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5 **The Landscape Inventory of Galicia (NW Spain): GIS-web and Public**  
6 **Participation for Landscape Planning**

7  
8 **Abstract**

9 The European Landscape Convention recognizes the importance of public participation for  
10 landscape planning in order to capture local knowledge, sensitive issues and conflicts, boost  
11 exchanges of information and democratize the process. However, traditional public participation  
12 methods are frequently restricted to public exposure at the final stage of the planning process.  
13 New public participation movements call for a greater role for the people at all stages. The  
14 growing development of ICT and geospatial information technologies provides new means of  
15 improving the participation process. This paper describes the public participation procedure and  
16 the PPGIS used to develop the Landscape Inventory of Galicia, whose results were used for the  
17 characterization of landscape types, the delimitation of special interest areas from the locations  
18 identified by citizens and the definition of special attention areas from the degraded areas located  
19 by population.

20  
21 **Keywords:** PPGIS; European Landscape Convention; landscape perception; landscape  
22 characterization

## 23 **1 Introduction**

24 Public participation comprises processes that offer the possibility to influence the results of a  
25 procedure to individuals or social groups usually excluded from formal decision making  
26 performed by governments and local authorities. This kind of participation is necessary for many  
27 reasons: it captures local knowledge, helps identify sensitive issues and manage conflicts, boosts  
28 exchange of information and, in short, democratizes and legitimates the process. Numerous  
29 studies have demonstrated that collecting local knowledge has a positive impact on the plan  
30 success (Burby, 2003; Golobic & Marusic, 2007).

31 The European Landscape Convention (ELC) recognizes the importance of public  
32 participation on decision making with regard to landscape protection, management and planning.  
33 Article 5c specifically states the commitment to establish “*procedures for the participation of*  
34 *the general public, local and regional authorities, and other parties with an interest in the*  
35 *definition and implementation of [...] landscape policies*” and article 6C1b requires that  
36 landscape characterization takes into account “*...the particular values assigned to them by the*  
37 *interested parties and the population concerned.*” Public participation is implicit in the ELC's  
38 definition of landscape as an area “*as perceived by people*”, which entails the need to capture the  
39 perception of the people in landscape-related planning.

40 Despite the need to consider expert knowledge in landscape planning (Alberts, 2007;  
41 Perera, Drew, & Johnson, 2012), an approach based exclusively on expert opinion can easily  
42 overlook local knowledge of places and circumstances, which may be extremely relevant. The  
43 Guidelines for the implementation of the ELC (Council of Europe, 2008) recommend  
44 bidirectional communication between experts or scientists and citizens at an early stage of the

45 planning process. This is required to achieve at least the fifth rung on the Arnstein's participation  
46 ladder (Arnstein, 1969).

47         Despite the fact that including public opinion in landscape planning and management is  
48 generally and publicly acknowledged as a need, it is still difficult to carry out and represents a  
49 scientific and politic challenge (Scott, 2002). Nevertheless, no solution or universally accepted  
50 approach has yet been developed, as reflected in the different approaches used in public  
51 participation implemented by the signatory states to ELC (Jones & Stenseke, 2011). Conrad,  
52 Christie, & Fazey (2011) analyzed many of the most relevant research papers related to the ELC  
53 and concluded that the participatory emphasis of ELC is not being giving equal priority in  
54 landscape research and that there is significant scope for more research in terms of developing  
55 new participatory techniques for landscape planning, "giving an identified need for such  
56 instruments (De Montmollin, 2006; Glover et al., 2008)". The need to develop tools and methods  
57 that allow for a trade-off between democratic decision making and expert or scientific  
58 knowledge has been stated in numerous studies (e.g., Golobic & Marusic, 2007; López Martínez,  
59 Pérez Morales & Gil Guizado, 2016).

60         The implementation of public participation processes to develop the ELC is described in  
61 detail in Jones and Stenseke (2011), highlighting some of the main initiatives carried out in  
62 several ELC signatory countries. Many of the more recent initiatives using different visual  
63 media, such as photorealistic design (Tress & Tress, 2003), 3D displays (Schmid, 2001) and GIS  
64 (Scott, 2002).

65         The growing development of ICT and new geospatial information technologies, such as  
66 GIS, GIS-web or Public Participation GIS (PPGIS, also PGIS), provides new means and  
67 opportunities to improve the participation process and obtain richer and more relevant

68 information. The use of PPGIS improves people's knowledge about the land and increases their  
69 ability to express their opinions and perspectives about landscape, as well as to communicate  
70 them (Brown & Kytä, 2014; Poplin, 2012; Sieber, 2006). When applied to land planning, web-  
71 based GIS open up land planning processes – previously limited to professionals – to citizens  
72 and provide an effective medium for public participation.

73         The term PPGIS arose in 1996 at the NCGIA meeting to describe GIS technology to  
74 support public participation in a variety of applications. The first web-based PPGIS aimed at  
75 encouraging public participation only allowed users to view and query geographic and  
76 alphanumeric data. A further step in the development of such systems allowed a two-way flow of  
77 spatially referenced information. One of the first and best-known systems of this kind, in which  
78 citizens were able to attach suggestions to point locations in a map in order to improve the  
79 village of Slaithwaite, was described by Kingston, Carver, Evans, & Turton (2000) and Carver,  
80 Evans, Kingston, & Turton (2001). Rinner (2001) introduced argumentation maps as a way of  
81 supporting map-related discussions in online planning. Bugs, Granell, Fonts, Huerta, & Painho  
82 (2010) proposed a similar PPGIS, and Poplin (2012) described the integration of interactive GIS  
83 maps with an online questionnaire. Recent PPGIS include tools for more complex spatial  
84 analysis and multicriteria decision-making techniques. These systems are relatively common in  
85 environmental planning (e.g., Gangopadhyay, 2002; Ghaemi, Swift, Sister, Wilson & Wolch,  
86 2009; Rao et al., 2007; Sikder & Gangopadhyay, 2002). However, few PPGIS for land planning  
87 include multicriteria decision-making techniques. For instance, Dragicevic & Balram (2004)  
88 developed a web-based GIS to apply the collaborative spatial Delphi method for urban planning;  
89 McHugh, Roche, & Bédard (2009) proposed a PPGIS that makes complex spatial queries; and  
90 Simao, Densham & Haklay (2009) developed a web-based GIS that includes an argumentation

91 map and a simple multicriteria evaluation module to analyze alternative sites for wind farms.  
92 Even more complex multicriteria decision-making techniques were integrated in the PPGIS  
93 described by Mansourian, Taleai & Fasihi (2011) in order to submit development permits  
94 according to the urban plan, as well as in the Ecosystem Portfolio Model (Labiosa et al., 2013)  
95 for land use planning.

96         Among the applications specifically designed for landscape planning, those aimed at  
97 assessing landscape values stand out. Beverly, Uto, Wilkes, & Bothwell (2008) located forest  
98 landscape values through a GIS-web and correlated them to the proximity of relevant landscape  
99 elements. Brown and Brabyn (2012) used a PPGIS based on Google® Maps to identify locations  
100 with landscape values, which were subsequently related to landscape classes. More recently,  
101 Brown, Weber, & Bie (2014) used the same system to identify and quantify social and cultural  
102 values associated with different types of public natural spaces. Vries et al. (2013) evaluated the  
103 attractiveness of natural sites identified by people on Google Maps and Zhu, Pfueller, Whitelaw,  
104 & Winter (2010) evaluated the use of a publically available GIS to locate 12 types of landscape  
105 values. Many of the recent PPGIS address the characterization of landscape functions or services  
106 (Brown & Fagerholm, 2015), although with different purposes to that intended here and by the  
107 ELC.

108         The aforementioned systems were mainly applied mostly as case studies within research  
109 projects. However, examples of these systems and methods applied to a whole country or region  
110 are difficult to find, particularly when the initiatives are carried out by the Government or Public  
111 Authorities (Brown, Weber, & de Bie, 2014) and there is little evidence for their use in actual  
112 decision support (Brown & Fagerholm, 2015). The objective of the present study is to describe  
113 how a public participation process can be used for the official development of a legal landscape

114 planning instrument, by taking advantage of the potential value of PPGIS to capture the public  
115 opinion about those aspects in which the public perception is a key factor and to integrate this  
116 information with expert knowledge and technical analysis to develop several aspects of the  
117 landscape plan, in this case, the Landscape Inventory of Galicia.

## 118 2 The Landscape Inventory of Galicia

119 The autonomous region of Galicia (NW Spain) covers an area of 29 000 km<sup>2</sup> and has a  
120 population of almost 3 million people. The ELC was signed by Spain in 2007, and one year later  
121 the Galician Government passed Law no. 7/2008 concerning Landscape Protection, which  
122 included landscape inventories, among other instruments, for landscape protection, management  
123 and planning.

124         The Landscape Inventory of Galicia is a technical document focused on the first stage of  
125 landscape planning (<http://mapas.xunta.es/visores/paisaxe/> and [http://cmaot.xunta.gal/seccion-organizacion/c/CMAOT\\_Instituto\\_Estudios\\_Territorio?content=Direccion\\_Xeral\\_Sostibilidade\\_Paisaxe/Catalogo\\_paisaxe\\_galicia/seccion.html&std=Introduccion.html](http://cmaot.xunta.gal/seccion-organizacion/c/CMAOT_Instituto_Estudios_Territorio?content=Direccion_Xeral_Sostibilidade_Paisaxe/Catalogo_paisaxe_galicia/seccion.html&std=Introduccion.html)), i.e. on landscape  
126 analysis and diagnosis, which includes the following: (i) delimitation of landscape areas and  
127 identification of landscape types in each area, (ii) an inventory of landscape values, (iii) analysis  
128 of the drivers of each landscape type, (iv) diagnosis of the current state of the landscape, (v)  
129 zoning of landscape units and delimitation of areas of special landscape interest and (vi)  
130 identification of degraded areas. The first step in the development of the inventory was carried  
131 out by a technical team and involved the identification of 258 landscape types, as a combination  
132 of five geomorphology categories, five climate categories and 12 land use patterns, resulting in  
133 28350 landscape units (Figure 1), which are defined as homogeneous regions in terms of  
134 landscape type. A main objective of the following subsequent steps was to integrate expert and  
135  
136

137 local knowledge for landscape planning, especially for analysis in which citizens' landscape  
138 perception is a key factor; that is, for the characterization of landscape types according to  
139 landscape values assigned by citizens and for the identification of special interest areas and  
140 degraded areas. With this aim, public participation was elicited at the next stages of inventory  
141 development.

142 <Figure 1>

### 143 **3 Public Participation Process**

144 A public participation strategy was designed with the aim of ensuring that citizens' opinion was  
145 taken into account from the beginning of the process and included in the final results. The design  
146 sought to meet a series of requirements: (i) integrating scientific knowledge and public  
147 participation, (ii) including participation in every stage of the process, (iii) involving a set of  
148 stakeholders and relevant participants from the community and, particularly, (iv) incorporating  
149 the results of public participation in the results and contents of the inventory in an explicit, direct  
150 and transparent manner.

151 Two approaches can be taken in relation to public participation in the context of the ELC.  
152 One is focused on expert knowledge and the other one on the concept of landscape as an area “as  
153 perceived by people,” promoted by the ELC itself (Olwig, 2007). The procedure designed thus  
154 attempted to combine both expert and local knowledge by including a panel of experts and a  
155 public participation process based on workshops and a PPGIS.

#### 156 *3.1 Panel of Experts*

157 A panel of experts with 16 members was divided into three teams. Each team was  
158 allocated **one** of the three general areas of land use change in Galicia (Figure 2). A balanced

159 number of experts with a functional and formal approach to studying landscape was sought for  
160 each team.

161 <Figure 2>

### 162 *3.2 Public Participation Geographic Information System (PPGIS)*

163 The objective behind the development of a PPGIS (<https://sixot.es/paisaxe/Aeip?6>) was to  
164 achieve more proactive public participation by providing citizens and different stakeholders with  
165 the means of supplying information, expressing their preferences and collaborating in the  
166 elaboration of the inventory in a convenient and flexible manner.

167 This system was programmed with Java for the J2EE platform and the database was  
168 implemented in DBMS PostgreSQL with the spatial extension PostGIS, using MapServer as the  
169 web map server and a geographic viewer developed using DBOX library. The interface for the  
170 PPGIS was developed in order to be as simple and user-friendly as possible, and an explanatory  
171 video showing how to use the system was provided. A prize of free accommodation in a bed and  
172 breakfast was offered, as previous studies have demonstrated that this type of incentive increases  
173 participation rates (Brown et al., 2014).

174 To gain access to the system, users had to register by introducing a username, password,  
175 name, email and, optionally, personal data such as address, age, gender and education. Personal  
176 data were requested because they can be used to help analyze the preferences and opinions about  
177 landscape in relation to social group. Once registered, users accessed a web interface divided into  
178 three modules: Locations, Values and Degraded Areas. These modules were designed to elicit  
179 information about three different aspects:

180 (1) Locations of landscape interest (Figure 3): land areas with high landscape quality, which are  
181 deemed unique or representative.

182 (2) Landscape values (Figure 4): elements that give character to a **site**, values or features that  
183 make the landscape unique or characteristic.

184 (3) Degraded areas (Figure 5): areas in which certain actions have transformed the land and  
185 impacted the landscape, leading to loss or decrease of landscape value, in a way that requires  
186 measures of protection or intervention.

187 <Figures 3, 4 and 5>

188         The first requirement for effective public participation is the availability of appropriate  
189 up-to-date accessible information. This was achieved by including a web map for each module,  
190 in which different layers of geographic information could be displayed and queried. The layers  
191 enabled specific areas (administrative borders, landscape areas and regions, road networks,  
192 railways, settlements, aerial photographs and topographic maps) to be located and provided  
193 information about the landscape (landscape types, elements of cultural heritage, natural spaces,  
194 viewpoints and locations with landscape interest identified by technicians).

195         In addition, an editable layer was included in each module to allow users to add  
196 information about the module itself. In the Locations module, users were asked to draw a point  
197 on places with high landscape value and to introduce a comment in a free-text box entitled  
198 “Description” about the spatial extent of the area associated with this location and the reasons for  
199 it being considered of special landscape interest. In the Values module, users were asked to draw  
200 points on locations with certain types of relevant values or features, differentiating between: (i)  
201 natural-ecological values, (ii) cultural-heritage values, (iii) aesthetic-scenic values and (iv) values  
202 of use. In order to achieve this goal, users had to locate a point on the map, select the type of  
203 value in a drop-down list and type a comment about the reasons for this selection. In the

204 Degraded Areas module, users were asked to draw a point on places with landscape impacts and  
205 to include a descriptive comment about the degradation.

206         The PPGIS was used in workshops but it was also made available to the public between  
207 September and November 2015, so that participants could input as many points as they wanted  
208 and express their opinions and preferences. The PPGIS also automatically stored the spatial  
209 location of the places of special interest, degraded areas and types of values in a GIS database.  
210 The information was linked to the corresponding user data and to the date the information was  
211 **included.**

212         Points were used to spatially represent the preferences of users because this is the easiest  
213 spatial referencing method to use and is the most understandable for the users. Brown and Pullar  
214 (2012) evaluated the use of points versus polygons in PPGIS and concluded that the use of points  
215 minimizes cognitive complexity and enhances ease of use – which is essential to increase  
216 participation rates -, although is higher data demanding. New methods based on fuzzy models  
217 (Carver et al., 2009; Evans and Waters, 2007; Huck, Whyatt, & Coulton, 2014) address the  
218 limitation of both point and polygon-based methods.

219         The previous tests confirmed the conclusion of Brown and Pullar (2012) regarding the  
220 preference of participants for using points and thus the higher probability of users completing the  
221 PPGIS mapping activity, whereas polygon methods are more suitable for expert users or  
222 supervised activities. When points are used, the spatial attribute identified is supposed to extend  
223 outward from the point in some unknown distance and direction, resulting in greater complexity  
224 in spatial interpretation for the analyst. In order to overcome these problems, two strategies were  
225 used. On the one hand, locations with landscape interest were marked with a point, but the user  
226 was asked to fill in the free-text box “Description” with information about the extent of the

227 geographical area associated with that location and about the reasons for the landscape interest.  
228 This technique, amongst others, is applied in fuzzy-based PPGIS methods, which use free-text  
229 comment for the analysis of collected data. On the other hand, the points located by users as  
230 representative of landscape values were assigned to the polygons of landscape units, in a similar  
231 way to the analysis carried out by Plieninger, Dijks, Oteros-Rozas & Bieling (2013). Landscape  
232 units are homogeneous regions in terms of landscape type, and it can therefore be assumed that  
233 these units are also homogeneous in terms of landscape values. Both types of analysis are  
234 explained in greater detail in the following sections.

### 235 *3.3 Workshops*

236 Workshops were designed so that participants could represent the community. However, such  
237 representativeness is not always evident, and two types stakeholders are usually identified  
238 (Tieskens, Schulp, Verburg, & Kuemmerle, 2014): those with influence on landscape  
239 management and those with an active role in this management (landowners or managers). These  
240 groups are consistent with the “communities of place” described by Selman (2004) and by  
241 Swanwick, Bingham, & Parfitt (2013), who distinguished them from “communities of interest”.  
242 Communities of interest can be divided into government departments, government agencies,  
243 local authorities and non-governmental organizations. They also include associations with  
244 environmental or other specific interests, as well as other local interest groups involved in the  
245 various land uses that shape the landscape.  
246 Communities of place are the individuals who live or work in a particular area or visit it, and  
247 have the most at stake in their local environment. They are the main landscape “producers” and  
248 managers, such as farmers, landowners, foresters, builders **and tourist** companies.

249 Table 1 details and classifies the stakeholders identified in several studies about public  
250 participation in landscape planning.

251 <Table 1>

252 On the other hand, the four types of landscape values (natural, cultural, aesthetic and use)  
253 considered in the inventory reflect the different interests of diverse stakeholders. The people  
254 invited to the workshops were selected in order to ensure maximum representativeness of the  
255 interests in each type of landscape value, as well as of the two groups of stakeholders, resulting  
256 in eight types of participants. A balanced distribution of these eight types of participant profile  
257 was sought in the list of invited agents, although workshops were open to the general public and  
258 anyone could participate.

259 Each workshop started by introducing the Landscape Inventory project, explaining its  
260 objectives, contents and methodology, as well as the overall process for public participation. The  
261 first activity of the workshop was an “icebreaker”, consisting of a simple exercise in which  
262 participants had to write a brief definition of landscape. The facilitator subsequently questioned  
263 the participants about the definitions, analyzing some of them and generating a debate.

264 The central part of the workshop was dedicated to working with the PPGIS and was  
265 organized in three sessions. In the first session, participants registered on the web platform and  
266 began identifying locations with landscape interest. The technical team had previously explained  
267 the concept of location with a special landscape interest and asked the users to describe the  
268 spatial extent of the location. In the first part of this session, participants were asked to locate  
269 these places within their local landscape area. In the second part, they had to identify such  
270 locations in the entire region. In the second session, the technical team explained the concept of  
271 landscape value and the four types of values and requested participants to characterize their

272 habitual environment according to its prevailing values. In the third session, the concept of  
273 degraded area was explained and participants were asked to identify preferably locations or  
274 impacts on landscape that could be recovered or improved. The last ten minutes were dedicated  
275 to a plenary session for the presentation and discussion of the workshop results.

#### 276 *3.4 Evaluation of the Public Participation Process*

277 A first evaluation was carried out by means of a survey consisting of ten questions (Figure 6),  
278 which was administered to workshop participants.

279 <Figure 6>

280 In addition to this, the framework proposed by Eiter and Vik (2015) was applied in order  
281 to evaluate the effectiveness of the participation, i.e. the active involvement and the influence of  
282 population in the land planning process (Arnstein, 1969). This framework suggests five criteria,  
283 scored between 1 and 5, where 1 indicates a low evaluation and 5 a high evaluation:

284 (1) Scope: What is the scope of public participation? It varies from “informing the public” (1) to  
285 “public participation in defining scope and methods of landscape assessment” (5).

286 (2) Representativeness: How representative is the public involved? It ranges from “no efforts to  
287 control the sample” (1) to “specific efforts to ensure representativeness” (5).

288 (3) Timing: At what stage of the process is the public involved? It varies from “involvement only  
289 in concluding stages” (1) to “involvement from the start of the process” (5).

290 (4) Comfort and convenience: Are efforts made to render public participation easy for  
291 participants? It ranges from “giving the initiative to the public” (1) to “involving the public in  
292 defining the participation methods” (5).

293 (5) Influence: How much influence does public participation have on derived results? It varies  
294 from “no influence on process and result” (1) to “fundamental influence on assessment and  
295 characterization exercise” (5).

## 296 **4 Results of Public Participation**

### 297 *4.1 Data*

298 Twelve participative workshops were held in the largest settlement in each of the twelve  
299 landscape areas in which Galicia is divided in the inventory. A total of 1171 stakeholders directly  
300 involved in landscape management were invited by telephone and email to attend the workshops.  
301 Of those contacted, 157 finally attended. As the workshops were open to the general public, the  
302 final number of participants was 208, including 121 members of organizations or associations  
303 involved somehow with landscape. The efforts dedicated to planning workshops and selecting  
304 participants were successful, as the distribution of participant profiles was quite balanced (Figure  
305 7). The workshops were complemented with eight specific workshops, arranged for  
306 organizations or associations which requested them, with 128 participants. Furthermore, another  
307 41 people took part in visits (short workshops) to interest groups.

308 <Figure 7>

309 A total of 584 users registered on the GIS-web platform, whose profile is summarized in  
310 Figure 8. In total, 330 users input some kind of data between September 10 and November 6,  
311 resulting in identification of the following: (i) 2096 locations of special landscape interest  
312 (Figure 9); (ii) 407 degraded areas (Figure 10); and (iii) 995 landscape values (Figure 11),  
313 divided into 254 natural or ecological values, 253 cultural or heritage values, 171 aesthetic or  
314 scenic values and 316 values of use. The number of locations with special interest identified by  
315 each user ranged from 1 to 120, with a mean number of 6.

316 <Figures 8, 9, 10 and 11>

317           Some global conclusions can be drawn from the characteristics of the locations with  
318 landscape interest identified by the people. For example, 74% of these locations are not in a  
319 protected natural spaces, suggesting that the local population may highlight locations within their  
320 own area, relevant at a local level but less known at a regional level. However, this may also  
321 indicate that people want to protect places with landscape value that do not currently have any  
322 type of protection.

323           Once landscape values were allocated to sites identified by the population, some  
324 interesting data were noted. Of the locations, 29% had natural or ecological value, 24% of them  
325 had cultural or heritage value and 48% had aesthetic or scenic value. The fact that an aesthetic  
326 value can be assigned to half of the locations is of particular interest. Furthermore, 671 of the  
327 2096 locations (32%) are in the coastal area (area of the Coastal Management Plan of Galicia,  
328 which only covers 7% of the total area of Galicia), confirming the perceived landscape value of  
329 the coast.

#### 330 *4.2 Evaluation Results*

331 The results obtained for the first eight questions in the evaluation survey are shown in Table 2. In  
332 the first question participants were asked to evaluate the workshop by assigning a score between  
333 1 (very poor) and 5 (very good): the final score obtained was 3.9. In the second question, related  
334 to workshop logistics, 94% of the participants that filled out the survey considered the date of the  
335 workshop to be suitable, 91% considered the timetable suitable and 97% agreed with the chosen  
336 venue.

337           The third question evaluated the help provided by facilitators between 1 (very poor) and 5  
338 (very good), and a final score of 4.8 was obtained. Analysis of the fourth question shows that

339 97% of participants who filled out the survey easily understood the concepts and activities  
340 developed. According to the answers given to the fifth question, most of the participants became  
341 aware of the workshop directly through a telephone call from the technical team and, to a lesser  
342 extent, through the web page.

343 <Table 2>

344 The remaining questions in the survey, related to the evaluation of the PPGIS, show that  
345 118 out of 173 participants (68%) think that the platform could be used by anyone, indicating  
346 high levels of usability and friendliness, although some users experienced some difficulties.  
347 Questions on the users' opinion about the platform achieved 94% positive answers (171 out of  
348 181 participants) regarding the potential to facilitate public participation.

349 Questions 7 and 10 are related to aspects that should be improved in the platform and  
350 question 9 concerns the most valued characteristics. The most valued characteristics are the  
351 contribution to public participation and accessibility (47 times), the operability and simplicity of  
352 use (33), the potential for sharing information (28) and the help provided in raising awareness  
353 about the concept of landscape (7). The most cited items in terms of improvements required were  
354 the slow speed when displaying layers in the web map (58), the lack of a search engine for place  
355 names (16), the lack of accessibility to everyone (14), the complexity of use (14) and the  
356 inability to edit inputs (8).

357 The participation process was also evaluated and scored on the basis of the framework  
358 described by Eiter and Vik (2015). The “Scope” criterion was awarded a high score (4), because  
359 citizens participated actively by providing information and contributing to results, although they  
360 did not collaborate at the initial stages in designing the objectives and methodology.

361           Regarding the “Representativeness” criterion, great efforts were made to ensure a  
362 balanced distribution of the profiles of workshop participants, which was achieved as described  
363 above. However, as the final number of workshop participants (377) and web users (584) was  
364 not high relative to the total population, a score of 3 was assigned to this criterion.

365           In our case, the score of the “Timing” criterion is closely linked to that of the “Scope”  
366 criterion because citizens only participated from the stage of data collection, although the  
367 involvement of the population took place at a very early stage of the process. Consequently, the  
368 score was the same for both criteria (4).

369           The “Comfort and convenience” criterion refers, on the one hand, to the actions aimed at  
370 achieving public involvement, and, on the other hand, to the efforts made to enable population to  
371 participate. In the first case, numerous and diverse diffusion strategies were applied. These  
372 included media (press, radio and television), Internet and social networks, and personal contact  
373 by phone or email. The second issue was tackled by distributing the workshops throughout the  
374 entire region of Galicia, with the aim of achieving spatial equity in accessibility to the process  
375 and aiming to guarantee that anyone could participate. However, the size of each of the 12  
376 landscape areas (925 km<sup>2</sup> for the smallest area and 5,152 km<sup>2</sup> for the largest) made it difficult  
377 for a great part of the population to attend the workshops, which took place in the largest  
378 settlement in each area. This problem was partly overcome by holding specific workshops for  
379 associations and, in particular, by enabling participation at any moment and from any place  
380 through the web platform. These methods could increase the score of this criterion to 4.  
381 However, the web platform was only available for a limited time period, thus reducing the  
382 results, so a final score of 3 was assigned.

383 Finally, the “Influence” criterion was assigned the maximum score (5), since, as  
384 described below, the information provided by citizens directly influenced inventory contents. In  
385 addition, the method used to analyze this information and its incorporation into the final results is  
386 described in detail in the inventory document.

#### 387 *4.3 Characterization of Landscape Types*

388 Information collected through the PPGIS was used to characterize the landscape types defined in  
389 the inventory by analyzing the incidence of the different landscape values in each landscape  
390 type. The natural, cultural and aesthetic values distinguished by the population, as well as the  
391 landscape values assigned by technicians to the locations of special interest located by citizens  
392 were used. Georeferencing land values by using point locations enabled landscape values to be  
393 related to landscape units easily and efficiently. Other methods of geographically locating  
394 landscape values would make this type of analysis more difficult. The direct relationship  
395 between landscape values and units is established on the basis of the homogeneous  
396 characteristics of a landscape unit in terms of land use pattern, geomorphology and climate.

397 The analysis entailed calculating, on the one hand, the frequency of appearance of each  
398 landscape value in each landscape type (number of locations with that value located in a specific  
399 landscape type divided by the total number of locations with that value) and, on the other hand,  
400 the proportion of each landscape type in the landscape area (Figure 12). Finally, the ratio  
401 between both values was obtained to reflect the relationship between the different landscape  
402 values and the landscape types.

403 <Figure 12>

404 Calculating the relationship between the frequency of appearance of landscape values and  
405 landscape types enabled the identification of landscape types in which natural, cultural and

406 aesthetic values are most common. For ratios close to 1, there is no or little correlation between  
407 landscape type and landscape value. Ratios above 1 suggest a concentration of a given landscape  
408 value in a given landscape type, and an increase in the correlation as the ratio increases, whereas  
409 ratios below 1 suggest negative correlations.

410 Table 3 shows an example of this analysis, with results for one of the 12 landscape areas, “Rías  
411 Baixas”. This coastal area is characterized by a high level of anthropization, which is reflected  
412 by urban sprawl (25% of the area) and a predominance of intensive agricultural systems, mainly  
413 of afforestation with allochthonous species (20% of the area), resulting in less than 2% of the  
414 area having indigenous hardwood. Analysis of the landscape values identified by citizens  
415 showed that most of the natural or ecological values are concentrated in landscape types with  
416 shrub land cover, which is the most natural land use as indigenous forests are not significantly  
417 represented in the area. In addition, cultural and heritage values are also frequent in areas with  
418 this land cover, although these values are also concentrated in rururban areas, due to the presence  
419 of built cultural heritage. The same was observed in vineyard areas, as vine crops have a high  
420 cultural component in this area where terrace farming is carried out. Aesthetic and scenic values  
421 are mainly located in landscape units with mountainous geomorphology, as most of these values  
422 correspond to viewpoints and sites with panoramic views in this area.

423 <Table 3>

#### 424 *4.4 Special Interest Areas (SIA)*

425 Areas with special landscape interest are usually referred to in the literature as those areas related  
426 to a diversity of high landscape values. The concept is similar to that of “Special Landscape  
427 Areas (SLA)”, understood as those areas with special elements or locations that have high,  
428 unique or rare landscape values (Scott & Bullen, 2004). One of the few examples of SLA

429 delimitation that can be found in literature is reported by Swanwick (2003). She describes the  
430 implementation of a system for Landscape Character Assessment by using the LANDMAP  
431 system to identify all possible SLA by overlaying several factors and adjusting the limits to  
432 landscape structuring elements.

433         A similar procedure was used here (Figure 13). Firstly, Locations of Special Landscape  
434 Interest (LSLI) were identified. These locations were selected by the technical team from  
435 different information sources (731 locations) and by citizens in the public participation process  
436 (2096 locations). The presence or absence of natural, cultural and aesthetic value was then  
437 assigned to each LSLI, removing locations lacking any of these values. The area extent was  
438 indicated for each LSLI, specifying whether the LSLI referred to a point location or to an area  
439 location. The spatial extent of a LSLI was obtained from the required description of the location  
440 and of the causes of special interest (e.g. “the forest of”, “the river stretch between the village  
441 and”, etc.). Area locations corresponded to areas larger than 2 ha, the minimum mapping unit for  
442 the inventory. A 1 km buffer from each LSLI was calculated, so that the LSLI with point areas  
443 that were not included in the buffer of other LSLI were removed. The LSLI with area extent and  
444 areas resulting from merging several buffers gave rise to a candidate SIA when they had at least  
445 two different landscape values. As a result, 445 candidate areas were selected (Figure 14) and  
446 were delimited by applying different criteria according to 1) the existing types of landscape  
447 values, 2) landscape units and 3) areas protected by natural and cultural heritage legislation.  
448 <Figure 13 and 14>

449         Simultaneously, the information layers corresponding to the inventory landscape values  
450 were overlaid in a raster GIS. A layer of natural or ecological value was calculated from GIS  
451 layers corresponding to the protected natural spaces, the forestry areas with hardwood, the **sites**

452 of geological interest and water bodies. A layer of cultural or heritage value was obtained from  
453 the layers of protected areas with cultural heritage value, protected areas in the St. James's Way  
454 and traditional manor houses and botanical gardens. Finally, a layer of scenic value was obtained  
455 from the viewsheds of the main viewpoints, from St. James's Way and from hiking and mountain  
456 biking routes. The weighted sum of these three layers was calculated by allocating a weight of  
457 0.4 to the layers of natural and cultural values and a weight of 0.2 to the layer of scenic value  
458 resulted in the map of global landscape value (Figure 15). By analyzing this map, we defined a  
459 threshold of global landscape value from which LSLI were identified. SIA were subsequently  
460 delimited according to the criteria described above.

461 <Figure 15>

462 Application of both procedures led to delimitation of 348 SIA. This is a lower number  
463 than the number of SIA candidates, mainly due to the merging of neighbouring areas and, to a  
464 lesser extent, to the fact that some areas were disregarded because of the lack of land  
465 connectivity between several LSLI. Finally, the panel of experts and the technical team selected  
466 207 SIA (Figure 16) from the initially obtained SIA.

467 The population identified some LSLI in 171 of the final SIA, i.e. 83% of these. Moreover,  
468 66 of these (32%) were identified exclusively from citizen contributions. The quality of the  
469 information provided by the people is reflected in the fact that 43% of the SIA identified by  
470 citizens exceeded the threshold of global landscape value. Similarly, 48% of the SIA identified  
471 by the technical team reached this value.

472 <Figure 16>

473 *4.5 Special Attention Areas*

474 The identification of special attention areas was based on a set of locations with landscape  
475 impacts preselected by the technical team (100 locations) and on the degraded areas located by  
476 citizens in the public participation process (407 areas).

477         Once this input was filtered and refined, each location was classified according to the  
478 cause of the impact on landscape. In this case, spatial areas were not delimited and only seven  
479 general types of special attention areas were identified, corresponding to the most common types  
480 of impact or degradation:

- 481 1. Degraded urban landscapes (75 locations): poorly preserved historical centers, buildings and  
482 urbanization processes that remain unfinished, excessive urban growth with deficient urban  
483 planning, new urbanization unconnected to existing urban areas, etc.
- 484 2. Infrastructures (73 locations). Areas with a high concentration of high-voltage power lines and  
485 wind farms included in SIA were defined as special attention areas.
- 486 3. Mining and quarrying activities (66 locations).
- 487 4. Areas degraded by other types of environmental or landscape impacts, including invasion by  
488 allochthonous species, forest fires, contamination of rivers or sea filling, among others.
- 489 5. Industrial activities poorly integrated in the landscape (45 locations).
- 490 6. Abandoned areas (32 locations), including buildings of cultural or architectural value, other  
491 buildings, abandoned villages, abandoned infrastructures, etc.
- 492 7. Impacts by agricultural and forestry uses (18 locations), the most frequent being afforestation  
493 with allochthonous species, especially in SIA.

## 494 **5 Conclusions**

495 The results of the above described process demonstrate the viability of public participation as a  
496 means of obtaining important information about landscape elements, values and status. The

497 evaluation survey and the technical criteria for evaluation of public participation yielded a good  
498 overall assessment of the process.

499         The local knowledge obtained from public participation was easily integrated with  
500 technical work and expert knowledge, largely due to the easily analyzable format provided  
501 through the PPGIS, which enabled joint analysis of the knowledge and information provided by  
502 both experts and population through different procedures and methods in order to characterize  
503 landscape types, delimit SIA and identify special attention areas. As a result, citizens' opinion  
504 was completely integrated in the inventory, directly influencing both the procedures and the final  
505 results. Interestingly, the population identified some locations of special landscape interest in  
506 83% of the SIA delimited. Moreover, 32% of SIA were identified exclusively as a result of the  
507 public participation process.

508         The use of the point-based approach has facilitated the use of the PPGIS by non-expert  
509 users and its unsupervised use, which allowed wide participation in a short time. However, the  
510 simplicity of the spatial information collected has implied the involvement of greater effort and  
511 complexity in analysing the data obtained. The lack of detailed information about the  
512 geographical component of the data was overcome by the use of two approaches.

513         The first approach involves the application of a technique used in the new fuzzy-based  
514 PPGIS, based on the use of free-text descriptions, for the analysis of collected data. In this case,  
515 a textual description of the geographical area associated with the point located and of the reasons  
516 or the landscape characteristics that motivated the selection of that location as a Location of  
517 Special Landscape Interest (for example; “the forest of”, “the monastery and its vineyards”, etc.)  
518 was requested so that it could be used in the spatial delimitation of SIA by combining this  
519 information with other data and technical knowledge in a systematic process.

520           The second approach was based on the previous delimitation of 28350 landscape units as  
521 geographical areas with a specific landscape type, and consequently with the same landscape  
522 values, which enabled the landscape value located at a point by a person to be extrapolated to the  
523 entire landscape unit. The easy allocation of landscape values across the whole region enabled  
524 quantified and objective evaluation of the main landscape values of each landscape type  
525 according to the public perception. The findings revealed significant and logical relationships  
526 between landscape values and landscape types, despite the individual variability in mapping  
527 responses and the spatial errors of data located by participants.

528           The method implemented in this PPGIS for capturing the spatial component of the  
529 information was simple. Nonetheless, use of the system enabled collection of information that  
530 could not otherwise have been obtained with the time and resources available, due to, amongst  
531 other reasons, the large extension of the region (30000 km<sup>2</sup>) which makes use of paper maps of a  
532 suitable scale almost impossible and would imply large errors in locating site by participants.  
533 The possibility of centring the map at the site selected by the user and at the selected scale,  
534 together with the use of aerial photographs that facilitates identification of places on the web  
535 map, helped to reduce the chance of erroneous placement and provided a high level of spatial  
536 detail.

537           However, the experience acquired throughout the process led to the identification of  
538 several aspects that should be improved, such as the need to make it easier for users to input  
539 information. In particular, the allocation of landscape values or reasons for landscape interest to  
540 point locations should be facilitated by providing a drop-down list with predefined values.  
541 Experience showed that participants did not generally insert locations already identified by other  
542 users, although they had been asked to do so. The PPGIS could therefore be improved by

543 enabling users to vote for locations already introduced by other users. Advanced users requested  
544 the possibility to draw areas instead of points. However, this option would be difficult for most  
545 users, and a possible improvement would be the inclusion of an option to select locations by  
546 drawing a point or an area. These conclusions and improvements will be applied to the  
547 participatory process for developing Galician Landscape Guidelines, mainly aimed at defining  
548 landscape quality objectives.

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Table 1. Stakeholders in landscape planning

Table 2. Survey results

Table 3. Ratio of different landscape values in the “Rías Baixas” **landscape area**

Figure 1. Example of landscape units

Figure 2. Location map of Galicia with the three global areas of land use change

Figure 3. PPGIS interface for mapping locations of landscape interest

Figure 4. Identification of a landscape value in the PPGIS

Figure 5. PPGIS module for locating degraded areas

Figure 6. Survey for workshop and PPGIS evaluation

Figure 7. Profile of participants in workshops

Figure 8. Profile of PPGIS users

Figure 9. Locations with special landscape interest identified by the population

Figure 10. Degraded areas identified by the population and the technical team

Figure 11. Landscape values identified by the population

Figure 12. Characterization of landscape types from landscape values assigned by population

Figure 13. Flow chart of the procedure for the delimitation of SIA

Figure 14. Areas identified from LSLI for the selection of SIA candidates

Figure 15. Map of global landscape value

Figure 16. Special Interest Areas