# Urban heritage endangerment at the interface of future cities and past heritage: A spatial vulnerability assessment

## Research Memorandum 2011-36

**Eric de Noronha Vaz**
**Pedro Cabral**
**Mário Caetano**
**Peter Nijkamp**
**Marco Paínho**

vrije Universiteit *amsterdam*

# URBAN HERITAGE ENDANGERMENT AT THE INTERFACE OF FUTURE CITIES AND PAST HERITAGE: A SPATIAL VULNERABILITY ASSESSMENT

Eric de Noronha Vaz[1,2]; Pedro Cabral[1]; Mário Caetano[1]; Peter Nijkamp[3]; Marco Paínho[1]

## Abstract

Uncontrolled urban growth has been an increasing concern in many regions in Europe and elsewhere. Brought forth by a natural tendency of population growth in relation to unsustainable land use, city sprawl has led to complex spatial developments that are creating both benefits and challenges to decision makers. A major problem inherent in uncontrolled growth of cities is the threat to fragile cultural and ecological heritage, which may escalate to permanent and irreversible damage due to factors such as environmental depletion and landscape decay. Using modern geosciences and spatial information technologies as predictive tools to analyse and forecast urban growth, a regional spatial decision system may be useful in order to offer seemly and timely information on the risk of overburdening the carrying capacity regarding historico-cultural heritage at local levels.

The present paper will develop a predictive toolkit for urban heritage in relation to urban cultural endangerment for the region of the Algarve in Portugal. The use of the Algarve as a laboratory for testing this novel methodology relies on a combined analysis of urban growth potentials and threats to the abundant presence of archaeological heritage in the area. Our approach supports the paradigm of city growth in the context of the European agenda emerging from the Valetta Treaty, in which archaeological heritage is recognized as a key element for sustainable development. The present study offers novel empirical results from the above mentioned modelling approach. This paper proposes an integrative spatial analysis methodology on the issue of historico-cultural endangerment, proposing a novel approach of comparative spatial analysis for decision making at regional scale on urban heritage endangerment. The discussion extends further on to a more conceptual level of urban planning: is urban sprawl influencing the way we perceive cities? If so, are there positive advantages in the paradigm of urban growth and urban sprawl which might help us to protect past heritage while offering sustainable and modern cities?

Pn404evpcmcmp

[1] Institute of Statistics and Information Management - Universidade Nova de Lisboa, Lisbon, Portugal.
[2] Faculty of Economics - Universidade do Algarve, Faro, Portugal.
[3] Faculty of Economics and Business Administration – VU University Amsterdam, Amsterdam, the Netherlands.

# 1. Introduction

## *1.1. On urban growth and urban sprawl in Europe*

Changes in the landscape of cities and regions have increasingly occurred in the last decades. Most of these changes have had a crescent relation to humans' socio-economic activity regarding the environment. With the increasing growth of cities, irreversible land use change has become an important fact for planning (EEA Report, 2006). The structural changes of city landscapes have mainly been influenced by the rapid population increase as well as the concentration of economic activities in urban regions. While cities represent often a positive externality, leading to a better management of commuting costs and may significantly contribute to sustainable development, urban areas must be treated with special care, as mismanagement may result in irrecoverable landscapes and severe imbalances in urban areas. As cities grow on their supporting infrastructures, and population density augments due to job concentration from the service sector, territorial occupation becomes often overburdened, and consecutively market failure is common. Congestion, pollution and loss of landscape aesthetics are but a fragment of the different downsides of urban change. However, these consequences are not a result of growth by itself, but rather from the excessive (Brueckner, 2000) and scattered concentration of urban areas into rural lands (Harvey and Clark, 1965), which defy the spatial agenda of urban planners. By definition, such type of urban growth is defined as *urban sprawl*. This type of growth depicts a chaotic essence, and is becoming an increasing concern especially in coastal regions where Europe has grown increasingly over the last decades. Predominantly, this growth has been a result of economic activity related to the service sectors: tourist areas, for instance, have witnessed with the increase of mobility an astonishing growth in urban perimeters. Within a Schumpeterian vision, the concentration of urban regions has been a result of increase of the

demand of specific factors (such as - in the case of tourism-leisure activities and natural landscapes in marine regions), while supply of those goods have been produced excessively without enough flows of innovation, leading to depletion and scarcity of the available goods (natural landscape). The spatial analysis of available data on urban growth in Europe shows that the natural landscape is becoming a 'scarce resource' often unavailable to offer high-quality tourism, as important regions for tourism become lost due to increasing human pressure. While this problem has been widely studied from an ecological perspective, little work has been carried out on the consequences of the loss of landscape resource from a historical heritage perspective. In fact, historical (and archaeological) heritage, presents an important asset for tourism, and an increasingly important tool for sustainable development. Losing archaeological heritage - as vulnerable as it is due to pollution and loss due to coastal erosion - is also becoming lost through the invisible hand of urban growth. Under the European umbrella, the importance of preserving historical cities and fragile monuments has been widely recognized. But no effective solution integrating the cost of urban growth has been offered or studied. Spatial monitoring however, serves to use both types of tools to integrate the preservation of archaeological heritage as well as to monitor the increasing consequences of urban growth. The European Spatial Development Perspective (ESDP) had natural and cultural heritage as a major topic of discussion on the table: "*Natural and cultural heritage in the EU is endangered by economic and social modernization processes. European cultural landscapes, cities and towns, as well as a variety of natural and historic monuments are part of the European heritage. Its fostering should be an important task for modern architecture, urban and landscape planning in all regions of the EU.*" (European Commission 1999).

Coping with urban change is a prerequisite to maintain our quality of life at present. While in the short term local sustainability plays a major relevance, in the long term common structural changes must be considered (Capello 2001). This observation clearly exemplifies the relevance of conservation of our heritage, in which archaeological heritage preservation has a vital role in the sustainable development of cities.

## 1.2. The cities' nexus: past archaeology and modern infrastructures

Aesthetics of the natural landscape are strongly linked to the preservation of open spaces and maintenance of natural and cultural heritage. Heritage has enjoyed in recent years an increasing attention from policymakers, as they often represent an important resource for economic growth. It is thus plausible that preservation of those resources is an essential ingredient for sustainable development and also for sustainable tourism (Vaz et al., 2010). Over time, landscapes have changed rapidly and constantly due to human impact since pre-18th century (Antorp, 2005). Antorp's definition of post-modern landscapes recognizes that "*visible break in the continuity with the past is created. However, all these changes are made with the same concern of importing the living environment to the new needs of a growing population, which is mainly urban. People become increasingly mobile and the ecological footprint of the urbanity now stretches beyond their city*". In the case of the Algarve, the spatial movements of the extending cities converge towards archaeological sites, which could be an important resource for tourism alternatives to rebalance the asymmetries of the urban and rural fringes (Vaz et al., 2010). Urban sprawl in the cities' nexus has as a consequence the inclusion in the area of various jeopardized archaeological sites and historical buildings. The local identity of the place becomes increasingly

lost and the costs of losing local identity in a region such of the Algarve may yield to a mass tourism industry which overburdens the fragile marine ecosystems. The re-equilibration of a sustainable tourism industry has intrinsically an impact on the stability of the environment. Increasing change and construction on the landscape is leading to an unprecedented fast pace of landscape changes.

Monitoring urban growth and heritage tourism offers an alternative to the process of centralization of tourist activities and tracking those changes. Centralization of tourism attractions is a result of lack of efforts regarding heritage preservation and exploration of neglected historico-cultural landscapes. As a consequence, overburdening tourism in certain heritage sites not only affect will the challenging carrying capacity of local areas in a vicious negative cycle (Russo 2002), but may also, lead to permanent loss of fragile archaeological sites in the long run.

Application of landscape strategies can reverse these negative impacts: (1) in the short-run (local measures): protection of existing urban patrimony often endangered due to air pollution - a consequence of human activity within an urban area due to gas emissions – through the creation of a diversified cultural heritage supply. (ii) long-run (regional measures): promotion of the design of a future urban growth that leads to a balanced choice for future urban development which may benefit directly urban planning by reducing negative impacts of urbanization.

The solution to avoid negative externalities in the long-run should take into account the usage of predictive modelling approaches, regarding both - urban growth and archaeological heritage. Both of these models should be spatially explicit, and are of crucial importance for sustainable development. The possible integration of Stonehenge in UNESCO's endangered sites list

(Webster 2007) is a clear example of the importance of understanding the future impacts of urban planning.


### 1.3. Predicting urban change and protecting archaeological heritage


The notion of urban sustainability and "living cities" is characterized by their exclusivity with unique historic patrimony. The impact of growing cities should not jeopardize the continuum of secular memories of urban areas, but should rather articulate the secular presence in the modern conception of the urban preservation agenda. This can only be accomplished through a transversal effort of different areas in which planners contribute to understanding the synergistic dimension of economic positive externalities and the carrying capacity of vulnerable areas.

Understanding the dynamics of spatial land use change is of vital importance to equilibrate the aesthetics of the landscape and to avoid further loss to marine environments. The objective of this paper is to address a two-fold approach based on location awareness of the urban growth continuum as well as a probable location of archaeological heritage. The city is seen as a complex and non-linear system, which is extending into archaeological heritage sites that may have an important role for avoiding continuous pressure on the coastal regions of the Algarve. Thus, the logical organization of this paper follows a systematic understanding of the urban changes felt over the last decades in the Algarve and to predict future urban change at a spatial level. Furthermore, a spatial Archaeological Predictive Model based on a known site location of archaeological sites will be assembled to link the spatial location of important vestiges of archaeological cultural heritage. These vestiges - the Algarve is one of the most important regions of Roman activity in Portugal - are important as an alternative tourist-asset which could

redefine the patterns of urban growth brought by economic pressures of tourism. It is in the convergence of both models – the Urban Growth Model (UGM) which informs of the spatial distribution of current and future urban sprawl and the Archaeological Predictive Model (APM) that shows the propensity of finding archaeological sites along the Algarve - that a strategy may be defined at the level of municipalities, to enhance the local value of cultural heritage and the existing cities concerned

## 2. Research Methodology

### 2.1. The study area

With a total area of 5412 km2 and a population of 458734 inhabitants, the Algarve offers a vast and rich historical and ethnographical background. Allied to a moderate Atlantic climate following short winters and agreeable summers, the Algarve has long been a region of tourism. With a total of 16 municipalities, the Algarve is famous for its sandy beaches, which since the sixties have led to the development of large and one of Europe's most important tourist industries. While the region itself has benefited from an economic perspective from the growth brought by the tourism sector, nowadays, the Algarve is suffering from some of the consequences for the carrying capacity of the coastal regions, due to excessive concentration in coastal areas of the Algarve. Nevertheless, in the vein of the definition of sustainable tourism, the exploration of the Algarve in a wider sense than sun and beach, might avoid this excessive concentration and reshape the asymmetries of the rural Algarve and the littoral fringe.

The Algarve represents a very interesting region of study, as the region is suffering from an increasing friction between natural ecosystems and urban growth. The historico-cultural richness of the Algarve as well as the ecological diversity and available land-use inventories of European interest (Painho and Caetano 2006), frame this region as a relevant case of consequences of unmonitored urban growth (see Figure 1). The coastal fringe in the Algarve has significantly changed over the last 20 years. Accompanied by a population increase and the demand for new infrastructures to cope with the tourism sector, the Algarve has predominantly expanded along the coastal shores, putting at risk fragile ecosystems part of the NATURA network, such as the *Reserva Natural da Ria Formosa*.

Cities in the Algarve represent a very diverse cultural legacy, brought forth from the Moorish influence combined with the Roman and traditional Portuguese styles. It is therefore a cradle of different civilizations, which shared the region since the Neolithic age (Calado and Rocha, 2006).
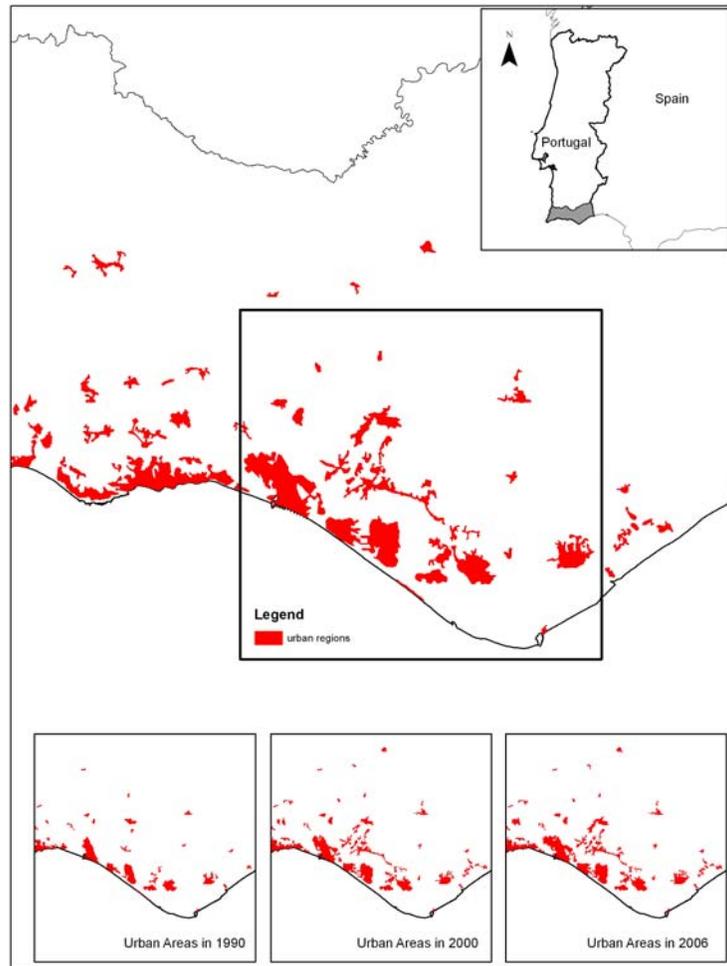
Figure 1 – Change in urban regions in the Algarve

## 2.2. Data types and sources

The approach in this study draws forth from a comparative assessment of areas with higher propensity for urban sprawl with regions showing more probability of becoming archaeological landscapes. While urban sprawl is unavoidable, segmentation of regions of city growth may help to protect areas of archaeological interest. The major reason of this protection is a result of the Valletta treaty, justifying the importance of preservation of a collective Archaeological memory.

Several data types are adjusted to allow the following research efforts: (1) creation of an urban growth model (UGM) based on socio-economic and environmental variables to assess the propensity for urban growth, and (2) integration of a predictive model showing the regions with a high probability for important archaeological sites. To allow the generation of the UGM, the data types used were assessed from the CORINE Land Cover data over a period of 1990 to 2006. The major classes related to artificial land use were filtered through the spatial inventory, as to allow an assessment of land use change.

## 3. Urban Growth Models

The urban growth model (UGM) follows a classical SLEUTH modelling approach, encapsulating socio-economic and geophysical variables that respond to the most plausible outcome of urban sprawl in the Algarve in the forthcoming years. These variables explore the tendency for urban growth up until 2020, based on Markov transition probabilities, and are then compared to the spatial location of most probable archaeological sites. The integration of both spatial information systems, allowed us to elaborate on a spatial model which reported the location of probable archaeological sites and valued historico-cultural places in the vicinities of existent urban fringes.

Cell-based models allow an accurate interpretation of urban growth dynamics and changes facing land use as well as its resulting impacts (Oguz et al. 2007). The importance of such models is intrinsically related to the need to monitor sustainable urbanization and is closely linked to global sustainable development (Camhis 2006). Urban Growth Models (UGM) follow a long tradition

in the spatial sciences (Wilson 1974) and have been for decades considered of great interest in simulating future growth patterns (Tobler 1970).

The cell-based model approach, due to their similarity to urban growth behaviours, is an optimal choice for tracking urban change (Batty 2005). As such, these models may have an important role in the decision-making process regarding future urban growth and regional planning strategies (Piyathamrongchai and Batty 2007). The change is conditioned by the distinct states adopted by urban or non-urban, represented as **S**. These states, **S**, are influenced by the subsequent propensity derived from the Markov transition matrix (*f*). Thus, the state of the cells (*Sc*) may be defined as:

$$Sc^{t+1} = f(Sc^t, Sn(c)^t) \tag{1}$$

The transition rule takes into account the previous time (*t*) within the propensity of the surrounding neighbourhood (*Sn*) moving then forward to the state in t+1.

The Markov transition matrix (*f*) is calculated by the relationship of the existing change from one land-cover to another and may be represented as:

$$P_t = \begin{pmatrix} p_{11} & \cdots & p_{1Nw} \\ \vdots & \ddots & \vdots \\ p_{Nw1} & \cdots & p_{NwNw} \end{pmatrix} \tag{2}$$

$P_t$ is the probability of transition for $x_i$ to $x_j$ in *t* steps, given the weights:

$$P_{ij}(x_i, x_j) = \frac{x_{ij}(x_i, x_j)}{d_i} \tag{3}$$

11

and

$$d_i = \sum_{j=1}^{N_w} w_{ij} \qquad (4)$$

Due to the capacity to create a transition matrix based on conditional probabilities of $P_{ij}$, land use change probabilities may be assessed underpinned by multi-temporal land use covers. Thus, a resulting matrix will necessarily evoke the changes occurring within a defined timespan. The mechanisms of change between t and t+1 are thus detected and repeated as to allow an accurate perception of the next moment t+2, in which every pixel changes based on a transition rule as a function of the neighbouring pixels so as to form the t+2 moment expressed as a land use map.

The importance of this known time reference is that of a validation that allows a future projection of urban growth for 2020. As we see, the coastal areas of the Algarve have shown the largest increase in urban growth in the last decades and tend to grow even thus becoming most probably continuous artificial areas.

The propensity map (Figure 2) for urban growth used the CORINE Land Cover data information for urban areas, proximity to road networks, population density per parish and proximity to coastal areas.
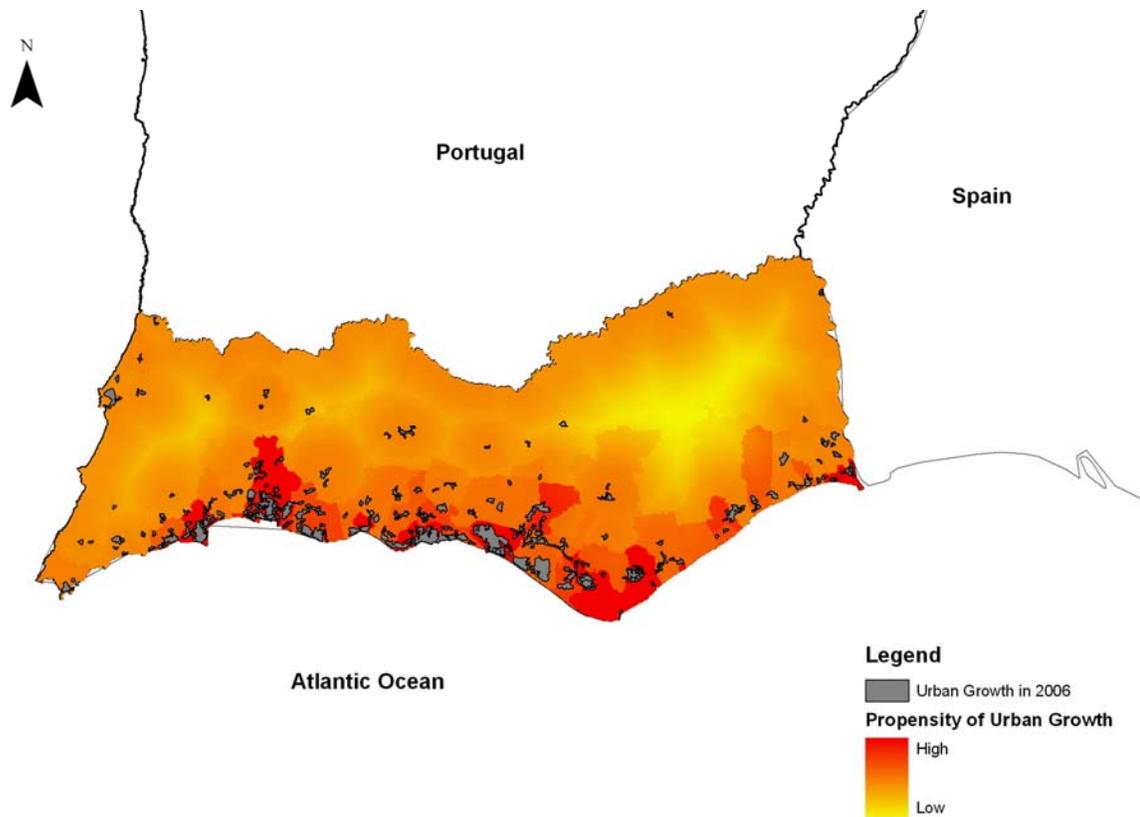
Figure 2 – Propensity of Urban Growth Map and Urban Growth by 2006

Understanding of spatial dynamic models and urban growth scenarios is important and has been studied widely in the literature (Meaille and Wald 1990; Al-kheder and Shan 2005).

Urban growth in the Algarve started suddenly in the 1960s with the exploration of the tourist industry in this region. The Algarve expanded and its littoral cities became major foci of mass tourism, especially during the summer season, due to its temperate climate and beach areas. The demand generated an increasing economic prosperity in the Algarve and took four decades later naturally its course. The Algarve has prospered due to this active industry, while the coast line of the Algarve is in fact one of the most expensive areas of Portugal for habitation, where many large and expensive investments are found.

13

The population in the Algarve in the winter season is a tenth of the population in the summer season. One of the problems of the hospitality industry in the Algarve has been to cope with the seasonality of the tourist industry which has far less activity during the winter time. Tourism, as such, has shown for the Algarve both, a symbiotic and antagonistic impact where antagonistic relationships are strongly linked to the rigidity of the supply in the short term compared to the elasticity of demand (Matias 2004).

The Algarve has specific fauna, flora and cultural characteristics, that make this region worthwhile of and an alternative for tourism opportunities that generate more symbiotic effects rather than the already existing antagonistic ones. The main problem lies in the re-qualification of existing urban tissue and the capacity to cope with a further landscape for adequate urbanization of those areas. Also, new urban areas support the aggregation of previously existent urban tissues, leading to a continuous artificial land cover highly endangering the natural landscapes as well as the existent ecosystem. As a consequence of this, small towns such as Olhão have become cities, where proximity to the district capital Faro transformed Olhão into a dormitory city. The consequence of this agglomeration generated a continuous urban area of circa 5 km reaching from Faro to Olhão. This continuous urban area, due to the proximity to the Natural Reserve and the existence of important cultural heritage resources, has in fact endangered the highly valued patrimony. Monitoring and creation of prospective future scenarios is an important task to avoid similar situations in future.

Currently, ongoing regional policies, such as the Programa Regional de Ocupação do Território do Algarve (PROTAL), protect some aspects of growth in the region. Still, it is important to understand urban growth in this region, as it has been modestly studied. If assessed correctly, it

may prevent future environmental collapse by a direct impact on strategic planning or sensitizing and creating social awareness.

## 4. An Archaeological Predictive Model for the Algarve

Since 1970 an ongoing scientific debate regarding archaeological predictive modelling has taken place. This debate has been accompanied by technological advances which led to possibilities of better understanding and predicting archaeological past. The initial models presupposed strong statistical backgrounds (Savage 1990) mainly as a result of archaeological processualism.

It was in the beginning of the 90s that APM prompted various discussions in an attempt to design new approaches. This pragmatic decade of modelling is marked by a stage in which archaeologists become quite certain that predictive modelling should not only rely on correlations with environmental factors, but also an historic non-quantifiable data has an important tool for prediction. Clearly, if a specific site location contains archaeological vestiges, the argument becomes one of available theories of spatial distribution of archaeological material as well as empirical and historical observations of site records (Wheatley and Gillings 2002). It is in this scenario that disagreement occurs more often, as scientists do not agree yet on a common methodology and a general theory which incorporates correlative and cognitive approaches. Nonetheless, in this spirit of controversy, deductive and inductive approaches for APM have risen over the past decades. The inductive models are considered to be more spatially-related, and as a consequence of empirical and analytical tools related to environmental variables. Deductive modelling focuses mainly on the available historical data leading towards a more cognitive nature. One of the classic inductive models has been the class of Logistic Regression

Models (LRM). LRM have been used since the 70's for archaeological evaluation. Considered as a classical approach towards modelling (Kvamme 1991), these models present a lack of capability to understand anthropological change due to their simple stochastic methodologies (Sebastian and Judge 1988). The existent Roman sites from a collection of site inventories were used so as to allow a total of 370 Roman archaeological sites in the Algarve. Given the bibliographical support of topography, proximity to water (Brandt et al. 1992) and the importance of trading circuits in the Algarve area during the Roman period, these variables were combined with the location of archaeological findings from the same period. This led to the following relation:

$$A = D + f_1 B + f_2 C + f_i x \dots + e \tag{5}$$

where $A$ equals site density; $B$, $C$ and $x$ represent the independent variables considered; $f_1$, $f_2$ and $f_i$ represent the weights for $B$, $C$ and $x$, respectively; $D$ is a constant, and $e$ is an error term. Thus, $B$ and $C$ represent independent variables in which the relationship to the sites is of utmost importance for our model and become the key for the parameterization of a propensity map, in which the different probabilities of finding a site in a given location may be assessed. Furthermore, geographical trades such as slope, hillshade, aspect and current land-cover as well as soil type were stochastically analysed by the dependency of the variables using Kolmogorov-Smirnov statistics to infer the statistical significance with results as follows (Table 1).

Table 1 – Results of Random / Not Random variables

| Variable | Dmax | D K-S | Dmax-D K-S | Relation |
|----------|------|-------|------------|----------|
| Aspect | 0.153 | 0.079 | 0.07 | Not Random |
| Elevation | 0.000 | 0.079 | -0.08 | Random |
| Hillshade | 0.075 | 0.079 | 0.00 | Random |
| Land use | 0.005 | 0.079 | -0.07 | Random |
| Slope | 0.849 | 0.079 | 0.77 | Not Random |
| Soil | 0.194 | 0.079 | 0.12 | Not Random |
| River Distance | 0.973 | 0.079 | 0.89 | Not Random |

While random variables were discarded, non-random variables allowed to draw the final equation with independent variable considered as: Aspect, Slope, Soil and River Distance. This resulted in the following propensity for finding archaeological sites, defined by the tendency of finding more Roman archaeological sites in the coastal regions, than in the interior (Figure 3). The settlement patterns of the Romans in the Algarve are quite similar to the contemporary areas of city settlement, suggesting the expected secular construction of cities as in the past. Proximity to river basins and some regions of the interior in the Algarve appeared to show however, additional importance.
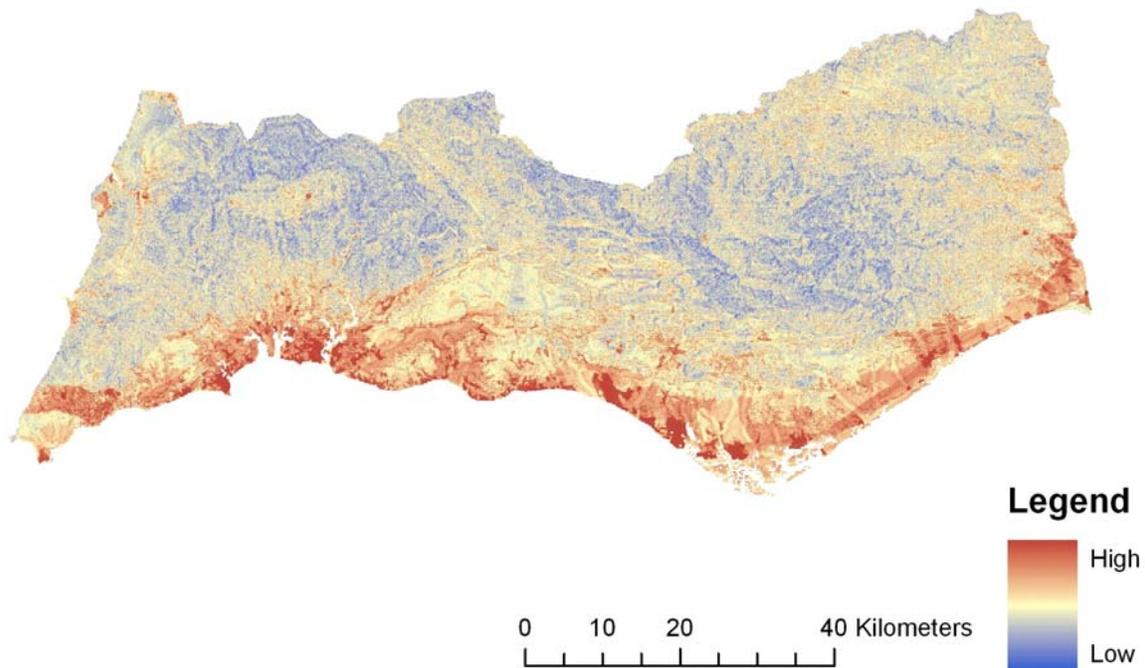
Figure 3 – Archaeological Predictive Model for the Algarve

This predictive model consisted of a sensitivity analysis of low to high propensity of finding Roman archaeological sites. As proposed by Kvamme (1999), a jack-knife sample of 70 random archaeological sites was left out of the model, so as to test the effectiveness of predicting archaeological sites. Most sites were found within the 70 to 80% range, corresponding to a satisfactory result for archaeological site propensity.

Most archaeological sites are located in the perimeters of the larger city boundaries, suggesting a settlement pattern in the Algarve since the Roman period. This relationship is consistent with the available historical resources, pointing out the location of the ancient Roman cities of *Ossonoba* in present days, viz. Faro, *Balsa* (Tavira), *Esuris* (Castro Marim), *Portus Hannibalis* (Portimão) among others. Surrounding those regions, the interior of the Algarve shares also a high propensity for Roman sites. These areas are of particular archaeological interest, and should be cherished for scientific purposes to better understand Roman civilization in the Algarve.

## 5.   Urban Cultural Endangerment - A spatial modelling framework for the Algarve

The importance of cultural assets leads to the construction of a model which compares urban growth with archaeological site propensity in the Algarve. Understanding these dynamics permits a better decision process regarding: (i) preservation of archaeological sites from a cultural heritage perspective, (ii) proactively taking measures on construction sites to cope with existing heritage, (iii) awareness of for archaeological heritage preservation while sharing the local information on existing heritage. The comparison of both models was achieved by the analysis of urban growth and archaeological heritage propensity (see Table 2).

Based on the average mean of those propensities per municipality, the urban heritage endangered per municipality was assessed.

Table 2 – Urban Heritage Endangerment ( [1] Urban Growth, [2] Archaeological Heritage)

| Municipality | Urban Growth | Heritage | Average risk | UHE (%) | Pressure: |
|---|---|---|---|---|---|
| Lagoa | 181 | 185 | 182.92 | 71.74 | UG[1] |
| Olhão | 182 | 166 | 174.23 | 68.33 | UG[1] |
| Faro | 185 | 157 | 171.16 | 67.12 | UG[1] |
| Portimão | 181 | 153 | 166.81 | 65.42 | UG[1] |
| Albufeira | 171 | 157 | 163.91 | 64.28 | UG[1] |
| Vila Real de Santo António | 156 | 150 | 153.11 | 60.04 | UG[1] |
| Vila do Bispo | 109 | 148 | 128.61 | 50.43 | AH[2] |
| Loulé | 121 | 125 | 122.96 | 48.22 | AH[2] |
| Tavira | 76 | 119 | 97.38 | 38.19 | UG[1] |
| Castro Marim | 93 | 141 | 117.43 | 46.05 | AH[2] |
| Silves | 108 | 120 | 114.35 | 44.84 | AH[2] |
| Aljezur | 100 | 115 | 107.35 | 42.10 | AH[2] |
| São Brás de Alportel | 104 | 104 | 104.22 | 40.87 | UG[1] |
| Alcoutim | 79 | 118 | 98.72 | 38.71 | AH[2] |
| Monchique | 92 | 95 | 93.38 | 36.62 | AH[2] |

The municipalities with the highest probability of urban heritage endangerment were identified as Lagoa (71,74%), Olhão (88,33%), Portimão ( 65,42%) and the district capital of Faro (67.12%). All these municipalities represented also the highest propensity for urban growth, identifying urban growth as a key pressure for archaeological heritage endangerment.

The role of Archaeological Predictive Models is twofold: As the analysis of site location allows a better understanding of behavioural civilization patterns as proposed by traditional APM literature, nowadays it has an important impact (and less explored) in the decision-making process for sustainable development. In a region such as Portugal, where historico-cultural heritage is an important asset for the tourism industry, evaluation of the site potential can create regions with specific niches for heritage tourism.

It has been shown that Predictive Archaeological Models may be important to understand spatial dynamics from the past. Not only in a historical context could they make sense, but mostly, the capability to predict accurately the location of archaeological sites may help future technology to discover new findings as well as understanding behavioural patterns of past societies. There is much need for such work in an area such as Portugal, where little of such work has been done, although there is a vast historic and civilization background.

We may conclude generally, that the Romans in the Algarve had a similar preference as ours to spatial occupation, as the highest propensity of sites is in fact in proximity to current urban areas. This characteristic concatenated to the fact of constant urban expansion and sprawl, justifies the need of the present study. Urban growth has been a constant process in the last decades. This is an eminent concern, and has been largely discussed in a European context. Regionally, the Algarve is suffering from this problem, and the continuous growth at the constant rate it has had in recent years, will quickly in the next 15 years endanger natural and artificial patrimony. One

of the reasons which appear to be related to the urban growth areas in the Algarve is tourism, as urban areas with higher tourist activity are more rapidly expanding than others. As cultural heritage is a phenomenon which may work as a tourist product by itself, it is up to stakeholders to allow a more sustainable development of further tourist growth having in mind cultural patrimony. It is clear that urban growth cannot be hindered, and that the tendency is for the creation of mega-cities. The question is then: how can cosmopolitan areas be sustainable and conciliate fauna, flora and manmade patrimony simultaneously? This is indeed a challenge for the short future and may be a decisive step for future generations.

Monitoring in the next years the proposed areas may be a proactive approach for future preservation. As cities grow, cultural heritage teams may become engaged as housing is planned, recovering archaeological sites and cataloguing this valuable patrimony considered to be "the most universally valued and most even distributed resource in the world". (Box, 1999). Also, the decision-making process on where to build may become more accurate, as strategies such as the PROT (Plano Regional de Ordenamento do Território) exist. Until 2020, the urban landscape will change rapidly and cultural heritage may be jeopardized. The need for action is absolute and urgent to avoid future endangerment of the studied municipalities. Special care should be taken in the municipalities of Lagoa, Olhão and Albufeira that, due to a mix of existing archaeological vestiges and historico- cultural background as well as rapid growth, seem to be mostly jeopardized. Olhão shows a very high propensity for cultural heritage and further excavations and ongoing research regarding this municipality should take place especially in the areas of imminent urban construction. Much work can still be done regarding both studied dimensions. Regarding Archaeological Predictive Modelling, it has been shown that despite divergences from the scientific community, they are an important tool which may be used in a regional context.

Thus, new methodologies that intertwine the doubts of the scientific community are of much importance. As APM become more accurate avoiding the problem of accuracy and consistency (Berman, 2006), urban growth models have to be better understood. Using GIS for UGM is a mandatory direction for future urban planning and predicting the scenarios in such a context is very important. Analysing urban growth with CORINE Land Cover seems to be a sound direction, as it is the actual European spatial data inventory that shows the scenarios for an entire European tendency of growth. Still, the Minimum Mapping Unit of the CORINE Land Cover as we have seen is quite large, and as a result, it would be an interesting opportunity to study how accurate CORINE Land Cover may become, or actually, is in an urban growth study context.

The future is challenge indeed a question of European and regional synergies in an attempt to build solid information as well as to create knowledge. The transversal research areas called for in such a venture share a common ground in the usage of IT and GIS in order to shed clear light of monitoring and sustainable planning. Above all, the present study has made us realize that the most important future step for sustainability is the need to work together and think together in an attempt to grasp new processes and ideas that may create more accuracy on proposed methodologies in the hope of sustainable preservation and growth. From a short-term perspective, a stronger focus should stakeholders must lead to the promotion of cultural awareness supporting, for example, tourist services related to heritage tourism which might boost the local and regional economy while reducing negative externalities (Vaz and Nijkamp 2009).

**References**

Al-Kheder, S. and Shan J. (2005) *Cellular Automata Urban Growth Simulation and Evaluation - A Case Study of Indianapolis*, Proceedings of the 8th International Conference on GeoComputation, pp. 1-19.

Batty, M., (2005) *Cities and Complexity – Understanding Cities with Cellular Automata, Agent Based Models and Fractals*, MIT Press, Cambridge, MA.

Box, P., (1999) *GIS and Cultural Resource Management: A Manual for Heritage Managers*, UNESCO, Bangkok.

Brandt, R; Groenewoudt, B. J. and Kvamme, K. (1992) An Experiment in Archaeological Site Location: Modeling in the Netherlands using GIS Techniques, *World Archaeology*, Vol. 24 No.2, pp. 268-282.

Calado, M and Rocha, L (2006), *Menires e Neolitização: História da Investigação no Algarve*, pp. 75-88. Proceedings of the 4th Meeting of Archaeology in the Algarve (Silves, 24-25th November, 2006).

Camhis, M (2006), *Sustainable Development and Urbanization* in The Future of Sustainability, Editor: Keiner, M., Springer

Capello, R. (2001) *Urban Growth in Italy: Economic Determinants and Socio-Environmental Consequence*, Report 10:2001, CERUM

EEA Report (2006) *Urban Sprawl in Europe – The Ignored Challenge*, European Environment Agency, Report 10-2006, EEA

European Comission, (1999) "ESDP European Spatial Development Perspective: Towards Balanced and Sustainable Development of the Territory of the European Union".

Goodchild, M. F. (1997) What is Geographic Information Science?, NCGIA Core Curriculum.

Kvamme, K. (1991) Geographic Information Systems and Archaeology. In Computer Applications and Quantitative Methods in Archaeology, edited by G. Lock and J. Moffett, (Oxford: BAR International Series), pp. 77-84.

Kvamme, K. (1999), Recent Directions and Developments in Geographical Information Systems, *Journal of Archaeological Research*, 7(2), pp. 153-201.

Longley, P. (2002) "Geographical Information Systems: will developments in urban remote sensing and GIS lead to 'better' urban geography?" *Progress in Human Geography*, pp. 26 – 31.

Meaille, R. and Wald, L., 1990. Using geographical information system and satellite imagery within a numerical simulation of regional growth. *International Journal of Geographical Information Systems*, (4)4, pp. 445–456.

Ogyz, H., Klein, A. G. and Srinivasan, R., (2007) "Using the Sleuth Urban Growth Model to Simulate the Impacts of Future Policy Scenarios on Urban Land use in the Houston-Galveston-Brazoria" *Research Journal of Social Sciences*, 2, pp. 72-82.

Matias, A. (2004) "Economic Geography, Gravity and Tourism Trade: - The case for Portugal", I Congress on Tourism Economics, Universitat de les Illes Balears, Palma, 28-29 May 2004.

Painho, M.; Caetano, M. (2006) "Cartografia de Ocupação do Solo: Portugal Continental, 1985-2000: CORINE Land Cover 2000." Amadora, Instituto do Ambiente.

Piyathamrongchai, K. and M. Batty, M., 2007, Integrating Cellular Automata and Regional Dynamics Using GIS, In Modelling Land-Use Change Progress and Applications, edited by Koomen, E.; Stillwell, J.; Bakema, A. and Scholten, H. J., (Dordrecht: Springer), pp. 258-277.

Russo, A.P., 2002., Annals of Tourism Research Volume 29, Issue 1, January 2002, pp 165-182

TOBLER, A., 1970, A Computer Movie Simulating Urban Growth in the Detroit Region W. R. Tobler Economic Geography, Vol. 46, Supplement: Proceedings. International Geographical Union. Commission on Quantitative Methods. pp. 234-240

Savage, S.H., 1990, GIS in archaeological research. In Interpreting Space: GIS and archaeology, edited by: Allen, K. M. S., Green, S. W., Zubrow, E. B. W. (London: Taylor & Francis), pp. 22-32.

Sebastian, L. and Judge, J. (1988) *Predicting The Past: Correlation, Explanation, And The Use Of Archaeological Models*, In Quantifying The Present And Predicting The Past, edited by Judge, J., Sebastian, L., (Denver: US Department of the Interior, Bureau of Land Management), pp. 325-418.

Wheatley, D. and Gillings, M. (2002), *Spatial Technology and Archaeology: The Archaeological Applications of GIS* (London: Taylor & Francis).

Wilson, A.G. (1974), *Urban and regional models in geography and planning* (New York: Wiley & Sons)

Vaz, E and Nijkamp, P. (2009), *Historico-Cultural Sustainability and Urban Dynamics*, In Enhancing the City: New Perspectives for Tourism and Leisure, edited by Giovanni Maciocco and Silvia Serreli., (UK: Springer), pp. 155-177.

| 2007-1 | M. Francesca Cracolici<br>Miranda Cuffaro<br>Peter Nijkamp | Geographical distribution of enemployment: An analysis of provincial differences in Italy, 21 p. |
|---|---|---|
| 2007-2 | Daniel Leliefeld<br>Evgenia Motchenkova | To protec in order to serve, adverse effects of leniency programs in view of industry asymmetry, 29 p. |
| 2007-3 | M.C. Wassenaar<br>E. Dijkgraaf<br>R.H.J.M. Gradus | Contracting out: Dutch municipalities reject the solution for the VAT-distortion, 24 p. |
| 2007-4 | R.S. Halbersma<br>M.C. Mikkers<br>E. Motchenkova<br>I. Seinen | Market structure and hospital-insurer bargaining in the Netherlands, 20 p. |
| 2007-5 | Bas P. Singer<br>Bart A.G. Bossink<br>Herman J.M. Vande Putte | Corporate Real estate and competitive strategy, 27 p. |
| 2007-6 | Dorien Kooij<br>Annet de Lange<br>Paul Jansen<br>Josje Dikkers | Older workers' motivation to continue to work: Five meanings of age. A conceptual review, 46 p. |
| 2007-7 | Stella Flytzani<br>Peter Nijkamp | Locus of control and cross-cultural adjustment of expatriate managers, 16 p. |
| 2007-8 | Tibert Verhagen<br>Willemijn van Dolen | Explaining online purchase intentions: A multi-channel store image perspective, 28 p. |
| 2007-9 | Patrizia Riganti<br>Peter Nijkamp | Congestion in popular tourist areas: A multi-attribute experimental choice analysis of willingness-to-wait in Amsterdam, 21 p. |
| 2007-10 | Tüzin Baycan-Levent<br>Peter Nijkamp | Critical success factors in planning and management of urban green spaces in Europe, 14 p. |
| 2007-11 | Tüzin Baycan-Levent<br>Peter Nijkamp | Migrant entrepreneurship in a diverse Europe: In search of sustainable development, 18 p. |
| 2007-12 | Tüzin Baycan-Levent<br>Peter Nijkamp<br>Mediha Sahin | New orientations in ethnic entrepreneurship: Motivation, goals and strategies in new generation ethnic entrepreneurs, 22 p. |
| 2007-13 | Miranda Cuffaro<br>Maria Francesca Cracolici<br>Peter Nijkamp | Measuring the performance of Italian regions on social and economic dimensions, 20 p. |

| | | |
|---|---|---|
| 2007-14 | Tüzin Baycan-Levent<br>Peter Nijkamp | Characteristics of migrant entrepreneurship in Europe, 14 p. |
| 2007-15 | Maria Teresa Borzacchiello<br>Peter Nijkamp<br>Eric Koomen | Accessibility and urban development: A grid-based comparative statistical analysis of Dutch cities, 22 p. |
| 2007-16 | Tibert Verhagen<br>Selmar Meents | A framework for developing semantic differentials in IS research: Assessing the meaning of electronic marketplace quality (EMQ), 64 p. |
| 2007-17 | Aliye Ahu Gülümser<br>Tüzin Baycan Levent<br>Peter Nijkamp | Changing trends in rural self-employment in Europe, 34 p. |
| 2007-18 | Laura de Dominicis<br>Raymond J.G.M. Florax<br>Henri L.F. de Groot | De ruimtelijke verdeling van economische activiteit: Agglomeratie- en locatiepatronen in Nederland, 35 p. |
| 2007-19 | E. Dijkgraaf<br>R.H.J.M. Gradus | How to get increasing competition in the Dutch refuse collection market? 15 p. |

| | | |
|---|---|---|
| 2008-1 | Maria T. Borzacchiello<br>Irene Casas<br>Biagio Ciuffo<br>Peter Nijkamp | Geo-ICT in Transportation Science, 25 p. |
| 2008-2 | Maura Soekijad<br>Jeroen Walschots<br>Marleen Huysman | Congestion at the floating road? Negotiation in networked innovation, 38 p. |
| 2008-3 | Marlous Agterberg<br>Bart van den Hooff<br>Marleen Huysman<br>Maura Soekijad | Keeping the wheels turning: Multi-level dynamics in organizing networks of practice, 47 p. |
| 2008-4 | Marlous Agterberg<br>Marleen Huysman<br>Bart van den Hooff | Leadership in online knowledge networks: Challenges and coping strategies in a network of practice, 36 p. |
| 2008-5 | Bernd Heidergott<br>Haralambie Leahu | Differentiability of product measures, 35 p. |
| 2008-6 | Tibert Verhagen<br>Frans Feldberg<br>Bart van den Hooff<br>Selmar Meents | Explaining user adoption of virtual worlds: towards a multipurpose motivational model, 37 p. |
| 2008-7 | Masagus M. Ridhwan<br>Peter Nijkamp<br>Piet Rietveld<br>Henri L.F. de Groot | Regional development and monetary policy. A review of the role of monetary unions, capital mobility and locational effects, 27 p. |
| 2008-8 | Selmar Meents<br>Tibert Verhagen | Investigating the impact of C2C electronic marketplace quality on trust, 69 p. |
| 2008-9 | Junbo Yu<br>Peter Nijkamp | China's prospects as an innovative country: An industrial economics perspective, 27 p |
| 2008-10 | Junbo Yu<br>Peter Nijkamp | Ownership, r&d and productivity change: Assessing the catch-up in China's high-tech industries, 31 p |
| 2008-11 | Elbert Dijkgraaf<br>Raymond Gradus | Environmental activism and dynamics of unit-based pricing systems, 18 p. |
| 2008-12 | Mark J. Koetse<br>Jan Rouwendal | Transport and welfare consequences of infrastructure investment: A case study for the Betuweroute, 24 p |
| 2008-13 | Marc D. Bahlmann<br>Marleen H. Huysman<br>Tom Elfring<br>Peter Groenewegen | Clusters as vehicles for entrepreneurial innovation and new idea generation – a critical assessment |
| 2008-14 | Soushi Suzuki<br>Peter Nijkamp | A generalized goals-achievement model in data envelopment analysis: An application to efficiency improvement in local government finance in Japan, 24 p. |
| 2008-15 | Tüzin Baycan-Levent | External orientation of second generation migrant entrepreneurs. A sectoral |

| | | |
|---|---|---|
| | Peter Nijkamp<br>Mediha Sahin | study on Amsterdam, 33 p. |
| 2008-16 | Enno Masurel | Local shopkeepers' associations and ethnic minority entrepreneurs, 21 p. |
| 2008-17 | Frank Frößler<br>Boriana Rukanova<br>Stefan Klein<br>Allen Higgins<br>Yao-Hua Tan | Inter-organisational network formation and sense-making: Initiation and management of a living lab, 25 p. |
| 2008-18 | Peter Nijkamp<br>Frank Zwetsloot<br>Sander van der Wal | A meta-multicriteria analysis of innovation and growth potentials of European regions, 20 p. |
| 2008-19 | Junbo Yu<br>Roger R. Stough<br>Peter Nijkamp | Governing technological entrepreneurship in China and the West, 21 p. |
| 2008-20 | Maria T. Borzacchiello<br>Peter Nijkamp<br>Henk J. Scholten | A logistic regression model for explaining urban development on the basis of accessibility: a case study of Naples, 13 p. |
| 2008-21 | Marius Ooms | Trends in applied econometrics software development 1985-2008, an analysis of Journal of Applied Econometrics research articles, software reviews, data and code, 30 p. |
| 2008-22 | Aliye Ahu Gülümser<br>Tüzin Baycan-Levent<br>Peter Nijkamp | Changing trends in rural self-employment in Europe and Turkey, 20 p. |
| 2008-23 | Patricia van Hemert<br>Peter Nijkamp | Thematic research prioritization in the EU and the Netherlands: an assessment on the basis of content analysis, 30 p. |
| 2008-24 | Jasper Dekkers<br>Eric Koomen | Valuation of open space. Hedonic house price analysis in the Dutch Randstad region, 19 p. |

| 2009-1 | Boriana Rukanova<br>Rolf T. Wignand<br>Yao-Hua Tan | From national to supranational government inter-organizational systems: An extended typology, 33 p. |
|---|---|---|
| 2009-2 | Marc D. Bahlmann<br>Marleen H. Huysman<br>Tom Elfring<br>Peter Groenewegen | Global Pipelines or global buzz? A micro-level approach towards the knowledge-based view of clusters, 33 p. |
| 2009-3 | Julie E. Ferguson<br>Marleen H. Huysman | Between ambition and approach: Towards sustainable knowledge management in development organizations, 33 p. |
| 2009-4 | Mark G. Leijsen | Why empirical cost functions get scale economies wrong, 11 p. |
| 2009-5 | Peter Nijkamp<br>Galit Cohen-Blankshtain | The importance of ICT for cities: e-governance and cyber perceptions, 14 p. |
| 2009-6 | Eric de Noronha Vaz<br>Mário Caetano<br>Peter Nijkamp | Trapped between antiquity and urbanism. A multi-criteria assessment model of the greater Cairo metropolitan area, 22 p. |
| 2009-7 | Eric de Noronha Vaz<br>Teresa de Noronha Vaz<br>Peter Nijkamp | Spatial analysis for policy evaluation of the rural world: Portuguese agriculture in the last decade, 16 p. |
| 2009-8 | Teresa de Noronha Vaz<br>Peter Nijkamp | Multitasking in the rural world: Technological change and sustainability, 20 p. |
| 2009-9 | Maria Teresa Borzacchiello<br>Vincenzo Torrieri<br>Peter Nijkamp | An operational information systems architecture for assessing sustainable transportation planning: Principles and design, 17 p. |
| 2009-10 | Vincenzo Del Giudice<br>Pierfrancesco De Paola<br>Francesca Torrieri<br>Francesca Pagliari<br>Peter Nijkamp | A decision support system for real estate investment choice, 16 p. |
| 2009-11 | Miruna Mazurencu Marinescu<br>Peter Nijkamp | IT companies in rough seas: Predictive factors for bankruptcy risk in Romania, 13 p. |
| 2009-12 | Boriana Rukanova<br>Helle Zinner Hendriksen<br>Eveline van Stijn<br>Yao-Hua Tan | Bringing is innovation in a highly-regulated environment: A collective action perspective, 33 p. |
| 2009-13 | Patricia van Hemert<br>Peter Nijkamp<br>Jolanda Verbraak | Evaluating social science and humanities knowledge production: an exploratory analysis of dynamics in science systems, 20 p. |

| 2009-14 | Roberto Patuelli<br>Aura Reggiani<br>Peter Nijkamp<br>Norbert Schanne | Neural networks for cross-sectional employment forecasts: A comparison of model specifications for Germany, 15 p. |
|---|---|---|
| 2009-15 | André de Waal<br>Karima Kourtit<br>Peter Nijkamp | The relationship between the level of completeness of a strategic performance management system and perceived advantages and disadvantages, 19 p. |
| 2009-16 | Vincenzo Punzo<br>Vincenzo Torrieri<br>Maria Teresa Borzacchiello<br>Biagio Ciuffo<br>Peter Nijkamp | Modelling intermodal re-balance and integration: planning a sub-lagoon tube for Venezia, 24 p. |
| 2009-17 | Peter Nijkamp<br>Roger Stough<br>Mediha Sahin | Impact of social and human capital on business performance of migrant entrepreneurs – a comparative Dutch-US study, 31 p. |
| 2009-18 | Dres Creal | A survey of sequential Monte Carlo methods for economics and finance, 54 p. |
| 2009-19 | Karima Kourtit<br>André de Waal | Strategic performance management in practice: Advantages, disadvantages and reasons for use, 15 p. |
| 2009-20 | Karima Kourtit<br>André de Waal<br>Peter Nijkamp | Strategic performance management and creative industry, 17 p. |
| 2009-21 | Eric de Noronha Vaz<br>Peter Nijkamp | Historico-cultural sustainability and urban dynamics – a geo-information science approach to the Algarve area, 25 p. |
| 2009-22 | Roberta Capello<br>Peter Nijkamp | Regional growth and development theories revisited, 19 p. |
| 2009-23 | M. Francesca Cracolici<br>Miranda Cuffaro<br>Peter Nijkamp | Tourism sustainability and economic efficiency – a statistical analysis of Italian provinces, 14 p. |
| 2009-24 | Caroline A. Rodenburg<br>Peter Nijkamp<br>Henri L.F. de Groot<br>Erik T. Verhoef | Valuation of multifunctional land use by commercial investors: A case study on the Amsterdam Zuidas mega-project, 21 p. |
| 2009-25 | Katrin Oltmer<br>Peter Nijkamp<br>Raymond Florax<br>Floor Brouwer | Sustainability and agri-environmental policy in the European Union: A meta-analytic investigation, 26 p. |
| 2009-26 | Francesca Torrieri<br>Peter Nijkamp | Scenario analysis in spatial impact assessment: A methodological approach, 20 p. |
| 2009-27 | Aliye Ahu Gülümser<br>Tüzin Baycan-Levent<br>Peter Nijkamp | Beauty is in the eyes of the beholder: A logistic regression analysis of sustainability and locality as competitive vehicles for human settlements, 14 p. |

| 2009-28 | Marco Percoco<br>Peter Nijkamp | Individual time preferences and social discounting in environmental projects, 24 p. |
|---|---|---|
| 2009-29 | Peter Nijkamp<br>Maria Abreu | Regional development theory, 12 p. |
| 2009-30 | Tüzin Baycan-Levent<br>Peter Nijkamp | 7 FAQs in urban planning, 22 p. |
| 2009-31 | Aliye Ahu Gülümser<br>Tüzin Baycan-Levent<br>Peter Nijkamp | Turkey's rurality: A comparative analysis at the EU level, 22 p. |
| 2009-32 | Frank Bruinsma<br>Karima Kourtit<br>Peter Nijkamp | An agent-based decision support model for the development of e-services in the tourist sector, 21 p. |
| 2009-33 | Mediha Sahin<br>Peter Nijkamp<br>Marius Rietdijk | Cultural diversity and urban innovativeness: Personal and business characteristics of urban migrant entrepreneurs, 27 p. |
| 2009-34 | Peter Nijkamp<br>Mediha Sahin | Performance indicators of urban migrant entrepreneurship in the Netherlands, 28 p. |
| 2009-35 | Manfred M. Fischer<br>Peter Nijkamp | Entrepreneurship and regional development, 23 p. |
| 2009-36 | Faroek Lazrak<br>Peter Nijkamp<br>Piet Rietveld<br>Jan Rouwendal | Cultural heritage and creative cities: An economic evaluation perspective, 20 p. |
| 2009-37 | Enno Masurel<br>Peter Nijkamp | Bridging the gap between institutions of higher education and small and medium-size enterprises, 32 p. |
| 2009-38 | Francesca Medda<br>Peter Nijkamp<br>Piet Rietveld | Dynamic effects of external and private transport costs on urban shape: A morphogenetic perspective, 17 p. |
| 2009-39 | Roberta Capello<br>Peter Nijkamp | Urban economics at a cross-yard: Recent theoretical and methodological directions and future challenges, 16 p. |
| 2009-40 | Enno Masurel<br>Peter Nijkamp | The low participation of urban migrant entrepreneurs: Reasons and perceptions of weak institutional embeddedness, 23 p. |
| 2009-41 | Patricia van Hemert<br>Peter Nijkamp | Knowledge investments, business R&D and innovativeness of countries. A qualitative meta-analytic comparison, 25 p. |
| 2009-42 | Teresa de Noronha Vaz<br>Peter Nijkamp | Knowledge and innovation: The strings between global and local dimensions of sustainable growth, 16 p. |
| 2009-43 | Chiara M. Travisi<br>Peter Nijkamp | Managing environmental risk in agriculture: A systematic perspective on the potential of quantitative policy-oriented risk valuation, 19 p. |
| 2009-44 | Sander de Leeuw | Logistics aspects of emergency preparedness in flood disaster prevention, 24 p. |

|          |                                                                 |                                                                                                          |
|----------|-----------------------------------------------------------------|----------------------------------------------------------------------------------------------------------|
|          | Iris F.A. Vis<br>Sebastiaan B. Jonkman                          |                                                                                                          |
| 2009-45  | Eveline S. van Leeuwen<br>Peter Nijkamp                         | Social accounting matrices. The development and application of SAMs at the local level, 26 p.            |
| 2009-46  | Tibert Verhagen<br>Willemijn van Dolen                          | The influence of online store characteristics on consumer impulsive decision-making: A model and empirical application, 33 p. |
| 2009-47  | Eveline van Leeuwen<br>Peter Nijkamp                            | A micro-simulation model for e-services in cultural heritage tourism, 23 p.                              |
| 2009-48  | Andrea Caragliu<br>Chiara Del Bo<br>Peter Nijkamp               | Smart cities in Europe, 15 p.                                                                             |
| 2009-49  | Faroek Lazrak<br>Peter Nijkamp<br>Piet Rietveld<br>Jan Rouwendal | Cultural heritage: Hedonic prices for non-market values, 11 p.                                           |
| 2009-50  | Eric de Noronha Vaz<br>João Pedro Bernardes<br>Peter Nijkamp    | Past landscapes for the reconstruction of Roman land use: Eco-history tourism in the Algarve, 23 p.      |
| 2009-51  | Eveline van Leeuwen<br>Peter Nijkamp<br>Teresa de Noronha Vaz   | The Multi-functional use of urban green space, 12 p.                                                     |
| 2009-52  | Peter Bakker<br>Carl Koopmans<br>Peter Nijkamp                  | Appraisal of integrated transport policies, 20 p.                                                        |
| 2009-53  | Luca De Angelis<br>Leonard J. Paas                              | The dynamics analysis and prediction of stock markets through the latent Markov model, 29 p.             |
| 2009-54  | Jan Anne Annema<br>Carl Koopmans                                | Een lastige praktijk: Ervaringen met waarderen van omgevingskwaliteit in de kosten-batenanalyse, 17 p.  |
| 2009-55  | Bas Straathof<br>Gert-Jan Linders                               | Europe's internal market at fifty: Over the hill? 39 p.                                                  |
| 2009-56  | Joaquim A.S. Gromicho<br>Jelke J. van Hoorn<br>Francisco Saldanha-da-Gama<br>Gerrit T. Timmer | Exponentially better than brute force: solving the job-shop scheduling problem optimally by dynamic programming, 14 p. |
| 2009-57  | Carmen Lee<br>Roman Kraeussl<br>Leo Paas                        | The effect of anticipated and experienced regret and pride on investors' future selling decisions, 31 p. |
| 2009-58  | René Sitters                                                    | Efficient algorithms for average completion time scheduling, 17 p.                                       |

2009-59     Masood Gheasi     Migration and tourist flows, 20 p.
                     Peter Nijkamp
                     Piet Rietveld

| 2010-1 | Roberto Patuelli<br>Norbert Schanne<br>Daniel A. Griffith<br>Peter Nijkamp | Persistent disparities in regional unemployment: Application of a spatial filtering approach to local labour markets in Germany, 28 p. |
| --- | --- | --- |
| 2010-2 | Thomas de Graaff<br>Ghebre Debrezion<br>Piet Rietveld | Schaalsprong Almere. Het effect van bereikbaarheidsverbeteringen op de huizenprijzen in Almere, 22 p. |
| 2010-3 | John Steenbruggen<br>Maria Teresa Borzacchiello<br>Peter Nijkamp<br>Henk Scholten | Real-time data from mobile phone networks for urban incidence and traffic management – a review of application and opportunities, 23 p. |
| 2010-4 | Marc D. Bahlmann<br>Tom Elfring<br>Peter Groenewegen<br>Marleen H. Huysman | Does distance matter? An ego-network approach towards the knowledge-based theory of clusters, 31 p. |
| 2010-5 | Jelke J. van Hoorn | A note on the worst case complexity for the capacitated vehicle routing problem, 3 p. |
| 2010-6 | Mark G. Lijesen | Empirical applications of spatial competition; an interpretative literature review, 16 p. |
| 2010-7 | Carmen Lee<br>Roman Kraeussl<br>Leo Paas | Personality and investment: Personality differences affect investors' adaptation to losses, 28 p. |
| 2010-8 | Nahom Ghebrihiwet<br>Evgenia Motchenkova | Leniency programs in the presence of judicial errors, 21 p. |
| 2010-9 | Meindert J. Flikkema<br>Ard-Pieter de Man<br>Matthijs Wolters | New trademark registration as an indicator of innovation: results of an explorative study of Benelux trademark data, 53 p. |
| 2010-10 | Jani Merikivi<br>Tibert Verhagen<br>Frans Feldberg | Having belief(s) in social virtual worlds: A decomposed approach, 37 p. |
| 2010-11 | Umut Kilinç | Price-cost markups and productivity dynamics of entrant plants, 34 p. |
| 2010-12 | Umut Kilinç | Measuring competition in a frictional economy, 39 p. |

| 2011-1 | Yoshifumi Takahashi<br>Peter Nijkamp | Multifunctional agricultural land use in sustainable world, 25 p. |
|---|---|---|
| 2011-2 | Paulo A.L.D. Nunes<br>Peter Nijkamp | Biodiversity: Economic perspectives, 37 p. |
| 2011-3 | Eric de Noronha Vaz<br>Doan Nainggolan<br>Peter Nijkamp<br>Marco Painho | A complex spatial systems analysis of tourism and urban sprawl in the Algarve, 23 p. |
| 2011-4 | Karima Kourtit<br>Peter Nijkamp | Strangers on the move. Ethnic entrepreneurs as urban change actors, 34 p. |
| 2011-5 | Manie Geyer<br>Helen C. Coetzee<br>Danie Du Plessis<br>Ronnie Donaldson<br>Peter Nijkamp | Recent business transformation in intermediate-sized cities in South Africa, 30 p. |
| 2011-6 | Aki Kangasharju<br>Christophe Tavéra<br>Peter Nijkamp | Regional growth and unemployment. The validity of Okun's law for the Finnish regions, 17 p. |
| 2011-7 | Amitrajeet A. Batabyal<br>Peter Nijkamp | A Schumpeterian model of entrepreneurship, innovation, and regional economic growth, 30 p. |
| 2011-8 | Aliye Ahu Akgün<br>Tüzin Baycan Levent<br>Peter Nijkamp | The engine of sustainable rural development: Embeddedness of entrepreneurs in rural Turkey, 17 p. |
| 2011-9 | Aliye Ahu Akgün<br>Eveline van Leeuwen<br>Peter Nijkamp | A systemic perspective on multi-stakeholder sustainable development strategies, 26 p. |
| 2011-10 | Tibert Verhagen<br>Jaap van Nes<br>Frans Feldberg<br>Willemijn van Dolen | Virtual customer service agents: Using social presence and personalization to shape online service encounters, 48 p. |
| 2011-11 | Henk J. Scholten<br>Maarten van der Vlist | De inrichting van crisisbeheersing, de relatie tussen besluitvorming en informatievoorziening. Casus: Warroom project Netcentrisch werken bij Rijkswaterstaat, 23 p. |
| 2011-12 | Tüzin Baycan<br>Peter Nijkamp | A socio-economic impact analysis of cultural diversity, 22 p. |
| 2011-13 | Aliye Ahu Akgün<br>Tüzin Baycan<br>Peter Nijkamp | Repositioning rural areas as promising future hot spots, 22 p. |
| 2011-14 | Selmar Meents<br>Tibert Verhagen<br>Paul Vlaar | How sellers can stimulate purchasing in electronic marketplaces: Using information as a risk reduction signal, 29 p. |

| 2011-15 | Aliye Ahu Gülümser<br>Tüzin Baycan-Levent<br>Peter Nijkamp | Measuring regional creative capacity: A literature review for rural-specific approaches, 22 p. |
|---|---|---|
| 2011-16 | Frank Bruinsma<br>Karima Kourtit<br>Peter Nijkamp | Tourism, culture and e-services: Evaluation of e-services packages, 30 p. |
| 2011-17 | Peter Nijkamp<br>Frank Bruinsma<br>Karima Kourtit<br>Eveline van Leeuwen | Supply of and demand for e-services in the cultural sector: Combining top-down and bottom-up perspectives, 16 p. |
| 2011-18 | Eveline van Leeuwen<br>Peter Nijkamp<br>Piet Rietveld | Climate change: From global concern to regional challenge, 17 p. |
| 2011-19 | Eveline van Leeuwen<br>Peter Nijkamp | Operational advances in tourism research, 25 p. |
| 2011-20 | Aliye Ahu Akgün<br>Tüzin Baycan<br>Peter Nijkamp | Creative capacity for sustainable development: A comparative analysis of European and Turkish rural regions, 18 p. |
| 2011-21 | Aliye Ahu Gülümser<br>Tüzin Baycan-Levent<br>Peter Nijkamp | Business dynamics as the source of counterurbanisation: An empirical analysis of Turkey, 18 p. |
| 2011-22 | Jessie Bakens<br>Peter Nijkamp | Lessons from migration impact analysis, 19 p. |
| 2011-23 | Peter Nijkamp<br>Galit Cohen-blankshtain | Opportunities and pitfalls of local e-democracy, 17 p. |
| 2011-24 | Maura Soekijad<br>Irene Skovgaard Smith | The 'lean people' in hospital change: Identity work as social differentiation, 30 p. |
| 2011-25 | Evgenia Motchenkova<br>Olgerd Rus | Research joint ventures and price collusion: Joint analysis of the impact of R&D subsidies and antitrust fines, 30 p. |
| 2011-26 | Karima Kourtit<br>Peter Nijkamp | Strategic choice analysis by expert panels for migration impact assessment, 41 p. |
| 2011-27 | Faroek Lazrak<br>Peter Nijkamp<br>Piet Rietveld<br>Jan Rouwendal | The market value of listed heritage: An urban economic application of spatial hedonic pricing, 24 p. |
| 2011-28 | Peter Nijkamp | Socio-economic impacts of heterogeneity among foreign migrants: Research and policy challenges, 17 p. |
| 2011-29 | Masood Gheasi<br>Peter Nijkamp | Migration, tourism and international trade: Evidence from the UK, 8 p. |
| 2011-30 | Karima Kourtit | Evaluation of cyber-tools in cultural tourism, 24 p. |

Peter Nijkamp
Eveline van Leeuwen
Frank Bruinsma

| 2011-31 | Cathy Macharis<br>Peter Nijkamp | Possible bias in multi-actor multi-criteria transportation evaluation: Issues and solutions, 16 p. |
|---|---|---|
| 2011-32 | John Steenbruggen<br>Maria Teresa Borzacchiello<br>Peter Nijkamp<br>Henk Scholten | The use of GSM data for transport safety management: An exploratory review, 29 p. |
| 2011-33 | John Steenbruggen<br>Peter Nijkamp<br>Jan M. Smits<br>Michel Grothe | Traffic incident management: A common operational picture to support situational awareness of sustainable mobility, 36 p. |
| 2011-34 | Tüzin Baycan<br>Peter Nijkamp | Students' interest in an entrepreneurial career in a multicultural society, 25 p. |
| 2011-35 | Adele Finco<br>Deborah Bentivoglio<br>Peter Nijkamp | Integrated evaluation of biofuel production options in agriculture: An exploration of sustainable policy scenarios, 16 p. |
| 2011-36 | Eric de Noronha Vaz<br>Pedro Cabral<br>Mário Caetano<br>Peter Nijkamp<br>Marco Paínho | Urban heritage endangerment at the interface of future cities and past heritage: A spatial vulnerability assessment, 25 p. |