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Mapping landscape potential for outdoor recreation using different archetypical recreation user groups in the European Union

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Highlights

- We present landscapes' outdoor recreation potential for 5 archetypical user groups.
- Spatial patterns of outdoor recreation potential are mapped across the EU.
- Distinction of archetypical outdoor recreation types may help targeted management.

Abstract

Engagement with the natural environment and public enjoyment of access to farmland and woodland often takes the form of outdoor recreation. Numerous studies on landscape preferences of outdoor recreation have focused on individual characteristics and attitudes of recreation users. Although the importance of differences in user groups has been acknowledged, a clear distinction of archetypical user groups has not yet been made. This study presents spatial maps of landscapes' outdoor recreation potential throughout the EU based on the different landscape preferences of five archetypical outdoor recreation user groups. The resulting maps are based on spatial indicators for landscape characteristics identified through a literature review of landscape preferences and an expert workshop regarding the relative importance of those preferences. We find overlapping patterns of outdoor recreation potential for all user groups, as a result of similar preferences for elevation, cultural heritage and presence of specific flora and fauna. Areas with high recreation potential for multiple user groups are dominated by forest or mosaic land use and often concentrated in mountainous areas, showing the areas' multifunctional potential. The developed maps provide a synthesis of available information and data on the differential preferences and patterns for outdoor recreation in the EU. The differentiation of user groups enables stakeholders at different levels to develop sustainable landscape management strategies targeted at the demand for and supply of outdoor recreation opportunities.

Keywords

Outdoor recreation, Public Goods, Landscape preferences, European Union

1. Introduction

Engagement with the natural environment and public enjoyment of farmlands and forests often takes the form of outdoor recreation, nature-based tourism, and ecotourism. These concepts are increasingly recognized as an important contribution of ecosystems to well-being (Bennett et al., 2015; De Groot et al., 2002; MEA, 2003; Plieninger et al., 2015) through physiological, attentional and emotional stress-recovery (Kaplan and Kaplan, 1989; Korpela and Borodulin, 2014; Thompson et al., 2012).

Outdoor recreation refers to any leisure time activities where recreants access non-urban landscapes (Silvennoinen and Tyrväinen, 2001), including short-term recreation in nearby green space, one-day or overnight tourism (Daniel et al., 2012), educational recreation (Holdnak and Holland, 1996; Smith and Jenner, 1997), and spiritual recreation (Sharpley and Jepson, 2011). Nature-based tourism, often referred to as nature tourism, focuses on the direct enjoyment of undisturbed nature (Kline, 2001; Valentine, 1992; Weiler and Davis, 1993), in terms of natural reserves, national parks, forests, or tourism close to lakes or the sea (Bell et al., 2007). Nature tourism activities are often congruent with the qualities of the natural environment (Silvennoinen and Tyrväinen, 2001), but might include traditional or mainstream tourism activities that are linked to a negative environmental impact (Bell et al., 2007; Kline, 2001). A term strongly related to nature tourism is ecotourism, focusing on rural and peripheral areas with a strong concern for the protection of nature. Main attractions of ecotourism include flora, fauna and cultural heritage (Bell et al., 2007), engaging in activities at local arts and craft centres, enjoying local food or hiking (Kline, 2001).

Tourism and recreation are often used interchangeably. Tourism, even though compatible with the concepts of leisure and free time, also incorporates activities, e.g. business travel, that do not

take place within the leisure setting (Williams, 1998). This paper will therefore focus on outdoor recreation as an activity or experience that is set only within the context of leisure and free time. We explicitly focus on short-term recreation, thus leaving out several-day holidays.

The recreational enjoyment of non-urban landscapes is an increasingly important activity with a variety of economic and environmental implications depending on changes in the demand *for* and trends *of* outdoor recreation (Bell et al., 2007; Buckley, 2003). Within outdoor recreation, recreationists' preferences for areas and activities are based on different elements, including landscape attributes, accessibility and specific facilities (Paracchini et al., 2014). Preferences for specific landscapes are associated with the structure and composition of a landscape and related landscape attributes (Van Zanten et al., 2014). Due to this direct link with the natural environment, recreationists' preferences regarding outdoor recreation are influenced by goods and services provided by landscapes, referred to as Public Goods (PGs) or Ecosystem Services (ES) (Costanza et al., 1997). PGs are goods and services that are beneficial to the public and thus highly desired by society but not readily traded on the market (Dwyer et al., 2015). PGs focus on aspects of management and governance, such as the type of provision and societal demand of goods, whilst ES (e.g. water quality regulation, soil nutrient regulation, pollination, biological control) focus on the benefits for and dependence of humans on ecosystems (De Groot et al., 2002; Haines-Young and Potschin, 2010; MEA, 2003). Recreation is therefore regarded as a Cultural Ecosystem Service, a specific group of ES defined by the Millennium Ecosystem Assessment (2003) as "nonmaterial benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experiences" (MEA, 2003, p. 8). Quantifying and evaluating outdoor recreation as a cultural ES relies, more than biophysical ES, on the perceptions and value assignments of stakeholders and users (Daniel et al.

2012; Weyland and Laterra 2014). Most landscape preference studies take into account that preferences, and the values stakeholders assign to landscapes, differ according to landscape users' individuals characteristics and attitudes, such as socio-economic and demographic characteristics, environmental attitude, residential location, familiarity with the landscape and ethnicity (Dearden, 1984; Howley et al., 2012; Strumse, 1996; Swanwick, 2009; Van den Berg and Koole, 2006). However, previous literature regarding the spatial mapping of outdoor recreation has often treated recreationists as one single user group, not accounting for a distinction between different user groups based on preferences for landscape attributes. An exception is a previous regional-scale map for outdoor recreation by Kienast and Degenhardt (2012), who took different recreational user groups based on age of respondents and type of transportation into account. Distinguishing variations in the user groups of outdoor recreation is important for two reasons. Firstly, due to the heterogeneity in appreciation of similar landscapes by different individual users, the generalization capacity of outdoor recreation is quite low (Weyland and Laterra, 2014). Secondly, knowledge about the preferences of different recreation user groups and their spatial distribution will enable stakeholders to adopt their agenda at different levels (e.g. landscape management, spatial planning, development of recreational facilities) in order to meet recreational users' demands and prevent the occurrence of potential conflicts (Bell et al., 2007).

Mapping the potential of landscapes to be used for outdoor recreation, demands extensive empirical and spatial information in order to be able to capture the heterogeneity of recreational preferences. Only limited research is available on landscapes' outdoor recreation potential, with exception of selected case studies (e.g. Bastian et al. 2015; DeLucio and Múgica 1994; Schmitz

and Aranzabal 2007) and national-scale evaluations (e.g. NaturalEngland, 2016). At a European scale, Van Berkel et al. (2011) included the potential for outdoor recreation in an assessment of spatial variations in rural development options for Europe. Paracchini et al. (2014) published the first study focused on mapping the outdoor recreation potential at EU scale. Their framework is based on several common recreational preferences (e.g. maximum travel distance, preferred destinations) using information from three Northern European visitor surveys. However, they do not include information on different user groups, due to the limited amount of studies that explicitly address the role of landscape characteristics in relation to outdoor recreation.

The objective of this paper is to address this lack of differentiation between recreation user groups at supranational levels. We aim to map outdoor recreation potential at the EU scale by taking different archetypical outdoor recreation user groups and their specific landscape preferences into account. As a result of the great heterogeneity in individual recreational and landscape preferences across the EU and the relatively small amount of empirical data to support the differentiation of user groups, our ambitions were modest. The main aim of the archetypical user group distinction in this paper is to illustrate the variation in recreation focus and landscape preference of different recreational user groups and to show to what extent these can be mapped across the EU based on the available information. We aim to create maps that allow for the analysis of general outdoor recreation patterns and spatial concurrence of these user groups, rather than creating an exact reflection of the European recreationist population.

2. Material and methods

To synthesize and map the outdoor recreation potential for different user groups, a variety of data sources and methods were used. Figure 1 provides an overview of the used methods that will be described in more detail in the following sections.

As a basis for archetype delineation, we distinguished archetypical outdoor recreation user groups inspired by the work of Cohen (1979), who established a typology of recreational user groups based on the meaning of culture appreciation, social life and natural environment for the individual traveller. He divided recreationists' motivations for touristic experiences into five distinct 'modes' of experience: the recreational mode; the diversionary mode; the experiential mode; the experimental mode; and the existential mode (Cohen, 1979). Cohen's typology is a useful starting point to define archetypical recreation user groups due to its applicability to various different recreational activities, its simplicity and its potential relevance to policy and management (Elands and Lengkeek, 2000). Cohen's framework was further evolved for outdoor recreation by Elands and Lengkeek (2000), who relate each motivation to the perceived quality of a landscape. We elaborated on the earlier work by Cohen (1979) and Elands and Lengkeek (2000) by gathering landscape preferences of different user groups linked to interpretations of Cohen's recreational motivations in a literature review, and by translating these into specific landscape attributes in order to spatially represent user-group-specific outdoor recreation potential across the EU. These landscape attributes were mapped using one or more spatial proxies. We define landscape preferences of outdoor recreationists as the desire for the presence of a certain landscape characteristic such as naturalness or wilderness. Moreover, we apply Santos (1998, p. 81) definition of landscape attributes as being 'biophysical attributes of the scenes that are objectively measured'. All types of ecosystems, from natural to more intensively

managed ecosystems, are included as all types of ecosystems are potential providers of outdoor recreation (Paracchini et al., 2014). Urban core areas were excluded, thence we could not account for outdoor recreation in urban green spaces.

In contrast to outdoor recreation potential, the actual supply of outdoor recreation depends on the presence of people in a landscape (Costanza, 2008). To account for this, we include an additional analysis on the accessibility of each user group's preferred landscapes, following the approach presented by Paracchini et al. (2014).

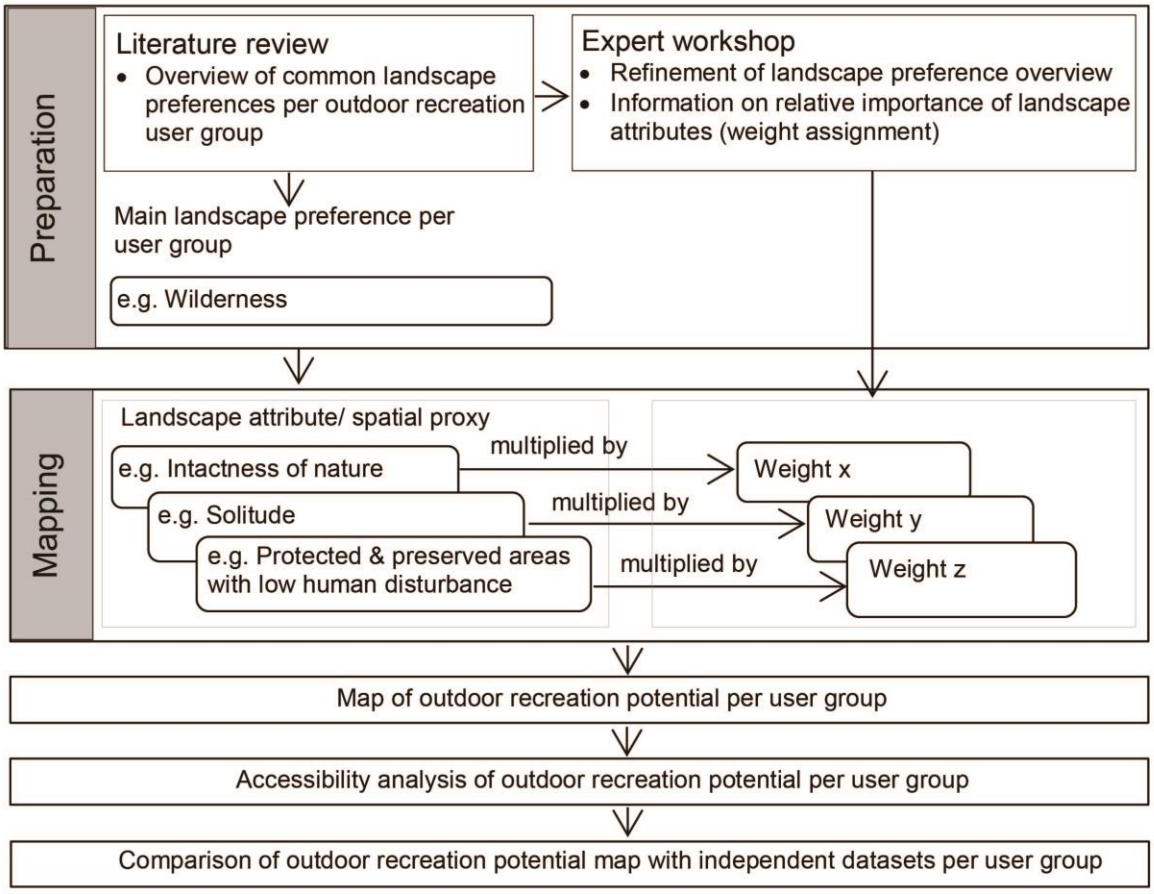


Figure 1: Flowchart of methods for synthesizing and mapping outdoor recreation potential for different user groups

2.2 Literature review

We developed an overview of common landscape preferences for different outdoor recreation user groups in the EU by analysing available conventional academic literature in English. We thereby limited our literature review mainly to Europe because we wanted to ensure that the landscape preferences attributed to the various recreation user groups were linked to European landscapes and users specifically, as European landscapes encompass unique characteristics owing to their diversity and long land use history (Diamond, 1998). We collected information by using queries in relevant databases (Google Scholar, Scopus, Science Direct). These queries included ["outdoor recreation" AND Europe], ["nature based tourism" AND Europe], ["close to home recreation" AND Europe] and [geotourism AND Europe]. The set of literature was then narrowed down to studies that clearly described one or more of the distinguished outdoor recreation user groups and provided information on the groups' specific preferences for activities or landscapes. Using a snowball search we found further academic literature as well as grey literature. Regarding the latter, we used information originating from national outdoor recreation surveys (e.g. NaturalEngland 2016). Literature collection resulted in 19 studies and reports with relevant information following the above-mentioned criteria (see Supplementary material 1), indicating that the number of studies providing relevant information was rather limited. The included studies also showed a slight overrepresentation of Spanish case studies.

2.3 Expert workshop

To gain additional information on the relative importance that different groups of outdoor recreationists assign to landscape attributes, we organized an expert workshop. Expert workshops are used regularly in mapping studies to synthesize different contextual knowledge (Serna-Chavez et al., 2013; Soliva et al., 2008; Van Berkel and Verburg, 2011).

147 Twenty-five experts with specialized knowledge in relevant issues regarding public goods
148 related to agriculture and forestry, representing thirteen European countries, were participating in
149 a workshop in Brussels in July 2016 as a sub-session of a larger meeting on public goods from
150 agriculture and forestry. During this workshop, we collected the experts' views regarding the
151 identified user groups, their main identified landscape preferences and the selected landscape
152 attributes. Additionally, experts were asked to individually state the relative importance of
153 relevant landscape attributes per outdoor recreation user group. We used the average relative
154 importance as assigned by the experts to weigh the different landscape attributes per landscape
155 user group (see Figure 1).

156 **2.4 Data and mapping**

157 The identified preferences for specific landscape attributes were translated into spatial indicators
158 (see Figure 1). Most of the mentioned landscape preferences could be approximated by spatial
159 data. However, some landscape preferences had to be omitted due to the absence of suitable
160 spatial indicators. All spatial information was collected at a detailed resolution (1 km^2) and
161 manually classified to five classes, ranging from low (1) to high (5), to allow comparison
162 between the different indicators. For each user group, a weighted overlay of selected landscape
163 attributes with the relative importance given by experts resulted in a map of outdoor recreation
164 potential (see Supplementary material 2 for details on the included data). Subsequently, we
165 combined the different user-group-specific maps in an overlay, using only the high outdoor
166 recreation potential of each user group (classes 4 and 5), to assess the concurring patterns of the
167 dominant outdoor recreation potentials.

168 Accessibility was addressed in order to assess how recreationists can deploy a landscape's
169 outdoor recreation potential. To assess the accessibility of areas with high outdoor recreation

potential, accessibility maps originating from Van Eupen et al. (2012) were used, which are based on a simple time-cost model. This model calculates the travel time to the nearest city for each square kilometre in Europe, thereby accounting for the variable travel speeds of different road and terrain types. We applied different accessibility thresholds for each outdoor recreationist group to identify areas with low versus high accessibility per user group. These were based on each outdoor recreation user groups' maximum willingness to travel expressed in kilometres and minutes using an average road speed of 50 km/h (Table 1). See Supplementary material 3 for more information on the chosen thresholds.

Table 1: Accessibility thresholds per outdoor recreation user group

User group	**Thresholds**
Convenience recreationist	8 km or 9.6 min
Day tripper	150 km or 180 min
Education recreationist	150 km or 180 min
Nature trekker	200 km or 240 min
Spiritual recreationist	200 km or 240 min

2.5 Comparison with independent datasets

For this study, a full or partial validation of the developed maps was not possible due to a lack of suitable independent data. If independent, directly observed data on the recreation potential or actual use for the different groups would be available, the work as presented in this study would not have been needed. Nevertheless, to assess the validity of the results, a triangulation of methods approach was used that facilitates cross-verification from different research methods verifying the same phenomenon (Denzin, 2009; Yin, 2014). We combined information gathered from literature with an expert workshop to collect experts' views on the identified user groups, the related landscape preferences and the relative importance of landscape attributes. Finally, we

188 compared the developed recreation potential maps with independent point data on a variety of
189 selected recreation facilities with appropriate European coverage (Table 2), as recreation
190 facilities provide a proxy for the use of the landscape for a specific recreation purpose.
191 Recreation facilities were selected based on their potential fit with the specific outdoor recreation
192 preferences per user group. We assume these facilities are an indicator for a high recreational use
193 reflecting the demand for outdoor recreation.
194 For the comparison, we classified the outdoor recreation potential maps per user group – not
195 accounting for accessibility – into 5 classes ranging from 1 (low) to 5 (high) (see Figure 5). For
196 each class of the map, we counted the number of facilities (see Table 2) and total percentage of
197 facilities. Additionally, we tested the sensitivity of the selected proxies for one user group,
198 namely the nature trekker, using data on wilderness and alpine huts (OSM, 2016) to calculate the
199 statistics.

200 **Table 2:** Selected outdoor recreation facilities per outdoor recreation user group

User group	Recreation facilities dataset
Convenience recreationist	Fire pits (OSM, 2016)
	Picnic sites (OSM, 2016)
Day tripper	Visitor's centres (OSM, 2016)
Education recreationist	UNESCO heritage (UNESCO, 2017)
Nature trekker	Long distance hiking paths: E1-E12 (OSM, 2016)
Spiritual recreationist	Main pilgrim paths (OSM, 2016)

201

202 ## 3 Results

203 ### 3.1 Literature review

204 Based on a literature review, we made an archetypical distinction of outdoor recreation user
205 groups, linked to interpretations of Cohen's recreational motivations, illustrating the groups'
206 variation in recreation focus and landscape preferences. We refer to the 5 user groups as: 'the

207 convenience recreationist', 'the day tripper', 'the education recreationist', 'the nature trekker'
208 and 'the spiritual recreationist'. The principal aim of 'the convenience recreationist' is to relief
209 tension from everyday life (Cohen, 1979) through easy short-term leisure activities (Atauri et al.,
210 2000) close to the place of residence (Ezebilo et al., 2015). Convenience recreationists prefer a
211 landscape with a high level of attractiveness or scenic beauty (DeLucio and Múgica, 1994; Urry
212 and Larsen, 2011), with close proximity to water as an important factor (DeLucio and Múgica,
213 1994; Ezebilo et al., 2015). Individual case studies in Spain mentioned the importance of green
214 mountainsides (DeLucio and Múgica, 1994) as well as flat landscapes without snow or a chilly
215 appearance (Atauri et al., 2000). A minimum of human modifications or human interference to
216 the environment is mentioned in two studies (Atauri et al., 2000; Ezebilo et al., 2015). Moreover,
217 two case studies emphasized the importance of landscape accessibility for this recreation user
218 group (Atauri et al., 2000; Schmitz and Aranzabal, 2007).
219
220 'The day tripper' tries to escape from the stressful routine of everyday life (Cohen, 1979)
221 through active and sportive experiences of nature (Schmitz and Aranzabal, 2007; Urry and
222 Larsen, 2011) with the goal of bodily recovery (Cohen, 1979). The day tripper is mainly attracted
223 by the naturalness of a landscape (Bastian et al., 2015; Schmitz and Aranzabal, 2007; Urry and
224 Larsen, 2011). A case study in the German Ore mountains mentioned that mountain meadows
225 and hedgerows, raised bogs, watercourses as well as mixed forests are especially attractive for
226 this type of recreationist (Bastian et al., 2015). Two case studies report that recreationists of this
227 group are especially interested in doing outdoor sports in landscapes whose characteristics allow
228 for sport recreation (Schmitz and Aranzabal, 2007; Türk et al., 2004). Moreover, animal

229 pasturing as well as cultural landscapes are seen as important preferences (Bastian et al., 2015;
230 Schmitz and Aranzabal, 2007; Van Zanten et al., 2013).
231
232 The 'education recreationist' is interested in cultural differences and scenic variances compared
233 to the home environment (Cohen, 1979; Roberts and Hall, 2001). A literature review by Mocior
234 and Kruse (2016) has shown that factors such as rare ecosystem features, the degree of human
235 disturbance, the number of interesting geological features, the geological age of a landscape and
236 its ecological value are important indicators for the quantification of the educational value of
237 ecosystems. The educational level, defined as the usefulness of a landscape for education, is also
238 important. Moreover, a study by Roberts and Hall (2001) mentioned spectacular sights, rare
239 species or natural phenomena as well as landscape variation to be of interest for this type of
240 recreationist.
241
242 The 'nature trekker' engages in physical activities in nature, similarly to the day tripper. Contrary
243 to the day tripper, this group's focus is strongly related to authenticity (Cohen, 1979), by aiming
244 to find "real nature" in recreational activities (Urry and Larsen, 2011). The nature trekker is
245 attracted by landscapes showing a high degree of wilderness and remoteness (Atauri et al., 2000;
246 Roberts and Hall, 2001; Urry and Larsen, 2011). Moreover, two studies have emphasized the
247 desire for unexplored places (Roberts and Hall, 2001; Williams, 1998). One case study in Spain
248 mentions the attractiveness of the natural and wild character of the landscape without human
249 disturbance (Atauri et al., 2000). Other landscape preferences for this group of recreationists
250 consider mountainous landscapes characterized by roughness, higher risk and inaccessibility
251 (Atauri et al., 2000) or hostility (e.g. aridity, altitude) of the terrain (DeLucio and Múgica, 1994),

252 which makes it suitable for adventure tourism including activities such as hiking, mountaineering
253 and trekking (DeLucio and Múgica, 1994; Roberts and Hall, 2001; Urry and Larsen, 2011;
254 Weber, 2001; Williams, 1998).

255

256 The 'spiritual recreationist' is markedly different from the other outdoor recreation user groups,
257 due to the search for an authentic way of life through a closeness with nature (Cohen, 1979) that
258 leads to the development of new beliefs and values regarding the meaning of nature and the
259 recreationist's place in it (Elands and Lengkeek, 2000). Developing these new beliefs is closely
260 related to the concept of spirituality, i.e. "a way of being and experiencing that comes about
261 through awareness of a transcendent dimension" (Elkins et al., 1988, p. 10).

262 The likelihood of a landscape to be perceived sacred or spiritual increases with the presence of
263 outstanding qualities such as unusual rock formations, spectacular lakes, canyons (Ivakhiv, 2003)
264 or exceptional beauty (Sharpley and Jepson, 2011). Due to a lack of literature on spiritual
265 recreation in Europe, we have also taken global case studies into account to assess the landscape
266 preferences relevant for this user group. In these studies, the presence of elevation within a
267 certain area is mentioned (Anderson et al., 2005; Ball, 2000; Sharpley and Jepson, 2011), as well
268 as sacred woods (Ambinakudige and Sathish, 2009; Byers et al., 2001), characterized by specific
269 tree species with remarkable sizes or age (Dudley et al., 2009).

270

271 **3.2 Expert workshop**

272 There was an overall consensus between the experts regarding the identified user groups. Also,
273 experts agreed that the landscape preferences identified through the literature review captured the

most relevant elements. Experts had some disagreement regarding potential missing landscape preferences and spatial attributes, mainly relevant to characteristics of specific regions. Based on the feedback on missing landscape preferences gathered during the workshop, we have added new preferences for some user groups, e.g. ‘availability of wild food’ and ‘cultural heritage’ for the day tripper user group.

Table 3 gives a summary of the translation of landscape preferences into landscape attributes and spatial proxies. A detailed description of this translation including the relative importance of landscape attributes given by experts is provided in Supplementary material 2.

3.3 Landscape outdoor recreation potential

Individual maps of the landscapes’ outdoor recreation potential per outdoor recreation user group are presented in Figure 2. Although the landscape outdoor recreation potential among user groups shows clear similarities, especially regarding the dominance of patterns of high potential in mountainous and coastal areas, the spatial patterns of landscape outdoor recreation potential per user group also show clear regional differences. The outdoor recreation potential for the convenience recreationist shows distinct patterns of high potential in coastal areas of Southern Europe, such as Greece, but also in mountainous areas of northern and southern Europe. These patterns can be explained by water proximity and higher elevation, which are landscape attributes relevant for this user group. For the day tripper, patterns of higher potentials appear mainly in coastal areas of Catalonia and the southern French-Italian coastline. Higher potentials in mountainous areas are displayed primarily in north-eastern Italy, the north-eastern Alps and north-western England. These patterns mainly occur because of the higher densities of cultural heritage and the availability of wild food.

297 **Table 3:** Translation of each outdoor recreation user group's landscape preferences into spatial attributes and their spatial proxies.
298 More information can be found in Supplementary material 2.

Outdoor recreation user group	Landscape preference	Landscape attribute	Spatial proxies	Data source	Comments
 The convenience recreationist	Degree of attractiveness/ scenic beauty	Water Proximity	Areas within different distance classes from waterbodies (Lakes, rivers and coastline)	EEA (2013, 2012a)	Paracchini et al. (2014) assumes that water attractiveness decreases with the distance from the coast (sea and lakes), using a distance buffer at 2000m. We included two distance classes: namely 2-4km and >4 km, to show the decrease in attractiveness. We regarded areas of 0km as being least suitable (value 1).
		Elevation	Average height differences (m) within a 10-km radius	Computed from 1000m DEM from SRTM3 data (NASA, 2003)	There is preference for mountainous areas (Atauri et al., 2000; Bastian et al., 2015; DeLucio and Múgica, 1994). However, very mountainous areas are most likely less attractive for short term recreation due to accessibility (Van Zanten et al., 2016a).
		Vegetation variety	Land cover composition divided into 5 main land cover classes	Berkel and Verburg (2011)	A meta-analysis of preferences for European agrarian landscapes shows that landscape attributes describing mosaic land cover are preferred (Van Zanten et al., 2014). Recreationists also show preferences of forests (Ezebilo et al., 2015; Tyrväinen et al., 2001).
		Air quality	PM10 (Particle pollution) concentration per km^2 in $\mu g/m^3$	Pistocchi (2015)	PM10 is particulate matter (< 10 µ in diameter) originating from fuel combustion, industrial and natural sources such as dust. Even though PM2,5 is believed to impose greater health risks, PM10 was chosen as it is reported in the majority of studies (Ostro et al., 2004). Thresholds are based on the EEA Air quality report (EEA, 2012b): <=20µg/m^3 - reference level for the annual mean >20<=31 µg/m^3 - proxy for the daily limit value when translated into annual mean >31 <=40 µg/m^3 - limit value for human health, annual mean. Classes including higher values have not been taken into account, as our data does not include these values.
 The day tripper	Degree of naturalness	Absence of light pollution	Presence of stable night time lights at a given place	NOAA (2010)	As no thresholds could be found on the absence of light pollution preference by outdoor recreationists, classification was based on natural breaks assuming the less light pollution the better.
		Absence of noise pollution	Quietness suitability map	Computed following the method of EEA (2014) using airports and railway (EuroGeographics, 2016) and major roads (ESRI, 2016) information.	To produce this map we have used the method of EEA for their Quietness suitability map (EEA, 2014).

	Presence of livestock	Spatial distribution of livestock computed as the nr. of livestock per km^2	Neumann et al. (2009)	Choice experiment assessing the contribution of landscape features shows aesthetic importance of livestock especially in Netherlands and Germany (Van Zanten et al., 2016b).
		NH_3 emissions from terrestrial ecosystems, industry and waste management in kg N km^{-2} yr^{-1}	Leip et al.(2011)	We included livestock that is mainly found on the fields and not in sheds such as dairy and beef cattle, goats and sheep. To exclude industrial farming we used the Leip et al. (2011) data on NH 3 emissions from terrestrial ecosystems, industry and waste management (highest class >1000 kg N km^{-2} yr^{-1} total area). The overall assumption is the more livestock the better, as long as it is not industrial.
	Naturalness of landscape measured through human modifications of landscapes	Land cover composition divided into 5 main land cover classes	Van Berkel and Verburg (2011)	Forest landscapes show very low levels of human intervention resulting in high levels of tranquillity, while mosaic landscapes have low levels of human intervention resulting in moderate levels of tranquillity. Open/agricultural landscapes have a moderate level of human intervention and show moderate levels of tranquillity (Van Berkel and Verburg, 2011)
Wild food	Wild food	Species distribution of wild edible plants, mushrooms and game computed as the nr. of species per km^2	Schulp et al. (2014)	It can be assumed that the availability of wild food is interesting to a certain extend. As no threshold on how many different species are interesting, it was assumed that the more different species available, the better.
Cultural landscape	Cultural/ historical/ legendary heritage	Panoramio photo density computed as the nr. of geotagged photos per km^2	Panoramio (2015)	Panoramio was chosen to represent the revealed preferences of people regarding visited cultural/ historical/geological places of interest in landscapes (Tieskens et al., 2017). As no threshold could be found on how much heritage is preferred by outdoor recreationists, we assumed that the more there is, the better.
Suitability for sport tourism	Water sports	Availability of waterbodies and water ways	EEA (2013, 2012a)	Laws regarding sportive water way use have not been regarded. Moreover, it can be assumed that water sports can take place on/in the water as in very close proximity to the water. Therefore, we have applied an arbitrary buffer of 1 km around the water areas.
	Mountain sports	Average height differences (m) within a 10-km radius	Computed from 1000m DEM from SRTM3 data	Including different kinds of sport such as mountaineering, climbing, via ferrata climbing, snowshoeing and mountain biking that ask especially for higher elevation (DAV, 2016). However, as very mountainous areas are assumed to be also least accessible (Van Zanten et al., 2016a) there are likely to be less suitable for mountain sport.
	Trail sports	Presence of marked trails for walking and biking (E1-10; EV1-11) with an 1km buffer	OSM (2016)	As it can be assumed that the outdoor recreationist is interested in the landscape next to the trails and not the trails itself, we applied an arbitrary buffer of 1 km around the trails.

 The education recreationist	Rarity of landscape	Habitat distribution of rare flora or fauna	Density/ spatial distribution of rare species computed as the nr. of rare species per km^2	Using information on mammals, amphibians, reptiles and birds (Thuiller et al., 2015)	Rare flora has not been included due to data availability. The data in rare fauna is very detailed, and the only available data on flora from IUCN contains rather rough polygons that would not be suitable to be combined with rare fauna data. However, we know that especially reptiles and amphibians are sensitive to good habitat quality meaning that it can be assumed that species richness on (rare) flora is similar to fauna. No thresholds could be found on how many rare species are preferred by outdoor recreationists. We therefore assume the more rare species the better.
	Degree of human disturbance	Protected/preserved areas with low human disturbance and nature reserves	Distribution of terrestrial and marine protected areas	IUCN and UNEP-WCMC (2016)	IUCN Cat III (Natural Monument or Feature): protecting specific natural monument e.g. landform, geological feature IUCN Cat V (Protected landscape): area of distinct ecological, biological, cultural or scenic value IUCN Cat VI (Protected area with sustainable use of natural resources): traditional natural resource management systems
	Educational level of a landscape	Cultural/ historical/ legendary heritage	Panoramio photo density computed as the nr. of geotagged photos per km^2	Panoramio (2015)	The educational level of a landscape specifies whether the site is useful for education (Mocior and Kruse, 2016). Panoramio was chosen to represent the revealed preferences of people regarding visited cultural/ historical/geological places of interest in landscapes (Tieskens et al., 2017). As no threshold could be found on how much heritage is preferred by outdoor recreationists, we assumed that the more there is, the better.
 The nature trekker	Wilderness	Intactness of nature	Remaining historic habitat (forest, grassland and other lands) after 110 years per cell	Fuchs and Herold (2015)	Exclusion of industrial/intensive forests and grass lands as they do not entirely fit with the concept of naturalness. Intensive forestry threshold of $500m^3/km^2$ forestry/yr has been chosen based on comparison with most intensively used forests.
			Industrial forests, defined by wood supply > 500 m^3 / km^2 forest/yr	EFI (2010)	
		Solitude	European population density computed as the nr. of people per km^2	Gallego (2010)	Population density reclassified according to US study of Aplet et al. (2000). This reclassification is seen to be valid also for Europe, as lowest population density of Europe can be found in Lapland with <1person/km^2. generally associated with solitude. Highest population density can be found in Malta with >1000persons/km^2.
		Protected and preserved areas with low human disturbance	Terrestrial protected areas	IUCN and UNEP-WCMC (2016)	IUCN Cat Ia (strict nature reserve): excluded as human visitation is strictly controlled and limited IUCN Cat Ib (Wilderness area): large unmodified or slightly modified areas IUCN Cat II (National park): large natural or near natural areas

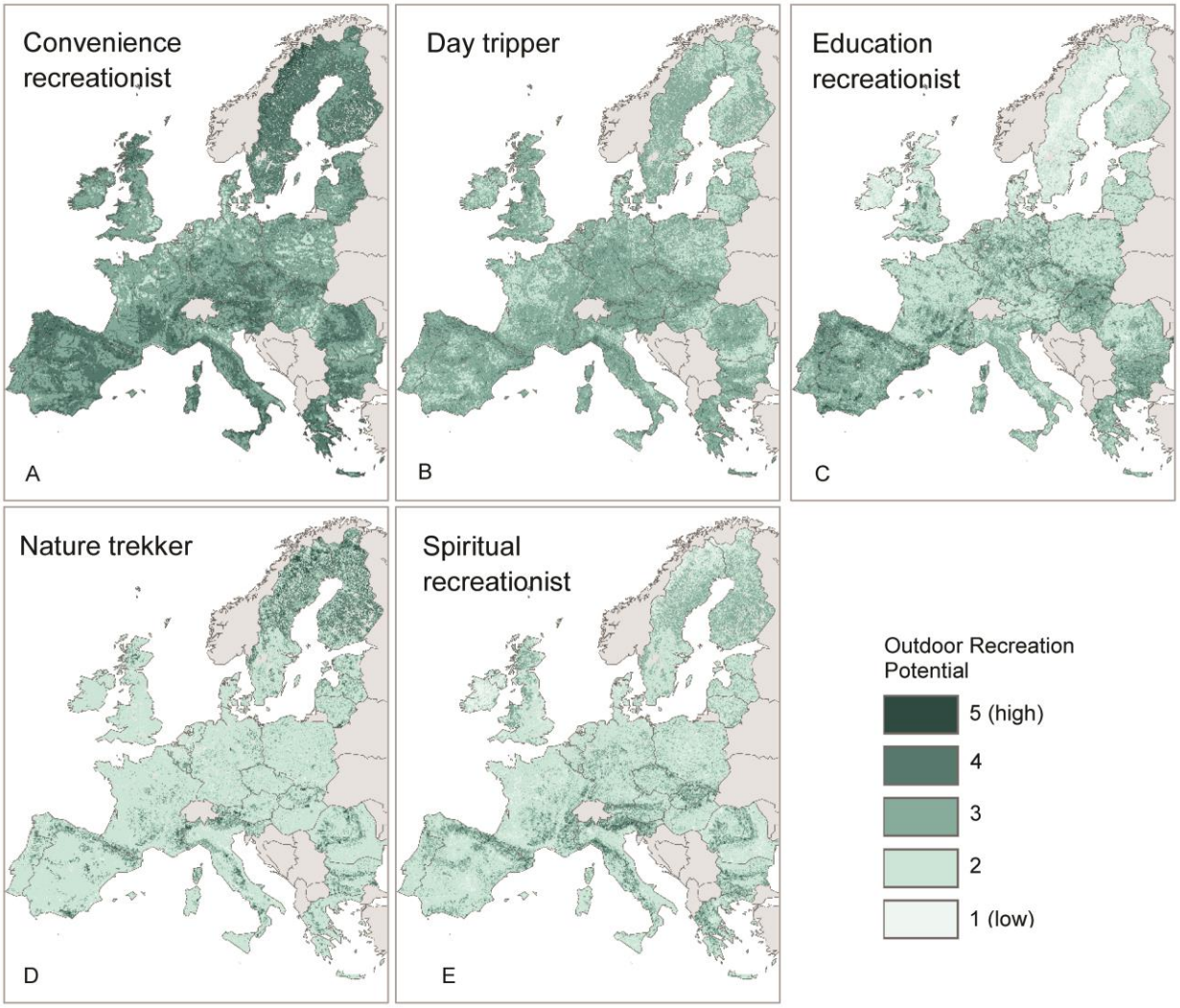
 The spiritual recreationist	Sacred woods	Old tree cover/old growth forest vegetation	Remaining historic forests after 110 years per cell	Fuchs and Herold (2015)	Exclusion of industrial/ intensive forests as they do not entirely fit with the concept of spirituality and old tree cover. Intensive forestry threshold of 500m^3/km^2 forestry/yr has been chosen based on comparison with most intensively used forests.
			Industrial forests, defined by wood supply > 500 m^3 / km^2 forest/yr	EFI (2010)	
	Specific spiritual Flora	Specific spiritual flora	Spatial distribution ritual plants of Europe computed as the nr. of plant species per km^2	Eatable sacred species selected from data by Schulp et al. (2014)	Only eatable sacred species have been used due to their potential use in naturopathy. The data sets on plants and trees have been compared with the ritual species described in De Cleene and Lejeune (1999). No thresholds could be found on how many ritual species are preferred by spiritual recreationists. We therefore assumed the more ritual species the better and classifies the data with natural breaks.
			Spatial distribution ritual trees of Europe computed as the nr. of tree species per km^2	De Rigo et al. (2016)	
	Prominence of Elevation	Prominence of elevation	Relative height in m	De Ferranti et al. (2012)	Prominence of elevation describes especially elevation and therefore slope compared to the direct environment. The steeper the slope the higher prominence of elevation is assumed to be experienced. Cut of threshold as described in Lew et al. (2015) for topographic prominence is >=300m. The data set on prominence by (De Ferranti et al., 2012) describes values over 600m as has been seen as the most complete dataset. We created a buffer of 7km around the point data as stated in Lew et al. (2015).
	Biodiversity	Faunal and floral species richness	Spatial distribution patterns of mammals, amphibians, reptiles and birds computed as % of habitat of species per km^2	Thuiller et al. (2015)	As we could not find information on how much flora and fauna will lead to more intensively experienced spirituality, we assumed that the higher faunal and floral species richness the better. We therefore set the thresholds with 5 natural breaks.
			Spatial distribution patterns of vascular plants computed as the nr. of species per km^2	Overmars et al. (2014)	
	Sacred sites/heritage	Cultural/ historical/ legendary heritage	Panoramio photo density computed as the nr. of geotagged photos per km^2	Panoramio (2015)	Panoramio has been chosen to represent the revealed preferences of people regarding visited cultural/ historical/geological places of interest in landscapes (Tieskens et al., 2017). As no threshold could be found on how much heritage is preferred by outdoor recreationists, we assumed that the more there is, the better.

299

Areas with higher outdoor recreation potential for the education recreationist are displayed predominantly in mountainous areas of southern Europe (e.g. southern Spain), eastern Europe (e.g. the Southern Carpathians) and Northern Atlantic. The patterns mainly appear due to denser cultural heritage and lower degrees of human disturbance. High potential in the Cantabrian mountains (Spain) can be explained through the denser habitat distribution of rare flora and fauna on the Iberian Peninsula. Worth mentioning are also the areas of low potential in northern Sweden that can be explained by the absence of protected areas.

In the map for the nature trekker (Figure 2D), especially northern Sweden and Finland show high outdoor recreation potential, which is most likely caused by high values for solitude. High potential is also displayed in mountainous areas throughout the EU (e.g. the Highlands of Scotland, the Alps, the Pyrenees and the Carpathians), that is likely to be the result of large areas of remaining historic habitat and solitude.

The map for the spiritual recreationist (Figure 2E) displays similar patterns for mountainous areas that can be explained by the prominence of elevation. High outdoor recreation potential in specific mountain ranges, such as the Carpathians, appear due to old grown forest vegetation, spiritual flora and high cultural heritage density.



316

317 **Figure 2:** Landscape's outdoor recreation potential per outdoor recreation user group: (A) The
318 convenience recreationist, (B) The day tripper, (C) The education recreationist, (D) The nature
319 trekker and (E) The spiritual recreationist.

320 Using the dominant outdoor recreation potential for each user group, we created an overlay in
321 order to show overlapping patterns of high recreation potential. A distinct pattern appears in
322 mountainous areas (e.g. the Cantabrian mountains and Northern Carpathians) with high outdoor
323 recreation potential for most outdoor recreation user groups, showing the areas' multifunctional
324 potential.

For some regions, specific user groups show overlapping patterns. The most dominant is the concurrence of the convenience recreationist and education recreationist (see Figure 3, red), often in close proximity to a combination of the convenience recreationist, day tripper and education recreationist (Figure 3, yellow). Another noticeable pattern appears in the Alps region, which has a high potential for both the day tripper and spiritual recreationist.

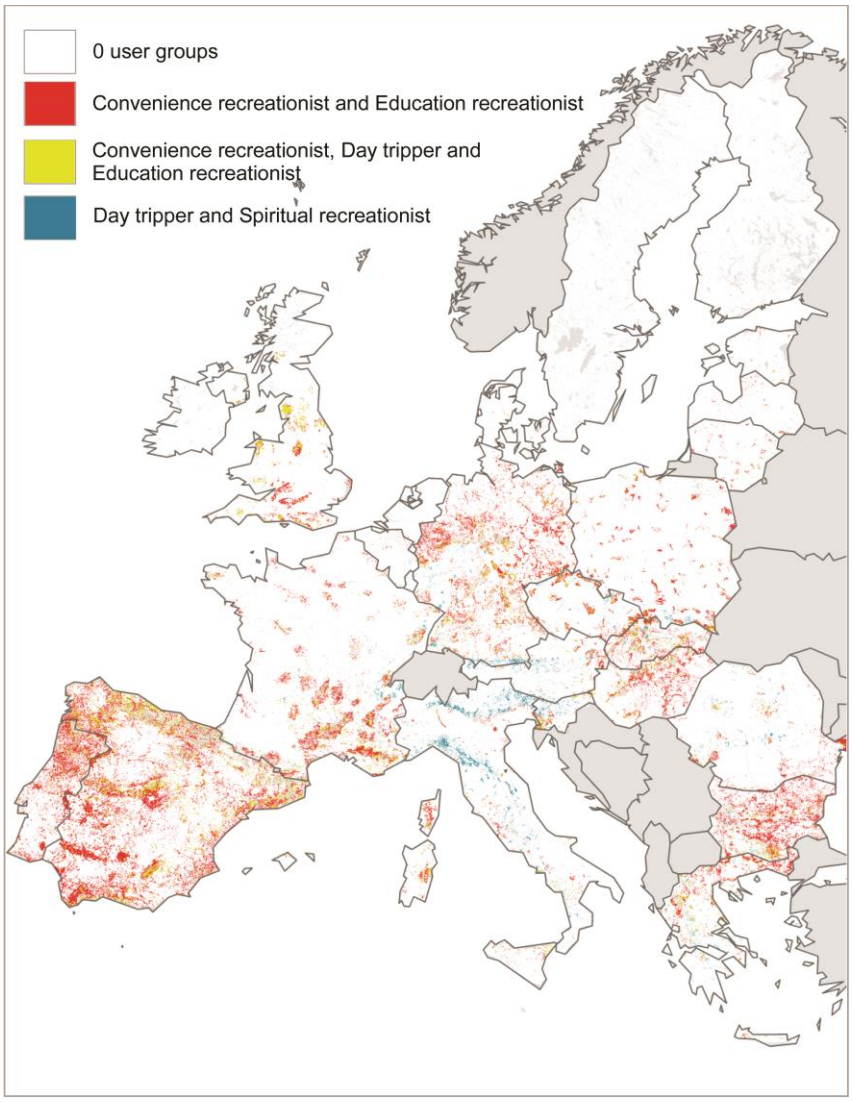
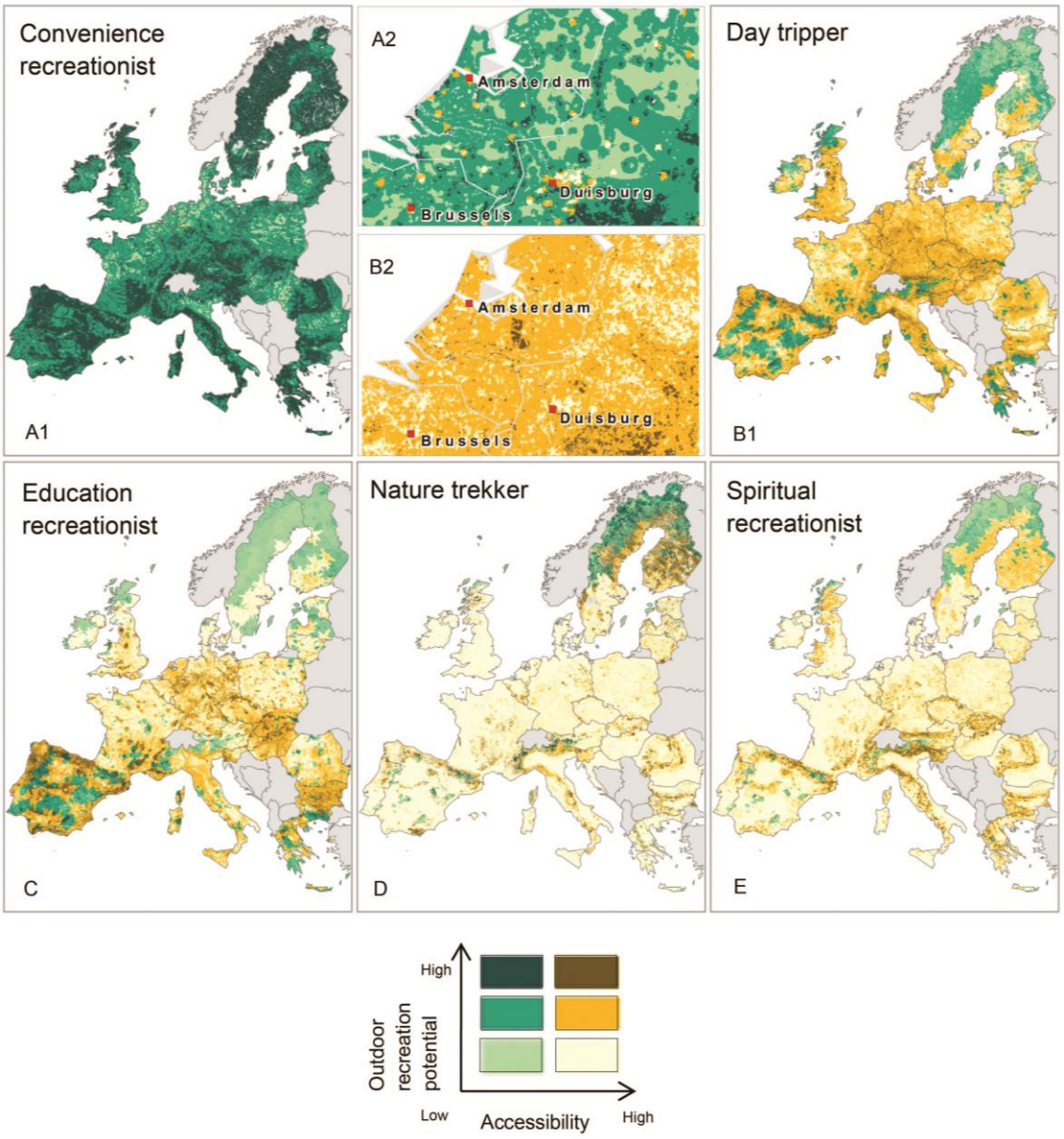


Figure 3: Overlay of the dominant outdoor recreation potentials for all outdoor recreation user groups. Map was simplified for visualization purposes by removing small patches. Full original dataset can be downloaded from www.environmentalgeography.nl.

Areas of high outdoor recreation potential with different accessibility thresholds are shown in Figure 4 (see Supplementary material 3 for details on accessibility thresholds). For these maps, the 5 classes of outdoor recreation potential were summarized as low (class 1 and 2), medium (class 3) and high (class 4 and 5) to increase readability (See supplementary material 4 for the original maps). Overall, it shows that the degree of accessibility strongly differs among areas with high recreation potential, ranging from 0,1% of areas with high recreation potential classified as highly accessible for the convenience recreationist, compared to 97% for the spiritual recreationist. Not surprisingly, for the convenience recreationist patches of highly accessible areas with high outdoor recreation potential (Figure 4, dark brown) appear especially in highly urbanized zones, e.g. in The Netherlands or the German Ruhr area. These areas extend with increasing willingness to travel, as is the case for the day tripper. Well accessible areas with high outdoor recreation potential for this user group appear especially in areas of northern Spain. For the education recreationist, highly accessible and highly desirable areas are displayed in southern and eastern Europe. The map of the nature trekker shows well accessible areas with high outdoor recreation potential mainly in southern Finland and in several mountain areas. Highly accessible areas with high potential for spiritual recreation can be found in southern Europe, such as northern Spain and northern and western Italy.



352

353 **Figure 4:** Accessibility of outdoor recreation potential across the EU for (A1) The convenience
354 recreationist, with (A2) a zoom in on The Netherlands and the German Ruhr area; (B1) The day
355 tripper, with (B2) a zoom in on The Netherlands and the German Ruhr area; (C) The education
356 recreationist; (D) The nature trekker and (E) The spiritual recreationist.

357

3.4 Comparison with independent dataset

We compared independent point data on a variety of selected recreation facilities with appropriate European coverage with the developed outdoor recreation potential maps. The results indicate that the outdoor recreation potential of three user groups is well supported by the chosen facilities. The overlap has been calculated as the total percentage of facilities that fall within each class of outdoor recreation potential, ranging from 1 (low) to 5 (high). For areas with an average to high outdoor recreation potential (class 3 to 5), the overlap of facilities for the convenience recreationist, day tripper and education recreationist is 95%, 91% and 77% respectively. These values are much weaker for the nature trekker and spiritual recreationist group. To assess the sensitivity of the comparison with respect to the selected proxy, we have also compared wilderness- and alpine huts (OSM, 2016), which are used as shelter and sleeping accommodation by mountaineers, with the outdoor recreation potential for the nature trekker. From the 3433 found mountain huts in rural areas, 48% are located in areas with average to higher outdoor recreation potential, showing an increase of proxy suitability of 26%.

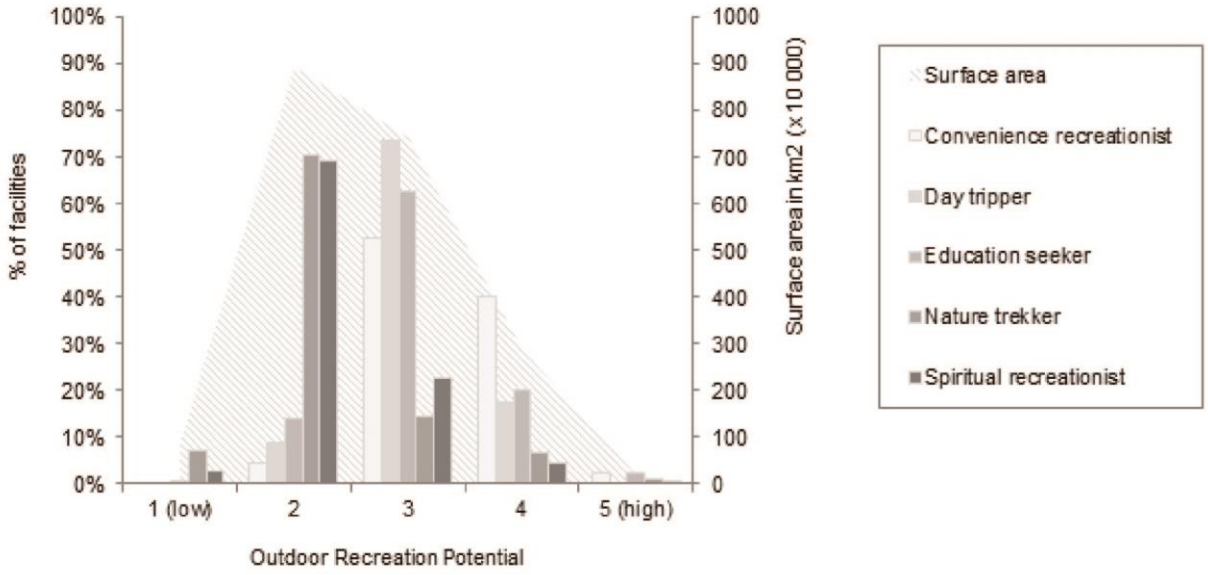


Figure 5: Facility count in % per outdoor recreation potential class ranging from 1(low) to 5(high) for each outdoor recreation user group with an indication of the surface area per class in km^2 (x10.000).

4 Discussion and Conclusion

Outdoor recreation is an important means to engage with the natural environment and is often regarded as a Public Good or Cultural Ecosystem Service. Most studies on landscape preferences are based on empirical information with a limited geographical scope and mostly focus on one single user group. Our study is the first attempt to map the outdoor recreation potential of landscapes at EU scale while differentiating between diverse recreational user groups. At the same time, our study identifies large knowledge gaps in our understanding of landscape preferences of different user groups beyond the case study level. The presented synthesis of available information may help stakeholders at different levels (e.g. landscape management, spatial planning, development of recreational facilities) to better understand the recreational users' demands (Bell et al., 2007) and prevent the occurrence of potential conflicts in landscape management objectives.

4.1. Spatial patterns of outdoor recreation potential

The different maps of outdoor recreation potential for archetypical user groups show clear spatial similarities, especially regarding high values in mountainous and coastal (here: lake, sea and river) areas. For the nature trekker for instance, high outdoor recreation values occur in various mountain ranges (e.g. northern Sweden, the Scottish Highlands or the Alps), due to larger areas of remaining historic habitat and solitude. This result is comparable to the study of Paracchini et al. (2014), who ascribed similar patterns to a high degree of undisturbed naturalness and the provision of specific opportunities for recreation (areas of outstanding natural value).

Further overlap between the outdoor recreation potential of different user groups is mainly caused by landscape attributes that are similarly interesting for different user groups, as found in the literature review and which are therefore operationalized using comparable spatial proxies. Examples are similar elevation classes for the convenience recreationist and the day tripper and a focus on flora and fauna for the education recreationist and the spiritual recreationist. The importance of similar landscape attributes for different user groups can also be found in case study examples, which highlight that similar landscape attributes are appreciated for different functions (see e.g. Surová and Pinto-Correia, 2016).

Despite these similarities, there are also clear differences in patterns between the user groups which in turn can be ascribed to diverging landscape preferences. One example concerns dissimilar outdoor recreation potential patterns for the convenience recreationist and the nature trekker (see Figure 2). While high potential for the former is widely dispersed throughout the EU, it is largely confined to Scandinavia and Finland for the latter. This disparity can primarily be explained from the nature trekker's preference for wilderness, which in the EU can only be found in a few remote areas. The convenience recreationist, by contrast, prefers accessibility of the recreation area in combination with a high degree of scenic beauty, leading to a contrasting spatial recreation pattern.

When we take a closer look at accessibility, we see that the degree of accessibility strongly differs among areas with a high recreation potential. For instance, landscapes with high outdoor recreation potential for the convenience recreationist occur especially in greatly urbanized areas, e.g. in The Netherlands or the German Ruhr area, that imply high accessibility. This co-occurrence of high accessibility and high potential could be a result of an increasing demand for

418 touristic attraction in close proximity to urban agglomerations, with urban residents searching for
419 easy access recreational enjoyment of open space (Zasada, 2011).

420 In contrast, highly desirable outdoor recreation landscapes for the nature trekker are mainly
421 found in northern Europe (Figure 2D), caused by preferences for solitude and wilderness that
422 connote lower accessibility in general (Figure 4D). However, southern Finland is an exception to
423 the mutual exclusivity of a high potential for the nature trekker and a high accessibility. The
424 promotion of outdoor recreation in rural southern Finland was one of the most important
425 objectives of the Finnish policy-making processes related to outdoor recreation in the past. These
426 policies aimed at ensuring recreation areas with attractive nature that were well accessible by
427 second home owners and meant to enhance economic growth and eliminate unemployment
428 (Pouta et al., 2006).

429 **4.2 Mapping methods for outdoor recreation potential**

430 Numerous typologies have been developed to examine the differences between outdoor
431 recreational user groups (see e.g. Horner and Swarbrooke, 2016). A seminal work in this field
432 has been Cohen's (1979) typology, which provides a theoretical framework on the classification
433 of tourists by dividing the tourist journey into distinctive forms of experience, based on when,
434 where and how people release themselves from their daily world (Cottrell et al., 2005). For our
435 study, we choose to use Cohen's typology as a starting point, as it focuses on recreational
436 experiences, meaning that it recognizes the possible transition between user groups over time in
437 response to socio-economic or demographic changes. Unlike approaches centred solely on
438 motivational or interactional aspects, experience-based typologies can be considered suitable to
439 apply for classifying leisure activities, as they enable a constant connection between leisure
440 experiences in various situations with respect to different activities (Cottrell et al., 2005;

441 Lengkeek, 2001; Murphy, 2013; Raadik and Cottrell, 2007). Elands and Lengkeek (2012) argue
442 that leisure experiences are linked to the quality conditions of natural settings. We used a similar
443 interpretation as Elands and Lengkeek (2012), namely that each mode of experience can be
444 linked to a certain perceived quality of the landscape and thus certain landscape preferences.
445
446 Mapping the potential of landscapes attractive for outdoor recreation demands extensive
447 information in order to be able to capture the heterogeneity of recreational preferences. As
448 evidence for different outdoor recreation user groups' preferences is rather anecdotal, we are
449 aware that the included landscape preferences and landscape attributes might be incomplete. Our
450 mapping attempt is fully based on a literature review where we include all main scientific
451 literature by using a broad set of search terms. We captured the most important landscape
452 attributes documented in literature to explain the potential attractiveness of the landscape. The
453 maps provide a synthesis of this information in a spatial context. However, the included
454 indicators do not comprise regionally important recreation characteristics, which would increase
455 local sensitivity as sufficient information on regional distinctions is lacking. A more structural
456 analysis of outdoor recreation motivations, recreation activities and landscape preferences
457 throughout Europe would be needed.
458 The limited literature available on the subject made the definition of the spiritual recreationist
459 user group especially challenging. Relating the complex concept of spirituality to specific
460 landscapes and landscape attributes proved to be particularly difficult in this context. We were
461 nevertheless adamant to include this user group, as spirituality has traditionally been a
462 meaningful force in European history with a strong impact on people's motives and actions (De
463 Cleene and Lejeune, 1999), including their experiences of nature (Cooper et al., 2016). In this

464 paper we therefore assume that spirituality is expressed through spiritual activities (McDonald
465 and Schreyer, 1991) within the natural environment, such as the collection of spiritual plants
466 known within the field of naturopathy (De Cleene and Lejeune, 1999) or visiting forests with
467 higher spiritual values (Dudley et al., 2009). Because of the limited available information, we
468 were dependent on several non-scientific literature sources for this user group, which likely
469 influenced the reliability of the user group characterization. In addition, spirituality is sometimes
470 attached to a location, based on its history or connotations (see e.g. Nolan and Nolan, 1992),
471 rather than linked to measurable landscape characteristics.
472 As the literature gave insufficient evidence of the relative importance of the different landscape
473 attributes to each outdoor recreation user group, we used an expert-based weighting method to
474 derive weighing factors. While this approach can be seen as a source of uncertainty, this method
475 is often used in multi-criteria analysis and other studies were literature gives little information on
476 the importance of individual characteristics (see e.g. Chow and Sadler, 2010; Koschke et al.,
477 2012). During the workshop, experts gave feedback according to their geographic and
478 educational background, which is likely to have influenced the distribution of relative
479 importance. But, as the experts included have different disciplinary backgrounds and originate
480 from different residential countries across Europe, we assumed that the overall bias is limited.
481 Experts were also asked to provide suggestions for additional landscape preferences and
482 attributes. This yielded suggestions relevant to specific regions, which needed to be adjusted to
483 general indicators because of their low generalization capacity for entire Europe. For example,
484 experts advised to include berry-picking as an important experience to the day tripper, which is
485 characterized as a seasonal activity predominantly relevant for Scandinavia and Eastern Europe.
486 We included the collection of mushrooms and vascular plants to account for the regional

variation in wild food collection, using data on wild food by Schulp et al. (2014). Another example of regionally different preferences concerned the suitability for sport tourism. We chose to map this indicator based on the suitability of the landscape for different groups of sport tourism (water, mountain and trail sports) rather than focusing on specific landscape characteristics for individual sports. For example, we mapped the suitability for different mountain sports by the availability of elevation, without considering specific characters that would restrict specific sports, e.g. rock suitability for climbing.

Providing a spatial characterization of different recreation user groups in the EU is limited by the available spatial information at a European scale, which is especially lacking regarding the cultural dimensions (Plieninger et al., 2015). Data on heritage values of landscapes was derived from a social media photo platform (Panoramio), a method earlier described by Wood et al. (2013) and Van Zanten et al. (2016a). In contrast to all other data sets used in our analysis, this dataset directly reflects recreationists' revealed preferences, as they show the location where users have taken pictures and uploaded them on the web (Tieskens et al., 2017). Furthermore, Panoramio users are not representative for the whole population of recreationists (Boyd and Crawford, 2012) as the use of social media platforms is skewed toward particular demographic groups (Van Zanten et al., 2016a). Information on specific landscape attributes and facilities was sometimes also not available at a European scale. For example, the most complete available dataset for trail sports (hiking and biking) consisted of unpaved but marked European long-distance trails for hiking and biking derived from Open Street Map, as the many other paths suitable for trail sports had insufficient European coverage. Regarding the inclusion of facilities in our study, we differentiated between recreation facilities that are likely to reflect potential outdoor recreation demand (e.g. picnic benches, visitor's centres) and facilities with a pure

511 cultural connotation such as cultural heritage or trails for hiking or biking. The latter were used
512 in the analysis of outdoor recreation potential. Integrating the different proxies per outdoor
513 recreation user group through a weighted overlay resulted in final output maps that we classified
514 into 5 classes ranging from 1 (low) to 5 (high) to be able to map variation in outdoor recreation
515 potential across the EU. This manual non-continuous classification of outdoor recreation
516 potential imposes another limitation of the current approach, affecting the quality of the
517 typology. The thresholds chosen per proxy strongly influence the level of outdoor recreation
518 potential per user group as small nuances in outdoor recreation potential are not displayed due to
519 this classification.
520
521 For this study, a full or partial validation of the maps was not possible due to a lack of suitable
522 independent data. Data on e.g. direct demand for outdoor recreation are usually constricted to
523 smaller areas and are not available on EU level. Schägner et al. (2016) has recently made a first
524 attempted to upscale the direct demand by using visitor statistics of several designated National
525 Parks in Europe. This focus on National Parks alone, however, makes this approach not suitable
526 for our study. Instead, we have used independent point data on a variety of selected recreation
527 facilities with appropriate European coverage (Table 2) to make a comparison with earlier
528 developed maps on outdoor recreation potential, similar to the approach used by Van Berkel et
529 al. (2011). We assume these facilities serve as a proxy for outdoor recreation demand on EU
530 level.
531 Recreation facilities are more likely to be built in countries with a higher GDP or where large
532 investments in the tourism sector are made. Moreover, data completeness on Open Street Map is
533 more likely to be found in countries with a larger interest in having the available facilities found

online and thus attract potential recreationists. The comparison results also indicate that a considerable uncertainty remains. This is largely due to the complexity of outdoor recreation potential that cannot easily be captured by facilities considered. One example is the comparison of the outdoor recreation potential for spiritual recreationists with a dataset on main pilgrim paths in Europe, with 72% of the facilities being situated in landscapes with lower outdoor recreation potential. Also the nature trekker has a low overlap, with 78% of the EU long distance hiking paths leading through areas with lower outdoor recreation potential. Both values can be explained by potentially lower suitability of the facility proxies used for the comparison. For the spiritual recreationists, choosing an appropriate facility is difficult, especially on larger scales, as the perception of spirituality differs among communities (Daniel and Muhar, 2012). For the nature trekker, we believe that the selected facility proxy might include too much of the surrounding areas, as the focus of hiking paths is to connect different landscapes.

4.3 Implications

The results of this study form a first attempt to map the variations of outdoor recreation potential across the EU while taking different types of outdoor recreation user groups into account. Previous studies that focussed on outdoor recreation potential at a European scale, like Van Berkel et al. (2011) and Paracchini et al. (2014), aggregated recreation into a general potential of the landscape, but our approach demonstrates how a landscape's potential can vary among different user groups. As demands of different types of recreationists vary regarding landscape and location, this calls for more context-specific policy. Our results are especially relevant for policy regarding sustainable rural developments on European scale, but a similar approach on smaller scale could also be relevant for locally-informed policy making. For example, the identification of potential trade-offs among outdoor recreation user groups may help to identify

where potential land use conflicts might occur. Co-occurrence of different user groups (e.g. day trippers vs nature trekkers) might negatively influence the provision of Public Goods and Ecosystem Services (Pröbstl et al. 2010), meaning that stricter nature conservation restrictions might be necessary. Knowledge about trade-offs among user groups might benefit the design of regulations that on the one hand serves the balancing of supply of and demand for outdoor recreation and on the other hand contributes to environmental conservation. This however raises the question, whether landscapes with high outdoor recreation potential should be managed or not (Kline, 2001).

Our maps are based on recreationists' current landscape preferences, which might change together with future natural, cultural, socioeconomic, political as well as technological conditions (Brandt et al., 1996; Bürgi et al., 2004; Plieninger et al., 2015). We also expect changes in landscape structure and land use, independent from the users, to influence the potential for outdoor recreation. At the same time, changes in or between user groups can trigger a change in environmental impact of outdoor recreation on Europe's landscapes.

A future potential continuation of this study would be to assess the actual capacity of a landscape to welcome an increasing number of recreationists, taking into account the demand trends for outdoor recreation per user group and the environmental impact of each outdoor recreation user group. The conceivable damaging effects of outdoor recreation on the landscape and the environment has become a growing concern, demanding active management strategies (see e.g. Hadwen et al., 2007; Monz et al., 2013). The presented methodology in the paper could furthermore be used at a lower spatial scale, to assess the potential and actual demand for outdoor recreation per user group in more detail, e.g. by taking the revealed preferences and visitor behaviour into consideration, suitable for regional or local policy making.

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