Ecosystem Services 32 (2018) 112–124

Contents lists available at ScienceDirect

Ecosystem Services

journal homepage: www.elsevier.com/locate/ecoser

Landscape conflict assessment based on a mixed methods analysis of qualitative PPGIS data

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ARTICLE INFO

Keywords:
Urban stream corridors
Conflict assessment
Public participation GIS
Mixed methods analysis
Landscape values
Improvement preferences

ABSTRACT

The paper presents a public participation GIS (PPGIS) approach designed to support landscape decision-making by spatially identifying and describing conflict. This method is based on participatory mapping and qualitative interpretation of positive landscape values (stemming from cultural ecosystem services), negative landscape values (derived from landscape factors that negatively influence social perception), and improvement preferences. It is developed and tested using data collected from 53 interviews with local community members from a highly urbanised stream corridor in the Metropolitan Region of Barcelona (Spain). Intensity score maps of positive/negative landscape values are combined according to their significant spatial co-existence. Conflict index maps are computed for each co-existing pair of positive/negative values, delimiting the areas with the highest index values. Qualitative analysis of the improvement preferences identified within these areas contributed to an understanding of the reasons behind these conflicts. Finally, a weighted linear combination of the positive/negative landscape value intensity maps is applied to identify the areas with the highest level of conflict. Therefore, this approach not only produces a spatial delimitation and prioritization of landscape conflict based on context specific landscape values, but it also characterizes the underlying drivers of conflict on the basis of the qualitative understanding of improvement preferences.

1. Introduction

Cultural ecosystem services are the "*ecosystems' contributions to the non-material benefits (e.g. capabilities and experiences) that arise from human-ecosystem relationships*" (Chan et al., 2012). Public's contrasting viewpoints regarding landscape use or management decisions that affect cultural ecosystem services can be a source of conflict (Vorkinn and Riese, 2001; Ryan, 2005; Schaich, 2009). Exploring how these different viewpoints spatially converge can inform decision-makers as to the nature and location of conflict (Hauck et al., 2013; Satterfield et al., 2013). The main objective of this study is to contribute to this field by developing and applying a Public Participation GIS (PPGIS) method to assess landscape conflict. A review of how landscape values have been previously operationalised to support landscape management is presented below. Next, the main contributions of the proposed PPGIS approach to assessing landscape conflict are highlighted.

1.1. The operationalisation of landscape values to support management

How stakeholders perceive the use and management of natural resources is related to their personal and interpersonal value system (Kolkman et al., 2007). The term "value" can be categorized as "held" and "assigned". Held values refer to underlying ideals or principles that are relevant to people (e.g. responsibility, loyalty or happiness). Assigned values concern the relative importance of objects (i.e. the worth of an object in a given context relative to other objects). Assigned values are influenced by held values through the subjective evaluation of objects (Brown, 1984). In this sense, mapping values enables people to articulate their underlying ideals or principles related to how they perceive the physical landscape and its management. In this way, the public's spatially explicit *landscape values* can support landscape management in exploring priority, suitability, or predicting conflict (Brown and Weber, 2012).

Given the theoretical interest in landscape values, some studies have operationalised them to support management. In the field of multiple-

Abbreviations: CCI, combined conflict index; CI, conflict index; CA, conflict areas; HCA, highest conflict areas; MADA-GIS, GIS multi-attribute decision analysis; MCDA, multiple-criteria decision analysis; PGIS, participatory GIS; PPGIS, public participation geographic information system; WLC, weighted linear combination; VGI, Volunteered Geographical Information

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https://doi.org/10.1016/j.ecoser.2018.07.003
Received 30 October 2017; Received in revised form 31 May 2018; Accepted 4 July 2018
2212-0416/

criteria decision analysis (MCDA) research, landscape values have been used as spatial criteria to draw up management priority or suitability maps (Villa et al., 2002; Brody et al., 2006). In some cases, this has been done integrating the stakeholders' different viewpoints through the weighting of these landscape values, according to their subjective relevance (Brody et al., 2006). In these cases, though, spatial information about landscape values was obtained from objective indicators in the form of spatial data that can only approximate an explicit public assessment of these values, such as location of green areas or species habitats (Brody et al., 2006). At the same time, some researchers have operationalised different methods to obtain spatially explicit information about landscape values and preferences using participatory mapping methods (PPGIS, Participatory GIS [PGIS] or Volunteered Geographical Information [VGI]). PPGIS refers to the use of GIS methods and technologies to engage the public in decision-making (Sieber, 2006). PGIS is similar to PPGIS but it has focused on supporting participatory planning approaches in developing countries (Brown and Fagerholm, 2015). VGI is any process involving the creation and use of spatial information provided by individuals and communities (McCall et al., 2015).

Using landscape values data from PPGIS, PGIS or VGI to manifest the public's spatial management priorities is still an incipient research field, but some approaches can be identified in the existing literature. For instance, there are studies that couple spatially explicit data on social values of ecosystem services with biophysical or ecological spatial data to identify social-ecological hotspots (Alessa et al., 2008; García-Nieto et al., 2013; Whitehead et al., 2014; Karimi et al., 2015). Conversely, there are studies in which identification of management priority areas is exclusively based on PPGIS data about positive landscape values and their spatial interaction or co-existence with perceived negative impacts (Raymond et al., 2009). In all of these cases, spatial concentration of positive landscape values denotes importance and, therefore, management priority, since these places hold a greater value for more people (Raymond et al., 2009). On the other hand, spatial co-existence of positive landscape values and perceived negative impacts serves to identify socio-environmental conflicts (Bryan et al., 2010).

Recent research has applied PPGIS data on landscape values and land use preferences to identify landscape conflict based on different conflict indices (Brown and Reed, 2012; Brown and Raymond, 2014; Hausner et al., 2015; Brown et al., 2017; Karimi and Brown, 2017; Moore et al., 2017). For instance, Moore et al. (2017) developed and applied a conflict index based on compatibility of spatially coincident positive landscape values using qualitative PPGIS data. Conversely, other authors based their conflict indexes on the compatibility of different spatially converging land use preferences and landscape values obtained from quantitative PPGIS methods (Brown and Reed, 2012; Brown and Raymond, 2014; Hausner et al., 2015; Brown et al., 2017; Karimi and Brown, 2017). However, in all these studies, the compatibility scores used to estimate the conflict indexes were based on either the research team's judgment (Brown and Raymond, 2014; Moore et al., 2017) or responses from a small, convenient sample of experts (Brown and Reed, 2012; Karimi and Brown, 2017). This might be problematic given the challenge of assigning weights to intangible landscape values and preferences, and addressing the associated trade-offs (Satterfield et al., 2013).

1.2. Contributions of the PPGIS approach based on qualitative data to assessing landscape conflict

This study contributes to and differs from previous conflict research in some relevant aspects. Firstly, unlike most quantitative PPGIS approaches, it does not use predefined categories of landscape values to evaluate conflict. Instead, we used context-specific categories obtained from a qualitative content analysis of people's perceived landscape values (as in Raymond et al., 2009; Klain and Chan, 2012; or Moore et al., 2017), thereby decreasing redundancy and ambiguity of the spatial attributes used in the analysis. Secondly, the contrasting viewpoints on management of flood risk and ecological restoration (Fliervoet et al., 2013; Seidl and Stauffacher, 2013), or on the amenity values affected by social use and poor maintenance (Asakawa et al., 2004; Özgüner et al., 2012), exemplify how conflict emerge when contradictory landscape values coincide spatially. Accordingly, we delimited conflict areas based on the co-existence of both positive and negative landscape values. Thereby, this study represents an exploratory/inductive approach to identifying conflict related to the perception of landscape. Thirdly, the identification and prioritisation of conflict areas is not subject to the estimation of conflict indexes based on the personal judgement of a few experts (Brown and Reed, 2012; Brown and Raymond, 2014; Karimi and Brown, 2017), instead using exclusively the PPGIS results and a weighted linear combination technique. Fourthly, the qualitative interpretation of the participants' expressed improvement preferences spatially coinciding in these conflicting areas sheds light on the reasons for these conflicts (Bryan et al., 2010).

Consequently, this analytical process not only produces a spatial delimitation and prioritisation of landscape conflict based exclusively on spatially explicit information about context-specific landscape values, but it also has the advantage of characterising the underlying drivers of conflict on the basis of a qualitative understanding of improvement preferences. Finally, the versatility of the approach presented offers the possibility of assessing landscape conflict at a local scale and in highly urbanised areas, a scale and environmental context rarely analysed using PPGIS.

2. Study area

The study area is the Caldes Stream corridor, located in the Metropolitan Region of Barcelona (Fig. 1). This urban stream corridor includes four principal municipalities. These are (from north to south) Caldes de Montbui, Palau-Solità i Plegamans, Santa Perpètua de Mogoda and La Llagosta. These four municipalities cover 71 km^2 and, in 2016, the population size was estimated at 70,434 (with a corresponding density of 992 inhab./km^2). In the last 20 years the population has increased by 36%, and by 66% in the last 30 years. This is, then, a highly urbanised area that has experienced a fast-growing demographic and land use change in recent decades.

Historically, the communities settled in this area were mainly dependent on agriculture for their livelihood. From the 1960s to the 2000s, the floodplain, originally occupied by scattered farms and small towns, underwent fragmentary occupation, becoming an urban corridor. Three main dynamics overlapped in this urbanisation process: (1) during the 1960s and 1970s, rapid, scattered development as a result of the relocation of factories from the city of Barcelona and the growing popularity of second homes (Font et al., 1999); (2) between the late 1980s and late 1990s, the arrival of medium- to large-scale international companies in the electronics, information technologies and pharmaceutical sectors attracted by the proximity of the metropolitan market, and the availability of cheap but quality industrial land (Font and Vecslir, 2010); and (3) between 1980 and 2000, low-density residential growth in the agrarian municipalities of Barcelona's hinterland, supported by an enhanced metropolitan road system (Muñoz, 2005).

In the early 2000s, rural land preservation by means of consolidating agricultural parks was applied as a corrective response to urban densification in the river corridor (Font, 2011). Simultaneously, public administrations and citizen associations promoted the protection, environmental improvement and social use of the remaining open spaces within this area (Benages-Albert and Vall-Casas, 2014). For many years, the impacts derived from this urbanisation process have degraded the historical rural and natural landscape, and distorted the traditional human-environment relationships and resource management practices of these communities. A reflection of the effects of