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Advancing Novel Spatial Methods for old Problems at Regional Level

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TABLE OF CONTENTS

A REGIONAL SPATIAL-RETROFITTING APPROACH (RSRA) TO GEOVISUALISE REGIONAL URBAN GROWTH: AN APPLICATION TO THE GOLDEN HORSESHOE IN CANADA

Eric Vaz
Amy Buckland
Kevin Worthington

ABSTRACT

Understanding urban change in particular for larger regions has been a great demur in both regional planning and geography. One of the main challenges has been linked to the potential of modelling urban change. The absence of spatial data and size of areas of study limit the traditional urban monitoring approaches, which also do not take into account visualization techniques that share information with the community. This is the case of the Golden Horseshoe in southern Ontario in Canada, one of the fastest growing regions in North America. An unprecedented change on the urban environment has been witnessed, leading to an increased importance of awareness for future planning in the region. With a population greater than 8 million, the Golden Horseshoe is steadily showing symptoms of becoming a mega-urban region, joining surrounding cities into a single and diversified urban landscape. However, little effort has been done to understand these changes, nor to share information with policy makers, stakeholders and investors. These players are in need of the most diverse information on urban land use, which is seldom available from a single source. The spatio-temporal effect of the growth of this urban region could very well be the birth of yet another North American megacity. Therefore, from a spatial perspective there is demand for joint collaboration and adoption of a regional science perspective including land cover and spatio-temporal configurations. This calls forth a novel technique that allows for assessment of urban and regional change, and supports decision-making without having the usual concerns of locational data availability. It is this sense, that we present a spatial-retrofitting model, with the objective of (i) retrofitting spatial land use based on current land use and land cover, and assessing proportional change in the past, leading to four spatial timestamps of the Golden Horseshoe's land use, while (ii) integrating this in a multi-user open source web environment to facilitate synergies for decision-making. This combined approach is referred to as a regional-spatial-retrofitting approach (RSRA), where the conclusions permit accurate assessment of land use in past time frames based on Landsat imagery. The RSRA also allows for a collective vision of regional urban growth supporting local governance through a decision-making process adhering to Volunteered Geographic Information Systems. Urban land use change can be refined by means of contribution from end-users through a web environment, leading to a constant understanding and monitoring of urban land use and urban land use change.

Keywords: Golden Horseshoe, Land Use Change, Regional Management, Urban Growth

JEL Classification: O44, R11, R52

1. INTRODUCTION

Canada, one of the most diverse countries on Earth, has a unique abundance of natural landscapes, mineral resources, wetland and forest systems as well as the largest freshwater resources in the planet. However, Canada is quite concentrated concerning anthropogenic activity, with certain regions in Northern Canada, for example, remaining largely uninhabited. While governance is increasingly investing in the peripheral regions of the country, population concentration is still predominant in the regions where climatic conditions are suitable for anthropogenic activity. This anthropogenic activity has led to a series of concerns relating to the consequences on the acidification of aquatic ecosystems, mostly resulting from human pressure (Dillon et al., 1987). The massive increase in population dynamics and the resulting patterns in the rapid urban expansion (Brueckner, 2000), has been linked directly to the growing Canadian economy, leading to new migration patterns, and economic growth around the major metropolitan areas of Canada (Moore and Rosenberg, 1995). One of these regions is Ontario, in particular southern Ontario, where within a rather small area a total of 26 per cent of the Canadian population is present, and is strongly linked to commuting infrastructures between cities (Axisa et al., 2012). This region is growing and changing dramatically, and holds as of 2011, a total of 8.67 million people. This number is rapidly on the rise, and while it entails a unique opportunity of continued economic growth for Canada (Leung et al., 2012), it also deems the first signs of what can be defined as a megacity. Megacities bring excessive urbanized regions, and have unforeseen impacts on the geomorphology of the landscape and ecosystems (Zipperer and Pickett, 2012), that must be carefully managed (Li et al., 2010). Planning and offering diversity of ecosystems and land use types is, therefore, paramount to increase sustainable development, health and well-being (Tzoulas et al., 2007, Xavier and Martins, 2012). It is also important to efficiently explore available resources without jeopardizing the carrying capacity of the region, while offering a sound understanding of land use change simulation (BenDor et al., 2013) to avoid the negative consequences of regional urban sprawl. In this sense, remotely sensed imagery (Bhatta, et al., 2010) and Geographic Information Systems through combined landscape and spatial methodologies (Kiran and Joshi, 2013) bring fundamental tools for regional support systems of urban areas (White and Engelen, 2000). This is additionally fostered by the need of integrated modelling approaches that take advantage of spatial data availability and remotely sensed imagery and design systems that evaluate and visualize the effects on the natural and urban environment (Williams et al., 2012). These systems should be open to the public, and through geovisualization techniques they should assist in the implementation of integrated knowledge systems (Cash et al., 2003) concerning land cover and land use over time. The study of land cover is one of the most important factors for planning and managing activities regarding the use of land surface on earth (Ratanopad & Kainz, 2006). In North America, priority is driven by the abundance of available land and economic demand of population growth in a country like Canada. The market conditions have been favourable for urban sprawl, and only recently have become part of the larger framework of land use change that should be formally understood and quantified to generate more sustainable urban regional and peri-urban environments. Understanding the impacts of urbanization on natural and cultural heritage is essential as it sets out opportunities for future economic growth, without jeopardizing the environment (Vaz, et al., 2012a). Regions are expected to change dramatically and should, therefore, be monitored adequately by means of geoinformation technologies (Stellmes et al. 2013). A tension has formed between future anthropogenic activity and preserving environmental sustainability (Lyle, 1994) rendering the natural capital of the land in expanding regions through growing understanding of the existing ecological changes in face of change (Haines-

Young, 2000). As sustainable development is derived from the regional understanding of the harmony of landscapes, biodiversity and ecology over space, Geographic Information Systems have shown to be the ideal fit to measure spatio-temporal dynamics, provided the incorporation of land use data and remotely sensed imagery to better understand the consequences of the impacts of land (Vaz et al., 2011). It is especially ideal when these systems entail the possibility to be used, shared and assessed by a wider community, as well as when they include the integration of spatial decision support in a regional framework. This understanding is often limited to restrictive regional policy visions. However, it must be rearranged from a bottom-up approach, where the myopic local analysis opens up to the needs of regional demands and brings a deeper understanding of spatio-temporal dynamics. This becomes offered through the contribution of researchers, planners and volunteered geographic information contributors, leading to more efficient policies. This is the role of the regional spatial-retrofitting approach (Figure 1).

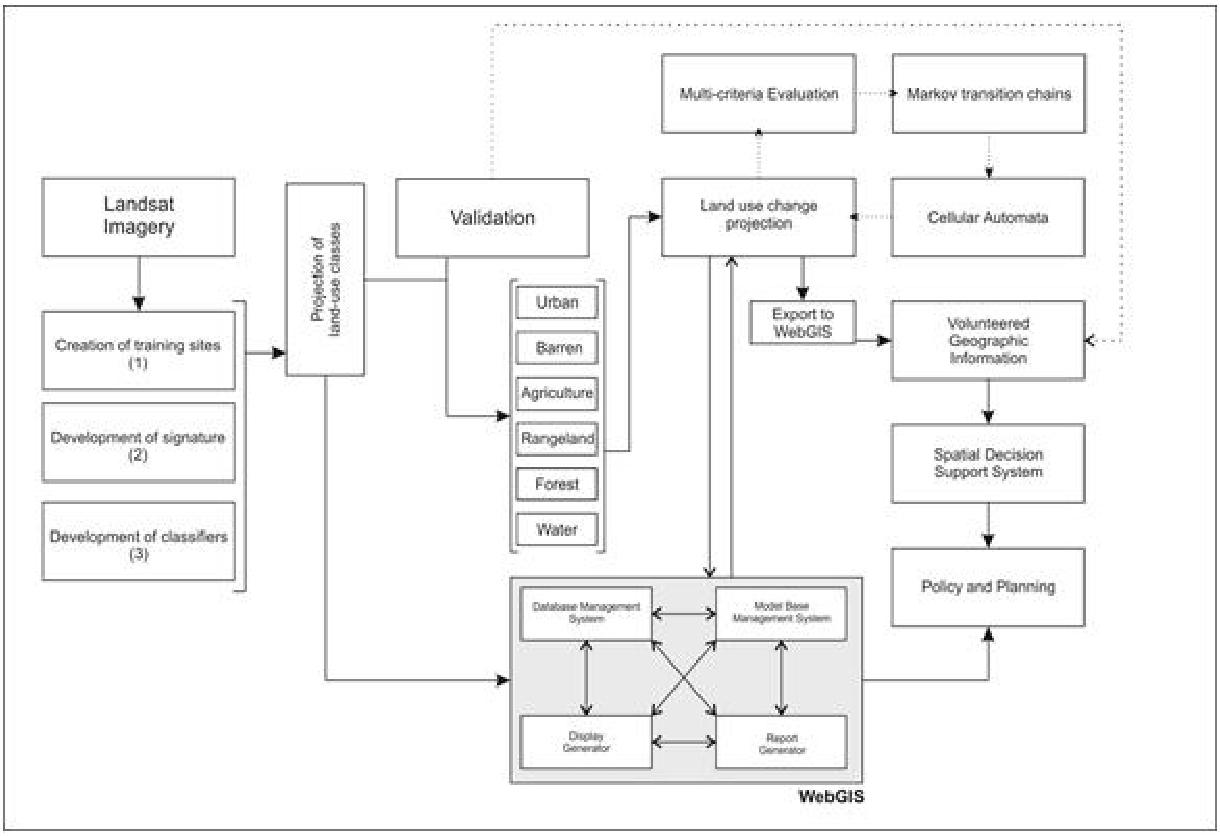

Figure 1 – Integration of the RSRA Framework

The model takes advantage of local governance and spatial decision support systems that envision regional land use dynamics based on available satellite imagery on ubiquitous models of scenario generation, which monitor and present future land use dynamics allowing for spatio-temporal conclusions. There is an integration of non-linear stochastic models in the predictive modelling output to support spatial decision making via Spatial Decision Support Systems (SDSS) for policy and planning. This is achieved by a natural evolution of Armstrong and other's (1986) SDSS proposed model, but brings to light the possibilities of using Volunteered Geographic Information (VGI) and WebGIS. The microcomputer solution proposed by the authors in the 1980's allows the integration of a web 2.0 platform. This brings the RSRA framework to a larger audience and provides a community driven solution and therefore, making it more complex. This allows for adaptation and readjustments to be made on the fly for spatial data and land use information. But most importantly, it allows for a collectively integrated support system from a planning and regional development perspective that considers regional scale, rather than local policies leading to spatial exploratory analysis (Dragicevic and Balram, 2004). This allows us to take advantage of available non-linear spatial techniques, and contributes to regional decision making (Vaz and Walczynska, 2011). In regions such as the Golden Horseshoe, the unique opportunity at the provincial level to foster emigration, tourism and preservation of its rich and abundant heritage justifies a spatio-temporal understanding of the dynamics of change and exportation of them to a collective regional vision. The regional sustainability dimension explored by Gadal (2006) shows the applicability of taking regions such as the Golden Horseshoe and applying an empirical perspective to land use modelling to enable decision-makers to better understand methods for a sustainable future. The objective of this paper is to contribute to (i) a multi-temporal understanding at regional level of the land use / land cover in the Golden Horseshoe in Canada, (ii) foment the usage of freely available remotely sensed imagery to define land use/cover for different regions throughout the world, while showing that integration of support systems such as WebGIS can help decision-making and (iii) foster the notion that landscape metrics aid in the design of more sustainable futures, bringing quantified tools to the context of regional strategies and urban planning, besides the traditional applications in ecology, and finally (iv) offer a scientific outlook of applied research for the Canadian regional agenda, concerning land use and land cover change systems and their applicability at the regional level.

2. STUDY AREA

The Golden Horseshoe is located at 43.6°N 79.73°W, and is one of the most dynamic socio-economic regions of Canada. It is located in Southern Ontario, and it stretches its boundaries south to Lake Ontario and Lake Erie. It is thus, a particularly interesting area because it is surrounded by fresh water. It has been found that freshwater shore zones are amongst the most ecologically valuable places on the planet, and the complex interactions that exist within their biodiversity have been heavily damaged by anthropogenic activity (Strayer and Findlay, 2010). It cradled over 8.1 million people in 2006, meaning it is home to two thirds of Ontarians and to one quarter Canada's total population (Statistics Canada, 2006) (Figure 2). One of its key characteristics is the urban concentration, (Edmonston et al., 1985) counting as one of the most concentrated economic regions in North America, with one of the largest growth rates alone being in the Greater Toronto Area (GTA) (Yeates et al., 2011). The population of the Golden Horseshoe is rapidly increasing with a growth rate of 8.4% per annum, and some of the fastest growing municipalities include Vaughan, Brampton and Milton. Milton had a growth rate of 71.4% in 2006 (Statistics Canada, 2006). Integration of Landsat satellite imagery from the United States Geological Survey (USGS), allowed for a supervised classification of the different land use/cover classes based on Landsat and TM data with some interesting results for

Figure 2 – Study area – The Golden Horseshoe Core Area

classification purposes, as discussed by (FitzGibbon and Chen, 2008). The land use classes were classified into (i) urban/built-up, (ii) agriculture, (iii) forest, (iv) rangeland and (v) waterbodies. These classes were taken into account as to keep spatio-temporal consistency and diversity in regional applications. This diversity was especially welcome in a context of the collective WebGIS, where the depiction of the continuous flow of the changing land use patterns within the Golden Horseshoe is of interest concerning different sets of land use. The available land use classification for 2006 was used as an ex-ante classifier to provide ancillery information on the accuracy and generalization procedures of our land use classification and to guarantee accurate classification. An overall accuracy of 84% was accomplished in the land cover classification. From a regional perspective, the multi-temporal analysis of land use poses interesting challenges not only to planning, but also to understand the aggregate of land use change function closer to previously existent urban areas, and regions which are in the suburban location of the rural fringe.

3. METHODOLOGY

3.1. Land use and Land cover in the Golden Horseshoe

Land use classes were developed by different categories based on composite mosaic of Landsat imagery. A nomenclature for land use was defined by the extraction of land use classes for Ontario in 2006, and correlating land use classes available for Toronto in 2010. The nomenclature was standardized as to have a consistent description for all the timestamps, corresponding to 1980, 1990, 2000 and 2010. The choice of a 10 year interval, resulted from available Landsat imagery within a three to four year span, where the paths and rows for the Golden Horseshoe were available. The merged spatio-temporal tiles, allowed extracting a polygonal shape mask, which was kept constant during the entire thirty years span (Figure 3).

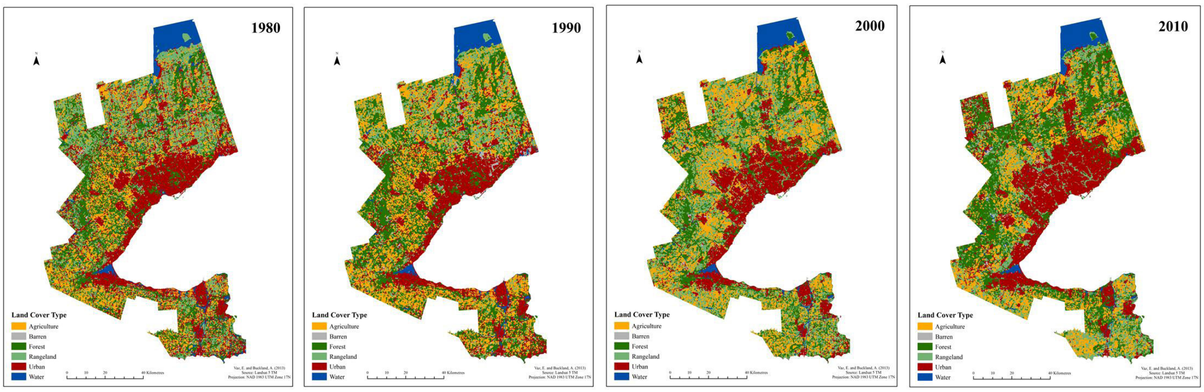

Figure 3 - Supervised land cover classification of the Golden Horseshoe from 1980 to 2010

This technique of filtering, concentrating and generating a nomenclature over a series of different time stamps for land use was widely applied in the CORINE Land Cover project in the beginning of the eighties and is currently in its third edition. The availability of four timestamps for any land use classification, as discussed in Vaz and others (2012b), allows the generation of a better statistical validation on the accuracy of both classification and prediction. In this sense, it is also important to mention that Landsat satellite imagery is an accurate source to measure spatio-temporal change at the regional level, as explored by Bedard and others (2007). This is particularly the case when focusing not only on a multi-temporal assessment, but also when assessing the regional dynamics of land use change, benefiting from a more global vision of geographical change dynamics at the regional level. A supervised classification was conducted based on a set of samples generating a significant amount of land use classes. Six classes were considered as main classes of land use, and reflect both the most relevant environmental characteristics of the topology of land use in the Golden Horseshoe. The Maximum Likelihood algorithm was constructed for all timestamps, namely for 1980, 1990, 2000 and 2010. For each individual time stamp, the following steps were taken carefully into account: (i) identification of training sites resulting from similar values in the electromagnetic spectrum and their reflectance attributes, (ii) classification at a pixel level of each land cover class, and finally, the production of a thematic map (Lilesand et al., 2004), consistently identifying land use and land cover for the region of the Golden Horseshoe in Canada. Although Canada is quite advanced in spatial data availability, some concerns exist in the usage and organization of land use data, where no generalized repository exists that contains and allows analysis of the land cover data for the Golden Horseshoe. At the regional level, such data availability would be of utmost importance to permit the execution of advanced spatio-temporal studies both in line with research as well as policy makers. There is an intrinsic need for the sharing of spatio-temporal land use information among the community and there is a demand for integrating a WebGIS interface, which we have successfully explored by offering the different land use covers available for free download. This again, was inspired in the CORINE Land Cover project, as well as in the fact that our approach, of building 1:100,000 maps does allow low-budget assessments of land use change and delivers up to date information for scientific purposes. The satellite imagery used was downloaded from the USGS Earth Explorer (http://earthexplorer.usgs.gov/), and Landsat TM data was converged and mosaics were built for each temporal land cover.

3.2. Geovisualization of Urban change

Urban growth geovisualization allows for an accurate understanding of the spatial changes and morphology by interpreting possible future outcomes from an empirical standpoint (Clarke, 2003). In this sense, Landsat imagery allows a composition of generating timestamps to depict urban change, but it is up to non-linear modelling techniques to allow the assessment of land change (Pontius et al., 2008) enabling the possibility to construct possible future outcomes at the regional level of urbanization processes (Jantz et al., 2010). Thus, while satellite imagery allows detection of change patterns for large regions and classification of urban land use types (Xiao et al., 2006), it is the urban growth modelling framework that assesses the dynamics of change, by means of comparing in a WebGIS environment the different land use covers for urban land.

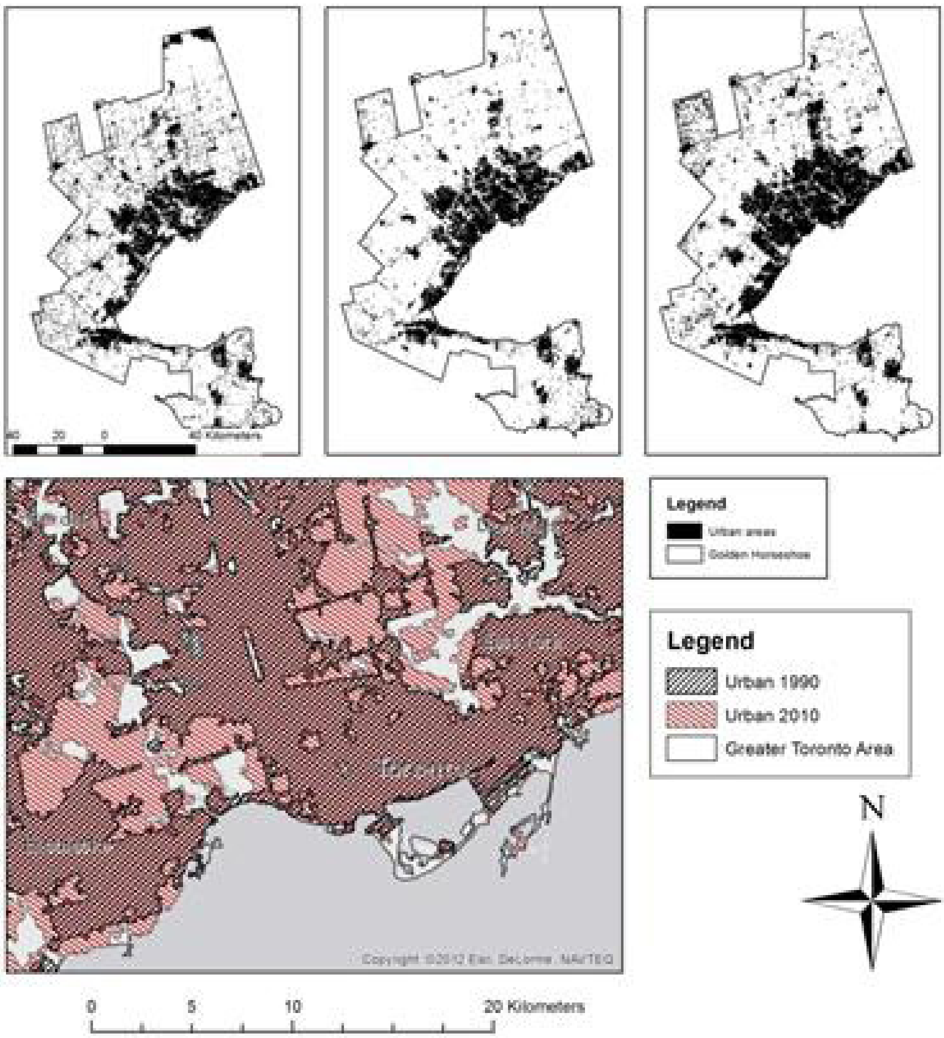

Figure 4 – Visualization of urban change in the Golden Horseshoe (1990-2010)

3.3. WebGIS

By incorporating a WebGIS as part of the urban land-use analysis we will enable open access to information, promote community participation and support decision-making processes. The ability to access information for free 24 hours a day, 7 days a week using a standard computer and web browser has become the status-quo. Widespread applications have led to people expecting more and more from GIS, and users now wish spatial data to be presented not only as static, but also as dynamic (Tang et al. 2008). End-users expectations have been furthered as modern technology enables more visually compelling and interactive online presentations without the need to install additional software. Web-based mapping applications are a product of this innovation and web users are becoming savvier to them. These applications promote interactivity and create a sense of relation for end-users due to their geographic nature and geo-location. To satisfy the needs of this project the open-source Web Mapping Platform Leaflet has been chosen. As modern web technology is able to display content dynamically using map-based web applications, so too can it allow end-users to update this information if they deem necessary. By facilitating the ability for end-users who have a local knowledge to update information, content is able to more accurately be represented. Editors of online content will be able to track their changes by creating an online account. Information will be immediately displayed on the map for other viewers to see. Historical information will also be maintained showing the evolution of changes made. In addition, the ability to revert changes back to a previous point in time will also be possible in case an error is made. Supporting decision making processes will be achieved through the WebGIS using a combination of features. Firstly, the ability to interact with the map by targeting a specific area of interest and zooming-in allows them to see more granular data. By adjusting controls such as filters, displayed information is able to be customized to satisfy their specific needs. And once the desired data is displayed on the screen, it can be downloaded in a usable fashion for further research and analysis.

4. DISCUSSION

The RSRA is an applied method of spatial analysis and planning at the regional scale and has provided an integrated approach not only for land use analysis, but for collective geovisualization and information sharing. The model presented serves as a useful tool in planning and development in the Golden Horseshoe, which has been an area of interest to the Government of Ontario in the past decade. Figure 3 shows land cover change in the region in the past 30 years. The urbanization is identifiable and the most recent decade shows much faster growth than the previous three decades. This spatial information would prove useful for the Growth Plan for the Greater Golden Horseshoe, which was approved in 2006, and strives to revitalize downtowns and communities, while reducing urban sprawl and protecting the environment (Ministry of Infrastructure, 2006). The RSRA method allows for analysis of past, current and future trends in anthropogenic activity, and therefore could be used in the planning process. The tool is designed to help planners to understand the geographical relationship between the human and natural environment. Within this, planners can specifically begin to understand the relationship between the region's economic, human and physical resources. Ontario has a combination of quality soil and suitable climate that makes Southern Ontario the best place for agricultural production in the country (Caldwell and Stewart, 2005). Therefore, preservation of farmland in the region is important, and the monitoring of the land cover is one major component. The RSRA can also be used to identify areas with the capacity of economic growth. The town of Milton has undergone rapid population growth over the past 10 years, with a growth rate of 56.5% reported in 2011 (Statistics Canada, 2011). This urban growth is captured in the RSRA model and can be quantified to understand the nature and extent of it to ensure a sustainable economic approach to growth is taken. The infrastructure and services are being outgrown by the rapid population growth, and this is why studying the settlement pattern is so important to ensure development is served equally, effectively and sustainably. The RSRA method also allows planners to analyse the interactions that take place within urban areas as well as between them. Looking at growth patterns over time allows linkages among settlements and the degree of access that they have to one another to become apparent. Analyzing the rural-urban relationship is crucial to understanding regional development in the Golden Horseshoe. Transportation is one of the major focuses of Ontario's Growth Plan, and incorporating models for a long-term solution is needed for decision-support. Despite the attention of models for transportation modeling, there are a large number of jurisdictions within Canada that adopt outdated models or do not rely on integrated land-use or transportation modeling for decision-support (Hatzopoulou and Miller, 2009). Without the spatial dimension of regional planning in the Golden Horseshoe, the process will be costly for the government. A method like the RSRA reduces the uncertainty of future trends in an interdisciplinary way by detecting changes through time. As seen in Figure 3, urban growth in the past 30 years is getting closer to the greenbelt, and monitoring this growth is becoming even more essential. The WebGIS aspect of the RSRA promotes the interdisciplinary of studying land use and land cover change over time. Users can freely enter and access diverse information, which could lead to further enhancement of public involvement in environmental management (Kearns, F. et al., 2003).

5. CONCLUSIONS

Spatial equilibrium within regions are linked to the importance of generating urban hubs, that allow for economic and regional growth, and often underlie a monopolic competition, leading to spatial agglomeration (Fujita and Krugman, 1995). This spatial structure found in urban areas is closely linked to the knowledge and skills that urban regions can foster as productive hubs of generating significant contributions to learning and innovation, and where spatial organization of agglomeration may be very useful in an urban context (Cooke and Morgan, 2000). It is especially useful in an age where a collective approach residing on information sharing must be fostered as to plan anthropogenic activity at regional and local level. Innovation and technological advances therefore, allow for the creation of more sustainable regions, while fostering an increase in production, and also inspires investment and a causal relation of immigration patterns in what Wolfe defines as the 'Schumpeterian hubs' of Canadian cities (Wolfe, 2009). This has been particularly the case of Canada, where the changing urban landscape can be measured by means of GIS technology. Also, the regional challenges faced in urban areas given the pressure on the carrying capacity of humankind, have led to some concerns on the sustainability of continued pressure on rural areas, as well as the conversion of natural habitats and ecological sustainability (Hathout, 2002., Vliet et al., 2009). It is however not an issue of reshaping and redesigning the city, but much rather, taking advantage of the different institutions that partake in the collective process, as explored by Sancton (2008) and adopting bottom-up approach for Canada at the provincial level. Sustainable environmental development is also fostered by understanding in a collective sense, the intrinsic urban dynamics in regions as the Golden Horseshoe. From an economic perspective, this allows for a maximization of knowledge flow for potential investors in the region, helping collectively to promote sustainable policies through the adoption of the spatial-retrofitted methodology. The importance of regional preservation and environmental concerns have been outlined in the leadership of the Conservative Prime Minister Stephen Harper, bringing as an example the importance on how Canada must cope with a changing land and environment, due to unpredictable reasons such as climate change, land use transitions and population increase. The Golden Horseshoe from a spatial economic perspective, represents a polarized space where central place theory plays a unique importance, because Toronto is becoming increasingly one of the major hubs in North America for economic growth, which also spans out to the Greater Toronto Area. From an economic perspective, it is of utmost importance to follow this growth, and use available tools found in the geographical rationale to collect information, and retrieve spatial knowledge for planning purposes. The RSRA approach tackles precisely these relations, by means of implementing and using WebGIS solutions as tools to retrieve land use dynamics over time, and by interpreting remotely sensed information. It has become more evident for planners and governance to reflect on a spatial perception of land use change, while rendering better solutions for sustainable land use changes. This paper has discussed an integrated approach for using WebGIS through remotely sensed imagery to extrapolate land use, and has reflected on the changing land use in the Golden Horseshoe. The implementation of a WebGIS in a decision making context further allows for the understanding and reflection on the future challenges such an active region faces, and that spatial economic rationale can foster a better and more accurate decision process when linked to the correct set of tools, such as advanced spatial information, when interpreted from a spatio-temporal perspective.

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THE SPATIAL BUSINESS LANDSCAPE OF INDIA

Eric Vaz

ABSTRACT

India has in the last decade become of the fastest growing entrepreneurial landscapes in the world. With a total population of almost 1.2 billion inhabitants, it has developed from a rural economy into a highly competitive market. This study analyses the spatial configuration across the country from a regional perspective, offering an assessment of the spatial autocorrelation of business as to understand the spatial configuration of what I define as a regional-spatial business landscape. In this study, the patterns of distribution of all the registered Indian businesses are assessed counting a total of 6500 registered businesses from 1850 to 2010, which were geocoded and imported into a Geographic Information System environment. A geostatistical analysis is conducted measuring business growth and performance at a national level by means of a Global Moran's I calculation and followed by assembling a Local Getis-Ord for regional assessment of correlation of road networks. These local spatial statistics reveal clustering of hot spots within threshold distances of road concentrations, suggesting a positive relation between location of businesses and concentration of road networks. The agglomeration of Indian businesses becomes defined by the importance of road infrastructures to allow commutes and interaction of businesses. As a result, it becomes possible to see that India's business landscape is far from homogenous, and responds well to Weber's theory of industrial agglomeration, while predicting possible inter-firm collaboration. These business hubs in the business landscape are assessed at national level through spatial autocorrelation and then regionally diagnosed by identifying hot spots of business location given business density, and bringing to light the precise location of India's business hubs from a spatial business landscape perspective at present.

Keywords: Business Landscape, GIS, Spatial Analysis, Geostatistics

JEL Classification: Q01, R52

1. INTRODUCTION

1.1. Background

The Indian business has changed dramatically since its economic policy in 1991 (Kohli, 2006). While competition was scarce, restrictions on entering the market were little and mainly guided by an inward looking policy based on self-reliance, resulting from the independence in 1947. As a manifestation of an innate passivism and lack of competition, very few successful cases of entrepreneurship were reported until 1991. Performance of capital goods industries was very poor, causing a great concern given the weak performance of the agriculture sector which had little infrastructural investments. Over the years, control and regulations was tightened to such an extent that the cost and quality structure of Indian products deteriorated and Indian products became non-competitive. Indian goods were not able to be sold in the global market without support of export credit, subsidies and other concessions. Domestic buyers had no option but to buy high-cost-low-quality goods produced with obsolete technology, leaving the country to pay a high price for its structural rigidity and inefficiency (Montek, 1998). In sum, the prevailing weaknesses in the Indian economy became prominent because of unfavorable external factors (Cerra and Saxena, 2002), but also internal inefficiency to cope with business growth. Production and marketing apparatus did not remain fit to meet the domestic demand and compete in foreign markets. In addition, to carry forward the benefits of new policies on enduring basis, the long term issues of structural rigidity had also to be urgently addressed. This consisted of decontrolling the private sector, reforming the public sector and taking other appropriate measures so as to give competitive edge to the economy. The Government, in view of these developments and compulsions, reformulated its economic strategy and introduced the new economic policy (NEP) of which globalization was an integral part. In 1991, resulting from an aggregate growth in the early to mid-eighties and with the introduced neo-liberalization of markets, a series of reforms opened India's economy, and gave the private sector much more possibilities of economic sustainability. The government of India liberalized the economy leading to an outstanding change concerning the business landscape which started becoming highly competitive. Indian economy has emerged with remarkable rapidity and is projected to move up and become a $2 trillion dollar economy. This has been possible because of the leading corporate actors who have made a valuable contribution to the development of the Indian economy. Indian organizations therefore have to deal with territorial competition, and move fast to position in an international market. While Indian companies are able to capture market globally, it becomes of utmost importance to define the spatial hubs and distribution of business activity, as well as respond whether businesses show pattern through spatial business agglomeration and communication network, a first positive outlook for a sustainable business landscape. In this sense, this paper proposes an integrated spatial analysis approach based on geostatistical methodologies. The spatial Indian business landscape is understood by assessing first a national spatial autocorrelation technique, after geocoding the entire dataset of Indian registered businesses. In a second stage, and as explored in an important contribution by Datta (2012), the assessment takes the location of road networks into account, correlating these with the geocoded businesses. Finally the business landscape is defined through the existence of business hubs, which are calculated through spatial autocorrelation (Ord and Getis, 2002) approach to understand, not only the relation of road concentration vis-à-vis businesses, but also, the location of business hubs in India.

1.2. The Spatial Business Landscape

Globalizing markets have found unique challenges and opportunities, following territorial competitiveness (Boschma, 2002). Territorial competitiveness may be defined as the ability a territory may have to achieve high growth rates over time, building on the standards of living of its inhabitants (Poot, 2000). As pointed out by Cappellin (2003), the local endowment of intellectual capital, does follow a spatial rationale that can be measured, enhancing thus competition in a given region, and boosting territorial competitiveness by channeling innovation through communication and agglomeration of sectors at local and regional level (Cainelli, 2008).

The district level of innovation capability of business performance, gains thus a geographical context of its undermining relation to space and territorial competitiveness that should find a compromise between location and geographic models (Krugman, 1999). A good example of the integration within competition and the spatial rationale is the application to the model of the Porter's Diamond (Porter, 1990) where growth may be assessed by (i) factors and conditions for growth, (ii) the firm strategy, (iii) the demand conditions and (iv) supporting industries, are all dimensions that have an intrinsic geographic dimension.

These dimensions are all closely linked to location of business where as a result spatial agglomeration and environmental constraints result in positive or negative externalities that increase or decrease business performance (Rey, 2001). Understanding the spatial topology and underpinning the business landscape is thus a fundamental asset to monitor and boost the sustainable growth of business from a territorial perspective. This is linked to the concept of clusters that emerge from the equilibrium of place, and the socio-economic determinants that generate growth. From a Geographical perspective, this process may be seen as what is defined as the first law of Geography where Tobler states that" everything is related to everything else, but near things are more related than distant things", an intrinsic relation exists over performance and space which allows for spatial analysis (Miller, 2004). One of the main reasons is the existence of spatial association creating causality between aggregations of clusters over space and giving place to more complex evidence found in spatial autocorrelation where complexity also arises from the differences between autocorrelation in time (Cliff and Ord 1970, Vaz et al., 2013). The techniques found in spatial analysis and in particular in geostatistics to understand the locational patterns of businesses is therefore of utmost importance. In the case of India, as pointed out by Datta (2012), businesses do become more competitive and find fewer obstacles in production with enhancement of highways and extending the road infrastructures. The assessment of the business landscape, must consider therefore the creation of new road infrastructures concerning the business landscape, in particular in a country where market oriented reforms are supporting economic growth (Ghate et al., 2013). This leads to the importance of rendering a geographical proxy in understanding the patterns of territorial competitiveness, resulting in better local synergies which enable business performance (Porter, 2000) while generating sustainable entrepreneurial ecosystems (Pitelis, 2012). The spatial results of these changes may be identified by the occurrence of agglomeration and scale economies to explain why business tend to join, taking advantage from this proximity. In recent times however, a vast theoretical framing was developed to extend the reasons why organizations are getting closer, linked by common interests to ease the present challenges of growing competitiveness. Most of these arguments are related to organization theory, fitting in the area of clusters and networking analyses. After the emergence of the concept of clustering to designate a new concept of geographical and institutional proximity among companies, Porter and Sölvell (1998) also explained that a cluster offers the adequate environment for the development of a common language, social bounds, norms, and values as an advantageous social capital. This implies an intrinsic geographical dimension where similar values allow increasing performance and become part of the business landscape. The cognitive rationale assessed by Pouder and John (1996), who explained that within a cluster, managers and decision-makers share many cognitive references, perceptions and experiences that facilitate growth. If all entities within the cluster share the same propensity for combined growth then one can expect that the whole cluster will show such patterns of creation and innovation leading to increased competitive levels among companies and, territories, leading to the generation of entrepreneurial ecosystems as part of a community (Cohen, 2006). This phenomenon reflects not only a better capacity to face competitiveness but also more mobility for goods, services, capital, information and technology with intensification of exchanged knowledge and, consequently, creating more added value. As outlined by Karlsson (2008), "resource-based" models emphasize the importance of labor supply in knowledge-intensive business as their primary location factors. Skills promote sustainable competitive advantages, increasing the expertise level of regions or countries, in particular when clusters accumulate different forms of knowledge. In this context, not only the theories of agglomeration of firms, i.e. clustering, internal economies of scale and size of the potential internal and external market regions, are used as the main factors to explain the effect of spatial clustering of firms. Knowledge flows also justify the intensification of clustering advantages, promoting networking systems and increasing external economies to add up to the internal economies of scale. A given cluster may face both internal and external risks: Internal threats can originate in rigidities develop as a consequence of the obsolescence of technologies, of inadequate infrastructure, but also of the long lasting deficient conditions of labor's training and education or even in the inflexibility of the governance and regulatory systems (Porter, 1990b). External pressures are much more difficult to surpass and include economical and financial crises, abrupt technological changes, and alterations in political strategy or regulations (Karlsson, et al. 2005).

2. METHODS

The present study assesses the distribution of business location in India using autocorrelation techniques and defining what I call regional business topography. The usage of volunteered geographic information is of crucial importance to understand the dynamics with large set and complex sets of spatial data such as the location of business in relation to the distance of road networks. The distance of road networks as well as the location of business and their intrinsic relations to nearest neighbour, allowed generating an understanding of the key hotspots that are currently of major importance for India's business performance, sharing information on the regional scope of changing economies. From a dynamic perspective, it is quite probable that distance from main commutes continues to be of key importance for India's business development. The methodology proposes a spatial influence in autocorrelation of location of all types of business in India, area of utmost importance. The combination of spatial analysis techniques with geocoded information and VGI will play major importance for combinatory analytics of economic landscapes and defining at country level tendencies for economic performance and relations of industry and business sectors. In this sense, Geographic Information Systems can play a key role in better understanding the influence of location and combination of other derived spatial variables in relating for the potential of business topographies at country level. The present study has furthermore advanced in a new type of understanding of spatial information: a combinatory approach to VGI datasets with entrepreneurial ecosystems and the relation to areas where little data is available. These combined methodologies support novel tools to assess and interpret spatial change over time, and augment the possibilities of creating functional synergies in the interdependencies and generated value of business hubs located in the entrepreneurial ecosystems. The combination of the database management carried out in geocoding the registered businesses for India as discussed above, combined with OpenStreetMap data sets for road networks, allowed for a spatial interpolation of the impacts of road networks on the location of businesses India. This may be considered the data dimension (Figure 6) where the usage of volunteered geographic information (VGI) data sets allows to have an accurate perception of existing infrastructures conveniently mapped.

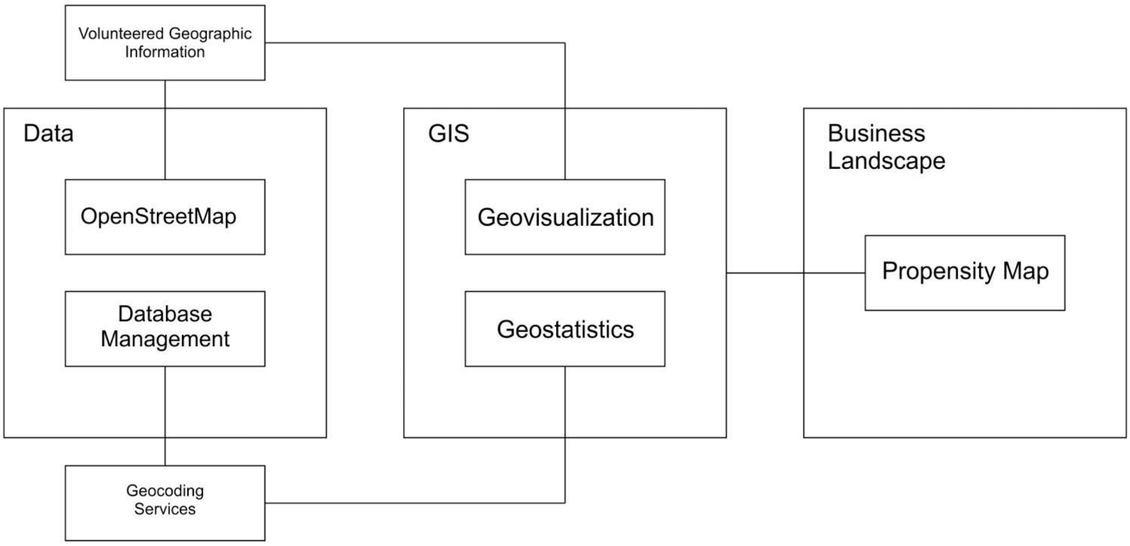

Figure 6 - Construction of the spatial business landscape

2.1. Study area

The study was applied to India, the seventh-largest country by area and the second-most populous country in the world, with over 1.2 billion people. India holds a total area of 3,287,263 km, and has an estimate total GDP for 2012 of $4.7 trillion. India lies atop the minor Indian tectonic plate, and holds a very diverse geomorphology. With elevation ranging from Kanchenjunga, with an elevation of 8,586 m, bordering Nepal and the Indian ocean at sea-level 0 m. Average annual temperatures vary greatly between north and south of India. North India holds Alpine climate, while south-east India has tropical wet and west India majorly has Tropical wet. As per the World Bank report, the precipitation average was of 1083mm in 2009, where 80% are supplied during this season, a four-month period and becomes one of the Earth's most wet seasons with highest precipitation indices. The diversity of the landscape and concentration of urban regions, create a fairly large division between urban and rural areas. This division between urban regions is further enhanced by the location of the business landscape that was matched spatially via a geocoding process. In this sense, geographic information systems become powerful tools to add and describe based on mailing datasets by mapping information about spatial distribution. This process is called geocoding, and holds one of the critical elements as having an address range where latitude / longitude of a corresponding point may be added. This is a challenging task, and rates of accuracy must be compared as to match if the constructed spatial data sets to match correct addresses. This is done by an accuracy assessment based on a random sample of the distributions, and a search of matching these samples to geographical space and the accurate information of roads and spatial metadata. The dataset consisted of a total of 6674 businesses, organized by Company Name, Latitude, Longitude, Province, District, City and Year of Incorporation. The databases were structured as to have a unique identifier per field, adding on candidate keys that allow the geocoding regarding the location of businesses. Finally, accuracy was tested for a random sample of 100 businesses; where metadata and text information was queried as to allow the validity of the assembled data structure once geocoded (Figure 1).

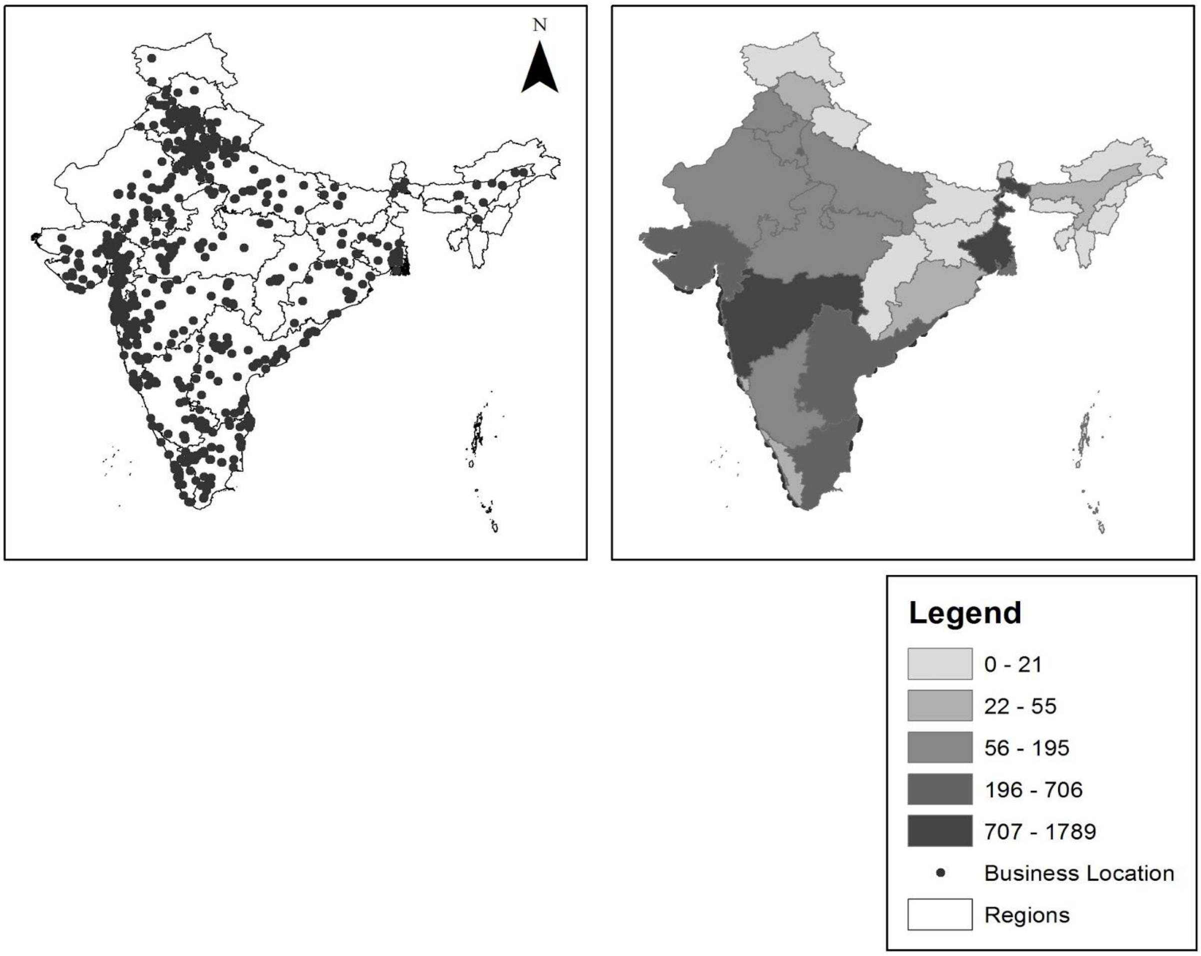

Figure 1 - Location of Businesses in India and count per regions

The now spatial dataset was then aggregated through the primary key to other relevant information, such as the case of the year of incorporation and profit after tax (PAT), from 1990 to 2010. This counts as one of the main advantages of the constructed data sets, as it became a solid support for understanding not only the morphology of India's business landscape, but also have a spatially-explicit dataset correlating important business variables from a locational standpoint.

2.2. The Volunteered Geographic Information dimension

The removal and editing of peripheral roads was carried out in ArcGIS 10 and from overlaid high resolution satellite imagery, which permitted a visual disaggregation of road types. Without the aid of Volunteered Geographic Information (VGI), this study would have been impossible given the complexity and the quantity of road networks for India, and the difficulty in manually digitising the commute systems for the entire country. In this sense, VGI played a major role in incorporating the business landscape in terms of geocoding of the 3561 addresses of registered businesses. The existence of VGI repositories contribute for a fundamental change in the way we deal with spatial information, but must also be handled carefully as to guarantee the quality and credibility of such datasets (Flanagin and Metzger 2008). However the notion of a collective spatial repository allows for panoply of available spatial information which in most of the cases seems to be fairly accurate concerning the topological and spatial characteristics of certain features, such as commutes and motorways when compared to traditional sources of spatial data (Haklay, 2010). The main motivation of VGI resides in the transversal profiles of users and the quantity of active volunteers, contributing as 'human sensors' (Goodchild, 2007) leading to a better understanding of the geographical and spatial reality at different scales. This may be of extreme importance for business performance, where the spatial dimension at may represent the social perception of importance and priorities in embedding as VGI components spatial information. In the case of India, comparison with higher resolution imagery through exporting the vector polylines corresponding to the road networks to Google Earth, allowed for an assessment of the quality and accuracy of the volume of present road networks in India. The secondary road networks as well as unclear classifications were discarded.

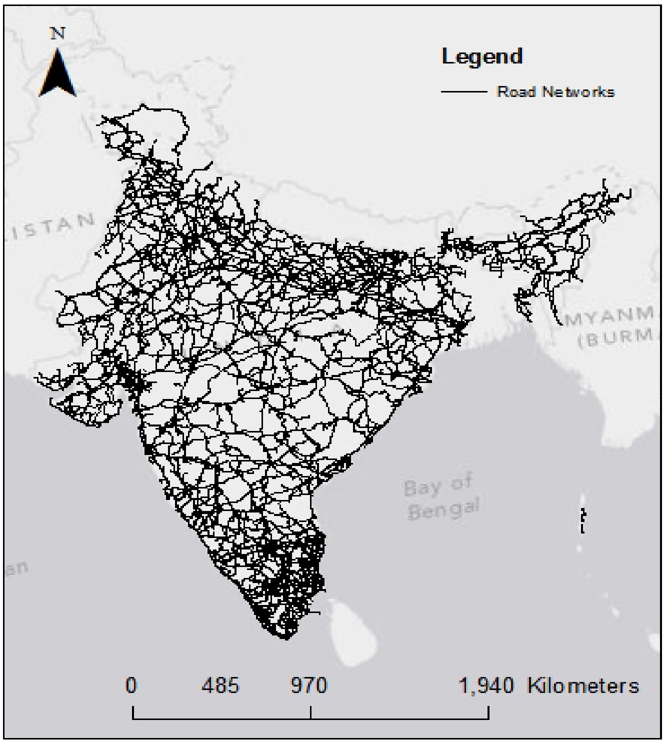

Figure 3 – OpenStreetMap filtered road networks in India

2.3. Spatial autocorrelation

2.3.1. Global Moran's I statistic

Clustering of the Indian business landscape was assessed by using global and local spatial autocorrelation statistics. A spatial weight matrix was defined over a radius of 1km, using a rook contiguity filter, corresponding to an adjacency matrix for each region given the limits of the area. The assumption of this was that i) closer businesses within the administrative region tend to interact at a closer spatial proximity and, ii) road networks are used for communication with businesses farther away leading to iii) existing of business hubs located in functional metropolitan regions where business activity must be given territorial competition more intense. A Global Moran's I (Equation 1) statistic was conducted testing the null hypothesis (Ho) of no significant clustering of businesses in India.

$$I = \frac{j}{\sum_{i=1}^{i=n}\sum_{i=1}^{i=n} w_{ij}} \bullet \frac{\sum_{i=1}^{i=n}\sum_{j=1}^{j=n} w_{ij}(x_i-\bar{x})(x_j-\bar{x})}{\sum_{i=1}^{i=n}(x_i-\bar{x})^2} \qquad (1)$$

Where corresponds to a binary weight matrix defined with the weight of one, given a contiguity of adjacency for any value that holds and any value without adjacency as . The product of the distance is defined as for any location in distance to relation to its mean. This holds as a statistic for assessing the entire spatial distribution of adjacency formed for the region, having led to a Moran's I of 0.206 suggesting that the business landscape is highly clustered in certain spatial hubs. This result confirmed the existence of significant clusters over the region, refuting the result of Ho for no autocorrelation for India. A closer analysis was thus conducted to assess the regional dimension of spatial business distribution as discussed in the following section.

2.3.2. Local Getis-Ord Analysis

The Local statistic was calculated by first defining business density. This was carried out by counting the locations of businesses into each administrative level. A higher administrative level was used to define business density, dividing the total number of businesses in the administrative region by the area in kilometres concerning each administrative boundary. This allowed to define business density at a spatial level and allowed to calculate the geostatistic, defining the location of business hubs in the Indian business landscape to determine local clusters (Getis and Ord, 1992). The calculation of the local statistic was calculated for each *tehsil* level (similar to western parishes) as smallest unit of administrative space in India was carried out by using the rook contiguity weight matrix calculated earlier, and correlated with the density of road networks per parish.

$$G_i^*(d) = \sum_j w_{ij}(d)x_j \,/ \sum_j x_j \qquad (2)$$

Where is the spatial weight matrix following a 1 km distance (d), andis assumed as 1 when the distance of one *tehsil* to another is within the expected otherwise, is assumed as 0. The existence of local clusters of businesses in India originated spatial hotspots at regional level. This aided in understanding that at regional level, there are a series of well-defined hotspots in India where business concentration exists, leading to clear and very distinct spatial concentrations on the business landscape (Figure 4).

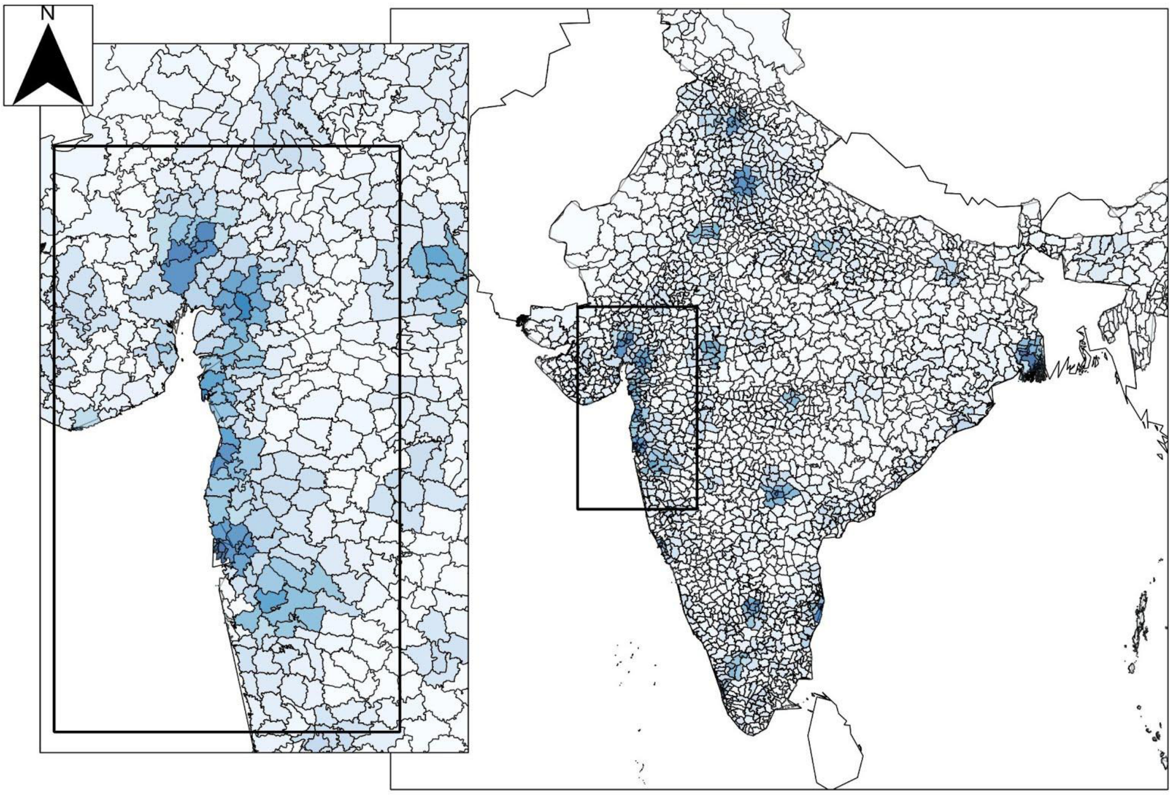

Figure 4 - Local results for India (left: zoom into the Maharashtra region and Mumbai, right: overview of India in general)

3. RESULTS

3.1. Correlation of road networks and the Indian business hubs

This step led to the analysis of distance from businesses, as a correspondence to a nearest neighbour analysis where an initial distance was calculated to ensure the existence of at least one neighbour. The confidence interval for this distance for calculating a Local G autocorrelation index corresponded to 180 km, ensuring the confidence interval needed for an autocorrelating neighbour within the area (Figure 5).

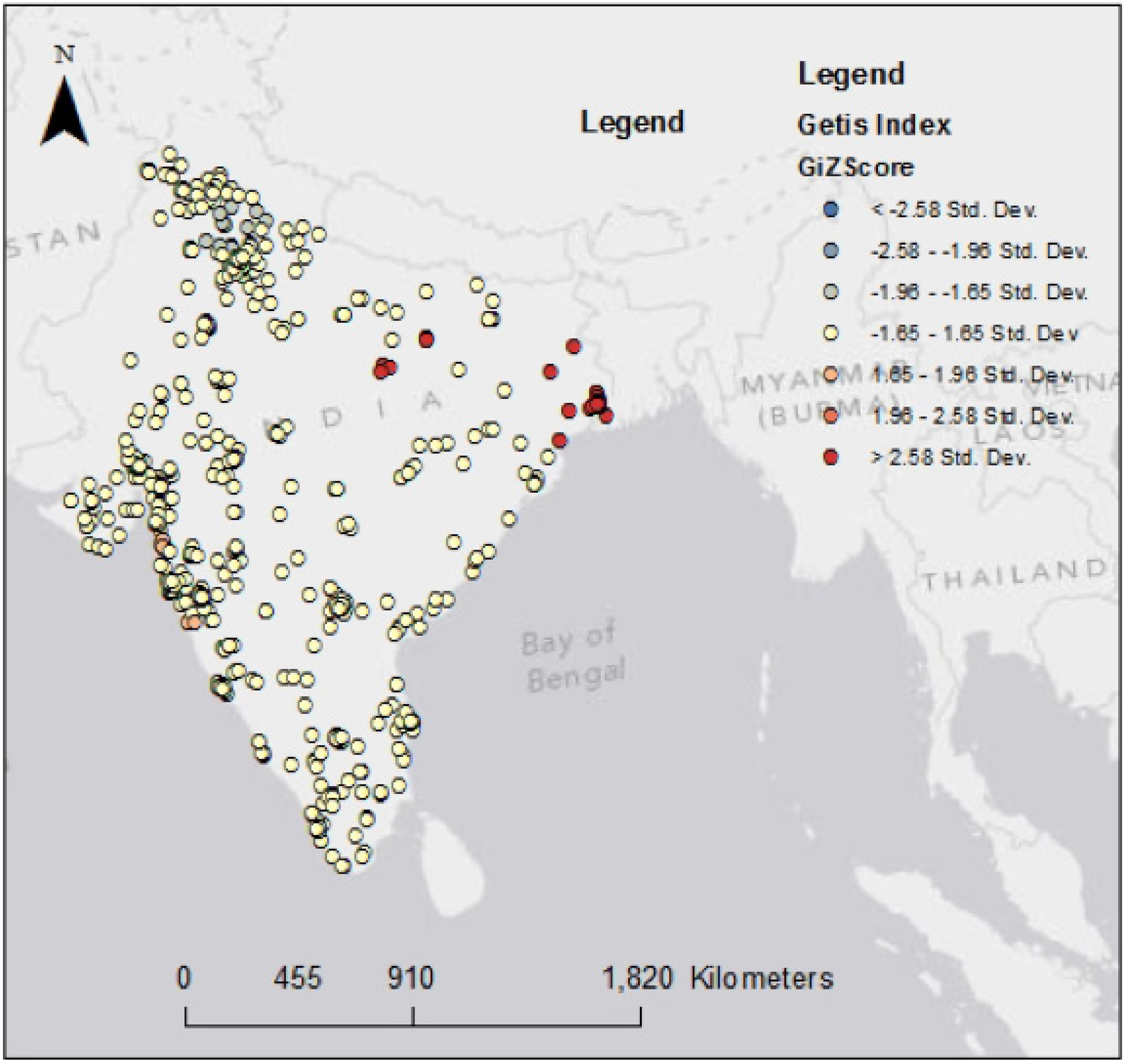

Figure 5 – Local G Statistic and identification of cold and hot spots in relation to road networks

The Moran autocorrelation index proved that at a distance of 250 km there is a greater likelihood in forming a cluster between sites, suggesting the existence of Hot and Cold spots in India for Business activity.

3.2. Dominating features of the Indian business hubs

Besides the impact that clustering has upon the efficiency of business performance, there is also a correlation of these on the readiness of companies to innovate. As largely accepted, innovation is a complex activity profiting from knowledge and in particularly from new knowledge – this resulting from a cumulative and re-interpretative process. Part of this knowledge, reaching the firm from external sources (Cassiman and Veugelers, 2002 and 2006), serves as a crucial factor to promote innovation activity (Rosenberg and Frischtak, 1986). Over the last decades, the importance of knowledge generated outside the firm for its own use has increased significantly, but the simple contact to external sources of knowledge is not enough to generate success and, in particular, to sustain innovative activities.

Many authors described external knowledge flows as an aid to strategic decision-making at the firm level (Cohen and Levinthal, 1989). But the firms have a certain absorptive capacity that limits them or enhance them when facing external knowledge (Bapuji et al., 2011). The concept of networks, further to clustering, facilitates the absorptive capacity of the firm making its external knowledge base a result of other factors such as: the density of firms clustered in a given geographical area; the sector of activity; the social ties; the nature of the exchanged knowledge, for example (Gordon and McCann, 2000).

It is also important to emphasize that firms exposed to the same amount of external knowledge flows differ in their ability to identify and exploit such flows (Giuliani and Bell, 2005). Thus, both the amount and effect of external knowledge flows are unequally distributed across the population of firms of a same cluster and the absorptive capacity of a company can still be a source of a firm's competitive advantage. A firm's absorptive capacity depends on its existing knowledge stock, much of which is embedded in its products, processes and people (Escribano et. al, 2009).

4. CONCLUSIONS

It is expected that this trend will continue over time, developing hubs for business and entrepreneurial activity for the future generations of Indian entrepreneurs.

This is then converted into shapefiles to allow incorporation in a GIS environment and spatially relevant information at local level to India and offering additional research datasets that can be integrated (Ridwan et al., 2012). While this allows some of the geovisualization capabilities of the Indian distribution of businesses, it is important to note that one of the most interesting challenges resides in understanding the underlying patterns of business location from a geostatistical perspective, adding on the road networks and spatial proximity to urban hubs, the spatial distribution both of profit at regional level, as well as the calculated spatial autocorrelation coefficient.

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A GRAPH THEORY APPROACH FOR GEOVISUALIZATION OF ANTHROPOGENIC LAND USE CHANGE: AN APPLICATION TO LISBON

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Joseph Aversa

ABSTRACT

Urban sprawl and growth has experienced increased concern in geographic and environmental literature. Preceding the existence of robust frameworks found in regional and urban planning, as well as urban geography and economics, the spatial properties of allocation of urban land use are still far from being completely understood. This is largely due to the underlying complexity of the change found at the spatial level of urban land use, merging social, economic and natural drivers. The spatial patterns formed, and the connectivity established among the different subsets of land-use types, becomes a complex network of interactions over time, helping to shape the structure of the city. The possibility to merge the configuration of land-use with complex networks may be assessed elegantly through graph theory. Nodes and edges can become abstract representations of typologies of space and are represented into a topological space of different land use types which traditionally share common spatial boundaries. Within a regional framework, the links between adjacent and neighboring urban land use types become better understood, by means of a Kamada-Kawai algorithm. This study uses land use in Lisbon over three years, 1990, 2000 and 2006, to develop a Kamada-Kawai graph interpretation of land-use as a result of neighboring power. The rapid change witnessed in Lisbon since the nineties, as well as the availability of CORINE Land Cover data in these three time stamps, permits a reflection on anthropogenic land-use change in urban and semi-urban areas in Portugal's capital. This paper responds to (1) the structure and connectivity of urban land use over time, demonstrating that most of the agricultural land is stressed to transform to urban, gaining a central role in future. (2) Offer a systemic approach to land-use transitions generating what we call spatial memory, where land use change is often unpredictable over space, but becomes evident in a graph theory framework, and (3) advance in the geovisual understanding of spatial phenomena in land use transitions by means of graph theory. Thus, the structure of this combined method enables urban and landscape to have a better understanding of the spatial interaction of land-use types within the city, promoting an elegant solution to rapid geovisualization for land-use management in general.

Keywords: Graph Theory, Spatial Interaction, Urban Change, Land Use Change

JEL Classification: R52, R11, R14, R58

1. INTRODUCTION

The fragmentation of landscape and its subsequent effects on land use and ecosystems has become a global concern (Nagendra et al., 2004). Brought by economic growth, the creation of new infrastructures to support demand, have led to profound structural changes in the traditional concept of the city (Davidson, 1998). This has changed the local perceptions of the city to a much larger urban agglomerate in transition of urban and rural interactions (Helbich and Leitner, 2009; Vaz and Campos, 2013), understood as the urban region leading often to environmental degradation (Czamanski et al., 2008). While traditional cities have represented positive sources of economic prosperity, the agglomerated city (Rosenthal and Strange, 2001), sets out a new role. This role emphasizes the importance of urban areas, and debates whether or not the methods of sustainable urban growth are most suitable for future generations as they will ultimately face the challenge of promoting a low carbon society and preserving the vitality of the urban-rural fringe (Han et al., 2012). Pollution for instance, has an adverse impact on development, as most of the urban regions today show an augmenting number of mortalities caused by pollutants, as well as, changes in territorial occupations. Urban areas have seen an increase in crime rates as coping with excessive concentrations of people in these areas has shown to be difficult (Cusimano et al., 2010). With their growing technological enhancements, better transportation (Litman and Burwell, 2006), health and education systems, as well as fostering social movements (Nicholls, 2012), cities offer a source of hope for better lives with sustainable solutions. The ecofriendly city has brought greener planning initiatives to a research agenda of environmental science and offered, as a consequence, a holistic vision of urban processes (Roseland, 1997), where the interactions of human with ecosystems can promote a better social conscience, but also lead to a clearer understanding of how urban regions must interact with nature. One of the most important interactions is linked to the carrying capacity of land, in which a function-analysis, function-valuation, and conflict analysis, should be present to understand the landscape dynamics, and foster sustainable development (de Groot, 2006). This is strongly linked to a better understanding of the spatial dimension of land-use change and land-use transitions, fostered by the integration of Geographic Information Systems as tools to assess and manage the present and future. In this sense, land use plays a vital and fundamental role in maintaining a balance on the environment in general, and one of the culprits of urban growth has become the loss of certain types of land which have a unique function for the complex interactions of environment (Xiao, et al. 2006). An entire set of literature has been built on this premise, concerning impacts of land-use, which has aided in a more accurate and better planning for sustainable development at a spatial level (Batty, 2005). These models are designated by urban growth models, and draw largely from an integration of geography, economics, mathematics and social sciences. This leads to the paramount importance of land use planning and understanding the changing land use patterns over a given extend of time (Koomen et al., 2007). In this sense, manipulation of spatial data brings a spatial multilevel assessment, leading to a better understanding of the urban structure (Schwanen et al., 2004), helping to optimize urban regions. Geographic Information Systems have proven to be an effective tool to understand underlying patterns of spatial phenomena, offering through spatial analysis a quantifiable and assertive technique to propose a better understanding of the spatial structure. The scattered nature as well as the often fragmented characteristics of urban growth are however still hard to fully understand and represents a burden also on the aesthetics of the landscape (Sullivan and Lovell, 2006). One of the reasons is linked to the fact that land-use change models and urban growth models foment stochastic understanding of possible outcomes of urbanization processes (Han et al., 2009) and little attention has been given to the interactions and consistency of land use types.

This landscape and land use consistency, is however a common prerequisite for sustainable development. While in the short term, local sustainability is of major significance, in the long term, common structural changes must be considered (Capello 2001). In this sense, we have addressed the following research questions in this paper:

- What is the relation of land use classes per type over an urban metropolitan area over time? Is there an underlying pattern that allows for graph theory to visualize urban land use consistency?
- Can we arrive to conclusions on future growth patterns and add on the process of urban land use in a region where economic recession, after a large urbanization process, shows signs of stagnation?

2. MATERIALS

2.1. Study Area

Lisbon, the capital of Portugal constitutes part of the Metropolitan Area of Lisbon (Figure 1) and holds a total population of over 2.6 million people and a total area of 2,957.4 km2 (AML, 2005). The city core itself is located at 38°42′49.72″N 9°8′21.79″W, and has an urban area of 985km2, with a population density of 6,458 km2.

Figure 1 – Location of study area

Urban sprawl began in the beginning of the eighties, where economic growth witnessed in the nineties, created suburban areas where local intervention have shaped high connectivity areas lead to a polycentric city, stagnating on the urban growth of Lisbon's core. The region underwent several profound social and political phases that can be defined as: (i) urban to rural migration, a unique phase that took place in the fifties and sixties creating a higher concentration on a concentrated and monopolistic urban fringe (Malheiros, 1996), (ii) the return of thousands from the overseas ex-colonies in the seventies, settling mostly in suburban parts of the Lisbon metropolis (Carlos, 2005; Malheiros, 1998), (iii) the integration in the mid-eighties of Portugal in the European Union, changing the economic activities from a Fordist to a service sector based model, where European support allowed to modernize and create new infrastructures on the urban fringe and finally, (iv) the economic recession witnessed in recent years, leading to obsolete infrastructures and abandonment of urban land and investments. As mentioned by Dias and others (2009), the territorial development model for Lisbon sets out three priorities: (1) to strengthen Lisbon's role in the global and national networks, (2) consolidate the city and promote sustainability and (3) promote urban qualification and public participation. These three priorities are strongly linked to the complexity of spatial decision, and tools found in geovisualization and spatial analysis. Of pivotal importance is the role of a changing urban landscape that resulted from the different economic patterns the city has witnessed over the last decades, it is important to foment sustainability by understanding within the polycentric morphology of the urban area, the relations of space and to adjacent land use types. This is a dimension often neglected in urban regions but should be considered in countries such as Portugal, where the present recession accrues to the importance of coping with obsolete infrastructures and developing solutions for continued land sustainability without jeopardizing the environment, biodiversity and the landscape.

3. METHODOLOGY

3.1. From connectivity to land use connectivity

The difference between land use types and contrasting characteristic of anthropogenic activity are a reflection of the complexity of this activity in the case of urban land. This complexity is dealt by integration of different sets of input parameters that allow generating multiple scenarios and supporting best management options using the inherent potential of numerical models in a GIS environment (Dragicevic and Marceau, 2000). This has led in recent years to a growing concern on which techniques can be used to monitor and understand the change of anthropogenic land. The difficulty however, is linked to the uncertainty and complexity of predictive modeling approaches, and the shifts in policy and decision making processes by stakeholders. Deciphering these patterns however, is of utmost importance as it may allow to better plan the relations that exist over space in land use types, leading to better management and decision processes for a sustainable future. From an ecological perspective, the existence of heterogeneous landscapes has been long understood (Levin, 1976, DeAngelis et al., 1985), and a framework of landscape ecology built under the pertinence that Geographic Information Systems can be used as exemplary tools for monitoring impacts on landscape sustainability (Burrough, 1986). One of the main characteristics imported from the relation of Geographic Information Systems and ecology, has been the possibility to understand landscape connectivity to measure the structure of the landscape (Taylor et al., 1993). This has allowed for a better understanding of the interdependency between different patches that represent functional characteristics over space, and interpretations of landscape processes over larger areas (Bergerot, et al., 2013). From an ecological perspective, and given the link to biodiversity, this has been very important development for sustainable growth. Many of the techniques however, can be used to examine anthropogenic patterns over land use, by transforming the concept of patches formed in a functional connectivity perspective brought from ecology, to an understanding of neighboring adjacency of land use types.

3.2. Graph theory: An abstract approach to urban areas

A Graph represents an abstract mathematical concept of a network. By any means, it is always a portrait of many types of relations. Combined by 'nodes' and 'edges', the nodes (represented usually as points or vectors) are the end that permits the linkage through an 'edge' to another 'node'. In Mathematics, this concept has been used very early, and is the best structural relation we may have of a two-dimensional space and the relations of interactions over space. Graphs represent a defined topological structure, where the connection between one 'node' to another, or the relation formed between the connection, is much more than spatial, and permits a quantifiable understanding of connections, far different from traditional geometric Euclidean spaces. The length as such of a graph, can be discarded from a purely mathematical background, and may represent different types of phenomena, and serve to find patterns of discrete relations over space. The interest in describing the complexity of the structure of the landscape enables to assess but also to quantify the interactions over space in representing and understanding the connectivity of the landscape in its complexity (Cantwell and Forman, 1993). The relations of land-use over the total landscape are however quite complex, and thus, one of the main elements that should be considered in framing the complexity of spatial interactions is land-use.

3.3. Aggregation of land use types by adjacency

This paper considers that land use and land cover, independent of its area, format or size, is adjacent to another type of land use. This not only makes land-use connected, but also harbors characteristics of similarity between land-use types given the first law of Geography, where things closer to each other are inherently more related (Tobler, 1970). This concept of neighboring land and spatial proximity is translated by a graph of a finite number of connections, varying sizes of spatial areas, type of land, and geomorphological characteristics of the terrain and the landscape through adjacency (Figure 1).

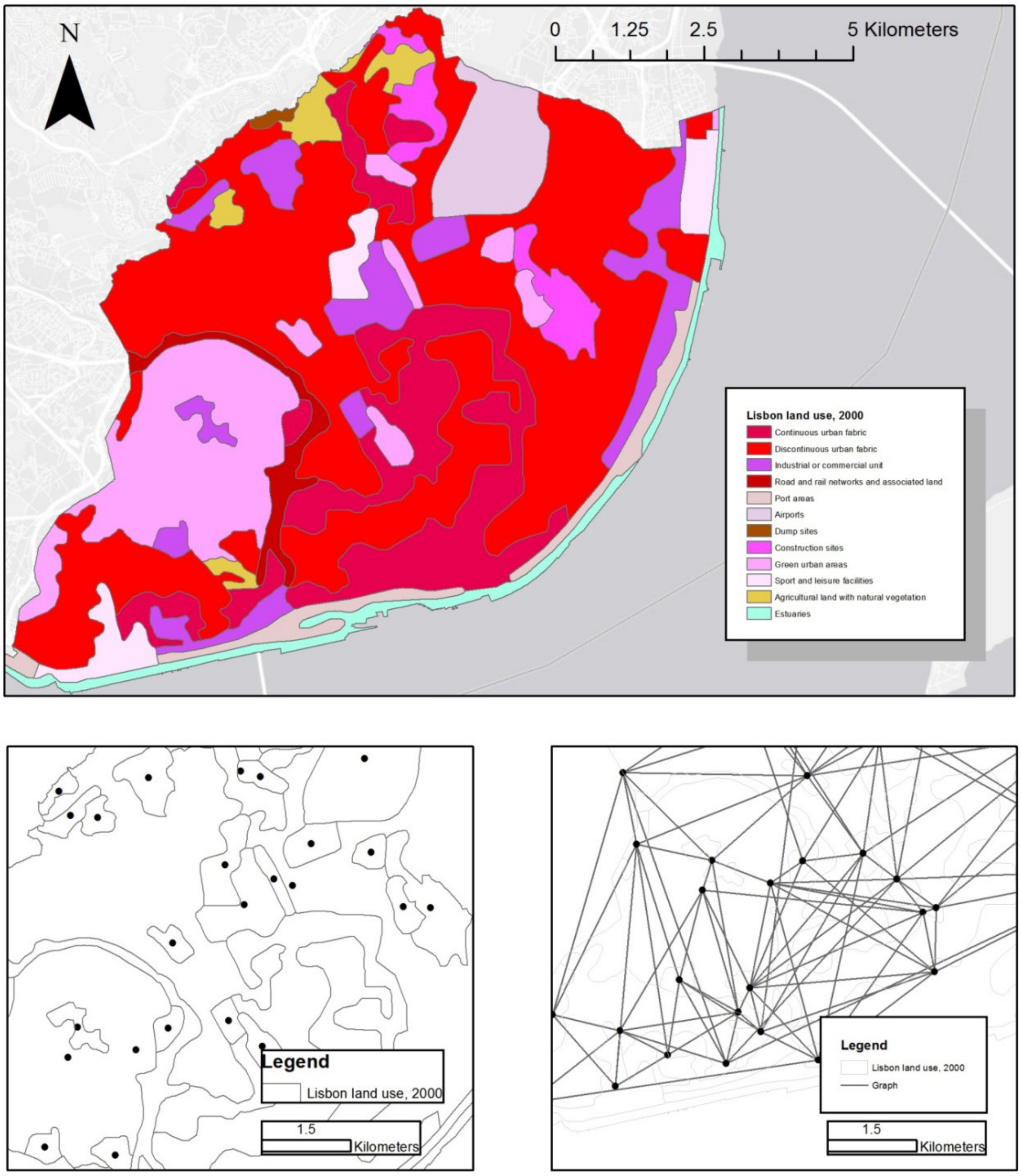


Figure 1 – Geographic abstraction of land-use into graph

We also take for granted that each land use may be represented geometrically as a geometric polygon, of which I can derive a centroid. By definition my centroid is the result of a finite set of *k* points $x_1 + x_2 + \cdots + x_3 \text{ in } \mathbb{R}^n$ is:

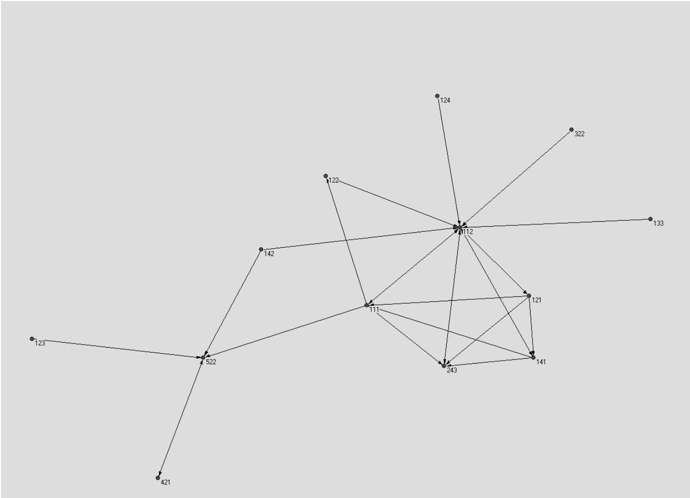
$$C = \frac{x_1 + x_2 + \cdots + x_3}{k} \qquad \text{Equation 1.}$$

This centroid may thus represent the central point of equidistance within a given land use type. The geometric point that this centroid represents is characterized by centroids derived from the neighboring land use classes, thus the cumulative land use classes could be represented as $\varepsilon = c_1 + c_2 + \cdots + c_3$ equally in R^n, defined as the centroid geometrical space. This space ε will now be considered ε=G, where is a pair G=(V,E) in which V is a finite set called the vectors of G and E is a subset of V designated as edges. In our geometrical space of centroids ε, it is thus considered that we can define E as long as $V=c_n$. In doing this, the data is transformed a geometrical space into a representation of a simple graph. Within this representation, it is stated that the spatial relations found between the geometric spaces of land use, may be represented as a simple graph, where interactions of land use can be processed by their adjacency to different land use types. These relations are explored visually by the definition that a graph may be force directed based on the number of connections existing within different land-use types within the geographic area. This pertains to the different connections allowed between land-use for the adjacency of existing land-use types in a city or urban regions.

The position of nodes and the location of the abstract interpretation of land-use per node is of great importance for geovisual analysis. This visually enhances the size of the edges in order to allow for few crossing edges among the different nodes. In the case of land-use, this is of particular importance as this enables a better understanding of the relations of different land-use among the area. The Kamada-Kawai algorithm allows conceptualizing an ideal set of distances between vertices that are not neighbors (Kamada and Kawai, 1988). The ideal distance therefore, becomes proportional to the length of the shortest path between them. In the case of land-use, knowing that the connection of land-use through adjacency does not register the farther away land-use types, but acknowledges through the first law of geography that still this adjacency relation exists. This solution proves to be elegant in considering the number of adjacent features for a total plane of land use registered over space.

4. DISCUSSION

Lisbon, the capital of Portugal, is one of the most vibrant and diverse urban regions of Portugal. Since the early eighties the socio-economic changes in the city have led to a fragmentation of some urban areas, and an increase in urban land in the cities nexus. Portugal, as a country, has changed dramatically since the end of its dictatorship in 1974;several important moments in the Portuguese political and economic scene have contributed to what Portugal is today at a land-use level. With the integration of Portugal in the European Union in 1984, land-use has predominantly become urban land, and rural exodus has led to abandonment of agricultural and rural areas. In the mid-eighties, new urban regions were formed and the tourist industry shaped most of the Portuguese coastal areas into what it is today. The strategy of the service sector allowed cities to become hubs of economic growth, while agricultural land was reformed through funding of the European Union. After the successful growth of Portugal in the nineties, the new millenium gave rise to protected agricultural areas and ecosystems, followed by a stronger legislation on the protection of these land -use types. The recent economic recession has resulted in a stagnating development ofurban sprawl, and the analysis of urban land-use change since the nineties for Portugal clearly shows that this is a tendency generally found in most of the mainland, which is deemed to follow over the next years. The land use of Lisbon is an interesting empirical application, given its diversity of urban land-use, its concentrated city nuclei, and the availability of datasets from CORINE Land Cover. A closer analysis on the resulting graph transformed by the Kamada-Kawai algorithm, visually responds to the adjacency relations found over all of the urban metropolis of Lisbon in 1990 (Figure 2).



111 – Continuous urban fabric
112 – Discontinuous urban fabric
121 – Industrial or commercial units
122 – Road and rail networks
123 – Port areas
124 – Airports
133 – Construction sites
141 – Green urban areas
142 – Sport and leisure facilities
243 – Agriculture and natural vegetation
322 – Moors and heathland
421 – Salt marshes
522 – Estuaries

Figure 2 – Land use in Lisbon in 1990

We can see that a construct of inter-related land use types is formed between anthropogenic land-use, corresponding to continuous urban fabric, industrial commercial units, and the attempt to add green spaces within the urban area. Agricultural land and natural vegetation are also considered in the context of existing urban areas. This integrated vision in the nineties, is strongly linked to the plans of the national inventory of agricultural land as explored in Vaz and others (2012). Sport and leisure facilities are fundamentally centered along the proximity of the coastal areas, and of natural environment, while forming quite an independent link. Discontinuous urban fabric seems to have been of central importance in 1990 as well as in 2000 (Figure 2). This relation of discontinuous urban fabric fosters the concept that land use is in a permanent transition process, depending on the current economic, social and environmental constraints within the urban nexus. The differences in the morphology of adjacency found in 2000 are clearly evident. A much more centered role seems to exist, where land-use is interchanged among different land -use types and expressed by a land-use mix, where all land-use types are interlinked with the exception of leisure facilities as well as the appearance of a new class, relating to natural grass land. From 1990 to 2000, Lisbon land-use types have become much more functional, expressing by the number of connections within the graph, leading to a more heterogeneous city combining availability of infrastructure, urban fabric, and the natural environment.

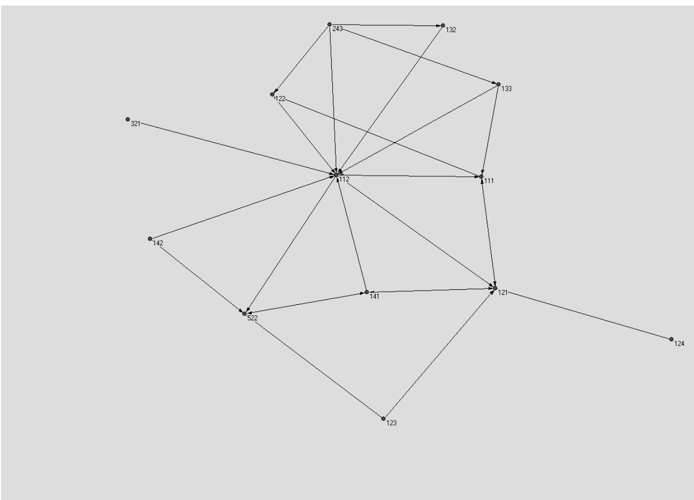


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Figure 3 – Land use in Lisbon in 2000

5. CONCLUSIONS

The current methods to assess spatiotemporal change have increased the possibility of understanding and delineating land use transitions. However, a limited set of work has focused from a land use perspective in understanding the relation between land use types and their changes in future. Lisbon, as many urban regions throughout the world, hold vast spatial data resources that allow comparing, assessing and visualizing land use change. This allows consolidating urban dynamics and trends, while entertaining urban dynamics from a land use perspective, and their connectivity. The importance of monitoring this in countries where rapid land use changes have been witnessed is fundamental for planning purposes. While population dynamics are strongly linked to population shifts in the urban area, a relevant increase in urbanization is proportional to the generation of new infrastructures to support population dynamics (Young and Jarvis, 2008). Tools such as graph theory, allow for visualizing the connectivity and fragmentation of land use types. An evaluative spatial approach of the interaction of land use categories concludes the relation of spatially sustainable land use choices and the integrative role in urban processes for megacities, and urban regions of highly occupied and developing cities throughout the world.

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A MULTI-DASYMETRIC MAPPING APPROACH FOR TOURISM

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Ana Claudia Campos

ABSTRACT

The challenge of measuring at municipal level tourism density has been a daunting task for both statisticians and geographers. The reason of this is enforced by the fact that administrative areas, such as municipalities, tend to be large spatial administrative units, sharing a large demographic asymmetry of tourist demand within the municipality. The rationale is that geographic characteristics such as coastal line, climate and vegetation, play a crucial role in tourist offer, leaning towards the conclusion that traditional census at administrative level are simply not enough to interpret the true distribution of tourism data. A more quantifiable method is necessary to assess the distribution of socio-economic data. This is developed by means of a dasymetric approach adding on the advantages of multi-temporal comparison. This paper adopts a dasymetric approach for defining tourism density per land use types using the CORINE Land Cover dataset. A density map for tourism is calculated, creating a modified areal weighting (MAW) approach to assess the distribution of tourism density per administrative municipality. This distribution is then assessed as a bidirectional layer on the land use datasets for two temporal stamps: 2000 and 2006, which leads to (i) a consistent map on a more accurate distribution of tourism in Algarve, (ii) the calculation of tourism density surfaces, and (iii) a multi-locational and temporal assessment through density cross-tabulation. Finally a geovisual interpretation of locational analysis of tourism change in Algarve for the last decade is created. This integrative spatial methodology offers unique characteristics for more accurate decision making at regional level, bringing an integrative methodology to the forefront of linking tourism with the spatio-temporal clusters formed in rapidly changing economic regions.

Keywords: Dasymetric Mapping, Tourism Density, Land Use Dynamics, Tourism Analysis

JEL Classification: R52, L83, O44, R12, R15

1. INTRODUCTION

Understanding the spatial dynamics of demographic transitions is of utmost importance to generate an accurate profile of distribution of spatial phenomena (Turchin, 2003). It has however been a challenge to cope with the cartographic constraints of using the available administrative boundaries. This challenge is a result of: i) size, where the scale of the area of the administrative boundary often does not correspond to the spatial distribution (Turner et al., 1989), ii) the demographic distribution at spatial level itself, that is often not homogeneously linked to the total area of the aggregate population (Rees and Wilson, 1972), iii) the rationale of ecological fallacy, where misinterpretation of the population occur due to surrounding neighbours with a certain demographic profile (Kramer, 1983). This is particularly visible in regions where peri-urban areas are detached from urban land, and possible negative externalities occur due to excessive pressure. In this sense, larger dissemination areas in a population count to estimate density over space are often an imprecise representation of the real geographical distribution. Moreover, they do not offer an integrative vision of the population dynamics both over space and time leading to misinterpretation of data. This has been described by Openshaw (1983) as the modifiable area unit problem (MAPU) where scalability of information influences the results on the spatial perception. From a statistical perspective, this limits the geostatistical interpretation of administrative boundaries and information about the space and territory (Xing-zhu and Qun, 2013). Regarding applications such as tourism, where a concise understanding of location and distribution is of utmost importance perception of the spatial distributions is of great importance. Spatial distributions reinforce strategic decision where often traditional statistical and economic information fail to respond with the same accuracy. It is noted that the contribution of spatial information develops more accurate and descriptive quantitative information that can then be integrated in the fields of economic and sociology. In line with the traditional and often unrealistic distributions of demographic data in conventional areal units, this is of great importance for decision making. For Europe, this often pertains to the notion of municipality, where discrepancies within a single municipality are large, and spatial distribution not homogeneous. In very active tourism regions throughout the world such as the Algarve, this information may be entirely misleading. Techniques for dasymetric mapping of population, can be used as useful methods to assess the density of tourism, and allow more accurate information on demographics, than expected in the traditional interpretation of spatial administrative boundaries. In line with the importance of fomenting sustainable Tourism as well as the importance of creating tools that contribute to sustainable development and growth, dasymetric approaches become adequate for management due to their quantitative and spatial properties (Petrov, 2012). The rationale is simple and elegant: volumetric data, such as population density, can be easily adapted do different data sets, such as land use, allowing creating a more explanatory framework of the configuration of a given set of variables along space. The method itself engenders a technique to avoid the traditional ecological fallacy, often present when defining traditional mapping approaches. In observing an area such as the Algarve, this becomes even further important given the excessive growth the coastal urban region has witnessed, and the importance to monitor and perceive population density transitions accurately at local level. The changes in population dynamics have been a growing concern in Europe, and under the current economic recession, urbanisation and land use changes must be carefully planned and match drivers of economic drivers, such as Tourism in line with regional performance and spatial allocation.

2. STUDY AREA

The district's capital of Algarve is Faro, located at 37°0′52″N 7°56′7″W. The region itself presents mostly a rather shallow elevation of 11m, peaked by the mountains to the north, delimiting the three geomorphological regions of the Algarve: *Serra, Barrocal*, and *Litoral*. These three sub-regions have each a unique landscape, biodiversity and local social and economic characteristics. It is with this diversity that Algarve has become since the sixties a unique tourist region. Until the 19th century, the region was famous for its agricultural and piscatorial traditions, linking early industrial production with the exploration of rural and agricultural landscapes at the abundant wetland systems. The region itself has a strong link with three major civilizations, the Phoenicians, the Romans and the Moors. The abundance of heritage legacy surrounding the region's landscapes and the unique ecological habitats recognized by the NATURA network have generated a high demand of international travellers to visit Algarve, leading to a strong tourism industry and the shaping of Algarve as a unique destination for sun, beach, and beauty of landscapes alike (Vaz et al., 2012). As pointed out by Vaz and others (2013), Algarve is one of the regions strongly jeopardized in the NATURA 2000 initiative, as 38,6% of the territory is part of this natural ecological reserve, and is bound to constraints due to the excessive pressure brought by rapid urbanisation. With a total of seventeen NATURA sites, socio-economic growth must be monitored carefully, as to avoid continuous eutrophication of wetland reserves (Zaldivar et al., 2008) and focus on sustainable tourism opportunities by recognizing the importance of planning and management of the distribution of pressure areas at local level, that continue to add stress on the landscape. One of these pressures is the concentration of population, aggravated by the excessive disparity of the Tourism demand in the summer months. This could lead to irreversible damage on the natural landscape, as well as negative externalities along the the coast, where most of tourism activity is located. The strategy of diversifying tourism options in line with sustainable development (Perreira et al., 2003) is quite appealing and of utmost importance, but must be matched with adequate tools to monitor, assess and define relevant indicators that cater to better and more robust policies at the local level. This is especially the case in the coastal regions of Algarve, where tourism has been rather concentrated, leading to overburdening of carrying capacity of fragile coastal perimeters, such as is the case of Loulé, Albufeira and Portimão (Figure 1).

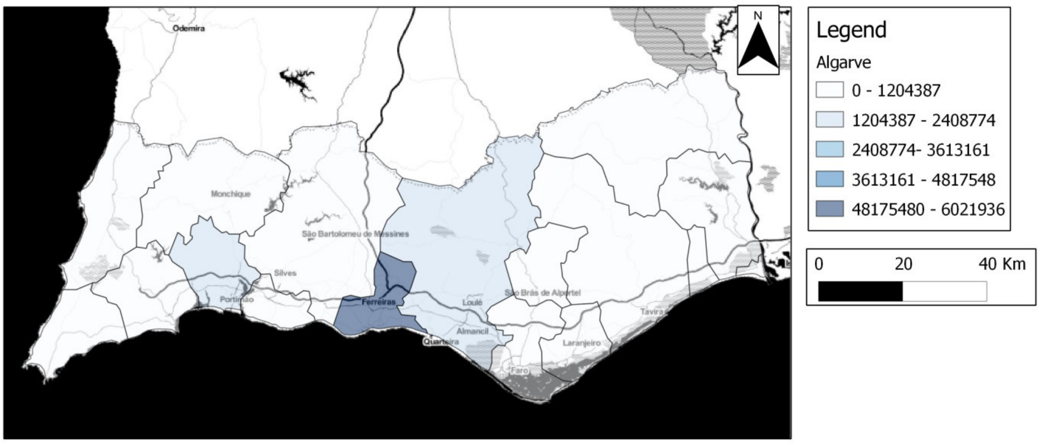
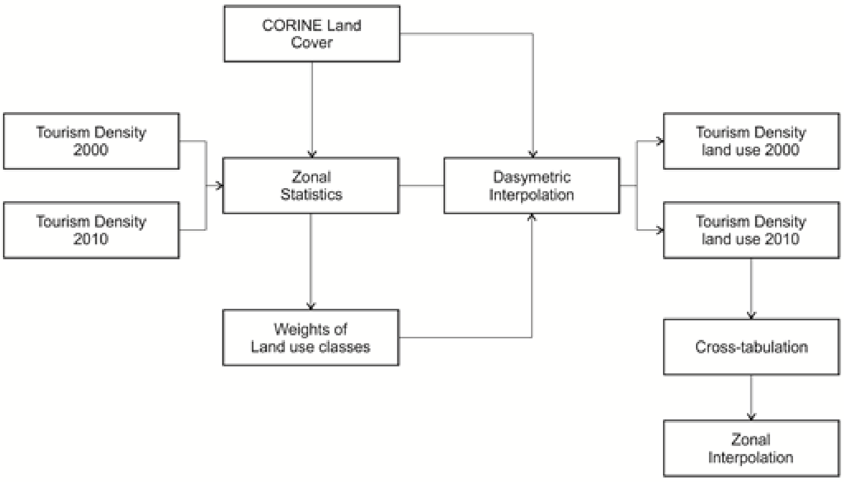


Figure 1 – Tourism count in Algarve in 2010

3. METHODOLOGY

We propose a combined methodology taking advantage of spatially weighted dasymetric calculations, and using zonal information for spatial interpolation of land use for Tourism (Figure 2)



The usability and application of dasymetric mapping has been widely well known in the field of geography since the mid-thirties (Wright, 1936). The author proposed a method to offer a more realistic vision of the distribution of population, given the constraints of terminal-mountain range ridges and areas that were located in wilderness, and therefore should not have a cartographic representation of habitable areas. The technique use consisted of a simple equation to measure out a density function of population by division of township, where m and n are obtained by the division of a given township into two parts that disaggregate population into sparse m and dense n. This was done by topographic interpretation, offering a vision of an average density of population as follows:

$$\frac{D - D_m a_m}{I - a_m} = D_n \tag{1}$$

Where D is the average density of population of the township as a whole, D_m the estimated density in m, a_m the fraction of the total area of the township comprised in m, and $I - a_m$ the fraction comprised in n, and D_n the density that must accordingly be designed to n. This allowed an approximate distribution of population density (Wright, 1936). This simple start of dasymetric mapping became much more elaborate, in particular given the definitions of the variables m and n, that is, the division per township based on cartographic evidence has in the last years become much more accurate due to the existence of spatial inventories that allow to generate stochastic methods of representing population density per land use more clearly. This has been well structured by Gallego and Peedell (2001), where an assessment of population density estimation is carried out assuming a homogenous behaviour over space, where a regression type coefficient can allow understanding population density correlated with land use over large areas. The correlation coefficient allowed the authors to estimate a weight at county level of population density per land use class, leading to a better understanding of the distribution of population density at more accurate scales then the traditional census configurations. Such approaches allow thus for a more accurate understanding of the statistical and geostatistical interpretation of space, leading to a better perception of the possibilities of evaluating zones more accurately. The techniques and the applications of dasymetric mapping in other fields have however not yet been thoroughly assessed (Eicher and Brewer, 2001). The applications of a geostatistically sound dasymetric mapping approach are well described by Langford and Unwin (1994) who offer a binary approach by comparison of land use typologies and comparison of the population density distribution rendering the distribution as a population density surface. The advances in the quality of land use inventories and high resolution satellite imagery are at present allowing mapping population density even at higher scales and for larger regions (Silva et al., 2013). These advances have started to bring new interpretations of spatial demographic distributions over density surfaces, applied to different fields of research (Mitsova et al., 2012; Shannon and Harvey, 2013). The ability offered by dasymetric mapping has over a century of applications where the recent advances are bringing additional possibilities for regional and local techniques, and have been applied to different fields in line with Geographic Information Science and cartography. It is only natural that such a concise technique, while allowing a better extrapolation of crucial spatial information, should be applied in the social science, in particular, in fields of research that merge planning, with population distributions and optimization of land and environment. One of these lines of research is tourism, where spatial analysis has shown to lead to optimization of planning and more sustainable and better management.

3.1. An application of dasymetric mapping to the Algarve

Mass tourism developed in the Algarve in the sixties lead to a growing demand and often irreversible construction of infrastructures for the tourist sector. The hundreds of infrastructures that were built, ranging from hotel units in fragile coastal stretches to abandonment of rural areas, led to an intensive destruction of the natural landscape and fragile ecosystems. This brought a great challenge on the region to cope with urbanisation processes in the nineties that lead to a soaring local economy. The International Airport of Algarve, located in the district capital of Faro, is an example of the growing supporting tourist infrastructure that at present is expanding and led by international stakeholders. Nevertheless, tourism concentration is intrinsically spatial. This spatially explicit characteristic of tourism is visible in the attempt of finding the optimum of location to satisfy demand, and offer in return unique landscapes and ecosystems that show the diversity of Algarve. This locational optimum however is often directly linked to the productions of goods and services that may have fundamental impacts on the carrying capacity of the environment. In the case of Algarve, this has been found to be a result of the increasing tourism demand that must be followed by better monitoring of the supporting urban and rural infrastructures. This creation of supporting urban regions is often linked to discontinuous urban fabric, resulting from leapfrogging as to find the most attractive value in the most pristine locations for tourism. Figure 2 accounts for the distribution of land use cells for the Algarve, where discontinuous urban fabric is much more present than any other land use class.

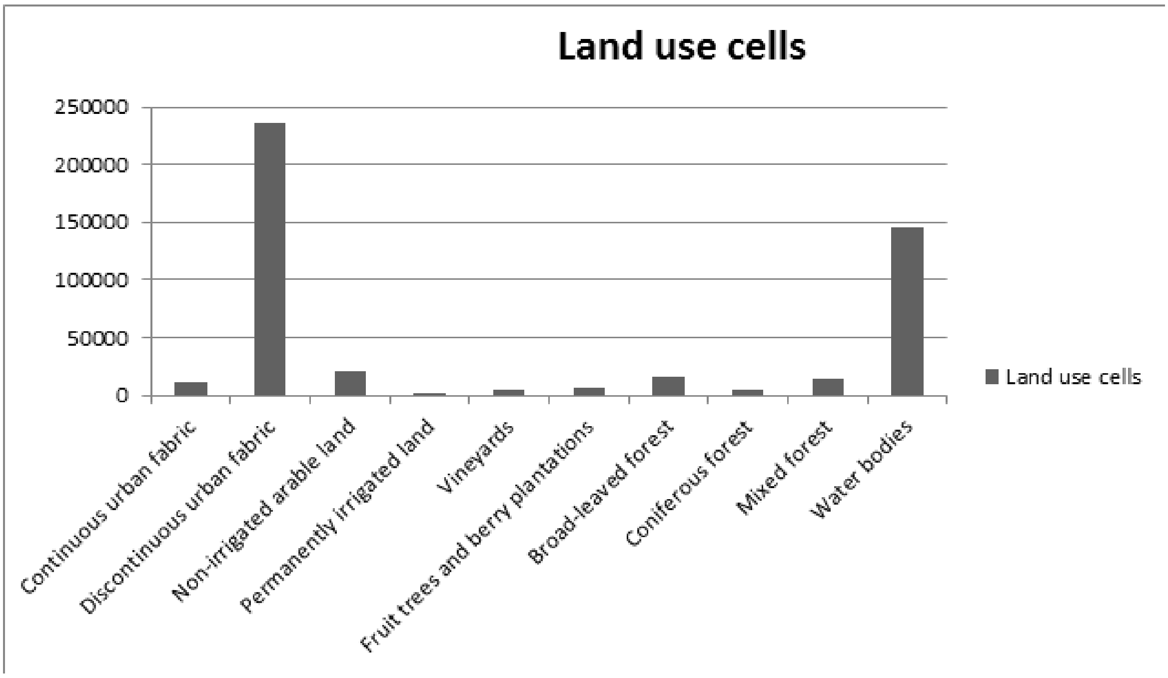


Figure 2 – Distribution of land use in the Algarve

Urbanisation and population increase are a consequence of economic growth, showing from one side the importance of tourism for the region, but adding on the need to inspect carefully the relations of population dynamics, in particular tourism concentration in regions, and the integration of strategies of planning per land use sustainability. Dasymetric and Geographic Information Systems combined may lead to better awareness of the multi-temporality of tourism density change, and Algarve offers to be a fascinating study case for such an assessment. The assessment was first observed by means of interpolating the CORINE Land cover data for 2006 into raster format. This permitted a cell based division where a count function of every single land use cell per municipality was carried out.

3.2. Dasymetric results for the Algarve

The weighting coefficient was calculated by creating a zonal histogram of land use per municipality.

$$LU_n = \frac{LU_i}{\sum_{i=1}^{n} LU_i} \quad (2)$$

Where, LU_n is the normalized land use type per each class in a municipality, and LU_i corresponds to each individual land use type. This leads to the calculation of C_i, defined as the coefficient weight where:

$$C_i = \frac{LU_n}{\sum_{i=1}^{n} LU_n} \tag{3}$$

The weighting coeficients were applied for the entire region of the Algarve, and a dasymetric test was sampled by means of a the demographic estimate originating the following maps (Figure 3).

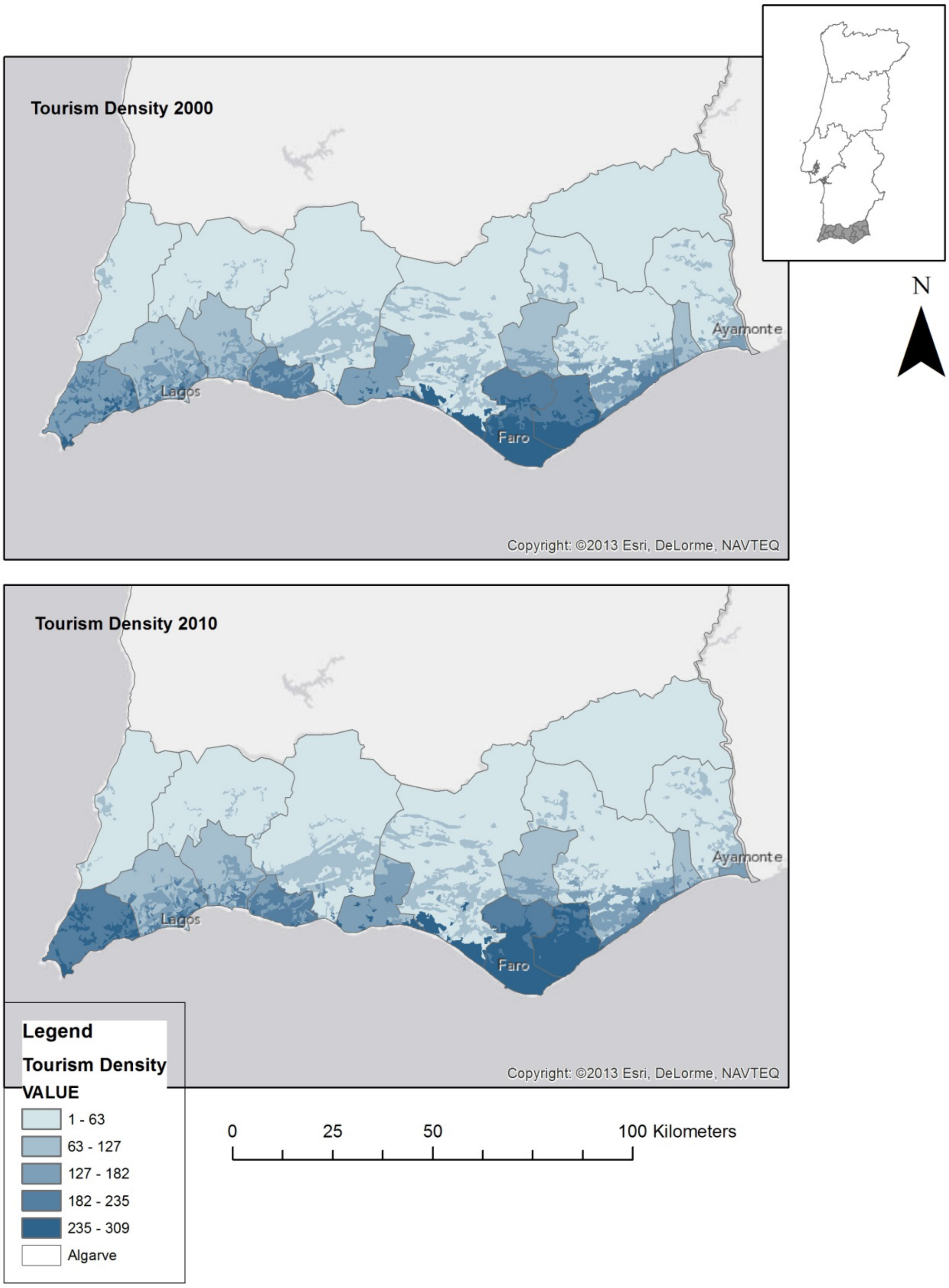


Figure 3 – Dasymetric calculation of Tourism density in the Algarve in 2000 (top) and 2010 (below)

4. DISCUSSION

The Algarve region took part of tourism growth during the 60s, when Faro International Airport started operations. The rapid growth of tourist demand that followed meant, from the supply perspective, the continuous increase of accommodation offer, related touristic facilities and enclave tourism spaces (Brito, 2009), catering for visitors in search of sun, sand and sea experiences. The specialization in sun, sand and sea type products that dominated for over four decades (Martins and Centeno, 1999) have been a growing regional concern, given the high seasonality during summer, overburdening the carrying capacity at local level. This monoculture of tourism generated both socio-economic and environmental negative impacts, professing profound impacts on unmanned urban sprawl as well changes in traditional economic sectors. The impacts of dasymetric change at land level show an interesting trend in the distribution of tourism in Algarve over the last decade (Figure 4)

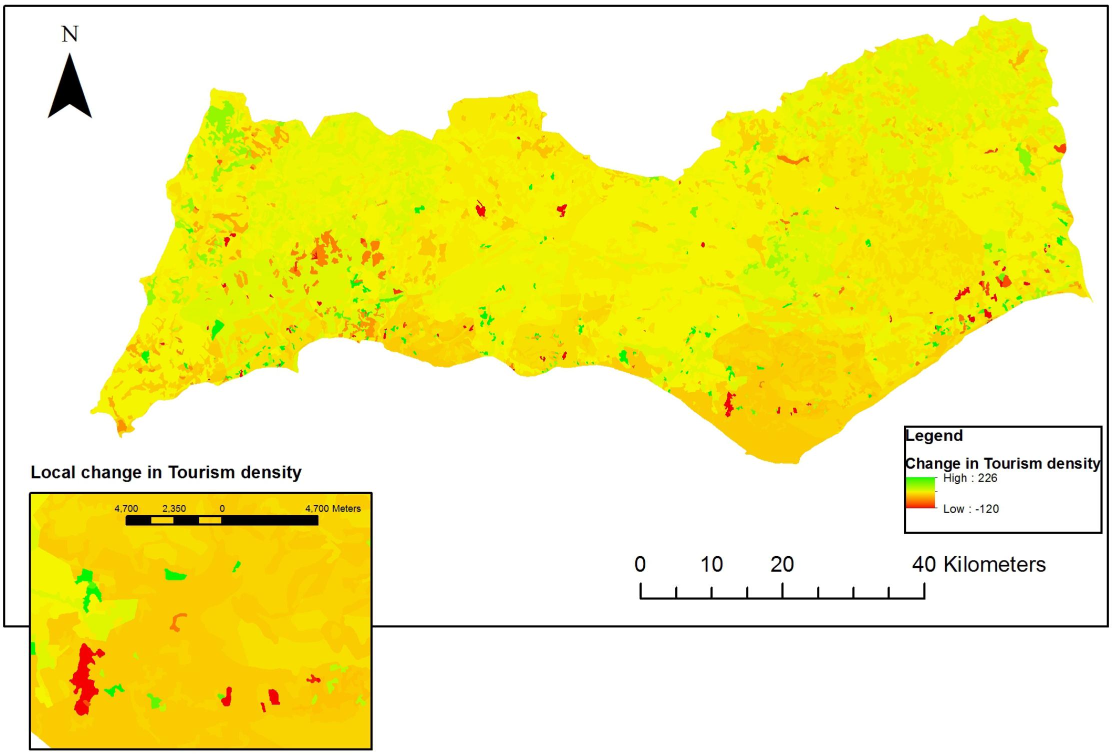


Figure 4 – Changes in Tourism density patterns between 2000 and 2010

Alterations in tourism distribution in Algarve point to an increase of occupation of inland areas, mainly in the *Barrocal* strip and, in contrast, a decrease in coastal areas. From a geographical perspective, data obtained are most revealing in terms of the evolution of tourism in the region.

In fact, changes observed are due to the convergence of factors of demand, supply, as well as the investment made by regional governmental bodies in the adoption of policy instruments adapted to a holistic approach to tourism development.

In general terms, it is now widely acknowledged that tourism behavior has changed relatively to previous decades during the predominance of the mass consumption and production paradigm (Torres, 2002). In what has been labeled 'the experience economy' (Pine and Gilmore, 1999) of post-modern societies (Cova, 1996), tourists as consumers are adopting new personal and consumption values and expressing new motivations with impacts on destination choice. Despite individualism manifestations in behavior, ethical and sustainability concerns are surpassing considerations of strictly egoistic wants and needs (Yeoman et al., 2007), and destinations offering sustainable environmental and social systems are more likely to capture the attention of touristically experienced and mature visitors. In addition, there is greater awareness of the complexity behind tourist motivations, and educational motives associated with discovery, knowledge acquisition, learning, and personal development (Andersson, 2007, Morgan et al., 2009) add to more traditionally known motivations of relaxing and escaping from everyday environment and routines (Bansal and Eiselt, 2004).

In terms of evolution in the tourism industry, most prominent mutations relate to the globalization of competition, with destinations available in almost every corner of the globe (Page and Connell, 2006), and the pervasive awareness of planning the development of tourism destinations in harmony with principles of economic, social, and environmental principles and values (Ritchie and Crouch, 2003) which followed the announcement and approval of international programmes meant to address global sustainability issues, such as the United Nations Environment Programme and the AGENDA 21 (Middleton and Hawkins, 1998).

The design and use of policy instruments to regulate tourism growth and development at the destination level currently integrate sustainability concerns identified by international bodies and agencies, and the same is true of the Algarve region. Algarve is undergoing changes in terms of instruments conceived to divert four decades of unplanned tourism growth, and these have been acknowledging the dependence of tourism activity from spatial contexts and their particular characteristics, either natural or man-made. For instance, in PENT (*Plano Estratégico Nacional Para o Turismo*), the national plan for the strategic development of Portuguese tourism, it is stated that 'in order to improve the [Algarve] region's performance it is necessary to create a set of initiatives for product development, as well as transversal actions aiming at all tourism products, while paying special attention to land use, environmental resources, protection of the coastline, and heritage preservation'.

PROTAL 2007 (CCDR, 2007) is a plan for the land use of the Algarve region. In this document, tourism is considered a strategic and competitive dimension in the development of the region and recognition of regional asymmetries claims urgent regulation of tourism development in the coastline, on one hand, and the need of developing touristic activity in inland areas, on the other, through stimulation of diversification of traditional tourism products. Similar propositions may be found in the *Development Strategy for Algarve 2007-2013* (CCDR, 2006), designed by the Regional Committee for the Development of Algarve (CCDR), namely the need to spatially distribute tourism offer. Spatial distribution is to foment coastal rearrangement and restoration, environmental protection and enhancement, but also the renewal of urban heritage mainly found in inland zones (e.g. traditional settlements and villages).

In fact, inland Algarve (especially Barrocal and Serra) have been hugely affected by massive investment and concentration of tourism activity and business in the coastline, eventually becoming low density areas in terms of population and urban settlements. Low density areas in Algarve have been characterized as declining spaces in terms of rural life, cultural and economic activity, yet with great potential for sustainable tourism development (CCDR, 2002). The lack of proper tools for sustainable tourism development had been found a major weakness of the region (CCDR, 2006). Stronger efforts are being made to overcome this specific problem and programmes have been implemented to stimulate economic, cultural and touristic dynamics in most affected areas. Particularly the PROLOCAL programme (CCDR, 2002) comprehends four lines of action (*Algarve Villages, Thematic Networks, Urban Renewal, and Endogenous Potential- Pilot Projects*) which together aim to achieve the following objectives: the restructuring of urban settlements, the protection of natural resources and tangible and intangible heritage, infrastructures improvement necessary to assist local production, quality improvement of human resources, improvement of public performance, and diversification of regional production. Planning instruments for a sustainable and holistic approach to regional development, in which tourism plays a key role, converge to common notions of Algarve's weaknesses and strengths alike. The intensification of use and implementation of these instruments, in harmony with stronger efforts to promote the region as a quality sustainable destination (CCDR, 2007) may explain partially the data found on tourism density changes.

Many spatial clusters, especially located along the coastal areas have changed, some of these areas had been prone in the nineties to summative investments in the tourism industry in Algarve. Areas such as Vilamoura, Quinta do Lago, and an overall trend in the coastal regions of Algarve has witnessed a decrease in tourism. This is a result of two antagonistic forces felt in southern Europe: the clash between traditional tourism ventures of sun and beach products and more attractive destinations at international level with equally competitive prices, and the demand for alternative tourism products related to sustainable and ecological tourism choices. In an attempt to satisfy tourist demand, businesses disinvested in traditional economic activities, such as fishing, agriculture and manufacture of regional productions, and residents abandoned rural areas in search of better life conditions in the coastline towns, with dire consequences in terms of inland desertification. The specialization in tourism along with highly seasonal visitor flows eventually pushed inhabitants to face severe constraints related to sustainable economic dynamics, urban and coastal traffic, carrying capacity of places, leading to the gradual jeopardize of local communities' quality of life (Ahn et al., 2002). On the other hand, the growing investment made by the private sector on *coastal* tourism generated environmental negative effects, such as massive building in sensitive areas (cliffs, wetlands, and dunes), soil and aquifer contamination, natural resources depletion, and generally speaking, disruption of ecosystems' balance (CCDR, 2007). This in fact, represents an opportunity for consequently redefining the current structure of tourism demand in Portugal and in southern Europe. The Algarve region, given this spatial change in moving to more pristine areas and natural areas, could consolidate the demand for ecological tourism and reconfigure the morphology of the overburdening coastal tourism. Alas, the existing infrastructures built largely three decades ago share a lesson learned for the future and a warning that tourism must be thought in line of unexpected changes in economic growth, and therefore must be a reflex in line with the landscape and sustainable development. The current strategy foments this by integrating public authorities and stakeholders involved in regional development progressively started to address critically the issue of traditional tourism development. This is achieved by becoming aware of the need to deal with negative externalities of tourism growth in destinations by adopting a sustainability approach to management (CTP, 2005, Coelho et al., 2010). Policy instruments have been designed and implemented to meet the needs of the tourism system stakeholders, and concrete actions have been taken to leverage the rehabilitation and renewal of urban areas, requalification of accommodation units and the promotion of cultural heritage and activities (Brito, 2009). From an environmental point of view, regulations have been adopted to control environmental damage by means of restrictions applied to construction in sensitive areas, delimitation of protected areas, and use of zoning methods (CCDR, 2007, Taveira Pinto, 2004). No tourist destination is immune to external and internal forces that influence and can endanger its attractiveness and competitiveness (CTP, 2005). Globalized competition, fashion issues, changes in visitors' preferences and motivations, and widespread ecological awareness are among the factors that affect the spatial distribution of tourist flows and, as a consequence, destinations' competitiveness and attractiveness. On the other hand, problems associated with the lack of residents' quality of life due to pressures put on the natural and built environment claim urgent action in terms of design and use of planning, management and monitoring tools able to assist the making of decision. The sustainability paradigm applied to tourism means the adoption of instruments adequate to support the controlled development of the system so that social, economic, and environmental positive effects occur to the benefit of stakeholders (Inskeep, 1991, Agapito et al., 2012). In light of the above, as Bansal and Eiselt (2004) argue, government and tourism planners must converge in dealing with tourism development main issue which is *where to locate new facilities and which type*. In this context, dasymetric mapping in addition to Geographic Information Systems may provide valuable assistance to tourism management and the making of responsible decision.

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Ex: Costa, J. (1995). *Caracterização e constituição do Solo*. 5th edition, Foundation Calouste Gulbenkian. Lisbon. ISBN: 000 000 000 0000

Book Chapter:
Ex: Silko, L.M. (1991). The man to send rain clouds. In: W. Brown and A. Ling (eds.), *Imagining America: Stories from the promised land*. Persea. New York.

Online Document:
Last name of the author, First initial. (Publication year). *Document title*. Accessed in: day, month, year, in: URL.
Ex: Chou, L., McClintock, R., Moretti, F. e Nix, D.H. (1993). *Technology and education: New wine in new bottles – Choosing pasts and imagining educational futures.* Acceded in 24th of August 2000, on the Web site of: Columbia University, Institute for Learning Technologies: http://www.ilt.columbia.edu/publications/papers/newwine1.html.

Dissertation:
Ex: Tingle, C.C.D. (1985). *Biological control of the glasshouse mealybug using parasitic hymenoptera*. Ph.D. Thesis. Department of Biological Sciences, Wye College, University of London. 375 pp.

Tables, Figures, Graphics and Boards:
All tables, figures, graphics and boards are to be numbered using Arabic numerals and should have a title explaining its components above the body, using size 9, bold, centred.
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