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Eric Vaz
Ryerson University, evaz@ryerson.ca

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Collapsing landscapes? The regional science contribution to spatial understanding

Eric de Noronha Vaz[1]

Abstract

Recent decades have witnessed unprecedented landscape change. Most of these changes have been brought by human impact on the environment, and excessive exploitation of resources. While economic growth has brought prosperity and better living conditions, much of the human impact has had irreversible consequences on environmental systems and destroyed fragile ecosystems and biodiversity. As much as our impact on earth has brought irreversible environmental change, our landscapes have in detriment of these choices witnessed a substantial change, most of it affecting our natural and historical heritage (Vaz and Nijkamp, 2009). In the context of regional development, economic geography and complex space-time dynamics are factors of continuous change (Nijkamp and Abreu, 2009). Monitoring of the transitions of land at regional level, is thus of utmost importance for founder regions in future. It is of utmost importance to preserve landscapes by enabling efficient economic growth, without jeopardizing the natural ecosystems and mitigating the impacts on the anthropogenic heritage and archaeological landscapes alike. This paper advances on the possible spatial interpretations of landscape change by means of defining the role at present of Geographic Information Systems as tools to allow sounder urban and regional interactions. Thus, I propose three pathways integrating regional development within a spatial landscape preservation framework. It draws inspiration from much of the work realized by Peter Nijkamp, concerning lessons learned from complex spatiotemporal interactions of regions. I arrive to the conclusion that we are facing what I designate as a general collapsing landscape, a result of rapid economic changes followed by landscape functionality. From a spatial perspective, regions can only become sustainable, when spatial memory – that is, the identity of place and time and economic traditions – are coherent and long lasting. From a regional science perspective, three types of landscape paradigms within the collapsing landscape are defined, posing as solutions for sustainable development in future: (i) the coherent landscape, (ii) the dominant landscape and (iii) the vertical landscape. All of these types of landscapes largely depend on our options taken in the next decades. The usage of Geographic Information Systems, in particular the recent advances in location based services, crowd sourcing and ambient information, play a leading role in the development of regions and may act as a visual tool for evaluation landscape change.

1. Introduction

[1] Ryerson University, Department of Geography, Toronto, Canada

Advances in complex spatial modelling when linked to regional science (Nijkamp and Reggiani, 1998) have allowed juxtaposing traditional quantitative thinking to decision making through computational methods. One of the main advantages of has become the possibility to explore possible future ecological challenges on the landscape at a spatial level (Lathrop Jr. and Bognar, 1998). The right, as well as the duty, of protecting and maintaining integrity of landscapes is a social responsibility and a commitment to transmit our heritage to future generations by keeping sustainable development (European Council, 2000). In recent years we have perfected the possibilities of mixing quantitative and qualitative analysis, integrating data abundance in triangulation frameworks (Jick, 1979). One of the abridging tools of both these scientific realities have become Geographic Information Systems (GIS), boosted by the availability of spatial information that permits an integration of research in the social sciences which are intrinsically spatially-explicit (Sohl et al., 2012). In this sense, understanding emergent behaviours in a context of spatial sciences has aided the development of fuzzy set theory (Altman, 1994), which incorporated with multiple variables of different origin, allow interpreting the underlying dynamics of anthropogenic behaviour on land use, landscape and ecosystems in what are defined as complex spatial systems (Batty et al., 2012). This is further enabled by the already present interest in maintaining diversity at the regional level (Noss, 1983) where diversity depends on a fine balance of interactions of space, land use, human behaviour. The non-linear dimension of changes in the equilibrium of changing landscapes for instance, may benefit greatly from the interaction with Geographic Information Systems (GIS) that by offering a set of distinct spatial techniques permit a better understanding of the dynamics of complex system patterns linked to land use, resilience and the stochastic understanding of regional change (Zander and Kächele, 1999). These regional changes are largely resulting from anthropogenic actions that are taken over time and space, and at the different levels (social, natural and economic) within the anthroposphere, leading to negative consequences on the natural environment and jeopardizing sustainable development (Goudie,

2006). These different levels have a distinct understanding of space, and make it particularly difficult to draw a combined effort to use spatial information from an ontological perspective. This is largely a result brought by human interpretation of space: from a social perspective, space is linked to place, that is, to the subjective description of memory of the region, and the narrative importance of these regions given a set of emotional values. From an economic perspective, space is the territorial definition of proximities to markets, and may much better be understood when adapted as location and efficiency of location for economic growth. From a natural environment perspective, space is the subset of the environment as a whole, without considering the anthroposphere (Figure 1). The designation of environmental change comes precisely as a result from social, economic and natural impacts human being has exerted on the environment, taking form in the limits of carrying capacity and the possible outcomes of loss of spatially explicit landscapes and human environments (Roughgarden, 1974).

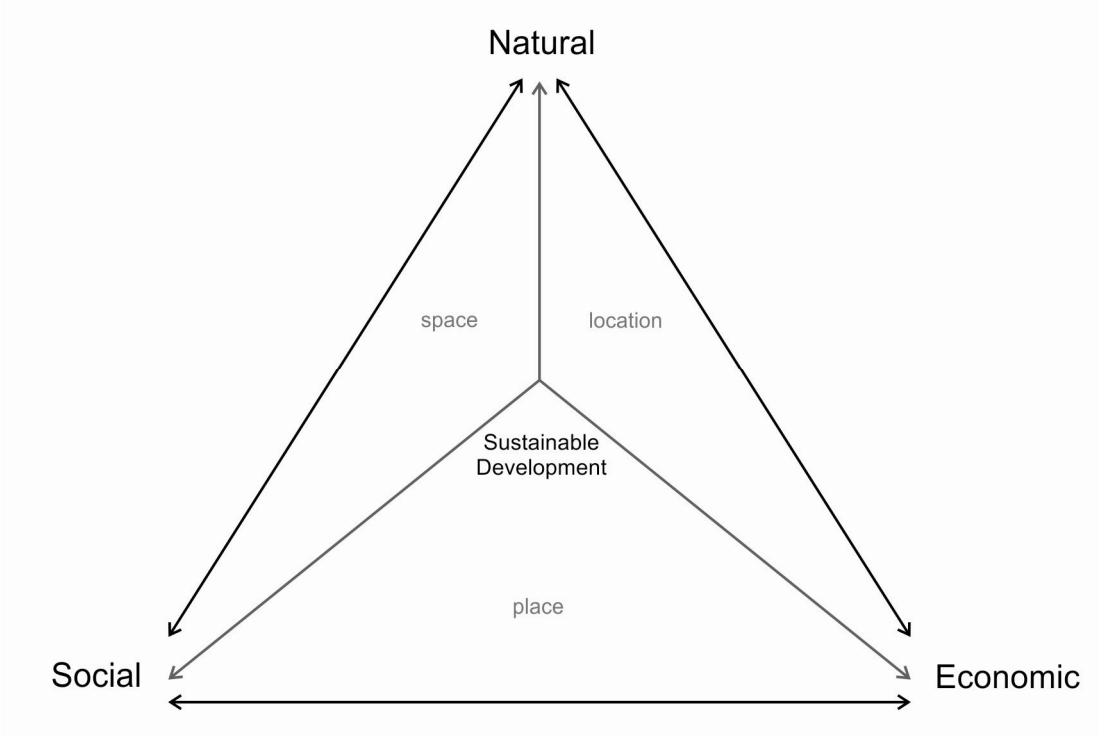

Figure 1 – The spatial dimension of sustainable development

In detriment of economic growth, land use diversity of non-artificial land is decreasing. This is having a negative impact on the landscape leading to permanent loss of diversified

landscapes (Holtorf and Ortman, 2008) and increasing fragmentation of land use. One of the ways to assess human impact on the landscape and on heritage is by measuring the variations of land use change focusing in particular on the registered changes of urban land use. In this sense, urban regions represent drivers of social and economic change, offering a clearer understanding on the impacts on the structure on the ecosystem services (Bolund and Hunhammar, 1999) and diversity in urban ecosystems as a whole (Francis et al., 2012). The complexity of these urban regions (Batty, 2007) calls for a holistic perspective where urban regions should be intrinsically diverse and presence of archaeological heritage and historical landscapes catered. The consequences of anthropogenic behaviour over space, in particular population growth (Meyer and Turner II, 1992) has led to excessive urban sprawl and severe impacts on land use, leading to irremediable loss of heritage (Vaz et al. 2012). The population increase and the urban concentration is not only creating additional pressure on the natural environment, but also jeopardizing our historical ancestry, by depleting our own heritage. These landscapes, as pointed out by Antrop (2005), share a unique and irreplaceable value that may be directly experienced, with a higher level of symbolic and cognitive value. Landscapes of the past are as such a vital part of monitoring and sustaining the landscapes of the future. The role of spatial information and geovisualization is thus to foster the role of assessing, quantifying and identifying their risks, pressures and shape at present. Also, the scenic values of these landscapes are important properties for sustainable tourism, permitting a diverse understanding of humankind as well as their origins and traditions. This participatory role of sustainable tourism and heritage preservation, leads to a local and regional territorial identity, eventually generating a better quality of life and enhancing social responsibility for the environment in general. To evaluate and research these boundaries of spatial, economic, and social values is a fundamental role of applied regional science. Regional science combines the economic aspect of the preservation of the local, and foments the existence of functional urban and rural regions, merging from sociology, economy with

regional decision analysis. Recent years have promoted the addition of spatial complexity and complexity science, where landscapes are having a key role as determinants of understanding and dealing with change. A good example is given by Vaz and others (2011): Cairo, one of the biggest megacities in the world, is witnessing an excessive urban growth brought by population growth, and creation of new infrastructures to support tourism, economic growth and population increase. A closer analysis of the future urbanisation processes of Cairo (Figure 2) leads to a better understanding on how to protect fragile and important historical heritage in future.

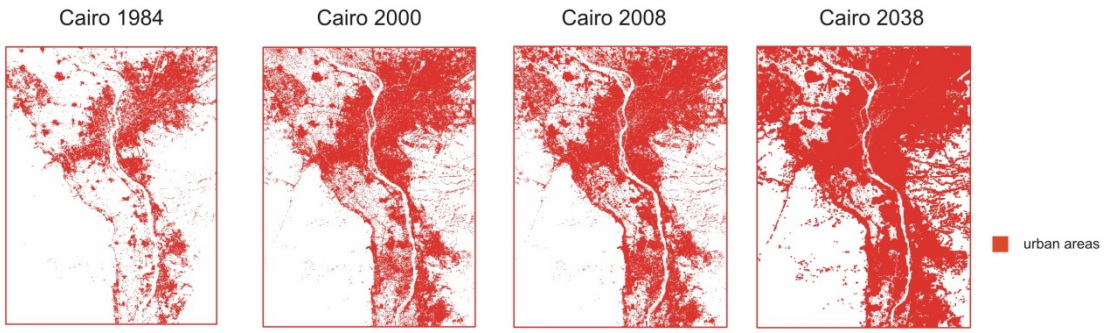

Figure 2 – Future urban growth in Cairo (Vaz et al., 2011)

The distribution of this information along space, allows decision makers to understand and to visualize the consequences on the urban environment at multiple levels (Diamond and Wright, 1988), avoiding collapsing landscapes in future. By collapsing landscapes, and as later explored, I understand the landscapes that have lost their territorial identity, in largest part due to human interaction with land use, and increased anthropogenic activity. These landscapes however, are part of the residual memory of society having a unique historical, social and affective value. The regional dimension gains a very important output given the advances in geocomputation, the conceptual understanding of future environmental change, becomes possible to interpret by assembling software compliant with space-time (Rey and Janikas,

2006) that allows forecasting possible change and optimising better solutions for planning purposes (Nijkamp and Scholten, 1993). This 'landscape collapse', is increasingly witnessed through rapid shifts in traditional land use and leads to depletion of the culture of the landscape,, that is, its historical and regional territorial identity (Plieninger et al., 2006). These changes are well observed by the advances of geovisualization techniques, remote sensing and spatial analysis. Witnessed at multiple scales (Lang and Langanke 2005), one of the regional evidences of the impacts of the landscape collapse, is the permanent loss of material evidence found in Archaeology, consequence by rapid urbanisation processes, and loss of agricultural land and rural areas as well as coastal erosion, where archaeological sites have always been present. It is thus of utmost importance to consider that Archaeology should have an important role in the preservation of landscape and of sustainable development. Therefore, archaeological findings, must represent a parameter to measure the quality of unchanged regions, and should also be adopted in a framework of regional sciences for sustainable development.

2. Must Archaeology be part of the landscape? A regional science paradigm

Quantification of information in the human sciences is not an easy process as most human sciences relay on qualitative analysis and narrative interpretation of phenomena rather than methods found in exact sciences. Some fields of the social sciences, such as sociology, geography, anthropology and archaeology, have managed to integrate quantitative methods in the epistemological processes given their strong connection to space and geographical understanding. This quantifiable nature of social sciences has brought a convergence between mathematical and statistical methodologies to understand parts of more complex patterns and have built a bridge between quantitative and qualitative topics. This integrative approach has been interpreting the future of mankind and sustainable development (Costanza, et al. 2007).

Archaeology as a human science has had an interest in quantitative and technological methodologies, supported by the possibility of quantifying material evidence (Doran and Hodson, 1975). With the evolution of Archaeological science and geocomputation, applications have become more pervasive, and spatial data from sites and material evidence have led to important tools for analysis, comparison and prompting of archaeological phenomena and information (Connolly and Lake, 2006). Archaeological catalogues that, first started as simple archaeological registries of stratigraphic or site location interest, have developed into large data containers with information which may be created, retrieved, eliminated and changed. Hence, the basic circumstances for a database management system were established in the field of Archaeology that allowed integration of information related to archaeological site phenomena. In this sense, Archaeological database are not only an asset for Archaeological cataloguing, but also an extremely important tool for sharing information and as a consequence to use Archaeological evidence to prompt for sustainable development. Information in Archaeology needs as a consequence, physical storage space, which can be either stored in manual files or in a database which may represent accurate information at regional level. Another source of spatial data has in recent years risen: crowd sourced spatial data. This data has enabled the user to be part of the manipulation, gathering and editing of geographic information and embedding this information into a GIS. The role of the 'human sensor' as defined by Goodchild (2012) is one of contribution to generating spatial information and sharing this information worldwide. This bottom-up approach is strongly linked to the advances in mobile technology and locational technologies for the end-user, not only permit to pinpoint the location of archaeological and historical sites, shared by a common WebGIS application such as OpenStreetMaps, but furthermore, expand on the dissemination of information generating tacit knowledge through the integration of spatial information with ancillary information resulting from social networking. Social sensitizing of historical landscapes and archaeological material evidence is thus a conciliatory dimension of

the already existent GIS solutions. The location of archaeological artefacts through space may foment better planning of preservation of archaeological sites as discussed above and as foresight tools to quantify archaeological and historical presence throughout space. The traditional tools that GIS represented a decade ago enabling the user to edit, access and visualize spatial data, have now become in the web 2.0 context tools for information sharing. The human sensor has a crucial role in building on the regional importance of the broadcasting of the regional value of the landscape, but also embeds by media sharing a greater awareness of our past heritage.

3. Spatial solutions for sustainable development: A systemic vision

While spatial information proves to be a fundamental tool to connect landscape preservation with sustainable development, social sciences have an increasing participatory role in shaping the future. Concerning natural and historical landscapes, new integrative solutions must be built to link urban design with economic and environmental planning. A systemic vision of sustainable development considering spatial characteristics and the morphology of the landscape answers these challenges from a spatial perspective. In this sense human being acts as a keystone species capable of manipulating and changing the environment for his present needs (O'Neill and Kahn, 2000). This brings a threat posed on the antroposphere and on the natural environment alike, interacting with humankind through biological and chemical processes that strain the carrying capacity of the existing equilibrium between humans and the natural environment. Sustainable development as such, may be seen as the result of generating a balance between these apparently antagonistic forces: environmental and human equilibrium. One of the main culprits to generate this antagonism is in large, economic growth. The excessive and asymmetric consumption human being incurs, leads to a sink on the environmental sustainability, observed by systemic changes the landscape. Examples of

this strain are rapid land use changes found in urbanization processes, loss of ecosystems and biodiversity, and exploration of available resources leading to scarcity. Regional development tries to attenuate, understand and generate policies that mitigate the effects of human being on scarcity and therefore rely on a sound understanding of land use and landscape. This keystone species role of human being is nested in the capacity of creating policies on the limits of environmental exploration, as well as informing and conceptualizing our ecological footprint as a species. The notion of territory and sustainable development, at a regional scale gains in this context a great importance (Figure 3). Regions and local communities can adopt a decisive role on endogenous growth, and local communities may shape social behaviors at a global scale through internal local actors (Cavallaro and Dansero, 1998).

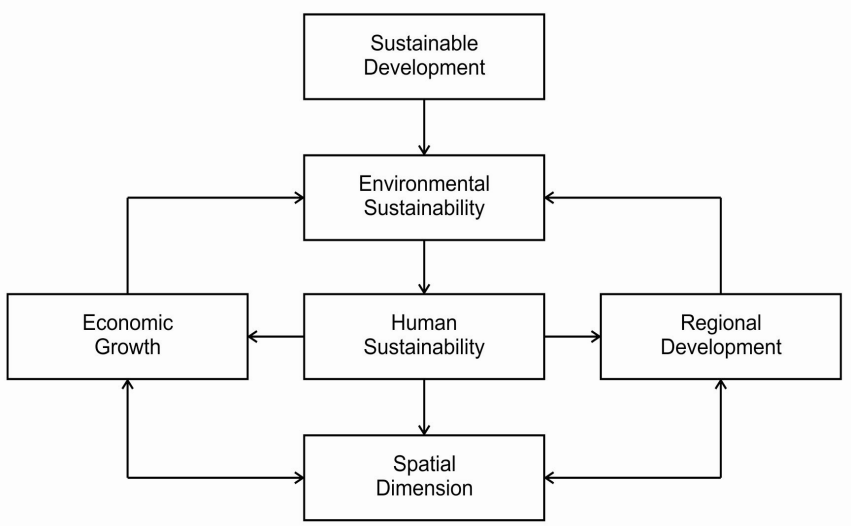

Figure 3 – Integration of the spatial dimension for sustainable development

In this sense, the role of historical and archaeological landscapes is dual. On one side, boosting consumption by using available historical landscapes as a resource and guaranteeing human economic growth while avoiding the negative externalities brought by economic growth. Examples of these include among others, the refinement of sustainable tourism and exploration of agricultural sectors while fomenting the local creative class. The nurturing of

the creative class results in social and cultural awareness, that from a spatial perspective is intrinsically linked to the territorial memory. Furthermore, when aided by spatial information systems and ambient information systems the local values are shared as a knowledge base throughout the world, and foster examples of a living consciousness of global sustainable development through regional science. I do assume that we are nowadays witnessing what may be designated as 'collapsing landscapes', shared by a post-modernist vision of fragmentation of (i) land use, where the landscapes have been afflicted by such profound changes in the structure of its land use and environment that heritage landscapes and their contribution to economic growth may become lost for future generations, such as: (ii) territorial identity, that is, the memory of the land and of the traditional sectors of economic and social activity have irreversibly become lost with the disappearance of historical, archaeological legacy and (iii), memory, where the land use and historical identity share an affective value which society takes for granted, as the process is slow, steadily changing the landscape. This leads to assume that the available spatial information of archaeological sites and natural heritage in a region should be considered as an indicator of sustainable human habitats resulting from a transversal integration of disciplines (Vos and Meekes 1999) . This results in two distinct future visions on the interaction of landscape and human heritage from a spatial systemic perspective that may represent pathways to avoid the fragmentation mentioned earlier: (i) coherent landscape, where urban planning plays an important role in maintaining a balance between the urban environment, the regional environment, and the physical structure of the city and its hinterlands. On the other hand, (ii) the dominant landscape is applicable to cities registering which are witnessing strong regional conflicts at present. These conflicts are a result of war, policy and politics, and often lead to complete destruction of landscapes of the past.

3.1. The coherent landscape

Within the notion of changing regions, the values of landscapes are measured by the transitions of land use and land cover. A sign of progress in terms of sustainable development for the coherent landscape is the least amount of changes on the ecosystems, maintaining the memory of the region as an intact and predominantly presence in shaping the regions of the future. Within what I define as a coherent landscape, urbanization processes remain fundamentally static over time. The coherent landscape depends on the integration and synergy of ecosystems and biodiversity for human being. In this sense, urban regions and rural areas are integrated into a homogenous platform, where small towns are stimulated instead of large urban regions. The landscape is thus strictly functional and depends on the local and regional resources and is self-sufficient. The coherent landscape is further explored by the creative class, taking advantage of innovation within small clusters of expertise, that contributes to creating a territorial identity where values are shared, but remained continuous over time. This spatio-social coherence in the landscape is transmitted to urban areas, and should provoke fewer changes on land use, as well as assimilation of historical landscapes and archaeological landscapes as a part of the social and economic product the region offers.

3.2. The dominant landscape

The dominant landscape pertains as part of the conflicting structure of rapidly changing regions, whether as a consequence of excessive population and urbanization, war, or social asymmetries. The structure of these cities is to fundamentally re-equate the regions based on de-growth strategies and limit radically the possibilities of urbanization. I suggest an urban quarantine, limiting urbanization processes in areas where accelerated processes have been witnessed over the last decades. Within the dominant landscape, where urban pressure seems

to be eminent, and heritage must serve as a containments factor to preserve the authenticity of the current landscape. Heritage endangerment (Vaz et al., 2012) is thus seen as a tool to measure the fragility of the area that informs decision makers of the limits to growth within these regions.

4. Geovisualization: The role of mentoring the future

The different forms the landscape may reflect in future are largely a result of the possibilities to visualize and calibrate our socioeconomic and environmental variables at present. The spatial component is quite relevant for understanding the changes witnessed at land use level, and become even further important as to understand the complex interaction between human being and its environment. Geographic Information Systems, and in particular geovisualization will have an even larger role in future. This role is boosted by the capacities of computing future scenarios of urban and regional change for sounder decision making, as well as social awareness of regional social interaction of information with the advent of web 2.0. The changing landscapes will rely heavily on technological advances to promote sustainable behaviors and allow population dynamics to act based on information. Concerning regional growth this may lead to a more equilibrated society, where resource use is shared and optimized, supporting a more functional region. Example of this include location based services to ameliorate commutes and transportation systems, distance learning facilities, and media sharing of historical, natural and biodiversity, as tools for social sensitizing of global problems. In this sense, information becomes the driving force of an autonomous functional society, where resources of habitation and spatial understanding of regions promotes a better living quality as a whole. While at present the role of geovisualization is defined as a tool to assist in understanding the geographical dimension of the region, in future this role will be shared to a collective sense, of jointly changing the region to become more functional for the

individual promoted by ambient information systems, where people interact and relate to digital information in the context of their environment. This ubiquitous role of spatial information is accelerated by the recent advances in crowdsourced especially through crow-designing, where urban interactions can be used to converge top-down and bottom-up approaches setting up a live knowledge network (Salim et al., 2009). This live knowledge network must be linked strongly to the regional decision making agenda. While Geographic Information Systems alone can only offer a limited number of solutions, it is through the creation of transversal efforts in regional science that the understanding of landscape and its complexity becomes possible. The advances of using spatial information combined to regional sustainable development, and understanding of socioeconomic interactions, can allow creating a new agenda for regional science, where the focus is of transmitting to future generations the changes beginning at present.

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