Planning for Desirable Land Uses in Periurban Landscapes: Application of a Spatial Concept for Territorial Sustainability

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Abstract

With the aim to test the categorical formulation of a spatial concept on the functional, desirable characteristics of land-use distributions inside periurban landscapes, in the research we envisaged and developed an original quantitative method, deployed in nine study-cases worldwide.

Increasingly facing a generic set of pressures from suburbanization and unregulated land-use change, unwanted spatial outcomes in those landscapes often arise after trespassing critical thresholds of ecosystems' processes inadvertently: Overriding the minimum-area requirements, for example, of crucial ecosystems providing basic ecological services to whole urban regions.

Spatial concepts can be powerful tools for strategic planning of territorial systems, helping to avoid shortsighted plans and policies. From the narrative of a spatial concept supportive of strategic planning and regulatory policies for territorial sustainability (the "Aggregates-with-Outliers" -AWO), we developed an original synthetic, quantitative method fostering statistical analysis between diverse locales, years, and scales -as well desirable scenarios.

From the joint maximization of size variance and land-use diversity (JMV+D model), we evidenced deficits and potentials on the composition of heterogeneous periurban landscapes, from the universal perspective of the concept. It is considered a tool (among the many required) for the strategic planning of territorial sustainability in those landscapes, especially required of a flexible definition on the desirable spatial outcomes of plans and policies.

Keywords: Territorial Sustainability, Spatial concepts, Landscape analysis, Mosaic heterogeneity

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1. Introduction

Stating the case for applicability of normative spatial concepts in strategic planning, in the study we tested a spatial concept (*Aggregates-with-Outliers*-AWO; Forman 1995) that defines desirable land-use distributions in periurban landscapes -the ones at the fringe of metropolitan areas or urban regions.

Spatial concepts are tools which often seek optimization of functional processes by integration of landscape components. Some rely (to different extent) on the non-linear dynamics paradigm, as the referent on the complexity of territorial systems: In the AWO case, with the explicit aim to improve territorial sustainability and resilience of the landscape (as a coupled natural-human system) in an applied way.

Following this goal, we focused on the question whether this particular concept could be developed and applied as a technically-relevant tool for strategic planning; eventually becoming a universal reference for the functional analysis of the fast-changing, old cultural landscapes of the metropolis. Through the comparative analysis of historic-agricultural landscapes located inside urban regions or megalopolis (Barcelona region in Spain; North-East megalopolis of US; Beijing megalopolis and Anhui-Nanjing region in China), the research contributes this way to the definition and implementation of integrative approaches on territorial planning.

These landscapes experience indeed similar strong urbanization pressures, and increasingly have problems with the provision of natural ecosystems' services. Those global trends take place across different continents and bioclimatic regions, yet within specific physical contexts and diverse socio-economic, cultural, and political background or traditions. From this perspective, differences on socio-economic characteristics, cultural or political structure are shaping in a good part the specific land-distributions to account for, in a comparative analysis; in part the product of a local situation, and the physical context in which they are embedded. This is a territorial complexity playing at multiple scales too: From the ecosystem to the landscape, and the biosphere.

The specific coevolutive patterns resulting from human and natural subsystems' integration are still reflected, nowadays, on the land-use structure of vernacular landscapes; where human adaptations (out of poverty and necessity) were cultural investments in nature. Yet nowadays we see, instead, a globalization process that homogenizes human impacts, and provides standard solutions on land uses; increasingly alienated from nature, and affected by not-retrofitting the actual impacts on the environment. As a consequence, humans are greatly affected by the decrease on the amount and quality of the "taken-for-granted" ecosystem services (as clean water, clean air, fertile and productive agricultural soils, or clean food).

To place the problem in context, for the first time in history there are now more humans dwelling in urban areas than not, increasingly in a characteristic low-density suburban sprawl which already comprises over fifty-percent of the total area available in some countries (since year 2000 in US); quickly becoming a universal-trend or 'urban tsunami' (Forman 2008: 253). This is the urban fringe where the rural-urban dichotomy becomes messy, often a mix of non-structured and waste spaces. Hence, strategic planning should focus on those not-yet urban landscapes with unresolved structures, in order to avoid wasteful consumption of space (inside a seemingly disposable landscape).

Besides, periurban landscapes often retain agricultural land which is critical for whole urban regions, both in decreasing the ecological footprint and for maintaining the strategic supply of ecosystem services, food and materials: Increasing resilience this way against global alterations, while diminishing risk spreading (from economic fluctuations and climate change, eg.).

Regarding the impacts over environmental systems, and the question of how fast biodiversity is disappearing, no precise estimates are available -neither on the number of species lost, or the range. We do know that the current decline of biodiversity is occurring 1,000 to 10,000 times faster than at any other time in geological history, and that over the last 50 years humans have modified those ecosystems more rapidly and extensively than in any comparable historic period (Millennium Ecosystem Assessment 2005).

We know as well that biodiversity reduction is a function of territorial size and isolation, and that a ten-fold increase in area results in a doubling of species. This leads to the concept of interrelation of species and area (Wilson & Peter 1988), and the definition of compositional thresholds for interrelated ecological, socio-economic processes (for example, the threshold in suitable land uses, and species movement of percolation theory; see Farina 2000 eg.). If we know human settlement and activities are the main drivers of land-use change and natural impacts, striving for the remedial planning (and positive actions required) becomes the more compelling, therefore.

As a proactive tool for strategic planning, remedial proposals usually integrate socio-economic and historical factors in order to explain actual and desirable mosaic-pattern configurations. This balance can be framed, for instance, as a dynamic multifunctional equilibrium; not least, in order to cope with the rising tension between providing human and ecological services, and the required flexibility of planned development (Alberti & Marzluff 2004).

Eventually, with properly-integrated approaches we will consider, in a synthetic way, the most significant components of spatial complexity inside existing cultural landscapes, from their definition as coupled territorial systems. This includes its main environmental and socio-economic aspects, social values and the cultural meaning attached to different spaces. Even when considering the spatial concepts as 'thought experiments' (theorizing on the optimal distribution of land uses in the landscape eg.), its development may contribute to the quest for a dynamic balance between the provision of ecosystem services and the amount of desirable, regulated land development.

For such integrative (holistic) purpose, we are told consistency inside a diversity of methodological approaches is especially required, starting with data collection: As roadmap, we should design studies allowing contrasts to emerge from comparison of data, guided by a conceptual framework that accounts for interactions at multiple scales (O'Sullivan 2004; Carpenter et al. 2009).

Our approach, then, was defined in line with applied efforts to characterize and quantify, in a consistent and systematic way, the actual situation and diversity of such compromised landscapes worldwide. For this, we aimed to test the applicability of a spatial concept from Landscape ecology, elaborating on the adequacy of normative concepts for strategic planning in general. Our sequence started by testing the conceptual strength of the spatial concept. Once validated, we would inquire on the feasibility of its deployment; eventually allowing at the end (as a development) the functional definition of the desirable landscape characteristics, and a comparative analysis on mosaic distributions from a universal perspective.

This would be a quantitative approach that measures the spatial blueprint of territorial complexity and human activity in periurban landscapes, as reflected by our original synthesis on composition and heterogeneity of land uses. It may become, therefore, a suitable tool for the territorial macro-diagnostic of the study units, and the evaluation of the policies implemented.

2. Conceptual Framework

2.1. Spatial concepts: Problem-solving strategies in landscape planning

The AWO concept was originally formulated to address, in a synthetic way, the spatial optimization of periurban landscapes, combining both natural and human subsystems (Forman 1995). As any normative statement, it has to be analyzed mainly at conceptual level: Eventually its applied, technical relevance derives from a sound theoretical framework, and effective formulation.

In contrast to descriptive empirical approaches, by definition spatial concepts are strategies used to build systemic solutions to complex problems (Ahern 2005). Partly intuitive problem-solving tools for planning, spatial concepts usually start by addressing a perceived lack or malfunction in territorial systems. In this sense, they can be regarded as extensions of thought-experiments, where a multiplicity of competing accounts of the same setting is possible. The context and intent of each concept's narrative become important elements on the evaluation.

For instance, when we ask -from a similar problem-solving stance: "Why are societies no-longer able to produce landscapes of ecological and aesthetic integrity?", we invariably return to historical concerns arising from a perceived malfunction of human subsystems, since the Industrial Revolution at least: The failure to design new urban patterns coherent with history and context, inside pre-existing cultural landscapes.

Either perception or evidence on failed integration of human and natural systems, it was nonetheless in reaction to this perceived loss (or "uglyfication") that landscape tourism emerged during the first half of the 19th century in New England, and other industrialized regions. Nowadays, and perhaps going full circle, tourism and recreation play a determinant -yet ambivalent- role, on the remaining agricultural landscapes of the urban regions or megalopolis.

Hence, in terms of meaning landscape-planning strategies are quite related to social perception (Walker 2005: 84). On the other side of the same coin, for successful planning we are required to shape existing community values and perceptions (Gunder 2005). Far from objective, we must clarify the purpose of our intended optimization processes (eventually, a questionable goal in itself).

How then can we define the problem and the required methods, in order to validate our spatial intuitions regarding the perceived loss of cultural landscapes, and its territorial effects? Probably this can only be answered by holistic, synthetic spatial approaches that integrate social and environmental subsystems, at the same time than identify the spatial dimension as key factor for the analysis of elements' interactions.

Following such methodological approach, after some analysis our "informed intuitions" may be quantifiable -when based on sound conceptual formulations. For instance, we can define our quest as a statistically-comparable, mensurative experiment (*sensu* McGarigal & Cushman 2002) concerning the functionally-desirable outcome of a landscape mosaic -as an integrated territorial system, composed by coupled human-natural subsystems.

2.2. Spatial optimization in cultural landscapes

From dynamic systems' theory and resilience thought, we are told the key to preservation of existing cultural landscape integrity and identity (fostering place-making) arises, as a whole, from enhancing resilience of socio-ecological systems: Rather than optimizing efficiency of some isolated component, we need to foster adaptability of the whole system to internal and external change. This implies allowing for the necessary innovation to take place, inside an inherently creative cultural process (Walker and Salt 2006).

In this sense and considering historical precedents, we can question whether the traditional approaches of East-Asian societies were more integrative (and aesthetically successful) than currently-engineered approaches.

It may be the case for example of the traditional Chinese Feng-Shui landscape, where the fractality of territorial systems (disposed as 'boxes-within-boxes') provided the 'live-within' integrative context for inhabitants — the equivalent of a phenomenological process of dwelling (Yu 1994: 330): An integrated hierarchical vision which fostered the psychological requirements of place-identity. At the dwelling-scale for example, and in order to reflect the cultural character, designs symbolized and had a meaning attached to family expectations; fitting the house into its social and historical background, and providing the symbolism shared by its dwellers (Xu 1998).

The traditional disposition of Korean nested-villages inside "woman valleys" (defining the *Tong* or "same people" communities) would be another such case. Similar integrative views were present in the multifunctional Satoyama landscapes in Japan (lit.:"village-mountain"), which combined intensive-rotational productivity schemes, and the maintenance of long-term ecosystem's services. This was an adaptive survival strategy which, remarkably, resulted in a higher natural diversity too (Yokohari et al. 2000; Duraiappah & Nakamura 2012): A good example that human activity can be a positive agent shaping natural systems, and not always pernicious.

Although in Western context the urban and the rural are traditionally seen in dichotomy, we can find as well some precedents of integrative planning and design. Inside the regions of study for example, mid-19th century pioneer, urbanist Ildefons Cerda envisaged and deployed a plan aiming for the spatial optimization of Barcelona expansion. Arising from his egalitarian Social philosophy, he had as declared goal improving urban population's living conditions while fostering place-making (Cerda, 1867). With the aim to urbanize the rural and *ruralize* the urban, the balanced outcome of his equation is still considered a reference on city spatial-optimization -even if from a characteristic 19th-Century positivistic approach (Pallares et al. 2011).

As a more recent -yet equally pioneering- approach, the integrative goal of Ian McHarg's (1969) regulatory planning model (or *ecosophy*) was essentially a multi-layered planning sequence, which advanced the current view of natural system's processes as social values in themselves (like ecosystem services): Land, air and water resources are indispensable to life; and recognition of those as social values will, in turn, define the character of a given place. Inferences can be drawn then regarding land utilization in order to ensure optimal use, with the enhancement of the social values that constitute its intrinsic suitability: Each place is inherently suitable for a multiplicity of human uses, and it remains within society to make the choices, therefore.

In parallel, from system's theory and biology, the concept of resilience has become a key issue for the definition of sustainable territorial strategies nowadays. In Panarchy theory for instance, the systems' non-linear, alternating stable-states create normal journeys (or constantly-evolving outcomes) that maintain the diversity of components, spatial patterns and genetic attributes: This composes the basis of ecological resilience, counter to the engineering resilience concept (Holling 2001).

Still, we keep implementing models that seek incremental growth and efficiency optimization in a linear way, for a single productivity variable (the "business as usual" option). Yet, such optimization does not work when applied as a best-practice model in reality, since long-term response to shocks and disturbances depends on the context, the connections across scales, and the current state of the system (Walker and Salt 2006).

Efficiency by itself may not be the problem; however, when applied to a narrow range of values, and a particular set of interests eventually sets the system in a long-term trajectory that, due to its complex nature, leads to highly-unwanted outcomes. If we acknowledge reiterated evidence over long periods in conservation programs, it may well follow the era of ecosystem's management via increases in efficiency is over (Peterson 2002).

Almost in opposition to the traditional paradigm, from non-linear system dynamics we are told that heterogeneous, unique ecosystems arise from concatenations of beneficial processes striving to achieve coherence, selection and centripetality (generalized autocatalysis or self-organization), against the ineluctable tendency of structure to decay following the second-law of thermodynamics (Ulanowicz 2009).

Thus, landscapes may self-organize in a similar way than other systems that contain life. This fact could be detected when looking to the complex spatial patterns of ongoing processes (Cumming 2011). Not surprisingly, in coupled socio-environmental systems, social values play an important role in the maintenance of current spatial patterns (same time than affected by). Or as M. Castells remarked (1983), space is not just a reflection of society, it *is* society. The paradox of efficiency and spatial optimization includes the fact that, with a given increase in efficiency, it results in major inefficiencies in the way we generate values for society (Walker & Salt 2006).

Is this social dimension's (ambivalent) role so difficult to detect? If quantifiable, the interactive effects of community values and landscape spatial distribution would be clarified, fulfilling communities' quality-of-life standards, and attached place making.

Further questions on social values and attached meaning refer for example to the role of recreation and tourism, increasingly important parts of the territorial equation. Similarly, the characterization and quantification of the impacts of new drivers of change, and its dynamics, may provide a useful complementary view: Those are presumably modular (with breaks) at multiple scales. Equally, measuring the spatial implications of the new global context may be relevant, in relation to ongoing cultural change (as a footprint, for instance).

In the study and following from the analysis of functional typologies of patches, we considered this way whether collective values and related human activities could be comparatively discerned at all, from any particular arrangement of actual landscape mosaics, and its inherent spatial heterogeneity.

Operatively, to foster adaptability of whole systems to dynamic change will require more than incrementally-optimizing a single-productivity variable. Yet, deploying whole arrays of indexes in purely-exploratory approaches probably will tell us nothing relevant, either about the subjacent factors of overlapping indexes, and the frameworks required for interpretation. Which kind of guidance for positive action should we expect, when lacking a putative, mechanistic explanation of the results?

Alternatively, a methodological approach would be to consider the joint optimization of critical-heterogeneity variables -the known spatial-keys fostering resilience to the whole territorial systems. This implies, on the one hand, a normative statement on such crucial aspects affecting the range of the desirable spatial distributions to be achieved. Operatively, it implies a convergence towards a broadly-optimal, or desirable range of values for the critical variables involved, rather than optimizing a single variable.

2.3. Developing on the Aggregates-with-Outliers *concept*

As one of the many spatial concepts arising from Landscape ecology, the AWO concept defines seven guidelines for strategic planning. It does so while trying to answer the apparently-ingenuous, yet provocative question: ‘Which is the optimum spatial distribution of land uses in the landscape?’(Forman 1995; table 1).

Derived from the conceptual Patch-Corridor-Matrix spatial model (Forman & Godron 1986), the AWO concept is part of a “Spatial Solution” that states, in a normative way, there are universal land-use configurations that respect most ecological conditions, allow for a range of human uses, and permit the conservation of the greatest part of natural processes (Forman & Collinge 1996).

Table 1. Normative criteria of the Aggregates-with-Outliers spatial concept (Forman 1995).

Aggregates-with-Outliers
1. Existence of large Aggregates of natural vegetation
2. Variance on grain size
3. More than one big block of natural vegetation or agricultural use
4. Existence of small patches (“Outliers”)
5. Small patches located along large patches’ borders
6. Small blocks of natural vegetation
7. Corridors

The soundness of the AWO normative concept for strategic planning is stated in the literature (eg. Ahern 2005, Wu 2008). At the basis of the normative definition, seven criteria are defined as qualitative guidelines for the improvement of functional characteristics on territorial sustainability of periurban areas; ones which arise from a desirable combination of specific typologies of spaces, inside the heterogeneous mosaics.

The quantification models to develop and apply should direct then the analysis of actual mosaic configurations to the conceptually-desirable optimal situation, as stated in AWO terms. For this, the definition of internally-homogeneous spaces, and its diversity is a central aspect: Nonetheless, it is from compositional analysis on internal diversity, than system's relational aspects emerge (Gustafson 1998).

At the end, our main interest in performing a compositional analysis of the landscape in AWO base derives from the statement of a few functional, qualitative criteria of universal value by the spatial concept. Eventually, once the functional typologies of spaces and related thresholds identified in actual datasets, the quantification of landscape mosaics could follow. Following from this original development, our mensurative experiment may also provide the mechanistic approach avoiding an enumeration of values by indexes of form and structure; or empirical analyses without an integral conceptualization of natural and human subsystems.

The aim here would be to provide a more coherent, synthetic interpretation on the configuration of the heterogeneous landscapes. Yet, before any development, it has to be proved the validity of the concept from an applied modeling perspective; this is, has to be considered technically and functionally relevant, demonstrating instrumental capacities for applied analysis (and strategic planning) of the actual landscape.

2.4. Synthetic approach to the analysis of landscape pattern

In practice, it is to expect that conceptually-vague or ill-defined questions may arise, following from the deployment of any theoretical formulation into reality. In our study, issues arise mainly reflecting the inherent difficulty of applying abstract spatial concepts to existing territories: For instance, they will appear the moment we treat an ecosystem (definable as a set of processes) as a closed, spatially-bounded biotic unit. Adding to this, although human alteration and impacts are pervasive, usually is not defined as part of ecosystems' processes.

Similarly, to face the wide-ranging consequences of the "urban tsunami" over the fast-changing territories, also implies questioning and redefining the (often implicit) social values at community level. The redesign of daily-life landscapes (the "place") at the scale of the functional region or mega-region (the relevant context for analysis of cultural landscapes nowadays) would be the objective here. Among other issues, this is why we are required to work with coupled socio-environmental systems and processes, in order to attain the necessary integration, at the system domain, of the landscape and region.

In line with integrative goals of systemic approaches, for attaining such redefinition we are required to foster some sort of ecological resilience inside territorial systems (self-organized flexibility and redundancy), increasing system's innovation and adaptability, therefore. This implies questioning optimization solutions which, by defect, limit the range of available options to the narrower engineering-resilience concept.

We should look instead at the partitioning of diversity, the non-random phenomena associated with discontinuous structure, or the key clumps, discontinuities and thresholds generating modularity and resilience. Options include checking the actual situation of ecosystems against the compositional thresholds defined in studies (table 2).

Table 2. Proposed thresholds in ecosystem management and conservation. *Fonts (eg.): Stauffer & Aharony 1994, Gardner et al. 1987; Harris 1984, Holling 1992; Svancara et al. 2005; Roth et al. 1996; Alberti & Marzluff 2004.*

Percolation thresholds	*Old growth forest*	*Higher bird diversity*	*Fish comm. Health*	*Impervious watershed*
40% habitat reduction, configuration disconnected	100ha large patches are required	Large patches 100ha, over 30% total land	50% land in watershed as agricultural	Max. 10-15% urbanized of total area

Nonetheless, to increase the resilience of landscape's spatial pattern we can generate novel conceptual and methodological approaches. For example, the use of "Open historicity" conceptual frameworks allows us allocating a given landscape mosaic inside a continuum of spatially-dynamic patterns (by the "temporal convening of the spatial"; Massey 1999: 262). In a similar way, both the ideal AWO distribution and the actual mosaics can be defined along a contemporary axis on entropy, or spatial heterogeneity degree (figure 1).

It is also possible to define them as "territorial narratives" hinting at mosaic distributions, at a given place and time. Those de-contextualization schemes would be, anyway, part of the required collection of heterogeneous experiments on landscape pattern (O'Sullivan 2004; Carpenter et al 2009).

In sum, we can develop specific methods and tools for strategic planning when looking to formulate (as in our study) the desirable, synthetic landscape-pattern for a given area; same regarding design of mensurative experiments: As long as we are aware they are part of a narrative, that spatial heterogeneity may interact non-linearly with the existing drivers of land-use change, and there is no optimal land-architecture that works for everything (Turner 2010), we will be contributing to find the effective means to deal with territorial complexity in those increasingly-altered landscapes, from an existing knowledge base.

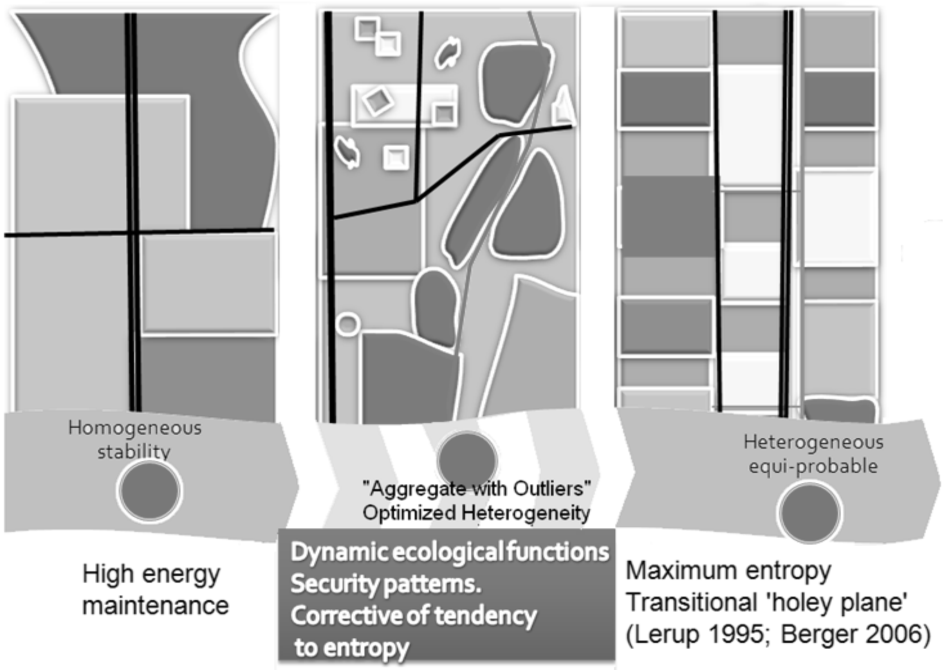


Figure 1. Diagram of heterogeneity gradient (aggregated land uses) in the landscape: Homogeneous AWO heterogeneity Heterogeneous sprawl

3. Materials and methods

3.1. Structure of the methodology

For the applied, strategic planning of territorial systems we know some basic characteristics to be fulfilled by the integrated problem-solving approaches, avoiding methodological *ad-hoc* solutions: Implying, at the end, a conceptual framework that accounts for interactions between components at multiple scales (O'Sullivan 2004; Carpenter et al. 2009); cementing our search for evidences of subjacent systemic processes that may emerge, while considering each case as unique. In the first place then, we need to redesign studies for comparability, shifting between scientific-reasoning approaches when required to gain insight. In so doing, we will widen our analytical frameworks, and promote the epistemological dialog inside holistic approaches (Rhoads 1999).

In this sense, the paradigm of complex living-systems in Biological Sciences appears as especially suited for systemic, holistic approaches. It implies, nonetheless, a leap from the deterministic mechanicism that still defines most of the lineal (partial) approaches to system's efficiency and optimization (both in natural and human subsystems); and landing instead at the emerging paradigm of non-lineal systems' dynamics, with an emphasis on living systems' processes and interrelations, and the optimization of ecological resilience.

One of the main implications of the shift in emphasis on ecological resilience, is the in consideration of the functionality of marginal elements (eg. habitats) in a system –a "Copernican shift" maybe: The "outliers", instead of the marginal, redundant (thus inefficient) elements in a system awaiting efficient planners and managers to do their job, are the main providers of flexibility, innovation capacity, and resilience to the whole system, in case of alteration.

The consideration of the landscape or region similarly undergoes a shift in perspective, stated ultimately as a main research question: Are these territorial systems a passive reflection of external agents; or are in fact "self-organizing complex systems" (SOCs), in analogy to living systems' theory?

This was a subjacent question framing the present study, and its development. In particular, we implemented an analytical sequence which considered, in parallel, the feasibility to develop such kind of spatial analysis. In so doing an unexpected, original development emerged along the process -as debated in the discussion. For instance, initially and in line with analytical goals, the sequence implied:

1. Checking the strength of the conceptual formulation, the basis for further criticism and development. This amounted to validate the deductive process of analysis, and the formulation of the normative criteria: Its synthesis on spatial principles from landscape ecology, biology conservation, and related fields (Forman 1995; Ahern 2005; Wu 2008).

   It included checking the topological definition of functional patches, as implied by the spatial concept's criteria; as well the "entification" of internal spaces, and the landscape unit. This equated to testing in practice the vaguely (or implicit) spatial formulations of the concept. That is, the feasibility of its application to actual study-cases (technical relevance).

2. After stating its conceptual strength and with the clarification on preliminary topological issues, we were to check the functional relevance of the spatial concept's typologies of spaces: The value of any modeling or development depending on this particular.

   As envisaged, the measurement of landscape-mosaic heterogeneity according to AWO classification was the applied, empirical stage of the research. This involved the definition of size-thresholds differentiating typologies of spaces related to their functionality. Results were later to be checked in two ways:

   a) From usual compositional analysis: With statistics on diversity and density of elements, as well distance-decay models;

   b) How the empirical results on AWO-base compared to definitions of functional thresholds in ecological studies, both for natural and human systems (table 2).

   If functional relevance was empirically attached to the AWO spatial criteria, they would eventually satisfy the requirements for any new development (qualitative or quantitative), when based on these premises. Corresponding to the final stage of the research, it would allow implementing a mensurative experiment based on the spatial concept's formulation, even if synthetic refinements were required. We would be able to measure, then, differentials in percentage of area for the actual typologies of land uses, against the ideal ones the AWO concept states.

3. At this point, and emerging from the conceptual and empirical findings, we found it was quite feasible (almost unavoidable) to formulate a synthetic model based on just two key, jointly-optimized variables; ones which satisfy most of the spatial requirements of the AWO concept, as well ecological management studies –table 2. At the same time, allowing for the implementation of the mensurative experiment in a simplified way.

   This is then the actual development of the present research, considered an original contribution to the sustainable, strategic landscape-planning: A compositional-optimization method, which deploys the Joint Maximization of Diversity and Variance (JMD+V) at its core.

Hence, and in line with the spatial concept premises, at the end it would allow a development which may provide, on universal grounds, some of the highly-required applicability characteristics regarding the planning of desirable periurban landscapes, as arising from the integrated spatial analysis of territorial systems. Providing insight and guide, for instance, on the definition and search of the relevant spatial information and metrics required; taking into account, from the start, the functional implications of actual and desirable typologies of spaces and thresholds, in landscapes where human agency and intention are the main drivers of change: A comparative analysis eventually providing insight into coevolving, self-organizing landscape processes.

3.2. Compositional optimum method

Following from the AWO qualitative formulation then, in the study we hypothesized the functional quantification of landscapes' spatial typologies and thresholds may actually allow for an original, synthetic refinement built on universal ground. After checking the validity of the conceptual formulation and its technical relevance, we defined the "Compositional Optimum Method" (COM) as the basis of an original, applied mensurative experiment on landscape composition purely in AWO base. Progressing along the initial methodological sequence, as main output we finally were to obtain percentage differentials regarding the existing-versus-desirable land use distributions, for a given landscape (figure 2).

Here the definition of land-use typologies of homogeneous spaces ("patches") followed from the functional definition along the gradient "natural vegetation / agricultural / urban". The other compositional dimension (size-variation of patches) involved the definition of functional typologies of spaces according to size (as stated by the spatial concept), and thresholds implied.

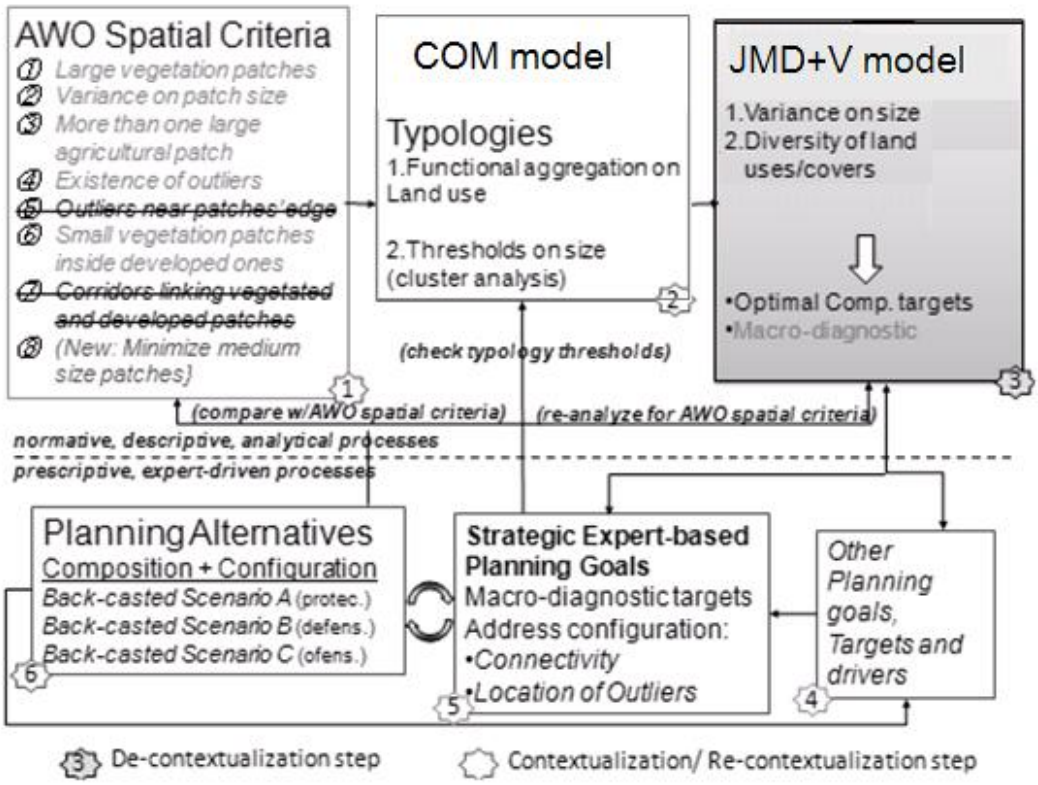


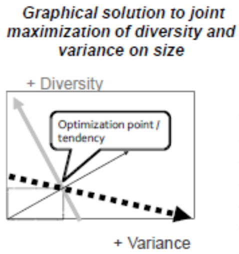
Figure 2. Conceptual diagram for application of the synthetic approach in the study.

Operatively, in order to test AWO suppositions about the existence of functional typologies of spaces by size (following from the basic differentiation between "Aggregates" and "Outliers"), from the start we treated the comprehensive analysis of landscapes' patches independently of any functional land-use aggregation. "Raw" patch-size typologies were simply defined this way through a Cluster-analysis dichotomization sequence (deploying the K-Means method on variance), giving as outcome the resulting size-aggregations and thresholds.

Besides a spatial macro-diagnostic of the landscape, the quantification of differentials against the actual situation would equally allow for the comparison between landscape distributions. Initially to be deployed as a mensurative experiment inside the Barcelona urban region, it was the first step for the characterization and diagnostic of worldwide periurban-landscapes in AWO base.

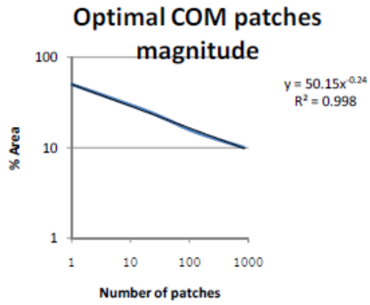
Results were expected also to (comparatively) point to thresholds of compositional values and parameters of spatial heterogeneity; ones which are instrumental for the provision of the universal ecosystem services and, eventually, may help identify related social values.

The definition of AWO functional typologies of patches would allow, at the end, a territorial macro-diagnostic on landscape pattern composition, against which different spatial patterns of the culturally-unique landscapes could be contrasted, and possible scenarios defined (figure 2).



Opposite behavior of diversity and variance

Cases	pi	pi	pi	pi
1	100	99	50	25
2	0	0	50	25
3	0	0	0	25
4	0	1	0	25
Diversity	0	0,06	0,69	1,39
Standard dev.	43	43	29	0
Variance	1875	1826	625	0



Category spaces	Proportion size	Proportion Use	Spaces use
Matrix	0,56	0,56	Agriculture
Large	0,32	0,08 0,08 0,08 0,08	Forest Agriculture Urbanized Transition
Medium	-	-	
Small	0,12	0.027 0.027 0.027 0.027	Forest Agriculture Urbanized Transition

JOINT OPTIMIZATION	Agriculture	Woodlands	Urban	Transition	Total
Matrix	~~6%~~ 25	~~6%~~ 0	~~6%~~ 0	~~6%~~ 0	~~25%~~ +26% 51%
Large	6%	6%	6%	6%	25%
Medium	~~6%~~ 3%	~~6%~~ 3%	~~6%~~ 3%	~~6%~~ 3%	~~25%~~ 12%
Small	~~6%~~ 3%	~~6%~~ 3%	~~6%~~ 3%	~~6%~~ 3%	~~25%~~ 12%
Total	~~25%~~ 65%	~~25%~~ 11'5%	~~25%~~ 11'5%	~~25%~~ 11'5%	

Figure 3. Examples of joint maximization of variance and diversity: behavior of the two variables, zero-medium patches and best fit (accumulated area) scenarios.

At this stage, we already detected main composition criteria were subjacent in configuration ones (eg. existence of corridors, or location of the "outliers" dependent on the number and area of large-patches). Hence, along the process we found our mensurative experiment was possible to be developed in an even-more synthetic way, following the universal heterogeneity requirements subjacent in the logic of the AWO concept, and applied ecological studies (eg. ones in table 2): We defined thus an original synthetic model ("*JMV+D model",* after 'Joint Maximization on size-Variance and land-use Diversity' -figure 3) that quantifies differentials against desirable situations or scenarios, from the joint maximization of key criteria on spatial heterogeneity.

3.3. Application to study cases

The applied, quantitative goal of the study was to provide evidence then on the variability (differentials, correlations) of the mosaic distribution by the JMD+V model: A procedure defined as an observational - mensurative experiment (McGarigal & Cushman 2002). In the general case, potential study cases are found within a larger filtered set -all the periurban landscapes of a given region, in our study. From their comparison, we are providing statistical evidence, in this way, on the degree (or close fit) from actual data on landscape distributions against the desirable, optimal distribution.

Use of explicit and replicable GIS analytic methods is of great help in the definition, test, and application of spatial planning concepts (starting with the measure of physical dimensions, eg.). When contextualized within existing socio-economic data (available surveys and datasets), the analysis of spatial variability and heterogeneity becomes an important support for prospective analysis in territorial planning: From that, we may attach new direction and meaning to obtained results, as well.

Geology and topography (contour levels, slopes) were the physical criteria in the study for the delimitation of the landscape units (e.g. sedimentary planes in a watershed), from which we analyzed the functionally-aggregated land-use typologies (the spatial definition of ecosystems, or ecotopes). Delimitation of study units was mostly coincident with the sub-watershed level, considered a desirable feature for the analysis of territories and its sustainability: Framing them as an integral part of the natural basins, and broader ecoregions.

Regarding the delimitation of physical boundaries, we have to work with distinctive landscapes inside watershed sub-basins; mainly characterized by hydrological processes, vegetation and topography (eg. alluvial plains, foothills, mid-mountain areas), with a repetitive land-use internal configuration. Particular configurations of topography, vegetation, land-use and settlement patterns already define some coherence of natural and cultural processes, and activities (Forman 1995; Farina, 2000; Antrop, 2001).

The nine cultural landscapes analyzed by the study are located in the Barcelona region (plains of Valles, Penedes, Vic, Bages, Conca de Barbera), the North-east megalopolis of the US (Pioneer Valley MA, Conestoga PA) and in China (Miyun in the Beijing Mountain Area, Hefei Chaohu fringe in Anhui province).

Initially, the comparison of the five Barcelona periurban landscapes defined the methodology of the mensurative experiment that was expanded later to the rest study cases worldwide. Despite the suburbanization processes already in place, Barcelona's poly-nucleated region is considered a model regarding densification and arrangement of land uses, with a comparatively lower (more efficient) land consumption (Forman 2004; 2008). It stands, then, as a general referent on the desirable periurban outcome which is coincident with the intention, objectives, and postulates of the spatial concept.

The deployment in the sub-basins of Barcelona urban region was the first test of the mensurative experiment then; providing evidence and guidance on the main spatial characteristics of the actual-versus-ideal distribution, the expected range of values for typologies, and keys for interpretation of the interrelations with the physical, social and economic context.

After this initial experiment, application to study-cases worldwide became the next step: Expanding the filtered set of landscapes, to encompass similar landscapes of all the regions of the Earth, in practice. The main interest for the selection of cases inside such large set was to expand, potentially, the range of variability or coincidence, on the periurban landscape-distributions worldwide.

The selected cases of the North-east megalopolis of US were two characteristic cultural landscapes of special interest, yet for different reasons. The Pioneer Valley in Western Massachusetts is a visually contained sub-basin, allegedly fostering a sense of inclusiveness and place-making. Artists of the Connecticut School (and the legions of landscape tourists that followed) understood the appeal of the place in its proportions, which epitomized 18th century ideas about the proper balance between the natural world and the built environment (Buckley 2004; Doezma 2002). The physical depictions of the Valley still draw attention to the small, convoluted topography of the place, as opposed to the open plains of the West (Morgan 2002).

The landscape has a much different character today nevertheless, after several waves of immigration, the decline of both factory-based industry and agriculture, and the rise of low-density suburban sprawl. Population and housing density evidence the characteristic exurban/rural densities (equal or over 160 hab./km^2).

In Lancaster County PA, the Conestoga River flows through a highly-productive pastoral landscape ("The garden spot of America"), farmed extensively by the Pennsylvania "German farmers" (which include Mennonites and Amish, as well as other groups of the Anabaptist movement). The tension between rural and urban is heightened in the landscape by the historic connection to agriculture, against the metropolitan pressures of the nearby Philadelphia, New York and the whole North East region -to which are main providers of daily produce. Remarkably enough, despite pressures Amish and other residents remain devoted to farming: This is still a sacred landscape for them, and they consider themselves stewards of the land (Peterson 2005).

The analysis was quite appealing, from a territorial sustainability perspective. Existing social and community integration at the cultural level has fostered, in this case, a resistance to the centripetal driving forces working against the traditional rural communities everywhere (Walbert 2002). Nonetheless, upon this growing internal tension new pressures have emerged: With four million tourists annually an industry has developed in last decades, which is now second only to agriculture (Kraybill 2001).

In China, the Chaohu fringe in Hefei (Anhui province) is a historical representative of the highly-engineered, water-regulated agricultural plains. East of Nanjing and Shanghai regions, nowadays is one of the fastest-growing cities in China, facing strong suburbanization. The study area was located on the north side of the lake, south of the city center. Besieged by new developments encircling the remaining agricultural areas of this traditional polder landscape, is in close vicinity to some natural preservation areas on the lakeside; home to species of migrant birds such as egrets and herons, whom locals still want to coexist with. Hence the proposed motto: "Egret city" (Li et al. 2005).

Huairou-Miyun in the Beijing North Mountain Area is considered a critical spot for ecosystems' service provision to the capital, especially water supply. Defined as its "Ecological Great Wall", effective protection of agricultural land by governmental regulations is allegedly providing a mechanism today to confront low-density suburban sprawl, helping to maintain water and food supply to the capital. Even so, as part of the Beijing megalopolis the whole basin faces the seemingly-unstoppable progression of a characteristic "scrambled city" suburbanization pattern (Yu et al. 2011).

Besides their specific cultural and political context, with the two selected periurban landscapes we wanted to look for comparative evidence of differentials in landscape-pattern inside China, as well against Western countries. This having in mind the characteristic interplay of central and local powers in city planning (eg., see Ma 2002); and eventually widening the range in the definition of an unstable, multi-functional spatial balance for the periurban landscapes worldwide. Nonetheless, it will be in Asia —particularly in China — where ongoing experiments on sustainable urbanization may reshape the future patterns for the whole planet. This was in fact a concomitant interest for the study.

4. Results and discussion

4.1. Results

From the application of the mensurative experiment, one of the main empirical results was identifying similar size typologies and gaps for all landscapes:

1. It was evidenced the existence of a single, main characteristic space of the landscape (the "Matrix"): Typically the largest unfragmented, still-remaining space of agricultural use, except where advanced urbanization processes had already taken hold.

2. A common -yet dynamic- size threshold between large patches ("Aggregates") versus the smaller patches ("Outliers"): Approx. at 100 - 200 ha.

   This threshold-range seemed related to overall landscape dimension: Correlation became 0,72 (significant at 0,05 level; two-tailed) once Lancaster County was excluded. On the interpretation, this is the largest landscape, greatly affecting the result of correlation indexes; we had to consider it as a highly-remarkable exception to the general rule, therefore.

3. As another unexpected outcome, it was detected a size-threshold inside the "Outliers" class (the small patches), allegedly between medium-sized and the smallest-size typologies: Approx. at 15 - 30 ha.; yet this threshold was seemingly independent of landscape dimension.

For the discussion, those empirical results seemed quite coincident with AWO functional interpretation on patch typologies: Similarly to AWO criteria, we were at ease defining experimentally the matrix and the large patches, versus the smaller ones. Nevertheless the analysis evidenced a new threshold, defining the typologies of the medium vs. small patches.

As an example of the functional -as well technical- relevance of the classification, in almost all mosaics the analysis on size variance evidenced the most relevant threshold was one defined by the largest patch of the landscape (the matrix), against the rest. This typology accounted for over 90% of the total agricultural land in one case (P.Vic, BCN), almost conflating the total agricultural land-use with the matrix functional typology (figure 4).

Results seemed to corroborate the existence of domains of scale, against the scale-invariance hypothesis. This is, the patch-typologies effectively appeared defined by common variance thresholds or size clusters. Even if formulated as dynamic ones (relative to landscape overall extension eg.), the definition of different typologies of spaces as functional aggregations may have more relevance, at the landscape level, than the measure of the components' internal variability (eg. inside each size-class typology).

Table 3. Total area of landscapes and obtained thresholds: Aggregates or large patches vs. Outlayers; Medium Outlayers vs Small Outlayers (small patches).

LANDSCAPES / AREA THRESHOLDS	**N.Pioneer**	**Connestoga**	**Bages**	**Conca**	**Penedes**	***Valles***	**Vic**	**Huairou-Miyun**	**Hefei-Chaohu**
Total Area (Km^2)	399.5	1190.3	157.5	205.1	328.2	662	257.9	275.5	202
Threshold (ha): Aggregates/ Outlayers.	130	112	119	109	181	209	102	181	70
Threshold (ha): Medium/Small Outlayers.	30	30	27.5	17.6	30.2	14	12.2	15.2	20.8

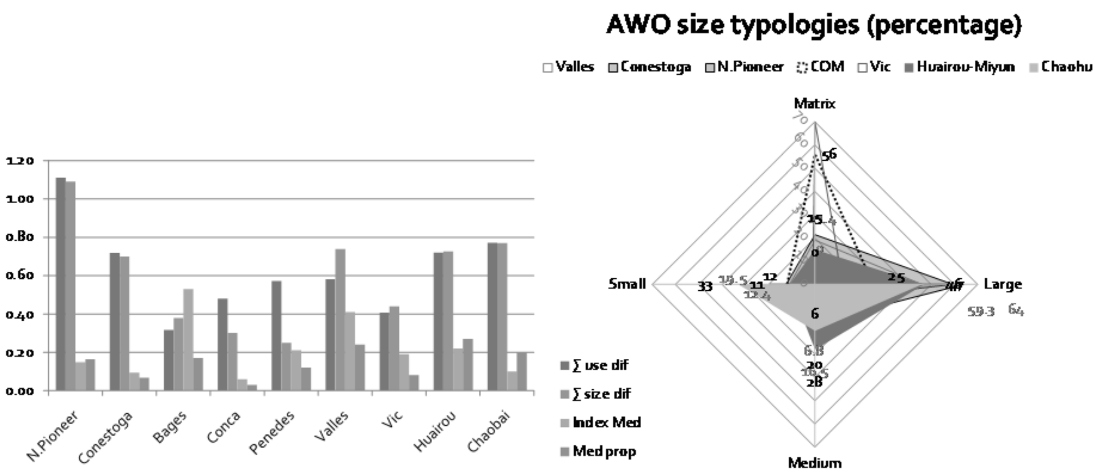


Figure 4. Comparative on AWO typologies for the nine periurban landscapes.

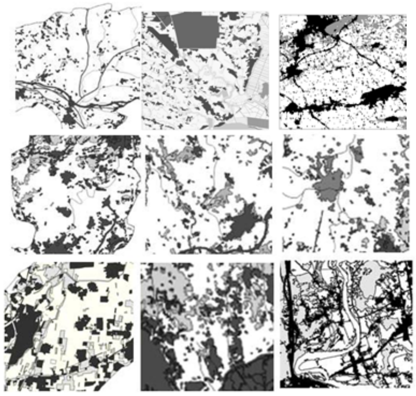


Figure 5. Visual samples of the research mosaics (10x10km aprox.).
Black: built-up; white: agriculture; grey: woodlands.
Left to right and top-bottom: 1 C. de Barbera BCN; 2 Hefei Chaohu 安徽; 3 Lancaster County PA; 4 P.de Bages BCN; 5 P. Penedes BCN; 6 P. Vic BCN; 7 Huairou-Miyun 北京; 8 P. Valles BCN; 9 N. Pioneer Valley MA.

Summarizing the results for the different regions, some of the best compositional situations were identified in Barcelona region. These are presented in the distribution comparison of table 3 and figures 4-5.

Results in the Conestoga landscape pointed as well to the existence of a highly desirable situation, with an agricultural matrix as the most important single space, while having a low index of medium patches -both indications of a lower rate of suburban sprawl. On the contrary, for the North Pioneer Valley even the definition of the matrix typology had to be discussed, as 14 patches were in this category instead of the usual one or two.

With regard to the results of the two Chinese landscapes, the agricultural matrix was clearly present, yet not in the range of desirable values anymore. In addition, there was a relatively high density (and mean area) of both medium and small patches. Results pointed to a specific situation in which a mix of intensive land uses coexist in quite a tight pattern. This was particularly the case of the Hefei-Chaohu urban fringe, where agriculture and dense built-up areas appeared to mingle with very few natural, temporary or unproductive (marginal) land uses.

4.2. Discussion

In general, results from our analysis on typologies of patches and thresholds were easy to relate both to existing literature on the ecological processes necessary to maintain or increase systems' global diversity and resilience; as well to the universal AWO requirements on functional structure and landscape pattern. This broad coincidence with empirical observations and observed thresholds (from ecological management studies, or from Panarchy theory eg.) equally seemed to confirm the functional meaning attached to the spatial typologies defined by the AWO conceptual formulation.

This was not deemed to be a chance occurrence anyway; but rather a fact deriving, mainly, from the compositional requirements for the matrix and large-patch typologies, on which most of potential ecological functions and services depend (with area-thresholds implied): For example, the fulfillment of the specific requirements on composition and configuration for natural habitats mostly depend on the existence of large patches (usually over 100ha –table 2), which foster overall connectivity potential, internal diversity and spatial resilience to the whole landscape.

Just by stressing the need to aggregate as much as possible existing land uses, we may effectively avoid degradation and fragmentation of natural land. Besides, the AWO spatial concept remarks the need to have a diversity of open or marginal space (mainly outliers or small-size patches) fostering variability, ecological resilience, and enhancing the system's long-term survival to alterations. Adding to this, and although formulated as a multi-layered, multi-functional planning tool, from the start the AWO conceptually gives preeminence to natural processes over human ones.

This synthetic view on compositional optimization may be considered, in fact, as a pre-condition for configuration designs, as the very existence of those key spatial typologies (and respective area) will be a strong determinant for design solutions. To place this in context: A situation in which the matrix and large spaces are compositionally weak inevitably leads to an increase in entropy (decreasing variance in size typologies, and increasing internal land-use diversity). Therefore, to the need to prescribe "offensive" scenarios –with intensive, high-cost solutions- to counter this trend accelerating natural and human system's disruption.

Another evidence of the same process of degradation, the amount of medium-size patches is considered by the study as an early-warning signal, probably reflecting a critical transition in landscape properties: Similar to thresholds defined for functional processes, they are an indication of a shift in the system's scale-properties and functionality –allegedly, to the "complex nature of the global systems" (*sensu* O'Sullivan et al. 2006: 614); breaking away with the coevolutive, self-organized processes of vernacular landscapes.

In practice, both the dysfunctional land-use patterns and the potentialities observed would not have been detected in any individual recount of variables, or a battery of them. An integrated approach is required in which we consider key compositional factors altogether (variance on size and land-use diversity), at a given time and place; identifying from the beginning the main characteristics which foster territorial systems' integration and sustainability. As corroborated by our findings too, these issues are incorporated into the spatial concept's guidelines in effect -if only qualitatively and fragmented.

In the study then, by applying an original contextualization and de-contextualization sequence was made explicit a quantitative procedure for a guided spatial analysis (figure 2). At the end, the method and its deployment effectively allowed for a comparative analysis on different study cases, from a universal base.

The JMV+D mensurative experiment emerged in fact from a hypothetical-exploratory approach, or the test on the properties of the AWO concept as a theoretical artifact (*sensu* Rhoads 1999). As such, it was an initially unexpected result arising from testing the technical and functional capacities of the concept; which started, nonetheless, by considering the conceptual framework on which the normative formulation is based, and the possible interrelations with the paradigm of living systems' theory. This approach was instrumental in synthesizing the basic requirements of the concept, always spiraling around the key spatial-heterogeneity (entropy) variables.

Nevertheless, to have into account the inherent multiplicity of dimensions involved in a holistic research (and the necessary epistemological dialog inside holistic approaches), we should remark probably the fact the present study spans a diversity of scientific reasoning methods: From the analysis of a compilation of basic postulates on the desirable distribution of periurban mosaics (which include human intention and agency), to the definition of an experimental method to test and apply in practice a theoretical concept; or from the descriptive study of study cases, to the statistic or probabilistic approach required for comparative analysis. For instance, statistical comparison among cases (and the optimal) was an intrinsic procedure of analysis, making evident the relational aspects implicit in the measure of internal diversity.

The array of methodological and scientific approaches involved should not overshadow, anyway, the fact that besides its central hypothetic approach, the present study can equally be considered, at the end, a synthetic development on the spatial-concept's criteria: A development mostly coincident with its normative, problem-solving nature, and applied goals (Forman, R.T.T. 2007, pers. comm., 24 Sept.).

This multiplicity nonetheless seems to fit well into the diversity of comparative methods required for the holistic, integrated analysis of territorial systems. This kind of synthetic approach may help, in fact, in testing the general case or validity of the conceptual frame when developing applications from a normative perspective, inside holistic conceptual frameworks: Eventually, opening new avenues for the analysis of territorial systems from analogy to basic postulates of non-linear dynamics, and living systems' theory.

As a summary, in the research we hypothesized the AWO spatial concept allows for (and promotes indeed) a methodological path satisfying the precepts for integrated analysis, and functional optimization of coupled natural and human subsystems –the Compositional Optimization Method (COM); a path that finally leaded us to the formulation of an applied, original solution for the strategic planning of the heterogeneous landscape mosaic (the JMD+V model). Or put in another way: Following from the AWO concept's stated goals for planning, we provided a genuine development proposal, based on the joint optimization of two-key compositional variables of spatial (functional) heterogeneity: Diversity of land uses, and variance on size of patches; one which can measure deficits and potentials, through the mensurative experiment defined.

As a territorial macro-diagnostic, this synthetic method effectively allowed for analysis and characterization of periurban sprawl. Arising from the interpretation of empirical evidence on functional land-use and size typologies of the landscape mosaic, it equally provided hints on ongoing development characteristics, as well possible territorial self-organization processes.

For example, from the study it was made evident the critical importance of maintaining the still-remaining agricultural matrix inside periurban landscapes, and its balanced relation with certain typologies of spaces (especially when decreasing). As a generic issue for territorial planning then, when there is a sharp decrease of the matrix-typology below desirable levels (aprox. 50% of total area; figure 3), and a relative increase of medium patches (from aprox. 30ha to 100/200ha; table 3), configuration designs will be crucial to reconnect the landscape mosaic.

Along with diagnostic results then, with our approach it seems equally possible to define alternative scenarios, following goals, targets, and drivers inside a specific planning context. This just by keeping track of the two main factors fostering territorial resilience, in a joint optimization approach: Heterogeneity of land-uses, and size-variance of patches (figure 2, steps 5-6). In this regard, the periurban landscapes presenting over 50% compositional differentials against the desirable range, may call for a scenario of positive intervention (figure 4); one which should be proactively planned, as in the case of Pioneer Valley (MA) for instance.

The differentiation of such "offensive" scenarios (figure 2) is considered in fact a helpful tool when designing planning strategies, and for the definition urban-growth equilibrium equations (*sensu* Berling-Wolff and Wu 2004). Adding to this, such spatial-integration methods may require little effort to be implemented as guidelines for further modeling -in Agent Based Models, for example.

Needless to say, results from application of this mensurative experiment are to be questioned and contrasted by new studies. Nevertheless, it will be so from a universal referent. We have to remark, this way, the potential value of comparative approaches arising from normative frameworks, once they are conceptually and empirically validated: Especially when derived from widely-acknowledged literature, and contrasted applications.

4.3. Study cases

Operatively, we need to remark the relative sub-optimal situation of most of Barcelona landscapes (and the urban region as a whole) in AWO terms -a valuable asset for the development of our approach. In this regard, the concentrated settlement pattern in Mediterranean-dry regions has probably a good part to do in the explanation: Presenting a characteristic lower land-consumption, maintained by regulations and usual practices -even if unconsciously. This close-to-desirable output may have arisen, in fact, from unwritten cultural values and the willingness to avoid (just for survival needs) land-waste and resources depletion (eg. scarce water, fertile soil or firewood).

These were stringent requirements that shaped, in the first place, the ecology of the highly-humanized Mediterranean landscape since millennia: Agriculturally dependent, while in a fragile equilibrium with the surrounding ecosystems; a slow, subtle outcome providing increased diversity, which emerged from agricultural practices almost lost. Another example yet on how human action can be a positive agent inside ecosystems. This highly-desirable, close to conceptual results for the periurban Barcelona landscapes is in fact coincident with world-scope comparative studies, at regional scale (see Forman 2008).

As in many vernacular landscapes, the old daily-markets' area of influence (defined by one-day trips inside a watershed) was both a physical and administrative unit, fostering local identity. Yet nowadays, the traditional socio-environmental containment seems to be disappearing in favor of the current driver of suburbanization, based on cheap-energy access; one which is locally unsustainable, and increases the regional ecological footprint. This outcome was easily noticeable in the study by the distribution of land uses; between the more and the less-urbanized landscapes of the region, for example (Valles and Penedes against Vic or Bages; figure 4).

In quite a different and advanced stage of suburbanization, Pioneer Valley MA hinted to a rampant low-density urbanization and the return of forests, probably from abandonment of former agricultural land (now almost residual). This is a landscape where a convoluted mix of the three uses has almost become the predominant cover. Even so, according to results it is still possible to plan for a different future, as it retains some prime agricultural land -thanks to property-easement policies, mainly. The discussion whether the community-feeling linked to the place is already fading, or if a 'small-town spirit' is to remain can be related through compositional evidence, in this way, to the suburbanization processes taking hold.

In summary, although not having a clear foreseeable outcome, our results challenge possible consideration of this landscape as one with a 'right balance' between human and natural systems anymore. Without a proactive and comprehensive planning strategy (offensive scenario), the highly-fragmented configuration may likely follow the same fate than nearby Boston urban region, with receding and disappearing agricultural land.

In contrast, the macro-diagnostic of the Conestoga landscape pointed to a close-to-optimal situation for its main agricultural patch (the matrix), and a lower index of medium-size patches. Adding to the exceptional attachment to the 100ha (approx.) threshold for the "large-spaces" typology (which is not altering the relative weight of typologies in practice –table 3; figure 4), this is a situation which still allows to focus on the maximization of diversity and variance for the rest of patch typologies; eventually resulting in a more protective scenario-proposal.

As hypothesis, thresholds and desirable percentages of patch-typologies here might indicate the persistence of certain self-organizing, coevolutive processes on the vernacular landscape. Even so, we found a lot more large urbanized patches than desirable: Caution should be taken to avoid the confluence of additional linear infrastructures on the remaining agricultural land (which eventually may conflate in a very large urban space, the new matrix).

Although certainly far from the traditional model of Feng-Shui, according to results the situation in both Chinese landscapes was considered still in a desirable condition, arising from its high-density settlement patterns and multifunctionality; away in this respect from the horizontal, low-density sprawl of Western countries. However, if not regulated to avoid further densification and spillage, it will probably recreate the characteristic scrambled-city pattern of Beijing, and other large conurbations (Yu et al. 2011).

In order to avoid total loss of natural functionality in the remaining (non-built) land, the strategy to "sponge" (or clean-up) the intensive land-use patterns should be stressed. This strategy should put into practice, for example, a combination of a) increased protection of the few remaining marginal spaces, b) the definition and regulation of large forest patches, c) design of green-heritage networks and recreation corridors, and d) avoiding land fragmentation and the "call effect" on local developments, coming from construction of linear infrastructure.

As a shared outcome then, it was detected a close-fit between the more-desirable natural values on landscape distribution (as stated by the AWO concept and ecological studies -table 2), and the actual land-use distributions of existing traditional landscapes and communities (eg. Plana de Vic, Bages, Conestoga).

Arguably, the evidence obtained from our method came from the fact that we were walking 'in the same shoes' (with the same synthetic goal) as the AWO normative concept: Looking to spatially-define territorial sustainability within a dynamic, flexible balance comprising human and natural subsystems. Closing the loop, the reference to human intentionality and perception comes back for reappraisal: Because human actions dominate, the adaptability of the system is mainly a function of the social component (Walker 2005: 84). Community living-standards could be, conceptually, the key to define the dynamic, unstable territorial balance required for periurban landscapes.

At the end, compositional evidence results mainly from ongoing human activities, and it is not difficult to anticipate the spatial outcome (eg. for habitats, connectivity thresholds) of a given land-use policy or decision. We have indeed a responsibility for the 'spatialities' (spatial qualities) in which we live and construct our lives (Massey 1999: 275).

Which urbanization model may be the most desirable in a near future then? Is it the apparently haphazard, dense Chinese mix which, eventually regulated, shows promise of a much lower rate of land consumption than most Western low-density developments, at the same time than maintaining higher productivity? Or is the Conestoga case which, in the Western context, explicitly points to the social values of stewardship of the land? Or is it simply the opposition to land-waste, that has shaped (since long ago) a close-to-optimum, balanced situation of vernacular landscapes -even if unconsciously; a situation maybe still reflected in the periurban areas of Barcelona region nowadays?

The implementation of this original method as a planning tool may increase, in any case, the effective chances for implementation of ecological resilience and spatial sustainability inside actual mosaic distributions; equally providing a reliable interpretation on the actual diversity of highly-humanized landscapes. Although arising from a normative formulation, developing this compositionally-guided approach allows for a dynamic definition and comparison of study cases (landscapes), which characteristically fits into acknowledged thresholds of ecosystem service provision; equally coincident with the enhancement of territorial sustainability premises, and entropy minimization goals.

5. Conclusion: Guidelines for periurban landscapes

From the test of a normative spatial concept (Aggregates with Outliers –AWO; Forman 1995), a comparative study on worldwide landscape's functional patch-typologies was deployed. Following an original method, we developed a compositional macro-diagnostic tool which stated spatial deficits and potentials of the landscapes. The joint maximization on key compositional variables (diversity of land-use and variance on size, or JMD+V model) fostered a synthetic approach considered as a technically as well functionally-relevant tool for strategic planning.

In this respect, the method allowed quantification on the main landscape's distribution features inside existing, desirable or expected mosaic configurations; helping to build a narrative or plot regarding the actual situation of different cultural landscapes worldwide. From the application done, it is equally feasible to define an unstable or dynamic equilibrium, for the urban-natural dichotomy inside periurban landscapes. As a "thought experiment", it becomes a metaphor for territorial sustainability. At the end, the implementation provided a coherent narrative, considered useful when defining and applying the required frameworks of territorial sustainability, as for contrasting different cases and scenarios.

This original method and implementation can be equally considered one of the many experiments implemented in the search of integrative methods, inside holistic approaches. At the end, we will give direction and guidance to planning and management proposals in strategic issues -for example, the desirable levels of spatial heterogeneity, within existing or given constraints.

The implementation and comparative analysis among diverse locales, times and scales was based at the end on the conceptual relevance of the spatial concept. Despite the limitations of normative approaches, what is urgently required is the functional explanation of integrated socio-environmental processes at the landscape and region levels: One that can be applied to the task with the goal to increase adaptability of the remaining cultural landscapes, inside growing mega-regions.

Human action and intention are the main determinant in this process; so the need of proactive, regulatory approaches designed with the goal to foster the desirable outcomes or trajectories is a must for integrated-planning approaches: Countering the "business as usual" (limited) strategies still enduring today, by widening the prospective range and the actual possibilities; accepting our responsibility on the spatial qualities of the territory we create, this way.

As future prospects, our preliminary empirical findings need to be contrasted with new study-cases. The fact this methodology is easy to use also suggests it should be further developed and tested without much difficulty. Integration with existing methods and applications allowing for the diagnostic of periurban landscapes (based on compositional thresholds), is equally considered one of the main interests: Ultimately, with the shared goal of developing a compilation (or atlas) on the actual situation of the world landscapes from a coherent, functionally-integrated perspective.

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