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RESEARCH ARTICLE

Mapping recreation and aesthetic value of ecosystems in the Bilbao Metropolitan Greenbelt (northern Spain) to support landscape planning

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Abstract This paper presents a method to quantify cultural ecosystem services (ES) and their spatial distribution in the landscape based on ecological structure and social evaluation approaches. The method aims to provide quantified assessments of ES to support land use planning decisions. A GIS-based approach was used to estimate and map the provision of recreation and aesthetic services supplied by ecosystems in a peri-urban area located in the Basque Country, northern Spain. Data of two different public participation processes (frequency of visits to 25 different sites within the study area and aesthetic value of different landscape units) were used to validate the maps. Three maps were obtained as results: a map showing the provision of recreation services, an aesthetic value map and a map of the correspondences and differences between both services. The data obtained in the participation processes were found useful for the validation of the maps. A weak spatial correlation was found between aesthetic quality and recreation provision services, with an overlap of the highest values for both services only in 7.2 % of the area. A consultation with decision-makers indicated that the results were considered useful to identify areas that can be targeted for improvement of landscape and recreation management.

Keywords Peri-urban ecosystems · Cultural ecosystem services · Social participation · GIS · Spatially explicit indicators · Supply · Demand · Land use management

Introduction

Cultural ecosystem services (ES) are defined as the non-material benefits obtained from ecosystems and include cultural diversity, spiritual and religious values, knowledge systems, educational values, inspiration, aesthetic values, social relations, sense of

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place, cultural heritage values, recreation and ecotourism (MEA 2005). These services are often mentioned but only rarely fully integrated in assessments following the ES framework (Chan et al. 2012; Daniel et al. 2012) because they are frequently characterised as being "intangible", "subjective" and difficult to quantify in biophysical or monetary terms (MEA 2005) or related more to the observer than to ecosystem conditions (Kumar and Kumar 2008). However, the fact that most cultural services are directly experienced and intuitively appreciated has played an important role in motivating public support for the protection of ecosystems (Daniel et al. 2012). The values of cultural services also provide opportunities for conservation, because maintaining ES is assumed to contribute to the conservation of habitats and species (Maes et al. 2011b, 2012a).

Land management decisions typically relate to the spatial distribution of landscape functions and services, making the assessment of the spatial heterogeneity of the landscape to provide these services important (de Groot et al. 2010). The EU 2020 Biodiversity Strategy recognised the high potential of mapping ES for policy support and decision making and the well-known TEEB study (Kumar 2010) called for an extra effort in mapping a wider set of ES that includes cultural services. On regional and landscape levels maps are often mentioned as being essential for proper management of ecosystems and their services (Hauck et al. 2013). However, there is a clear lack of such information relevant to local scale decision making (Turner and Daily 2008), which is necessary to support the establishment of different policies and plans. The explicit quantification and mapping of ES is considered as one of the main requirements for the implementation of the ES concept into environmental institutions and decision making (Daily and Matson 2008).

A recent review about ES mapping papers (Crossman et al. 2013) concluded that only in 18 % of the papers cultural ES were mapped. Moreover, Hernández-Morcillo et al. (2013) found that only 23 % of studies about cultural ES were including an explicit spatial representation. Cultural ES are very important in land use planning, e.g. for the planning of recreation facilities, landscape preservation policies, etc. Currently, there are only few methods available to quantify such services to support the land use planning practice. Some models explicitly link ecological structures and functions with cultural values and benefits (Burkhard et al. 2009; Kienast et al. 2009; Vihervaara et al. 2010; Haines-Young et al. 2012; Koschke et al. 2012), but they do not incorporate social evaluation approaches. Others try to map the community values based on surveys (Raymond et al. 2009; Brown et al. 2012; Sherrouse et al. 2011). Although all ES must incorporate social constructs, cultural ES may depend on them to a greater degree (Daniel et al. 2012). Cultural ES are not solely a function or a one-way flow from natural ecosystems to people, but they are co-generated through the interaction of humans and the environment. This paper aims at presenting a method to quantify cultural ES and their spatial distribution in the landscape, considering both ecological structures and social evaluation approaches.

Explorations by Naidoo et al. (2008) have indicated that regions selected to maximize biodiversity may not provide more ES than randomly selected regions. Important services can be delivered by semi-natural and agricultural ecosystems; therefore, it is necessary to develop ES maps and models also for the territory falling outside protected areas in order to estimate where ES are produced (Maes et al. 2011b). People find various cultural values in their everyday surroundings, not only in landscapes of outstanding biodiversity, heritage or scenery (Plieninger et al. 2013). Peri-urban ecosystems are often managed as recreation areas or to enhance aesthetic value on the urban fringe. A recent study carried out in the Bilbao Metropolitan Greenbelt (BMG), a peri-urban area in northern Spain, demonstrated that users' perceptions about the ES provided by the study area are related to the management practices in the area (Casado-Arzuaga et al. 2013). This is the reason why this study is oriented to the analysis of the spatial distribution of recreation provision and aesthetic quality services in the BMG. The objective of this paper is to study to which extent these cultural services are provided by the area and to analyse their spatial distribution to help better orient land use planning. Moreover, different surveys amongst service beneficiaries were carried out to validate the results obtained and study the social values of the services provided, making the demand for these ES more explicit.

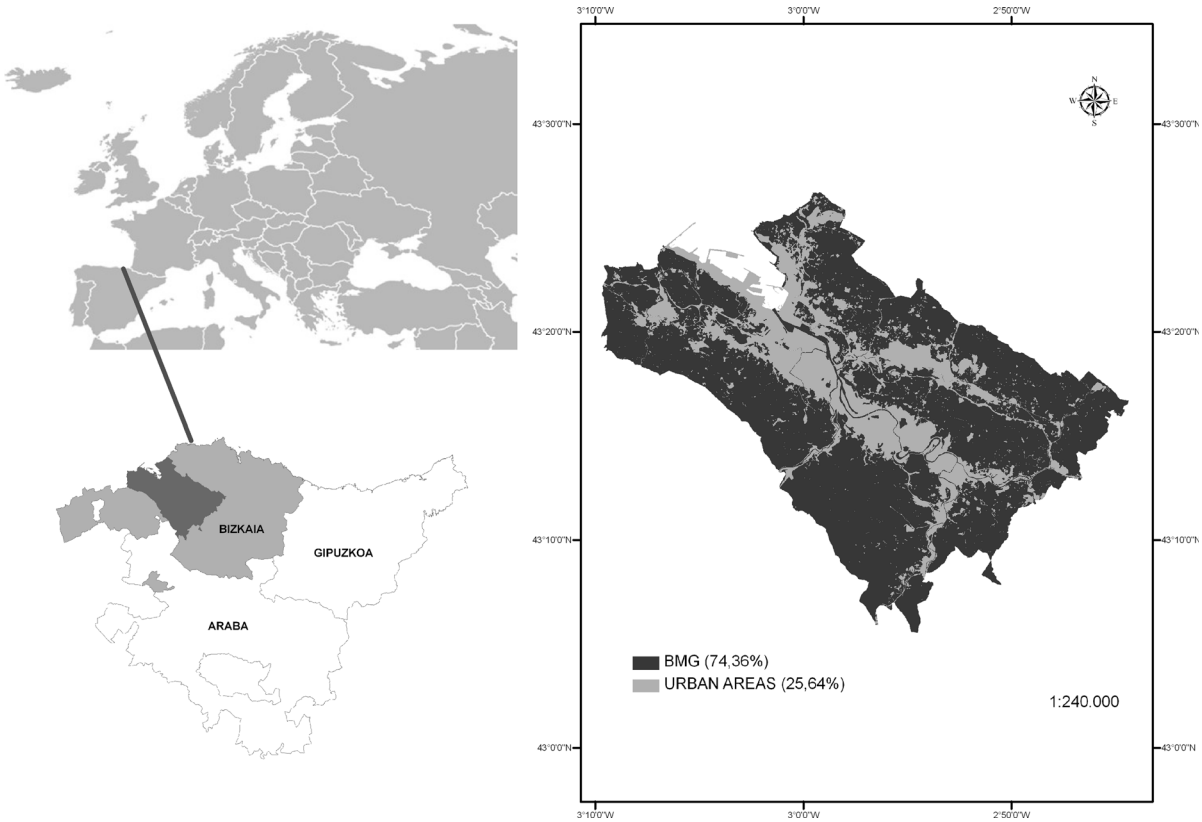

Fig. 1 Location of the study area

Methods

Study area

The social–ecological system of metropolitan Bilbao is located in the region of Bizkaia in the Basque Country, northern Spain (43°15′N, 2°55′W; Fig. 1). It is divided into 29 municipalities and has an area of 413 km^2 and a population of 893,697 inhabitants (Udalmap 2012), resulting in a high population density (2,164 inhabitants per km^2). In this region, urban areas are situated in the valley along the estuary of the river Nervión-Ibaizabal, delimited by small mountains and the coast to the north. The associated peri-urban ecosystems are called the BMG and occupy almost 75 % of its surface area (Fig. 1). These ecosystems include beaches, cliffs, rivers, meadows, scrublands and forests (Table 1) and, depending on their management, can provide a wide range of valuable ES.

Bilbao was founded as a village in the early 14th century and developed starting in the 18th century as an important economic area because of the iron found in the surrounding mountains. The heavy industrialization throughout the nineteenth and early twentieth century contributed to the economic development and substantial net gains in inhabitants' well-being, at the same time resulting in the degradation of the

Table 1 Distribution of land uses in the metropolitan Bilbao

Land use/cover	Area (km^2)	Percentage (%)
Urban areas	105.9	25.64
Forest plantations	117.4	28.40
Meadow and cultivation	87.1	21.09
Scrubland	43	10.43
Natural forests	39	9.44
Abandoned mining developments	8.1	1.96
Urban parks	5.5	1.34
Aquatic ecosystems	4.8	1.17
Cliffs, marshes, dunes and beaches	2.2	0.53

Table 2 Multi-source geospatial database developed for the case study

Data	Data source	Description
Land use/land cover map	Basque Government (ftp.geo.euskadi.net/cartografia/)	European Nature Information System (EUNIS), habitat types classification
Naturalness	Own elaboration based on the EUNIS and Loidi et al. (2007)	Degree of human influence on vegetation types
Natural protected areas (NPAs)	Basque Government (ftp.geo.euskadi.net/cartografia/)	Sites of Community Importance (SCI)
Coastline	Basque Government (ftp.geo.euskadi.net/cartografia/)	Coastline
Quality of bathing water	Own elaboration based on information from the County Council of Bizkaia	Quality of bathing water
Routes of geological interest (RGIs)	Basque Government (ftp.geo.euskadi.net/cartografia/)	Routes of geological interest
Cycling paths	Own elaboration based on information from the County Council of Bizkaia	Cycling paths
Climbing sites	Own elaboration based on information from the County Council of Bizkaia	Climbing sites
Recreational areas	Own elaboration based on information from the County Council of Bizkaia	Recreation areas
Density of mountain summits	Own elaboration based on information from the Basque Government	Density of mountain summits
Perceived value of different landscape units	Own elaboration based on the EUNIS and information from the CPSS (2005)	Perceived value of different landscape units
Diversity of landscapes	Own elaboration based on the EUNIS	Diversity of landscapes
Digital Elevation Model (DEM)	Basque Government (ftp.geo.euskadi.net/cartografia/)	Digital elevation model
Relief	Own elaboration based on the DEM	Relief
Viewsheds	Basque Government (ftp.geo.euskadi.net/cartografia/)	Polygons including the visible self-contained area from different vision points

ecosystems due to the intensive mining, deforestation, reduction of the original estuary through land reclamation, etc. However, the BMG is valued by residents and visitors for the different ES that it supplies and its capacity for supplying them in the future (Casado-Arzuaga et al. 2013).

Database development

To develop the GIS-based approach to map the selected cultural ES a multi-source database was required, composed of different geospatial data (Table 2). These data were available from local and regional governments and were digitised in GIS format. Subsequently, all the information was projected to the same coordinate system (ETRS89 UTM 30 N) to facilitate the spatial analysis. Based on these primary spatial data, other datasets were derived, such as naturalness and perceived value of different landscape units (Table 2).

The datasets were compiled in both vector and raster format. Vector files were rasterised based on their attribute data for facilitating posterior analysis using GIS software (ArcGIS 10 ESRI Inc.). The spatial resolution of all the raster datasets used in this study was 2 m.

Data analysis

The cultural ES addressed in this paper include recreation and the aesthetic quality of the landscape. The methodological approach (Fig. 2) was designed based on a review of indicators and methods used to map these services in the literature and considering the characteristics of the study area and the information available. Two components were considered for

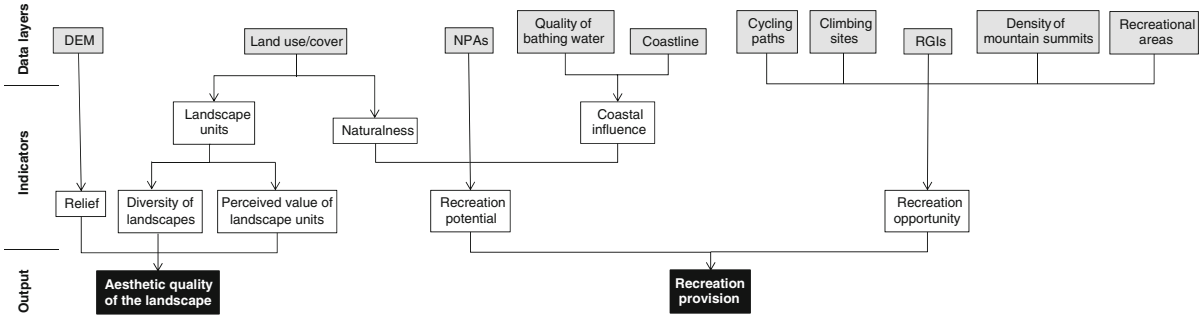

Fig. 2 Procedure for mapping recreation provision and aesthetic quality ES. Data layers, indicators and outputs are shown. *DEM* digital elevation model, *NPAs* natural protected areas, *RGIs* routes of geological interest

mapping the recreation service: the recreation potential and the recreation opportunity. The recreation potential was mapped with the assumption that it was positively correlated to a limited list of territorial features associated with attractiveness for recreational activities, i.e. the degree of naturalness, the presence of protected areas, the presence of coastal lines (sea) and the quality of the bathing water (Maes et al. 2011a; Table S1). Naturalness applied to vegetation types is a measure for the degree of human influence on them and comprises two aspects, the damage or transformations caused by humans in plant communities and how these plant communities are the result of and depend on human activity themselves (Loidi et al. 2007). To estimate the naturalness of the BMG ecosystems we used the index proposed by Loidi et al. (2007) for the Iberian Peninsula, considering the environmental units defined according to the land use/cover map. The presence of protected areas was mapped using the Natura 2000 database. The study area holds the Barbadún estuary, which is a Site of Community Importance. The coastline and data about the bathing water quality of the 7 beaches located in the study area were used to differentiate between the different coastal areas in the recreation potential. The recreation opportunity took into account the infrastructure that was in place to host or guide the visitors and included information regarding the density of mountain summits and the location of recreational areas, climbing sites, cycling paths and routes of geological interest (Table S1). Finally, the recreation provision service was calculated aggregating these two components (Fig. 2). The values of the resulting map were classified by Jenks Natural Breaks. Classification by natural breaks provides natural groupings inherent to the data (Reyers et al. 2009; O'Farrell et al. 2010; Onaindia et al. 2013). Class breaks identify the best groups of similar values and they maximise the differences between classes.

The aesthetic landscape value was calculated considering three elements (Table S2): the perceived value of different landscape units by people, the diversity of landscapes and the relief. First of all, 18 different landscape units were identified in the study area based on the land use/cover map (CPSS 2005). Then, they were given a value from 1 to 5 considering the perceived value of different landscape units of the Basque population (CPSS 2005; Table S3). The diversity of landscapes was studied by calculating the number of different landscape units surrounding each raster pixel while the relief was measured by calculating the difference between the z value (altitude) in each pixel and the mean z value in a 200 m radius. We assumed that a higher diversity of landscapes and a higher difference in relief were related to a higher aesthetic value (CPSS 2005; de Vries et al. 2007; Lovell et al. 2010; Kienast et al. 2012; Norton et al. 2012; Frank et al. 2013). We used the viewshed, i.e. the polygon including the visible self-contained area from different vision points as unit of analysis. The viewshed can be considered as the unit for describing the territory based on visibility criteria because it consists of the set of intervisible points. So, the viewshed contains information about the visual potential and visual incidence (CP 1990). All calculations were made within each viewshed in a radius of 200 m from each raster pixel. These three maps were subsequently aggregated to obtain the final map of the aesthetic value service (Fig. 2). The values of the resulting map were classified by natural breaks (jenks).

In addition to the mapping of the two different cultural services, we studied the spatial correlation between them (Pearson's correlation coefficient) using 100 randomly selected points within the study area and a buffer of 100, 200 and 400 m from each one. We also compared the location of the 25 % highest values of both services to analyse the overlap.

Social assessment

To validate the maps and incorporate a social evaluation approach, we used data of two different public participation processes. The recreation provision map was validated through data about the frequency of visits to 25 different sites within the study area. These were obtained from a survey completed by 500 visitors to the BMG in which their knowledge of and interest in the study area was assessed (Casado-Arzuaga et al. 2013). 97 % of the approached respondents completed the survey. The aesthetic value map was validated with the results obtained in a photo-questionnaire designed with pictures of 35 random points of the BMG ecosystems, one for each viewshed. The photographs were obtained from Google Maps (Street View) and they showed the different landscape units present in the study area. We decided to use photographs of landscape types because other authors have observed a stronger correlation between the visual assessment results based on landscape photographs and landscape metrics-based assessment outcomes than between the latter and satellite images or land cover maps (Frank et al. 2013). Images from Street View were used instead of other pictures or aerial photographs of the landscape to best reflect the landscape experience of the users and at the same have a standardised way of collecting the pictures (van Berkel and Verburg 2012). Respondents had to value each picture from 1 to 5 depending on their opinion regarding the aesthetic value of the landscape shown. Moreover, they had the option of indicating the positive or negative elements of the landscape underlying their overall evaluation of the landscape. This survey was administered by email and answered by 64 respondents. The participants of the survey were restricted to the people living in the Basque Country because they were familiar with this type of landscapes and were also the most likely potential beneficiaries. To evaluate the spatial synergies between the ES maps and the social assessments, correlations were calculated (Pearson's correlation coefficient).

The consideration of preferences both at the individual and the societal level displays a form of democratic validation (Hernández-Morcillo et al. 2013) and is useful to assess the demand side of the cultural ES analysed. Nahuelhual et al. (2013) also used participatory methods to validate attributes and spatial criteria.

Results

Recreation provision map

The resulting spatial distribution of the recreation provisioning is shown in Fig. 3, which also includes the maps of the two components that were aggregated to obtain it (recreation potential and recreation opportunity). Eleven percent of the study area had a high or very high value for recreation service, whereas 31.4 % presented a very low value. The map indicates a very high spatial variation of the service across the study area. The highest values where concentrated in coastal ecosystems, metropolitan parks and in the peri-urban ecosystems of the municipalities situated in the west side of the principal river, coinciding with the highest mountains (Pagasarri and Ganekogorta) and the abandoned mining areas converted into a park (Meaztegi Berdea metropolitan park).

The validation of the recreation provision map showed a high correlation between the values obtained from the map of recreation provisioning and the frequency of visits in the selected sites ($r = 0.71$, $p < 0.001$). This correlation is high as compared to the correlations between the frequency of visits and the recreation potential ($r = 0.38$, $p = 0.061$) or the recreation opportunity ($r = 0.50$, $p = 0.01$).

Aesthetic value map

The spatial variation of aesthetic value service showed a different spatial pattern, 35.1 % of the analysed area had a high or very high value for the provision of this service and only 1.8 % a very low value (Fig. 4). The areas with the highest value corresponded with rural settlements and farmhouses in the countryside, rough summits and coastal ecosystems such as cliffs. Many of these peri-urban landscapes were located very close to urban areas.

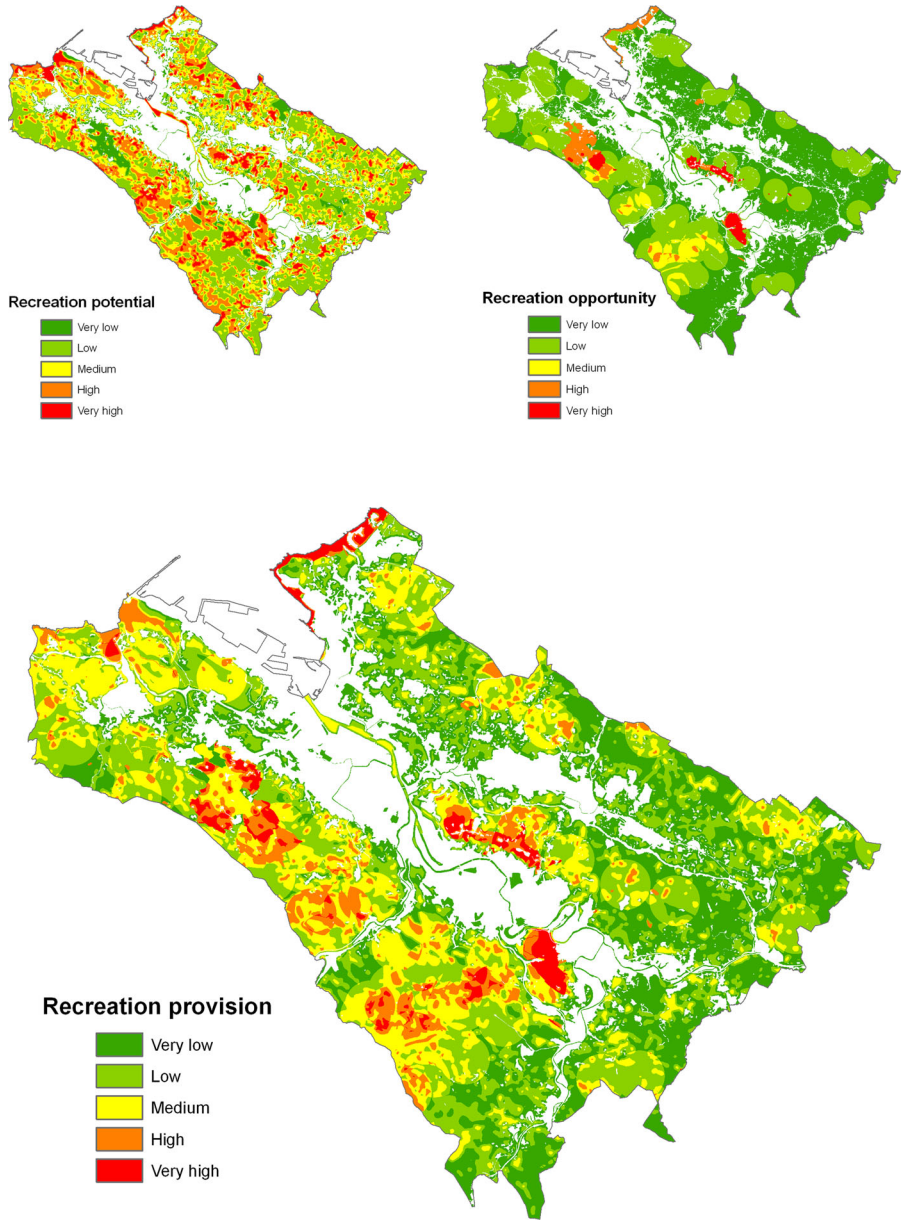

Fig. 3 Spatial distribution of the recreation provision service. The two components considered to map this service are also shown (recreation potential and recreation opportunity)

The results obtained in the photo-questionnaire confirmed the perceived values used for the different landscape units and had a good match with the resulting map ($r = 0.77$, $p < 0.0001$).

Correspondences and differences between ES

We found a weak spatial correlation between aesthetic quality and recreation provision services. The highest correlation was found for a buffer of 200 m but the results were relatively insensitive for buffer size (100 m buffer: $r = 0.27$; 200 m buffer: $r = 0.29$; 400 m buffer: $r = 0.27$). The map comparing the location of the 25 % highest values of both services (Fig. 5) identified the areas where the most important differences were located. 17.0 % of the analysed area showed a significant higher value in aesthetic provision service and 15.9 % had a higher value for recreation provision service, whereas only in the 7.2 % of the area was an overlap of the highest values for both services. These areas corresponded with some natural forests, scrubland and meadows. Recreation

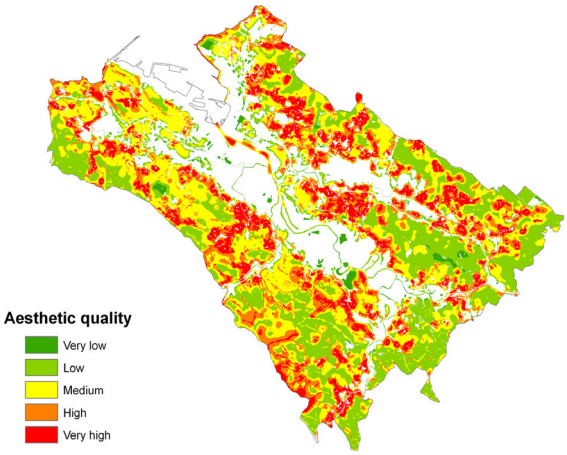

Fig. 4 Spatial distribution of the aesthetic quality of the landscape

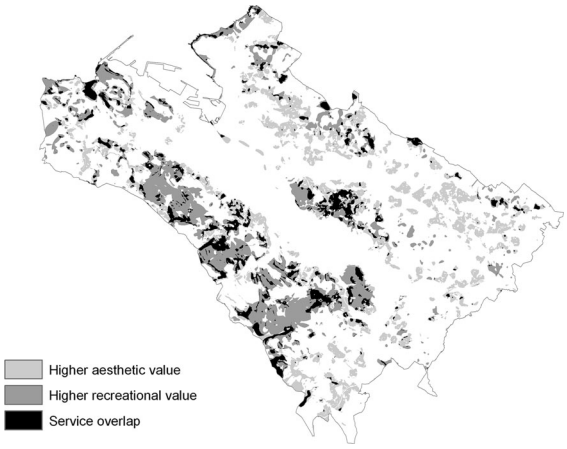

Fig. 5 Differences in the spatial variation of recreation provision and aesthetic quality services. Three classes are shown: only 25 % highest recreation (higher recreational value), only 25 % highest aesthetics (higher aesthetic value) and both 25 % highest recreation and 25 % highest aesthetics (service overlap)

service was concentrated especially in forested areas and scrubland and the highest aesthetic value was related to rural landscapes (farmhouses, forest plantations and meadows and vegetable gardens).

Discussion

Recreation service

Recreation and tourism provide many important benefits and contributions to physical and psychological well-being (Chan et al. 2012) and represent a major opportunity and nexus for managing the interaction between ecosystems and people (Daniel et al. 2012). These ES are the most commonly mapped services from the broad group of cultural services (Crossman et al. 2013), and varying methods for calculating their value are applied. Most recreation activities depend on built infrastructure, accessibility and other factors, but the ecological conditions have also been found important (Adamowicz et al. 2011). We mapped the recreation provision service considering the capacity of the BMG ecosystems to provide the service and the infrastructure that was in place to host or guide the visitors. The degree of naturalness of the landscape is a factor that has also been used in other studies (Maes et al. 2011a; Schulp et al. 2012), as well as the presence of natural protected areas (Willemen et al. 2008; Kienast et al. 2009) or the coast (Maes et al. 2011a; van Berkel and Verburg 2011; Norton et al. 2012; Schulp et al. 2012). Moreover, many authors have used place based information for mapping recreation provision, such as scenic spots (Chen et al. 2009b), cycling paths and walking trails (Willemen et al. 2008; Bieling and Plieninger 2012; Gulickx et al. 2013), picnic tables and car parks (Gulickx et al. 2013), subsistence gardens (Bieling and Plieninger 2012), presence of cultural historical elements (Willemen et al. 2008) or camping sites (van Berkel and Verburg 2011). The associated flow of benefits related to recreation is also influenced by the accessibility of ecosystems to humans, e.g., the proximity to population centres and major roads, as well as the access rights (Chan et al. 2006; Maes et al. 2011a). We did not consider these factors because the study area was assumed to be accessible to all the population living in the metropolitan area through walking trails or roads, due to its proximity to urban areas. Data about the level of public access were not available.

A high correlation was found among the recreation provision map and the frequency of visits to different locations within the BMG. However, there were some areas with high potentiality for recreational services that were currently not very frequently used by visitors. It seemed that the aesthetic value of the surrounding landscapes, other affections, such as the noise from highways (Ollargan metropolitan park) or the smoke produced in the industries (Punta Lucero mountain), and the ignorance about some recreational

areas (Mendikosolo) could have an effect in recreationists' decisions about visiting them.

Landscape structure and aesthetic preferences

Landscape aesthetics service is defined as the pleasure people receive from scenic beauty provided by natural areas and landscapes (Kumar 2010) and is an issue in landscape and environmental management (de Vries et al. 2007). The modelling and mapping of this service is commonly done through perceptual surveys, questionnaires or interviews on personal preferences (Daniel et al. 2012; Crossman et al. 2013), but there are also studies based on factors such as naturalness, relief, historical distinctiveness, skyline disturbance or the diversity of habitats (de Vries et al. 2007; Lovell et al. 2010; Sherrouse et al. 2011; Norton et al. 2012; Frank et al. 2013). The psychophysical paradigm defends that the preferences for and the attractiveness of a specific landscape are supposedly founded in the landscape's physical attributes. Therefore, it is possible to map landscape preferences using geographic data of the physical landscape (de Vries et al. 2007). Following this paradigm, we based the map of this service on three elements: the perceived value of different landscape units by people, the diversity of landscapes and the relief. As differences in aesthetic preferences across individuals, demographic, ethnic or other groups are commonly presumed (Daniel et al. 2012) we used data obtained from a previous study (CPSS 2005) to consider the perceived value of different landscape units of the Basque population. Relief and variety have also been considered in other studies because height contributes positively to landscape attractiveness (de Vries et al. 2007; Norton et al. 2012) as well as diverse or multifunctional landscapes (Lovell et al. 2010; Kienast et al. 2012; Frank et al. 2013).

The aesthetic quality map had a high correlation with the aesthetic value obtained for the pictures shown in the photo-questionnaire. These values reflected that more natural landscapes were more preferred. However, the forest/pastureland mosaic landscape unit and the rural settlements in the countryside also acquired a high perceived value. Thus, we can conclude that human influence can also have a positive effect on the landscape aesthetics. In fact, rural landscapes where the rural activity was still maintained (photographs showing crops or livestock in combination with farmhouses) acquired a higher aesthetic value than the ones that had abandoned their activity. For most of Europe, the rural landscape is shaped by an ancient history of farming and forestry and the variety of distinctive field systems and settlement patterns created by these traditional land uses are considered as attractive landscapes by residents and tourist (Gobster et al. 2007). Furthermore, we found that respondents had low knowledge of the native plants, as has also been found in other studies (Chen et al. 2009a), being not able to distinguish between natural forests and forest plantations. This could be due to the fact that forest plantations have been a landscape element since the 1960s in the area, occupying a 28.4 % of the surface currently. Either people have become very familiar with forest plantations or, being urban residents, value them highly given their green appearance as opposed to the city environment.

Recreation provision and aesthetic quality

Although we studied recreation provision and aesthetic quality separately, some authors have considered them together (Burkhard et al. 2012; Koschke et al. 2012) or have used some variables related to aesthetics when calculating the recreation provision service (Chen et al. 2009b; Nahuelhual et al. 2013). Often, it is assumed that aesthetics contribute to recreational experiences and, therefore, there is an overlap among these cultural ES categories (Daniel et al. 2012). However, the results obtained in this study demonstrated that these assumptions are not always correct. Therefore, researchers should evaluate the necessity of studying these ES individually. The BMG presented in many areas a higher value for the aesthetic landscape service than for the recreation provision service and a high spatial variation of both ES was found across the study area. These ES overlapped in 7.2 % of the BMG, coinciding with some coastal ecosystems, recreational areas or mountains, but were significantly different for 33 % of the study area. Thus, our results indicate that the most important areas for recreation did not coincide with the areas with the highest aesthetic value.

This result may depend on the characteristics of the study area and its beneficiaries. In the BMG rural landscapes had a high aesthetic value but low recreational facilities, as much of the land is private.

Moreover, the objective of recreationists is usually to exercise or spend time with family and friends, although once they arrive to mountain summits they enjoy the views from them. The recreational infrastructures introduce artificial elements (tables, car parks, paved roads, etc.) in these areas. From this perspective, recreation and aesthetic ES do not overlap.

Implications for land use planning

Research on mapping ES has grown substantially in the past decade partly due to the potential inclusion of ES in conservation policies as well as policies that address the use of natural resources (Maes et al. 2012a). Although many authors claim that their work can support decision making, the approaches they use are only rarely developed in collaboration with planning practitioners or other decision-makers (Hauck et al. 2013) and political application of outcomes are often lacking (Burkhard et al. 2010). In our case, there was a previous initial interest from the regional government in using the information of ES maps to orient land use planning and we had informal discussions with decision-makers in which maps' usefulness was discussed. As a result of these consultations, they decided to start using the results of the study to assess its operational potential. Moreover, the methodology developed in this paper is replicable and could be applied by planners in case they are proficient in geographical information systems. The most difficult or challenging issue in these assessments is the consideration of public opinion (the demand side) because planners are not used to engage into a participation process with the aim of taking the social dimension into account. However, this is key element to guarantee success when we are making decisions about areas that are intensively used by society.

Both the analysis of the supply and demand sides of the cultural ES and the effective participation of decision-makers of the County Council of Bizkaia in the present study allowed understanding the interaction between the biophysical and socio-economic environments within the BMG study area. Furthermore, some outcomes related to land use planning illustrate that the results are actually supporting the decision-making processes:

- On one hand, local decision-makers are evaluating if the investments made in different locations were correctly allocated based on the maps of the spatial variation in cultural ES. The maps can also help to identify areas where landscape and recreation management should be improved. The map of correspondences and differences between these services identified some areas where there were disproportionate recreational infrastructures compared to the landscape aesthetic values, while at other locations high aesthetic values were observed, but with a lack of recreational infrastructures. Local managers are interested in having recreational areas with high aesthetic value, so they are planning the area effectively using this information. Furthermore, when deciding the location of future recreational developments it is necessary to consider not only the characteristics of the location, but also the values in the neighbourhood because the latter can have an effect in the subsequent use of these areas.
- On the other hand, local decision-makers are taking into account the results of this study in the review of their municipal planning, and in the participation process for the definition of the Landscape Catalogues by the Basque Government. Maintaining the rural landscapes alive increases the aesthetic value of an area. Therefore, promoting agricultural and livestock activities in the BMG will improve the aesthetic value of the study area and make the views from the urban areas more attractive. These cultural landscapes contribute to place attachment and local identity and there is widespread support for their maintenance as an essential part of European cultural and natural heritage (Gobster et al. 2007). Moreover, the recreation or tourism infrastructures could be improved in these areas by developing, for example, rural accommodations. Both measures are in favour of economic development and avoid agricultural abandonment.

Methodological concerns

The capacity of different ecosystems to supply particular ES varies strongly depending on their structure and processes (Bastian et al. 2012). Land cover and land use explain a considerable part of the

variation in the spatial supply of ES (Maes et al. 2012b); therefore, a simple approach is to derive information on ES directly from land use/cover or habitat maps (Burkhard et al. 2009; Kienast et al. 2009; Vihervaara et al. 2010; Haines-Young et al. 2012; Koschke et al. 2012). However, this is only possible for ES with a one-to-one relation to land cover (Verburg et al. 2009). Cultural services are not straightforwardly related to land cover and researchers must rely on proxies for their quantification (Maes et al. 2012a). Land cover information is an appropriate starting point but it is necessary to integrate it with further data to assess the ecosystems capacities to supply cultural ES (Burkhard et al. 2012). Mapping the biophysical provision of ES is in general constrained by data availability. The results obtained in this study have considered most of the information available to calculate the cultural ES analysed as technicians of the regional government were involved in the process from the beginning. However, it is not always possible to transfer all the information available to a format that can be subsequently used because it is very time consuming. Therefore, a cautious use of the maps is needed because they might still need further refinement with more detailed spatial data and better socio-economic information.

Ecosystem functions and processes become ES when there are human beneficiaries (Fisher et al. 2009), i.e., when there is a demand for them. However, the direct comparison of ES supply and demand in spatially explicit maps is rather rare and there is a need to develop indicators that address the demand for ES (Maes et al. 2012b). All cultural services strongly depend on perceptions and expectations of the respective stakeholders (Daniel et al. 2012); therefore, the users' perception of a functional space needs to be given utmost attention when mapping these ES. Moreover, the incorporation of public involvement can be used to promote more effective understanding of cultural ES (Daniel et al. 2012). Nevertheless, the social dimension of the ES is not usually considered because authors assess the potential of the landscape to provide ES (Egoh et al. 2008; Burkhard et al. 2009; Kienast et al. 2009) or find difficulties because obtaining this type of data is very time consuming (Gulickx et al. 2013). But, some authors have tried to take into account this dimension using different proxies such as the number of tourists or overnight stays at particular locations (Adamowicz et al. 2011), the potential leisure cycling population (Willemen et al. 2008), the density and distribution of summer cottages (Maes et al. 2011a) or the annual tourism income (Chen et al. 2009b). Furthermore, Raymond et al. (2009), Brown et al. (2012) and Sherrouse et al. (2011) demonstrated that useful and spatially explicit results can be obtained from interviews, questionnaires or additional information sources. We studied the social dimension of the cultural ES analysed based on the results obtained in two social participation processes to make the demand for these ES more explicit. Both the validation through measuring the aesthetic value of the landscapes in the photo-questionnaire for the aesthetic quality map and the validation of the recreation provision map by the frequency of visits to different locations within the BMG were found to be useful. The validation of the maps was made considering the demand for ES at specific locations and there is a need to find ways which allow validating the complete maps. This has also been encountered in other studies (Kienast et al. 2009; van Berkel and Verburg 2011).

Conclusions

- The paper addresses an innovative combination of methodologies capable of mapping the supply and demand of cultural ES to support land use planning. It was possible to identify the areas where cultural ES were supplied and test the correspondence of these maps with the areas most used or appreciated because of their cultural ES provision in a social valuation.
- The participation processes used were found useful for validating the maps obtained. We identified some areas with high potential for cultural ES provision according to the mapping approach that were currently not very frequently used by recreationists or valued aesthetically.
- Cultural ES are directly experienced. If areas are managed with the principal objective of providing this kind of ES but they are not used by beneficiaries because of their provision then investments are not correctly allocated. The methodology presented in the paper is useful for identifying areas where landscape and recreation management could effectively be improved.

- Maintaining the rural landscapes alive increases the aesthetic value of the landscape in the study region.
- Landscape aesthetic and recreational value services are often assumed to coincide in the space. However, in the BMG the most important areas for recreation did not coincide with the areas with the highest aesthetic value.
- Consultation with decision-makers of the regional government about these results helped in understanding the outcomes of the study and the reasons why some decisions had been adopted. Moreover, the decision-makers appreciated the spatial information obtained to improve the management of the area regarding the provision of cultural ES.

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