Contributions of cultural services to the ecosystem services agenda

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Cultural ecosystem services (ES) are consistently recognized but not yet adequately defined or integrated within the ES framework. A substantial body of models, methods, and data relevant to cultural services has been developed within the social and behavioral sciences before and outside of the ES approach. A selective review of work in landscape aesthetics, cultural heritage, outdoor recreation, and spiritual significance demonstrates opportunities for operationally defining cultural services in terms of socioecological models, consistent with the larger set of ES. Such models explicitly link ecological structures and functions with cultural values and benefits, facilitating communication between scientists and stakeholders and enabling economic, multicriterion, deliberative evaluation and other methods that can clarify tradeoffs and synergies involving cultural ES. Based on this approach, a common representation is offered that frames cultural services, along with all ES, by the relative contribution of relevant ecological structures and functions and by applicable social evaluation approaches. This perspective provides a foundation for merging ecological and social science epistemologies to define and integrate cultural services better within the broader ES framework.

natural capital | scenic beauty | cultural landscapes | tourism | spiritual value

Various ideologies have historically reflected and guided human attitudes and actions toward the natural environment, including humans as conquerors and dominators of nature, as beneficiaries of nature, and as stewards of nature. The Ecosystem Services (ES) framework, as adopted by the Millennium Ecosystem Assessment (MA) process of the United Nations (1), has emerged as a formal approach to describe and categorize the relationship between ecosystems and society (2–4), and it is widely accepted within the international environmental science and policy communities (e.g., 5–9).

ESs arise when an ecological structure (e.g., wood fiber) or function (e.g., filtering function of vegetation and soils) directly or indirectly contributes toward meeting a human need or want. Such services (e.g., provision of clean drinking water) generate benefits (e.g., improved human health) that contribute to overall well-being. In ecological economics (e.g., 5), human benefits derive from the combination of natural capital (a stock of ecosystems "that do not require human activity to build or maintain" that yields a flow of goods and services) along with built, social, and human capital, with ES being defined by the relative contribution of natural capital. The ES framework extends prior models by expanding the focus from individual resources to the full array of contributions ecosystems make to human well-being and by better recognizing the interconnectedness of ecosystems across the broad temporal and spatial scales over which ecosystems and humans interact.

Numerous schemes categorize the variety of ES (10–17). Here, we use the classification offered in the MA (18): provisioning services (e.g., food, fresh water), regulating services (e.g., climate regulation, water purification), cultural services (e.g., aesthetic, spiritual, recreational experiences), and supporting services (e.g., nutrient cycling, soil formation). Basic provisioning services are widely recognized as essential for meeting human needs for nutrition, shelter, and safety. Regulating services are more complex but have been brought to public attention by discussions of climate change and recent natural disasters. Supporting services are fundamental to all other services, but their relationship to human needs can be indirect and complex. In contrast, most cultural services are directly experienced and intuitively appreciated, often helping to raise public support for protecting ecosystems (19).

All human–environment frameworks must address complements and conflicts among diverse sets of human needs because of the limited capacities of ecosystems to meet those needs sustainably. ES proponents have encouraged incorporation of economic valuation techniques to support environmental policy making (7, 9, 10, 16, 20). However, individual welfare optimization models have proven difficult to apply effectively to some important services (7, 18), and other ES may, as a matter of principle, require alternative evaluation approaches (1, 21, 22). The recent report on the economics of

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ecosystems and biodiversity (TEEB) (16) acknowledges the plurality of ecosystem values and proposes a tiered approach for recognizing, demonstrating, and capturing the value of ES for policy making.

Our purpose here is to highlight the importance of cultural services, including their potential to motivate and sustain public support for ecosystem protection. We review a selection of relevant social and behavioral science that has focused on relationships between ecological structures and cultural benefits to show how this work can productively be applied more effectively to integrate cultural services into the broader ES framework.

Cultural Services Within the ES Framework

The MA (1) defines cultural services in terms of the "nonmaterial benefits people obtain from ecosystems," and specifically lists "cultural diversity, spiritual and religious values, knowledge systems, educational values, inspiration, aesthetic values, social relations, sense of place, cultural heritage values, recreation and ecotourism" (18). Although some cultural values may have little dependence on ecosystems (e.g., those associated with historic buildings, paintings, and religious relics), cultural services, like all other ES, must demonstrate a significant relationship between ecosystem structures and functions specified in the biophysical domain and the satisfaction of human needs and wants specified in the medical/psychological/social domain.

The importance of cultural services has consistently been recognized, but in the rare instances in which there is any further consideration, they are often characterized as being "intangible," "subjective," and difficult to quantify in biophysical or monetary terms (18), thus retarding their integration into the ES framework. Of course, subjectivity relates to some extent to all ES: To qualify as a service, ecosystem structures and functions must contribute to meeting human needs and wants, which necessarily includes intangible and subjective aspects because the selection of ecological structures and functions, and their particular characteristics, that are considered to benefit humans changes with knowledge, technical, social, and cultural development.

The structures and functions produced and sustained by ecosystems arguably exist independent of human needs, and they are, in principle, equally concrete and quantifiable whether they are used for food or for aesthetic or spiritual purposes. The services derived from ecosystems (i.e., ES), however, cannot be defined without incorporating social constructs. Some human needs may be considered more basic and potentially definable by consensus on biological/medical requirements (e.g., the nutrients needed to sustain human life, as determined within prevailing science); however, in practice, humans consistently exhibit different preferences for how basic needs are met (e.g., not everything that is potentially nutritious is accepted everywhere as food). Although all ES must incorporate social constructs, cultural ES may depend on them to a greater degree, and in extreme cases (e.g., distinguishing a sacred from a nonsacred forest), it may be impossible to identify relevant concrete features independent of the subject culture. Nonetheless, within a given socio-ecological context (where, at least as a starting point, applicable cultural designations of both benefits and sources must be accepted as legitimate), some significant contribution from ecological structures and/or functions, however indirect, is required if cultural benefits are to be attributed as an ecosystem service.

Scientific Foundations for Integrating Cultural Services

A substantial body of social and behavioral research developed within prior science/policy frameworks (e.g., natural resources management) provides models, methods, and data that can effectively address cultural ES. To demonstrate the potential of this science base for better integration of cultural services into the ES framework, we specifically review research on landscape aesthetics, cultural heritage, outdoor recreation, and spiritual significance. Each area ranges widely across the social sciences, with prior reviews mostly emphasizing relationships among social and psychological factors. We focus here on work specifically addressing relationships between ecological structures/functions and human needs relevant to cultural values. We note that there can be overlap among cultural ES categories (e.g., aesthetics frequently contribute to recreational experiences), as well as between cultural and other services (e.g., the aesthetic and nutritional aspects of food preferences). Such intertwinements are simultaneously an indication of the importance of cultural services and a challenge to be addressed in their identification, assessment, and management.

Landscape Aesthetics. Aesthetics are consistently included as an example of cultural ES (1, 18), but more specific operational definitions to guide assessments are rarely provided. The MA (1) refers to the "beauty or aesthetic value in various aspects of ecosystems, as reflected in the support for parks, 'scenic drives,' and the selection of housing locations." More recently, de Groot et al. (23) represent aesthetic services based on "appreciation of natural scenery," and Chan et al. (21) link aesthetic values in rural areas with "the amount or configuration of open space in agricultural or forested (land use/land cover) types." These conceptualizations emphasize visual landscape aesthetics, especially scenic beauty (19).

Landscape aesthetics research has examined environmental contexts ranging from cities to agricultural areas to wilderness as viewed from the perspectives of numerous cultural and stakeholder groups (24–27). Studies addressing the aesthetic contributions of landforms, vegetative land cover, and water features emphasize natural capital, and thus are most consistent with efforts to define aesthetic services within the ES literature. For research and scientific purposes, aesthetic quality has most often been assessed by perceptual surveys, where quantitative measures of aesthetic quality are typically derived for targeted landscapes by averaging choices, ratings, or other measures across observers within statistically coherent groups (27).

Differences in aesthetic preferences across individuals, demographic, ethnic, or other groups are commonly presumed, and differences in aesthetic ideals or the importance of aesthetics relative to other values have been demonstrated, especially in the context of culturally modified landscapes (28, 29). However, perceptual assessments of predominantly natural landscapes have consistently shown consensus to be far greater than disagreement (30), and quantitative models based on biophysical landscape characteristics typically account for the largest share of variance in measures of perceived aesthetic quality within a given ecological context (31, 32).

In general, landscape aesthetic models best fit the ES concept when the landscape-characteristic variables are selected to provide a bridge to underlying ecosystem processes and conditions. Multiple regression models have related specific land cover patterns to perception-based measures of aesthetic quality (31, 33, 34). For example, Ribe (33) showed that timber harvest practices affected judgments of scenic beauty for northwestern US forest vistas; perceived beauty increased as the percentage of green trees retained in cut areas increased, so long as retained trees were evenly dispersed rather than clumped in small groups. At finer scales, research on "near-views" within forest landscapes has generally shown that densities of different species and sizes of trees, amounts of vegetative understory, and volumes of downed wood have the strongest effects on aesthetic judgments (35, 36).

Empirical models (33, 35, 37) are supported by perceptual surveys that use computer visualizations of changes in landscape features predicted by biologically based models to assess the perceived aesthetic consequences of those

changes (33, 34, 38, 39). Both types of models have supported monetary evaluations (40, 41), including demonstrations of increased values for private properties with views of aesthetically desirable landscapes (42). More often, however, assessments of visual aesthetic quality are treated as relative measures (preference scales) for specified populations of landscape scenes and observers, providing a basis for evaluations through separate economic, multiattribute utility, or other tradeoff negotiation processes. Aesthetic valuations thus can fit into either the demonstrated or captured TEEB (16) category.

Cultural Heritage. Natural or seminatural features of the environment are often associated with the identity of an individual, a community, or a society. They provide experiences shared across generations, as well as settings for communal interactions important to cultural ties. The MA (1) acknowledges that "many societies place high value on the maintenance of either historically important landscapes ('cultural landscapes') or culturally significant species." Cultural heritage is usually defined as the legacy of biophysical features, physical artifacts, and intangible attributes of a group or society that are inherited from past generations, maintained in the present, and bestowed for the benefit of future generations (43). Thus, research in this area emphasizes a broad range of biocultural relationships, extending beyond the visual/scenic focus in the preceding section. Cultural landscapes are significant constituents of cultural heritage characterized by the long-term interaction between site conditions and human influences (e.g., property distribution, cultivation, nature conservation).

In the original United Nations Educational, Scientific, and Cultural Organization World Heritage Convention (44), cultural heritage was associated with the built environment and artifacts. The concept has subsequently expanded to include practices, myths, knowledge, and skills that do not always imply a material representation and are summarized as intangible heritage (44). Both tangible and intangible aspects are relevant to cultural heritage as ES, including visible material representations of cultural activities on the landscape (e.g., rice paddies, viticulture terraces) as well as landscapes and individual species that are linked to intangible heritage, including myths, legends, and religious practices that refer to concrete locations and ecosystem features.

Although it is often difficult to measure in ES assessments, cultural heritage values for given socioecological contexts have been concretely linked to specific ecosystem features. There are numerous instances where particular types of forests, heaths, prairies, or deserts; particular species; or even individual plants or animals are strongly associated with cultural identities, place attachments, social practices, and images (e.g., ref. 45 and the discussion in ref. 21 of salmon in the northwestern United States and taro in Hawaii). These relationships offer the opportunity to define appropriate indicators for cultural heritage services and fit clearly into the ES framework. Different cultures may have different heritage associations with the same ecosystem features; thus, understanding cultural heritage as an ES requires simultaneous consideration of both the ecological and cultural contexts (46).

Cultural heritage is inextricably linked with historical relationships between human societies and ecosystems. Cultural landscapes are vessels of cultural values and contribute to the identity of communities (47). Over time, altered or even heavily managed ecosystems can acquire cultural significance. Key examples include the classic pastoral landscapes of England (48), terraced landscapes in Portugal (49) or the Alps (50), heath lands in Northern Europe (51), and orchard meadows in the temperate regions of Central Europe (52). The Satoyama concept stands for traditional small-scale agricultural and forestry use in Japan (53). In some cases, the cultural landscape, as well as the products derived from it, may represent a whole region and act as an important trademark for touristic offers and product marketing (54). Well-known examples are the Champagne region in France, Tuscany in Italy, the Napa Valley in the United States, and the Darjeeling region in India.

Culture is not static and is often an important driver of ecosystem change (55). For example, sites managed at a small scale with traditional practices can produce specific elements, such as solitary trees, hedgerows, and terraces, that affect ecosystem resilience and productivity as well as landscape beauty (56–58). Thus, preserving cultural heritage can have considerable synergy with preserving other ES, which is one of the motivations behind the establishment of agrienvironmental programs in the European Union and United States (59) and the recent Satoyama initiative to support the United Nations Convention on Biological Diversity (60).

Markets may indicate monetary values for some cultural heritage services, such as those that can be marketed to tourists, but it is questionable whether valuations are complete even in these instances. Ecological resources that contribute to cultural heritage are often common goods that are shared rather than owned. They typically lack convenient market prices as signals of value, which may be more clearly (but still imperfectly) expressed via politics. Nonmarket economic valuation techniques have been successfully applied to cultural heritage objects (61); however, valuations of some aspects, such as regional identity or sense of place, largely remain elusive (62). For effective policy and decision making more generally, it is important to identify specific ecologically based landscape features that are associated with the particular cultural heritage values of stakeholders in a given cultural context and then to assess how changes in these features would affect those values (21). This requires intensive interaction between carriers of cultural values and both social and ecological scientists. One proven approach is expertly facilitated deliberation, which can elicit and refine relevant cultural heritage values and the ecosystem features with which they are associated (63, 64), thus helping to articulate management tradeoffs and effectively capturing (16) these values for policy making, even if stopping short of monetization.

Recreation and Tourism. Many people engage in some form of outdoor recreation (65); thus, recreation and tourism represent a major opportunity and nexus for managing the interaction between ecosystems and people, including the development of a constituency that appreciates and supports protection of ecosystems. Recreational activities, such as walking, camping, and nature study (66), offer an opportunity for many people to experience the benefits of ES directly. This applies particularly to people living in urban environments, where contact with natural or seminatural ecosystems is often limited. Nonetheless, in the field of conservation biology, recreation and tourism have been recognized mostly as a threat to ecosystems [e.g., via wildlife disturbance and habitat fragmentation (67, 68)], and negative offsite effects are commonly attributed to traffic emissions and infrastructure developments for tourism (69, 70). However, recreation and tourism also provide many important benefits, such as physical exercise, aesthetic experiences, intellectual stimulation, inspiration, and other contributions to physical and psychological well-being (21).

In ES classifications, everyday short-term recreation in nearby green spaces, day tourism, and overnight tourism are often lumped together. Although overnight tourism seems to be recognized and integrated to some extent (66), everyday outdoor recreation in nearby green spaces is often not even mentioned. In the MA report (18), mental and physical health effects of outdoor recreation are only assumed. Meanwhile, numerous studies have shown that even short exposure to green spaces can have positive effects on human health (71–73), thus also contributing to

the economic productivity of society (74). Public green spaces are also important venues for promoting physical activities that improve health (75).

Of course, most recreation activities depend on built infrastructure, accessibility, and other factors, but the fundamental importance of ecological conditions has been widely demonstrated (76–79). For a specific example, Fuller et al. (77) surveyed visitors to urban/suburban parks and found that psychological well-being (gauged by factors derived from park visitor's reports, including reflection, identity, and attraction) was positively correlated with the species richness and habitat diversity in the park.

Research has used a variety of monetary and nonmonetary methods to capture the many facets of tourism and recreational experiences (66, 80). Assessing recreation and tourism services requires information about frequency and intensity of use. In support of such assessments, emerging visitor simulation models can determine the effects of changes in environmental characteristics on visitor behavior in space and time (81–84), information that is also essential for assessments of impacts of use on affected ecosystems. Methods from social science and ecological economics can indirectly translate visitor activity measures into monetary values. For example, at the global level, O'Connor et al. (85) estimate that whale watching generated expenditures of US $2.1 billion in 2008. In the United States, national parks are reported to create a value of more than US $10 billion per year (86), and Mayer et al. (87) estimated the economic impact of six German national parks at €500 million per year.

At finer scales, assessments of particular activities at particular sites can be extended to detailed models that quantify the specific contributions of setting characteristics, such as scenic beauty or the probability of wildlife encounters (78, 88), fitting the capture tier of the model of TEEB (16). More comprehensive approaches, including qualitative and quantitative research methods, such as in-depth interviews and tape recordings, to capture immediately recalled leisure experiences (89), on-site measurements of hiking experiences via questionnaires (89), and computer-animated choice experiments for recreational trail preferences (90) can further guide and help to justify ecosystem protection policies.

Spiritual and Religious Significance. Interest in spiritual and religious significance and values attributed to certain aspects of nature has been growing (91, 92), as reflected in their inclusion as a subcategory of cultural ES (18, 93, 94). Nature conservation practitioners have debated about the ways in which spiritual and religious values can be instrumental in promoting biodiversity conservation (91, 92), with some risk for underestimating the complexities of lived experiences of spirituality and religiosity. Diverse religious groups and conservationists have tried to strengthen the link between religion and environmental conservation, promoting the concept of "environmental stewardship" (92, 95, 96).

Attempts have been made to use sacred areas as a point of departure when creating protected areas (96, 97). This idea in itself is not new; for instance, during the colonial period in India, the British had to acknowledge the concept of sacred groves and land for local priests to avoid revolts (98, 99). What is new is the recent growth in translating "the sacred" into legislation or into legal institutions granting land rights (100). This requires extensive knowledge concerning the particular links between the sacred, nature, and society in a specific locale. Assigning spiritual or religious significance to certain areas or species occurs in most societies; however, how this significance is expressed varies across and within societies. Sacred areas are often marked by religious symbols (e.g., crosses or prayer flags on mountain summits, shrines along pilgrimage routes), their spatial extent may vary from a few trees to a mountain range, and boundaries may not be fixed. In some cases, access may be restricted to a few religious leaders. In other cases, sacred areas are open to the public to perform acts of worship, which may involve harvesting some of the natural resources. Sacred sites may also attract tourism, which may coincide or conflict with the religious or spiritual use of these sites, as observed at the heavily visited pilgrimage route to Santiago de Compostela in Spain (101). Thorough participatory assessments are required to suit local situations, needs, and expectations.

Relations between ecosystems and religion include moral and symbolic concepts but can also center around very material concerns, such as staking claim to land contested by immigrants, invading states, or development agencies (102, 103). Language is among the most powerful ways cultures map meanings through which the world is made more intelligible. For instance, the variety of names for a single site points to shared histories in an increasingly multicultural world (104, 105). Language can also operate through poetry, including the poetry of song and dance (106), to unlock the secrets of the landscape; examples range from Aborigine's song lines and pastoralists' oral mappings to European romantic operas. These have also been ways of placing oneself in and on the land (107, 108).

Spiritual and religious services do not generalize well across communities (100, 109), and they are difficult to value in economic or monetary terms (7, 94). However, there are more comprehensive methods for studying spiritual and religious ES, the way they are constructed and perceived, and their relation to land use and resource management. Many historical and anthropological studies demonstrate the complexities of spiritual services (103, 105, 110), and hence may contribute to policies that avoid the trap of overgeneralization and romanticization (100). Ecologists and ecological economists are increasingly adopting methods derived from history and social sciences to include spiritual and religious services in their analyses. Examples are the Integrated History and Future of People on Earth project (111) and the discourse-based valuation methods proposed by Wilson and Howarth (112). In contrast to the other examples of cultural ES discussed in this paper, efforts at monetary valuation of spiritual and religious services appear to be absent, even though the contribution these services could make to biodiversity protection has been recognized by scientists and policy makers (95).

Way Forward

The brief reviews of social and behavioral science related to landscape aesthetics, cultural heritage, outdoor recreation, and spiritual/religious significance illustrate effective approaches for operationalizing and integrating cultural services into the ES framework. Although this work was largely developed within prior science and policy frameworks, it does offer examples of socioecological models and methods that could be adapted to improve the definition, assessment, and evaluation of cultural ES. Following TEEB tiered valuation framework (16), spiritual and religious services are still largely limited to the recognition category, whereas evaluation of recreation services frequently includes some well-established monetary valuation methods. Evaluations of landscape aesthetic and cultural heritage services fall mostly in TEEB's (16) demonstrate class but have often been able to capture value for policy-making purposes by application of deliberative, multicriterion, or monetary methods. Some specific opportunities and challenges along the path of further development of cultural ES are briefly discussed below.

Integration of Scientific Epistemologies. Concepts and methods traditionally developed independently within the respective disciplines of ecology and social science are not sufficient to address the interrelated nature of ES (8). Within the ES community, the need for better

integration of social and ecological science has mostly been framed in terms of cooperation between ecologists and economists (113); however, for cultural ES in particular, the cooperation must be extended to broader domains of environmental and social sciences (8, 22).

A range of transdisciplinary approaches (114, 115) that incorporate public involvement can be used to promote more effective understanding of cultural ES that arise from complex socioecological systems (111, 116). People draw on multiple forms of knowledge to interpret problems and possibilities within their environment, from scientific or institutional to highly contextual local or traditional knowledge forms (117, 118). To include these multiple types of knowledge within and across multiple scales, approaches that do not assume scientific primacy or exclude alternative epistemologies are more likely to be successful (119, 120). The reviewed literature provides examples of how integrating a broader range of social sciences could widen perspectives in the evaluation of publicly shared goods and services, and could enlighten collective policy and decision processes (121).

Assessing and Modeling Interdependent Socioecological Systems. The research reviewed suggests several effective approaches for studying cultural ES within particular social and ecological systems. The capacity of a given ecosystem to contribute to a given service for a given stakeholder group may fluctuate, and social demands are also dynamic. In this context, useful biological assessment models will anticipate the relevant social contexts and provide outputs that can be useful inputs to social assessments; summary measures of biodiversity or gross productivity will generally not be sufficient. Similarly, useful social science models will allow for explicit linkages to ecological structures and functions, both to determine ecological drivers of social behaviors and outcomes and to anticipate the impacts on ecosystems (22). Innovative techniques for simulation and visualization of dynamic ecological systems (39, 90, 122) can be coupled with qualitative (e.g., focus groups, participatory scenario planning) and quantitative (e.g., formal surveys, economic valuation techniques) social science research methods to forge more explicit links between social and ecological systems and to improve the integration of knowledge from scientists, policy makers, and stakeholders. Integrated socioecological models could also be used to identify the particular ecosystem components to be used as indicators (10) for the associated cultural services, being careful to distinguish properly between the biophysical features/indicators and the values that people attach to the outcomes they support (123).

Defining the Spatial Dimension of Cultural ES. Spatially explicit simulation models have promoted better understanding of ecosystem processes, including changes at different scales over time (124). Promising spatial referencing schemes have been offered for several cultural ES (125, 126), but the object classes usually implemented in Geographic Information System (GIS) environments may not be sufficient to describe all interactions between ecosystems and social systems that define cultural services. For example, determining the cultural heritage significance of a specific ecosystem feature requires the participation of relevant stakeholder groups. Whereas mapping the location of an identified feature can be straightforward, delineating precisely the boundary of the area within which land use changes could affect the associated heritage value can be challenging. All cultural services strongly depend on perceptions and expectations of the respective stakeholders, and considerable conceptual and technical work may be needed to represent and model the complex socioecological relationships that define and constrain a given cultural ecosystem service adequately.

Addressing Tradeoffs and Synergies Across Multiple Value Systems. Ecosystems often support multiple services, and synergies and tradeoffs cannot be negotiated effectively if some services are unknown or ignored, which is likely to be the case for cultural ES (3, 74, 127, 128). Because of lack of information on interactions among services (129), many tradeoffs are still decided based on assumptions rather than facts (8), often ignoring potential synergies as well. Integrated socioecological models can provide information about tradeoffs and synergies, leading to better decisions, reducing unintended consequences, and better managing conflicts.

Divergence between stakeholder groups (130) and the need to integrate priorities for ecosystem management across spatial and temporal scales presents major challenges (23, 131). Monetary valuation schemes have traditionally provided the foundation for resolving such complex tradeoffs, and nonmarket valuation methods (132) have shown promise for monetizing benefits for some cultural services in limited circumstances. The research reviewed provides examples of other effective approaches for resolving tradeoffs among cultural ES and between cultural and other ES and policy goals, but more work is still needed in this area (16).

Visualizations can facilitate communication and improve reliability and validity of monetary valuations (122). GIS-based 3D representations of planned ecosystem changes have supported assessments of stakeholder preferences for different management strategies (133, 134). The combination of valid and intuitively accessible representations of environmental options with participatory deliberative decision methods (135), including citizen juries (136, 137), value construction

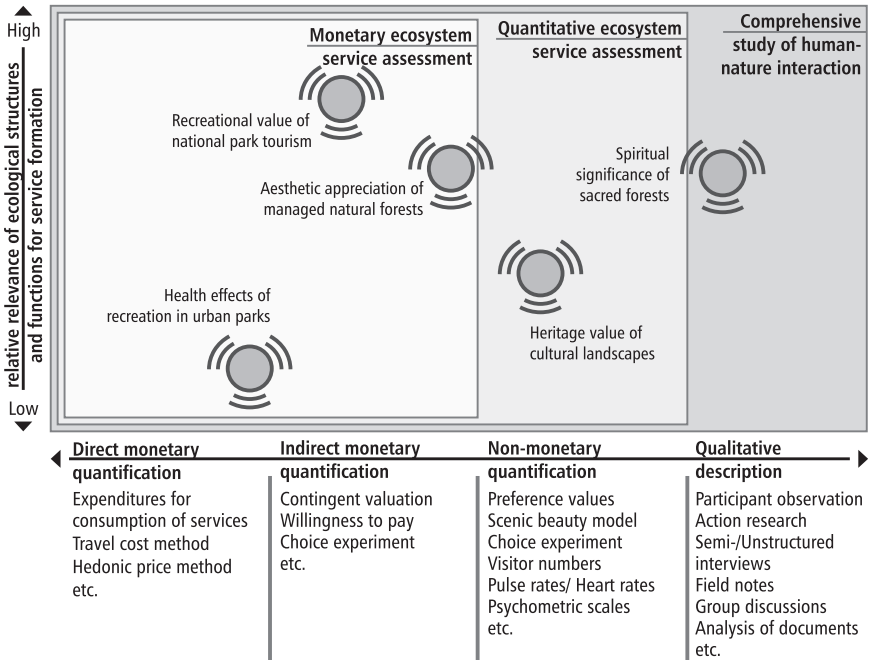

Fig. 1. Examples of cultural services represented within an ES framework.

(63, 138), and multicriterion decision analysis (139), offers proven tools for negotiating across preferences of multiple stakeholders and multiple scales without requiring the monetization of what many regard as intrinsically nonmonetary values.

Conclusions

It is common for taxonomies of ES to include a broad category labeled cultural ES. These should not be seen as a residual category after accounting for more utilitarian ES, such as water and food provision. Cultural services have value in their own right, and they have played an important role in motivating public support for the protection of ecosystems. In this paper, we have described a sample of relevant social science to show how cultural ES can be operationally defined in terms of socioecological models to enable better integration of these services within the broader ES science and policy framework.

Fig. 1 presents the cultural service categories reviewed above in terms of (*i*) the relevance of ecological structures and functions for their formation (the relative contribution of natural capital) and (*ii*) a nested set of methods for assessing human benefits consistent with the tiered approach adopted in TEEB (16). Based on the scope and assessment methods applied, we differentiate between (*i*) monetary assessments (2 types), (*ii*) quantitative (nonmonetary) assessments, and (*iii*) comprehensive studies of the human–nature interaction, which may include but also extend beyond the other classes. Specific examples of cultural services are represented in the 2D space by a centroid with extensions (Fig. 1), indicating that particular instances within each service category may vary considerably along both dimensions, a point that is reinforced by the inclusion of two different cases for recreational services. This perspective could equally serve to represent instances of other classes of ES.

The current weak integration of cultural services into the ES research and policy framework presents challenges and also obstructs many opportunities. Many aspects of cultural ES that have hindered integration into the broader ES framework (e.g., subjective, intangible, difficult to evaluate) also apply to some extent to all other ES. From this perspective, research to develop socioecological models further for cultural services, along with expanded systems for evaluation and tradeoff negotiation, would not only enhance the role of cultural services but could contribute to improved assessments, modeling, and integration of all ES.

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