

The Landscape Taxonomic Pyramid (LTP): a multi-scale classification adapted to spatial planning

Abstract

Recent decades have witnessed the burgeoning of diverse international treaties on landscape (European Landscape Convention = ELC, 2000; Latin American Landscape Initiative = LALI, 2013). Their influence leads to a growing need for landscape classification in all signatory countries. In Spain the ELC has encouraged the incorporation of landscape to land planning. As a result, concepts and methods have been put forward integrating taxonomies and inventories within a common hierarchical structure. This trend is sponsored by epistemic currents conceiving landscape as a continuous cognitive object, whose semblance is modulated by the scale of contemplation. Simultaneously some pragmatic requirements arise from the need to frame landscape policy to fit different spatial spheres for decision-making and public participation; recent instrumentation and automation developments push in the same direction, although landscape contains an irreducible core where subjectivity and expert opinion are dominant factors. Such are the circumstances leading to the present proposal, whose ambition is to revive the discussion on landscape classification focusing on subsidiarity. A multi-level taxonomic procedure is described, where landscape description offers the opportunity to relate levels of land use and landscape policy decision-making to appropriate landscape unit levels.

Keywords

Landscape; Scale: Multi-level taxonomy; Geography; Planning; Policy

1. Introduction

The search for spatial homogeneities, a pre-condition for spatial policy, promotes research aimed at identifying the connections between form and process manifest in the territory and nested within a spatial hierarchy. To reach a correct analysis, the

taxonomic scale of phenomena must be revealed, i.e. the systemic patterns which allow us to display similarities and functional relations.

The current debate concerning the possibility of establishing international guidelines to interpret landscape should not ignore earlier initiatives, such as the recently established Latin American Landscape Initiative (LALI), based on the ELC. The latter, adopted in 2000, is now in operation in most European countries (Déjeant-Pons, 2006). Their influence leads to a growing need for landscape classification in all signatory countries. As a result, a series of ELC-inspired attempts followed, aimed at the identification and description of European landscapes (van Eetvelde & Antrop, 2009; Mùcher et al, 2010). Concepts and methods have been put forward integrating taxonomies and inventories within a common hierarchical structure. This trend is reinforced by epistemic currents conceiving landscape as a continuous cognitive object, whose semblance is modulated by the scale of contemplation.

Landscape methodology needs to be adapted to political intervention and public participation (at either a regional or local level): this has reactivated expert and policy-maker demands for a suitable taxonomic classification, unveiling the continuity of landscape, highlighting its scalar transitions. Landscape classification is fundamental to landscape management and research because it provides a frame of reference for communication (Brabyn, 2009) and involves the task of identifying multiple conceptual layers of meanings, structures and functions inherent to landscape. This process is particularly difficult as it involves both physical reality and human perception, thus relying on a wide range of indicators and meanings (Idem.).

Defining homogeneities and hierarchies helps to organise understanding; specifying geographic levels for social agency provides a helpful guidance for landscape policy (protection, management and planning).

The ELC was signed by Spain in 2000; it came into force in 2008. Its application encouraged several Spanish regions to incorporate landscape as an important issue in land use regulation (XXXXX, 2010). Spain is divided into seventeen autonomous regions. Since 1991, spatial planning policy and legislation (including landscape) have been the exclusive responsibility of regional governments. As occurs in Belgium

(Van Eetveide & Antrop, 2009), autonomy has led to different approaches to landscape classification in the Spanish regions.

The repertoire of proposals for landscape classification and typology in Spain is large, with numerous zoning methodologies having been tried out in this country and its regions (Riesco-Chueca et al., 2008; Mata Olmo & Sanz Herraiz, 2004). ~~However, most of these proposals are not fully adapted to the needs of public agency and participation, as required by current societal demands on landscape policy.~~ In the most of these proposals landscape taxonomy has not played any significant role. However the hierarchical organization of landscape offers the opportunity to relate levels of land use and landscape management decision-making to appropriate landscape unit levels (Bastian et al., 2015). In addition this knowledge on complexity of this organization could contribute to “scale-sensitivity” (Paloniemi et al., 2012) of policy and measures for the ELC implementation.

The present work is based on a previous monography by Gómez-Zotano and Riesco-Chueca (2010). The case study is part of a pioneering LCA-inspired project for the implementation of the ELC in Spain, the Landscape Information System of Andalusia (SCIPA). To assess its applicability in a wide range of different landscape contexts, the methodology has been tested in the Andalusian Sierra Morena, which was selected because it contains the variety of eco-cultural and landscape elements required. The methodology was also applied to several study cases in Spain and South America (Arias-García et al., 2017; Muñoz-Guerrero & XXXXX, 2017), but we consider Sierra Morena as a key case study, because it provides a sort of laboratory for Mediterranean mountain landscapes. Its landscapes are subject to considerable territorial pressure (urbanization, infrastructural development, rural depopulation, forest fires...), while it conserves very important environmental and cultural values.

Leading on from earlier initiatives, and aiming at revitalising the landscape classification literature, we put forward a proposal for landscape taxonomy (including highly urbanised areas). This proposal builds on the authors’ prior work on the role of scale in landscape (XXXXX, XXXXX & XXXXX, 2008). Accordingly, it can be tuned to the requirements of landscape policy (urban planning in a broad sense, protection of natural and cultural heritage), and lends itself to flexible public participation. It is

suitable to contemporary environmental and territorial agendas and is sensitive to realistically framed social demands in terms of landscape. The method in question, namely the *landscape taxonomic pyramid (LTP)*, is based on the British methodology of *landscape character assessment* (Swanwick, 2004), takes into account the strategy set by the ELC, and incorporates all the benefits of instrumentation and automation.

2. Landscape taxonomy and scale

In contemporary landscape research, scale-based landscape characteristics (Marceau, 1999) form the backbone of any theoretical approach to territorial classification and are therefore fundamental when taking planning decisions or addressing social *debate*.

Taxonomy, classification and scale have been considered the core issues of landscape research since the beginning of the XXth century. The etymology of the word taxonomy is derived from the Greek words *táxis* ‘order, disposition, pattern; range’ and *nómos* ‘custom, use, organisation’ (Liddell et al., 1996): it can therefore be construed as an instinctive avowal of the links between ordering (cognition) and planning (policy). Taxonomy involves a “vertical” division of objects, because it contemplates hierarchy and subordination aspects, thereby creating possibilities for classification at many levels. But the horizontal division is also an important effect of landscape taxonomy: it enables the comparative survey of members belonging to the same class. In terms of landscape, numerous different classifications can be established based on structure, dynamics, historical elements and scale.. First theoretical studies including classification as a key element for landscape science appeared in Russia and Germany (Berg, 1917, 1947; Ramenski, 1938; Neef, 1967; Nikolayev, 1978; Pedrolí, 1983; Bastian, 2000; Potschin & Bastian, 2004), then in France (Bertrand, 1968; Rougeririe & Beroutchashvili, 1991). Later on landscape research based on numerous classification methodologies has become general (Bolos-i-Capdevila, 1992; Käyhkö, Granö & Häyrynen, 2004; Otahel, 2004; Perko & Urbanc, 2004; Potschin & Bastian, 2004; Wojciechowski et al., 2004, etc.); many of these studies focused the integration of landscape into territorial planning (Blankson & Green, 1991; Martínez, Cazorla & Solana, 1995; Brabyn, 2009; Bastian, 2000;

Groom, 2005; Van Eetvelde & Antrop, 2009; XXXXX & XXXXX, 2010; Múcher, Klijn & Wascher, 2010; Vallés, Galiana & Bru, 2013; Bastian et al. 2015).

From the first theoretical studies on landscape scale and classification, the approach included a nested hierarchy of diversely sized and bounded spatial units (Ramenski, 1938; Solntzev, 1949; Neef, 1967; Nikolaiev, 1978). The landscape classification model dominant in Russia from the 1940s included several biophysical categories (*taxon*)¹ each of which was based on different characteristics: classes (geomorphologic structure), groups (water and chemical regime), types (soil and vegetation characteristics), *genera* (relief genesis), landscape units (inner morphological structure), etc. (Beruchashvili & Zhuchkova, 1997). Within each landscape unit there are different morphological parts too: *mestnost'* (locality), *urochische*, *podurochische* and *facies* (Nikolaiev, 2000; Bastian et al., 2015).

Although these approaches used different biophysical factors for distinguishing a wide range of hierarchical levels, in Russia relief and geology were considered of crucial importance for landscape pattern character for the reason that first landscape classifications were linked to geomorphologic studies, in particular, of quaternary deposits. In addition the character of Central Russia landscapes analyzed as a basis for this classification seemed to justify a deterministic vision of “natural territorial complex” as a uniform pattern which lies within a single relief form, with a uniform microclimate and particular vegetation association (XXXXX, 2007).

In Russian landscape typologies, scale was treated as an objective spatial property and landscape boundaries were seen as a fixed reality. In spite of the widespread use of these taxonomies in the exploration for natural resources and for planned economic activities within the former Soviet Union (Bastian et al., 2014), ensuing discussions on its principles, its universal applicability (Dronin, 1999) and its practical use for landscape management (Khoroshev et al, 2006) revealed numerous problems. A problematic assumption is viewing landscape as an objective, organized and deterministic spatial construction with static boundaries which are easily detectable through field studies (XXXXX, 2007; Shaw & Oldfield, 2007). In addition, landscape units proved to be spatially heterogeneous and their components could belong simultaneously to different time scales (Phillips, 1995); therefore it was difficult to integrate time and landscape dynamics into the Russian classification

¹ Russian landscape taxonomy includes: *otdel* (section), *sistema* (system), *podsystema* (subsystem), *class* (class), *podclass* (subclass), *gruppá* (group), *tip* (type), *podtip* (subtype), *rod* (genus), *podrod* (subgenus), *vid* (type), *podvid* (sub unit).

based on static and cinematic models combining leading natural components (Pedroli, 1983; Khoroshev et al, 2006). This approach has been dominating Russian landscape science until the last decades of the XXth century, when adoption of new methods of landscape studies such as mathematical modelling, system and ecological approaches and landscape geochemistry opened new perspectives for landscape analysis (Shaw & Oldfield, 2007; Bastian et al., 2015).

Landscape ecology has enriched approaches to landscape classification with its findings all over the world. Marceau (1999) defines scale as the spatial dimensions at which entities, patterns and processes can be observed and characterized. As indicated by recent surveys, the scale is not a monosemic concept. If we observe space in an absolute framework, it could be defined as an operational tool used to split geographical space into nested units. If we use the relative framework, scale becomes the "window of perception", the filter or measuring tool through which the researcher chooses to view space; it is intrinsically linked to spatial entities, patterns, forms, functions and processes (Marceau, 1999; Hay et al, 2001).

Numerous studies have recognized that landscape is scaled not only in space, but also in time (O'Neill, Johnson and King, 1989; Wu, 1999). Wu (1999) emphasizes that different processes tend to prevail in distinctive domains and scales in time and space, therefore extrapolating information from one scale to another; a multiscale approach is therefore unavoidable (Hay et al. 2001).

In spite of this progress, many of the classifications based on physical characteristics were not taking into account an important characteristic of scale, which is not a mere spatial property and is observation-dependent. Consequently the scale of the process is fixed only once the observer has specified the actors in the system (Hay et al, 2001). Theorists of scale and a number of human geographers argue that scales are socially constructed, in mutual relation; they come into existence under certain conditions: scale should not be considered an ontological structure which "exists" but an epistemological one - a way of knowing or apprehending (Thrift, 1995; Sheppard, 2004; Sheppard & McMaster, 2004; Marston et al, 2005). Therefore most of classifications used by geographers involve a mix of qualitative, quantitative, subjective, and objective methods (Brabyn, 2009). On the other hand scales could be explored as simultaneously occurring spatial (physical and social) and temporal dimensions describing different entities (e.g., levels of landscape organisation, levels

of governance systems) that have evolving interactions between each other (Cash et al., 2006, Paloniemi et al., 2012).

Landscape classification should provide a frame of reference for communication between different actors (Brabyn, 2009). This implies understanding what landscapes people value and the grounds of their valuation, in order to improve their management and conservation.

This orientation of any landscape classification is especially important because the ELC defines landscape as “an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors”; implementing its policy should include planning procedures that allow the general public and other stakeholders to be involved.

3. Material and methods

3.1. Methodological framework

This landscape research endeavours to develop and apply a methodology of multi-scale classification of landscape character. It has been tested in Spain and specifically calibrated in the Sierra Morena ridge.

We propose a general and integrated procedure to identify and characterise landscape. It is based on the LCA methodology, which responds to the need to establish a hierarchical approach to analyse a continuous phenomenon, landscape (Swanwick, 2002; Wascher, 2005). A core concept in the LCA is landscape character, a distinctive and discernible pattern of elements which are consistently present in a given portion of space, in other words, those which differentiate it from another (Swanwick, 2004). This implies an emphasis on the relational content of landscape, conceived as an interaction between people and place, thereby providing a pragmatic answer to the question of landscape zoning through the systematic analysis of natural and social factors and an iterative articulation by subdivision in areas and types. The resulting classification combines elements of *specific* (each area is an environment with a name) or *abstract* information (each type comprises a range of features which are relevant to different contexts). This distinction between the spatial (*areas*) and the thematic (*types*) is important: areas are generally rooted in

collective perception and recognition, as reflected by an allusive place name, whilst types are the result of synthesis or induction, reflecting the dominant influences or factors in a given landscape. Nevertheless, in practice, the procedure tends to ignore the strict application of these distinctions: especially at smaller, more specific levels, pragmatic considerations (achieving recognisable, clear-cut units) tend to prevail over the purely conceptual approach.

By providing a comprehensive scalar range, our proposal attempts to reinforce the LCA methodology in terms of modularity (the capacity of the model to adapt itself to different territorial and policy-oriented scales and to structure them hierarchically) and landscape dynamics, thereby offering new insights into the multiple nesting of areas and types. This is one of the key features of the LCA, which only reaches its full potential when used for a meticulous description. Therefore, it seems convenient to explore how far can the scale ladder be travelled in that direction.

While the LCA has in practice been restricted to a very limited set of areas and types, adapted to the needs of a national classification scheme, our approach aims at providing an unrestricted formulation, involving a complete sequence of scalar levels. Running from the very bottom to the top can help achieving a joint perspective on the relevant variables entering the classification scheme at each level. At the same time, it is adapted to the peculiarities of landscape administration in Spain. Land use and landscape are decentralised; as a result, regional governments have a key role in landscape policy application. Local governments (municipalities) play only a secondary role in landscape regulation. Therefore in our case study we prioritize regional, subregional and supralocal levels.

On the other hand, LCA has occasionally been applied as an expert analysis with scarce citizens' involvement. Therefore it is necessary to complement quantitative data and expert analysis with dialogue in order to illuminate the social construction of landscape. This way the landscape classification can act as a nexus between abstract ideas about landscape character in different scales and the human perceptual experience of the qualities and functions of these landscapes (Hammarlund et al., 2016). It is especially important for Spain where the tendency towards a top-down and technocratic land planning system, inherited from centralized policies before 1978, still persists, and public engagement is generally seen as a

one-way communication with a pre-determined end result (XXXXX, 2010, Hammarlund et al., 2016).

The present proposal outlines an instrumental model for the consensual identification of landscape types and areas. The tool to that end is a multivariate semi-automatic treatment plus expert opinion and participative inputs operating on mapped variables and perceived phenomena ranging from the physical basis to the socio-cultural strata (Bunce et al, 1996). It is important to underline the fact that the procedure is open to the progressive inclusion of new variables depending on the demands of the study, the availability of cartographic information, and the possibilities of IT applications, whilst bearing in mind that, given the complexity of the landscape concept, landscape studies are not ideally suited to automated aggregation or generalisation. It is not only quantitative data which are being processed, as is sometimes the case in landscape ecology; culture-based variables are equally important and these cannot be handled in a purely automatic way. Therefore, expert opinion, as well as participative inputs, are essential and need to be considered as a key ingredient in all steps of the procedure.

3.2 A comprehensive proposal for the classification of landscapes

Figure 1 illustrates the proposed classification of landscapes as a multi-level structure, displaying its five reference scale levels. A nested taxonomy as proposed allows conceptualizing the territory as an iterative mosaic within a mosaic. It must be stressed that only under optimal circumstances can the full range of the multi-level description be achieved. In most landscape studies, it is not absolutely essential to contemplate all the levels since abbreviated versions of the pyramid may be more practical, as demanded by the policy context. However, browsing the full range of levels for landscape description is an enriching exercise, from which a flexible insight into the telescopic nature of landscape can be gained. Although we are conscious that in field observation boundaries between landscapes normally are not perceived as sharp limits and there are transitional zones between different landscape units, we treat them as clearly limited units in order to produce maps based on GIS data.

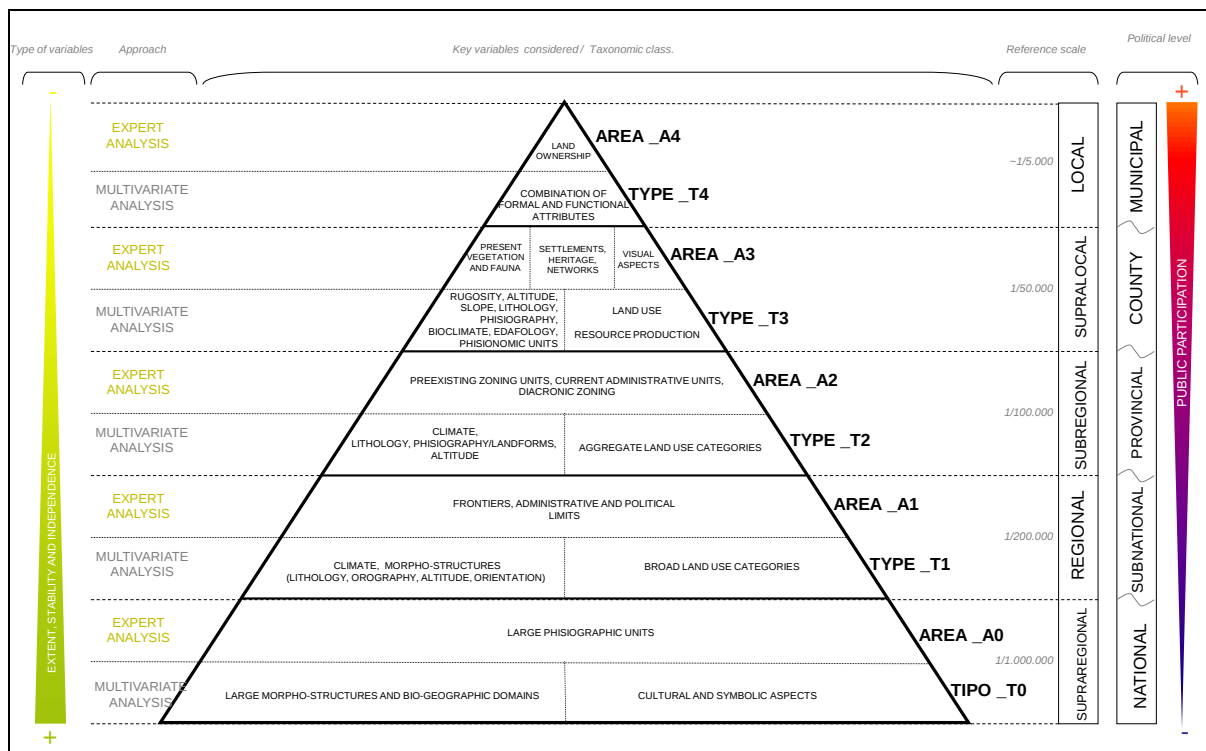


Figure 1

Landscape Taxonomy Pyramid (LTP). Identification and characterisation of landscape types and areas according to different spatial scales and levels of public agency. Source: The authors

The connection between spatial scale and political levels is extremely variable depending on the political context. Although the simultaneous assessment of landscape element and processes, as well as policy processes and practices at various scales and levels is necessary (Paloniemi et al., 2012), in our case study we focused on regional, subregional and supralocal levels in adaptation to the Spanish landscape regulation system.

The procedure is characterized by the following:

- The approach can be adapted to different territorial levels, and detects patterns within a hierarchical system (T0-T4 and A0-A4). It includes up to five reference scales: supra-regional (1/1,000,000), regional (1/200,000), sub-regional (1/100,000), supra-local (1/50,000) and local (1/5,000). The extremis of this scalar ladder (superregional and local scale) are not contemplated in our case study because it extends to national or local dimensions, which are weakly structured in Spanish landscape regulation. However, the pyramid must be drawn in its complete

dimension, providing a comprehensive scalar description. Each landscape displays specific methodological features in the range of scales between regional and local. The standard “unit of landscape” is mapped at a 1/10,000 scale.

b) The classification reflects the distinction between types and areas in the LCA. This is essential for inter-scalarity, allowing the interpretation of scale in a flexible rather than merely quantitative or dimensional manner. The classification is carried out at each level, firstly in terms of type and then in terms of area. There is no direct constraint linking the number of type / area levels and the scale levels, but for the sake of the present discussion, both numbers are equated. A key feature of the proposed method lies in the specific manner adopted for the combination of technical knowledge, expert analysis and public participation. The alternance of types (demarcated by GIS-based semi-automated procedures based on indicative variables) and areas (arranged by expert opinion, and patterned to suit the needs of public participation by focusing on perceived phenomena) ensure a balanced combination of all the ingredients. In our case study, both areas and types were defined by means of sharp borderlines. This is a compromise solution: while acknowledging the continuous nature of most landscape variables, there is a double need to draw the line somewhere across the transition between adjoining units; on the one hand, policy requires specific boundaries; on the other hand, public participation is easier to implement with a clear-cut classification.

c) Identified areas and types are labelled according to the following criteria: in the case of types, an essentially abstract category, we generally use between three and five terms which reflect the dominant factors or main influences on the landscape; the nomenclature used for areas can be inspired by their current placenames, either when they allude to inherent physiographic elements (Sierra Morena, River Guarrizas...) or when they refer to specific human-made features relating to a type of settlement or land use (Aracena, Pueblo Nuevo...). Social agents are usually involved in the designation of types, and especially of areas, with a view to strengthening identification. This designation could be done with different stakeholders and local actors involved into landscape management and land use (policy makers of different levels, practitioners, representatives of NGO, tourism entrepreneurs and other local stakeholders) through different type of surveys,

interviews or focus group discussions. Toponymic heritage helps in the search for place names which are based on local tradition, thereby avoiding unfamiliar or complicated terms which may discourage public participation. Toponymic heritage helps in the search for placenames which are based on tradition, thereby avoiding unfamiliar or complicated terms which may discourage public participation. In the smallest classification levels, certain areas may actually correspond to artificial realities, such as villages or farmsteads.

d) The procedure for the identification of types and areas is adapted to their specific nature. The former are identified via a semi-automated process through multivariate analysis (a combination of algorithms K-Means and ISODATA, along with TWINSpan) whereas the latter require expert analysis, i.e. a series of adjustments and discriminations based on a holistic and discursive understanding of the area's features. It is becoming increasingly common to adopt semi-automation for the generation of landscape units (Blaschke & Strobl, 2003; Brabyn, 2009), although the critical and interpretative contribution of a knowledgeable expert on territory is still indispensable since there are cultural factors with a high degree of subjectivity which are inherent to the study of a given area. The algorithms used are open to expert training and participation feedback by means of *ground truth* collection, but the very concept of landscape makes the automation of aggregation or generalisation processes difficult. In this respect, it should be emphasised that the aim is not only to process quantitative data but also to weigh the importance of culture-based variables, which are difficult to assess using information technology tools.

e) The procedure allows us to integrate key variables into the identification of types and areas at different scales thereby permitting the clear identification of the various different components of a landscape: abiotic, biotic, cultural and perceptual. The identification of types and areas is followed by a characterisation providing an overall description of the particular combination of traits of a given landscape which set it apart from another. This holistic description is defined in the LCA system as *character*. It does not however imply a valuation of the landscapes identified nor does it imply that they are unique or exceptional.

f) The pyramidal approach offers a well-structured visual representation of the complexity of landscape and reveals a number of properties which can only be detected at certain scale levels. Although our methodology focus on different descriptive variables for different scales, we are conscious that some landscape properties can be sensitive to processes of various hierarchical orders, therefore these variables could be modified according to characteristics of landscapes it is applied to. The scale-adapted methods of landscape analysis allow to transfer data from one scale to another avoiding their inappropriate extrapolation (Wu, 1999, 2004).

g) The procedure offers clear and easily measurable differences between primary data (temperature, precipitation...), secondary data or information which requires interpretation (land use, ecology) and human-made factors (economic, cultural and visual).

h) The graph shows degrees of dependency between the different landscape variables. Some are more stable and self-determining, whilst others are highly dependent. Abiotic components (climate, lithology, geomorphology, hydrology and bioclimate) are relatively independent and define the biotic components (vegetation, wildlife and soils). Dependency increases as we climb higher on the pyramid so the variables located at the top are dependent on those which serve as substrata. Procedures for defining landscape must pay special attention to this pattern when considering human activity. This can occur at all levels since the importance of human intervention on the landscape has increased continuously throughout history. Traditionally human activity had a less widespread or intense impact on the more independent components (climate, geology...) but recent examples such as climate change, fracking or macro-dams are altering our view of this premise. At the upper end of the pyramid human influence increases, especially in human-made elements, which are used as variables in the process (land use, settlement patterns, networks...) and which are often the most dependent.

i) As far as planning is concerned, the graph displays the significance of different taxonomic levels for different levels of spatial planning. For example, higher level

units are more relevant for strategic planning on national and regional planning, middle level is indicated for regional and provincial landscape atlases and inventories. Conversely, at lower political levels as in some other taxonomy-based approaches to landscape assessment (Bastian et al., 2015), there is greater precision and the associated mapping is more detailed, and mapping units could be used for the purposes of environmental impact assessment or for imposing restriction on land use. As a general but not universal guideline, landscape types can be useful for regional planning, whilst landscape areas are more helpful in district and local planning.

j) In terms of public participation, generally it is more effective on local scale, since landscapes participate in the construction of local identities or sense of place. Nevertheless for effective implementation of landscape policy cross-scale communication is necessary for policy makers, practitioners, experts and different actors involved in landscape planning and management. Therefore specific cross-scale communication platforms are considered an effective tool for landscape governance (Paloniemi et al., 2012).

k) [see point b].

4. Results

Once the overall characteristics of the approach have been outlined, the Andalusian Sierra Morena is used to show the specifics of the method (Figure 2, 3 below).

Sierra Morena is a mountain range with dense woodland and sparse population at the fringe between the Palaeozoic materials of the Meseta (central plateau) and the tertiary and quaternary sediments of the Guadalquivir basin. Towards the west it contacts the sea in the Algarve whilst to the east it links directly with the Meseta and the secondary and tertiary materials of the Betic Mountains. Rather than a mountain range in the strict sense of the word, Sierra Morena forms the transition between the Castilian Plateau and the Guadalquivir Depression, and could be described as a fracture or fault running for some five hundred kilometres (Alcántara et al, 2014).

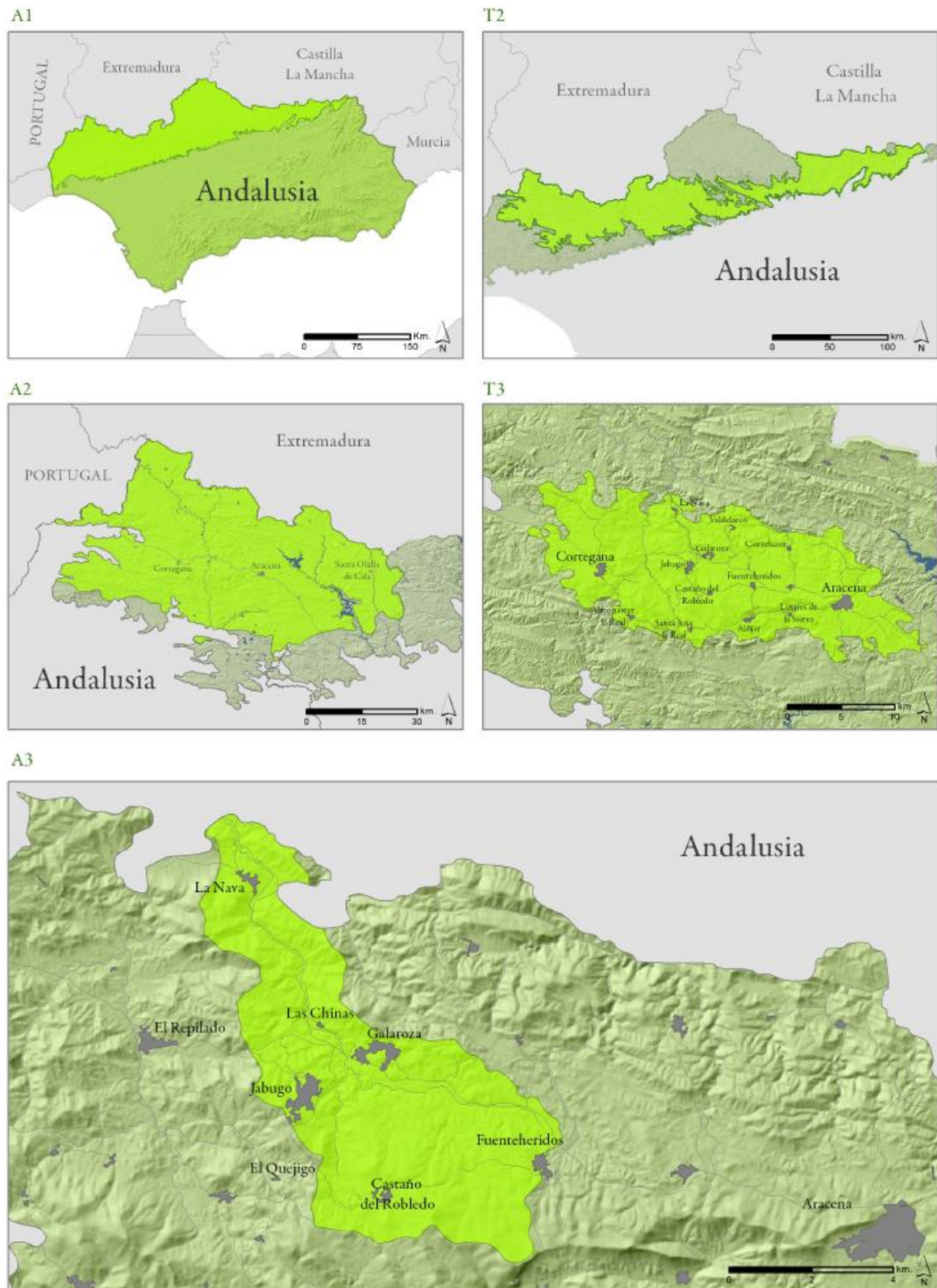


Figure 2

Areas and types in the case study (A1, T2, A2, T3, A3). Source: The authors.

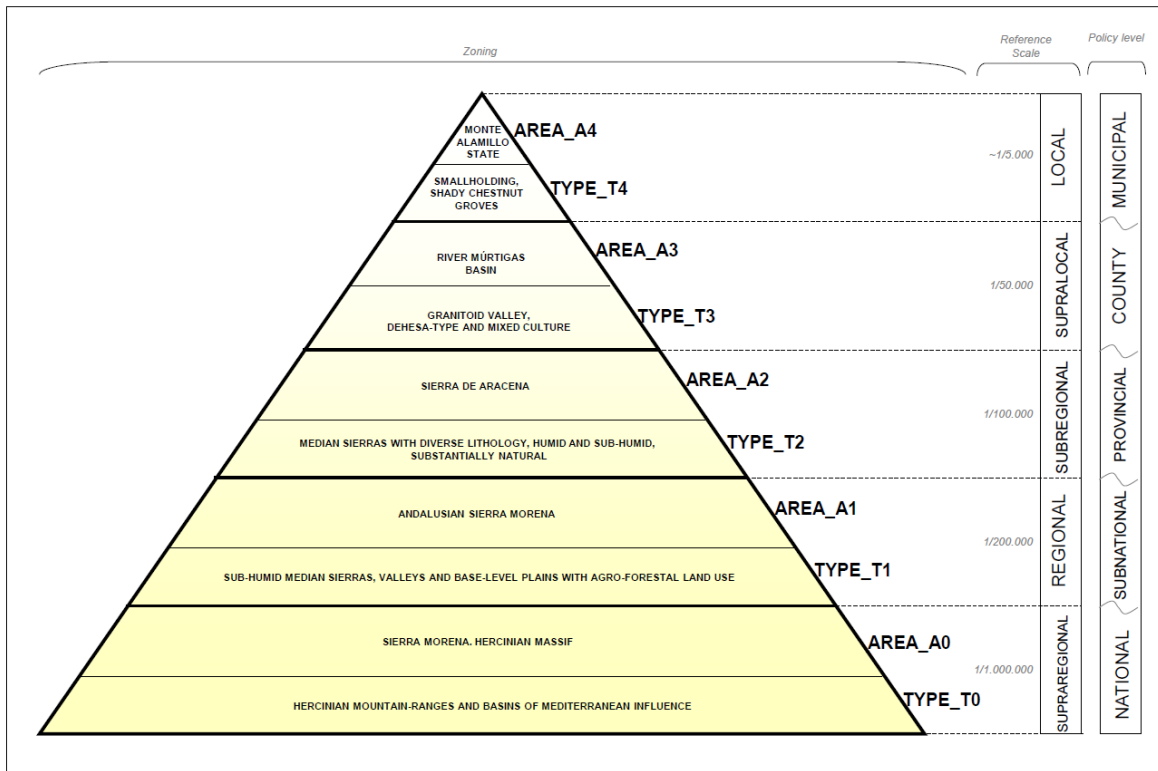


Figure 3

Landscape Taxonomy Pyramid (LTP). Identification of landscape types and areas in Sierra Morena (Spain). Source: The authors.

It should be noted that taxonomic classification aims to define homogeneous spatial units, not by subdividing into equally sized units, but by defining common functions and attributes, i.e. units displaying similar conditions and patterns. Depending on scale, these features may become less perceivable or relevant.

a) **TYPE_T0:** at supra-regional scale (1/1,000,000), this is the broadest level of landscape interpretation. It involves large surface areas and is generated by automatic detection through multivariate analysis of abiotic macrostructures which are relatively independent and stable, including large morpho-structures and bio-geographical features. At a regional level, the identification of landscape types is useful when defining general planning guidelines. Given the low degree of specific planning at this scale, public participation is of little relevance.

b) **AREA_A0:** these areas, as defined by experts, comprise landscapes which are associated with large distinctive physiographic units. The nomenclature generally

refers to the toponymy of large orographic or hydrological structures, except where such areas are defined by administrative or economic parameters which have superseded any such physical features. At this level there is an opportunity to recognise many of the basic natural features (large orographic systems, climate...) and historical memory of a given territory by using well-established or even ancient place names. The chosen name should be simple and ideally reflect the specific characteristics and location of the place in question whilst transmitting an overall perceived image. As such, it should be derived from traditional toponymy or from an initiative involving public participation. A0-areas may be useful in drafting planning policies and developing a general framework for the management of land use, rural development, landscape policies and the enhancement of the natural and cultural heritage.

c) TYPE_T1: at a regional scale (1/200,000), these types result from multivariate analysis of morpho-structure (lithology, topography, altitude and orientation) and climate. These abiotic, stable and independent variables are interlinked with large scale land use, a human-made variable which is more unstable and dependent. At this scale public participation plays a more significant role.

d) AREA_A1: from a socio-cultural point of view these areas coincide more or less with large regional units and they should be named in accordance with the traditional or administrative designation. Public consultation processes should aim to strengthen landscape identity and achieve consensus on territorial guidelines as established by sub-regional planning policies.

e) TYPE_T2: this is an intermediate scale (1:100,000) which permits the observation of the integration of macro and meso-structures in the same field. Meso-structures are identifiable within macro-structural units, since abiotic environmental components (climate, lithology, relief...) are combined with a range of land uses

conspicuous at intermediate scales. The former tend to be more stable but the latter change relatively quickly and following different transformation routes.

f) **ÁREA_A2**: includes areas associated with topographic units such as medium-sized mountain ranges and valleys. Other variables such as the historical information and human elements are assessed through expert analysis. In these areas, which are usually pre-established, place names are a fundamental element of the cultural expression of the landscape.

g) **TYPE_T3**: the reference scale for conventional landscape units as defined by its morphology (1:50,000); it contains a combination of abiotic potential, biotic resource use and anthropic elements. These types, which are obtained by multivariate analysis, occupy a significant position in the pyramid, at a level where human influences show up in greater detail along with the key interactions and combinations required for a full understanding of the landscape. At this scale, orography, bio climate, soils, land use and anthropic influences are the most commonly used variables when identifying and characterising landscape types and establishing their nomenclature. References to land use, either as natural vegetation cover or for agricultural purposes, are generally employed to enhance and differentiate the denominations of the physical features of the landscape. Generally the land use in itself does not form the core part of the name, unless it is closely linked with a particular type of terrain, as is the case with some specific descriptions of countryside such as plain, floodplain or moorland. In clearly urban spaces (towns, cities, neighbourhoods, infrastructures...) terms can be added in reference to elements such as the urban layout, overall image, vacant lots. Greater public participation is required at this level.

h) AREA_A3: these are areas associated with smaller topographic features (hills, peaks, valleys...). They are defined using expert analysis by correlating biotic (vegetation and wildlife habitat) and human-made elements (settlements, vestiges and networks) as well the visual or scenic dimension (inter-visibility). At this scale, vegetation or heritage elements provide the core defining the formal or visual aspects of the territory. Conversely, larger territorial components become less clear and are harder to perceive. As was the case at the previous level, it is necessary to involve the public so that the names selected reflect everyday language.

i) TYPE_T4: this is the last and most detailed of the identifiable landscape types included in the hierarchical structure. At a local scale (1:5,000), the types identified here have small extension; they are defined by the semi-automatic combination of diverse formal and functional attributes which vary according to the characteristics and scope of the study. T4-types are useful for planning certain zones and sectors of natural areas. Public participation is essential.

j) AREA_A4: these areas are most intimately related to landscape details. A4-areas have the smallest extension; they are defined by expert analysis of the landholding structure of T4-types. The only variable used (a microstructure) is relatively dependent on other factors such as land use or historical evolution, so there is a certain degree of instability. At this reference scale (1:5,000) and political-administrative level (municipal), areas are used for the integration of landscape into town planning policies which require a high degree of definition and precision (land which may or may not be developed) and therefore significant public participation is imperative. At this scale the degree of detail is magnified and the field of vision becomes so reduced that subtle territorial components are not easily discernible within their overall context. Horizontal relationships of geographical interest become invisible so that new methodological approaches need to be implemented, particularly in the case of dense urban areas.

4. Discussion

In this paper we focus on ordering landscapes in a hierarchically structured classification, so that the larger areas encompass smaller ones, leading to a nested classification. The approach relies on similarities and shared functionality between classes (Tversky, 1990; Fan & Li 2009; Xie et al. 2009), with an emphasis on the societal relevance of the patterns detected, which should delineate clear geographical units for the sake of public communication and deliberation. The analysis of the structure and function of a landscape is based on a basic geographical concept, scale (Lam & Quattrochi, 1992), widely used but controversial. In addition to consensual notions linked to scale (cartographic scale, spatial extent, resolution), the operational scale should also be considered, i.e. the spatial extent at which certain processes operate in the environment. Furthermore, the scale as a constructed or culturally bound object is an additional conceptualization route (Sheppard & McMaster, 2004). For the purposes of the present research, however, operational scale is not a rigid framing device: it is revealed by the landscape variables chosen at each level. **The fact that scale is sensitive to social considerations will be reflected by a continuous gradient, both in terms of public participation and by the flexible arrangement of policy levels.**

Multi-scale taxonomy displays the special dimension of landscape in a hierarchical manner, thereby expressing the existing spatial relationships. Multi-scale taxonomies can be labelled with qualitative denominations (global, regional, local, other), or via numerical indices (for instance, among other possibilities, large scale, medium scale or small scale). A combination of both approaches is generally adopted.

The components which are present in a given area of landscape manifest themselves in diverse ways in terms of space and time and this affects the definition and interpretation of each scale; furthermore, the policy arrangements exhibit variable configurations depending on the scale, though no strict reciprocal relationship exists between landscape scale and political or administrative levels of territorial planning and policy.

Recognising the methodological idiosyncrasies of each landscape scale is fundamental (XXXXX, XXXXX & Álvarez, 2008). The involvement of all social agents interested in landscape is stimulated and guidelines for participation are clarified.

Classifying landscapes is not only a theoretical and methodological need but also a tool bringing landscape knowledge and methods closer to the general public. Numerous proposals have used Geography as a resource to strengthen the theoretical foundation of landscape classification: from the simplest geosystemic-landscape relationship to the LCA. In both cases, an increased flexibility in our understanding of a given landscape as viewed from different scales is one of the main contributions made by geographers. Travelling across scale has enriched geographical analysis, and contributed important insights into this essentially synthetic concept, landscape.

The possibility of transferring conclusions from one scale to another (scaling) provides numerous benefits to landscape theorists. Not everything that is valid or relevant in one scale can be correlated with another, but simply interpreting the results of a study within its own scale and against the backdrop of other scales (upwards or downwards in the ladder) is an exercise which enhances understanding. Therefore, a model allowing tentative extrapolation and interpretative comparison across scales is a good basis for the creative enhancement of research on landscape's content, dynamics and values. Accordingly, the proposed LTP methodology allows:

- The systematic structuring of a continuous phenomenon such as landscape into a hierarchical system. However, the experience of landscape at each scale presents peculiar features which need to be addressed adequately.
- Providing a flexible methodology for different territorial variables and scales, as in the examples above. This involves identifying areas and types, defining their characteristics, dynamics and pressures, and incorporating public opinion and participation to decision-making processes.
- Detecting homogenous features in diverse environments whilst highlighting scale-based similarities in functional patterns and boundary conditions.

- Ensuring the balanced inclusion of all physical, social, cultural, economic and visual factors which define landscape and provide it with its inherent complexity.
- Suggesting potential new subjects for landscape research and policy.
- Establishing procedures to identify the relations between landscape scale and political / administrative levels of territorial planning and the natural and cultural heritage policy, providing criteria for a reflective subsidiarity.
- Establishing a mechanism to contextualise a landscape study, a diagnosis or a planning proposal in the absence of detailed landscape information.

5. Conclusions

The objective of landscape studies and initiatives covering a range of scales is to cater to the needs of a whole range of planning and regulatory activities. Adjusting landscape methodology to the field of political intervention to facilitate the implementation of international agreements on the matter, is a clearly felt need; thus the urgent search for iterative and functional approaches allowing public participation, generally on an inter-scale basis, and adapted to the different policy geometries in the different signatory States. The present paper aims to contribute to this by setting a framework suitable for different political contexts and levels of spatial integration (municipality, district, region, nation), and consequently involve a range of different modes of social participation. Five levels have been described, focusing on the landscape protection, management and planning, with a flexible rather than a quantitative approach.

The landscape gradient extending from the supra-regional to the opposite extreme, the local, is a key component of landscape perception, a perception which tends to lose clarity when it refers to areas which are larger than regions, or conversely to urban areas or other small-scale units.

Amongst current landscape methodologies, the LCA inspiration has demonstrated an exceptional capacity for providing pragmatic solutions, leading to a prolific landscape knowhow, rich in recommendations, good practices and experience. The adaptation

of this model to new demands concerning landscape (application of the ELC, educational purposes) allows us to design and develop new methodologies and approaches which, like the one presented in this paper, are multiscalar and display the rich conceptual layers inherent to landscape.

Looking towards the future, the objectives of taxonomic study ought to be ambitious: acting as a catalyst for better national and international agreement concerning the principles of landscape classification; developing common landscape terminology with the aim of improving communication, coordination and international understanding; and, as a result, making landscape research more effective throughout the world. The success of the European Landscape Convention and the Latin American Landscape Initiative is a clear indication of the need to incorporate landscape into the policies for territorial organisation at diverse spatial scales.

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