Public participation GIS for assessing landscape values and improvement preferences in urban stream corridors

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Abstract

Over the past several decades, urban development has severely impacted river and stream. Rehabilitating urban riparian corridors may provide an array of benefits highly valued by the public. However, most of these landscape values are commonly overlooked in decision-making processes. We aimed (i) to identify the landscape values and improvement preferences (IPs) that are most relevant for the communities in the Caldes Stream Corridor (Catalonia, Spain), (ii) to explore the relationships among these landscape values to understand how they are spatially intermingled, and (iii) to assess the spatial relationships between landscape values and IPs. Based on a mixed qualitative-quantitative public participation geographic information system (PPGIS) approach, we interviewed 53 stakeholders. We identified a total of 14 positive and 13 negative landscape values. These were spatially bundled according to 8 factors, namely amenity-attachment, natural-unclean, unpleasant-economic, social-educational, wildlife-flooding, people-wildlife barriers, unsustainable-insecurity, and spiritual/religious. The public reported up to 277 IPs, which were grouped into three main categories: paths and itineraries, environmental quality, and socio-cultural assets. We found significant spatial associations between some of these factors (amenity-attachment, natural-unclean, unpleasant-economic, social-educational and wildlife-flooding) and the locations of IPs. In addition, the amenity-attachment factor was strongly associated with the spatial identification of IPs for improving paths and itineraries, while the natural-unclean and social-educational factors correlated significantly with the spatial identification of IPs for improving environmental quality. We conclude that this spatially explicit information on values/preferences and their spatial relationships provides a valuable basis for the development of more consensual and efficient rehabilitation strategies.

Keywords: Urban stream corridors; rehabilitation; landscape values; improvement preferences; public participation GIS; Besòs River Basin**.**

1. Introduction

In recent decades, many urban rivers and streams have been changed from their natural states as a result of intensive flow regulation, channelization or water pollution, among other factors. In the case of Europe, the implementation of water, flood protection and integrated river management policies (e.g., the Water Framework Directive, 2000/60/CE, or the Floods Directive, 2007/60/CE) has improved both water quality and flood control in urban rivers, enhancing the environmental quality of these ecosystems and reducing the risk they pose to society. At the same time, it is pertinent to recall that, in 2000, the European Landscape Convention was ratified. This treaty and other similar measures reflect the reality that the landscape is an essential element that determines individual and social welfare and quality of life, and that it should be considered in formulating land use policies, urban planning, and environmental and cultural management, among others. In this context, authorities and the general public have begun to see the rehabilitation of these degraded urban riparian landscapes as a unique opportunity to bring nature back to cities (Lundy & Wade, 2011). In many parts of the world, urban planning policies have progressively included rehabilitated river corridors in their systems of urban public spaces (Warner, van Buuren, & Edelenbos, 2012). Despite this favourable socio-political context for increased integration of river landscape management and rehabilitation, public participation processes are still very limited. This prevents the main beneficiaries (residents, recreationists, environmentalists, etc.) from being involved in planning and managing rehabilitation schemes. Furthermore, conflict between the visions, values and interests of stakeholders often blocks or retards rehabilitation (Buijs, 2009). In this situation, taking into account the various views and preferences of local communities is critical for resolving these conflicts and enabling integrated river landscape management and rehabilitation (Eden & Tunstall, 2006). With this purpose in mind, some studies have investigated the influence of different river basin landscape values in determining the individual level of acceptability of rehabilitation projects. These values include aesthetic appreciation (Nassauer, 2004), recreational values (Seidl & Stauffacher, 2013) and naturalness (Junker & Buchecker, 2008), among others. On the other hand, some studies have implemented public participation geographic information system (PPGIS) techniques to assess the spatially explicit public's perceived positive values and negative aspects of the landscape (p.e. disservices, threats, etc.) (Tyrväinen, Mäkinen, & Schipperijn, 2007; Brown, Montag, & Lyon, 2012; Fagerholm, Käyhkö, Ndumbaro & Khamis, 2012; Plieninger, Dijks, Oteros-Rozas, & Bieling, 2013). However, very few have investigated the interactions between these place-based values to understand the public preferences associated with landscape management (Brown & Raymond, 2014; Bryan, Raymond, Crossman, & Macdonald, 2010). In addition, no study of this kind, to our knowledge, has been conducted in the context of urban stream corridors, enabling community member to articulate and spatially identify positive and negative landscape values and social and environmental quality improvement preferences. The main objective of this study is to identify the most relevant positive and negative landscape values and their spatial distribution attributed by local community members to an urban stream corridor, and to identify the most preferred improvement actions and their spatial distribution according to their perceptions. In addition, this study seeks to investigate the spatial associations between these values and preferences.

2. Case study

We selected the Caldes Stream in the Besòs River Basin (Catalonia, Spain), which is located within the Metropolitan Region of Barcelona (Fig. 1 and 2). The particular municipalities along the Caldes Stream corridor considered in this study are Caldes de Montbui, Palau-Solità i Plegamans, Santa Perpètua de Mogoda and La Llagosta. These four municipalities have a total population of 70.449 inhabitants (in 2014), a surface area of 71 km^2, and a population density of 991 inhab./km^2. The Caldes Stream Basin is located within the Plain of Vallès, although in a slightly hilly area. However, in the headwaters, above the town of Caldes de Montbui, it is dominated by mountainous forests. This stream basin exemplifies the changes that the landscape and the perception of river corridors have undergone in the cities of the developed world. During the 1960s and 1970s, the Caldes Stream suffered from repeated impacts from unfettered urbanization, pollution, flooding and channelling, which are especially relevant in the Mediterranean context and are characteristic of the transformation of rural land into areas affected by suburban sprawl. The sense of belonging that prevailed during the first half of the 20th century, when the river's contribution to irrigation, energy and raw materials was essential to the still-agrarian economy, was replaced by a progressive disconnection during the period of riparian landscape degradation. The simultaneous industrial development, with the subsequent loss of the river's economic significance and its environmental degradation, precipitated the abandonment of the river banks, which became marginalized areas (Panareda 2009). However, from the start of the 1980s, efforts made to improve environmental quality, reduce flood risk, and promote the social recovery of the area around the river have revived the local communities' bonds with this riparian landscape (Benages-Albert, Di Masso, Porcel, Pol, & Vall-Casas, 2015). Currently, the system of open areas associated with the Caldes Stream plays a strategic role in the physical and social integration of the urban fabrics in this study area. The river has become the daily backdrop for many riverside residents, who use it for everyday leisure activities, and for many city-dwellers who use the area for cultural and recreational pursuits during the weekend. Moreover, Caldes Stream is one of the most emblematic industrial corridors of the metropolitan region of Barcelona, and is endowed with large river parks that have contributed to the prestige of this productive area. The consequent interwoven coexistence of the multiple economic, socio-cultural and ecological values of this stream corridor (Benages-Albert & Vall-Casas, 2014) supports the appropriateness of this case study for identifying the landscape-related values of the local stakeholders and their improvement preferences.

[FIGURE 1 HERE]

[FIGURE 2 HERE]

3. Methodology

This study is based on a PPGIS mixed method approach, in which data collection is mostly qualitative and data analysis methods are generally quantitative (Raymond et al., 2009; Klain & Chan, 2012) . Figure 3 summarizes the methodological procedure.

[FIGURE 3 HERE]

3.1. Data collection: qualitative participatory mapping, categories of values/preferences and GIS data processing

Two experienced interviewers conducted in-person interviews (53 in total) with stakeholders between October 2015 and January 2016. Interviews generally lasted between 45 and 85 minutes and occurred in the interviewee's home or in public facilities of their choice. We used a purposive sampling strategy aimed at maximizing the heterogeneity of the sample concerning the respondents' main knowledge areas (economic, social and/or environmental) and their municipality of residence. Potential participants were identified from a list of contacts obtained in a previous study that was also conducted in the Caldes Stream Corridor (Benages-Albert et al., 2015). Contact details of local-level activists, practitioners and decision-makers obtained from documentary research on the Internet complemented the list of potential participants. Finally, based on the snowball sampling technique, additional potential participants were obtained by asking interviewees to suggest up to 3 potential contacts. Of these, we selected and approached subjects with different professional and/or social profiles.

Data collection was based on semi-structured interviews using a set of open ended questions and a final survey questionnaire with socio-demographical, and snowball sampling questions. The principal open ended questions that guided the interviews had three main objectives: 1) to locate sites considered to have landscape values (positive and/or negative) and to determine the respondents' improvement preferences; 2) sketch the identified sites using points, lines or areas; and 3) discuss the respondents' reasons for selecting these sites. Accordingly, participants were first asked to map and describe places with positive and negative landscape values based on (but not restricted to) a predefined landscape value typology. As a guiding positive landscape values typology, we used seven categories of cultural ecosystem services based on the Millennium Ecosystem Assessment classification (MEA, 2005) that has previously been used in previous PPGIS-based empirical studies (Brown et al., 2012; Fagerholm et al., 2012; Plieninger et al., 2013). These categories included *Aesthetic/scenic, cultural heritage, education, recreational/tourism, social interaction/relations, special places*, and *spiritual/religious*. In addition, we also included *naturalness* as a guiding positive landscape value category because it is a critical perceptual factor influencing the public acceptability of environmental changes in urban rivers (Junker & Buchecker, 2008; McCormick, Fisher, & Brierley, 2015). Concerning negative landscape values, we used seven categories, following a review of factors influencing social preferences for urban river rehabilitation actions (Asakawa, Yoshida, & Yabe, 2004; Özgüner, Eraslan & Yilmaz, 2012; Garcia, Benages, Buchecker & Vall, unpublished data): *Aesthetic unpleasantness, flood risk, insects or other animals, pollution, sense of insecurity, smell*, and *uncleanliness*. Regarding improvement preferences, participants were asked to describe and map "*sites where rehabilitation, restoration or improvement actions should be implemented to enhance the social and environmental quality of the urban stream corridor and its impact on the well-being of city-dwellers*". A single general category of improvement preferences (*general improvement preference*) was defined that includes all improvement preferences. The final classification of landscape values and improvement preferences identified by the participants was applied based on the procedure detailed in section 3.2.

During the interviews, we used printed orthophotomaps as a cartographic base to help respondents to identify and sketch sites with landscape values or improvement preferences. To facilitate this mapping exercise, participants were first asked to locate several reference points on these maps (e.g., their home, City Hall, etc.). After the interview, all the sketched sites were digitised by the interviewers using Quantum GIS (QGIS Development Team, 2012). The GIS database associated with the sites layers included a unique feature ID and several values/preferences IDs with information about the absence or presence (0, 1) of landscape values and improvement preferences. These values/preferences IDs fields were set up according to the final categories defined in the interview content analysis and classification procedure detailed in the supporting information (appendix A). From the semi-structured interviews, we obtained in total 159 GIS vector layers with values/preferences information (53 interviewees x 3 layers, including point, line and polygon layers). From these vector layers, intensity raster maps were created that represent the spatial distribution of values and preferences in the Caldes Stream Corridor. Details on the assembly of the spatial database and the creation of the intensity raster maps are presented in the supporting information (appendix B).

3.2. Spatial analysis

3.2.1. Frequency and spatial distribution

The identification of the distribution of landscape values in a specific area may contribute to understand the potential conflicts associated with land use development plans (Brown & Weber, 2012). In addition, the frequency of mapped landscape values is strongly correlated with separate measures of the ranked importance of the same landscape values (Beverly, Uto, Wilkes, & Bothwell, 2008); therefore, it can be interpreted as a proxy measure for the perceived importance of landscape values. Accordingly, for each value/preference category, we analysed their respective vector layers and the intensity raster maps together to evaluate 1) their frequency (the number of mapped vector features), 2) the area they covered in their intensity maps, and 3) their density (the number of mapped features divided by the area they covered). This analysis contributes to understanding the spatial distribution of landscape values and improvement preferences and their relative importance in the Caldes Stream Corridor, assuming that those more frequently mentioned are presumably more important in terms of providing benefits to society.

3.2.2.Landscape value factors

Many landscape values are intricately interlinked according to human perceptions. In the ecosystem services lexicon, they are known as “ecosystem services bundles” (Milcu, Hanspach, Abson, &

Fischer, 2013). To explore the patterns of formation of bundles of landscape values or landscape value factors (LVF), we performed a Principal Component Analysis (PCA) with varimax rotation on the full set of landscape values. In addition, PCA allowed the reduction of landscape value spatial data into a smaller number of components to be used in the model. Prior to this and the subsequent spatial analyses, we vectorised the intensity raster maps, principally to use this spatial information with advanced statistical packages. At this stage, all the landscape value and improvement preference intensity raster maps were represented as grids with 523,224 cells (559 columns x 936 rows). Raster areas with no values/preferences in any of the intensity raster maps were masked; thus, only 191,540 grid cells remained non-null. Within this, we computed a random vector point layer with 19,154 points, that is, the 10% of the total number of grid cells. The landscape value and improvement preference intensity scores in the intensity raster maps (i.e., the number of times a value/preference has been identified at a specific site) were uploaded to the corresponding attributes of the random point-vector database based on the location of the points using the *v.what.raster* GRASS GIS tool. To apply PCA and explore the emerging factors, the point-vector layer database was imported to SPSS 15®. Factors with eigenvalues greater than 1 were retained. Landscape values with rotated factor loadings (RFLs) above |0.4| formed the basis for the interpretation of the resulting landscape value factors (Hair, Anderson, Tatham, Black, 1999). Commonalities were also computed to estimate the proportion of variance of each landscape value that can be predicted by the extracted landscape value factors.

3.2.3.Landscape value factors and improvement preferences relationship

In the river rehabilitation literature, it is common to explore factors that condition the preference for improvements, in order to anticipate conflicts and increase the acceptability of improvements (Ryan, 1998; Sullivan, Anderson, & Lovell, 2004). With this purpose in mind, we first implemented a bivariate and then a spatial multivariate approach at the stream corridor scale, using the LVFs as "exposure variables" and the improvement preferences at a given location as "outcome variables".

Although the use of the LVFs as exposure variables, instead of the original landscape values, can lead to difficulties in the interpretation of the results, it also controls for multicollinearity issues in the spatial multivariate approach and increases the reliability of the resulting coefficients, since the factors are nearly uncorrelated or orthogonal (Sangun, Cankaya, Kayaalp & Akar, 2009). In addition, to facilitate computational model building, the sample size was decreased to approximately 5% (n = 991) of the total number of points in the sample.

In the bivariate approach, we tested the correlations between LVFs and improvement preference categories by means of Spearman's Rho non-parametric test, given the non-normal distribution of most variables. We defined *r* values higher than |0.5| as representing strong correlations, *r* values between |0.5| and |0.3| as representing moderate correlations, and *r* values lower than |0.3 | as representing weak correlations (Fagerholm et al., 2012).

To test the spatial multivariate associations between the resulting LVFs (exposure variables) and improvement preferences, we used the *general improvement preferences* intensity score as a general indicator of preference for improvement in a given location (outcome variable). When applying statistical inference with spatially explicit variables, the possibility of spatial autocorrelation should be considered, since we might violate the assumption of independent residuals (Hu & Lo, 2007). Assuming that strong spatial autocorrelation exists in the factors/preferences dataset, and that we want to explore the spatially varying relationships between LVFs and *general improvement preferences*, a Geographically Weighted Regression (GWR) model was applied (Fotheringham, Brunsdon, & Charlton, 2003). In GWR, the traditional regression model is extended by allowing the regression parameters ($\beta_0, \ldots, \beta_k$) to vary with location, thus obtaining local model estimates (i.e., for each of the 991 points in the sample) (Brunsdon, Fotheringham, & Charlton, 1996; Fotheringham et al., 2003). Thus, an advantage of GWR is that it is based on traditional regression and that it incorporates local spatial relationships in an intuitive and explicit manner (Fotheringham et al., 2003). The computation of the GWR was carried out using the GWR4 software package (Nakaya, 2014). Initially, the model type had to be selected. In this case, Gaussian or Poisson model types were compared using the corrected Akaike's Information Criterion (AICc). According to this, the model with the smallest AICc should be selected as the optimal model, so long as the difference in AICc values is greater than 2 (Feuillet et al., 2015). In this case, the Geographically Weighted Poisson Regression (GWPR) model type was selected. In fact, Poisson regression has been proven to be a more appropriate alternative when the outcome variable represents a count data (Lovett & Flowerdew, 1989), such as the number of times a place has been preferred for improvement by participants (that is, *general improvement preferences*). The statistical motivation behind the GWPR method has been described in detail elsewhere (Nakaya, Fotheringham, Brunsdon, & Charlton, 2005). We set the kernel bandwidth in the model as fixed (that is, based on metric distance) instead of adaptive (based on the *k*-th nearest neighbour distance for each regression) because the sample points were regularly distributed. The fixed bi-square kernel type and the optimal bandwidth size were also selected based on AICc, as this criterion provides better results for Poisson regression as well (Nakaya, 2014). The statistical significance for each LVF local coefficient was calculated using pseudo *t*-values (Fotheringham et al., 2003). Finally, also based on AICc results, several models combining subsets of exposure variables were compared in order to eliminate those that were redundant.

4. Results

4.1. Description of the population

A total of 53 subjects (the mean and standard deviation (SD) of their ages are 50 and 15 years, respectively) were included, mostly male (64%), active workers (79%), and from the general public (62%) (Table 1). They were unevenly distributed according to municipality of residence; 30% were living in Caldes de Montbui, 26% were living in Palau-Solità i Plegamans, and 23% were living in other municipalities not in the study area (although they were currently working or had previously lived in the study area).

[TABLE 1 HERE]

4.2. Classification of landscape values and improvement preferences

The final classification of positive and negative landscape values is presented and defined in detail in Table 2. Six new categories were obtained in the analysis and codification of the interviews. These new categories were *Ecological, economic, connection, lookout, air pollution regulation*, and *provisioning*. Similarly, six additional negative landscape value categories were identified, and these additional categories were *negative behaviours, barriers, barriers for wildlife, invasive species*, *other risks*, and *unsustainability*.

[TABLE 2 HERE]

In the 53 interviews, a total of 277 improvement preferences were collected. Based on the interview content analysis, we identified 15 different categories of improvement preferences (see Table C.1 in the appendix C) that were subsequently reduced to three after excluding redundancies, existing implementations, unfeasible implementations, and inappropriate answers. These were improving *paths and itineraries*, *environmental quality*, and *socio-cultural assets*. Table 3 defines these three main improvement preferences categories. Further details on the resulting improvement preferences classification procedure can be found in the supporting information (appendix C).

[TABLE 3 HERE]

4.3. Frequency and spatial distribution of landscape values and improvement preferences

Table 4 presents the frequency, total area of distribution, and density of landscape values and improvement preferences mapped in the semi-structured interviews. Regarding positive landscape values, the six most frequently mapped categories, which are thus presumably more relevant in this context, were the *recreational/tourism* (n = 269), *cultural heritage* (n = 267) *aesthetic/scenic* (n = 233), *social interaction/relations* (n = 132), *special places* (n = 130) and *naturalness* (n = 110) categories. In the case of negative landscape values; *pollution* (n = 47), *aesthetical unpleasantness* (n = 88), and *uncleanliness* (n = 94) were the categories that were most often mapped and are thus most relevant. Regarding the categories of improvement preferences treated in this study, all 3 categories showed a similar frequency and included from 47 to 53 mapped features. Despite this fact, their areas of distribution varied strongly; areas covered by *environmental quality* occupied 3622.79 ha, *paths and itineraries* occupied 1847.98 ha and *socio-cultural assets* made up only 251.67 ha, due to their different spatial natures (areas, lines or points).

[TABLE 4 HERE]

4.4. Landscape value factors

After carrying out the PCA, 8 factors (or LVFs) were extracted from the 27 original landscape values that explain approximately 75% of the variance (Table 5). The KMO index, which was above 0.5 (0.807), indicated that the intercorrelation among the variables was good; therefore, it was appropriate to conduct a PCA. Bartlett's test of sphericity (Chi-square = 418,510.9, df = 351, $p < 0.001$) confirmed that the correlation matrix was not an identity matrix, indicating that significant correlations existed among the variables, and that the model factor was relevant (Hair et al., 1999). The 8 landscape value factors were labelled according to their most representative landscape values, depending on their RFLs and frequency (Table 4). Where possible, words that gather these relevant values (e.g., amenity) were used. For instance, factor 1, which represented 20% of the total variance, was explained principally by 8 positive landscape values with RFLs >|0.4|: special places, air pollution regulation, aesthetic/scenic, cultural heritage, ecologic, recreational/tourism, connection, naturalness and provisioning (Table 5). Factor 1 was therefore labelled “amenity-attachment”. Accordingly, the other resulting factors were labelled as natural-unclean (18% of the total variance), unpleasant-economic (11%), social-educational (6%), wildlife-flooding (6%), unsustainable-insecurity (5%), people-wildlife barriers (5%), and spiritual/religious (5%).

[TABLE 5 HERE]

4.5. Relationship between landscape value factors and improvement preferences

Table 6 indicates that *paths and itineraries* was strongly correlated with *amenity-attachment* (*r* = 0.540) and moderately correlated with *unsustainable-insecurity* and *people-wildlife barriers* (*r* = 0.395 and 0.313, respectively). In contrast, the preference towards improving *environmental quality* was strongly correlated with *natural-unclean* and *social-educational* (*r* = 0.673 and 0.518, respectively), and it was also negatively and moderately related to *unsustainable-insecurity* (*r* = -0.35).

[TABLE 6 HERE]

During the process of constructing the multivariable model, the optimal kernel bandwidth size was estimated to be 4832.6 metres, and a minimum AICc of 530.5 was obtained. The LVFs *unsustainable-insecurity, people-wildlife barriers* and *spiritual/religious* were eliminated to improve the model fit, achieving a significant decrease of AICc from 538.8 (with all the LVFs in the model) to 530.5. The final model had a satisfactory goodness of fit, according to its percent deviance explained of 0.845. Figure 4 depicts the spatial distribution of the local model coefficients for *amenity-attachment, natural-unclean, unpleasant-economic, social-educational* and *wildlife-flooding* landscape value factors. It shows that the relationships between landscape value factors and improvement preferences are spatially variable in this case study, especially in the case of the *amenity-attachment* factor.

[FIGURE 4 HERE]

5. Discussion

Using an innovative mixed qualitative-quantitative PPGIS approach, this study has identified the most relevant positive and negative landscape values and improvement preferences for enhancing the well-being of communities in an urban stream corridor context. Fourteen positive and thirteen negative landscape values were identified, along with three different improvement preferences categories. In addition, this study has analysed the interactions among the landscape values to understand how they are spatially intermingled. Eight landscape value factors were obtained according to the participants' perceptions. Finally, the spatial relationships among the resulting landscape value factors were assessed, first according to the different improvement preferences categories (using Spearman's Rho correlations), and second according to the general improvement preferences (using the GWPR model). The results show that amenity-attachment, natural-unclean, unpleasant-economic, social-educational, and wildlife-flooding landscape value factors are influential in predicting the spatial distributions of general improvement preferences. In addition, the amenity-attachment factor strongly influences the spatial identification of improvement preferences for improving paths and itineraries. Moreover, the natural-unclean and social-educational factors correlated significantly with the spatial identification of preferences for improving environmental quality within the corridor.

5.1. Landscape values and improvement preferences in the Caldes Stream Corridor

The positive landscape values that were most frequently identified were *recreational/tourism, cultural heritage, aesthetic/scenic, social interaction/relations, special places* and *naturalness*. These results reinforce the idea that, in urban contexts, open and riparian areas are strongly valued as amenities by the local community (Garcia & Pargament, 2015). However, a special feature of this case is the frequent identification of cultural heritage values, which is not commonly found in similar studies (Raymond et al., 2009). This feature can be related to the specific characteristics of the Caldes riparian landscape. Particularly, the small-scale colonization of the Mediterranean agricultural and river landscape, which contains small and overexploited rivers within small areas, may explain the higher density of heritage sites (e.g., historical farmhouses, Roman or medieval buildings or equipment, and rural villages, among others). The negative landscape values most often identified were *pollution*, *aesthetical unpleasantness*, and *uncleanliness*. These negative landscape values are clearly in conflict with the positive landscape values mentioned previously, that is, they negatively affect the use or value of these open and riparian areas as amenities (Özgüner et al., 2012; Weber & Ringold, 2015).

The principal categories of improvement preferences found in this study are *paths and itineraries*, *environmental quality* and *socio-cultural assets*. These are consistent with the intense societal use of the stream corridor and the consequent demand for an acceptable level of environmental quality, better accessibility and leisure and socio-cultural facilities. Regarding *environmental quality* improvement preferences, studies often report the willingness of members of communities to improve the environmental quality of their nearby landscapes, especially in urban contexts (Gobster & Westphal, 2004). In addition, *environmental quality* has been frequently mentioned because it is generally perceived as easy to accomplish by local and/or regional authorities through common landscape management actions such as frequent trash collection or wild vegetation control. However, the frequent identification of socio-cultural assets that need to be improved is notable, probably due to the relatively large number of heritage elements in the study area that require maintenance or restoration actions. In addition, the common identification of required improvement actions focused on paths and itineraries is also remarkable, reflecting the appreciation of these elements in enhancing public access and recreational functions (Åberg & Tapsell, 2013) .

5.2. Landscape value factors

Each landscape value factor is a place-related construct that allows an accurate understanding of the collective meanings embedded in specific places within this urban stream corridor. The *amenity-attachment* factor is primarily explained by the positive landscape values *recreational/tourism, naturalness, aesthetic/scenic* and *ecologic.* This evidence that the positive values associated with this factor represent those sites that are aesthetically appreciated for their ecological values, perceived naturalness, and for providing recreational and ecotourism opportunities to local communities, among other reasons (Junker & Buchecker, 2008; McCormick et al., 2015). In addition, the representation of *cultural heritage* and *special places* indicates also that these sites coincide with cultural heritage elements that, when taken together, convey a sense of attachment to the communities and identification with them, besides being considered sites that contribute to *air* *pollution regulation*. These sites are generally agrarian areas and urban and river parks that have high amenity value and frequently cultural heritage value. The *natural-unclean* factor describes sites valued for their *naturalness*, for their *provisioning* of material outputs, and for their *recreational/tourism* and *lookout* functions. To a larger extent, this factor also characterizes those places perceived as unclean (*uncleanness*), *polluted*, and where natural risks other than floods are common (*other risks*). These sites coincide with mountainous and forested areas, with a perceived lack of maintenance of the forest vegetation and with fire risk. They are also represented by stream channels and riparian areas, where pollution and trash problems were often reported, as well as the desire to control the vegetation. The *Unpleasant-economic* LVF is represented by assets to the local or regional economy (*economic*). However, these sites were also often identified as having *smell* problems, being *aesthetically unpleasant* and having problems with antisocial events or behaviours that affect the environment negatively (*negative behaviours*). These sites are commonly represented by farms and industrial estates, some of them fairly close to residential areas, that are poorly maintained or integrated with the urban and natural landscapes. Sites scoring high in the social-educational factor are commonly used for *social relations/interactions*, and contribute to the environmental *education* of the citizens. Urban allotment gardens, agrarian parks, urban parks, plazas and some itineraries represent this landscape factor very well. The *wildlife-flooding* LVF is generally explained by the negative landscape values having to do with *flood risk*, *invasive species* and *insects and other animals* and represent riparian landscapes where flooding is common and people perceive issues with fauna and flora, especially invasive plants. The *unsustainable-insecurity* factor is commonly represented by sites perceived as unsustainable (*unsustainability*) and where the feeling of insecurity is common (*sense of insecurity*). For example, residential estates of single-family detached houses often have high scores in this factor. On the other hand, positive scores in the people-wildlife barriers factor describe sites perceived negatively as *barriers* that prevent people from accessing other valued sites and as a *barrier for wildlife*. These sites are often made up of linear land transport infrastructure elements, such as highways or railways. Finally, the *spiritual/religious* factor is only explained by the *spiritual/religious* value and is commonly represented by religious buildings, spiritual places or routes. Previous research has already demonstrated that different positive landscape values are commonly spatially bundled, according to public perception (Plieninger et al., 2013; García-Nieto et al., 2015). However, this study has also shown how the public's landscape perceptions can clearly interrelate positive and negative values. In fact, the natural-unclean and unpleasant-economic landscape value factors together can explain almost 30% of the total variance. This result reflects how intense social and economic pressure generates controversial perceptions in these landscapes, for instance, due to a lack of maintenance of vegetation, the presence of litter and pollution in open areas (Asakawa et al., 2004; Özgüner et al., 2012), and the unpleasant effects of intense economic activities (smells, air pollution, etc.).

5.3. Spatial relationships among landscape value factors and improvement preferences

Amenity-attachment (Fig. 4) is the landscape value factor that presented the most noticeable spatially varying relationships with *general improvement preferences*. Within the urban stream corridor, this LVF is positively and significantly related with improvement preferences in the most densely urbanized areas (indicated as "A" in Fig. 4), which are mostly inhabited by newcomers, and are subjected to intense urban pressure and social demand. It is in this context where actions aimed at sustaining and enhancing amenity-attachment values should be strongly supported (Junker & Buchecker, 2008). For instance, any action aimed at improving recreational opportunities will be highly appreciated by these community members (Matsuoka & Kaplan, 2008). That may explain also why the *amenity-attachment* factor was strongly related to the *paths and itineraries* improvement preference. Places where the community feels attached, due to their amenity and/or heritage value, is where members of the public prefer to implement actions to improve pedestrian and bicycle paths to enhance amenity value. However, in the middle-upper section of the corridor, particularly in Caldes de Montbui (B), the *amenity-attachment* factor is negatively and significantly related with improvement preferences. This is a less urban and industrially developed area, mostly inhabited by old rooted communities. In this context, improvement actions may be negatively perceived because they might threaten the integrity of local heritage and consequently conflict with place attachment feelings (Buijs, 2009). The similar results obtained in the southern Serra Marina Mountains (C) might be explained by the satisfactory perception of this area, which is included in a well-equipped and accessible natural park.

The *Natural-unclean* LVF is positively and significantly related with improvement preferences throughout the stream corridor, except in the middle-lower sections of the corridor. Most of the interviewees perceived that green spaces with high naturalness but with uncleanness or pollution issues should be improved. Additionally, the *natural-unclean* factor was strongly correlated with *environmental quality* improvement preferences, which means that participants preferred to focus on actions aimed at ameliorating environmental quality in places perceived as natural but unclean, as polluted or as having fire risk (Vollmer, Prescott, Padawangi, Girot, & Grêt-Regamey, 2015). Unmaintained natural vegetation, trash, or water quality issues are common factors that cause the lay public to perceive a landscape as being unclean (Asakawa et al., 2004; Özgüner et al., 2012). However, in the middle-lower sections of the corridor, particularly between the agricultural land of Gallecs (an agricultural protected area) and Santiga (D), the local relationships of *general improvement preference* with this LVF were non-significant, presumably because of the negligible perception of issues related to uncleanness, risk and pollution and its satisfactory naturalness and recreational value (Schauman & Salisbury, 1998; Gobster, Nassauer, Daniel, & Fry, 2007) .

The unpleasant-economic factor is generally positively and significantly related to improvement preferences all over the study area. This result fits well with the fairly regular distribution of farms, industrial estates and low density residential estates within the Caldes Stream Corridor, except on the eastern side of Farell Mountain (E) which may explain why the relationships are not significant in that place. Despite their attributed economic value, places with a negative aesthetic appreciation, based on visual or olfactory evidence, are strongly preferred to be improved, especially by active anthropogenic interventions (Hands & Brown, 2002).

The *social-educational* factor is positive and significant over most of the study area. Alternatively, in the forested areas close to the park of Torre Marimon (F), and in the Serra Marina (G), the perception of the area as a place that contributes to education or to foster social relationships was insignificant or even negatively related to preferring the implementation of improvement actions. This ambivalence may be explained by the perceived need to improve the environmental quality of sites with social-educational value, as shown in Table 6 (which reflects a strong correlation between the *social-educational* LVF with *environmental quality* improvement preferences), except in those green spaces where environmental quality is already perceived as satisfactory, thus replicating the same pattern observed in C, D and E. Therefore, these results demonstrate that participants preferred to implement actions in places where people spend time interacting socially or learning about their environment (e.g., urban allotment gardens or green spaces), especially in those places where environmental quality is not satisfactory.

The *wildlife-flooding* factor also presented a homogeneous distribution of positive and significant coefficients, except in the headwaters of the urban stream (H) where, compared with the rest of the urban stream corridor, these issues are perceived as negligible. Thus, in general terms, or at least in riparian landscapes that are more strongly affected by human activities, perceiving a place as having problems with invasive species, insects or other animals, and flood risk influence the preference for conducting improvement actions positively. In this sense, previous studies have demonstrated that insects or other animals are a relevant concern when managing riparian landscapes (Ryan, 1998). In addition, flood risk perception is commonly a relevant factor to consider in rehabilitation plans to avoid conflict (Ryan, 1998; Seidl & Stauffacher, 2013). Historical flood events in the Caldes Stream that have caused significant damage can explain this result (Seidl & Stauffacher, 2013). Areas containing invasive plant species, especially giant cane (*Arundo donax*), are common in the Caldes

Stream channel and its tributaries, and might be perceived to contribute to flood risk by accumulating under bridges and blocking the water flow during extreme rainfall events. However, other respondents may be more aware of ecological and aesthetic concerns related to invasive plant species and prefer their eradication for these reasons (Ryan, 2005).

5.4. Implications of the study

Several studies have already explored which are the most relevant values influencing the public's evaluated landscape preferences in riparian areas. However, these analyses have rarely explored their interactions using spatial information at the local scale. The results found in this study are consistent with the specific physical, economic and social characteristics of the Caldes Stream Corridor, as has been discussed above. This fact supports the validity of the mixed qualitative-quantitative PPGIS approach implemented in this study for identifying the most relevant landscape values and improvement preferences in urban stream corridors, as well as the analytical method deployed to explore their spatial relationships.

The place-based information obtained in this study about landscape values and their relationship with spatial improvement preferences may provide useful information for decision-makers responsible for the management and planning of open and riparian areas in urban stream corridors. Concretely, these results may better inform decision-makers about the nature and distribution of those landscape values that are highly appreciated and those negative values that, on the contrary, are severely affecting the well-being of their communities (Tyrväinen et al., 2007; Plieninger et al., 2013). In addition, the analytical and modelling approach implemented in this study could result in a useful tool to inform decision-makers about the most preferred locations for improvement actions, as well as the nature of those improvement actions, according to the public's perceptions. This can contribute to enhanced local acceptance of improvement actions, as well as local appropriation of, or even identification with, the rehabilitation process (Menzel, Buchecker & Schulz, 2013).

The use of values/preferences spatial information at the local scale allows an accurate understanding of local communities' perception of stream corridor landscapes. Specifically, the results of multivariate and bivariate analyses have demonstrated that there is a fairly broad consensus on the need to implement improvement actions in places where negative landscape values are identified, particularly when these are spatially bundled with positive landscape values. On the other hand, spatial heterogeneity was evident in terms of the relationships between positive landscape factors and improvement preferences across our study area (e.g., *amenity-attachment*). This demonstrates that the public's predilection for acting in areas with high positive landscape value is strongly place-dependent and is determined by local communities' perception of, first, the demand to enhance the positive landscape values, second, the relative weight of the negative landscape values that offset the positive landscape values, and third, the risk that the improvement actions compromise the integrity of existing positive landscape values. Consequently, efficient urban stream corridor management of open and riparian areas should focus on strategies to enhance positive landscape values where these are most needed, as well as mitigate negative impacts derived from urban and industrial activities or mismanagement of rural and forested areas, especially in places where local communities' place-based perceptions of conflict with positive landscape values are noticeable.

5.5. Limitations of the study and future research

A potential limitation of this study may be the selection of participants to represent the public. As discussed by Schlossberg & Shuford (2005), who should be involved as representatives of the "public" in participation processes such as PPGIS is a complex question. In this study, we followed the approach of considering as members of the public those individuals who might have better information or knowledge on local values and issues that might contribute to a better decision-making (Thomas, 1995). Therefore, rooted members of the community, technical experts and elected officials were taken into account as members of the public (Schlossberg & Shuford, 2005). However, there is a poor representation of members of the public that do not possess a high level of place-based knowledge of the territory (e.g., newcomers, employees who work at local factories, or visitors), but might be potentially interested in the social or environmental recovery of the Caldes Stream Corridor. Failing to involve the wider potentially affected public may have introduced some bias into the values/preferences evaluation (García-Nieto et al., 2015). Thus, future research should prioritize their identification and involvement (Luyet, Schlaepfer, Parlange, & Buttler, 2012). A feasible option to overcome this limitation is applying a web-based PPGIS approach that would give the wider public a greater opportunity for engagement and thus improve the representativeness of the values/preferences evaluation (Carver, Evans, Kingston, & Turton, 2001)

6. Conclusions

The PPGIS approach, which is supported by both qualitative and quantitative analyses, allowed the accurate identification of 1) the landscape values, both positive and negative; and 2) the preferences for improvements to enhance the well-being of local communities in this urban stream corridor. Additionally, the spatial relationships among these landscape values, and between the resulting factors and improvement preferences, provided a sound public-based understanding of the open and riparian landscapes at the local scale. Integrating local values and preferences that arise from the public's uses and perceptions as complementary criteria in decision-making may decrease conflict over management and planning decisions regarding urban stream corridors.

Acknowledgements

This research has been supported by RecerCaixa, a program promoted by the Obra Social "la Caixa" in collaboration with the ACUP (2015ACUP 00184). In addition, this work has also been supported by the Obra Social "la Caixa"- UIC post-doctoral grant, promoted by the Universitat Internacional de Catalunya, in collaboration with Obra Social "la Caixa".

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Tables

Table 1. Socio-demographic statistical descriptors of the participants (n = 53).

Variable	Category	n	%	Mean	SD
Gender	Female	19	36		
	Male	34	64		
Age (years)				49	15
Work status	Studying	1	2		
	Working	42	79		
	Unemployed	1	2		
	Retired	9	17		
Decision-making involvement	General public	33	62		
	Council staff	15	28		
	Government team	5	9		
Education level	Primary	6	11		
	Secondary/high school	22	41		
	University or above	25	47		
Municipality of residence	Caldes de Montbui	16	30		
	Palau-Solità i Plegamans	14	26		
	Santa Perpètua de Mogoda	9	17		
	La Llagosta	2	4		
	Other municipalities	12	23		

Table 2. Final classification and definition of positive and negative landscape values based on the predefined categories used in the semi-structured interviews and the new categories obtained from the interview content analysis.

Type of value	Name	Final description
Positive landscape value	*Aesthetic/scenic*	Sites of particular aesthetic/scenic beauty. It also includes places perceived to be clean and/or tidy, as well as places that convey calm, tranquillity and accomplishment.
	Cultural heritage	Sites relevant to local history and culture.
	Connection	Sites relevant for connecting people with sites of special value.
	Ecological	Sites of ecological value as a habitat for wildlife, as an ecosystem on account of the abundance of species found there, or their function as ecological corridors.
	Economic	Sites of special value as an asset for the local or regional economy.
	Education	Sites used to learn about the environment.
	Lookout	Sites used as a lookout or conveying openness.
	Naturalness	Sites where people can be in touch with nature or that are simply perceived as natural.
	Provisioning	Sites with value in that they provide natural resources (water, food, game animals, wood, etc.)
	Air pollution regulation	Sites with value for regulating the effects of air pollution.
	Recreational/tourism	Sites used for recreational and ecotourism activities. It also includes tourism values indirectly linked to natural spaces or processes.
	Social interaction/relations	Sites serving as places to meet with other citizens.
	Special places	Sites that foster a sense of attachment or identity.
	Spiritual/religious	Sites with special spiritual or religious value.
Negative landscape value	*Aesthetic unpleasantness*	Sites perceived as aesthetically unpleasant or unattractive.
	Negative behaviours	Sites where antisocial events or behaviours perceived as negative to the environment tend to occur (e.g., drinking alcohol in the street, the racing of motorbikes, etc.).
	Barriers	Sites that are perceived as barriers or that limit passage to sites of special value
	Barriers for wildlife	Sites that are perceived as a barrier for wildlife
	Flood risk	Sites perceived to have flood risk.
	Insects or other animals	Sites having problems with insects or other animals.
	Invasive species	Sites having problems with invasive plant species
	Other risks	Sites perceived as having other risks not associated with the stream (forest fires, earthquakes, chemical exposures, traffic, etc.).
	Pollution	Sites perceived to have any type of pollution problem (spills, gas emissions, noise, etc.).
	Sense of insecurity	Sites perceived to have problems with insecurity.
	Smell	Sites perceived to have an inappropriate smell.
	Uncleanliness	Sites perceived as unclean and/or neglected. It includes both the presence of rubbish and a lack of maintenance of the natural vegetation.
	Unsustainability	Sites that are considered particularly unsustainable, especially in economic, social or environmental terms.

Table 3. Final classification and definition of improvement preferences.

Name	Final description
Paths and itineraries	Actions aimed at improving the pedestrians and bicycles mobility, either by establishing new pathways, signalling or rehabilitating existing ones.
Environmental quality	Actions aimed at improving the environmental characteristics of the landscape, including the cleaning of solid waste.
Socio-cultural assets	Actions aimed at providing outdoor and indoor activities, improve or establish new urban parks and facilities, and recovery of heritage and cultural assets.

Table 4. Frequency, total area of distribution, and density of landscape values and IPs.

Type of values/preferences	Name	Features (n)	Total area (Ha)	Features/Ha
Positive landscape value	*Aesthetic/scenic*	233	7326.2	0.032
	Cultural heritage	267	3131.59	0.085
	Connection	35	2522.37	0.014
	Ecological	41	4376.3	0.009
	Economic	26	948.76	0.027
	Education	63	5508.61	0.011
	Lookout	24	1573.24	0.015
	Naturalness	110	7388.93	0.015
	Provisioning	18	5517.56	0.003
	Air pollution regulation	11	1406.38	0.008
	Recreational/tourism	269	8766.79	0.031
	Social interaction/relations	132	3189.44	0.041
	Special places	130	6411.34	0.020
	Spiritual/religious	30	719.92	0.042
Negative landscape value	*Aesthetic unpleasantness*	88	1799.39	0.049
	Negative behaviours	29	396.89	0.073
	Barriers	33	305.83	0.108
	Barriers for wildlife	9	119.08	0.076
	Flood risk	36	413.03	0.087
	Insects or other animals	10	41.28	0.242
	Invasive species	6	64.98	0.092
	Other risks	11	1954.43	0.006
	Pollution	47	2866.41	0.016
	Sense of insecurity	10	136.84	0.073
	Smell	44	389.57	0.113
	Uncleanliness	94	3832.31	0.025
	Unsustainability	12	295.26	0.041
Improvement preferences	*General improvement preferences*	280	6609.47	0.042
	Paths and itineraries	50	1847.98	0.027
	Environmental quality	47	3622.79	0.013
	Socio-cultural assets	53	251.67	0.211

Table 5. Landscape value factors obtained based on the rotated factor matrix from principal component analysis (PCA) including varimax rotation with Kaiser normalization. Grey-coloured cells contain RFLs >|0.4|.

	Landscape value factors								
Landscape values	***Amenity-attachment***	***Natural-unclean***	***Unpleasant-economic***	***Social-educational***	***Wildlife-flooding***	***Unsustainable-insecurity***	***People-wildlife barriers***	***Spiritual/religious***	**Communalities**
Aesthetic/scenic	0.879	0.187	-0.019	0.277	0.042	-0.027	-0.055	0.102	0.900
Cultural heritage	0.872	-0.187	0.011	0.035	-0.032	-0.023	-0.014	0.017	0.799
Connection	0.571	0.383	-0.038	-0.172	0.352	0.004	0.093	-0.212	0.681
Ecological	0.797	0.186	-0.051	-0.079	0.123	0.002	0.001	0.307	0.787
Economic	-0.075	-0.054	0.897	0.048	0.021	-0.024	0.013	0.014	0.817
Education	0.316	0.359	-0.066	0.603	-0.095	-0.072	-0.151	-0.175	0.665
Lookout	0.087	0.737	-0.088	-0.148	0.041	0.025	-0.024	-0.040	0.584
Naturalness	0.491	0.742	-0.084	0.338	-0.032	-0.051	-0.099	0.016	0.926
Provisioning	0.453	0.700	-0.089	0.200	-0.149	-0.032	-0.088	-0.203	0.815
Air pollution regulation	0.899	-0.124	0.015	-0.046	-0.047	-0.010	-0.008	-0.246	0.890
Recreational/tourism	0.695	0.552	-0.040	0.363	0.068	-0.023	-0.059	-0.163	0.956
Social interaction/relations	0.016	0.260	-0.010	0.762	0.075	0.034	0.011	0.065	0.661
Special places	0.901	0.083	-0.027	0.010	-0.033	-0.034	-0.028	0.265	0.893
Spiritual/religious	0.159	-0.083	-0.021	-0.016	-0.036	-0.019	-0.001	0.937	0.912
Aesthetic unpleasantness	0.302	0.014	0.722	-0.115	-0.024	0.280	0.218	-0.151	0.775
Negative behaviours	-0.064	0.029	0.818	0.038	0.015	-0.046	-0.032	0.051	0.681
Barriers	-0.028	-0.043	0.047	0.029	0.029	-0.004	0.775	0.059	0.610
Barriers for wildlife	-0.020	0.017	-0.016	-0.065	-0.061	-0.020	0.747	-0.057	0.570
Flood risk	-0.062	-0.154	0.044	0.352	0.497	-0.017	0.273	-0.011	0.475
Insects or other animals	0.022	0.019	0.007	-0.015	0.806	0.015	-0.024	-0.024	0.652
Invasive species	0.057	0.017	0.004	-0.022	0.706	-0.012	-0.092	0.013	0.511
Other risks	-0.010	0.927	-0.052	0.083	-0.012	0.029	-0.028	0.049	0.872
Pollution	-0.114	0.797	0.171	0.182	-0.072	0.014	0.143	-0.012	0.737
Sense of insecurity	-0.040	-0.088	-0.018	0.069	-0.004	0.822	-0.030	-0.004	0.692
Smell	-0.081	0.014	0.885	-0.065	0.011	0.017	-0.041	-0.010	0.796
Uncleanliness	-0.058	0.927	0.110	0.225	0.092	-0.007	-0.055	0.017	0.938
Unsustainability	-0.032	0.107	0.081	-0.075	-0.001	0.834	-0.001	-0.010	0.720
Variance (%)	19.673	17.659	10.619	6.001	5.946	5.442	5.09	4.81	

Table 6. Correlations between landscape value factors and improvement preference categories. Spearman's rho correlation coefficients *r* ≥ |0.5| (indicating strong correlation) are depicted in dark grey, |0.3| ≤ *r* < |0.5| (indicating moderate correlation) are shown in light grey, and cells containing *r* ≤|0.3| (indicating weak correlation) are not filled.

LVFs	**Categories of improvement preferences**		
	Paths and itineraries	*Environmental quality*	*Socio-cultural assets*
Amenity-attachment	0.540*	0.136*	0.096*
Natural-unclean	-0.019	0.673*	-0.083*
Unpleasant-economic	0.26*	-0.015	0.042
Social-educational	-0.182*	0.518*	-0.013
Wildlife-flooding	-0.05	-0.124*	0.048
Unsustainable-insecurity	0.395*	-0.35*	0.047
People-wildlife barriers	0.313*	0.116*	0.085*
Spiritual/religious	-0.043	0.202*	0.03

* Variable significant at the 0.01 level

List of Figures

Figure 1. Location of the Caldes Stream Urban Corridor and riparian municipalities.

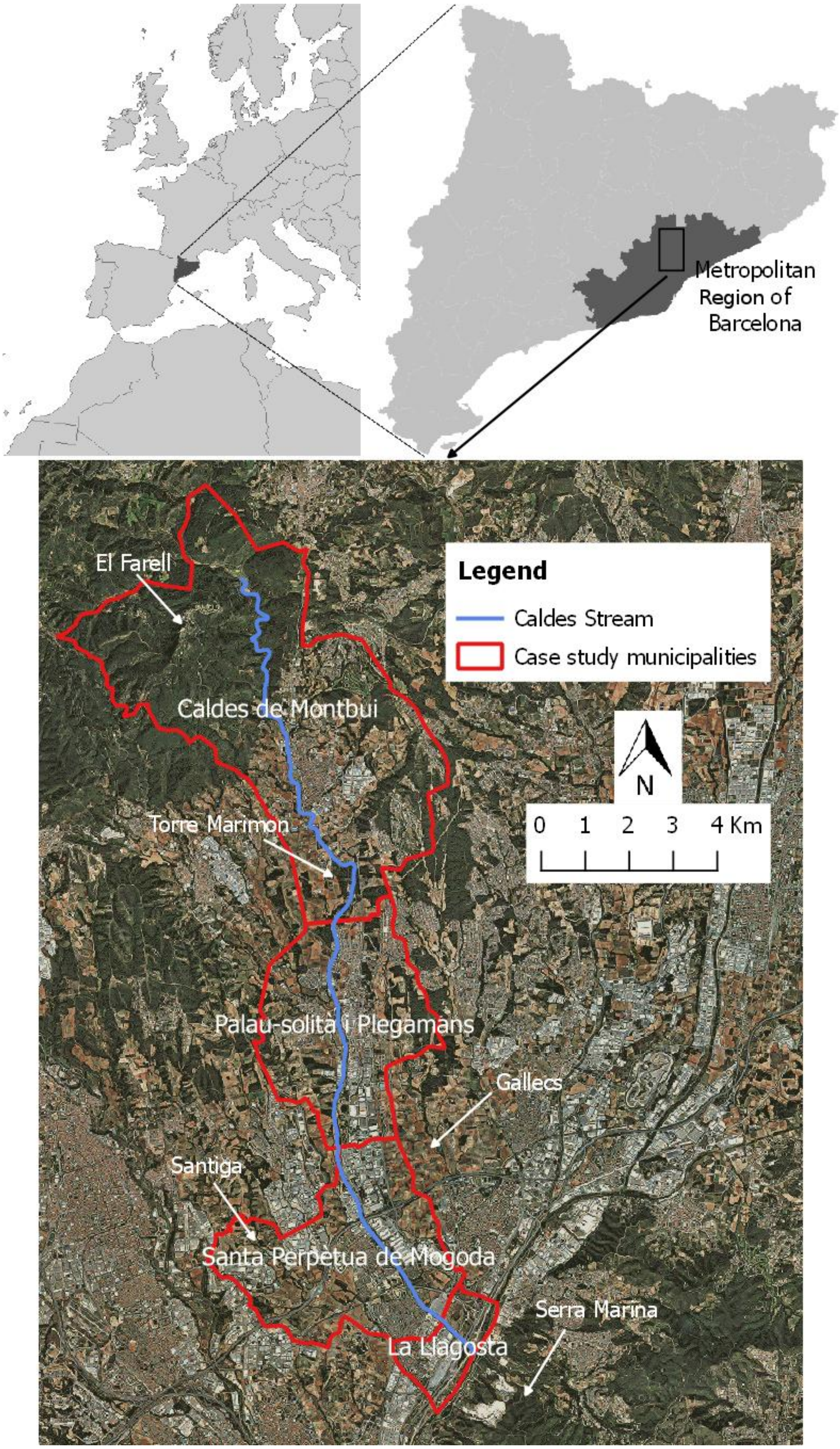


Figure 2. Photograph showing the channel of the Caldes Stream where it passes through the town of Santa Perpètua de Mogoda and its industrial areas.

Figure 3. Flow diagram describing the main steps of the methodology. Text in red indicates methodological processes. Underlined text denotes the study's main outcomes.

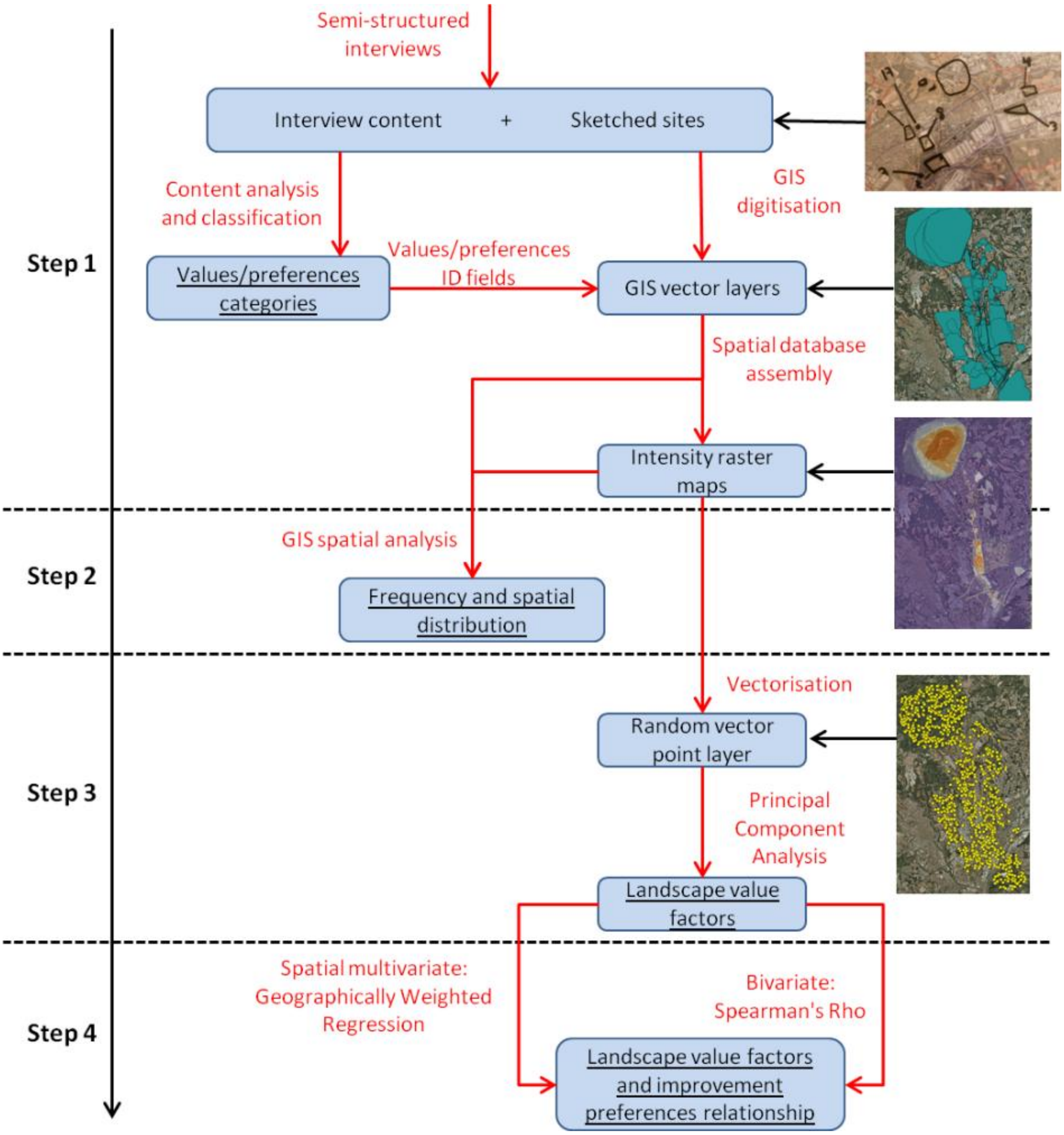
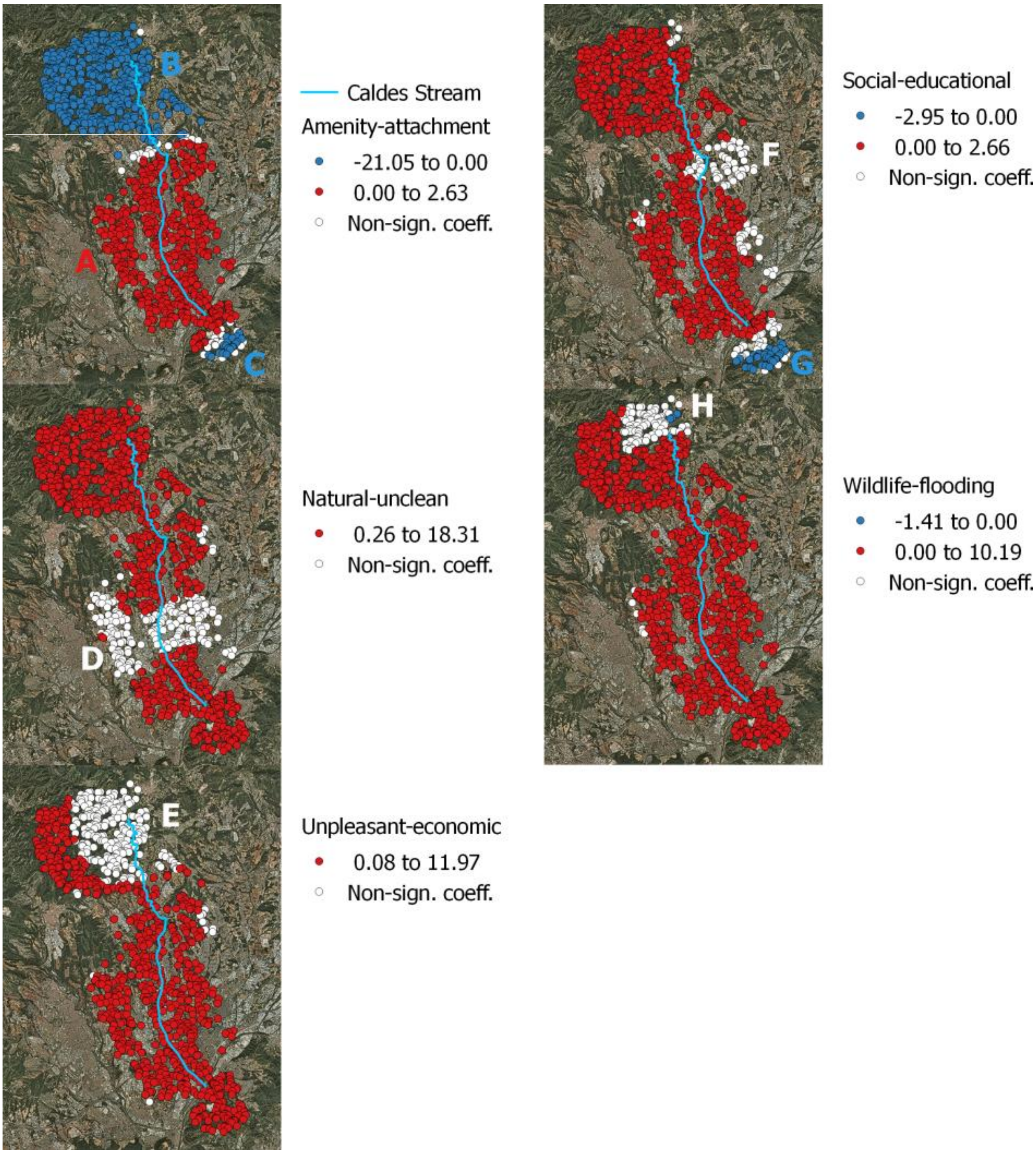


Figure 4. LVFs and spatial multivariate relationships with general improvement preferences. Positive (red) and negative (blue) GWPR local model coefficients that are significant at the 0.05 level (pseudo t-values ≥ |1.96|) and non-significant (white) local estimates, are shown as points for each LVF.



Appendices

Additional supporting information may be found in the online version of this article.

Appendix A. Interview content analysis

Appendix B. Spatial database assembly and intensity maps

Appendix C. Improvement preferences classification procedure

Appendix A. Interview content analysis

All interviews were transcribed for interpretative text analysis to classify all types of positive and negative landscape values, and improvement preferences mentioned by the interviewees. Initially, we applied a general review and segmentation of the free-flowing texts in positive landscape values, negative landscape values and improvement preferences. After this first mechanic data treatment, a more reflexive and iterative analysis was conducted in both groups following three main steps: (1) sampling, (2) coding process, and (3) verification (Miles & Huberman, 1994).

Sampling consisted in a purposive selection of thematic units according the research objectives and the definition of exclusion criteria (Krippendorf, 1998). For instance, for the case of the improvement preferences, we applied a line-by-line reading of all them and defined their exclusion criteria according its feasibility and physical relation with the riparian area and near surroundings. Coding process consisted in a line-by-line reading of the thematic units to identify all the themes and classify them according to codes both established from the literature and new codes emerging from the specific and contextual data (Miles & Huberman, 1994). Coding process step was composed by: a) an "explicit coding" to classify the selected units of analysis of the text according to previously defined control variables (e.g., typologies of positive and negative landscape values obtained from literature review); b) an "inductive coding" based on a close review of the text to define new codes and write memorandums synthesizing the interviewees words as a process of internal reflexivity, to obtain main categories of improvement preferences or to identify and define new typologies of landscape values; c) and a "codebook building" including a detailed description of each code, inclusion and exclusion criteria, and original quotes from the interview's transcription as examples. Finally, the verification step consisted in a validation and reclassification when necessary of all data using the final codebook by a close reading of the whole text again (i.e., according to the final list of landscape values or the improvement preferences' main categories).

Appendix B. Spatial database assembly and intensity maps

From the semi-structured interviews, we obtained in total 159 GIS layers with values/preferences information (53 interviewees x 3 (point, line and polygon layers)). To facilitate the spatial database assembly, point and line layers were merged with polygon layers by converting them into polygons using the buffer tool in QGIS, and setting at 25 meters the buffer distance parameter. A final polygon layer with 1052 features was the result. In order to create positive landscape value, negative landscape value and improvement preference intensity maps for each of the final categories: 1) we used the values/preferences IDs to select all the features with a given landscape value or improvement preference (e.g., selecting only features with cultural heritage value ID = 1)), 2) we created a new layer with the selected features, 3) we split this vector layer using the unique feature ID to obtain a series of one-feature-only vector layers having such values/preferences, 4) we converted these vector layers with the same landscape values/preferences into a series of raster layers of 25 meters cell size, and finally, 5) using the r.series GRASS GIS tool, we created an intensity map by counting the series of input layers. The selection of the buffer distance parameter, and the raster cell size (both 25 m), were heuristics based on the smallest land area of some of the mapped sites (e.g, cottages, historical buildings, small squares, etc.) (Brown & Weber, 2012).

Appendix C. Improvement preferences classification procedure

During the 53 interviews, it was collected a total of 277 improvement preferences. Although the open ended question of the interview was aimed at detecting preferences to improve the environmental and social quality of stream and corridor area, the interviewer permitted to the interviewee to mention all kinds of improvement preferences in order to facilitate empathy during the interview.

Figure C.1 summarises the improvement preferences classification procedure. A first reading of all the improvement preferences (IP) mentioned allowed us to exclude those repeated by the same individual (8 in total) and classify the remaining 269 IP into 15 different categories according its purpose (table C.1). Afterwards, we discarded 74 of the remaining 269, because they were already implemented (IM = 1) or they did not fit with the purpose of the question due to the lack of viability (39 including I, R, IE, RS and G), or they refereed to places too far away from the corridor (RE = 34). From the 195 remaining improvement preferences expressed by the interviewees (groups PI, B, C, RA, H, A and TP), we applied and additional exclusion criteria, discarding those which have not direct physical transformation implications in the corridor. Therefore, we eliminated awareness (A = 8) and tourism promotion (TP = 10) improvement preferences because they did not imply a direct physical transformation. A final regrouping of the 177 remaining improvement preferences according its purpose in more general terms, allowed us to simplify from 6 to 3 final categories of improvement preferences: improving paths and itineraries (*IP_PI* = 62), improving environmental quality (*IP_EQ* = 57), and improving socio-cultural assets (*IP_SC* = 58). Definition of these final improvement preferences categories is presented in table 3. As in the case of the first classification approach, where the *IP_G* category was obtained, the last exclusion criterion applied was also their geospatial representation as a GIS feature, to allow their spatial representation and analysis of their relationship with the landscape values, resulting in *IP_PI* = 50*, IP_EQ* = 47 *and IP_SC* = 53 mapped features per each improvement preferences category.

[FIGURE C.1 HERE]

[TABLE C.1 HERE]

References

Brown, G. & Weber, D. (2012). Measuring change in place values using public participation GIS (PPGIS). *Applied Geography*, *34*, 316–324.

Krippendorf, K. (2004). Content Analysis. An Introduction to Its Methodology. Thousand Oaks: Sage.

Miles, M. B. & Huberman, A. M. (1994). Qualitative Data Analysis. An Expanded Sourcebook. Thousand Oaks: Sage.

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Table C.1. Initial interpretation and classification of the 277 total improvement preferences mentioned during the semi-structured interviews.

ID	Class	Description	Nº
PI	Paths and itineraries	Actions aimed at improving the pedestrians and bicycles mobility, either by establishing new pathways, signalling or rehabilitating existing ones.	62
B	Biophysical	Improving the biophysical characteristics of the riparian environment.	40
C	Clean-up	Actions to remove solid wastes from the channel and corridor.	17
RA	Recreation activities	Actions aimed at providing recreational activity areas in the corridor or improve / propose new parks and facilities	28
H	Heritage	Rehabilitating or promoting heritage (mainly architectural) directly or indirectly related to the stream according to its proximity.	30
A	Awareness	Actions aimed at raising awareness and education of citizens regarding the stream and corridor.	8
TP	Tourism promotion	Actions aimed at promoting tourism in the stream and corridor.	10
I	Infrastructures	Removing, modifying and creating electric and transport infrastructure.	14
R	Regulations	Regulatory actions to manage land uses planning.	7
RE	Remote	Set of actions that refer to remote areas in relation to the stream and corridor.	34
IE	Industrial estates	Removing, relocating or promoting economically or aesthetically industrial estates.	11
RS	Residential	Removal or rehabilitation of degraded residential areas or sub-urban estates.	2
G	Generic	Non-specific actions unrelated to the research objective such as: make a plan to improve catering sector, social services or boost trade.	5
IM	Implemented	Actions already implemented.	1

List of Figures

Figure C.1. Summary of the improvement preferences classification procedure.

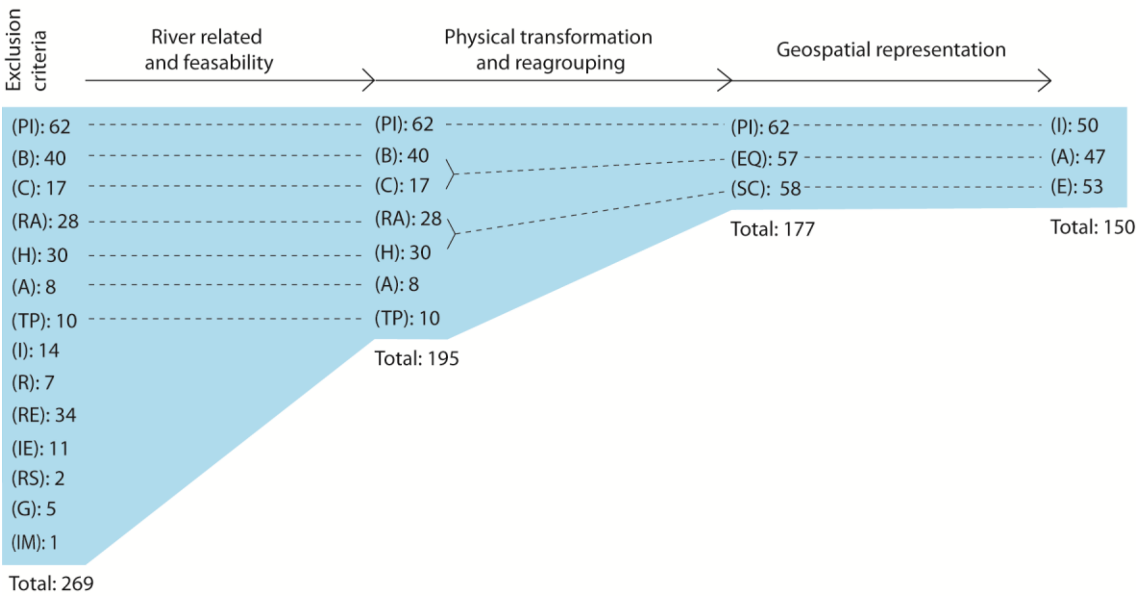

Figure 1
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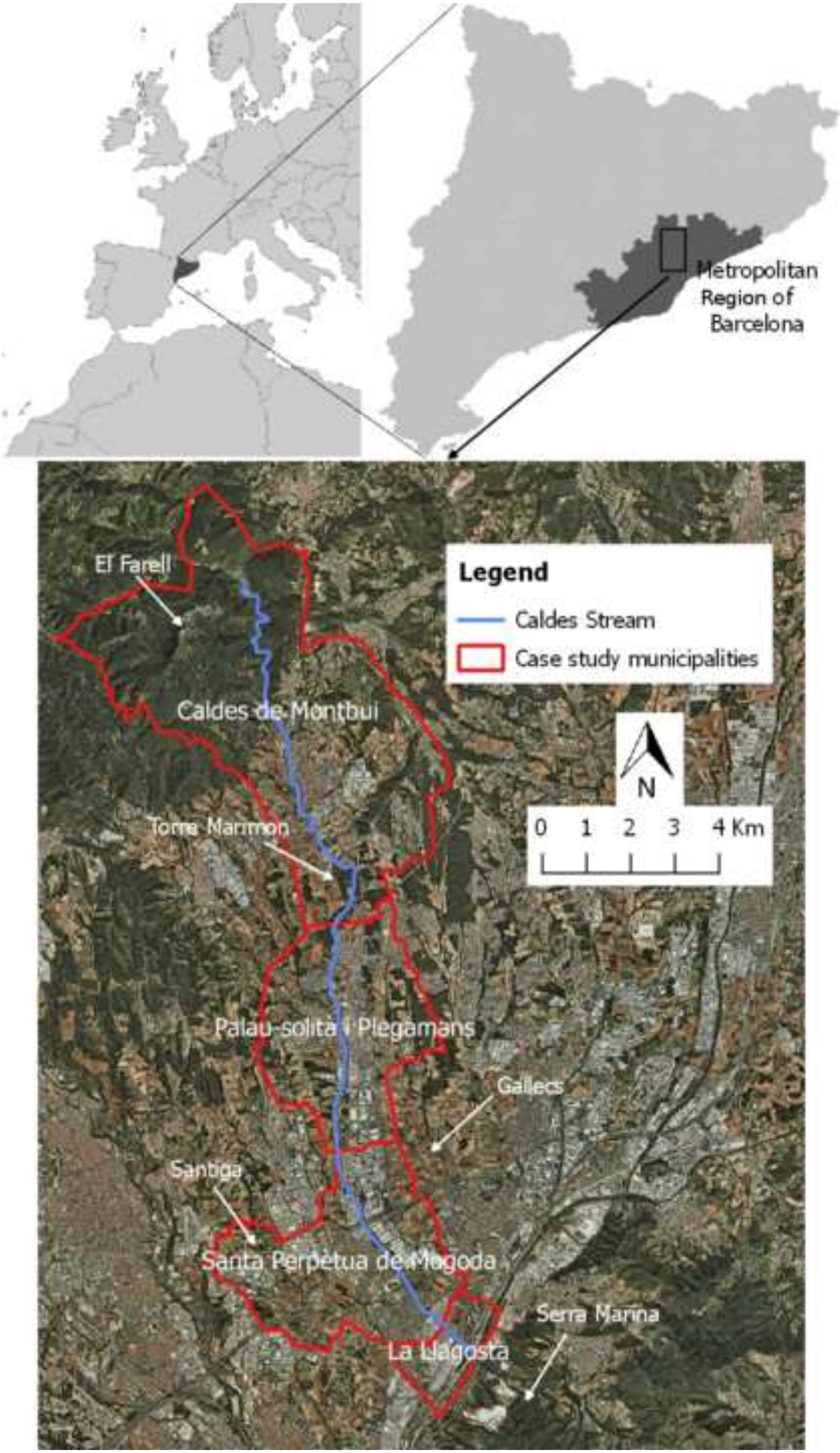

Figure 2
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Figure 3

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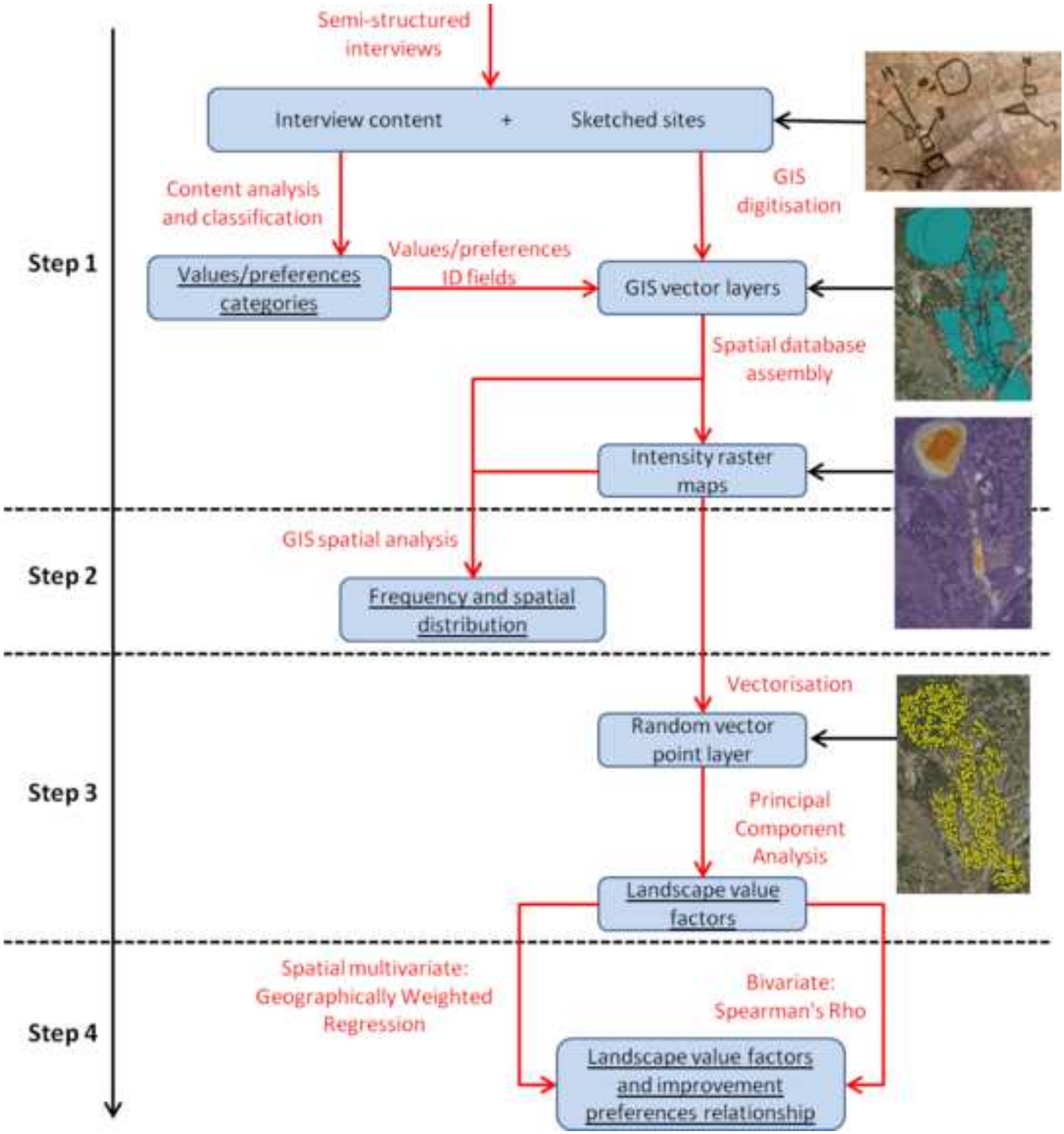

Figure 4

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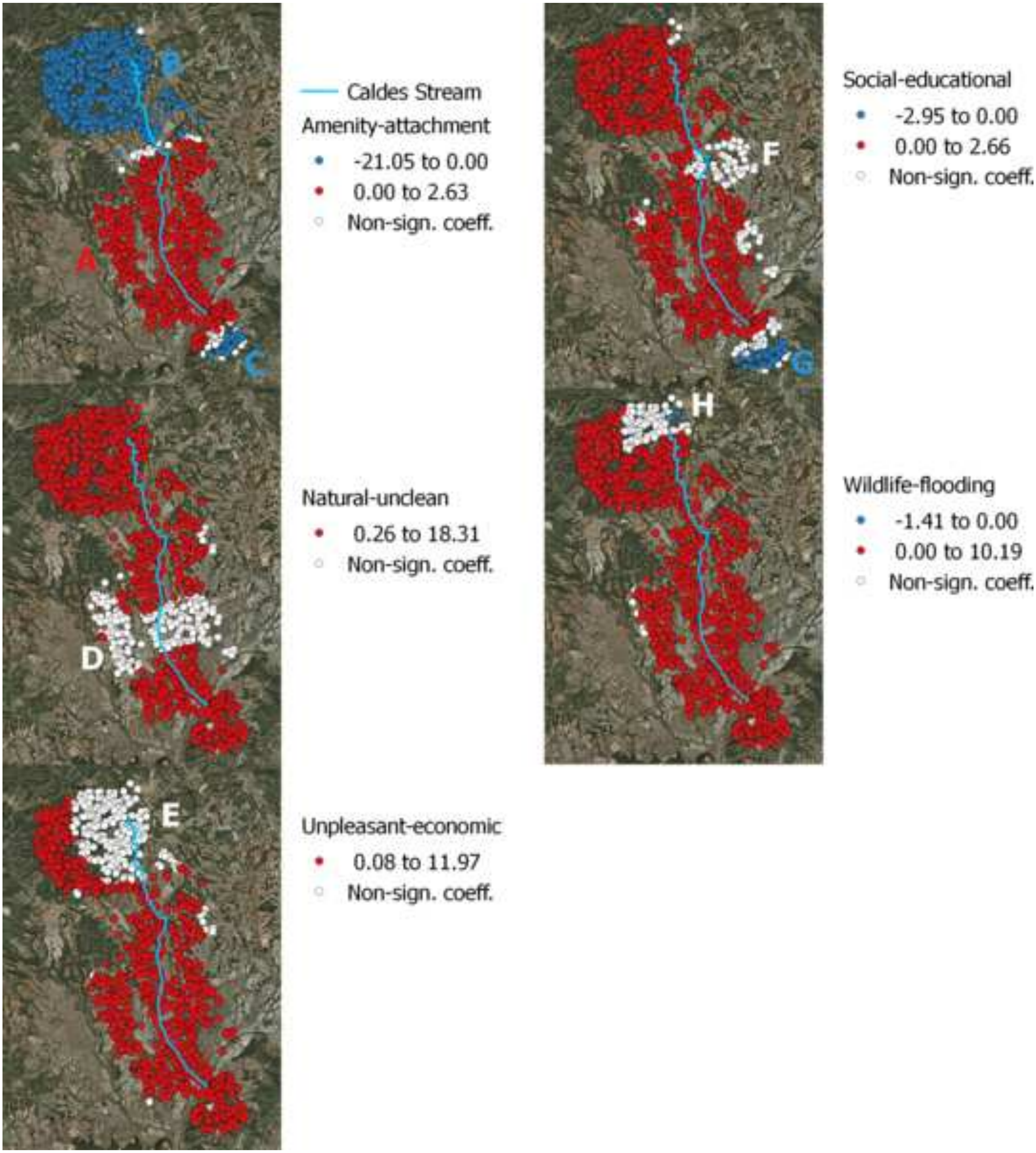

Appendix A B C
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Figure C.1
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