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Review

Necessity to Assess the Sustainability of Sensitive Ecosystems: A Comprehensive Review of Tourism Pressures and the Travel Cost Method

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Abstract: Sensitive ecosystems play a major role in the future of the environment, economy, and society, as they affect and mitigate natural hazards, provide food, energy, and medicinal resources, and job opportunities, as well as cultural and recreational services. Meanwhile, the rapidly growing nature-based tourism sector is applying unsustainable pressures on such ecosystems, prioritizing the assessment of their sustainability, i.e., environmental, economic, and social functionality. To ensure long-term development and conservation, benefits from the natural capital must be valued and included in its management plan. The travel cost method (TCM), although heavily exploited in research, exhibits application challenges and methodological weaknesses. This paper seeks to comprehensively present the most recent applications of TCM, focusing on aquatic ecosystems that serve as tourist destinations, whereupon research gaps are identified, ultimately providing insights for future directions in the field. Quantifying the economic worth of sensitive ecosystems is a prerequisite to address issues, such as overexploitation, pollution, and climate change, so these problems can be alleviated in the long-run. In parallel, the critical long-term double effect of fair entrance fees is recognized, which not only motivate visitation by securing accessibility but also guarantee adequate financial resources to protect and maintain the ecosystems' integrity.

Keywords: ecosystem valuation; travel cost method; sustainable development; sustainable tourism

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1. Introduction

Protected areas are of immense ecological importance due to their ability to preserve and promote biodiversity. In addition to their key role in the formation of nutrient-rich soils and sediments, as well as critical habitats for vulnerable species, they are a coping mechanism for natural disasters, such as floods, while contributing to climate regulation. These two traits, rich biodiversity and resilience to disturbances, are strongly related due to portfolio effects and functional redundancy [1–3].

Another asset of healthy ecosystems are the provisional services related to food, energy, and medical resources. Ecosystems are also found to regulate the range and number of species that may pose a threat to human health and safety. Marine and coastal protected areas, such as mangroves and wetlands, for instance, can act as natural barriers to invasive species and prevent the proliferation of harmful pathogens, like those ones that cause harmful algal blooms or infectious diseases, while providing a home to natural predators that help control the populations of dangerous animals [4–6].

Apart from promoting physical fitness, access to nature and outdoor activities can offer a unique chance for relaxation and stress relief, symptoms that are reportedly intensified by urbanization. Frequent exposure to green and blue settings, either natural or artificial, has been linked to improved mental health outcomes, including reduced anxiety, attention restoration, children's cognitive development and enhanced visitors' overall well-being.

Moreover, the presence of protected areas can contribute to a sense of place and community identity. Protected areas often serve as cultural and historical sites, where local communities can connect with their heritage and traditions while visitors gain opportunities for environmental education and awareness, as well as social integration [7,8].

Finally, protected areas can provide numerous cultural and recreational benefits, including enjoyment and appreciation of their aesthetic value and, of course, tourism. Nature-based tourism is associated with employment in multiple sectors and industries [9]. Therefore, to ensure the long-term development and conservation of an ecosystem, benefits from the natural capital must be assessed and included in its management plan.

Non-market economic valuation (EV) serves as a tool that can be used to estimate the monetary value of the benefits that humans obtain from natural resources through goods and services that are not traded in the market. Given that the conservation of the ecosystem services that these natural resources offer has a positive economic value higher than the cost of misusing them, the information estimated regarding its ecological, cultural, aesthetic, and economic benefits can underpin conservation actions. The economic value of ecosystem services is necessary information affecting government decision-making for developing protection plans, which are usually limited to an admission fee, based on Pigou's tax theory or Coase's contract theory [10,11].

Valuing the environment to improve or maintain its quality has been subject to controversy, due to a misunderstanding the valuing approach. The concept of "value" encompasses a broad set of ideas with two main categories: "held values" and "assigned values". Held values are a person's beliefs on what is good or preferable, while assigned values are given to an object relative to other objects. Non-market valuation estimates assigned values, which are affected by held values, and have to be expressed in a specific scale that enables direct comparison [12].

Still, non-market valuation faces conceptual and ethical challenges when assessing environmental goods and services, recently called "the tragedy of well-intentioned valuation" [13]. Anthropocentrism raises concerns due to the potential confusion between the intrinsic value of nature and value derived from individual preferences, as well as the lack of consideration for the social distribution of benefits and costs. The aggregation of values is also challenging due to the heterogeneity of methods used, making comparisons difficult. Technical difficulties arise from certain issues, like double-counting and the simultaneous valuation of mutually exclusive uses. Value discounting for future uses introduces uncertainty, reducing the weight given to far-reaching consequences and raising concerns about neglecting critical issues. The reliability of non-market valuation information and its application in nature monetization have been subjects of debate, with the Exxon Valdez oil spill as one illustrative example [14].

The aim of this paper is threefold. Firstly, it seeks to provide an overview of the most recent case studies employing non-market economic valuation methods, with a special focus on the travel cost method (TCM), showcasing its evolution and current state-of-the-art applications mainly on aquatic ecosystems facing sustainability challenges due to tourism and heavy visitation. Their results are gathered and presented in a comprehensive manner, targeting researchers, policymakers, and stakeholders who are interested in exploring the advancements in the valuation of ecosystem services. Additionally, it aspires to pinpoint the limitations and research gaps within the current body of TCM literature that are yet to be addressed. By highlighting these areas, it sparks discussion for innovative approaches and sets the foundation for future research.

This paper is structured as follows: the relationship between tourism, ecosystems, and sustainability (Section 2); a critical review of the most common non-market economic valuation methods during the last five years (Section 3); a crucial discussion on main outcomes, their long-term exploitation, as well as their limitation useful for researchers, policymakers and stakeholders (Section 4).

2. Sustainable Tourism and Sensitive Ecosystems

2.1. Tourism in Protected Areas

A total of 9.8% of the total global domestic product and 7% of global trade are related to tourism, as well as 11% of the global workforce [15]. Currently, 20% of jobs created over the past decade were due to tourism [16]. By 2030, tourism is expected to take over 57% of the global economy [15].

Europe claims 5 out of the top 10 tourism destinations in the world [17]. Still, Europe accepts 500 million arrivals annually, which corresponds to EUR 610 billion each year. Also, 12 million occupations are directly linked to European tourism, as well as 2 million enterprises [18].

Regardless of this constant growth, we have to bear in mind that other factors, such as carrying capacity, resilience, and natural resources, are not going to scale proportionally, but are bound to further deplete instead [19].

Protected areas (PAs) all around the world are estimated to attract around 8 million visitors/year. In Europe, up to 10,000 destinations contribute to economic security, with an ever-growing interest in the natural environment [20,21].

Apart from several initiatives, such as the "EU Biodiversity Strategy for 2030" and "European Green Deal" among them, the EU has established laws for the conservation of biodiversity and nature, regarding wildlife and the regulation of activities, such as hunting and fishing. Directive 2009/147/EC "Birds" and Directive 92/43/EEC "Habitat", first promoted in 1979 and 1992, respectively, protect over a thousand animals and plants and over two hundred habitat types, comprising the NATURA 2000 (N2K) network. This network encompasses the "Sites of Community Interest", later named "Special Areas of Conservation", following the "Habitats" Directive and also the "Special Protection Areas" that focus on protecting wild birds (NATURA 2000 Viewer https://natura2000.eea.europa.eu/ (accessed on 4 July 2023)).

Although Europe's protected areas cover 26% of its land, there are currently over 27,300 designated N2K sites, covering approximately 18% of the EU's land and about 4% of the marine area (Figure 1). Based on visitors' WTP, the value of recreation in these areas can potentially reach EUR 9 billion/year, a number far exceeded by the annual expenditures associated with tourism, which rise beyond EUR 80 billion/year. Due to the perpetual decline in ecological richness and variety in Europe, the N2K network is constantly expanding [20,22,23].

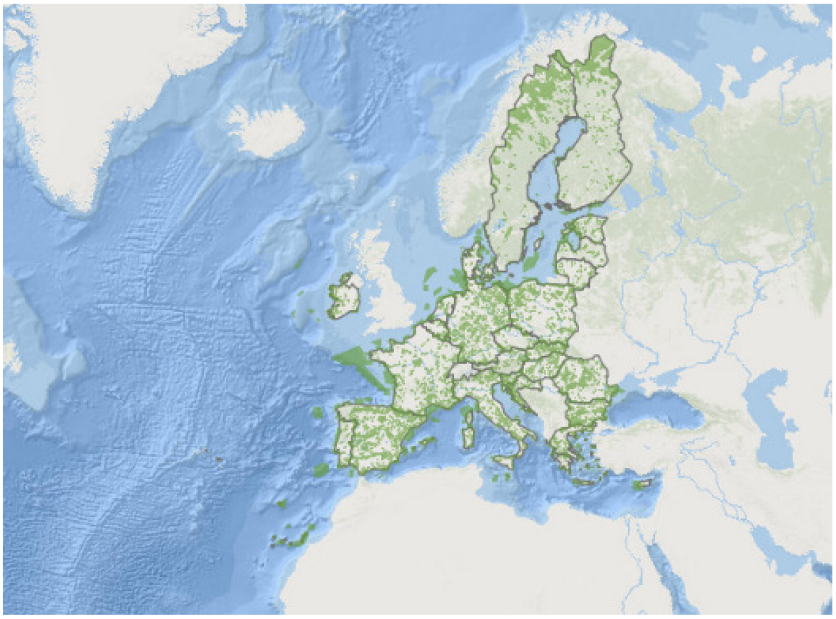

Figure 1. The NATURA 2000 Network (NATURA 2000 Viewer https://natura2000.eea.europa.eu/ (accessed on 4 July 2023)).

As has already been mentioned, protected areas are linked to working positions. Around 12 million full-time jobs in agriculture, forestry, fishing, recreation, and other industries are generated by the presence of an N2K site. Meanwhile, managing and maintaining these ecosystems demands over EUR 5 billion/year. Realizing the economic benefits of this network would require stakeholders' support and secure financing for conservation initiatives and additional investments [9].

Figure 2 illustrates a conceptual framework of nature-based tourism. Over the years, the purpose of tourism in protected areas has shifted from an anthropocentric approach towards a biocentric one. The "PA for visitors" evolved to the "PA with visitors" model, both retaining adverse environmental effects, leading to the "PA and visitors" ideal, which brings forward a symbiotic relationship between any given area and visitors, wherein both profit [24].

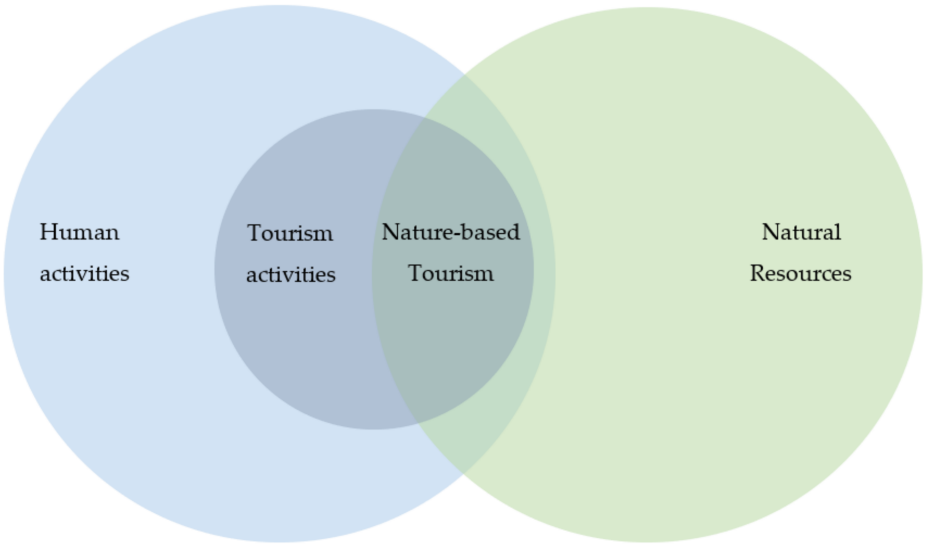

Figure 2. A nature-based tourism framework.

Several tourism types have been proposed in the context of sustainability, including those listed in Table 1.

Table 1. Types of sustainable tourism (Earth Changers https://www.earth-changers.com/ (accessed on 27 June 2023)).

Tourism Type	Traits	Origin
Sustainable tourism	Considers social, economic, and environmental needs of given community and visitors Aims to improvement	World Tourism Organization
Ecotourism	Stresses the importance of knowledge and education for everyone involved in a given area (stakeholders and visitors)	The International Ecotourism Society, 2015
Volunteer tourism	Working holiday for social and environmental causes Covers basic expenses	Not explicitly determined
Responsible tourism	Promotes activities that improve the economy and conserve the cultural heritage of a protected area	Cape Town Declaration, 2002, Goodwin
Geotourism	Involves environment, agriculture, culture, local cuisine, etc. Aims to improve the geographical character of protected area	National Geographic

All of the aforementioned tourism types have their pros and cons, but they still converse in encouraging a participatory approach, rather than a consumeristic one [25]. Of course, there are many other types, such as culture (heritage) tourism, community tourism, wildlife tourism, etc. [15].

2.2. Pressures Applied on Ecosystems Due to Unsustainable Tourism

The expansion of tourism applies environmental, economic, and social pressures in some parts of the world. The tourism industry is responsible for 8% of global CO_2 emissions, 72% of which are associated with transportation, 21% with accommodation, and 4% with tourist activities [26].

There are also other types of pollutants, such as microplastics in the marine environment and cigarette butts that display seasonality affiliated with tourist activities. As for waste generation, according to the European Environmental Agency, tourists produce 6.8% of Europe's waste [17]. Around 1 kg of solid waste per capita daily is double the amount produced by a local resident. In America, this number rises to 2 kg [15].

Loss of biodiversity is another existing issue. Many natural destinations are overexploited, leading to the disturbance of the wildlife they harbor. Beach resorts in Dubai are an example of damaged habitats. The maintenance of cultural heritage is also at stake, due to the construction of infrastructure that is ever-expanding [15].

Apart from these environmental issues, gender inequality (covered by the fifth goal of the UN's 2030 agenda) is a social phenomenon reportedly related to economic costs in addition to environmental damage. Women usually occupy front-of-the-house hospitality jobs, thus, confronting the worst aspects of the industry: oppression, sexual harassment, exploitation, pay gap, etc. [27].

Overtourism seems to be an up-and-coming problem for sustainable tourism. Defined as "the situation in which the impact of tourism, at certain times and in certain locations, exceeds physical, ecological, social, economic, psychological and or political capacity thresholds" by the European Parliament's Transport and Tourism Committee in 2018, it is reportedly linked to the expansion of international tourism, due to the following:

- Low-priced transportation tickets and travelling opportunities;
- An abundance of bed and breakfast accommodation, as well as several other tourists' facilities;
- Political phenomena, such as war or terrorist attacks, that disfavor certain destinations;
- The expansion of the Internet, through which information is easily obtained and experiences are shared on various platforms [28].

This situation stirs negative feelings towards visitors, as their presence is associated with rising prices or deterioration of residents' well-being. At this point, anti-tourism activity may take place, or even tourismphobia, in the form of discrimination or organized campaigns against tourists [29]. Thailand, the Philippines, Barcelona, Venice, and part of Scotland are dealing with this phenomenon via the implementation of entry fees or tourism downgrading policies [30].

After the failure of the Millennium Development Goals, the UN's 2030 Agenda is a promising strategy. Conveying 17 sustainable development goals, which include 169 targets, some of which have to do with the future of the tourism industry [27].

Specifically, the following are related to tourism:

- Inclusive and sustainable economic growth: 8, 9, 10 and 17;
- Social inclusiveness, employment and poverty reduction:1, 3, 4, 5, 8 and 10;
- Resources regulation, environmental protection and climate change: 6,7, 8, 11, 12, 13, 14, and 15;
- Cultural heritage and diversity: 8, 11, and 12;
- Peace and security: 16.

3. State-of-the-Art Research

The first step for constructing this review involved exploring scientific publications on the subject through ScienceDirect, Web of Science, Scopus, and ResearchGate. Focusing on the most recent work, results were limited to a date range between 2018 and 2022. The search terms (keywords) inserted were as follows: "Travel Cost Method", "Natura", "Beach", "Protected Area", and "Natura 2000".

The second step involved going through the obtained material and shortlisting it based on its relevance to coastal ecosystems, especially beaches and protected areas. The works mentioned include case studies from around the world, not only in the Mediterranean region or the EU. Consequently, the monetary values stated below have all been converted into euros, based on the change rate of the year each research was conducted (ExchangeRates software at: https://www.exchangerates.org.uk/USD-EUR-exchange-rate-history.html (accessed on 2 June 2023)).

3.1. Non-Market Economic Valuation Methods

There are two main categories of non-market EV methods: stated and revealed preference. Some of them are summarized in Table 2 [31–34].

Table 2. Most common non-market economic valuation methods [31–34].

Type	Method	Definition
Stated preference	Willingness to pay (WTP)	The total valuation is estimated by multiplying the average WTP by the total number of users. It is found that respondents tend to over-report their WTF under hypothetical questions.
	Contingent valuation (CV)	Users are presented with one or more hypothetical scenarios in which they are asked to express their WTP, for a specific improvement in environmental quality or conservation of a natural resource. The responses are then used to estimate the overall economic value of the environmental good or service. Suitable for sites with aesthetic features.
	Choice experiment (CE)	Users choose between different alternatives presented to them, each with a different combination of attributes regarding environmental quality or conservation policies.
Revealed preference	Mitigation behaviour (MBV)	MBV is based on estimated costs related to avoiding or reducing exposure to environmental risks (e.g., a potential flood).
	Hedonic pricing (HPM)	HPM involves gathering data on price variations, pinpointing their origin, and estimating the impact of the environment on them.
	TC method (TCM)	TCM is based on the assumption that the travel expenditures to a site are related to visitor's valuation of it. Suitable for tourist destinations.
	Dose–response (DR)	DR data are often utilized to estimate the impact of environmental quality (e.g., air pollution) on human health.
	Replacement cost technique	Mostly used in damage assessment, this method estimates the costs of replacing lost or damaged services or goods.

3.2. The Travel Cost Method

TCM was first proposed by Hotelling in 1947, where "zonal" data were defined around the examined site. These zones would usually but not necessarily be concentric circles of varying distances. Per area, the visitation frequency would be measured and, based on different average TCs per trip calculated per zone, a demand function would be constructed, providing information on the total consumer surplus. During the 1970s, a different approach emerged that included "individual-based" data (Brown and Navas, 1973; Gum and Martin, 1975) [35].

Both ZTCM and ITCM are compared in Table 3.

Table 3. Individual and zonal TCM comparison [6,36].

ITCM	ZTCM
Specifies individual's traits	Uses average data per zone
Produces more accurate demand function	Avoids outliers
Requires significant sample	Deals with lack of data
Assumes that an individual's characteristics affect travelling decisions	Considers certain socioeconomic variables statistically insignificant
Robust estimations require variation in visitation rate	Robust estimations require an adequate number of zones

Figure 3 illustrates the global extent of TCM applications over a five-year period (2018–2022).

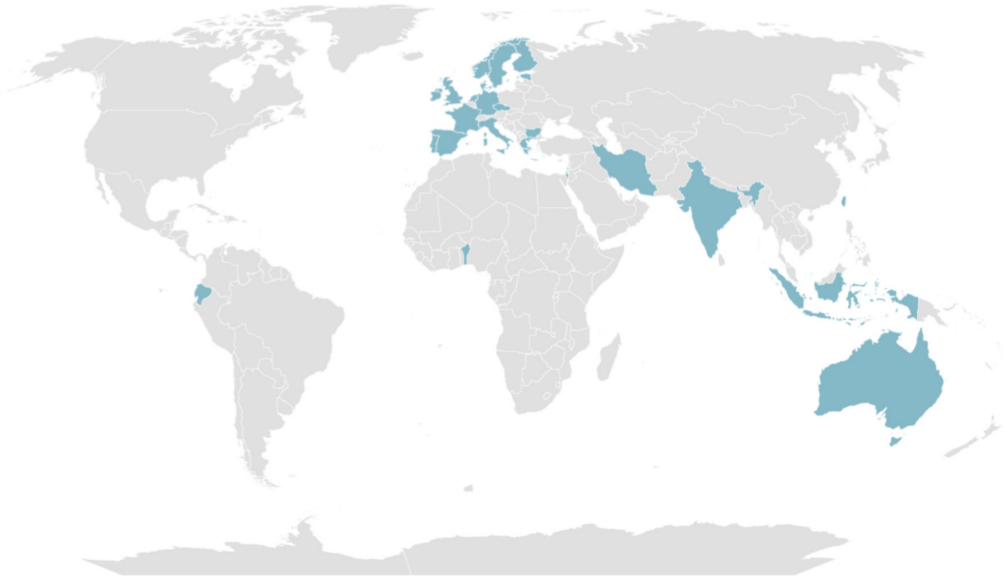

Figure 3. Mapping the application of the travel cost method across the world for 2018–2022.

3.2.1. Limitations of the Travel Cost Method

The TCM demand curve is based on two main factors: the users' WTP, given that they have spent both money and time to visit a site, and the frequency of their trips (usually annual), which is affected by their motivation and experience. The standard information needed is as follows:

- The number of trips to the area;
- Demographics;
- TC;
- Time spent travelling.

For a more elaborate model, the following are required:

- Time spent at the destination;
- Other sites visited during the same trip;
- Visiting purpose;
- Overall satisfaction (usually referring to environmental quality).

However, there are some elements that are hard to consider in this methodology, demonstrating its limitations. These include the following [32]:

- Travel duration: The time spent travelling to a destination can be seen as part of the trip's expenditures by time-constrained individuals, whereas others may benefit from a scenery journey.

- Multi-purpose and multi-destination trip: When visiting the examined site is part of a trip that involves several other destinations, there are difficulties in calculating the TC of interest. When the overall TC is allocated to different destinations, the partial cost drastically decreases.
- Substitute destinations: The presence of other destinations, even of the same type as the one ultimately visited, actually adds value to the latter. So, given two different travelers covering the same distance, the one with access to substitutes could value the preferred destination more.
- Other expenditures: In addition to transportation costs, there are several others, such as parking fees, vehicle maintenance expenses, as well as food and accommodation costs.

3.2.2. The Opportunity Cost of Time

According to some studies, the travel duration to a certain destination influences the value assigned to it, generating the opportunity cost of time (tC), which is usually considered proportional to income (varying from 0 to 100% of it) [36,37].

In some cases, the opportunity cost of time is not included in the TC model, due to a lack of information on income, the assumption that visitors are off work anyway, or that travelling time is part of the experience [31,38]. However, most studies propose that the opportunity cost of time is equal to one-third of the hourly earnings multiplied by the time spent on roundtrip travel [9,39]. The hourly earnings could be an average for different countries or zones [40] or the stated individuals' income [3]. To obtain the net hourly income, Lankia et al. divided the household monthly gross income by the number of adults, subtracted the corresponding tax rate, and then divided it by the standard 158-hour working time [41].

3.3. Global Experience

In Indonesia, Gunungkidul Regency encompasses a coastal area of 46 beaches, where the number of visitors has rapidly increased over the second half of the past decade. However, this surge in tourism and fishing activities has led to significant management issues, notably waste overload. In 2018, a study examined the economic value of the entire coastal area using TCM across six beaches. The results showed a value of EUR 190 thousand/year, emphasizing the importance of sustainable management of the coastal zone. The study also identified the push and pull factors that motivated visitors to the area, providing effective management actions [42].

Nanwan Bay, Kenting National Park of Taiwan, is a popular recreational area of high biodiversity that has recently turned into a busy attraction for water activities. This may be the repercussions of the abrupt economic growth of the country, which has enhanced the standard of living. Since 2001, the two days off per week policy has let more and more people enjoy recreational activities, and, thus, has created the need to produce a management plan. Dond et al. exploited a truncated Poisson model, a truncated binomial distribution model, and an on-site Poisson model based on TCM that estimated a consumer surplus of EUR 234/person per visit, or a yearly gross of EUR 221 million [43].

Villamil Beach National Recreation Area, Ecuador, is a highly visited tourist destination all year long. This protected area provides various recreational services at the shoreline. Economic valuation, which reveals diverse uses of natural resources, like beaches, has been employed to estimate the economic value of the area. Specifically, the individual TCM (ITCM) revealed that the estimated value for the whole sample (residents and tourists) is EUR 14.95/person/visit. A semi-elasticity analysis in this study showed that tourists are less sensitive to slight changes in travel expenses [10].

Malecón 2000, Ecuador, is a tourist destination, boasting a wide range of attractions, including historical monuments, retail shops, lagoons, and gardens. However, for the park to continue thriving in a sustainable manner, it is crucial to develop effective policies that ensure its maintenance. To achieve this objective, it is necessary to understand the

profile of the visitors who frequent the park. In 2020, researchers applied the ITCM, which yielded a value of approximately EUR 14/visit, indicating that new strategies could be put in place to improve the park's financial performance. It is projected that if these strategies are effectively implemented, the park's earnings could rise to EUR 334 million [44].

Using a TC modelling approach with online survey data as input, the economic value of beach usage by residents of New South Wales, Australia, was estimated. It is observed that the various activities have different consumer surplus values, with surfing, fishing, and swimming giving higher values than more passive activities, like enjoying the environment. Moreover, Sydney residents and non-Sydney residents have different values of EUR 11–22/trip, respectively. It is also suggested that a trip to the beach provides an initial consumer surplus of approximately EUR 9/trip for Sydney residents, with additional benefits coming from engaging in different activities. For instance, adding a walk along the beach after surfing can increase the value by EUR 15/visit [37].

Southwestern Victoria, Australia, encompasses the Greater Geelong area as well as the Great Ocean Road, along with several coastal villages. The ITCM, in conjugation with a choice experiment (CE) was applied to five seaside towns, the former for the estimation of the recreation values generated by the coastal caravan and camping parks and the latter to measure visitors' WTP to cope with climate change impacts on beach access. A total of 388 campers and 382 local residents were interviewed, revealing a value of EUR 40/person/night or EUR 1.6 thousand/camper/year. What is more, 66% of the campers were willing to pay around EUR 100/year so that beach size and park sites were not reduced [33].

The Benin government has shifted its focus to seaside tourism to boost economic growth. In order to inform public policies on preserving and enhancing the coast, costs and benefits of beach tourism and recreation have been examined by a study that focused on Fidjrossè Beach, using ITCM and negative binomial regression as a count model. The determinants of demand for recreation were highlighted, including the negative relationship between TCs and positive relationships with time spent on the site and level of education. The estimated visitor surplus was estimated at EUR 0.76 for overall expenses per visitor, which is relatively low, so further investigation is required to address methodological limitations [11].

Gahar Lake is situated in a valley surrounded by the Oshtrankooh Mountains, Iran. To assess the economic value of this resort, Kheyri et al. employed the ZTCM model, which involved surveying 380 randomly sampled visitors during the visiting seasons. The survey included sections on both economic and social aspects of the visitors' experience. The analysis of the data revealed a value of EUR 74/person or EUR 1.7 million/year. This study also found that the poor facilities available at the resort played a significant role in mainly attracting younger visitors. The results of this study stress the need to develop a comprehensive tourism plan for Gahar Lake, which should take into account the economic value of the resort as well as the users' profiles [45].

In the ongoing efforts to estimate the recreational value of India's coastal and marine ecosystems, TCM has been one of the first successfully implemented. This macro approach has been adopted in response to the recent and continuous land-use changes in the coastal zones, which have raised concerns about the sustainability of these ecosystems. The results of the ZTCM analysis indicate that the recreational value of the coastal areas of nine Indian states collectively contributes 0.9% to the country's GDP. Notably, the study also evaluated the consumers' surplus, which was found to be EUR 16 and 31 billion for locals and foreign visitors, respectively. These findings illustrate the immense economic significance of India's coastal and marine ecosystems, and the urgent need to develop sustainable policies that ensure their preservation and continued availability for recreational use [6].

Another study conducted in North Portugal aimed to estimate the benefits and costs associated with two beaches at the Azibo Reservoir Protected Landscape, which are home to a vast number of species, hence, gaining the Blue Flag eco-label. The ZTCM was used, involving 224 questionnaires. The results show that, in 2016, the Azibo beaches

had about 20,000 more visits during the high season compared to the previous year. The visitors' TCs were estimated at EUR 10 million, while their net benefits were around EUR 3.6 million. These figures indicate a surplus attributed to the site, even after accounting for the management expenses of EUR 162.5 thousand/year. Although certain socio-economic traits of the respondents were not included, the fact that the results were in line with other studies suggests that the ZTCM was a suitable choice compared to ITCM [36].

In a recent study for Prespa National Park, Greece, a hybrid TCM model was developed, in which the dependent variable was the number of trips/person (as in the zonal TCM), while including users' socio-economic characteristics (as in ITCM). Subsequently, to gather the necessary data, two surveys were conducted on hotelkeepers in the surrounding areas, utilizing both constructed and semi-constructed approaches. The consumer surplus per trip was estimated at EUR 59, resulting in an annual value of ecotourism worth approximately EUR 206 thousand [46].

Researchers conducted a study at Oosterschelde, the Netherlands, near the Belgian border, to explore whether Dutch and Belgian divers who visit this site would be willing to contribute towards its upkeep. The results of the study indicate that recreational diving alone provides a significant consumer surplus of EUR 108 and EUR 197 for Dutch and Belgian divers, respectively. This equates to an annual value of approximately EUR 22 million. It was also found that Belgian interviewees demonstrated a greater WTP than their Dutch counterparts. These findings provide valuable insights into the profiles of users of this site, which could be useful in developing effective management strategies, especially given the limited budgets available for maintenance [47].

TCM has also helped explore the impact of the recreational use of a seaside walking path on Galway Bay, located on the west coast of Ireland, due to natural disasters, specifically storms and erosion, as well as the cost of sustainable measures regarding green and gray infrastructure. A negative binomial model, along with input data based on an on-site survey, showed that the recreation value of the area is high, especially for locals. A further cost–benefit analysis was performed and indicated that both gray and green infrastructure could generate benefits over the span of two decades, with the latter being far more efficient. The method was assessed as robust after a sensitivity analysis [48].

Due to the COVID-19 pandemic affecting the marine tourism industry and, subsequently, coastal economies, it is now a priority for island nations to inspire and bring back overseas visitors. A study carried out in Ireland examined 610 visitors to Ireland's participation in the marine and coastal tourism market and the length of stay of tourists in multiple coastal areas. TCM was used to estimate the consumer surplus, as an extra value a person gains over their costs per trip in a coastal area, at EUR 295/day or EUR 1031/year [38].

It should be clear by now that TCM is usually applied in combination with another evaluation method. A study employed TCM and the contingent valuation method (CVM) to estimate the non-market value of recreation in two coastal lagoons: the Coorong (Australia) and the Ria de Aveiro (Portugal). Results showed that visitor profiles from both sites were similar. The consumer surplus estimated via TCM for Coorong and Ria de Aveiro were EUR 132 and EUR 160/person/day, respectively, whereas the equivalent values with contingent valuation were EUR 103 and EUR 110, respectively, with the CVM [49].

The Dead Sea has lately displayed a gradual water level decrease, which is leading to constant dehydration in its southwestern basin. Developing well-informed policies concerning the future of the southwestern basin calls for the estimation of its economic benefits. For this purpose, market and non-market benefits have been compared in a single study, combining TCM with CVM. The latter presented two different scenarios: a business-as-usual one and an alternative, in which Dead Sea hotels are to be closed due to climate change policies. Ultimately, the total non-market benefit loss was found to be EUR 24.4 million annually, about 19% of the overall benefits [50].

Following the same line of reasoning, TCM has been applied along with a partial cost–benefit analysis to compare the recreational surplus to maintenance costs of

three beaches in the Nerbioi Estuary, North Spain. In the early 1990s, the construction of a wastewater treatment plant in the vicinity enhanced the water quality of the surrounding area of these beaches, creating new opportunities for recreation. The findings of this study concluded that the annual EUR 3.5 million consumer surplus could fully cover the annual maintenance expenses and partially (12%) fund the operating costs of the sewage system. These benefits correspond to EUR 5.99, EUR 7.06, and EUR 8.09/trip, with these values varying because of the different visitor's profiles of each destination [51].

A study conducted in Finland opted to evaluate the impact of changes in water quality on recreational benefits, especially swimming trips. This study employed national recreation inventory data and a combination of TCM and a contingent behavior approach to estimate the value of a swimming trip in Finland at EUR 16/trip. Furthermore, results showed that under a water quality worsening scenario, the value would drop to EUR 8/trip, while under an enhanced water quality scenario, it would be elevated to EUR 19/trip. This means that the annual value of all swimming trips would increase by 53–80% with water quality improvement but decrease by approximately 80% with water quality decline [41].

The idea of co-benefits, first emerging in the 1990s, refers to GHG restriction policies concerning climate change. A study assessed the landscape co-benefits produced by the N2K networks with respect to "Timpa di Acireale", a coastal region in Sicily, North Italy. Both TCM and contingent valuation were employed, and data were collected via questionnaires for 159 local visitors and 75 non-local visitors. The cost-effectiveness of the existing management plan was calculated with a discounted cash flow analysis. The results indicated that resident users', local tourists', and foreign visitors' co-benefits reach EUR 75, EUR 100, and EUR 2000/year, respectively. Weaknesses in the site's management plan were attributed to poor infrastructure [9].

Another study conducted in Lake Puruvesi, Finland, used a combination of TC and a contingent behaviour (CB) model to evaluate the impact of water quality changes on water recreation. To avoid further water quality decline, researchers sought to reveal the spatial distribution of visitors. This was accomplished by utilizing an "Epanechnikov" kernel function, which estimated the density surface of the five chosen "hot spots". Data were collected through an on-site, as well as an online survey, that allowed the integration of spatial information. Results for the current state of water quality showed that the surplus per visit was around EUR 71. However, this number is much higher for car travelers, reaching EUR 300. As expected, the estimated consumer surplus decreases with water quality deterioration. The methodology proposed in this study helps policymakers prioritize the most vulnerable locations within the examined area [39].

The frequency of jellyfish blooms in the Northeast Atlantic region is reportedly increasing, as evidenced by multiple jellyfish–human interactions in coastal recreation areas. In order to evaluate the negative impact of these instances, a study applied TCM at St Ives, Cornwall, UK. Data were collected via questionnaires administered to beachgoers, further exploring potential changes in total visitation under different jellyfish bloom scenarios. The results indicate that beach closures due to jellyfish stingers would cause a daily loss of EUR 9.7 thousand, while non-stinger blooms would result in a daily loss of EUR 3 thousand. The study also found that beach users are willing to donate to anti-jellyfish management schemes, with a projected benefit of over EUR 5 thousand. The study suggests that jellyfish blooms could have a significant impact on coastal recreation in the UK, and so developing an anti-jellyfish management plan may lessen the impact [4].

Another multi-site study was carried out in 2021 across half of the EU member states using a TCM and CB approach. This research focused on blue spaces and went further than the existing literature by using a unified online survey, including different types of blue spaces, integrating user's opinions on water quality changes, and exploiting a multivariate Poisson lognormal regression model instead of the usual Poisson lognormal. The findings yielded were that the annual average visits to these sites are 47 per person, which corresponds to a recreation value of about EUR 41, which in turn suggests a total of EUR 631 billion/year. Based on the water quality standards dictated by the "Bathing Water

Directive", it is found that a 1-level increase in water quality causes 6.7% more annual visits, while 1-level decrease causes a 20.8% drop [31].

When estimating the value of natural areas for their incorporation into larger development plans, single-sited TCM evaluations may not prove sufficient. For example, a study conducted in 2022 attempted to compare the recreation value of six contrasting case studies across Norway, Denmark, Finland, and Sweden, so that its findings would potentially support a future, unified, Nordic bioeconomy policy. Using TCM in conjunction with survey data, the study found varying results depending on the type of ecosystem, whether it was urban, rural, forested, or including waters and rivers. The total annual values ranged from EUR 3.1 million for a forested area run by a river, to up to EUR 120.8 million for a historic agricultural landscape. Moreover, the study revealed that the recreation benefits were strongly linked to water quality [40].

TCM is rarely applied on a large scale, including a network of areas, as it is usually site-specific. However, a study conducted in 2018 included as many as 728 protected areas in New South Wales, South Australia. Most of them were wilderness areas, open to the public and providing multiple recreation activities. The data required for the random utility TCM were obtained through a phone survey of over 62,000 people. The results illustrated a strong influence of the built infrastructure available on visitor demand and indicated an annual value of EUR 3 billion, with most of it attributed to frequent visitors within the state of New South Wales [52,53].

Another study integrated data from geotagged photos on social media into the so-called crowdsourced TCM (CTCM). The results were validated using value estimates from on-site surveys for 16 German national parks and value transfer techniques. The study found that demand curves for park access followed standard economic and consumer demand theory and that consumer surplus ranged from around EUR 17 to 35. By incorporating social media data, the CTCM offers an innovative and cost-effective method for estimating economic values of recreational sites, thereby helping researchers and decision makers to better understand and manage these areas [54].

Metadata of geotagged photographs from social media has been another alternative data source to value recreation. A study conducted in 67 Italian protected areas utilized this material as input to build TC count data models, with a zero-truncated Poisson model returning down-sloping demand curves for 50 out of 67 sites. A significant TC coefficient was returned for 33 sites, which allowed for the estimation of consumer surplus. The welfare estimates were found to fluctuate from EUR 6–87, so the mean value was about EUR 33/trip. The study's use of social media data for valuing recreation in protected areas highlights the potential of big spatial data as a novel source for environmental research. Despite challenges, the study's findings could inspire new forms of data collection and analysis [3].

Table 4 illustrates key information on the state-of-the-art research regarding ecosystems valuation using TCM.

Table 4. Overview of studies from across the world that have utilized the TC method.

Year	Authors	Country	Type of Ecosystem	Valuation Method	Data	Consumer Surplus per Trip/Visitor (EUR)	Analysis	Annual Economic Value (EUR)
Non-European Countries								
2018	Riesti and Indah [42]	Indonesia	6 beaches	ITCM	On-site survey	-	Log-linear model	190 thousand
2018	Dong et al. [43]	Taiwan	Bay	ITCM	On-site survey	234	Truncated Poisson model, truncated binomial distribution model, on-site Poisson model	221 million
2020	Mukhopadhyay et al. [6]	India	Coastal zones	ZTCM	On-site survey	-	Panel regression	47 billion
2020	Kheyri et al. [45]	Iran	Lake	ZTCM	On-site survey	74	Linear regression	1.7 million
2018	Lavee and Menachem [50]	Israel	Lake	ITCM + CVM	On-site, online, telephone surveys	17	Linear regression	24.4 million
2021	Houngbeme et al. [11]	Benin	Beach	ITCM	On-site survey	0.76	Poisson model, negative binomial regression	-
2018	Zambrano-Monserrate et al. [10]	Ecuador	Beach	ITCM	On-site survey	15	Zero-truncated negative binomial regression	18 million
2020	Menendez-Carbo et al. [44]	Ecuador	Urban park	ITCM	Online survey	14	Zero-truncated negative binomial regression	271–334 million
2019	Pascoe [37]	Australia	Beach	ITCM	Online survey	15.5	Hurdle model	-
2021	Rolfe et al. [33]	Australia	5 coastal towns	ITCM + choice experiment	On-site survey	40	Advanced logit models	-
2018	Heagney et al. [52]	Australia	Various	ITCM	Telephone survey	28	Random effects ordered logit model	3 billion
European Countries								
2018	Clara et al. [49]	Australia + Portugal	Lagoon	ITCM + CVM	On-site survey	130	Negative binomial model	-
2021	Soares [36]	Portugal	2 beaches	ZTCM	On-site survey	23–114	Linear, linear-log, log-linear, log-log models	3.6 million

Table 4. *Cont.*

Year	Authors	Country	Type of Ecosystem	Valuation Method	Data	Consumer Surplus per Trip/Visitor (EUR)	Analysis	Annual Economic Value (EUR)
2018	Pouso et al. [51]	Spain	3 beaches	ITCM + partial cost–benefit analysis	On-site survey	7	Poisson model	3.5 million
2021	Trovato et al. [9]	Italy	Coastal zone	ITCM + CVM	On-site survey	-	Linear regression	3 million
2022	Sinclair et al. [3]	Italy	Various	CTCM	Geotagged photographs	6–87	Zero-truncated Poisson model	0.3–174 million
2019	Latinopoulos [46]	Greece	Lake	Hybrid TC	On-site survey	59	Log-linear regression	0.2 million
2022	Hynes et al. [48]	Ireland	Bay	ITCM + cost–benefit analysis	On-site survey	11	Negative binomial model	0.6 million
2022	Deely et al. [38]	Ireland	Coastal zones	ITCM	On-site survey	295	Logit model, negative binomial model	-
2022	Kennerley et al. [4]	UK	Coastal zone	ITCM + CVM	On-site survey	-	Negative binomial regression	-
2020	Sinclair et al. [54]	Germany	Various	CTCM	Geotagged photographs	17–35	Log-log ordinary least squares regression	1.67 billion
2020	Rousseau and Tejerizo Fuertes [47]	the Netherlands	Estuary	ITCM + choice experiment	Online survey	108–197	Log-linear regression	22 million
2019	Lankia et al. [41]	Finland	Coastal zones	ITCM + CVM	Online, mailed paper survey	16	Poisson model, negative binomial regression	-
2021	Tienhaara et al. [39]	Finland	Lake	ITCM + CVM	On-site survey	71	Poisson model	-
2022	Juutinen et al. [40]	4 Nordic Countries	Various	ITCM	On-site survey	21–64	Negative binomial models	3.1–120.8 million
2021	Börger et al. [31]	14 EU countries	Blue spaces	ITCM + CVM	Online survey	41	Multivariate Poisson lognormal regression	631 billion

4. Conclusions

Who can benefit?

The economic valuations derived from the studies presented in Chapter 3 quantify the benefits generated by different sites and can justify investments in conservation and sustainable management practices. Policymakers can use this information to prioritize resource allocation, design effective policies, and develop strategies to balance economic development with environmental protection and tackle existing challenges. What is more, it can serve as a means for raising awareness among the general public and stakeholders about the importance of these ecosystems. By highlighting the economic benefits associated with these areas, conservation organizations can build more robust cases for their conservation efforts and engage in effective campaigns.

By examining the findings of these studies, site managers gain insight into the preferences and behaviors of visitors, but also identify the key determinants of visitation patterns and make informed decisions regarding infrastructure improvements, visitor management and the provision of recreational services. Local businesses can better understand the market demand for recreational services and identify potential opportunities for economic growth. This information can guide and support the sustainable development of tourism-related businesses.

As far as research is concerned, the gathered material showcases how the TCM has advanced and adapted over time to accurately assess the economic value of recreational sites. Over the past 5 years, new approaches have been explored, incorporating complementary methodologies (e.g., CVM, CE, cost–benefit analysis, etc.) in order to capture a broader range of economic factors and improve the robustness of their analysis. Moreover, new types of TCM have emerged, based on alternative data collection and analysis (e.g., metadata from geotagged photographs, telephone and online survey, etc.), that render its application feasible even on a large scale, covering multiple sites.

Is it enough?

The focus on economic value may fail to fully capture the worth of protected areas. These ecosystems' ecological functions, including habitat provision, climate regulation, and preservation of biodiversity, cannot be adequately assessed through monetary assessments alone. Spotlighting the economic benefits may perpetuate a mindset that prioritizes anthropocentric gains over ecological integrity.

It is crucial to acknowledge that all reported values in these studies are specific to the assessed locations and are derived in order to address certain issues; thus, they may not be applicable to other contexts. Factors, such as cultural differences, regional economic disparities, typology, challenging circumstances, and variations in visitor profiles can significantly impact the estimated values. Therefore, extrapolating these findings to make broader policy decisions without considering the specificities of each area may lead to misguided and ineffective management strategies. Furthermore, multi-site studies have noted the importance of tailored approaches and the strengths of single-site ones.

The TCM itself raises questions regarding its accuracy and reliability. Estimating economic values based on consumer surplus and willingness to pay assumes that individuals have complete knowledge and rational decision-making capabilities. However, people's preferences and behaviors are influenced by various factors, including social norms, cultural values, and limited information. There are instances of recreation values that are either overestimated or underestimated, which becomes apparent when comparing them to other similar cases. Thus, its further refinement is a prerequisite with respect to reliability and precision.

In essence, quantifying the economic worth of sensitive ecosystems without addressing the root issues, such as overexploitation, pollution, and climate change, perpetuates the notion that these problems can be solved only through economic incentives. This narrow focus on economic valuation risks overlooking the need for holistic and systemic approaches that prioritize sustainability and conservation in the long run.

Exploitation of findings

As is often the case, practitioners leverage the information derived from economic valuation to establish entrance fee policies. To ensure equitable access to these sites and avoid an elitist approach, such fees need to cater to all segments of society, enabling everyone to visit and appreciate these ecosystems. Simultaneously, these fees can serve as a reliable source of income to cover various expenses, from personnel or infrastructure costs, to raising public awareness actions or supporting educational initiatives for both tourists and local communities.

This presents a dual effect caused by fair entrance fees, which create a positive feedback loop. It not only motivates visitation to these sites by securing accessibility, but also guarantees adequate financial resources to protect and maintain the ecosystems' integrity. This synergy is vital for the long-term viability of tourist sites as well as the overall health of the ecosystems they represent.

Furthermore, it is imperative to recognize the role of climate change in shaping the future of these ecosystems. As climate-related damage becomes more frequent and severe, the resilience of these sites is at risk. Therefore, integrating climate change considerations into the management strategies and funding plans is essential to safeguarding the ecosystems' health and functionality. Proactive measures to mitigate climate impacts and enhance resilience are fundamental for their continued existence as valuable tourist destinations.

Critical for future

To capture the full worth of sensitive ecosystems, it is crucial to enhance the TCM through continued research. Efforts should focus on addressing its limitations and incorporating broader aspects of ecosystem values, such as non-market values, as well as ecological and social indicators. This will require interdisciplinary collaboration, but not necessarily the incorporation of advanced statistical techniques and modeling approaches, as is seen so far. Due to the proliferation of digital platforms and mobile applications that provide alternative input sources (e.g., big data, metadata, geolocation data, real-time data) or based on innovative approaches, new types of TCM spring forth that involve simpler processes.

Sustainable management of sensitive ecosystems requires continuous monitoring and evaluation. Long-term, site-specific data collection can track changes in visitor behavior, environmental conditions, and the overall health of the ecosystem. This will shed light on the effectiveness of management interventions and allow for management adaptations for constantly changing sceneries.

Engaging stakeholders, including local communities, recreational users, policymakers, and academia, is crucial for successful sustainability assessments. Collaborative approaches that incorporate local knowledge and values can enhance the accuracy and relevance of the assessments. Additionally, involving stakeholders in the decision-making processes fosters ownership and promotes the development of management plans.

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