European Journal of Geography Volume 8, Number 2:55 - 77, February 2017

CLASSIFYING LANDSCAPE IN ENDORHEIC BASINS: A METHODOLOGICAL APPROACH FOR THE IMPLEMENTATION OF THE EUROPEAN LANDSCAPE CONVENTION

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Abstract

In this paper, we present a proposed methodology for classifying landscapes in the territorial areas of endorheic basins as well as for implementing the European Landscape Convention (ELC). The methodological sequence consists of two major stages: first, identification and characterization, followed by assessment and proposals. The objective in the first stage is the classification of the landscape into types and areas as well as its multiscalar integration and characterization. The objective in the second stage is to assess and establish the significance of the landscapes that have been identified and characterized in the first stage. This method has made it possible to establish a cross-sectional perspective for landscape analysis, by carrying out: an exercise in describing and analyzing the natural features of the landscape, and historical, socioeconomic and scenic-visual processes; a diagnostic exercise taking into account the transformation of the natural features of the landscape (the original ecogeographic units); and a forward-looking exercise, which aims at the assessment of the landscape and the possibility of implementing those proposals for action.

Keywords: *Landscape analysis methodology, endorheic basin, LCA, European Landscape Convention.*

1. INTRODUCTION

A defining characteristic of endorheic basins is their internal drainage system in which their waters currents converge or flow out at the base level. Water can disappear through seepage and/or evaporation, or, alternatively, stagnate and form lakes or lagoons whose origin, size, dynamics and seasonality vary in accordance with the mesological characteristics of each basin (Laity, 2008; Kar, 2013). They represent approximately 20 per cent of the earth's surface, and they are mainly found in arid and semi-arid regions (e.g., the Aral Sea, the Dead Sea, or Lake Eyre).

Because of their location, they are difficult environments for human settlement. Nevertheless, endorheic basins and their associated wetlands have been regarded as "damp islands" which have been proved highly attractive as sources of exploitable resources: factors such as population growth, overgrazing and overcropping, the increase in irrigation, industry, and tourism have contributed to the progressive depletion of lake reserves, and, as a consequence, to the transformation and degradation of their landscapes (Beaumont, 1993; Lemly, Kingsford & Thompson, 2000; Nichols, 2007).

The phenomenon of endorheic basins is of major interest with respect to their landscape, taking into consideration the convergence of physical, historical, sociocultural and perceptual factors. However, research on endorheic basins and their associated wetlands has approached the topic from a highly sector-specific angle (Arias-García & Gómez-Zotano, 2015). Thus, numerous studies have concentrated on establishing a relationship between aridity and endorheism in different spatial scales (Cooke & Warren, 1973; Abrahams & Parsons, 1994; Elmore et al., 2008), but there is an evident lack of landscape studies of this kind of space.

As a result, the interest in developing a methodological proposal for landscape analysis of endorheic basins originates from the convergence of two circumstances:

- A general lack of understanding of closed or endorheic basins: because of their closed or self-contained nature, this type of basin becomes extremely fragile in the face of human intervention since they have been subjected to major processes of environmental and landscape degradation, which is at its greatest where basins have led to the creation of wetlands. Nevertheless, sector-specific studies have basically concentrated on their hydrogeological, geomorphological, limnological and biological characteristics. As a result, a holistic (landscape) approach that takes into account environmental, historic, sociocultural and visual/scenic criteria is lacking.
- The lack of a suitable methodology for the analysis of the landscape of endorheic basins: the absence of scholarly contributions relating to the landscape in this type of terrain leads to the lack of a robust methodology for analyzing their landscapes. Nevertheless, since 2000 there has been a surge in the procedural and methodological requests arising from the European Landscape Convention (ELC) which require an increase in efforts to identify, describe and assess landscapes on the part of the signatory countries. However, to date no methodologies have been put into effect for the analysis of endorheic basin landscapes, nor have any procedures to incorporate them effectively in land-use planning been put into effect.

In light of these deficiencies, this paper aims to create a methodology proposal which makes it possible to implement the ELC in areas associated with endorheic basins. In order to achieve this objective, a methodological procedure is proposed, based on the guide to assessing landscape character, or the LCA, "Landscape Character Assessment: Guidance for England and Scotland" published in 2002 by the Countryside Agency and Scottish Natural Heritage (United Kingdom). Although this methodology forms the basis of our methodological proposal, it has been brought into line with the principles deriving from the ELC, with the aim of facilitating the implementation of the Convention in this type of space. Consequently, what it contributes is a methodology that is systematic (it includes territorial structures that derive from the double framework of the natural and sociocultural subsystem), genetic (it aims to find out how the current situation in any area has been arrived at), interscalar (it can be adapted to different territory scales), and, finally, it is iterative (it expresses an action made up of repeated actions: areas and types of landscape). In order to fine-tune the proposed methodology, the endorheic basin of Fuente de Piedra (Southern Spain) was chosen as the area for the pilot study. This is an area which, despite being home to one of the most important and largest wetlands in Southern Europe, is not immune to given pressures and risks as regards its landscape.

2. THEORETICAL FRAMEWORK AND BACKGROUND

2.1 Theoretical-methodological contributions of the European Landscape Convention (ELC)

Independently of the methodological and conceptual diversity in the treatment of landscape, such as the ecological approach (Wiens & Milne, 1989; Forman, 1995; Wu, 2006), the perceptual approach (Lowenthal, 1978; Morgan, 1978; Zube, Sell & Taylor, 2000), the systemic or integrated approach (Bertrand, 1968, 1974, 1978), the historical approach (Aldred & Fairclough, 2003; Stabbetorp et al., 2007; Lambrick, Hind & Wain, 2013), and so forth, it should be emphasized that this dialectic of views has been more or less superseded by the approval of the ELC (2000).

The Convention represents the only international instrument devoted exclusively to European landscapes, being its main aim to promote the protection, management and planning of landscapes, as well as to organize European cooperation in this field (Article 3 of the ELC). Moreover, with the Convention a consensus was reached on the definition of landscape: “Landscape means an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors’ (Council of Europe, 2000, p. 2). In accordance with this definition, landscape acquires a concrete material basis as the living environment or contextual space of social groups and their sensory perception.

In addition, as a prelude to any landscape activity, the Convention and the Guidelines for its application (Council of Europe, 2008) lay down that in order to deepen its understanding of its countryside, each party or state has to make the following commitments:

- To identify its own landscapes throughout its territory (Identification) and analyses their characteristics, and the forces and pressures changing them (Characterization). This involves an analysis of the landscape from a natural, historical, cultural and perceptual-visual point of view.
- To assess the landscape, taking into account its values (Assessment).
- To set Landscape Quality Objectives, interpreted as the formulation, by the competent public authorities, of the aspirations of the public with regard to the landscape characteristics of their surroundings.
- To monitor changes to the landscape.

Consequently, the conclusion from the ELC and its Guidelines is that there is a need to understand and describe the specific characteristics of each landscape in its current state while recognizing that it is the result of the action of natural and/or human factors and the interrelation between them; to analyses the development of landscapes over time and establish their temporal dynamics, past, present, and for the foreseeable future, and the pressures on them; and to recognize the characteristics of their value systems, both on the part of experts and through public perception.

Taking into account the foregoing discussion, while the ELC provides no procedure or concrete methodological sequence of steps for analyzing landscape, it does, nevertheless, point to the need to identify, describe and assess all landscapes fully, both those which have suffered degradation and those which are of great quality or outstanding. It is for this reason that the Convention has aroused great interest from a conceptual and methodological point of view when it comes to addressing landscape issues. Therefore, conceptually, this research adopts the definition proposed by the ELC; and methodologically, the need to identify, characterize, and assess landscapes.

2.2 Theoretical-methodological contributions of the LCA procedure (Landscape Character Assessment)

The LCA procedure came into being at the beginning of the 1990s within the Countryside Commission (United Kingdom), since when it has gained widespread recognition internationally: Ireland, Korea, China and Spain (Groom, 2005; Gómez Zotano & Riesco Chueca, 2010).

This methodology came into being with the aim of extending the treatment of landscape to cover the whole territory, thereby overcoming any exceptionalist or restricted approaches from which the analysis of landscape had been previously approached. Consequently, any approach directed towards establishing what is exceptional or outstanding in landscape resources is avoided (Gómez Zotano & Riesco Chueca, 2010).

Nevertheless, Jensen (2005) points out the existence of three prior theoretical-methodological stages leading up to the LCA methodology: (1) 1970s: Landscape Evaluation, generally using quantitative approaches with the aim of establishing the quality and value of landscapes in order to be able to compare them. (2) 1980s: Landscape Assessment: the character of the landscape is classified and described. That is to say, what makes one landscape different from another? Using this concept, differences between landscapes were determined on the basis of their character, not their value. (3) 1990s: Landscape Character Assessment: the character of the landscape now becomes the central concept of landscape analysis and action at all scales.

In 2002, the Countryside Agency and Scottish Natural Heritage published a guide to assessing landscape character, *Landscape Character Assessment: Guidance for England and Scotland* (Swanwick, 2002), the approach and method of which has the following characteristics: (1) Landscape discourse centers on the *character* of the landscape, in the sense of the particular, recognizable and coherent combination of elements in a given landscape that make it different from another landscape. An attempt is made to identify the key or distinctive characteristics of each landscape but not to assess them; (2) A clear distinction is made between the process of characterization and assessment; (3) It proposes a classification of landscape on the basis of *landscape types* and *landscape areas* (Swanwick, 2002, 2004):

- Types: system or grouping of territorial units with a particular, homogeneous landscape pattern as regards natural, social and cultural characteristics. These units have the same character or combination of characteristics. They are more abstract and they need not be connected.
- Areas: single, unique geographical areas within which there exists a particular type of landscape. Each area has its own character and identity, as a result of which they are given specific names (a place name, for example). They have an unmistakable territorial and landscape identity, which is unique and easily recognizable by the public.

According to Lipský & Romportl (2007) and Gómez-Zotano & Riesco Chueca (2010), this classification of the landscape into types and areas makes it possible to do the following: (1) To demonstrate the distinctive aspects which define landscape units and distinguish them from others. An attempt is thereby made to determine and map unique, individual landscapes, situated uniquely in particular places (areas); (2) To explore the generic features shared by landscapes which are located in different places. That leads to a systematization based on similarities and to a landscape typology (type).

3. MATERIAL AND METHODS

3.1 Study area

The Fuente de Piedra endorheic basin is located in the south of the Iberian Peninsula, in the north of the province of Malaga (Andalusia, Spain) (Figure 1). It extends over 153.5 km^2, and its boundaries, which are natural, make it a well-defined hydrological unit. The basin's base level (410 mamsl) corresponds to Fuente de Piedra Lake, a long, shallow, seasonal, salt-water lake with a surface area of 13 km^2, which is ellipsoidal (6.8 km long and 2.5 km wide). This wetland is the second-largest inland lake in the Iberian Peninsula and home to the largest colony of flamingos (*Phoenicopterus roseus*) in the Western Mediterranean, together with the Camargue (France). It became, therefore, the third Spanish wetland to be included in the Ramsar convention and has had "nature reserve" status since 1984 (Linares Girela & Rendón Martos, 1998; Arias García, 2016).

Source: DEA_100 (Spatial data for Andalusia. 1:100.000 scale; Ortophoto PNOA).

Figure 1. Fuente de Piedra endorheic basin map location. Photos: Fuente de Piedra Lake (A: 2011; B: 2012).

The basin constitutes a low-lying area with a major presence of Triassic outcrops which composes its fundamental geological basis. Climatically, it is considered to be semi-arid, with a dry Continental Mediterranean climate, annual average temperature of 16.6ºC and total annual rainfall of 447.2 mm. The rainfall, although irregular, in conjunction with the morphology of the area, creates a series of seasonal streams which are one of the major factors shaping the landscape and the lakes hydroperiod (Arias García, 2016; Rodríguez-Rodríguez, Martos-Rosillo & Pedrera, 2016).

In this context, the interrelationship between society and the environment throughout history has been marked by an age-old exploitation of natural resources which has led to major changes in land use. The use of the lake as a saltworks, which started in Roman times and lasted until the mid-twentieth century, is noteworthy; in contrast, the progressive occupation of the land for agricultural purposes: olive groves and extensive areas of arable crops (cereals and sunflowers) dominate what is a clearly agricultural landscape. As a result, natural vegetation is restricted to a narrow fringe around the lake and to mountainous areas, and the landscape has been intensively humanized.

3.2 Proposed methodology

The methodology outlined in this article sets out different stages and phases that make it possible to identify, characterize and assess landscapes in areas associated with endorheic basins. The methodological proposal is based on the British LCA methodology, the recommendations of the European Landscape Convention, and other theoretical and analytical resources, especially the idea of an integrated landscape proposed by Bertrand (1968, 1974, 1978) and Bertrand & Bertrand (2006). A description of the proposed methodology follows.

3.2.1 Stage 1: Identification and Characterization

The first stage consists of seven phases; its aim is to identify the landscape types and areas in the basin under study and to determine its character (characterization). Consequently, it is structured around three axes which are fundamental to landscape analysis: natural, historico-functional, and scenic-perceptual factors.

- *Phase 0/Initial phase. Defining the scope:* consists of the definition of the study area, delimiting it spatially and cartographically, and defining the scale of the project. The search for information sources and establishing a fieldwork schedule are also activities falling within this initial phases of the method.
- *Phase 1. Analysis of the basic natural features of the landscape*: (1) Relief: demarcation of lithological and geomorphological units: consists of the combined synthesizing analysis of different components. such as lithology, tectonics, gradients and morphogenetic modelling; (2) Climate: definition of climatic units on the basis of the analysis of temperature and rainfall data in order to detect spatial discontinuities that affect the landscape; (3) Surface-water hydrology and definition of hydrogeological units; (4) Bioclimate: recognition of spatial discontinuities by considering the different bioclimatic levels; (5) Vegetation series: the vegetation series present in the area under study are identified and mapped; (6) Original fauna habitat: the original fauna habitat is identified in order to contribute to defining original geosystems or original ecogeographical units (see phase 2); (7) Soils: definition of edaphic units.
- *Phase 2. Definition of original geosystems* (*original ecogeographic units*): cartographic overlay or combination of the variables analyzed in basic landscape features (phase 1) using the geographic information system (GIS) ArcGIS 10.1 tool, combined with expert judgement, makes it possible to demarcate units that are homogeneous as regards their ecological potential and biological exploitation. This phase is not contemplated in the LCA methodology. Nevertheless, this paper incorporates the conception of the systematic analysis of landscape, which concentrates on understanding the territorial structures that derive from the dual network of the natural and sociocultural subsystem. The precursor of this method was the French geographer Betrand (1968, 1974, 1978), who considers landscape as an open system with a particular structure and its own dynamic which gives it a temporal and developmental dimension.

Consequently, taking as our starting point the concept of "geosystem", we have incorporated the concept of "original geosystems or original ecogeographic units", which makes it possible to establish the conditions that shaped the landscape before human intervention; landscape presents an original base (features), anthropic processes that explain its current situation (dynamics), and evolutionary tendencies that can contribute to changing it (trends).

- *Phase 3. Analysis of historical processes in and the socioeconomic features of the landscape*: (1) Land use and land cover; (2) Fauna habitat and current fauna: wild fauna, fauna used for hunting, and livestock; (3) Typology of settlements and patterns of distribution; (4) Historical development: major milestones and historical processes that may have contributed to creating a specific landscape character; (5) Heritage: historic-cultural legacy that still continues in the territory and has an impact on the landscape; (6) Farming system in operation: farming system, highlighting the typology and the size of holdings; (7) Pressures and dynamics: assessment of the territorial processes of change currently in operation.
- *Phase 4. Visual and scenic structure*: the visual size of the basins is calculated from a series of static observation points distributed around the area under study.
- *Phase 5. Rough draft of landscape areas and types*: systematic mapping (original geosystems or original ecogeographic units) is combined with or superimposed on the anthropic information analyzed in phase 3. Cartographic superimposition is carried out semi-automatically using the GIS (ArcGIS 10.1) tool, and incorporating expert analysis with the aim of including cultural aspects linked to the landscape which do not easily lend themselves to automatic treatment.
- *Phase 6. Definition of definitive landscape types and areas*: after creating the rough draft of landscape types and areas, it is checked and modified through fieldwork. Subsequently, the landscape types and areas are identified and definitively named, and their multiscalar integration is undertaken.
- *Phase 7. Characterization*: on the basis of the insights previously gathered with regard to the basic natural features of the landscape, historical and socioeconomic processes, visual and scenic structure, etc., the key characteristics of the landscape areas and types are identified as well as their recent development, pressures, risks, and dynamics.

3.2.2 Stage 2: Assessment and Proposals

Following the identification and characterization of landscape types and areas (stage 1), their value and significance are established, as well as the policy guidance for their protection, management and planning. In this second stage, comprising three phases, we opted for the structure suggested by the ELC, which entailed reformulating the two last phases suggested by the LCA methodology (determining the criteria for assessment, and assessment itself), which have been replaced by definition of landscape quality objectives – monitoring – and establishment of indicators.

- *Phase 8. Qualification*: in accordance with the ELC Guidelines (Council of Europe, 2008), qualification consists of a dialectical comparison between analysis by experts and the values assigned to the landscape by the public in the context of the existence of different value systems, whether they are consolidated or in the process of being defined.

- *Phase 9. Defining landscape quality objectives*: by "landscape quality objective", the ELC (2000) means the formulation, by the competent public authorities, of local people's aspirations as regards the landscape character of their living environment, once its state, values and risks have been analyzed. This phase establishes possible guiding principles for action to protect, manage and plan landscape in order to protect those elements that have ecological, aesthetic, or cultural value.
- *Phase 10. Monitoring and establishment of indicators*: the ELC suggests setting up tools to monitor changes to the landscape and the effectiveness of policies adopted to carry out the monitoring. As a result, a series of environmental, cultural, and social landscape indicators are to be defined in such a way as to be understandable to local people, politicians, and public-sector managers.

4. RESULTS

In line with the methodological sequence previously proposed, in the first stage (Identification and Characterization) the scope and area of the study of the Fuente de Piedra endorheic basin were defined (initial phase or phase 0). Setting the boundaries of the area was carried out on the basis of natural boundaries given that we are dealing with an endorheic river basin. As regards fieldwork, 32 field trips were conducted between 2011 and 2016, taking into account the seasonality of the landscape with the purpose of detecting the most important changes in its annual cycle (landscape phenology), with special attention being paid to those changes which might affect the character of the landscape. As regards the scale to be used, a reconnaissance scale of no less than 1:25,000 was used, while more detailed scales were used when the information sources consulted allowed.

The next step was analysis of the basic natural features of the landscape (phase 1) on the basis of nine variables in the physical environment (lithology, geomorphology, climate, surface-water hydrology, underground hydrology, bioclimate – thermotypes, ombrotypes –, vegetation series and exoserial plant communities, fauna habitat and edaphic units). This phase made it possible to draw up a thematic map of the study area and also to define the boundaries of different spatial units or discontinuities for each variable analyzed (Table 1).

Subsequently, on the basis of the thematic mapping that had been produced, the original geosystems or ecogeographical units were demarcated in accordance with phase 2. First of all, the maps relating to ecological potential were combined (Lithological Units, Geomorphological Units, Climatic Units, Surface- water hydrology map, Hydrogeological Units and Bioclimatic map – thermotypes and ombrotypes –), which have a substantial impact on the characteristics of the biotic environment. Subsequently, we combined those variables that represent biological exploitation (Vegetation Series and Exoserial Communities map, fauna – the fauna habitat was not mapped, but instead an inventory with an approximate estimate of the zoning and distribution of the various animal species – and Pedological Units map (Figure 2). This combining or overlaying of maps made it possible to demarcate four original geosystems (G) or original ecogeographical units (Figure 3).

Table 1. Summary of the basic natural features of the landscape of the Fuente de Piedra endorheic basin: defined spatial units or discontinuities.

ABIOTIC SUBSYSTEM	
Lithological Units **(LU)**	**LU-1.** Argillaceous-evaporitic substratum; **LU-2.** Limestone and dolomites; **LU-3.** Calcarenites with flint & white marls; **LU-4.** Marlstone & marls; **LU-5.** Molasse deposits, predominantly sandy; **LU-6.** Watershed deposits; **LU-7.** Alluvial deposits, predominantly sand, clay, & boulders; **LU-8.** Argillaceous-loamy lacustrine deposits.
Geomorphological Units **(GU)**	**GU-1.** Argillaceous-loamy basin floor; **GU-2.** Flood plains; **GU-3.** Lacustrine terraces; **GU-4.** Elliptical endorheic lake; **GU5.** Argillaceous-arenaceous lake islets; **GU-6.** Undulating calcareous dolomite mountains (sierra); **GU-7.** Smoothly sloping ridges with a powdery crust and argillaceous outcrops; **GU-8.** Argillaceous-evaporite gently sloping hills and watercourses; **GU-9.** Gently sloping molasse hills and watercourses; **GU-10.** Gently sloping molasse hills and watercourses, predominantly calcarenites with flint and white marl; **GU-11.** Gently sloping hills, predominantly marls, marlstone and calcarenites **GU-12.** Glacis; **GU-13.** Alluvial fans; **GU-14.** Colluviums.
Climatic Units **(CU)**	**CU-1.** Dry Continental Mediterranean climate.
Surface-water hydrology *Wetlands* **(W)** Streams **(S)**	**W-1.** Laguna de la Serafina; **W-2.** Laguneto del Pueblo; **W-3.** Laguna de las Palomas; **W-4.** Laguna de los Abejarucos; **W-5.** El Origen-Los Juncares; **W-6.** Laguna de Cantarranas; **W-7.** Hoyo del Navazo; **W-8.** Laguna atalasohalina de Fuente de Piedra. **S-1.** Arroyo de Santillán; **S-2.** Arroyo del Charcón o de Humilladero; **S-3.** Arroyo de Mari Fernández; **S-4.** Arroyo de Los Arenales; **S-5.** Arroyo Molino de Viento; **S-6.** Arroyo Vaguada de Campos.
Hydrogeological Units **(HU)**	**HU-1.** Alluvial aquifer with quaternary surface deposits (mid-high permeability); **HU-2.** Miocene aquifer, predominantly calcareous sandstone (high permeability); **HU-3.** Paleogene aquifer, predominantly marl and calcarenites (impermeable) **HU-4.** Jurassic carbonate aquifer, predominantly limestone and dolomites (high permeability) **HU-5.** Triassic aquifer, predominantly clays and evaporites (low permeability).
Thermotypes **(T)** and Ombrotypes **(O)**	**T-1.** Meso-mediterranean thermotype; **O-1.** Dry sub-humid ombrotype.
BIOTIC SUBSYSTEM	
Vegetation Series **(VS)** and Exoserial Communities **(EC)**	**VS-1.** *(Quercus rotundifolia): Paeonio coriaceae-Querceto rotundifoliae S. Faciación termófila con Pistacia lentiscus;* **VS-2.** *(Thypha domingensis): Typho-Schoneoplecteto glauci Sigmetum;* **VS-3.** *(Tamarix canariensis): Elymo repentis-Tamariceto canariensis Sigmetum;* **VS-4.** *Aro italici-Ulmeto minoris S.;* **EC-1.** *Ruppietum drepanensis y Charion canescentis;* **EC-2.** *Suaedo splendentis-Salicornietum patulae;* **EC-3.** *Suaedo splendentis-Salsoletum sodae;* **EC-4.** *Salsolo sodae-Atriplicetum chenopodiodis;* **EC-5.** *Parapholido-Frankenietum pulverulentae.*
Fauna **(F)**	**F-1.** Fauna associated with Mediterranean lakeside woodland; **F-2.** Fauna associated with farmland spaces; **F-3.** Fauna associated with mountain spaces; **F-4.** Fauna associated with wetlands.
Pedological Units **(PU)**	**PU-1.** Calcareous Regosols and calcareous Cambisols; **PU-2.** Lithic Leptosols and Rendzic Leptosols; **PU-3.** Lithic Leptosols and Eutric Leptosols; **PU-4.** Petric Calcisols, calcic Cambisols, and calcareous Regosols; **PU-5.** Luvisoles cálcicos y cambisoles calcáricos; Calcic Luvisols and calcareous Cambisols **PU-6.** Gleyic cambisols and calcareous cambisols.

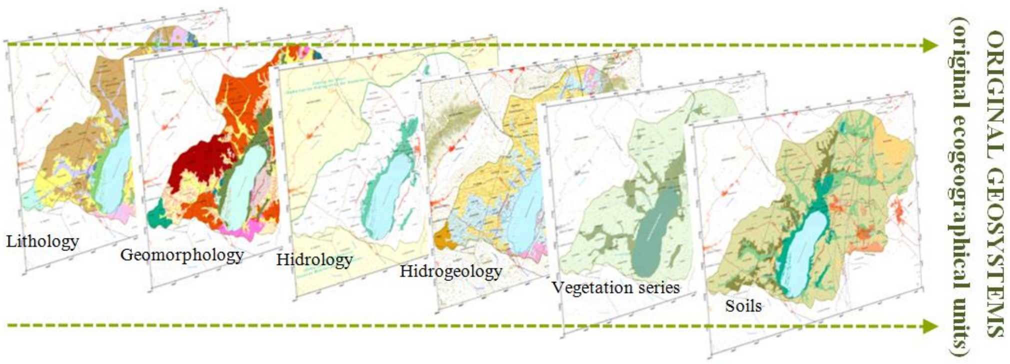


Figure 2. Combination/overlay of maps relating to ecological potential (abiotic subsystem) and biological potential (biotic subsystem). Fuente de Piedra endorheic basin (Southern Spain).

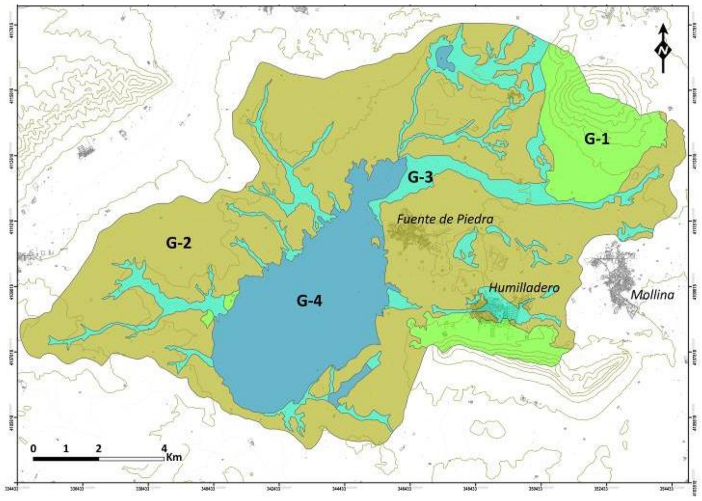


Figure 3. Map of Original Geosystems (G) or Original Ecogeographic Units. Fuente de Piedra endorheic basin.

Legend: ***G1.*** *Calcareous-dolomite mountains and ridges with dry/sub-humid meso-Mediterranean ilex groves.* ***G2.*** *Molasse and argillaceous-evaporite hills and watercourses with dry/sub-humid meso-Mediterranean ilex groves.* ***G3.*** *Alluvial floodplains with meso-Mediterranean riverine woodland and fauna.* ***G4.*** *Floor of the endorheic basin with seasonal lakes, Mediterranean riverine and lacustrine-marsh vegetation and aquatic birdlife.*

To analyze the transformation through human intervention of the original geosystems (G) or original ecogeographic units and the social construction of the landscapes, phase 3 consisted of the analysis and mapping of 7 variables relating to the fundamental-historical and socioeconomic characteristics of the landscape: land use and cover, historical development of the study area – with special focus on Fuente de Piedra lake as the key formative element of the basin – historical-cultural legacy or heritage , the system of farming in operation (size of agricultural holdings), territorial conditions (environmental protection figures), as well as other current territorial dynamics. Analysis of these variables allowed us to progressively identify certain spatial discontinuities which proved useful in differentiating landscape types and areas. Figures 4 and 5 show two examples of the mapping results obtained after analysis of the variables in phase 3.

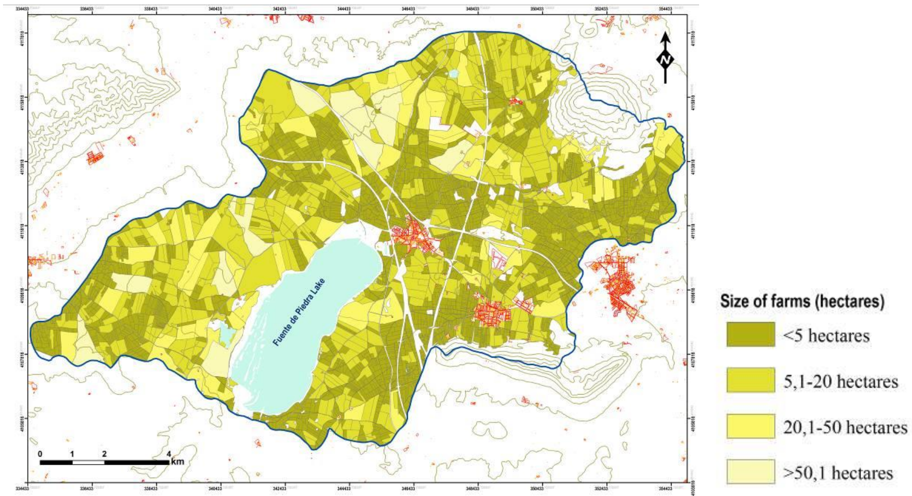


Figure 4. Map of the farming system in operation (size of farms). Fuente de Piedra endorheic basin (Southern Spain).

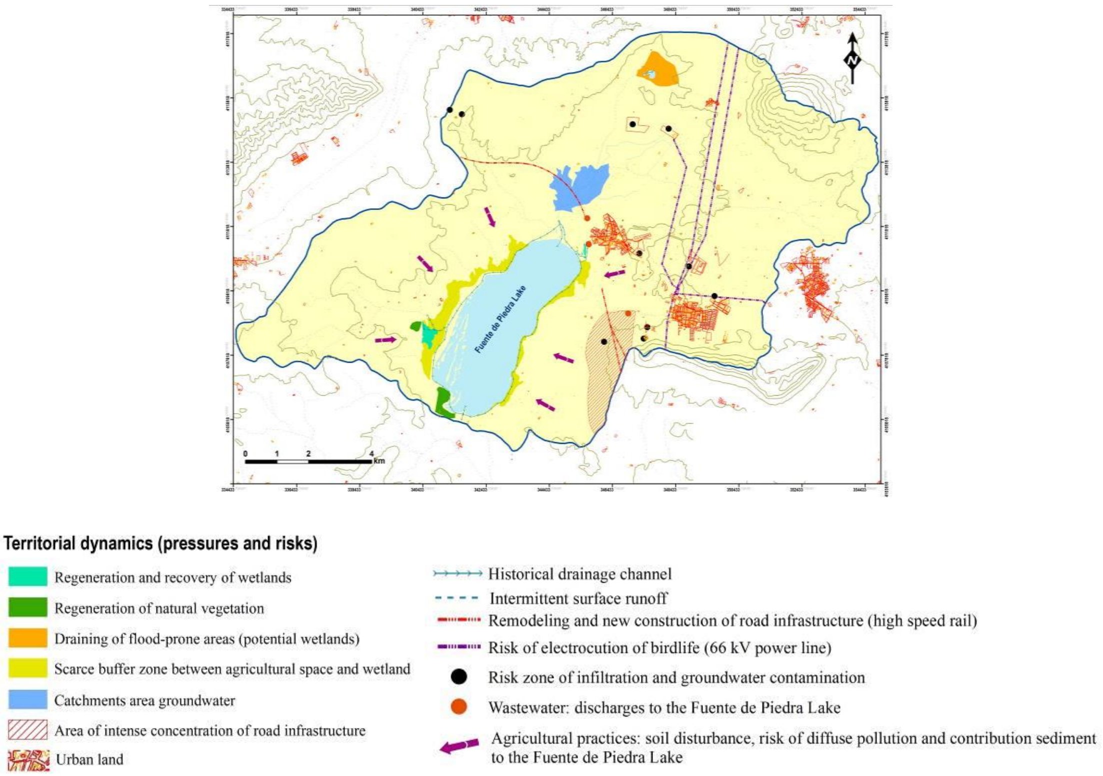


Figure 5. Territorial dynamics map. Fuente de Piedra endorheic basin (Southern Spain).

Phase 4 consisted of the analysis of the visual and scenic structure of the study area with the aim of detecting how much the hydrographic and visual boundaries of the basin match. Three static observation points (OPs) were selected, corresponding to basic visual reference for the observation of the main marshes of the basin and its surroundings; in other words, the places in the nature reserve with the highest visitor numbers (lookout points, hides, etc.)

To calculate the visual field of each OP, we used the high-resolution Digital Terrain Model (DTM05/DTM05-Light Detection and Ranging [LIDAR]. 2010) available at the Spanish National Geographical Centre. This is a DTM with a grid of 0.5 m (0.5 m resolution) obtained from the photogrammetric flights of the National Plan for Aerial Orthophotography (PNOA, Spain). A maximum visible distance of 50,000 m from the center of the basin was considered suitable. Using the 3D Analyst tool of the ArcGIS 10.1 program, the visual field of every OP was calculated, keeping to a factor Z (height of the observation point) of 1.7 m (average height of the eyes of a human observer). After calculating the visual field of each OP, a map overlay was developed with a view to obtaining an intervisibility map (Figure 6).

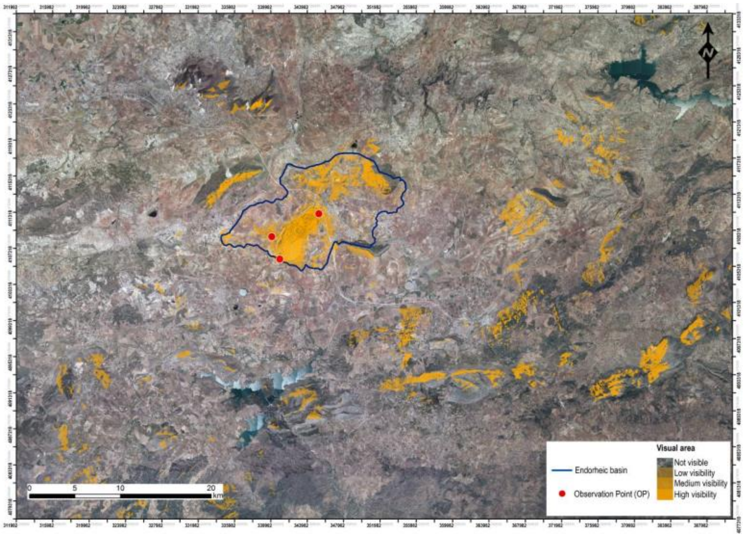


Figure 6. Intervisibility map. Fuente de Piedra endorheic basin (Southern Spain).

The analysis and mapping of the basic natural and socioeconomic properties of the basin, along with its visual and scenic structure, allowed us to derive a rough draft map of landscape types and areas (phase 5). Once the rough draft map had been created, fieldwork, in conjunction with consulting with social agents (the local population) and consulting the district and local toponymy (topographic maps, land register) allowed for successive modifications to this map until definitive types and areas were demarcated and integrated in a multiscalar fashion (phase 6). Four levels of integration were set, corresponding to the following spatial reference scales: supraregional, regional, district or supralocal, and local. This made it possible to carry out an iterative process in landscape types and areas, in which the largest (in area) types and areas include those smaller than them that come immediately below them in the hierarchy. The classification used conforms to the distinction between *areas* and *types* proposed by the LCA in order to maintain an iterative process.

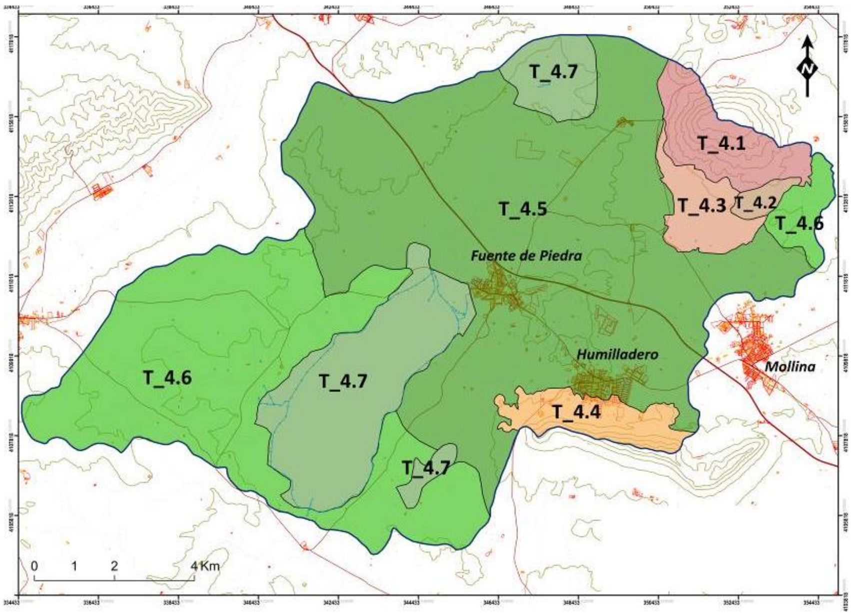
For each different map scale a zoning into types followed by another one into areas was carried out, in such a way that there as many layers of types and areas as there are different scale levels. This classification differentiates between what is thematic (type) and what is spatial (area). Types reflect dominant factors in the landscape, while areas tend to have certain sociocultural roots and recognition through possessing a place name, for example. In any case, we consider that when carrying out landscape assessment, planning, and management, detailed map scales (Levels 3 and 4) are the most appropriate.

Table 2. Landscape zoning at different levels of spatial integration (Adapted from Gómez Zotano, J., Riesco Chueca, P., & Rodríguez Rodríguez, J. (being reviewed)

LEVEL 1. Supraregional scale (≈ 1/1,000,000)	
TYPE_1 Is the most basic approach to the landscape. The landscape has an extensive surface area and its characteristics are determined by large-scale morphostructures and biogeographical domains, also taking into account cultural importance.	**AREA_1** A large physiographic unit with its own identity. Its designation refers to the toponymy of large-scale relief or hydrography structures. On occasion, when its formal identity is superimposed on physical characteristics, the designation follows administrative or economic demarcations.
LEVEL 2. Regional scale (≈ 1/200,000-1/100,000)	
TYPE_2 The landscape is determined by stable, independent abiotic variables and their correlation with major land use (anthropic variable more unstable and dependent). Mesostructures are defined within macrostructural units. Abiotic and biotic elements are combined with a land-use grouping that becomes prominent at medium map scales	**AREA_2** In assigning a name to the area, efforts will be made to have recourse to traditional or administrative names, in order to reinforce landscape identity and to agree with territorial guidelines laid down in regional planning policies.
LEVEL 3. District or supralocal scale (≈ 1/50,000-1/25,000)	
TYPE_3 Types at this level start to display fully and throughout their area a combination of abiotic potential, biotic exploitation and system of anthropic use important enough to understand the landscape. Elements such as relief, bioclimate, soils, and anthropic uses are generally used to identify and characterize landscapes at this level.	**AREA_3** In these areas, associated with medium-sized topographical units, the larger territorial components become blurred and cannot be perceived. As a result, how they are named must be in line with what the people of the district call them in order to reinforce their landscape identity.
LEVEL 4. Local scale (≈ 1/10,000-1:5,000)	
TYPE_4 The landscape typologies recognized in this last level of the hierarchy have a restricted surface area and derive from the combination of different kinds of formal and functional attributes (depending on the characteristics of the study area). Elements such as topography (altitude, slopes), lithology, physiography, bioclimate, vegetation or soil type in combination with references to land use are used to designate this type. Bearing in mind the detail that this scale of mapping offers, reference to the visual and scenic component is also incorporated.	**AREA_4** Naming the area matches the popular terminology used by local people. As result, the given name may refer to elements with a natural basis or to facts of anthropic origin (for example, a population nucleus or a property). Public consultation is essential in the naming process.

In the Fuente de Piedra basin, in accordance with the levels of spatial integration and the scales proposed in Table 2, the following landscape types and areas were identified:

- Level 1 (supraregional scale): Type T_1. Circum-Mediterranean Alpine mountain ranges; Area A_1. The Baetic mountain range.
- Level 2 (regional scale): Type T_2. Mediterranean intramontane depressions, predominantly agricultural and urban; Area A_2. The Antequera depression.
- Level 3 (district scale): Type T_3.1. Calcareous dolomite meso-Mediterranean mountains predominantly wooded and agricultural; and Type T_3.2. Meso-Mediterranean endorheic plains/flats with marshes/wetlands, agricultural use and urban-industrial. Following through with this iterative process, at this scale we identified three landscape areas corresponding to three smaller-scale topographical units with their own identity: Area A_3.1. Sierra de Mollina-La Camorra; Area A_3.2. Sierra de Humilladero; Area A_3.3. Llanura de Fuente de Piedra.
- Level 4 (local scale): the landscape became very diverse, in keeping with the large-scale maps used, and seven types (T) and 54 landscape areas (A) were identified and mapped (Figure 7 and Figure 8).



T_4.1. Calcareous-dolomitic hillsides with undergrowth, wild olive trees and scattered ilex.
T_4.2. Calcareous-dolomitic hillsides with dense pinewoods and widely visible undergrowth.
T_4.3. Surface glacis with upland tree planting and wide visibility
T_4.4. Calcareous-dolomitic hillsides with dense undergrowth and widely visible pinewoods.
T_4.5. Hills and valleys with cultivated land, population nucleuses and industrial infrastructure in visual corridors.
T_4.6. Hills and valleys with cultivated land and scattered buildings with heterogeneous visibility.
T_4.7. Shallow, seasonal endorheic lakes with moisture-loving vegetation, aquatic bird life and widely visible.

Figure 7. Map of landscape types (T) (Level 4. Local scale. Fuente de Piedra endorheic basin)

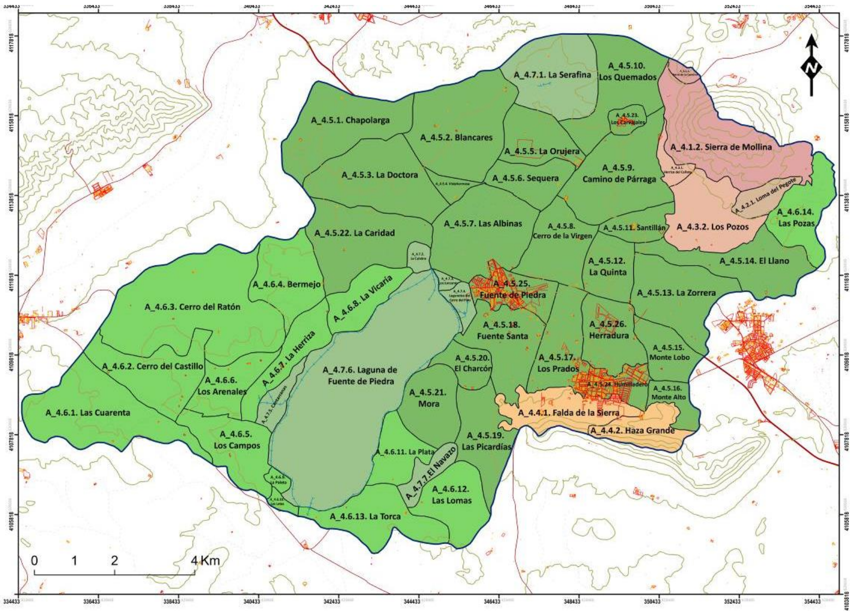


Figure 8. Map of landscape areas (A) (Level 4. Local scale. Fuente de Piedra endorheic basin. Southern Spain)

The final phase of this first stage of the method (phase 7) consisted of characterizing the landscape types and areas identified in the study area. The definition of such characters was decided on the basis of a particular and recognizable combination of the elements that define a given landscape type or area, with special importance being attached to the key characteristics that differentiate one landscape from another and which, consequently, endow it with its own character on the basis of such particularities as: abiotic subsystem, biotic subsystem, dynamics and evolution of the landscape (historical aspects and territorial heritage), pressure and risks (with a bearing on the landscape), and aesthetic and perceptual aspects.

An example of the landscape characterization of the Area *"A_4.7.6. Laguna de Fuente de Piedra (Fuente de Piedra Lake)" (Level 4. Local scale): from the lithological point of view, this area corresponds to a group of lacustrine deposits consisting of fine materials that are rich in organic matter (muds, marls, clays), that have created a continental lake with karst overlaid on evaporites. It has an irregular bottom, with an East-facing concavity, while a series of lake islets emerges to the West. Its dry Continental Mediterranean climate, interacting with its contours, creates temporary surface run-off which discharges into the base level of the basin, coinciding with a large, shallow, seasonal salt-water lake. As regards the evolution of the landscape, this area is characterized by human intervention stretching from prehistoric times to the present day but with an uneven level of utilization and exploitation of its resources. While its first inhabitants used the area basically for hunting, from the third century CE the lake was used as a saltworks, an activity that endured up until 1951 (…), 1984 being the year when it was declared a Nature Reserve. The location of this landscape area at the bottom of the depression makes it widely visible from various points in the basin. Among the elements that constitute this landscape area, the most characteristic is the colony of flamingos (Phoenicopterus roseus), which makes use of the waterlogged areas as a source of food. However, the "naturalness" of the fauna contrasts with the lakeside, an area which has been intensively cultivated, and where sunflowers, olives, and cereals predominate (…)* (Figure 9).

Figure 9. Photographs of the Area "A_4.7.6. Laguna de Fuente de Piedra (Fuente de Piedra Lake)".

Following the *Identification* and *Characterization* of the landscapes (first stage), we moved on to *Assessment* and *Proposals* (second stage), which consisted of an assessment of the value and significance of the landscapes (types and areas) previously identified and characterized. Phase 8 (qualification) consisted of a qualitative assessment process paying attention to the identification of the values of each type and area, namely ecological, productive, historic-heritage, social use, mythological, spiritual, symbolic and aesthetic values. For each variable, we defined a series of parameters, assigning each of them one out of four different values (low or zero, average, high, very high). For example, for the area "A_4.7.6. Laguna de Fuente de Piedra (Fuente de Piedra Lake)" (Level 4. Local scale) the parameters assessed for "ecological values" were: lithological diversity, uniqueness or rarity, diversity of geoforms, unique climatic phenomena, presence of natural or semi-natural run-off, fountains and springs, permanent water masses, temporary or seasonal water masses, degree of conservation of vegetation cover, abundance and diversity of fauna habitat, uniqueness and/or specificity, degree of connectivity with other wetlands, etc.; or, for example, the parameters assessed for "social use values" were: ease of access to the wetlands, frequency of visits (visual consumption), analysis of publicly used infrastructure, activities with public involvement, scientific and educational activities, etc.

Subsequently, phase 9 consisted of defining landscape quality objectives (future recommendations) for each landscape type and area. For example, for Area "A_4.7.6. Laguna de Fuente de Piedra (Fuente de Piedra Lake)" (Level 4. Local scale) recommendations and proposals were set out in four thematic areas: (1) agricultural holdings around the lake (increase measures controlling the use of water tables, hydrological and woodland restoration of the surface streams feeding into the lake, etc.); (2) public use of the wetlands (diversify programs of scientific-educational activity, manage the mass influx of visitors during the flamingo nesting period, etc.); (3) visual refurbishment and upgrading of built heritage (diversify the network of hides and lookout points, restore historic buildings and infrastructure and convert them into museums or landscape interpretation centers, etc.); (4) infrastructure construction (limit infrastructure development on the edge of the lake, as it creates a barrier effect and habitat fragmentation).

Finally, phase 10 consisted of the monitoring or establishing of indicators, the aim of which is to determine compliance with landscape quality objectives and to find out which change factors affect a given landscape type or area, in order to establish whether or not there is any change to its character. Consequently, a series of monitoring indicators was designed according to: (1) Ecological values (changes in surface water quality, developments in the flooding level of the trough, changes to the lake-wetlands trough); (2) Land use and anthropogenic exploitation (dynamics and trends in land use, state of and trends of the heritage and cultural elements present in the landscape type or area, identification of new physical elements, etc.); (3) Visual and scenic structure (degree of modification, compatible or incompatible visual elements, or those with a severe impact, etc.); (4) Assessment of the landscape character (stable or no changes, minor changes, drastic changes and/or new character).

5. DISCUSSION

5.1 Applicability of the LCA method

In the methodological procedure proposed in this paper two clearly differentiated stages were developed: identification and characterization, and assessment and proposals. The first stage consisted of the classification and characterization of the landscapes, and this stage is viewed as a crucial stage prior to assessment (Swanwick, 2002; Mücher et al., 2003; Jongman et al., 2006). This first phase focuses on both the objective and subjective aspects of landscape and it is an essential phase for its future assessment and proposals about it. In line with the LCA method, landscape identification and characterization requires an analysis of basic natural features (Natural Factors) as well as historical processes and socioeconomic factors (Cultural/Social Factors). The scale of detail used allowed a minute analysis of each and every one of the information layers considered useful for the identification and characterization process. Nevertheless, an intermediate phase has been incorporated in order to gain an understanding of the natural structure of the study area prior to human intervention: original geosystems or original ecogeographical units, considering the analysis of the abiotic and biotic subsystem before they were modified

The next step was the analysis and mapping of historical and socioeconomic processes, and analysis of the visual and scenic structure. In keeping with the LCA method, analysis of the scenic and perceptual structure is a fundamental stage prior to the identification of landscape types and areas. Accordingly, an analysis of the visual and scenic structure of the basin being studied was carried out in accordance with numerous studies that demonstrate the need to incorporate visibility criteria in landscape studies (Brabyn & Mark, 2011; Chamberlain & Meitner, 2013; Nutsford et al., 2015). Subsequently, we proceeded to roughly draw up a draft of types and areas prior to the definitive map. It should be emphasized that the fieldwork was fundamental and, in line with the LCA method, that it was incorporated in various phases of the methodological process, since both the research objectives and the scale of reconnaissance required this work. Accordingly, there are numerous studies that identify fieldwork as an essential in geographical and landscape research (Katz, 1994; Driver, 2003; Priestnall, 2009).

Subsequently, we proceeded to identify and name the landscape types and areas and to integrate them in a multiscalar fashion. The identification is the result of the semi-automatic superimposition of the information layers using the GIS tool. In line with previous studies (Salinas Chávez & Ramón Puebla, 2013; Warnock & Griffiths, 2015), this tool is useful for that purpose, but expert judgement has to be incorporated too, given that it is difficult to totally automate any landscape classification.

While the assessment of landscape character does not involve or imply judgements or quality appraisals, it does, in contrast, involve and imply the choice of “key characteristics”. According to Mücher et al. (2003), the decision about what the essential elements defining character are may involve a certain amount of subjectivity. Nevertheless, the process of characterization constitutes one of the major contributions of the LCA method, and even the ELC includes the concept of “character” in its definition of landscape: "Landscape means an area, as perceived by people, whose *character* is the result of the action and interaction of natural and/or human factors” (Council of Europe, 2000, p. 2). According to Brabyn (2009), the flexibility offered by this method with regard to scale, together with its being organized around the concept of “character”, is capable of providing a common frame of reference for landscape studies and the ELC.

5.2 Landscape and multiscalar integration

This method has made possible the compartmentalization of the territory into types and areas and its multiscalar integration on the basis of an iterative breakdown. However, this compartmentalization or demarcation turned out to be a complex process, especially at detailed scales (district and local). In accordance with previous studies (Ingold, 1993; Gómez Zotano & Riesco Chueca, 2010), the zoning or division into units (in this case, types and areas) remains a mental construct at the service of some aim, such as its operativity for planning and management.

Moreover, justifying the variables used for the division into landscape types and areas has made it necessary to consider the extent of the study area and the scale of work. Accordingly, previous studies (James & Gittins, 2007; Gómez Zotano & Riesco Chueca, 2010) confirm that the LCA procedure reaches its maximum potential when the result is a fine-grained description, fully compatible with detailed fieldwork.

Even though the LCA method allows for scalability or modularity (adaptation to different territorial scales), landscape classification is best expressed at a local, district or regional scale. At larger scales, certain properties of the landscape cease being perceptible or relevant and make landscape management difficult. Previous studies have confirmed the close relationship that exists between the scale of analysis and its methodological fit (Forman, 1995; Schermann & Baudry, 2002); a complex question that the LCA method has resolved for landscape analysis by means of its proposed classification into types and areas, which allows their integration, iteratively, into different scales.

In the proposed taxonomic classification of the landscapes of the basin under study, four scales and levels of reference are set out (supraregional, regional, district, and local). The results obtained confirm that in landscape planning and management the local scale is ideal, especially for managing the wetlands, due to the way they are exploited, with very localized pressures and risks affecting them.

5.3 Adapting the proposed methodology to the ELC

As it is mentioned in the ELC Guidelines (Council of Europe, 2008), there is a certain latitude as regards establishing landscape action steps and methodological procedures. Nevertheless, they also state that methods of observing and interpreting the countryside ought to: consider the territory as a whole and not be limited solely to places needing to be protected; integrate and simultaneously articulate different approaches (ecological, archeological, historical, cultural, perceptual, and economic; and incorporate social and economic aspects (Council of Europe, 2008, p. 8). By taking into account the measures set out in the Convention (Articles 6-7 of the ELC), the methodological procedure in this research has fully complied with the ELC recommendations:

- Knowledge of landscapes: identification, characterization. This phase laid down by the ELC for landscape action corresponds to the characterization phase of the British methodology. Nevertheless, the LCA terminology *Classification, Description and Characterisation* has been replaced by *Identification* and *Characterization* in order to adapt it to the ELC.
- Qualification and formulation of landscape quality objectives. These two phases replace the equivalent ones in the LCA (*Deciding the Approach to Judgements and Making Judgements)*, the contents of which are similar to the ELC but organized differently.
- Monitoring: this phase does not appear as such in the LCA method, but it is fundamental for taking into account the future evolution of the landscape, as well as compliance with landscape quality objectives, or for evaluating the effects of landscape policies.

In keeping with the ELC recommendations, this paper has viewed the basin as a whole in order to analyze it from an environmental, historical-cultural, and perceptual-visual point of view, identifying, moreover, all the landscapes in the area. In addition, with a view to proposing a complete methodological sequence, a monitoring phase has been included as the last part of the methodological process. It should be emphasized that this phase falls outside the scope of the research, given that it includes monitoring changes, evaluating the effect of policies, a possible redefinition of options, etc. Nevertheless, it was considered appropriate to include it in order to implement the ELC guidelines completely.

In any case, the LCA method looks like a robust methodology for implementing the ELC in different spatial scales, since there are numerous scholarly works confirming its usefulness in identifying and characterizing landscape (Brabyn, 2009; Atik et al., 2015) or to boost public participation (Capersen, 2009; Butler & Akerskog, 2014; Butler & Berglund, 2014).

6. CONCLUSIONS

In view of the widespread lack of understanding of endorheic basins, and the lack of a robust methodology suitable for analysis of their landscapes, a methodology proposal has been created in order to be able to identify, characterize and assess those landscapes with the aim of implementing the ELC in this type of space. The conclusions drawn from the methodological proposal and its application are as follows:

- The method developed herein makes it possible to implement the ELC by completing the stages proposed by the ELC as regards the processes leading to landscape action: knowledge of the landscape (identification, characterization, and assessment), the formulation of landscape quality objectives, and monitoring changes. It makes it possible, therefore, to establish a cross-sectional perspective in landscape analysis, introducing biophysical, historical, cultural, perceptual-visual and prospective criteria.
- The adaptability or freedom offered by the LCA methodology made it possible, in the area selected for study, to carry out: (a) a descriptive-analytical research into the basic natural features of the landscape; historical processes and socioeconomic bases; scenic and visual characteristics; (b) an assessment exercise, taking into consideration the transformation of the landscape's

fundamental natural characteristics (original ecogeographical units), its processes and historical dynamics and their impact on the current layout of the landscape; (3) and a prospective exercise, with a geohistorical basis, which aims at the assessment of the landscape and the possibility of implementing that assessment (landscape quality objectives).

- The proposed methodology presents interesting issues such as the demarcation of the landscape in an iterative fashion into types and areas and its applicability to different spatial scales (scalability). This flexibility made it possible to identify the landscapes in the endorheic basin being studied and to integrate them into a broader territorial context.
- The method has been structured in two major stages: identification and characterization of landscape types and areas, followed by assessment and proposals. In this way, one moves beyond a merely descriptive demarcation of the landscape into units. Therefore, this methodological sequence makes landscape types and areas able to be identified as functional and operational, by generating an assessment of the landscape and formulating landscape quality objectives as well as monitoring in accordance with the recommendations of the ELC.
- In accordance with the Guidelines of the ELC and on the basis of the methodology as applied, the following conclusion can be drawn, namely, that land planning has to take on board the fact that the task of characterizing and assessing landscapes is a preparatory step towards specifying actions and decisions aimed at their protection, management and planning. If this aspect of making proposals is lacking, the contribution of landscape to land planning would be limited to a strictly descriptive approach, which is alien to the dynamic character of the landscape.
- The current methodology proposal should be viewed as an adaptation of the LCA method to implement the European Landscape Convention in endorheic basins. It is, therefore, an indicative guide, open to being updated and/or adapted to the needs of landscape and land planning.

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