the same time, we'll take a closer look at the ecosystems that provide these services. How are they subjected to anthropogenic pressures? Because these degradations impact not only the environment, but also society. Because we are in an interconnected natural and anthropogenic system. As one of the laws of systems theory explains: "the whole is in the part". This implies that if we attack one part of the system, in this case Nature, the whole system will be affected, including society.

For past uses of ecosystem services, let's start with five old-fashioned pastimes made from natural elements. Firstly, we have the "bwa flo" from balsa, which was a light wood carved for surfing. Secondly, the branches of the mahogany tree were used as swings and its skin as a skipping rope. Thirdly, toys were made from the

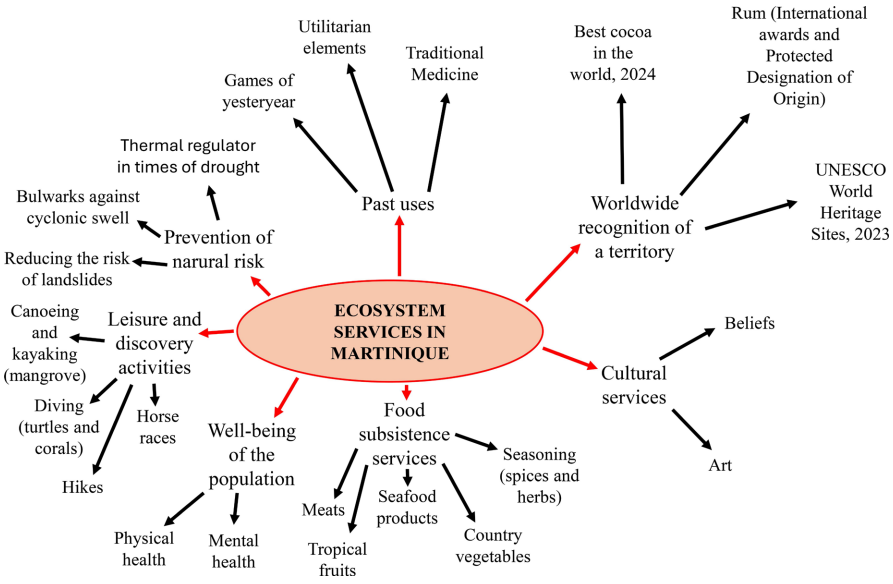

Figure 2. Typology of ecosystem services in Martinique (Source: Hirep L. M., 2024).

seeds of a tree. The fruit of the almond tree (*Terminalia catappa*) was used instead of wheels in the "home-made" production of small cars. Fourthly, coconut leaves could be used to make slides. And fifthly, the fishermen challenged each other on their gum trees (the boat had the same name as the tree) to see who was the fastest. This then gave rise to the traditional gum tree "yole" race, in which they used the white gum tree. Next, let's move on to some utilitarian elements. The calabash was used as a container for seasoning meat and fish. Another example is the production of "coui" using bamboo and calabash. The "coui" is a kind of pole that is very effective for collecting river water without getting wet. Bamboo was also used to irrigate gardens. Natural beauty treatments were already practiced. Avocado, crushed into an ointment, was used to treat the hair. To finish with a look at past uses, let's look at some traditional medical remedies. Traditional medicine with plants was used for a variety of health problems, including: "herbe puante" and "babin chat" for internal cleansing; "herbe couresse" for tension problems; "herbe amère" to relieve the liver; "citronelle", "herbe à pic", "atoumo", "arada" and "basilic" for fever and flu; "boldo" and "patchouli" for bloating; "charpentier", "brisée" and "chardon béni" for stress relief; "thé pays" for sore eyes; the sticky liquid from a cut banana tree to stop blood flowing from wounds; "soulier zombi" for good digestion; and a remedy based on "paroka" and castor oil for intestinal worms. One very special case of traditional medicine that deserves our attention is leech medicine. Leeches are collected in marshy environment, either in mangrove swamps or in ponds. They are then used to suck water and blood from swollen legs and stomachs. In addition to private individuals, even hospitals resorted to these practices. Unfortunately, all this knowledge is little known to the younger generation. Indeed, the transmission of traditional knowledge is rather succinct. Nevertheless, their limited knowledge of this subject is obtained in three different ways. There are places in Martinique that show younger generations how, in the

past, people lived in symbiosis with their natural environment. These places often welcome schoolchildren on educational visits. Schools are another way of discovering traditional knowledge about nature. But above all, the main channel of transmission remains the family, with parents and grandparents.

We've seen that nature can heal us, but we're going to see that it can also protect us against natural hazards. Martinique's rugged terrain means that the vegetation's root system is an important factor in reducing the risk of landslides. Mangroves and coral reefs are effective bulwarks against cyclonic swell. They protect Martinique's coastline. Plant cover is an excellent thermal regulator. It is a precious ally in times of drought. The north of Martinique has a lot of plant cover, so it is less affected by drought. It should be noted that the ecosystems that provide these services are subject to numerous anthropogenic disturbances. Take the island's largest mangrove, Génipa, for example. Its soil has already been partially artificialized by the construction of industrial zones, Martinique airport and the shopping mall of the same name. This situation has considerably increased the risk of flooding during periods of heavy rainfall, as the mangrove no longer plays its role as a rainwater buffer. Another phenomenon is uncontrolled urbanization on the slopes of the hills without authorization or building permits. This reduces the vegetation that is used to maintain soil stability. This increases the risk of landslides in two ways. Deforestation has made the sites more vulnerable to meteorological hazards. And the material and human stakes are higher because of the number of homes on these slopes. This is why urban planning authorities are incorporating the issue of environmental protection of urban structures into their land-use plans.

Now that it has been protected, nature can be used to entertain the people of Martinique, as well as being an asset to tourism. Here are a few examples of leisure and discovery activities that can be carried out in Martinique's natural environments: canoeing and kayaking to explore the mangrove swamps; diving to explore the seabed (turtles and corals); hunting and recreational fishing; horse-related activities such as the horse races on Sainte-Marie beach, with four categories (mule, pony, half-breed and thoroughbred) and the horse races organized at the Martinique racecourse; and finally, forest walks, which allow us to exercise while observing the plant structures. In fact, Martinique's great biodiversity can be seen not only on walks but also in activities along its coastline. Here are just a few of the species that can be encountered on three hikes. On the hike to Sainte-Anne, we have: Silver Argiope, *Argiope argentata*; Alabama Swamp Flatsedge, *Cyperus ligularis*; Fragrant Buttonsage, *Lantana involucrate*; Blue bell, *Centrosema virginianum*; Minnieroot, *Ruellia tuberosa*; Jumble prickle, *Opuntia dillenii*. On the hike to Diamant, we can discover a wide variety of species such as: Sensitive plant, *Mimosa pudica*; Water grass, *Commelina diffusa*; Martinique Trimezia, *Trimezia martinicensis*; Zarzabacoa De Monte, *Desmodium axilare*; Cascabelillo Axilar, *Crotalaria purdiana*; Wild marigold, *Wedelia calycina*; Nosegaytree, *Plumeria alba*. On the climb "Montagne Pelée", we can admire the following species:

"Krékré nwè" in Creole, *Miconia corymbose*; West Indian Treefern, *Cythea arborea*; "Krè a kok" in Creole, *Crantzia cristata*; Philippine Ground Orchid, *Spathoglottis plicata*; West Indian raspberry, *Rubus rosifolius*; "Gueule de loup montagne" in French, *Gesneria ventricose*; Wild pineapple–mountain, *Guzmania plumieri*; Pineapple-mountain, *Pitcairnia spicata*; Leatherleaf Eelvine, *Vaccinium racemosum*; Mountain thyme, *Chaetogastra chamaecistus*; Honey herb, *Besleria lutea*. As for Martinique's coastline, we can observe a wide variety of plants (American Mangrove, *Rhizophora mangle*; White Mangrove, *Laguncularia racemosa*; Black Mangrove, *Avicennia germinans*; Button Mangrove, *Conocarpus erectus*; Jumbie bean, *Leucaena leucophala*; Seagrape, *Coccoloba uvifera*; Shoreline Seapurslane, *Sesuvium portulacastrum*; India Almond, *Terminalia catappa*; Blacktorch, *Erithalis fructicosa*; "Galba" in Creole, *Calophyllum calaba*; Bayhops, *Ipomoea pes-caprae*; Spiny Fiddlewood, *Citharexylum spinosum*; Pigeon Berry, *Bourreria succulenta*; Falseteeth, *Capparis flexusa*; Seaside Mahoe; *Thespesia populnea*; Tree of little stars, *Clerodendrum aculeatum*; White Cedar, *Tabebuia heterophylla*; Jamaican caper, *Capparis cynophallophora*), birds (Grey Plover, *Pluvialis squatarola*; Snowy Egret, *Egretta thula*; Western Cattle Egret, *Bubulcus ibis*; Brown Pelican, *Pelecanus occidentalis*; Lesser Yellowlegs, *Tringa flavipes*; Magnificent Frigatebird, *Fregata magnificens*; Semipalmater Plover, *Charadrius semipalmatus*; Green Heron, *Butorides virescens*; Mangrove Cuckoo, *Coccyzus minor*) and crabs (Red rock crab, *Grapsus grapsus*; Ghost crab, *Ocypode albicans*; Blackback land crab, *Gecarcinus lateralis*; Rapacious Fiddler crab, *Uca rapax*; Blue Land crab, *Cardisoma guanhumi*; Bernhard's hermit, *Pagurus bernhardus*). Martinique society creates many moments of conviviality within this coastal biodiversity, such as outings to the beach or camping on the backshore. However, these multiple demands on nature create problems of use. The Caravelle peninsula in Martinique is a good example of a conflict of use between the development of tourist accommodation in the Tartan district and environmentally friendly activities in the Regional Nature Park. The peninsula can therefore be divided into two parts. In the first part, the vegetation is increasingly nibbling away. There are even gaps in the forest ecosystems where seasonal rental villas are being built. This real estate pressure is more or less contained to prevent these gaps from widening. We try to strike the right balance between tourism and the environment. In the second part, the peninsula has adopted a policy of ecotourism. Protecting the environment is the top priority. Even so, this does not prevent human activities such as hiking and visiting ruins in their green setting.

All these activities in the natural environment also produce induced well-being services for the population. Physical activities are more meaningful. Contact with nature is much more stimulating than repetitive indoor exercises. In terms of mental well-being, we have sylvotherapy, or "Shinrin-yoku" in Japanese, which means "forest bath", a practice that invites you to meditate in the midst of nature and helps you to refocus. So it's important to keep green spaces close to residents. In Martinique, we're not in a vast urban zone with a few green islands. But we are

in a natural zone with a few urban islands. The aim is to maintain this balance so that these urban islands can benefit from the surrounding nature in the long term. What's more, there's a placebo effect to consider. It's just as important to be aware of the well-being that nature brings us, so that we can enjoy it to the full. Communication in Martinique's media is not sufficiently focused on this issue. Like many media spheres, the social issues addressed are predominantly negative. This media policy has a nocebo effect on Martinican society. The expected feel-good factor of contact with nature is reduced.

The other element to be considered in maintaining a healthy society is diet. Local meat production is used to make typical Martinique dishes: chicken colombo; "boucané" chicken; Christmas blood sausage; and "méchouis" (the name of both the festival and the dish). The variety of tropical fruits also makes for a wide range of juices, jams (used in local pastries), ice creams and cocktails. Country vegetables, meanwhile, are cooked in gratins, "accras" (salty fritters) or simply boiled with a piece of cod. The ways in which the diversity of seafood products is cooked are also very much part of Martinique's identity, with dishes such as "trempage" (a mixture of crushed fishes and bread soaked in very spicy sauce), "blaff" (a kind of very spicy stock), "accras", fried, breaded or grilled fish and the Antillean fish stock. All these dishes are seasoned with local herbs and spices, making Creole cuisine very spicy. Finally, the processing of sugar cane into cane sugar, rum, cane juice and "battery syrup" (thick syrup from cane juice) are also hallmarks of the West Indian identity. Fertile soil and a very sunny climate mean that the region produces a wide range of foods. The diversity of these natural resources forms the basis of Creole cuisine. We can also add the relationships between the two sectors of food self-sufficiency: land-based with agriculture and sea-based with fishing. They are physically interconnected by streams and rivers. In normal times, these hydrographic networks are a positive source of nutrients for coastal waters. Today, however, some coastal areas are closed to fishing due to agricultural pollution. In particular, the presence of pesticide in the environment, chlordecone, has s*et al.*arm bells ringing among local health authorities. Chlordecone is one of the main causes of chronic disease on the island. But this is only the tip of the iceberg. The health impacts of all the pesticides and chemical elements injected into the environment have yet to be studied. This public health issue is rapidly becoming critical for an island territory. There is a cumulative and amplifying effect of chemical poisoning within the food chain. And the last link in the chain is the people of Martinique.

Other cultural elements linked to nature can also be mentioned: plant art and beliefs. So, what does vegetation contribute to art? We have the seeds of rainforest trees, which are used to make jewelry such as the "caconnier" and "job" seeds. Some decorative dolls are made from plants, such as breadfruit leaves to dress the doll, which are dried and then lacquered. Floral arrangements are made from West Indian flowers such as the "apinia", the "arum", the "porcelain rose" and "bird of paradise", including funeral sprays made from woven coconut leaves,

where the flowers are inserted into the interstices of the weave. Other artistic elements are made from plants: furniture in mahogany; musical instruments made from the calabash, bamboo or conch shell; and finally, the "bakoua" hat made from the fiber of the "bakoua" tree. Now that we've seen the cultural services linked to art, let's move on to those linked to beliefs. In the incense tree, its sap is used to make incense, which is then used in religious ceremonies. There are also religious rituals surrounding the "fromager" tree. These traditions are losing influence in the face of globalization, which has had a profound impact on the culture of the younger generation. The Americanization of society has also taken its toll on island cultures. In terms of food, many fast-food restaurants have flourished on the island. The explosion of e-commerce is putting small craftsmen in a difficult position. Local consumption of handicrafts is low. What's more, some products sold to tourist, which are presented as typical, come from elsewhere, where labor is cheaper.

Finally, biodiversity is part of our identity. It also enables the region to shine on the international stage. In fact, Martinique's rum is world-renowned for its superior quality, winning international awards and protected designation of origin status. The wide variety of distilleries on the island of Martinique, despite its small size, means that the flavors of the sugar cane and the associated rum are even mor complex. Martinique's chocolate has also made a stunning comeback. In 2024, it won the prize for the best cocoa in the world at the Amsterdam chocolate fair. At last, the "Montagne Pelée" and the "Pitons" from the North of Martinique have been listed as UNESCO World Heritage Sites since 2023. However, it's not enough to be recognized worldwide at a given moment. You must be able to maintain your reputation over time. To this end, work is underway to renovate the facilities on the "Montagne Pelée" trail. Rum producers are always investing in improving their production in terms of flavor. And the rebirth of cocoa bean production continues, with a group of producers and support from the Martinique local authority and the European Union.

6. Discussion: A Global Vision of Ecosystem Services

This wealth of ecosystem services is a source of debate in the scientific community. Let's look at some of the issues this raises.

As far as the past use of ecosystem services is concerned, the population's disaffection can be explained by modern dynamics. In particular, the toy craze is recent. It was when Christmas became a commercial holiday that the toy industry took off [28]. Most of these industrial toys are made of plastic with electronic components [29]. This was not the case in the past. Children were highly imaginative and used elements of their natural environment to create toys and games. These activities strengthened the bond between Man and Nature. Similarly, before the industrial boom of the consumer society [30], we made direct use of the materials that Nature offered us for everyday activities (gardening, cooking, music, etc.). Finally, before modern chemical medicine [31], we relied on natural reme-

dies. There was as much traditional medicine as there was territory. Because the raw materials were the surrounding plants. The additional contributions of modern medicine are simply chemical transformations by extracting the active ingredients from plants [32]. As far as traditional medicine is concerned, we can also add medical care with leeches, which is used worldwide [33].

These past services can be reactivated if the local population reclaims its natural environment. This would considerably enhance current services. But before this can happen, current services need to be identified and looked after for future generations. When drawing up a land-use planning project, local authorities must be aware of the benefits of Nature, particularly in terms of preventing natural hazards [34]. The importance of protecting the natural environment is therefore considered in the project. Vegetation reduces the risk of landslides by stabilizing the soil. The scientific consensus is high enough for researchers to include it in their projections, in their "future forest management scenarios" [35]. On this subject, they note that deforestation modifies plant composition. The vegetation is newer and less deeply rooted in the soil, the hydrological balance is disrupted, and this leads to an increase in landslides. We are therefore dealing with natural laws that have been highlighted by the international scientific community. But they are even more important because we are on a volcanic island with very uneven terrain and in an intertropical zone. Moreover, forests are known to be good thermal regulators [36]. Even in small areas such as parks in urban areas, which reduce the "heat island" effect [37]. Finally, there are mangroves, which are very important in the dynamics of intertropical coastal zones. They help to mitigate waves and protect the coastline from erosion. Hence the importance of funding the protection of mangroves when implementing development strategies to prevent natural hazards such as cyclonic swells [38]. Decision-makers must therefore increasingly take mangrove ecosystem services into account in their prevention strategies.

The other service that the authorities must not forget is that one of Nature's main economic assets is its appeal to tourists. What underpins tourism worldwide are the leisure activities and discoveries that Nature has to offer. This is precisely what makes it so attractive to travel and discover new areas with their diversity of natural environments. This aspect is highlighted in ecotourism, a form of tourism focused on promoting and protecting nature [39]. Biodiversity therefore needs to be protected in order to be enjoyed. These activities are also practiced by the local population, creating real moments of conviviality. It has been shown that nature in the city generates moments of conviviality [40]. The same process takes place in the great outdoors. Numerous events with friends or family are organized in the open air. This strengthens family ties and friendships.

These activities also create a sense of well-being [41]. Visits to nature, which are usually made in groups, with family or friends, facilitate social behavior. What's more, being outdoors and in the presence of natural elements increases our mental and physical energy. Not least because of the feeling of freedom and autonomy created by the open space with no visual boundaries. We can go further and enter

communion with Nature through meditation. Being in contact with Nature is good for your morale [42]. It is with this aim in mind that some experiments in Nature are being carried out to support people who have undergone psychological suffering. This is what is known as sylvotherapy. This need for Nature was strongly expressed during and after the "covid confinements" [43]. To conclude on this point, a pleasant living environment is also measured by the degree of accessibility to Nature.

The next service is vital for mankind: food self-sufficiency [44]. This is one of the objectives of the Millennium Development Goals (now one of the objectives of the 2030 Agenda): to feed the entire population of the planet and eradicate famine. Food sovereignty is a priority for every state and territory. Food security includes both quantity (the balance between production and consumption) and the quality and diversity of food. Martinique has a lot of work to do in terms of food self-sufficiency, with half of its agricultural production going to the foreign market. Food is also a marker of identity. Food practices play a part in the construction of a societal and personal identity [45]. Eating habits are acquired through the transmission of a culture. Intergenerational exchanges therefore play an important role. When biodiversity is cooked, it creates social links. It is part of a society's identity, particularly during wedding and communion ceremonies and Christmas and Easter celebrations. In Martinique, Creole cuisine is also a tourist attraction. Most of the restaurants along the island's coastline offer Creole cuisine with varying degrees of sophistication.

At this stage, we can see that cultural ecosystem services are fairly encompassing [46]. Even if this study on ecosystem services in Martinique restricts cultural services to art and spirituality. Past or traditional services, food, human activities specific to territory, the brilliance of a territory in a particular field can all be considered as cultural services. Hence the difficulty of establishing a typology of ecosystem services.

We must make selections in the classification of ecosystem services until we reach the last point: the global recognition of an area. An area can be recognized worldwide in different ways. The variety of distilleries and alcohol production contributes to the development and reputation of a region. Examples include tequila and mezcal for Mexican terroirs [47] and the different wine terroirs in Europe [48]. Territorial indications for agricultural products are used as quality marks at international level. The aim of recognizing local products is to encourage the preservation of agrobiodiversity. Martinique rum follows the same model of promoting the region through the diversity of its distilleries. Mass production of cocoa beans is dominated by three countries: Côte d'Ivoire, Ghana and Ecuador [49]. Small-scale producers do, however, have a way of differentiating themselves through the quality of their beans. This is precisely the case for the intertropical islands, which have a small quantity of beans but concentrate on quality. This gives them a chance to win awards and be noticed worldwide by chocolate specialists. Finally, we will look at the extent to which natural sites have been selected

by UNESCO [50]. In fact, following this distinction by UNESCO, the sites are becoming more successful, with a sharp increase in the number of tourists. However, attention must be paid to the impact of the tourist surplus. This creates additional pressure on the environment. The public authorities need to strike the right balance between economic development based on tourism and environmental protection.

Generally speaking, we can see that there is a clash between two worlds: a system based on traditional, ecological values, and a more urban, modern system. This opposition gives rise to a hybrid system, in which the role ecosystem services remains central. In any case, a system that rejects the benefits of nature is not viable. It will cross several disaster lines: ecological, tourist, economic, social and health related. Soil artificialization, agricultural, industrial and maritime pollution and the more or less permanent destruction of plant structures are all possible ecological disasters. In the long term, this can lead to a decline in tourism. If it's only to find the same elements of modernity, what's the point of traveling? It's these plant structures that make a region so rich. Fewer tourists mean fewer jobs, which are essential to the island's economy. If unemployment rises again, the social fabric will be weakened, with many families facing financial difficulties. And all this will have an impact on society's well-being, with the emergence of chronic illnesses due to the stress of families in financial distress. But also because of the various types of environmental pollution, which then affect the population and turn into a health crisis. It is therefore vital to maintain the system's equilibrium with environmental protection tools and a growing environmental awareness among the population. Hence the importance of communicating ecosystem services to the general public.

7. Conclusions

In conclusion, it can be said that ecosystem services in Martinique are very numerous and diverse. We have reviewed the different situations in which they are used by the population. The typology that we established identified three uses of ecosystem services in the past (games of yesteryear, utilitarian elements and traditional medicine) and six uses in the present (prevention of natural risks, leisure and discovery activities, well-being of the population, food subsistence services, cultural services and worldwide recognition of a territory). It seems that the relationship with nature was once stronger. Modernity and excessive regulation are perhaps the cause of this estrangement. Despite this, ecosystem services remain essential to the well-being, development and identity of Martinique society. We have seen that these different ecosystem services are also interrelated. There are many links in this typology of ecosystem services used by Martinique society.

Of course, each point covered would require more in-depth expertise, as the subject is so rich. Like the use of leeches in medicine, both in hospitals and in private homes, which is a subject in itself. Another line of research would be to study the impact of these ecosystem services on tourism. Given that tourism is an

essential part of the island's economy, how can all those involved in tourism make the most of this natural wealth? Knowledge of all of Martinique's ecosystem services is a prerequisite for making the best possible use of them, with no or as little degradation as possible.

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Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

References

[1] Boyd, J. and Banzhaf, S. (2007) What Are Ecosystem Services? The Need for Standardized Environmental Accounting Units. *Ecological Economics*, **63**, 616-626. https://doi.org/10.1016/j.ecolecon.2007.01.002

[2] Yi, C. and Jackson, N. (2021) A Review of Measuring Ecosystem Resilience to Disturbance. *Environmental Research Letters*, **16**, Article ID: 053008. https://doi.org/10.1088/1748-9326/abdf09

[3] Salles, J. (2011) Valuing Biodiversity and Ecosystem Services: Why Put Economic Values on Nature? *Comptes Rendus. Biologies*, **334**, 469-482. https://doi.org/10.1016/j.crvi.2011.03.008

[4] Naidoo, R., Balmford, A., Costanza, R., Fisher, B., Green, R.E., Lehner, B., *et al.* (2008) Global Mapping of Ecosystem Services and Conservation Priorities. *Proceedings of the National Academy of Sciences of the United States of America*, **105**, 9495-9500. https://doi.org/10.1073/pnas.0707823105

[5] Elmqvist, T., *et al.* (2013) Urbanization, Biodiversity and Ecosystem Services: Challenges and Opportunities. Spinger, 175-251. https://doi.org/10.1007/978-94-007-7088-1

[6] Daily, G.C. (1997) Introduction: What are Ecosystem Services. Societal Dependence on Naturel Ecosystems. Island Press, 1-10.

[7] Costanza, R., Kubiszewski, I., Ervin, D., Bluffstone, R., Boyd, J., Brown, D., *et al.* (2011) Valuing Ecological Systems and Services. *F*1000 *Biology Reports*, **3**, Article 14. https://doi.org/10.3410/b3-14

[8] Brondizio, E., *et al.* (2019) Assessing a Planet in Transformation: Rationale and Approach of the IPBES Global Assessment on Biodiversity and Ecosystem Services. Zenodo, 5-48. https://doi.org/10.5281/zenodo.3831852

[9] Maresca, B., Mordret, X., Ughetto, A.L. and Blancher, P. (2011) Évaluation des services rendus par les écosystèmes en France. *Développement durable et territoires*, **2**, No. 3. https://doi.org/10.4000/developpementdurable.9053

[10] Denizeau-Lahaye, C. (2015) Des SDAU aux SCoT: Évolution des objectifs des politiques d'urbanisme. *Cahiers du GRIDAUH*, **29**, 61-78. https://doi.org/10.3917/cdg.029.0061

[11] Graziani, S. (2004) Développement territorial durable et participation volontaire: Le cas du parc naturel régional de la Corse. *Revue d'Économie Régionale & Urbaine*, 2, 239-257. https://doi.org/10.3917/reru.042.0239

[12] Joveniaux, A. (2017) Le Conservatoire du littoral, quarante ans après: Quel bilan et quelles perspectives? *Hérodote*, **165**, 91-112. https://doi.org/10.3917/her.165.0091

[13] Gérard, Y. (2009) Une gouvernance environnementale selon l'état? Le conservatoire du littoral entre intérêt général et principe de proximité. *VertigO*, **9**, No. 1. https://doi.org/10.4000/vertigo.8551

[14] Mabile, S. (2006) Les parcs naturels marins consacrés par le législateur. *Revue Juridique de l'Environnement*, **31**, 251-264. https://doi.org/10.3406/rjenv.2006.4548

[15] Ingram, J.C., Redford, K.H. and Watson, J.E. (2012) Applying Ecosystem Services Approaches for Biodiversity Conservation: Benefits and Challenges. *Surveys and Perspectives Integrating Environment and Society*, **5**, No. 1.

[16] Fisher, B., Turner, R.K. and Morling, P. (2009) Defining and Classifying Ecosystem Services for Decision Making. *Ecological Economics*, **68**, 643-653. https://doi.org/10.1016/j.ecolecon.2008.09.014

[17] Daily, G.C., Polasky, S., Goldstein, J., Kareiva, P.M., Mooney, H.A., Pejchar, L., *et al.* (2009) Ecosystem Services in Decision Making: Time to Deliver. *Frontiers in Ecology and the Environment*, **7**, 21-28. https://doi.org/10.1890/080025

[18] Carpenter, S.R., Mooney, H.A., Agard, J., Capistrano, D., DeFries, R.S., Díaz, S., *et al.* (2009) Science for Managing Ecosystem Services: Beyond the Millennium Ecosystem Assessment. *Proceedings of the National Academy of Sciences of the United States of America*, **106**, 1305-1312. https://doi.org/10.1073/pnas.0808772106

[19] Myers, N., Mittermeier, R.A., Mittermeier, C.G., da Fonseca, G.A.B. and Kent, J. (2000) Biodiversity Hotspots for Conservation Priorities. *Nature*, **403**, 853-858. https://doi.org/10.1038/35002501

[20] Vittecoq, B., Lachassagne, P., Lanini, S. and Maréchal, J.C. (2010) Évaluation des ressources en eau de la Martinique: Calcul spatialisé de la pluie efficace et validation à l'échelle du bassin versant. *Revue des sciences de l'eau*, **23**, 361-373. https://doi.org/10.7202/045098ar

[21] Mazabraud, Y. (2019) Historical and Contemporary Use of Natural Stones in the French West Indies. Conservation Aspects and Practices. *Sustainability*, **11**, Article 4566. https://doi.org/10.3390/su11174566

[22] Joseph, P. (2006) Hypothèses sur l'évolution de la végétation littorale des Petites Antilles depuis l'époque précolombienne: Le cas de la Martinique. *Cybergeo*, **338**. https://doi.org/10.4000/cybergeo.1784

[23] Legrand, H. (2009) Base de Données Cartographique des Fonds Marins Côtiers de la Martinique: Biocénose Benthiques. Rapport Technique, Observatoire du Milieu Marin Martiniquais. http://ifrecor-doc.fr/items/show/1714

[24] Mazurek, H., Arreghini, L., Cochet, C., Daniel, J., Gros-Désormeaux, J. and Pereira, D. (2019) La création du parc naturel marin de Martinique: Entre concertation et fragmentation. *Natures Sciences Sociétés*, **27**, 310-326. https://doi.org/10.1051/nss/2019044

[25] Doumenge, F. (1987) Quelques Contraintes du Milieu Insulaire. *Iles et Archipels*, **8**, 8-16. https://www.persee.fr/doc/ilarc_0758-864x_1987_act_8_1_908

[26] Bertalanffy, L. (1968) General System Theory. Edition George Braziller.

[27] Hirep, L.M. (2016) Introduction to the Anthropo-System Theory. *International Journal of Recent Research and Review*, **9**, 10-16.

[28] Cross, G. and Smits, G. (2005) Japan, the U.S. and the Globalization of Children's Consumer Culture. *Journal of Social History*, **38**, 873-890. https://doi.org/10.1353/jsh.2005.0053

[29] Muñoz, I., Gazulla, C., Bala, A., Puig, R. and Fullana, P. (2008) LCA and Ecodesign in the Toy Industry: Case Study of a Teddy Bear Incorporating Electric and Electronic Components. *The International Journal of Life Cycle Assessment*, **14**, 64-72. https://doi.org/10.1007/s11367-008-0044-6

[30] Kellner, D. (1983) Critical Theory, Commodities and the Consumer Society. *Theory, Culture & Society*, **1**, 66-83. https://doi.org/10.1177/026327648300100306

[31] Lombardino, J.G. and Lowe, J.A. (2004) The Role of the Medicinal Chemist in Drug Discovery—Then and Now. *Nature Reviews Drug Discovery*, **3**, 853-862. https://doi.org/10.1038/nrd1523

[32] Yuan, H., Ma, Q., Ye, L. and Piao, G. (2016) The Traditional Medicine and Modern Medicine from Natural Products. *Molecules*, **21**, Article 559. https://doi.org/10.3390/molecules21050559

[33] Hosseini, M., Jadidi, A., Derakhshan Barjoei, M.M. and Salehi, M. (2024) Applications of Leech Therapy in Medicine: A Systematic Review. *Frontiers in Medicine*, **11**, Article 1417041. https://doi.org/10.3389/fmed.2024.1417041

[34] Ruangpan, L., Vojinovic, Z., Di Sabatino, S., Leo, L.S., Capobianco, V., Oen, A.M.P., *et al.* (2020) Nature-Based Solutions for Hydro-Meteorological Risk Reduction: A State-Of-The-Art Review of the Research Area. *Natural Hazards and Earth System Sciences*, **20**, 243-270. https://doi.org/10.5194/nhess-20-243-2020

[35] Malek, Ž., Boerboom, L. and Glade, T. (2015) Future Forest Cover Change Scenarios with Implications for Landslide Risk: An Example from Buzau Subcarpathians, Romania. *Environmental Management*, **56**, 1228-1243. https://doi.org/10.1007/s00267-015-0577-y

[36] Fries, A., Rollenbeck, R., Göttlicher, D., Nauß, T., Homeier, J., Peters, T., *et al.* (2009) Thermal Structure of a Megadiverse Andean Mountain Ecosystem in Southern Ecuador and Its Regionalization. *Erdkunde*, **63**, 321-335. https://doi.org/10.3112/erdkunde.2009.04.03

[37] Wang, W., Zhang, B., Xiao, L., Zhou, W., Wang, H. and He, X. (2018) Decoupling Forest Characteristics and Background Conditions to Explain Urban-Rural Variations of Multiple Microclimate Regulation from Urban Trees. *PeerJ*, **6**, e5450. https://doi.org/10.7717/peerj.5450

[38] Friess, D.A. and Thompson, B.S. (2016) Mangrove Payments for Ecosystem Services (PES): A Viable Funding Mechanism for Disaster Risk Reduction? In: Renaud, F., Sudmeier-Rieux, K., Estrella, M. and Nehren, U., Eds., *Ecosystem-Based Disaster Risk Reduction and Adaptation in Practice*, Springer, 75-98. https://doi.org/10.1007/978-3-319-43633-3_4

[39] Stronza, A.L., Hunt, C.A. and Fitzgerald, L.A. (2019) Ecotourism for Conservation? *Annual Review of Environment and Resources*, **44**, 229-253. https://doi.org/10.1146/annurev-environ-101718-033046

[40] Straughan, E., Phillips, C. and Atchison, J. (2022) Finding Comfort and Conviviality with Urban Trees. *Cultural Geographies*, **30**, 507-524. https://doi.org/10.1177/14744740221136284

[41] Pritchard, A., Richardson, M., Sheffield, D. and McEwan, K. (2019) The Relationship between Nature Connectedness and Eudaimonic Well-Being: A Meta-Analysis. *Journal of Happiness Studies*, **21**, 1145-1167. https://doi.org/10.1007/s10902-019-00118-6

[42] Mathias, S., Daigle, P., Dancause, K.N. and Gadais, T. (2020) Forest Bathing: A Narrative Review of the Effects on Health for Outdoor and Environmental Education Use

in Canada. *Journal of Outdoor and Environmental Education*, **23**, 309-321. https://doi.org/10.1007/s42322-020-00058-3

[43] Jastrzębska, J., Zaraś, E. and Botwina, J. (2024) Resting in the Forest in Times of Pandemonium for the Betterment of Life, or Bushcraft in the Polish National Forests. *Acta Scientiarum Polonorum Administratio Locorum*, **23**, 445-459. https://doi.org/10.31648/aspal.9685

[44] Baer-Nawrocka, A. and Sadowski, A. (2019) Food Security and Food Self-Sufficiency around the World: A Typology of Countries. *PLOS ONE*, **14**, e0213448. https://doi.org/10.1371/journal.pone.0213448

[45] Almerico, G.M. (2014) Food and Identity: Food Studies, Cultural, and Personal Identity. *Journal of International Business and Cultural Studies*, **8**, 1-7.

[46] Daniel, T.C., Muhar, A., Arnberger, A., Aznar, O., Boyd, J.W., Chan, K.M.A., *et al.* (2012) Contributions of Cultural Services to the Ecosystem Services Agenda. *Proceedings of the National Academy of Sciences of the United States of America*, **109**, 8812-8819. https://doi.org/10.1073/pnas.1114773109

[47] Pérez-Akaki, P., Vega-Vera, N.V., Enríquez-Caballero, Y.P. and Velázquez-Salazar, M. (2021) Designation of Origin Distillates in Mexico: Value Chains and Territorial Development. *Sustainability*, **13**, Article 5496. https://doi.org/10.3390/su13105496

[48] Martínez-Arnáiz, M., Baraja-Rodríguez, E. and Herrero-Luque, D. (2022) Multifunctional Territorialized Agri-Food Systems, Geographical Quality Marks and Agricultural Landscapes: The Case of Vineyards. *Land*, **11**, Article 457. https://doi.org/10.3390/land11040457

[49] Kongor, J.E., Owusu, M. and Oduro-Yeboah, C. (2024) Cocoa Production in the 2020s: Challenges and Solutions. *CABI Agriculture and Bioscience*, **5**, 102-130. https://doi.org/10.1186/s43170-024-00310-6

[50] Mugobi, T. and Mlozi, S. (2021) The Impact of External Factors on ICT Usage Practices at UNESCO World Heritage Sites. *Journal of Tourism, Heritage & Services Marketing* (*JTHSM*), **7**, 3-12. https://doi.org/10.5281/zenodo.4514800