

## Cultural ecosystem services: A review of methods and tools for economic evaluation

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### ABSTRACT

Cultural ecosystem services (CES) are non-material intangible benefits that humans derive from ecosystems, which are indispensable for the well-being of communities and directly influence the quality of life. CES are deeply interconnected to each other and to providing and regulating services, thus influencing everyday life. CES are among the most important values that people associate with nature, but understanding them may be challenging. The definition of CES is both self-evident and elusive, specifically because they consist of the interaction between two dynamic systems: human societies and natural ecosystems. This paper updates the state of the art about CES evaluation methods, underlining the gap between their economic values and their incorporation into planning and decision-making on different scales and in different sectors, and emphasizes their importance in conservation policies and sustainable development programs. This study reviewed 68 articles published between August 2019 and May 2023 from the SCOPUS database, and classified CES assessment into 15 evaluation methods. This review reveals that the choice of CES assessment methodologies has often depended on evaluation purposes. In addition, specific CES classifications are required, since different definitions and unstandardized economic concepts for assigning market values to the CES can lead to conflicting results. The combination of different methods, monetary and non-monetary, can aid better evaluation of CES by focusing on the interaction between different components, and can facilitate the mapping and quantification of social values of ecosystem services. This can help decision-makers to develop sustainable territorial planning and policies.

### 1. Introduction

Although it is not possible to assign a value to the ways in which the natural world impacts on human lives, there are countless benefits to living in a world with strong and healthy ecosystems. In recent years, these ecosystem services have been developed to describe the beneficial aspects that the ecosystems themselves or the wildlife provide. The benefits can be direct or indirect, small or large. Society's critical dependence on natural goods and processes has been described by several modern authors (Leopold, 1949; Odum, 1975; Westman, 1977).

De Groot et al. (De Groot et al., 2002) have provided a classification of 23 ecosystem functions that provide a much larger number of goods and services. The goods and services offered by ecosystems became more widely studied following two key publications by Daily (1997) and

Costanza et al. (1997), who referred to these benefits as ecosystem services (ES). According to the millennium ecosystem assessment (MEA), which further promoted and defined the concept of ecosystem services (ES), these are defined as the "benefits that people obtain from ecosystems" (M.E.A. A Report of the, 2005). MEA identified four principal categories of ecosystem services: provisioning, regulating, supporting, and cultural services. Cultural ecosystem services (CES) refer to the nonmaterial benefits which people obtain from the ecosystem and which directly influence their quality of life (M.E.A. A Report of the, 2005). The linkages between ES and human well-being are shown in Fig. 1.

Humans alter nature, in the same way that the natural world has altered them by being a constant presence in human social, cultural and intellectual development. In the very distant past, ancient civilizations

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depicted plants, animals and weather patterns on cave walls (M.E.A. A Report of the, 2005). Specifically, a cultural service may be defined as an intangible but effective beneficial enrichment that leads to cultural development. Ecosystems obviously have a major effect on cultures, from building knowledge to experiencing nature and providing creative opportunities such as architecture, art and recreation (M.E.A. A Report of the, 2005). Therefore, CES include aesthetic inspiration, cultural identity, a sense of home, and spiritual experience related to the natural environment. Tourism and recreation are usually included. Cultural services are strongly interconnected with each other and with the provision and regulation of services: e.g. although small-scale fishing may appear to provide only food and income, it is deeply connected to the lifestyles of fishing communities. (M.E.A. A Report of the, 2005).

Natural ecosystems provide almost unlimited opportunities for spiritual enrichment, mental development and leisure (De Groot et al., 2002). According to Foster (Forster, 1973) "... natural environments provide a highly inspirational and educative form of re-creative experience, with opportunities for reflection, spiritual enrichment and cognitive development through exposure to life processes and natural systems". The authors of the MEA concluded that humans have changed ecosystems more rapidly and extensively in the last 50 years than during any similar time period in human history, leading to a substantial and largely irreversible loss in the diversity of life on Earth. The complex relationship between changes in ES and the multiple dimensions of human well-being has been largely proven challenging to evaluate (Raudsepp-Hearne et al., 2010). When it comes to reversing the degradation of ecosystems maintaining the demand for services, MEA has considered some scenarios, which however involve profound changes to policies or institutions (M.E.A. A Report of the, 2005).

In this context, all nations have prioritized the assessment of ES for humanity’s sustainable future (Cimon-Morin et al., 2013). Researchers are therefore interested in developing methods for quantifying provision and value of ecosystem services so that this information can be incorporated into planning and decision-making on different scales and in different sectors (Hein et al., 2006; Kemkes et al., 2010). Of course, it will be necessary to obtain as much reliable information as possible to better understand how ecosystems provide services and how changes in ecosystems impact on service provision (Troy and Wilson, 2006).

The importance (or ‘value’) of ecosystems is roughly classified into three types (i.e., ecological, sociocultural, and economic value) (De Groot et al., 2002), which can contribute to environmental decision-making for the sustainable distribution of services to human well-being (Costanza et al., 1997; M.E.A. Ecosystems and Human Well, 2005; Kenter, 2016). ES evaluation can support practical applications such as landscape planning and policy making (Egoh et al., 2008; Lautenbach et al., 2011; Willemen et al., 2008). In fact, decision-makers are now integrating environmental issues and ES into policymaking for public and private sectors (Knudsen et al., 2006; Bateman et al., 2013; Loc et al., 2020). Since “evaluation” means the process of assessing the value of something in different terms (e.g. economic valuation, social valuation), it is extremely difficult to distinguish and identify the real value of each service (Daniel et al., 2012). For example, aesthetic values, spiritual and religious values, educational values and benefits for recreation may be considered in an aggregate manner. CES are “intangible”, “nonmaterial” and “invisible” services compared to other material services, and their evaluation is poorly understood (Martín-López et al., 2009; Tilliger et al., 2015), because the unclear boundaries between the different CES categories, can lead to problems

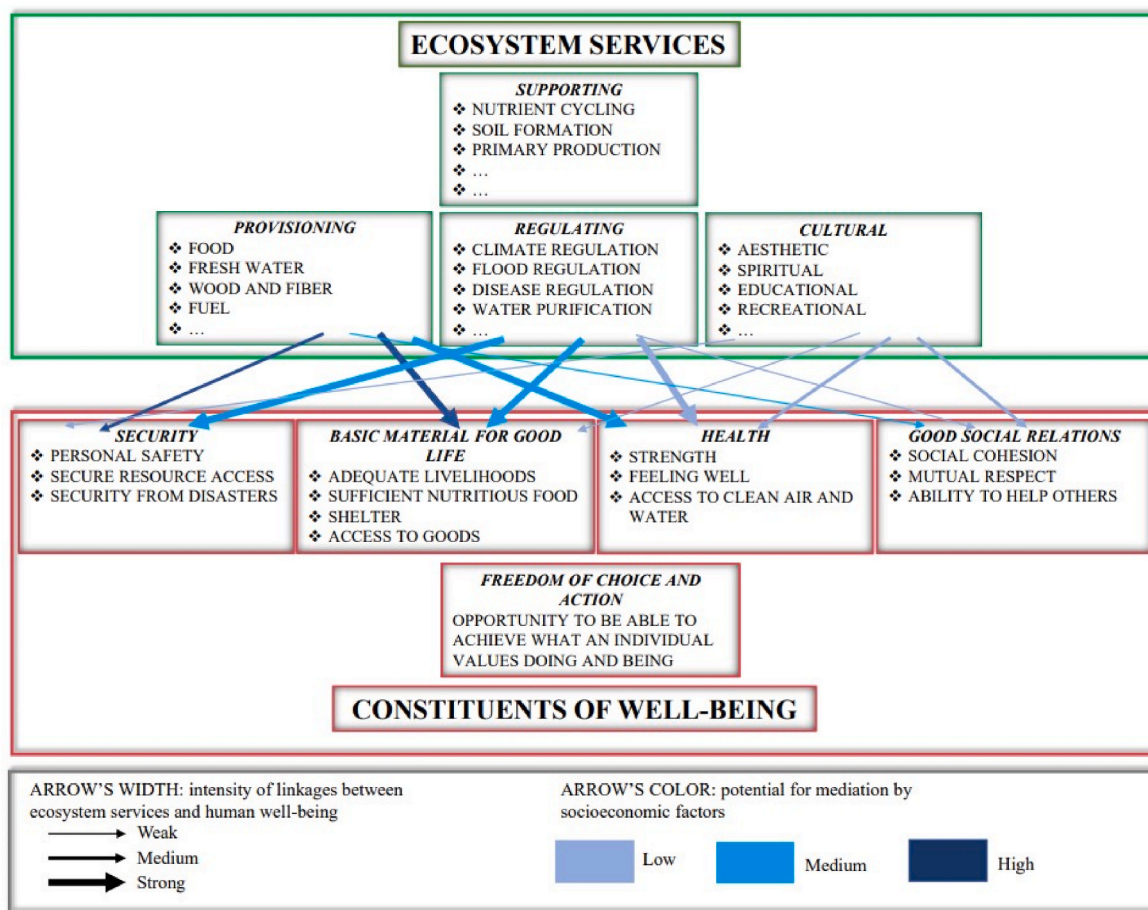


Fig. 1. Linkages between ecosystem services and human well-being (Authors’ elaboration from MEA, 2005).

of double-counting. Nonetheless, the science of ES assessment is expanding rapidly, and many authors have begun to evaluate ES from an economic perspective (Gómez-Baggethun et al., 2010; Braat and de Groot, 2012). However, researchers underline that many impacts of ES are rarely incorporated in various management strategies (Dasgupta et al., 2000; Lester et al., 2010), although the economic values are also required for comparison of different decisions at policy and management levels (Maes et al., 2012). On the other hand, global valuation of ES is being promoted as a resolution for effective management of ecosystems (Luederitz et al., 2015).

Evaluation of ES means assigning a currency or market value in order to equate the price of environmental protection compared with the benefits received (Nijnik and Miller, 2017). The assessment of ES should be incorporated into development planning to develop strategies that align with global sustainable goals. Researchers have used various methods to assess ES. In 2010, these evaluation methods were classified by TEEB (The Economics of Ecosystems and Biodiversity) as biophysical methods and preference-based methods. Preference-based methods were further sub-divided by Christie et al. (2012) into monetary and non-monetary methods. All methods were also summarily classified by Braat et al. (2000) and Hirons et al. (2016) as monetary methods and non-monetary methods. Monetary methods have been reviewed by many researchers: Spangenberg and Settele (2010), Chee (2004), Swinton et al. (2007), Christie et al. (2012), and D'Amato et al. (D'Amato et al., 2016). However, few papers have actually focused on reviewing the diversity of these different methods for CES assessment and how their evaluation is associated with the distribution of CES categories (Cheng et al., 2019). Furthermore, CES rarely have a direct market-price.

This paper aims to provide an updated and systematic quantitative literature review on CES evaluation methods based on the distribution of CES categories. It classifies and summarizes the CES evaluation methods used for green spaces including the evaluation process and the scope of application. Then it discusses the classified methods and their challenges based on this review. Finally, it discusses how CES evaluation can properly address the development and conservation priorities for green spaces.

This paper is designed to update of the work of Cheng et al. (2019) by using the so-called snowball strategy. Papers published in English language, and reported on the Scopus database after the mentioned work were selected and analysed in relation to their research object, geographic context, CES categories and related evaluation methods used by the studies.

This paper aims to contribute to fill the gap of knowledge about the economic evaluation of CES, pointing out their importance for citizens. A better knowledge will lead to a higher awareness and a better understanding of importance of CES and of their incorporation into planning and decision-making processes related to land use. That can lead both people and policy makers to take more conscious decisions regarding the environment and well-being development for the future.

The paper is organized as follows: after describing the materials and methods in Section 2, the results and their discussion are presented respectively in Sections 3 (the most common CES categories in Section 3.1 and combination of evaluation methods in Section 3.2.). Final remarks are reported in Section 4.

## 2. Materials and methods

The so-called snowball strategy is adopted in this review, meaning that a small number of fundamental studies lead to a larger number of relevant studies, according to their references and citations. This kind of narrative review makes it possible avoid duplications and at the same time offers a broad perspective of the topic. In addition, it can be used as a starting point for scholarly dialogue among readers who can write to the journal to express their opinions (De Boni et al., 2022). For the case study, the research has been based on the papers published after Cheng

et al. (2019) in order to update Cheng's review. Therefore, this selection has been limited to items published between August 2019 and May 2023. It was chosen to review only papers published in English, which is the only language used on the Scopus database. Over 120 papers were taken from Scopus. The relevance of each paper was analysed and verified: if a paper merely mentioned CES or CES evaluation methods without reporting evidence of assessment of the for one or more CES, it was not included in this review. Consequently, this screening resulted in 68 papers that were examined carefully. This approach limited the subjectivities of the adopted methodology.

With reference to Milcu's review (Milcu et al., 2013), a set of five questions was formulated (see Appendix A, Table A1): (1) the geographic location of the studies, (2) the research object of the studies, (3) CES categories addressed by the studies, (4) the CES evaluation method, and (6) whether the paper used monetary or non-monetary methods. The countries where each study was performed were also recorded to indicate the geographic location ("Europe" or "Global" indicate a study carried out in several countries) and the research objects of each study that constitute the sources of CES and CES categories can differ according to different sources. Studies that contained multiple research objects were counted separately.

The comparison with Cheng et al. (2019) showed that the cited paper used the ISI Web of Science and Scopus database to extract all the works in English language about CES by using keywords such as "cultural service" or "cultural ecosystem service". The research covered a frame time comprise between 2005 and July 2017. After a screening about the relevance of the topic, 293 papers remained.

CES categories included in this study derive from the classification and definition of CES according to the MEA as reported by Cheng et al. (2019) (Table 1). In Appendix A, Table A3 is reported the co-occurrence of the CES categories and the evaluation methods used in every study.

There are many types of evaluation methods, and research methods can generally be divided into two groups: monetary and non-monetary (Cheng et al., 2019; Hirons et al., 2016; Christie et al., 2012). Each group can then be divided into revealed preferences (real market, related to CES or documents and advertisements to determine directly or indirectly CES value or human preference for CES) and stated preference (i.e., by creating a hypothetical market and asking respondents about their willingness to pay or to relinquish some services or directly asking them about their values to assess CES) (Spangenberg and Settele, 2010; Christie et al., 2012; Cheng et al., 2019). The CES evaluation methods

**Table 1**

CES category classification quoted from the MEA (Authors' elaboration from MEA, 2005).

| Description and meaning of CES  | Category   |
|---|--|
| Ecosystem diversity is a factor affecting cultural diversity. Many religions assign spiritual and religious values to ecosystems.                               | Cultural diversity<br>Spiritual and religious values |
| Ecosystems have an impact on the knowledge systems of different cultures.   | Knowledge systems                                    |
| Many societies base formal and informal education on ecosystems, their components and processes.  | Educational values                                   |
| Art, folklore, national symbols, architecture, and advertising are inspired by ecosystems.  | Inspiration  |
| Beauty or aesthetic value is attributed to aspects of ecosystems, shown by the support for parks, 'scenic routes,' and locations for residential accommodation. | Aesthetic values                                     |
| Social relations in particular cultures are influenced by ecosystems.   | Social relations                                     |
| People value the 'sense of place' attached to the acknowledged characteristics of their environment, which include aspects of the ecosystem.                    | Sense of place                                       |
| Many societies assign great value to the preservation of historically significant landscapes or culturally significant flora and fauna.                         | Cultural heritage values                             |
| Leisure choices are often based on the features of a specific area's natural or cultivated landscapes.  | Recreation and ecotourism                            |

included in this study are reported in [Table 2](#) (monetary evaluation methods) and [Table 3](#) (non-monetary evaluation methods).

All methods used in each paper were classified accordingly. Where multiple CES assessment methods were mentioned and used in the same article, these were recorded separately.

Therefore, all 68 studies were classified according to the CES category and CES assessment method used. The two most common CES categories were also classified according to the assessment method used in the study, and also the combination of different methods used in the same study was analysed (i.e., combination of non-monetary methods and combination of monetary methods).

### 3. Results and discussion

With regard to the number of publications per year, it was observed that papers on CES evaluation methods increased considerably from 2019 to 2022 ([Fig. 2](#)). In 2022, the number of CES-related papers was approximately double that of 2021. For 2020, there were 12 papers, and the number increased in both 2021 and 2022. The number of CES-related papers for 2023 refers to the first five months of the year, and it is reasonable to suppose that their number will continue to increase during the rest of the year. So we can say that a positive trend is shown for years 2021 and 2022.

As [Fig. 3](#) shows, the reviewed studies have a clear geographic focus on Global location (29.4%), followed by China (17.6%) and Europe (10.3%). Twenty studies were Global, 12 studies involved China, seven involved Europe, four involved Italy and three Japan, while there were just one or two studies for all other locations.

Many studies focused on the CES of the urban green areas that were so important during the Covid-19 period. [Fig. 4](#) shows the percentage of

**Table 2**  
Monetary evaluation methods (Authors' elaboration from [Cheng et al., 2019](#)).

| Classification      | Method                  | Description of the method from the perspective of CES   |
|---------------------|-------------------------|---|
| Revealed preference | Market price            | CES economic values are estimated according to the price of products on the market. For example, park entrance fees are used to estimate values for recreation and ecotourism.  |
|                     | Travel cost             | CES economic values are estimated using travel costs. This method evaluates recreation and ecotourism using travel costs to locations where various recreational activities are offered.  |
|                     | Hedonic pricing         | The economic values of changes in CES are estimated using sale prices of similar properties. Hedonic approaches can measure values that become capitalized into the property's asset value; buyers and sellers recognize the impact of relevant CES on property prices. |
| Stated preference   | Benefits/Value transfer | Economic values are estimated by transferring existing benefits to CES evaluation. For example, the cost per trip per person from an existent study is adjusted and used in a new study to calculate recreation and ecotourism services.                                |
|                     | Deliberative evaluation | The deliberative process is combined with monetary methods. Integrating scientific or technical analysis with deliberation makes both facts and values more transparent so that they can be contested, which helps to inform CES preferences.                           |
|                     | Contingent evaluation   | People are asked about their willingness to pay for specific CES. This method can quantify passive use values held whether or not people will directly use a CES.   |
|                     | Choice experiment       | Respondents are asked to choose between different CES bundles described in terms of their attributes and attribute levels.  |

**Table 3**  
Non-monetary evaluation methods (Authors' elaboration from [Cheng et al., 2019](#)).

| Classification      | Method                           | Description of the method  |
|---------------------|----------------------------------|--|
| Revealed preference | Observation                      | Human action and behaviour are examined to reflect CES social value; park visitor numbers can be used to evaluate an area's recreational importance.   |
|                     | Document                         | Texts, images, and other documents provide information about CES preferences. For example, aesthetic value can be assessed from the number of photos taken by visitors and used in publicity materials.  |
|                     | Social media-based               | CES assessed using social media data. For example, the number of wildlife pictures on a photo-sharing website can be used to assess recreation and ecotourism values.  |
| Stated preference   | Interview                        | Provides detailed information about the reasons people value CES. Interviewees can speak freely about their feelings and ideas to provide better understanding of services like the sense of place or inspiration.   |
|                     | Questionnaire                    | A set of questions is used to collect CES information from participants. For example, a Likert scale is used so that interviewees can choose from a set of CES.  |
|                     | Narrative                        | Story-telling and descriptions of scenes by respondents are used to obtain CES information. The narratives are analysed to evaluate the sense of place.  |
|                     | Focus group                      | Respondents have the opportunity to provide more information and time for reflection or discussion. Facilitators enable participants to offer their opinions of CES in group discussions. Focus groups are used more to observe the dynamics of interaction and how a group interacts on the subject of CES. |
|                     | Expert-based                     | The professional knowledge and experience of experts is used to evaluate CES. They provide informed opinions on CES issues.  |
|                     | Q-method                         | Written statements are used to classify stakeholders into groups according to certain value orientations. Analysis of individual beliefs, interests and attitudes reveals respondents' distinct values concerning CES.   |
|                     | Participatory mapping            | Modern cartography tools are combined with participatory methods to map CES. For example, participants are asked to show on a map where they perceive the CES.   |
|                     | Participatory GIS (PGIS)         | Participatory mapping methods are combined with geographic information systems (GIS).  |
|                     | Public participation GIS (PPGIS) | The production of knowledge by local and non-governmental groups is promoted.  |
|                     | Scenario simulation              | Simulations of future scenes envisaging different CES capacities are used to support policy making and planning.   |

studies per research object, with urban green areas accounting for 39.7% (27 reviewed papers). Coastal areas and rivers and lakes were also very common: 10 studies concerned coastal areas (14.7%) and 8 studies concerned rivers and lakes (11.8%). The fourth most common focus was on regional and local areas followed by natural reserves, national parks and forests (5 or 6 papers for each research object). In addition, one or two studies explored rural areas, gardens, desert, karst ecosystems, wetlands or specific plants such as wild cherry.



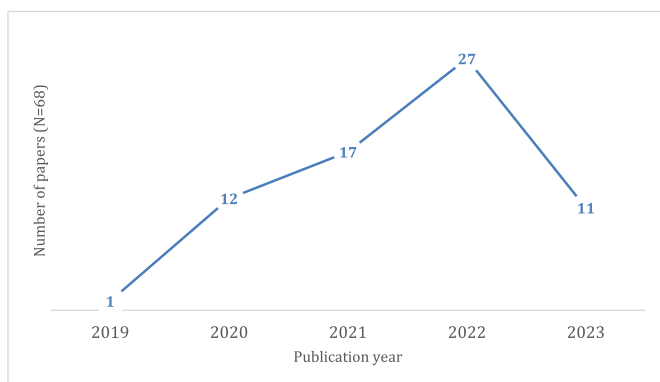


Fig. 2. Number of CES publications from August 2019 to April 2023.

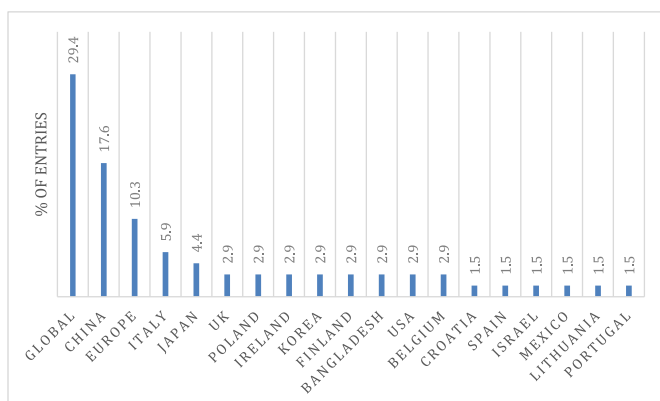


Fig. 3. Geographic distribution of the reviewed studies (% of 68 entries).

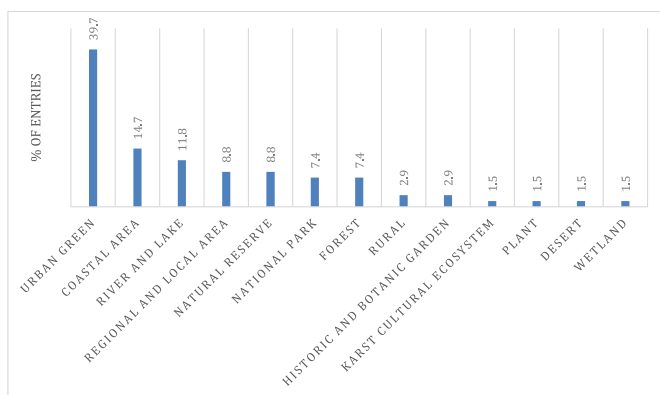


Fig. 4. Research object of the reviewed studies (% of 68 entries).

By combining Figs. 3 and 4 we can note a geographical trend on specific research objectives: Global studies are mainly focused on urban green with 9 papers/20 and the same is for Chinese papers with 9 works on urban green/12 papers. European studies are focused on river and lake with 3 studies/7 papers.

The percentage of papers and case studies was also analysed per CES category and CES evaluation method. The evaluation of CES categories is reported in Table 4.

Recreation and ecotourism were evaluated by the majority of studies (52 empirical papers), accounting for over 75% of the reviewed studies, followed by aesthetic values (41 studies) in approximately 60% of papers, then come cultural heritage values, general CES, educational values, spiritual and religious values, and a sense of place. Cultural diversity and knowledge systems attracted the least attention, with just

Table 4  
CES categories in the reviewed studies.

| CES categories                 | Number of studies | % of 68 entries |
|--------------------------------|-------------------|-----------------|
| Recreation and ecotourism      | 52                | 76.5            |
| Aesthetic values               | 41                | 60.3            |
| Cultural heritage values       | 31                | 45.6            |
| General CES                    | 30                | 44.1            |
| Educational values             | 29                | 42.6            |
| Spiritual and religious values | 28                | 41.2            |
| Sense of place                 | 26                | 38.2            |
| Social relations               | 21                | 30.9            |
| Inspiration                    | 14                | 20.6            |
| Cultural diversity             | 7                 | 10.3            |
| Knowledge systems              | 4                 | 5.9             |

seven papers for the former category and four papers for the latter.

The distribution of each CES category corresponds to different methods, as shown in Fig. 5, as well as the percentage of studies using monetary and non-monetary methods. Non-monetary methods were used by many more studies (96%) than monetary methods (4%). In total, 15 evaluation methods were used. Of the 68 reviewed studies, most used questionnaires to evaluate CES, which ranked first among all methods (38.2%), and this was followed by the use of social media (30.9%), which has increased considerably in recent years. Participatory GIS and interviews were used in 13.2% of studies, and documents in 10.3%. Participatory mapping was used in 8.8% of the studies and public participatory GIS in 7.4%. The use of other methods ranged from 1.5% to 5.9% in all studies.

### 3.1. The most common CES categories

Recreation and ecotourism, and aesthetic values were the two most common CES categories evaluated in the reviewed studies: 52 empirical studies concerned recreation and ecotourism while 41 papers concerned aesthetic values. The majority of the studies, 38 papers, considered both categories together, while 14 studies evaluated only recreation and ecotourism, and 3 studies evaluated only aesthetic values (Table 5).

These two CES categories are often also studied along with other CES categories: recreation and ecotourism are associated with other CES categories in 44 papers and aesthetic values is associated with other CES categories in 41 papers.

The list of publications for these two CES categories is shown in Appendix, Table A2.

Fig. 6 shows the evaluation methods corresponding to the two most common CES categories and the percentage of studies using monetary and non-monetary methods. Of the evaluation methods used in the 55 papers related to recreation and ecotourism and to aesthetic values, only 2 studies used monetary methods (4%), while 53 studies used non-monetary methods (96%). A total of 12 non-monetary evaluation methods were used: the questionnaire was the most used method (41.8%), followed by social media (30.9%), and participatory GIS (18.2%). With regard to the use of monetary methods, travel cost, benefit/value transfer and market price were used in 1.8% of the studies.

### 3.2. Combinations of evaluation methods

There were 36 studies using only one method in their study, while 19 studies adopted more than one method to assess recreation and ecotourism and aesthetic values. There were two main combinations:

- Combining non-monetary methods: 18 studies implemented several combined non-monetary approaches, of which participatory GIS + social media and questionnaires + interviews were the most common combination in three studies, respectively (see Appendix A, Table A2).

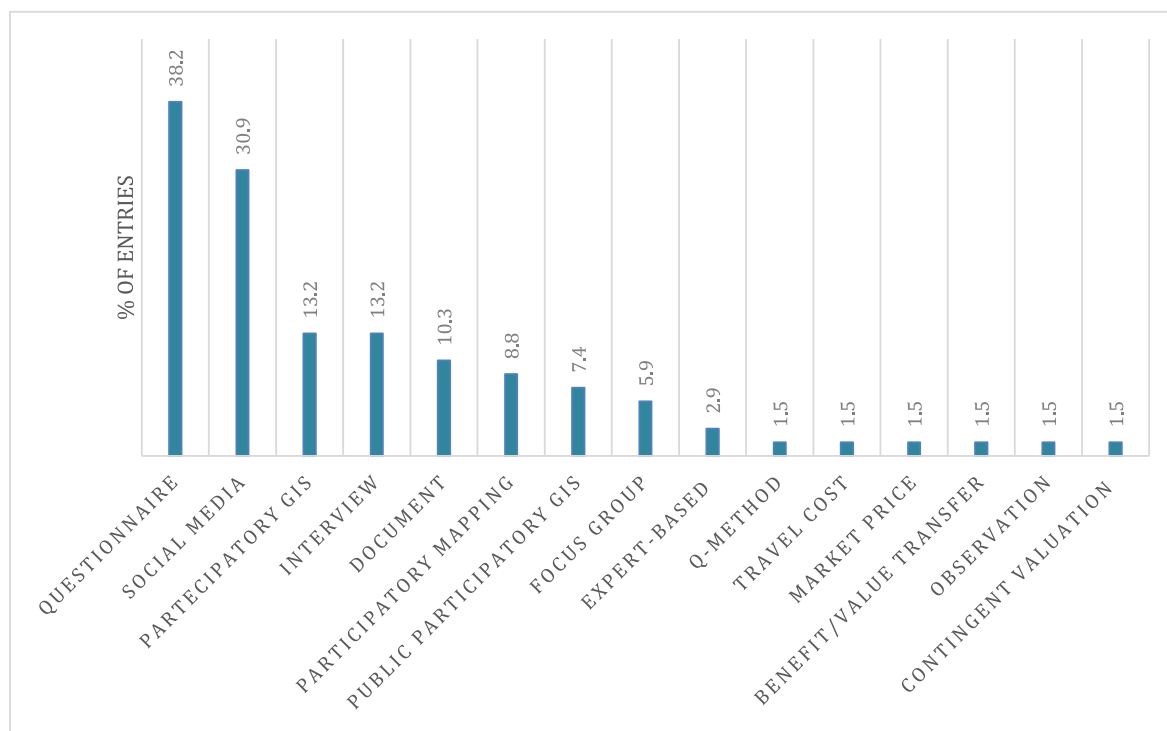


Fig. 5. Different methods used in the reviewed studies (% of 68 entries).

Table 5

Number of studies concerning the two most common categories either alone or combined.

| CES categories            | Total number of studies | Number of studies combining the two categories | Number of studies using single CES category |
|---------------------------|-------------------------|--|---|
| Recreation and ecotourism | 52                      | 38   | 14  |
| Aesthetic values          | 41                      | 38   | 3   |

Zhao et al. (2023) developed an integrated approach to the mapping of CES supply and demand and integrated the SolVES model with social media comments to investigate the matching relationship between CES (aesthetic inspiration, education, and recreation and ecotourism) supply and demand using Wuyishan City, China, with its protected areas, as a case study. SolVES is a GIS application created by the US Geological Survey (USGS) Earth Science and Environmental Change Science Center (Sherrouse and Semmens, 2020). This model used data from social survey information and relevant environmental factors as constraints (Sherrouse et al., 2011). The public's perceived preferences were analysed to enable the quantification of CES value and the formulation of a non-monetary evaluation (using a value index). Consequently, this study used SolVES to process the questionnaire answers and environmental data to create a spatial distribution map of the index values (0–10) for aesthetic inspiration, education, and recreation and ecotourism. CES demand was then quantified based on the number of social media reviews and the ratings for different CES. The conclusion of the authors was that for all areas investigated, this method can be used with great efficiency compared with traditional methods.

Neill et al. (2023) took social media data (photo-user-days or PUD from Flickr) and used a range of spatial models to obtain information for ES assessment. In particular, they used four models (i.e., global and local regression, maximum entropy and the InVEST recreation model) to investigate the same case study in County Galway, Ireland. They presented guidelines for the development of CES spatial models using data collected from social media; the authors pointed out that all spatial

models using social media data are imperfect, but that by discussing the workflow for each approach, it is possible to articulate where and why different models may be useful.

Meng et al. (2020) used an integrated approach that combined the SolVES model and a text analysis of the social media reviews to investigate the relationships among multiple CES in a spatially explicit way. They used the SolVES model to link perceptions of CES to environmental variables, and to map the CES supply. They then used the social media reviews to quantify the CES demand to calculate the matches and mismatches concerning supply and demand.

Shi et al. (2022) studied the imbalances in CES supply and demand via an integrated approach: they used interviews to assess CES supply, and questionnaires to assess CES demand. The imbalances in CES supply and demand were then pinpointed by Z-score standardization based on quantification of CES supply and demand.

Cheng et al. (Cheng et al., 2022a) combined the main evaluation methods to evaluate the interactions of eight CES, including recreation and ecotourism, and aesthetic values, in a city park in China. They used methods that included questionnaires, participatory mapping, and interviews. Questionnaires were used across the entire park, and participants were asked to respond to a set of questions on their perceptions of the selected CES. Mapping of the participants showed which bundles, trade-offs, and synergies of CES were perceived in the park, and where. Interviews revealed existent scenarios of CES interactions in the park and showed how landscape features can have a significant influence on these. These complementary methods were used to create a comprehensive assessment of CES and formulate scenarios. For example, it was found that with the traditional type of interview people are frequently unaware of cultural services, and had difficulties in expressing themselves about CES (Bieling and Plieninger, 2013). However, when interviews are used with participatory mapping, the participants find it easier to understand CES, because they have sufficient time to understand the concept and are also encouraged to experience map creation. Public participation would be improved if the decision-making process were integrated with people's perceptions. Moreover, integrating the interviews might improve the assessment of CES interactions and

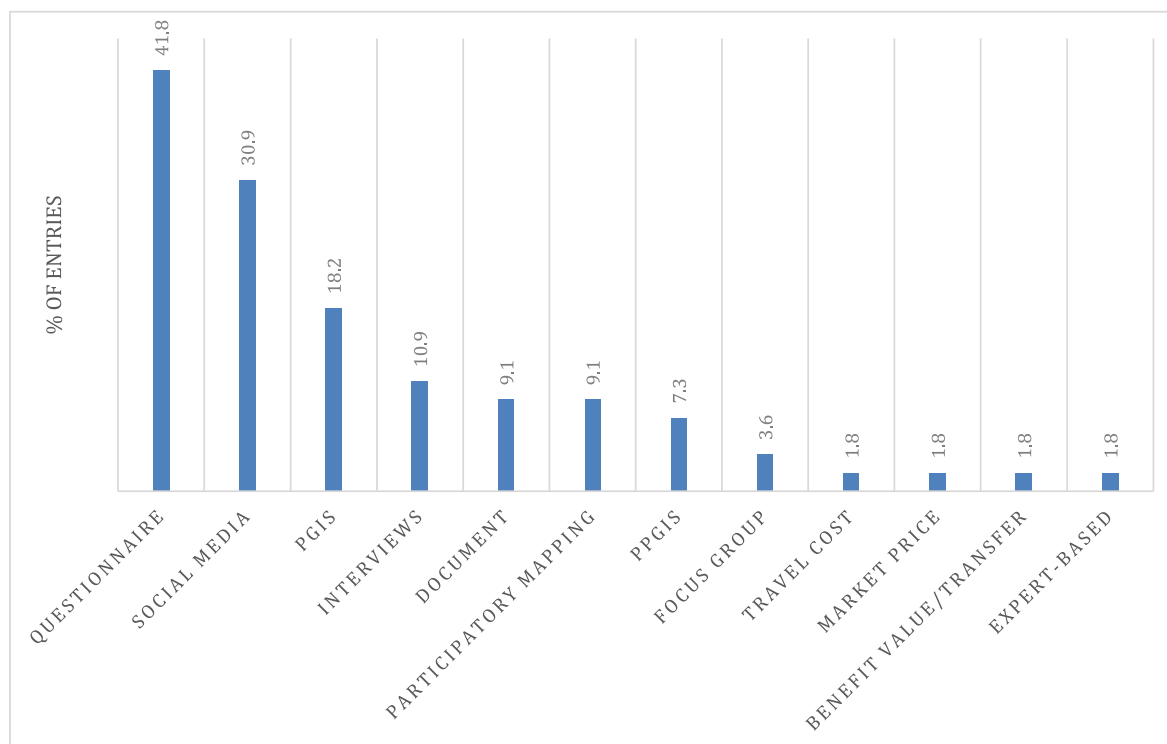


Fig. 6. Different methods used in the reviewed studies related to recreation and ecotourism and to aesthetic values (% of 55 entries).

identify existing scenarios, because participatory mapping cannot demonstrate the specific relationships identified by the spatial patterns because it cannot directly ask questions. On the other hand, the set questions used in the questionnaire could influence perceptions. For this reason, the authors assessed CES by combining the information obtained from the questionnaires, with participatory mapping and interviews. Evaluation results have often been enhanced with non-monetary methods. In many cases, the combination of different evaluation methods for interacting cultural services represents the products of an ecosystem that contributes to human welfare (Costanza et al., 1997).

Gai et al. (2022) conducted a study using face-to-face questionnaire surveys and interviews to analyse perceptions of CES in an urban park in Wudaokou, a multifunctional area in the centre of Beijing, China. These two evaluation methods were combined in order to provide a systematic analysis of perceptions regarding the importance and performance of urban parks' CES.

- Combining monetary methods: one case combined different monetary methods (see Appendix A, Table A2). Lausi et al. (2022) evaluated different CES categories that included recreation and ecotourism and aesthetic values for the Garden of Ninfa in Latina, Italy, and used two different methods: the market price (based on the income from ticket sales in 2019, 2020 and 2021) and the benefit/value transfer (using an international report as a reference database for TEEB framework (Van Der Ploeg et al., 2010)). They indicate how the monetary evaluation, ranging from €1.0 to €2.7 million a year, can encourage the similar actions, particularly in highly altered areas, and that ticket income can provide a useful indicator to highlight the economic benefits of the Garden of Ninfa, especially in areas like the Pontine plain where agricultural land use is intensive. They also noted that the Garden of Ninfa has retained its attractiveness after the pandemic, highlighting the crucial role that natural spaces and their CES can play in reducing stress and improving mental and physical well-being. Therefore, the combined use of different monetary methods can ensure accurate evaluation. However, the combination of monetary methods is usually limited to categories of CES that provide material services like ecotourism and recreation.

#### 4. Conclusions

This analysis and review of papers regarding CES leads us to formulate the following conclusions: (1) the number of publications has grown between 2021 and 2022 showing a positive trend (2) the study of CES has attracted attention in both developed and emerging countries alike, and most of the papers that were reviewed in the present work actually regard more than one country; (3) researchers have concentrated particularly on cultural services in urban green areas as a principal topic of interest; (4) the most frequent categories of CES are recreation and ecotourism and aesthetic values, which are found in over fifty percent of the papers reviewed, while cultural diversity and knowledge systems are the two least-evaluated CES; (5) the integration of CES into decision-making and management processes is important and should be enhanced in such a way to make them effective in ensuring the population's well-being; (6) methods for the evaluation of CES are still dominated by the traditional type of social questionnaire and interviews (51.5% of the papers), but social media and participatory GIS (30.9% and 14.7%, respectively) have also become two important of obtaining data for research, given the growing volume of data provided by social media and the need to obtain spatially-explicit models for natural capital accounting and ecosystem service assessments.

Nonetheless, this review has some inherent limitations: (1) the papers analysed here are from the Scopus database, but the literature of other databases has not been analysed; (2) the adopted methodology allowed to extract only one work on the monetary evaluation of CES and this may represent a limitation of the research which will therefore be subject to revision in future studies; (3) this review uses a quantitative review method to analyse the previous literature, and only the two most used CES categories are analysed in terms of quality.

In conclusion, combination of different monetary and non-monetary methods can enhance CES evaluation by focusing on the interaction between the different components, particularly between mapping and the social values of ecosystem services: economic assessment of CES combined with CES mapping on a spatial-scale can provide assistance for decision-makers in the development of sustainable territorial

planning and policies. For example, participatory mapping allows members of the public to have a better understanding of CES. Participants are usually given sufficient time to become familiar with the concept itself, **and** they are also encouraged to create maps. The decision-making process and public participation could be improved by integrating people's perceptions. Additionally, interviews can provide accurate assessment of CES interaction and reveal the scenarios that cannot be revealed by mapping because it cannot ask people direct questions. However, the set of questions used in the questionnaires may actually influence respondents' perceptions. On the other hand, focus groups and deliberative techniques aim at allowing people to express preferences in a more flexible way by giving them more time to understand CES, based on information provided by researchers. These methods naturally require the supervision of skilled professionals.

If people can see and understand the broader values of ecosystem services, and not just in terms of their economic value, this might help them to formulate conscious decisions regarding the environment itself, while ensuring enhanced well-being for the future. Quantification of

CES value could become a fundamentally important factor in the decision-making processes related to land use.

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### Declaration of competing interest

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

### Data availability

Data will be made available on request.

## Appendix A

**Table A.1**

Set of questions asked for every paper reviewed.

| Questions  | Response Categories  | See reference   |
|--|--|---|
| 1. Geographic location of the studies                  | The country that study performed   | Not available   |
| 2. Research object of the studies                      | Not available  | Not available   |
| 3. CES categories addressed by the study               | Cultural diversity<br>Spiritual and religious values<br>Knowledge systems<br>Educational values<br>Inspiration<br>Aesthetic values<br>Social relations<br>Sense of place<br>Cultural heritage values<br>Recreation and ecotourism  | (M.E.A. A Report of the, 2005) - (Cheng et al., 2019) |
| 4. CES evaluation methods                              | General CES<br>Market price<br>Travel cost<br>Hedonic pricing<br>Benefits/Value transfer<br>Deliberative valuation<br>Contingent valuation<br>Choice experiment<br>Observation<br>Document<br>Social media based<br>Interview<br>Questionnaire<br>Narrative<br>Focus group<br>Expert-based<br>Q method<br>Participatory mapping<br>Participatory GIS (PGIS)<br>Public participation GIS (PPGIS)<br>Scenario simulation | Cheng et al. (2019)                                   |
| 5. Does this paper use monetary or non-monetary method | Monetary method<br>Non-monetary method   | Cheng et al. (2019)                                   |

**Table A.2**

List of the publications related to the three most represented CES.

| REFERENCE  | CES ASSESSMENT METHOD              | YEAR | GEOGRAPHIC LOCATION |
|--|------------------------------------|------|---------------------|
| recreation and ecotourism, aesthetic values<br><a href="#">Zhang et al. (2022)</a> | Document                           | 2022 | China               |
| <a href="#">Jackson-Bué et al. (2022a)</a>   | focus group                        | 2022 | Europe              |
| <a href="#">Kičić et al. (2022a)</a>   | focus group, participatory mapping | 2022 | Croatia             |

(continued on next page)



Table A.2 (continued)

| REFERENCE                               | CES ASSESSMENT METHOD                             | YEAR | GEOGRAPHIC LOCATION |
|---|---|------|---------------------|
| Schirpke et al. (2021b)                 | focus group, PGIS                                 | 2021 | Europe              |
| Cheng et al. (2021)                     | Interviews  | 2021 | Global              |
| Shi et al. (2022)                       | interviews, questionnaires                        | 2022 | China               |
| Gai et al. (2022)                       | interviews, questionnaires                        | 2022 | Cina                |
| Lausi et al. (2022)                     | market price, benefit/value transfer              | 2022 | Italy               |
| Smart et al. (2021)                     | participatory mapping                             | 2021 | USA                 |
| Cheng et al. (2022b)                    | participatory mapping                             | 2022 | Global              |
| Cheng et al. (2022a)                    | participatory mapping, questionnaires, interviews | 2022 | Global              |
| Santarém et al. (2021)                  | PGIS  | 2021 | Global              |
| Zhao et al. (2020)                      | PGIS  | 2020 | China               |
| Zhou et al. (2020)                      | PGIS, questionnaires                              | 2020 | China               |
| Tian et al. (2023)                      | PGIS, document                                    | 2023 | China               |
| Meng et al. (2020)                      | PGIS, social media                                | 2020 | Global              |
| Valánszki et al. (2022)                 | PPGIS   | 2022 | Europe              |
| Koh et al. (2022a)                      | PPGIS   | 2022 | Global              |
| Tajima et al. (2023)                    | PPGIS   | 2023 | Japan               |
| Depietri et al. (2021)                  | PPGIS, social media                               | 2021 | Israel              |
| Shi et al. (2020b)                      | Questionnaires                                    | 2020 | China               |
| Djagoun et al. (2022)                   | Questionnaires                                    | 2021 | Global              |
| Sultana and Selim (2021)                | Questionnaires                                    | 2021 | Bangladesh          |
| Kovács et al. (2022)                    | Questionnaires                                    | 2022 | Japan               |
| Wang et al. (2022)                      | Questionnaires                                    | 2022 | Finland             |
| Nie et al. (2022)                       | Questionnaires                                    | 2022 | Global              |
| Schirpke et al. (2022)                  | Questionnaires                                    | 2022 | Italy               |
| Sultana et al. (2022)                   | Questionnaires                                    | 2022 | Bangladesh          |
| Zhang et al. (2023)                     | Questionnaires                                    | 2022 | China               |
| Gai et al. (2023)                       | Questionnaires                                    | 2023 | China               |
| Zheng et al. (2023)                     | Questionnaires                                    | 2023 | Global              |
| Kovács et al. (2021a)                   | questionnaires, document                          | 2021 | Mexico              |
| Marcinkevičiūtė and Pranskūnienė (2021) | questionnaires, document                          | 2021 | Lithuania           |
| Katsuda et al. (2022)                   | questionnaires, PGIS                              | 2022 | Japan               |
| Zhao et al. (2023)                      | questionnaires, PGIS, social media                | 2023 | China               |
| Kim and Son (2021)                      | social media                                      | 2021 | Korea               |
| Schirpke et al. (2021a)                 | social media                                      | 2021 | Europe              |
| Cardoso et al. (2022)                   | social media                                      | 2022 | Global              |
| <b>aesthetic values</b>                 |   |      |                     |
| Gosal and Ziv (2020)                    | document, social media                            | 2020 | UK                  |
| Shi et al. (2020a)                      | Questionnaires                                    | 2020 | China               |
| Kaiser et al. (2021)                    | social media, questionnaires                      | 2021 | Global              |
| <b>recreation and ecotourism</b>        |   |      |                     |
| Lhoest et al. (2020)                    | Interviews  | 2020 | Belgium             |
| Kalinauskas et al. (2023)               | PGIS  | 2023 | Global              |
| Richardson and Nicholls (2021)          | questionnaires                                    | 2021 | Global              |
| Xia et al. (2023)                       | questionnaires                                    | 2023 | China               |
| Grzyb et al. (2021)                     | social media                                      | 2021 | Poland              |
| Marine et al. (2022)                    | social media                                      | 2022 | Spain               |
| Manley and Ego (2022)                   | social media                                      | 2022 | USA                 |
| Azevedo et al. (2022)                   | social media                                      | 2022 | Global              |
| Grzyb and Kulczyk (2023)                | social media                                      | 2023 | Poland              |
| Lee and Son (2023)                      | social media                                      | 2023 | Korea               |
| Gosal et al. (2019)                     | social media, expert-based                        | 2019 | Europe              |
| Komossa et al. (2020)                   | social media, interviews, participatory mapping   | 2020 | Europe              |
| Neill et al. (2023)                     | social media, PGIS                                | 2023 | Ireland             |
| Funsten et al. (2022)                   | travel cost                                       | 2022 | Italy               |

Table A.3

List of the publications related to the all the CES categories.

| REFERENCE                | CES CATEGORIES  | CES ASSESSMENT METHOD             | GEOGRAPHIC LOCATION | YEAR |
|--------------------------|---|-----------------------------------|---------------------|------|
| Xia et al. (2023)        | sense of place, cultural heritage, spiritual, educational, recreation, aesthetic                | questionnaire                     | China               | 2023 |
| Tajima et al. (2023)     | recreational, educational, spiritual, aesthetic, cultural heritage                              | PPGIS                             | Japan               | 2023 |
| Tian et al. (2023)       | aesthetic, historical, recreation   | PGIS, documents                   | China               | 2023 |
| Zhao et al. (2023)       | aesthetic, educational, recreation and ecotourism   | questionnaire, PGIS, social media | China               | 2023 |
| Hubatova et al. (2023)   | spiritual, cultural heritage  | Q method                          | UK                  | 2023 |
| Grzyb and Kulczyk (2023) | recreation  | social media                      | Poland              | 2023 |
| Neill et al. (2023)      | recreation and ecotourism   | social media, PGIS                | Ireland             | 2023 |
| Lee and Son (2023)       | recreation and ecotourism   | social media                      | Korea               | 2023 |
| Gai et al. (2023)        | aesthetic, recreation and ecotourism, cultural heritage, inspiration, sense of place, spiritual | questionnaire                     | China               | 2023 |

(continued on next page)

Table A.3 (continued)

| REFERENCE                               | CES CATEGORIES  | CES ASSESSMENT METHOD                             | GEOGRAPHIC LOCATION  | YEAR |
|---|---|---|--|------|
| Zheng et al. (2023)                     | recreation, aesthetic, social relations, education, religious spiritual, cultural heritage  | questionnaires                                    | Cina, USA - Global   | 2023 |
| Kalinauskas et al. (2023)               | recreation  | PGIS  | Lituania, Portugal, Spain, China - Global                  | 2023 |
| Kičić et al. (2022b)                    | sense of place, aesthetic, cultural diversity, recreation and ecotourism, educational   | focus group, participatory mapping                | Croatia  | 2022 |
| Kovács et al. (2022)                    | educational, spiritual, aesthetic, cultural-historic, recreation, general CES   | questionnaire                                     | Japan  | 2022 |
| Ebner et al. (2022)                     | general CES   | questionnaire, social media, focus group          | Austria Italy - Europe                                     | 2022 |
| Moultaki et al. (2022)                  | general CES   | social media                                      | Lithuania Morocco France - Global                          | 2022 |
| Huai et al. (2022)                      | general CES   | social media                                      | Belgium, China - Global                                    | 2022 |
| Wang et al. (2022)                      | recreation, sense of place, aesthetic, inspiration, education, spiritual, cultural heritage, social relations   | questionnaire                                     | Finlandia  | 2022 |
| leBrasseur (2022)                       | general CES   | PPGIS   | Finland  | 2022 |
| Funsten et al. (2022)                   | recreation  | travel cost                                       | Italy  | 2022 |
| Nie et al. (2022)                       | aesthetic, recreation, cultural heritage, sense of place, spiritual and religious, educational, inspiration, social relations                                   | questionnaire                                     | USA, China - Global  | 2022 |
| Shi et al. (2022)                       | aesthetic, sense of place, social relations, cultural heritage, education, recreation   | interviews, questionnaire                         | China  | 2022 |
| Cheng et al. (2022a)                    | aesthetic, recreation, cultural heritage, sense of place, spiritual and religious values, educational values, inspiration, social relations                     | participatory mapping, questionnaires, interviews | China, Belgium - Global                                    | 2022 |
| Teff-Seker et al. (2022)                | general CES   | interviews  | Israel, Finland, Netherlands Scotland, California - Global | 2022 |
| Zhang et al. (2022)                     | aesthetic, recreation, cultural heritage, social relations, educational values, sense of place, spriritual, general CES   | document  | China  | 2022 |
| Marine et al. (2022)                    | recreational values, cultural diversity   | social media                                      | Spain  | 2022 |
| Cheng et al. (2022b)                    | recreation and ecotourism, aesthetic, educational, knowledge systems, spiritual and religious, inspiration, cultural heritage, social relations, sense of place | participatory mapping                             | China, Belgium - Global                                    | 2022 |
| Cardoso et al. (2022)                   | aesthetic, recreation, cultural heritage, spiritual, sense of place, social,  | social media                                      | Portugal, Spain, Brazil - Global                           | 2022 |
| Gai et al. (2022)                       | aesthetic, recreation, cultural heritage, spiritual, sense of place, social, inspiration, general CES   | interviews, questionnaire                         | China  | 2022 |
| Jackson-Bué et al. (2022b)              | aesthetic, inspirational, sense of place, recreation, ecotourism, spiritual religious, cultural heritage, educational   | focus group                                       | UK, Portugal, France - Europe                              | 2022 |
| Manley and Ego (2022)                   | recreation  | social media                                      | USA  | 2022 |
| Azevedo et al. (2022)                   | recreation, cultural diversity, general CES   | social media                                      | Brazil, Finland, Portugal - Global                         | 2022 |
| Katsuda et al. (2022)                   | history, recreation, aesthetic, educational, cultural diversity, general CES  | questionnaire, PGIS                               | Japan  | 2022 |
| Lausi et al. (2022)                     | recreation, cultural heritage, aesthetic, general CES   | market price, benefit/value transfer              | Italy  | 2022 |
| Schirpke et al. (2022)                  | recreation, educational, sense of place, easthetic, spiritual, general CES  | questionnaire                                     | Italy  | 2022 |
| Sultana et al. (2022)                   | recreation, aesthetic, sense of place, social, inspiration, religious and spiritual, cultural heritage, knowledge system, cultural diversity                    | questionnaire                                     | Bangladesh   | 2022 |
| Valánszki et al. (2022)                 | aesthetic, recreation, spiritual, Cultural heritage, educational  | PPGIS   | Hungary, Denmark - Europe                                  | 2022 |
| Zhang et al. (2023)                     | aesthetic, recreation, spiritual, generale CES, cultural  | questionnaires                                    | China  | 2022 |
| Koh et al. (2022b)                      | recreation, aesthetic, social, educational, general CES   | PPGIS   | Singapore, Thailand, Vietnam - Global                      | 2022 |
| Jiang and Marggraf (2022)               | spiritual and religious, educational, cultural heritage, inspiration, general CES   | document  | China, Germany - Global                                    | 2021 |
| Djagoun et al. (2022)                   | spiritual and religious, ecotourism, educational, aesthetic   | questionnaire                                     | Benin, France - Global                                     | 2021 |
| Kim and Son (2021)                      | recreation, aesthetic, sense of place, social, inspiration, religious and spiritual, cultural heritage, educational   | social media                                      | Korea  | 2021 |
| Schirpke et al. (2021a)                 | aesthetic, recreation, educational, social, spiritual, general CES  | social media                                      | Austria, Italy - Europe                                    | 2021 |
| Semeraro et al. (2022)                  | cultural heritage   | interviews  | Italy  | 2021 |
| Kaiser et al. (2021)                    | aesthetic, social relation, general CES   | social media, questionnaire                       | Germany, Israel - Global                                   | 2021 |
| Depietri et al. (2021)                  | recreational, aesthetic, educational, general CES   | PPGIS, social media                               | Israel   | 2021 |
| Santarém et al. (2021)                  | recreation, aesthetic, sense of place, social, inspiration, religious and spiritual, cultural heritage, educational   | PGIS  | Portugal, Finland, South Africa - Global                   | 2021 |
| Cheng et al. (2021)                     | recreation, aesthetic, sense of place, social, inspiration, religious and spiritual, cultural heritage, educational, cultural diversity, knowledge, general CES | interviews  | China, Belgium - Global                                    | 2021 |
| Schirpke et al. (2021b)                 | recreation, aesthetic, educational,   | focus group, PGIS                                 | Austria, Italy - Europe                                    | 2021 |
| Grzyb et al. (2021)                     | recreation  | social media                                      | Poland   | 2021 |
| Richardson and Nicholls (2021)          | recreation, general CES   | questionnaire                                     | USA, UK - Global   | 2021 |
| Zepp et al. (2021)                      | general CES   | expert-based                                      | Germany, China, Chile - Global                             | 2021 |
| Sultana and Selim (2021)                | recreation, aesthetic, sense of place, social relations, education, inspiration, religious, cultural heritage, cultural diversity, knowledge                    | questionnaire                                     | Bangladesh   | 2021 |
| Kovács et al. (2021b)                   | social, recreation, aesthetic, cultural heritage, spiritual   | questionnaire, document                           | Mexico   | 2021 |
| Marcinkevičiūtė and Pranskūnienė (2021) | recreation, aesthetic, cultural heritage, spiritual   | questionnaire, document                           | Lithuania  | 2021 |

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Table A.3 (continued)

| REFERENCE             | CES CATEGORIES  | CES ASSESSMENT METHOD                                     | GEOGRAPHIC LOCATION                          | YEAR |
|-----------------------|---|---|--|------|
| Smart et al. (2021)   | aesthetic, social, cultural heritage, recreation, sense of place                                  | participatory mapping                                     | USA  | 2021 |
| Xin et al. (2020)     | social  | observation, questionnaire, interview                     | Belgium                                      | 2020 |
| Meng et al. (2020)    | aesthetic, cultural heritage, recreational  | PGIS, social media  | China, Germany, Chile - Global               | 2020 |
| Gosal and Ziv (2020)  | aesthetic   | document, social media                                    | UK   | 2020 |
| Komossa et al. (2020) | recreation, sense of place, general CES   | social media, interviews, participatory mapping           | Netherlands Swiss - Europe                   | 2020 |
| Zhou et al. (2020)    | aesthetic, recreation, cultural heritage, spiritual, general CES                                  | PGIS questionnaires                                       | China  | 2020 |
| Caro et al. (2020)    | general CES   | documents   | Portugal                                     | 2020 |
| Tian et al. (2020)    | general CES   | contingent valuation                                      | China, UK - Global                           | 2020 |
| Cabana et al. (2020)  | general CES   | participatory mapping, PGIS, questionnaires, social media | Ireland                                      | 2020 |
| Shi et al. (2020a)    | aesthetic, sense of place, educational, cultural, spiritual general CES                           | questionnaire   | China  | 2020 |
| Lhoest et al. (2020)  | cultural heritage, inspiration, spiritual recreation, education                                   | interviews  | Belgium                                      | 2020 |
| Zhao et al. (2020)    | recreation, historical, aesthetic   | participatory GIS   | China  | 2020 |
| Shi et al. (2020b)    | recreation, aesthetic, sense of place, social relations, education, religious, cultural heritage, | questionnaire   | China  | 2020 |
| Gosal et al. (2019)   | recreation  | social media, expert-based                                | UK, France, Czech Republic, Germany - Europe | 2019 |

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