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Mapping recreation supply and demand using an ecological and a social evaluation approach

Lorena Peña*, Izaskun Casado-Arzuaga, Miren Onaindia

Department of Plant Biology and Ecology, University of the Basque Country (UPV/EHU), P.O. Box 644, 48080 Bilbao, Spain

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ABSTRACT

This paper provides a framework for addressing recreation as an example of Cultural Ecosystem Services and a methodology to support landscape management based on recreation activities at a regional scale. A GIS-based approach was used to estimate and map ecological and social factors illustrating recreation supply and demand in the Basque Country (northern Spain). The proposed methodology for recreation supply was based on recreation potential and accessibility, and the social demand was determined using a convenience sample of 629 persons that reported preferences for recreation activities using photo-questionnaires. Results showed that 23% of the viewsheds showed a high demand and higher recreation potential than accessibility, whereas only 3% showed a high demand and higher accessibility than potential. Approximately 74% of the territory showed a medium-low demand. We concluded that people's assessments on the basis of their aesthetic preferences may serve as a reasonable proxy for mapping recreation demand. The proposed visual method is fast, efficient and may be easily replicable in other regions. The proposed framework can be used as an input to support landscape management, to identify areas most demanded by society and to quantify spatially recreation supply and demand for supporting political strategies.

1. Introduction

Policy and decision-making for environmental management, land use planning and development at different scales requires robust quantification of ecosystem service (ES) supply and demand (MEA, 2005; TEEB, 2010). The explicit quantification and mapping of ES is considered one of the main requirements for the implementation of the ES concept into environmental institutions and decision making. Therefore, The Economics of Ecosystems and Biodiversity (TEEB, 2010) called for extra effort in mapping the flow of services, a wider set of ES (including Cultural Ecosystem Services (CES)) and the connections between the final benefits because mapping ES is a useful tool for spatially explicit prioritization and problem identification.

The European Union (EU) 2020 Biodiversity Strategy recognized the high potential of mapping ES for policy support and decision-making because maps are valuable representations of real conditions and very powerful tools for communicating complex data and information (Hauck et al., 2013). Recent studies on mapping ES have focused more on the supply side and have tended to overlook society's demand for the services (Burkhard et al., 2012), despite the wide agreement about the importance of incorporating the demand side into ES assessments (van Jaarsveld et al., 2005). Whilst biophysical and economic values are often included in spatial planning for conservation and environmental management, social values are rarely considered. However, the social values that people attach to the landscape are also important to consider in planning for environmental management (Bryan et al., 2010), and its quantification based on interviews or questionnaires can provide useful and spatially explicit results (Sherrouse et al., 2011).

Different reviews on ES quantification, modeling and mapping (Crossman et al., 2013; Egoh et al., 2012; Martínez-Harms and Balvanera, 2012) showed that the CES are the least commonly quantified and mapped ES. CES are defined as the nonmaterial benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experiences (MEA, 2005). One broadly agreed upon characteristic of CES is their intangibility, which has been advanced as an explanation for their poor appraisal (Daw et al., 2011). Currently, there are different methods available to quantify these ES (see Milcu et al., 2013). Some of them explicitly link ecological functions with cultural values and benefits (Koschke et al., 2012), but they do not incorporate social evaluation approaches. Others try to map only the community values based on surveys (Brown et al., 2012; Sherrouse

* Corresponding author. Tel.: +34 94 6015376.
E-mail address: lorena.pena@ehu.es (L. Peña).

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et al., 2011) and others use economic techniques (de Groot et al., 2010). However, there is still a lack of well-established and reproducible research frameworks and methodologies (Milcu et al., 2013).

This paper aims to provide a framework for addressing recreation as an example of CES, and an easily replicable GIS-based methodology to support landscape management based on recreation activities at a regional scale, which uses ecological and social factors for mapping recreation supply and demand. Recreation ES is defined as the "recreational pleasure people derive from natural or cultivated ecosystems" (MEA, 2005; TEEB, 2010). It was selected due to its importance for millions of people as it offers an array of benefits (aesthetics, therapeutic value, and psychological restoration) that are interpreted differently across stakeholder groups (van Riper et al., 2012). A landscape aesthetic service is defined as the pleasure that people receive from scenic beauty provided by natural areas and landscapes (MEA, 2005; TEEB, 2010). Although some authors considered both CES separately (Casado-Arzuaga et al., 2014; Maes et al., 2011), others considered them together (Burkhard et al., 2012; Koschke et al., 2012) or used some variables related to aesthetics when calculating the recreation service (Nahuelhual et al., 2013). We consider that aesthetics contribute significantly to recreational experiences (Daniel et al., 2012). Thus, in this study, we consider both CES together, using variables related to aesthetics when calculating the recreation supply and demand.

We propose a methodology for mapping recreation supply based on two components: the recreation potential and accessibility (Maes et al., 2011). Recreation potential is defined as the capacity of ecosystems to provide recreation according to their scenic beauty or specific characteristics. In this study all ecosystems are considered to be potential providers of recreation services. Accessibility is the other component of the proposed methodology because it is necessary that people reach sites in order to benefit from this ES.

We used a visual survey method based on preferences for recreation activities as a proxy to map recreation demand. This type of the visual method can help inform understanding of indicators that address the demand for ES (Maes et al., 2012). Other studies have previously analyzed the public perceptions of landscapes using time-consuming surveys based on questionnaires (Conrad et al., 2011); however, in this study we proposed a fast, efficient and easily replicable innovative visual method.

2. Methods

2.1. Study area

This study was conducted in the Basque Country, northern Spain (42°78′ N, 02°44′ W) (Fig. 1). It has an area of 722,436 ha and a population of 2,191,682, located mainly in the provincial capitals (Bilbao, Donostia-San Sebastián and Vitoria-Gasteiz) and their surroundings. This entails a high population density compared with the Spanish average (303 inhabitants per km^2 compared to 93, inhabitants per km^2). In this area, the bedrock at elevations up to 900 m consists of limestone and sandstone, and loam soils emerge in the middle elevations. The climatic conditions are characterized by moderately warm summers and mild winters, and the long-term annual mean precipitation and temperature are 1100 mm and 13 °C, respectively. The landscape is very diverse despite the small size of the region, and it attracts multiple types of visitors. The northern and central region is mountainous, with mountains of 600–1700 m; however, the southern region is flatter and used for agriculture. The region extends from the coastal landscape with cliffs, beaches and estuaries to the mosaic landscape dominated by forest plantations of *Pinus radiata* and *Eucalyptus* spp. and native forests (*Fagus sylvatica*, *Quercus robur*, *Quercus pyrenaica*, *Quercus faginea*, *Quercus coccifera*, and *Quercus ilex*) with grasslands and rivers. Urban areas are situated in the valleys along the main rivers. One of the main natural and cultural attractions for recreation activities in the region is the Urdaibai Biosphere Reserve (UBR), due to its outstanding natural ecosystems (estuary, littoral ecosystems and Cantabrian evergreen-oaks) and cultural sites (the painted forest, Santimamiñe cave, and others). It offers a wide range of open-air activities and nature sports in beautiful surroundings near human communities.

2.2. Database development

The methodological approach (Fig. 2) was designed based on a review of previous methods used to map selected CES (Casado-Arzuaga et al., 2014; Frank et al., 2013; Kienast et al., 2009; Maes et al., 2011, 2012; Nahuelhual et al., 2013; Norton et al., 2012; Paracchini et al., 2014; Schulp et al., 2012; van Berkel and Verburg, 2014; van Oudenhoven et al., 2012; Willemen et al., 2008) and considering the characteristics of the study area and the information available. First, we developed a multi-source database composed of different geospatial data in GIS format (Table 1). Data preparation involved projection to the same datum and coordinate system and homologation of scales and resolution. The GIS software used for the geoprocessing was ArcGIS 10 ESRI Inc., and the spatial resolution of all the raster datasets used in this study was 10 m.

2.3. Visual survey method

Firstly we identified 25 environmental units based on the habitat type's classification of the European Nature Information System (EUNIS) map for the Basque Country in a scale of 1:10,000 (Basque Government, 2009). We grouped EUNIS categories to level 4 as we considered that at this level all ecosystem types were represented (see Table 2). Subsequently, we designed a photo-questionnaire with a battery of 25 photos of the environmental units defined

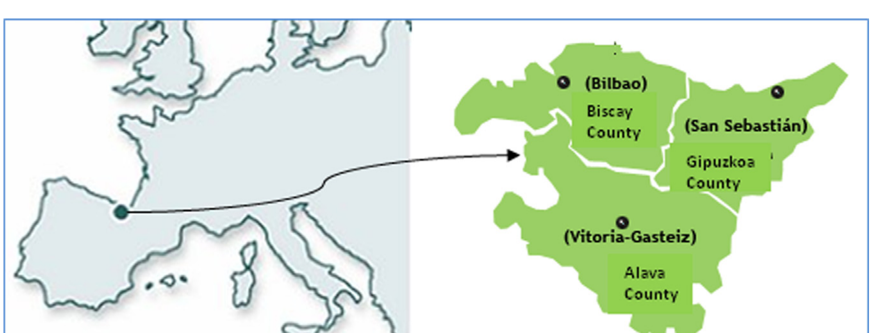

Fig. 1. Location of the study area.

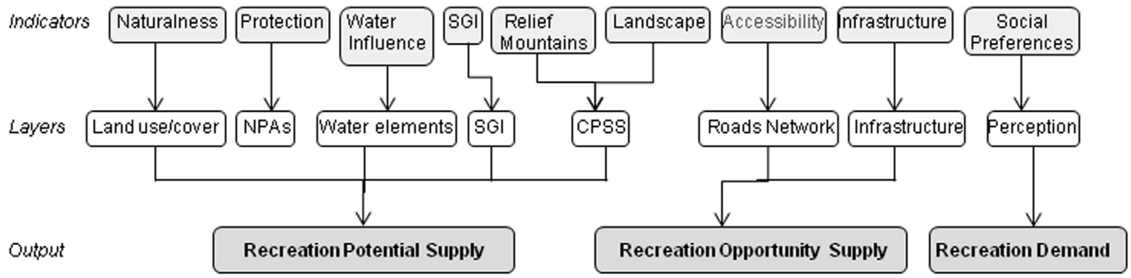

Fig. 2. Procedure for mapping recreation potential, accessibility and demand. Layers, indicators and outputs are shown. NPAs: Natural Protected Areas, SGI: Sites of Geological Interest, and CPSS: Open Catalog of Singular and Outstanding Landscapes of the Basque Country.

Table 1
Multi-source geospatial database developed for the case study. We used the mean values of index of relief and index of landscapes diversity to separate the viewsheds into two groups regarding the type of relief (mountainous and flat) and type of landscape (diverse and homogeneous), respectively, and the mean value of recreational value of SGI to separate the SGIs into two groups regarding their use for leisure (useful and not useful). EUNIS: European Nature Information System.

Data	Data source	Description	Evaluation
Land use/ land cover map	Basque Government (ftp.geo.euskadi.net/cartografia/)	European Nature Information System (EUNIS), habitat types classification	
Viewsheds	Basque Government (ftp.geo.euskadi.net/cartografia/)	Polygons including the visible self- contained area from different vision points	
Naturalness	Our elaboration based on the EUNIS and Loidi et al. (2007)	Index of degree of human influence on ecosystems. It comprises the damage or transformations caused by humans and how these ecosystems depend on human activity themselves (Loidi et al. 2007)	7: Natural forests, Continental Habitat without vegetation; 6: Salt marshes, wetlands, Coastal habitats; 5: Continental waters, Shrubs, Heaths; 4: Grasslands-hedges, Reservoirs; 3: Forest plantations; 2: Parks; 1: Crops, Orchards, Invasive species, Quarries; 0: Artificial soil
Natural protected areas	Basque Government (ftp.geo.euskadi.net/cartografia/)	Presence of natural protected areas	2: Natural parks, Protected Biotopes, Biosphere Reserve, RAMSAR wetlands; 1: Natura 2000 network, Sites of Naturalistic Interest; 0: No protected Areas or without naturalistic interest.
Presence of Water bodies (WB)	Basque Government (ftp.geo.euskadi.net/cartografia/)	Presence of rivers, water bodies, coastline related to recreation (bathing water, fishing, and beaches)	2: Viewshed with WB used for fishing or bathing; 1: Viewshed with WB no used for fishing or bathing; 0: Viewshed without WB
Sites of Geological Interest (SGI)	Basque Government (ftp.geo.euskadi.net/cartografia/)	Presence of SGI with high or low recreational value.	1: Viewshed with SGIs with recreational value ≥ 2; 0: Viewshed with no SGI or with SGIs with recreational value < 2
Relief and presence of mountain summit	Basque Government (ftp.geo.euskadi.net/cartografia/) and own elaboration based on information of internet (www.mendikat.net)	Index of relief for each viewshed (CPSS, 2005) and presence of mountain summit.	2: Viewshed with index of relief ≥ 32; 1: Viewshed with index of relief < 32 and some mountain summit; 0: Viewshed with index of relief < 32 and no mountain summits
Landscape	Basque Government (ftp.geo.euskadi.net/cartografia/)	Index of landscape diversity (ILD) for each viewshed (CPSS, 2005) and visual influence of landmarks (buffer of 200 m around the landmark)	2: Viewshed with ILD ≥ 1.70; 1: Viewshed with ILD < 1.70 and influence of some landmark; 0: Viewshed with ILD < 1.70 and no influence of any landmark
Accessibility	Basque Government (ftp.geo.euskadi.net/cartografia/)	Density of roads, paths, cycling paths	3: High density; 2: Medium density; 1: Low density.
Areas for recreation	Our elaboration based on information of internet (turismo.euskadi.net) and Basque Government (ftp.geo.euskadi.net/cartografia/)	Number of areas for recreation (Recreational areas, wine cellars, museums, ecological parks, theme parks and centers, interpretation centers, Biking centers, caves, climbing sites)	3: High number; 2: Medium number; 1: Low number.
Social preferences	Our elaboration based on the EUNIS and social preferences based on mail-in photo-questionnaires	Social preferences of different ecosystems and landscapes for recreation	

above and 6 pairs of photos of contrasting landscapes, i.e., a photo of a diverse landscape with a photo of a homogeneous landscape, a landscape with a water body and a landscape with no water body and a mountainous landscape with a flat landscape. The order of the photos was random for each respondent. The photo-questionnaires started with an introduction and clarification of the purpose of the study. Then a set of socio-demographic questions were asked regarding age, sex, birth place, address, interest in landscape (Yes/No) and profession for analysis of the variability of the respondents (van Berkel and Verburg, 2014). Subsequently, respondents were asked to rate each photo of the environmental units on a scale from 1 to 6 according to their scenic beauty with 6 being the highest value and 1 the lowest (Nahuelhual et al., 2013). Finally, respondents were asked to choose which of the two photos of contrasting landscapes were aesthetically more pleasing. The photos were obtained from Google Street View. Firstly, we selected all photos present in the Basque Country area which represented the desired feature (diverse landscapes, homogeneous landscapes, mountainous landscapes, flat landscapes, landscapes with a water body, landscapes with no water body, forest plantations, natural forests, crops,

Table 2
Mean perceived value of the environmental units (mean ± standard error) and results of Turkey's test: means with the same letter are not significantly different at $P<0.05$. ANOVA was significant at $P \leq 0,\ 0001$.

Environmental units	Perceived value	Environmental units	Perceived value
Rivers	5.68 ± 0.03 a	Villages	4.37 ± 0.05 gi
Rocky areas	5.49 ± 0.03 ab	Orchards	4.36 ± 0.05 gi
Montane grasslands	5.42 ± 0.03 b	Vineyards	4.31 ± 0.05 hi
Natural forests	5.39 ± 0.04 b	Mediterranean shrubs	4.18 ± 0.05 ij
Reservoirs	5.34 ± 0.04 bc	Peatlands	4.07 ± 0.05 j
Beaches	5.14 ± 0.04 cd	Crops	3.93 ± 0.05 jk
Cliff	5.11 ± 0.04 cde	Parks	3.72 ± 0.05 kl
Water bodies	4.98 ± 0.04 df	Coniferous plantations	3.70 ± 0.06 l
Cantabrian evergreen-oak forests	4.97 ± 0.04 df	Eucalyptus plantations	2.79 ± 0.06 m
Heaths	4. 90 ± 0.04 ef	Cities	2.29 ± 0.04 n
Salt marshes	4.76 ± 0.04 fg	Abandoned quarries	2.04 ± 0.05 o
Atlantic shrubs (no heaths)	4.43 ± 0.05 g	Active quarries	1.51 ± 0.04 p
Grasslands	4.42 ± 0.05 gh		

Fig. 3. Example of photos used in the photo-questionnaire.

parks, villages, etc.) and had a similar proportion of sky and land and a similar framing for not biasing people's preferences. Then we grouped the photos into 31 groups depending on the characteristic that were represented and we selected them randomly (see Fig. 3).

In November 2013 an internet link to the survey was initially emailed to 350 contacts, constituting individuals from different public and private institutions (universities, governments and non-governmental organizations, administrations, technology centers, educational centers, etc.) and respondents were asked to disseminate it to their contacts (snowball sampling strategy) (Conrad et al., 2011; McClintock et al., 2014). These institutions were selected because of their relation with recreation services at different scales in the Basque Country. Socio-demographic considerations were taken into account to ensure that a range of ages, genders, geographical background, educational level and occupations were included within this initial group. This sampling strategy allows for practical benefits including efficiency and reduced cost, although it is also known to involve constraints with respect to sample representativeness (Conrad et al., 2011) and calculation of response rate (McClintock et al., 2014).

Moreover, internet surveys appeared to be the most suitable method for this research as it allowed for easy dissemination and response, timeliness in terms of data capture and turnaround, and cost-saving. It should be noted, however, that this approach also presented challenges. Specifically, there was limited control of the respondent sample, which precluded responses from certain segments of the population (Conrad et al., 2011). Thus, the results of this study should be interpreted with the knowledge that some societal groups (e.g. non computer-literate individuals) were not necessarily represented and the response rate is unknown, this means that we do not have a sense of how well we captured the perspectives of interest. The survey was open for two weeks and responses were collected in an application associated with the survey. A total of 629 persons completed the photo-questionnaire, including almost equal numbers of men and women (51% and 49%, respectively). More than half of respondents (60%) were more than 40 years old.

The results obtained from the questionnaire about photos of the environmental units were analyzed using Principal Component Analysis (PCA) after calculating the mean value for each environmental unit (Table 2). PCA allowed us to analyse the joint variation pattern of preferences for environmental units, so that we could identify the main characteristics that respondents considered for their choice. We then used ANOVA to examine differences in social aesthetic preferences toward the environmental units and Turkey's test for comparison between means. The software used for analysis was XLSTAT 2008. Moreover, mean values for each environmental unit were used as a proxy to map the recreation demand.

2.4. Mapping recreation supply and demand

To map recreation supply and demand, we used viewshed as a quantification unit, which was operationalized as a polygon including the visible self-contained area from different vision points (Nahuelhual et al., 2013) because we used scenic beauty as an indicator for recreation supply and demand. Viewshed can be considered a unit for describing the territory based on visibility criteria because it consists of the set of intervisible points. We used 618 viewsheds delimited in the "Open Catalog of Singular and Outstanding Landscapes of the Basque Country" (CPSS, 2005).

2.4.1. Recreation supply

We considered two components for mapping recreation supply: the recreation potential and accessibility (Maes et al., 2011; Paracchini et al., 2014). The recreation potential was mapped taking into account six territorial features associated with aesthetic attractiveness for recreational activities and ecological values: (1) the degree of naturalness; (2) the presence of natural protected areas; (3) the presence of water bodies; (4) the presence of Sites of Geological Interest (SGI); (5) the type of relief (mountainous or flat) and the presence of mountains; and (6) the type of landscape (diverse or homogeneous) and the presence of landmarks. We assumed that natural ecosystems and protected areas were more attractive for recreation activities (Maes et al., 2011; Willemen et al., 2008) due to their higher biodiversity (Maes et al., 2012). In fact, some studies have demonstrated that the degree of psychological benefit was positively related to species richness; therefore, people prefer the green spaces that enhance their psychological well-being for recreation activities (Fuller et al., 2007). Moreover, we assumed that the presence of water bodies and SGI in the landscape, a higher diversity of landscapes and a higher difference in relief were related to a higher aesthetic value (Frank et al., 2013; Norton et al., 2012) and therefore, a higher recreational value. We valued each feature using different data and indicators (see Table 1). Finally, the recreation potential for each viewshed was calculated by aggregating the values of the six features described above. All components were considered equally important, covering complementary aspects of recreation supply; therefore, they were given equal weights, within and among them (Paracchini et al., 2014). The values for the resulting map were classified with Jenks Natural Breaks into three classes (High, Medium, and Low). Classification by natural breaks provides natural groupings inherent in the data by identifying the best groups of similar values and maximizing the differences between classes (Casado-Arzuaga et al., 2014; Onaindia et al., 2013).

The delivery of services strictly depends on the presence of people in the ecosystems. Thus, accessibility is a main component of the proposed methodology because people must reach sites in order to benefit ES therein. Accessibility was mapped considering: (1) the accessibility of the viewshed; and (2) natural and constructed infrastructures that were in place to guide or be enjoyed by visitors. The accessibility of the viewshed was estimated using the density of roads and paths in each viewshed (Table 1). The infrastructure used for recreation activities was estimated using information regarding the location of recreational areas, wine cellars, museums, ecological parks, theme parks and centers, interpretation centers, biking centers, caves, and climbing sites and they were mapped using the density of infrastructures in each viewshed (Table 1). We assumed that good accessibility and good infrastructure networks helped to facilitate more recreational activities (Maes et al., 2011; Willemen et al., 2008). The accessibility for each viewshed was calculated by aggregating the two features described above (Fig. 2). The values of the resulting map were classified with Jenks Natural Breaks into three classes (High, Medium, and Low).

2.4.2. Recreation demand

Recreation demand was calculated based on the mean value obtained for each environmental unit in the visual survey explained above and land use cover. Using spatial analysis techniques (Zonal statistics tool in ArcGis Spatial Analyst, version 2010) recreation demand was calculated within each viewshed and the obtained data were translated into a map. The values of the resulting map were classified with Jenks Natural Breaks into three classes (High, Medium, and Low).

3. Results

3.1. Recreation potential map

The spatial distribution of the recreation potential is shown in Fig. 5. 44% of the viewsheds showed high potential for recreation, whereas 19% presented the lowest values. The map indicates a very high spatial variation of the service across the study area. The highest values are concentrated in viewsheds that are characterized by protected and natural areas (areas of outstanding natural value) with diverse and mountainous landscapes, e.g. viewsheds of UBR. However, the lowest values are mainly concentrated in the south, where the landscapes are flat, homogeneous and dominated by ecosystems highly impacted by human activities (i.e. intensive arable agriculture).

3.2. Accessibility map

The spatial variation of accessibility showed a different pattern: 17% of viewsheds had high accessibility, whereas 49% presented the lowest values (Fig. 5). The viewsheds with the highest accessibility corresponded to coastal viewsheds and viewsheds with important urban areas as provincial capitals (Bilbao and Vitoria-Gasteiz). However, the lowest values are mainly concentrated in the central viewsheds dominated by natural and mountainous areas and southern viewsheds dominated by crops.

3.3. Recreation demand

3.3.1. Visual survey

The results obtained from the PCA (Table 3) indicated that naturalness of ecosystems was the most important characteristic to consider when respondents assessed their preferences for environmental units (Fig. 4). The first factor explained 29% of the variance and indicated that respondents preferred natural ecosystems over artificial areas. They found natural ecosystems significantly more pleasant, including rocky areas or natural forests, with artificial areas, such as quarries, cities or forest plantations being less pleasant ($P \leq 0.0001$) (Table 2). The second factor explained 11% of the variance, separating the different landscapes in the region, the northern landscapes more related to water ecosystems and the southern landscapes related to intensive arable agriculture. The respondents found coastal ecosystems such as cliffs and beaches significantly more pleasant, and agroecosystems such as crops were evaluated as less pleasant ($P \leq 0.0001$). However, some agroecosystems such as grasslands, vineyards or orchards were found to be significantly more pleasant than certain natural ecosystems such as peatlands ($P \leq 0.0001$) (Table 2). Montane grasslands were considered to be natural ecosystems as they did not show significantly different mean perceived values from rocky areas or natural forests.

Moreover, respondents preferred diverse landscapes, mountainous landscapes and landscapes with water bodies (89%, 88% and 69%, respectively) to those landscapes that were more homogeneous, flat and without water bodies.

Table 3
Results of the PCA.

	Eigenvectors	
	Axis 1	**Axis 2**
Parks	0.134	0.216
Cliff	0.096	0.052
Beaches	0.159	0.046
Cities	0.131	0.287
Rivers	0.111	−0.242
Reservoirs	0.179	−0.042
Rocky areas	0.140	−0.347
Montane grasslands	0.208	−0.125
Natural forests	0.181	−0.161
Salt marshes	0.161	−0.135
Water bodies	0.214	−0.118
Coniferous plantations	0.202	0.215
Atlantic shrubs	0.235	−0.049
Mediterranean shrubs	0.223	−0.173
Orchards	0.256	0.114
Crops	0.265	0.113
Peatlands	0.204	−0.164
Villages	0.238	0.052
Grasslands	0.268	0.099
Heaths	0.234	−0.209
Cantabrian evergreen-oak forests	0.191	−0.296
Eucalyptus plantations	0.195	0.299
Vineyards	0.236	0.153
Abandoned quarries	0.121	0.309
Active quarries	0.102	0.353
	Axis 1	**Axis 2**
Eigenvalues	7.424	2.735
% of Variance	28.555	10.518
Cumulative (%)	28.555	39.073

3.3.2. Recreation demand map

The spatial distribution of the recreation demand is shown in Fig. 5. Of the viewsheds 33% showed high demand for recreation, whereas 31% presented low values. The highest demand was concentrated in viewsheds that had protected natural areas with diverse and mountainous landscapes, as is the case for the viewsheds of UBR. However, the lowest demand was mainly concentrated in the viewsheds that showed a high degree of anthropization.

3.4. Overlap among recreation potential, accessibility and demand

We found weak overlap among recreation potential, accessibility and recreation demand, with only 12% of viewsheds showing the same value for all components (2% High; 6% Medium; 4% Low). This percentage corresponds to approximately 11% of the territory. This result shows the importance of using both components, the supply and demand in analyzing ES. Moreover, 23% of the viewsheds showed a high demand and higher recreation potential than accessibility, whereas only 3% showed a high demand and higher accessibility than potential (Fig. 6). The first viewsheds are characterized by a high degree of naturalness or provide specific opportunities for recreation, i.e. natural and semi-natural vegetation, protected areas and water bodies. The latter are characterized by the presence of cultural landscapes. The rest of the viewsheds (67% which corresponded to approximately 74% of the territory) showed a medium-low demand where most than half (60%) were characterized by a medium-high accessibility. These viewsheds are characterized by a higher presence of managed ecosystems, anthropization and more homogeneous landscapes.

4. Discussion

4.1. Overcoming difficulties to analyze CES

Currently, CES are among the most fragile of the ES due to rapid and severe degradation (Villa, 2010). This degradation is mainly due to the significant ecosystem loss of cultural value and the decrease in the quality of the aesthetics of natural landscapes. These ecosystem and social changes reduce the social recognition or appreciation of the cultural benefits that ecosystems are supplying to society. The CES are frequently characterized as being “intangible”, “subjective” and difficult to quantify in biophysical or monetary terms (MEA, 2005), so they are rarely included in decision-making processes. However, cultural services are just as important as any other ES for local communities, as has been demonstrated in various studies (Casado-Arzuaga et al., 2013; Zhen et al., 2010), and recreation service concretely provides many important benefits and contributions to physical and psychological well-being (Chan et al., 2012).

This study is a good example of the application of a spatially explicit assessment of recreation ES at the regional level in management, as we propose an approach based on landscape planning for recreation activities. For this approach, we have separately

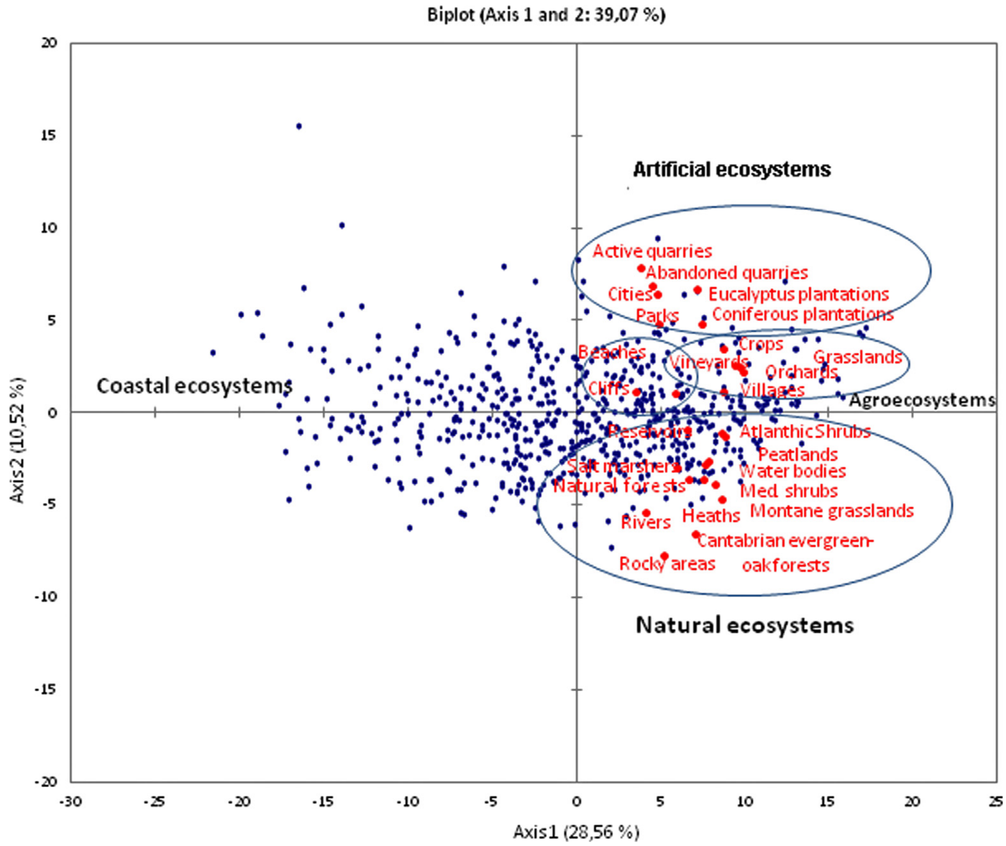

Fig. 4. Distribution of social perceived mean value of the environmental units.

considered recreation potential, accessibility and recreation demand to detect which viewsheds are the most adequate for recreation development based on both aesthetic preferences and ecological factors. Previous studies have presented methodologies with a similar framework, e.g. Paracchini et al. (2014) provide a first EU wide assessment of outdoor recreation as ES, based on behavioral data, population distribution data and existing approaches for recreation management at the country level. However, they found some limitations such as the under-representation of Southern EU countries, the inaccessibility to private property and other areas (i.e. cliffs were not taken into account), and the exclusion of hiking or cycling paths. In this study these limitations have been overcome, firstly because the Basque Country can be representative of the Southern EU countries. Secondly, all types of ecosystems (managed, unmanaged, accessible, inaccessible, etc.) have been valued using visual methods, which help to reflect the realism of hypothetical conditions. Finally, we have included information on recreation facilities that attract and ease the flow of visitors across landscapes (e.g. hiking or cycling paths, caves, recreational areas, relief, infrastructures for recreation, etc.) (Maes et al., 2011).

In relation to applied methodology, the visual survey method used in this study was helpful for validation and to ascertain aesthetic preferences. The proposed photo-questionnaires were a fast and efficient technique and may be easily replicable in other regions that prioritize knowledge about aesthetic preferences, which might be a reasonable proxy for mapping recreation demand. The visual research approach offers several advantages over narrative descriptions, including the ability to provide pertinent information to respondents that would be otherwise difficult or awkward to communicate (Arnberger and Haider, 2007; van Riper et al., 2011). In more conventional approaches, respondents may have to make assumptions about some characteristics, and these assumptions are likely to vary. Visual research methods also focus directly and exclusively on the variables under study. In this study, a total of 629 persons answered the photo-questionnaire; this high answer was probably due to the ease and speed of response to the survey. Moreover, the convenience sample utilized for this research allowed for more efficiency reduced cost and broad dissemination of results, though we were limited with respect to the representativeness of the sample.

4.2. Recreation potential, accessibility and demand

The recreation potential of this region is high due to the high naturalness of some ecosystems, some of which are protected, and to its high landscape diversity. Almost half of the viewsheds showed high recreation potential. In the Basque Country, approximately 34% of the area is protected or has a naturalistic interest due to its characteristic flora and fauna that attracts many people. Moreover, there is a high landscape diversity that differs considerably between the northern and southern region. The northern and central regions are mountainous, with natural forests and important coastal ecosystems (e.g., beaches, salt marshes) that are considered important tourist attractions. For example, in the UBR, there are approximately 1,500,000 visitors during summer alone. However, the southern region is flat and it is mainly dominated by agroecosystems.

In the case of accessibility, the Basque Country showed good accessibility and abundant and varied infrastructures such as recreational areas or parks, which are most abundant in the surroundings of urban areas like Bilbao, San Sebastian-Donostia and Vitoria-Gasteiz. However, the region also has important infrastructures in natural areas that are heavily used for recreation activities such as climbing and biking sites or caves.

People in the study area prefer diverse and mountainous landscapes with water bodies to more homogeneous and flatter landscapes, as in other regions (Maes et al., 2011). In the Basque Country,

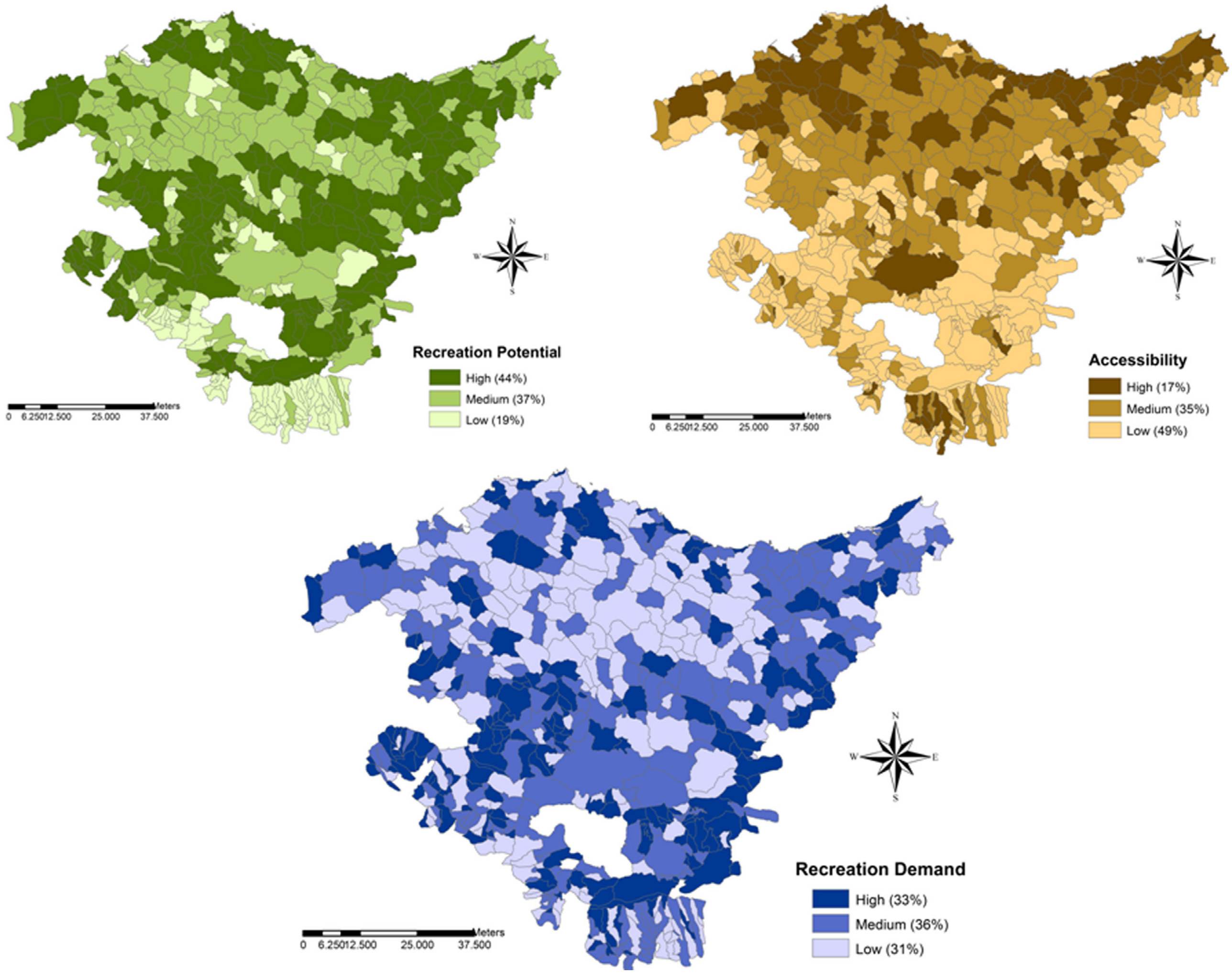

Fig. 5. Spatial distribution of the recreation potential, accessibility and recreation demand.

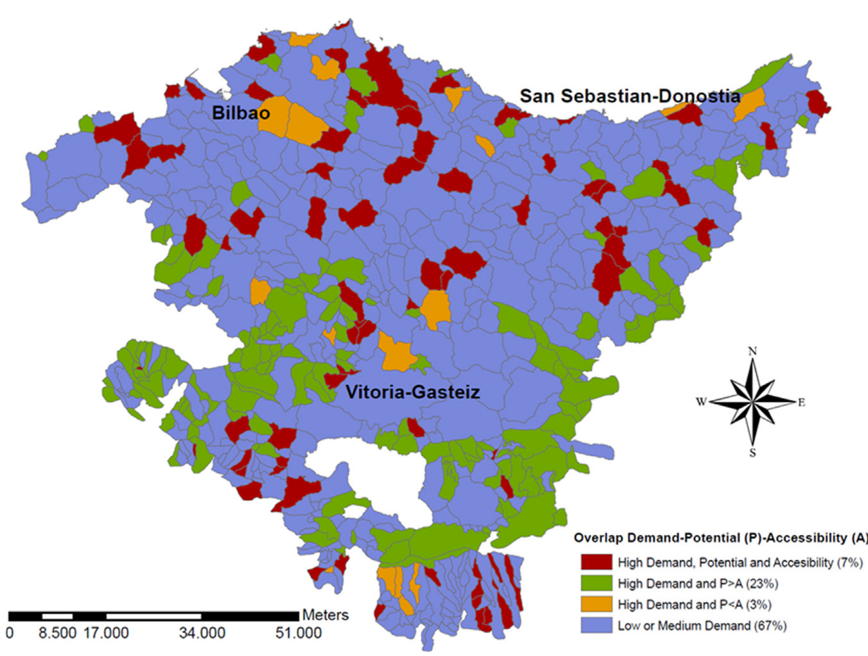

Fig. 6. Congruence in the spatial variation of recreation demand, potential (P) and accessibility (A). Four classes are shown: High Demand, Potential and Accessibility: viewsheds with high demand, high potential and high accessibility; High Demand and P > A: viewsheds with high demand and higher potential than accessibility; Higher Demand and P < A: viewsheds with high demand and higher accessibility than potential; and Low-Medium Demand: viewsheds with low demand or medium demand.

people in general are very fond of mountain climbing and water sports (surfing, canoeing and rowing). These results confirmed the assumptions made to map recreation potential. Results also revealed a clear preference for more natural ecosystems. Respondents showed higher preference for rocky areas, rivers and natural forests, than for artificial areas such as quarries or cities. These results are consistent with other studies demonstrating that naturalness is an important factor to consider when choosing a site for recreation activities (Casado-Arzuaga et al., 2014; Frank et al., 2013; Kienast et al., 2009; Maes et al., 2012; Norton et al., 2012; van Oudenhoven et al., 2012; Willemen et al., 2008).

Furthermore, respondents considered the presence of forest plantations (coniferous and eucalyptus) to be detrimental to the landscape. This may be because forest plantations currently occupy 28% of the land area. They cause homogeneity in the landscape, erosion of soil and biodiversity loss due to their inadequate management, which produces aesthetic quality loss for the landscape. People are clearly demanding more natural forests than forest plantations. Thus, these results must be considered for effective forest policy implementation and landscape management, and these maps may be used as tools to orient land use planning.

Aesthetic perceptions and preferences can be site-specific, based on local geographic and cultural characteristics, moral convictions, life experiences, and the use and non-use of particular areas (Daily, 1997). Therefore, case studies are important for capturing local differences (Lamarque et al., 2011). For example, this result contrasts with that obtained in the Bilbao Metropolitan Greenbelt (Basque Country) where urban residents value forest plantations highly for their green appearance, which is unlike the city environment (Casado-Arzuaga et al., 2014).

Moreover, respondents gave equal ratings to montane grasslands and natural forest or rocky areas. The variety of distinctive field systems and settlement patterns created by these traditional land uses are considered attractive landscapes by both residents and tourists (Gobster et al., 2007). In fact, some agroecosystems (rural settlements, orchards or vineyards) also acquired higher value than some natural ecosystems such as peatlands because they are considered cultural landscapes. These agricultural cultural landscapes are typically defined as landscapes managed by traditional agricultural techniques, locally adapted and historic, by family and/or subsistence methods (van Berkel and Verburg, 2014). The Basque Country is characterized by important cultural and natural landscapes, such as vineyards in the southern region, which have been proposed for inclusion in the World Heritage List. They feature an exceptional cultural landscape that is the result of human efforts to adapt to their environment and the development of a culture strongly associated with the long tradition of wine production in this area. Another example is the Salt Valley of Añana, which is one of the most spectacular and best preserved inland saltworks. Its value lies not only in its particular architecture or on its almost 1200 years of documented history, or even in its geological features, biodiversity or landscape values, but in the perfectly harmonious union of all of these features in a privileged context. In fact, 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). Brown and Raymond (2007) demonstrated that several landscape values such as aesthetic, recreation and spiritual contribute to place attachment.

4.3. Integrating ecological and social approaches

The social demand of ES is not usually considered because obtaining this type of data is very time-consuming. However, in this study, we have demonstrated that the data can be overestimated or underestimated if we consider only the supply side. In fact, only a small percentage of the territory showed the same value for recreation potential, accessibility and demand. The potential is mainly characterized by the environmental setting (e.g. presence of water bodies or mountains), land use management and its impact on the degree of naturalness or spatial distribution of protected areas; however, they may not match with demand. In fact, people showed a high demand for cultural landscapes despite their low potential. Cultural landscapes are a good point of departure for CES research (Milcu et al., 2013), as they facilitate a more inclusive social-ecological approach by exploring the interactions between social and ecological processes. Including immaterial benefits in landscape management can improve the social acceptance and legitimacy of management decision (Ban et al., 2013).

People's assessments of the aesthetic qualities of a landscape are mainly based on land use management and its impact on the degree of naturalness. These two components are those where landscape management based on recreation activities can intervene in order to guarantee a higher recreation demand. Establishing Green Infrastructures (GI) or replacing forest plantations by natural forests in the less demanded viewsheds will help improve the overall ecological quality and maintain healthy ecosystems delivering valuable services to society. This type of management will improve the potential of CES and will create synergies with other ecosystem services, associated with natural ecosystems (pollination, water regulation). In the case of replacing forest plantations by natural forest, this would present trade-offs with provisioning services, in this case named wood production. Considering that this economic activity is not currently very profitable in the area without public subsidies (Rodriguez-Loinaz et al., 2013), this economic sector could be reoriented without much difficulty, focusing on more multifunctional landscapes.

This study is focused on the analysis of recreation ES, although to support decision-making it is necessary to analyse different ES because synergies and trade-offs between them may occur.

We considered that the users' perceptions of a functional space would need to be given the utmost attention when analyzing ES for effective policy implementation and management, as all CES strongly depend on perceptions and expectations of stakeholders (Daniel et al., 2012). Moreover, understanding which landscapes and ecosystems are more valued by society is useful for targeting resources efficiently. We also demonstrated that mapping exercises are powerful tools for grasping the socio-cultural realities of communities, regions, landscapes, and ecosystems (Ryan, 2011).

This type of study has important implications for decision-making in landscape management based on recreation activities, as we identify the viewsheds with the highest or lowest demand based on aesthetic preferences for recreation activities and show the type of recreation potential and accessibility, high or low. However, the maps present in this study can also be used in other ways for landscape management, e.g., as a communication tool to initiate discussions with stakeholders, identify areas where landscape and recreation management should be improved, visualizing the viewsheds where valuable recreation service is produced or demanded, or explaining the relevance of this ES to the public in their territory.

5. Conclusions

This paper addresses a combination of methodologies capable of mapping the recreation potential, accessibility and demand to support landscape management based on recreation activities.

We concluded that data can be overestimated or underestimated if we consider only the supply side. Thus, it is necessary to consider both components of recreation ES, supply and demand, to implement a sustainable landscape management program based on recreation activities. People's assessments on the basis of their aesthetic preferences is a reasonable proxy for mapping recreation demand and the visual survey method used in this study may be a useful indicator for mapping recreation demand in other studies, as it is fast, efficient and may be easily replicable.

We concluded that people's aesthetic assessments are mainly based on land use management and its impact on the degree of naturalness. Thus, these two components are those where landscape management based on recreation activities can intervene in order to guarantee a higher recreation demand. However, it is necessary to analyse different ES to support decision-making because synergies and trade-offs between them may occur.

The proposed methodology is also useful for identifying areas most demanded by society despite their low recreation potential. This is the case of some agroecosystems (rural settlements, orchards or vineyards) which acquired higher demand than some natural ecosystems because they are considered cultural landscapes. Mapping is a useful tool for illustrating and quantifying the spatial mismatch between recreation ES supply and demand and the obtained maps can be used for communication and to support decision-making.

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Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at http://dx.doi.org/10.1016/j.ecoser.2014.12.008.

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