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GIS and regional development: Examples of applications

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38th Congress of the European Regional Science Association

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GIS and Regional Development

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Abstract

The recent development of Geographic Information Technologies (GIT), such as GIS, Remote Sensing and Desktop Mapping gives to the technicians of landscape management and regional development areas, access to a new powerful set of tools with an high potential for spatial analysis.

Our project's ambition is to confirm that GIT can be useful tools for the definition and management of development policies. The ability of GIT to analyse geographical information (more or less 80 to 90% of the overall information that exists can be georeferenced) will create conditions to establish a model for economical development and with the support of this model decisions can be more accurate. By doing so, we will encourage the use of GIS in the regional science field.

The results that we already had achieved with our project push us in front. That's why it is important to present them. In order to gather more people for this area.

This paper will resume the activities and the major conclusions of some projects being developed since 1996 with the main purpose of establishing a theoretical background and create sample methodologies to support economic development through the use of GIS:

- Project RUAOT
- Vasco da Gama Bridge Observatory
- Lisbon and Tejo's Valley Atlas
- Development Potential

1. GIS AND REGIONAL SCIENCE

Regional development studies aren't new. Many authors identify the birth of Regional Science in the 50's by the work of Walter Isard. Nevertheless its roots are in the work of the German speaking pioneers like Lösch, Von Thünen e Christaller (Polèse 1998; Krugman 1995). During it's, more or less, 50 years of history regional science as gone through some up's and down's (for example, I don't need to remember that the founding school – the Department of Regional Science at the University of Pennsylvania – was closed as many other government departments in the US and in the UK), nevertheless, today, it is still being rediscover every day. There are constantly new theoretical and empirical studies that make this area one of the most active scientific field.

Regional development might be understood in many different meanings. The more consensual ones are those that point towards the meaning of a process of resource mobilisation – human, natural, economic and institutional – to attract, to improve and to sustain regional/local economic activity. (Blakely 1994)

Although regional science is a multidisciplinary field, the more evident contribution comes from Economics and Geography. This is the point where Economics is more Geography, and the other way around. From Economics we get the models – micro and macro scale, more or less spatial – and from Geography we get the spatial science recognition and several tools for territorial understanding.

The recent studies uses the variable space in a integral sense. However, given the constant mutation of territorial configuration its important not only to built models and knowledge, but also to create new tools to deal with this constant spatial dynamics. If until today Economcs as been the great responsible for regional science growth, may be its time for Geography to make so considerable contributions by the application of new tools prepared to fully integrate spatial issues in modelling - Geographical Information Systems (GIS).

Like Paul Krugman says, if one can't model than it won't be taken under consideration. This was one of the principal reasons for the failure of Development Theory and Geoeconomics in integrating the mainstream of Economics. (Krugman 1995)

Among the recent development in Geography field the GIS area can make a decisive contribution for regional science modernisation.

If this kind of tools were initially used by technicians connected with landscape and planning studies, today, there are several application in several different areas.

The main purpose of GIS is to make spatial modelling enabling the use of territorial information as any other variable in a decision support analysis environment.

2. THE FINAL BARRIERS

Although it is clearly evident that GIS technology can play an essential role in the support of regional science studies, its use is still quite low. There are several different possible justifications for that (Drummond 1994). Beside the language problem between regional science and GIS specialists, we can identify, at least, four major barriers:

There are no **tradition** in the use of technology by regional science scientists. In fact those areas where GIS is nowadays widely used are by tradition more opened to the use of technology. I'm speaking, for example, of landscape management, territorial planning, environmental assessment. In these areas the use of computer technology and CAD systems was more widely expanded.

One of the more significant barriers is of **methodological** nature. In fact the methods used by regional science are completely different of those used by the territorial sciences. In landscape management, planning and in environmental assessment there were specific methods that deal with spatial issues – see, for instance, the work of Ian Mcharg – and when GIS technology arose they just needed to adapt their methods to the new tool. In regional science there is no similar methods, so we need to start from scratch.

The **capacity** and the **availability** of technology until just recent was quite a strong barrier. By one side, the software available didn't provide the necessary algorithms which obliged to a supplementary effort in developing analytical tools; by the other side, only recently Personal Computers running under Windows did start to have GIS software available. Today, this technological barriers is dimming day by day because of the implosion of hardware costs and because of the new generation of GIS tools.

The last barrier is still a very strong one – **Data**. In fact the existence, the availability and the data costs are still, maybe, the more important barrier to the development of GIS projects in every field.

By recognising these barriers it might be easy to avoid them and start using Gis as a essential tool in Regional Science field.

3. SOME EXAMPLES

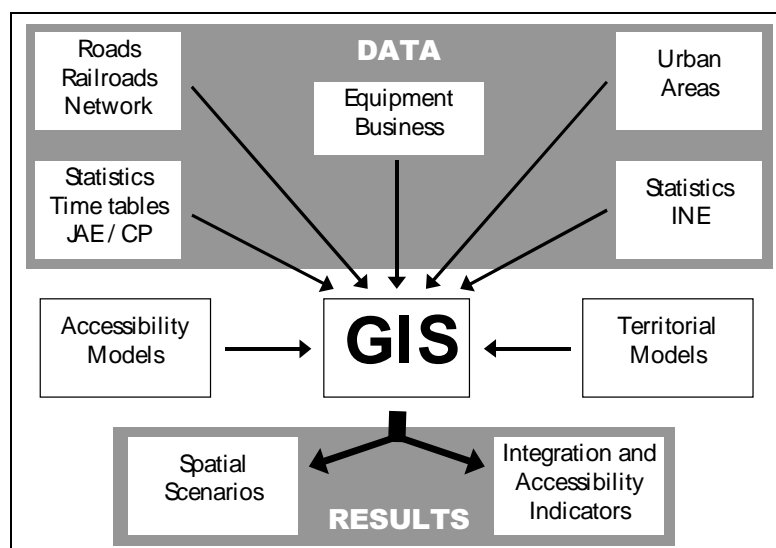
In order to make it easier to understand the potential of GIS in Regional Science field it is better to present some projects under development. The next three examples are from project's being developed by our team and by joint research with governmental institutions. The common issue is the use of GIS and it's application in regional development and planning.

3.1. RUAOT

The National Centre for Geographical Information (CNIG), together with our Department, is developing RUAOT project.

RUAOT stands for Rede Urbana, Acessibilidades e Ordenamento do Território (Urban Network, Accessibility and Territorial Planning). This project will be developed to the whole mainland of Portugal and one of it's major objectives is to evaluate the accessibility changes and their impact in the definition of urban areas' hinterland and in the urban network structure.

FIG. 1 – PROJECT'S STRUCTURE



For now this project is still in it's early stage due to the complexity of preparing the road network maps and gathering information about public transportation time tables.

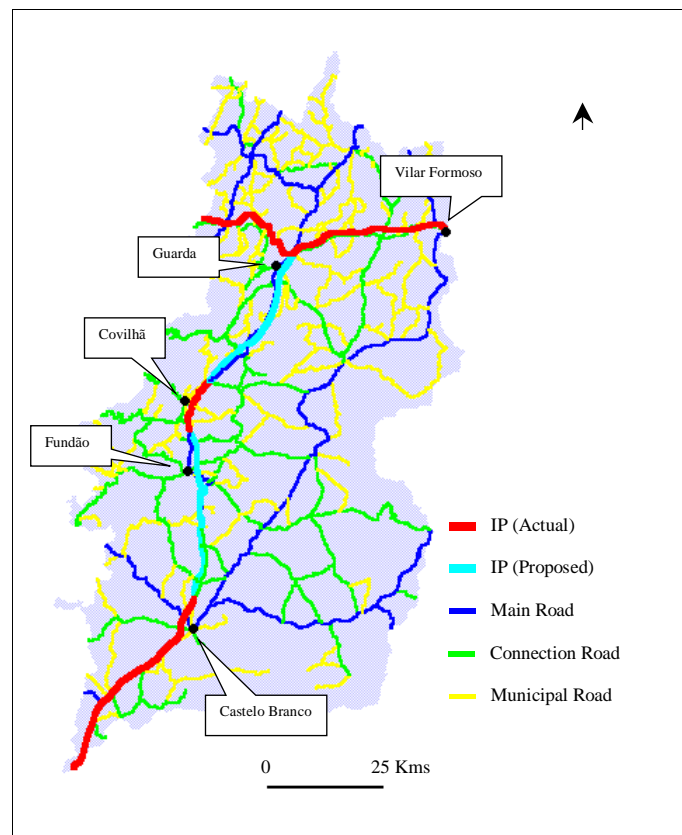
Nevertheless it's methodology is quite tested by the execution of several pilot essays. One of those essays was conducted to show how accessibility measuring can be used to support the evaluation of new road's projects.

FIG. 2 - STUDY AREA

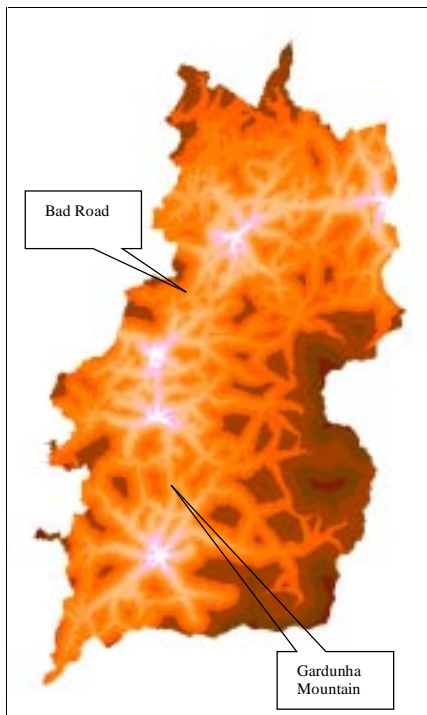


In this case we have studied the impact of a new road connection in a interior area of Portugal. This study area is a very depressed region called Beira Interior.

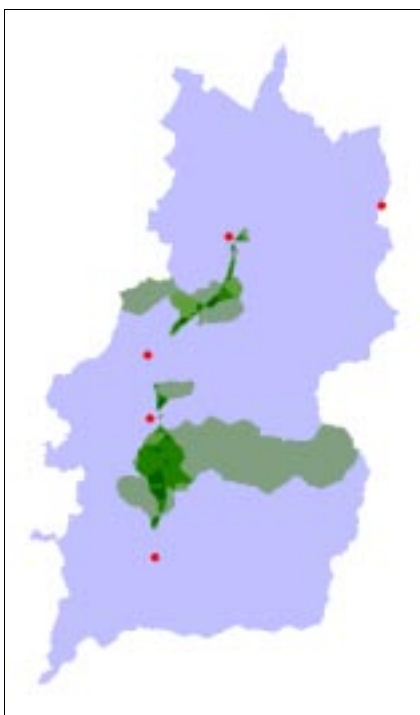
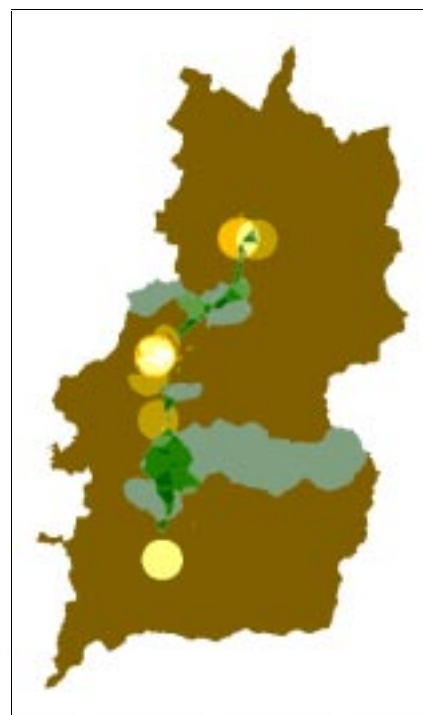
FIG. 3 - ROAD NETWORK



The idea of the National Road Plan is to connect the major population centres of this region by an express road called IP2.

FIG. 4 - ACCESSIBILITY BEFORE IP2**FIG. 5 - ACCESSIBILITY AFTER IP2**

Before the conclusion of the IP2 we can clearly see that the major centres are disconnected. Only Covilhã and Fundão can work together as a network. After the conclusion of IP2 it is more evident the connection between the centres.

FIG. 6 - ACCESSIBILITY GAIN**FIG. 7 - CONCLUSION**

These final charts clearly shows that the new road will have a very localised impact and we can question if it will be profitable the financial effort that was made. But if we take under consideration were people are, it is very evident that this road will close the links between the active areas of this region.

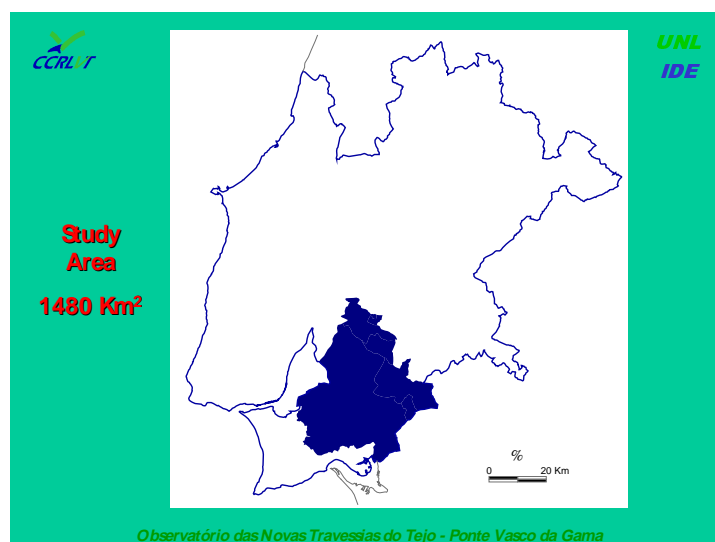
3.2. Vasco da Gama Bridge Observatory

The new bridge across the River Tejo in Lisbon - Vasco da Gama Bridge – will induce, together with other developments in the metropolitan area of Lisbon, huge transformations in a wide range of themes.

Concerned with the short and long term impacts of the territorial and socio-economic transformations induced by this new infrastructure opened this year in April, the Comissão de Coordenação da Região de Lisboa e Vale do Tejo (CCRLVT) as started a this observatory. The project aims a prospective analysis in terms of socio-economic development and local planning, focussing in an area that, considering its environmental characteristics and its stage of development, will be more open for a wide range of impacts.

The project's target area involves the municipalities of Alcochete, Benavente, Moita, Montijo and Palmela. All of these municipalities are in the south side of the river. This are is covered by more or less by 81 ortophotos at 1/10.000 scale.

FIG. 8 – STUDY AREA



The project, that was launched by CCRLVT in 1996, is being developed by a team of 12 elements resulting from the co-operation of several institutions, among which is the

Instituto de Dinâmica do Espaço (IDE) from the Department of Geography and Regional Planning of the New University of Lisbon. The IDE team, composed by 8 elements is particularly involved in producing the land use maps and in supporting the implementation of the project's GIS.

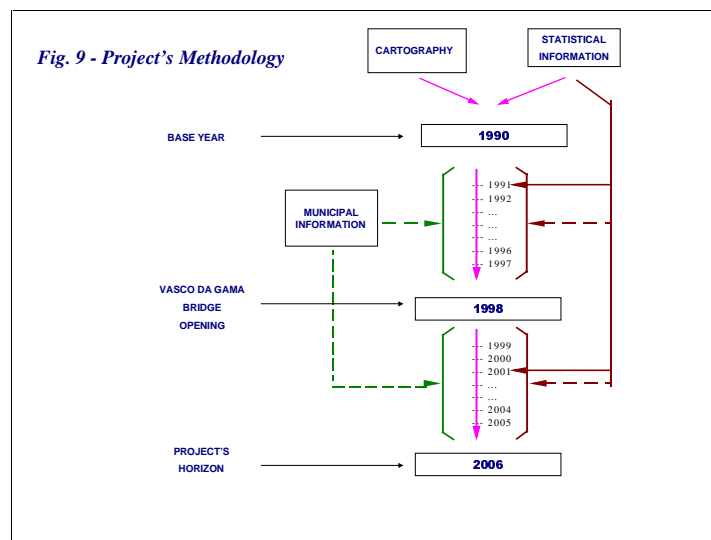
The decision of using GIS as an integration tool was made in its early stage. With GIS one can integrate different sources and types of data with the guaranty of its compatibility and integrity through the georeferentiation. In this project we must deal and integrate land use registry from photointerpretation, municipal data, census data and so on; so the use of GIS was the logical way to go.

To meet the unique characteristics of the project's area and to deal with the analysis profile that was required it was developed a rigorous methodological stream based on annual observations and in tree key years:

1990 – Base year. First analysis, just before the decision about the localisation of the new bridge.

1998 – Opening year. Second exhaustive analysis at the moment of the traffic opening.

2006 – Last year. The project period, 16 years, is centred in the opening year. Annual analysis during 8 years before the traffic opening and 8 years afterwards.

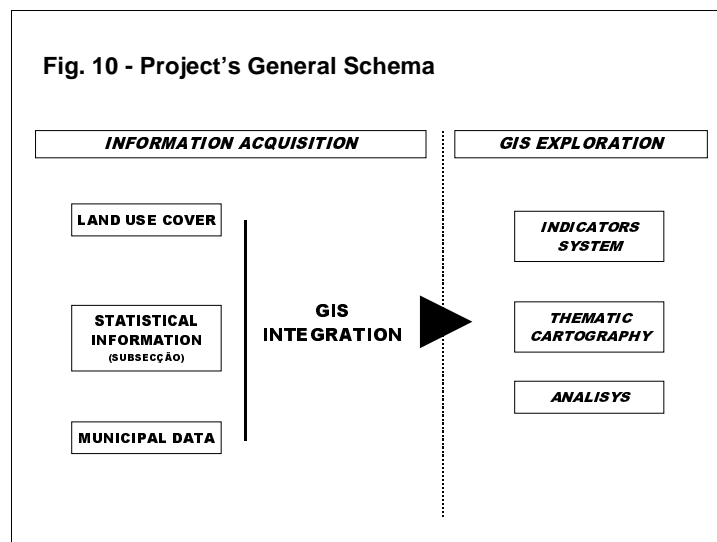


For each key year, it will be produced a land use map with a quite exhaustive legend and based on 1/10.000 scale. The idea is to plot urban areas and its inner structure and outside those areas every isolated building. If the building's area is bigger than 200 m²

it is also classified according to its use. To build these maps we are using 1990's black and white ortophotos at 1/10.000 scale. In this first year we used traditional ortophotomaps; for the second year we'll be using colour and digital ortophotos at the same scale; and, for 2006 we hope that it will be possible to integrate satellite imagery as a support to make the land use registry.

The first year of the analysis, 1990, will be completed with the integration of the census information of 1991 at a very high level of spatial resolution (subsecção). We know that the dates don't match, but the gap between the land use map date and the census one isn't too much significant; more, the territorial dynamics of that area, in those years, was very low.

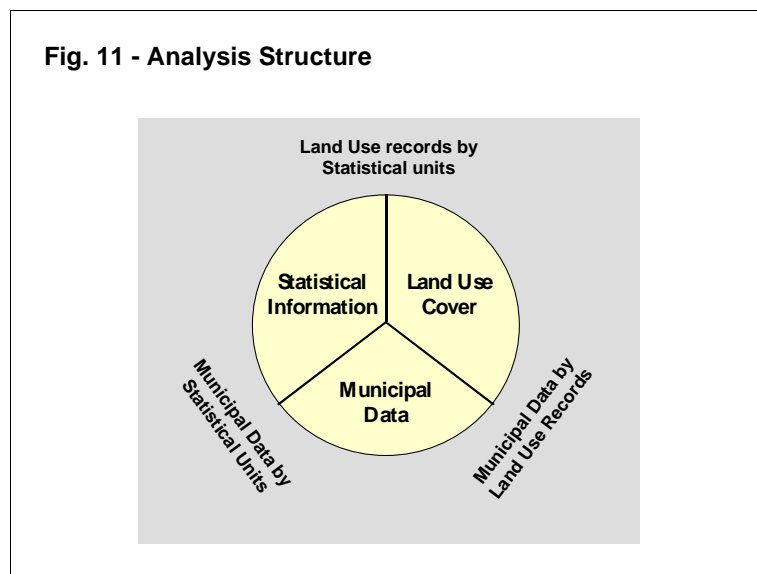
Between each key year it is made an annual analysis based on the municipal constructions records. Every single project or intention of building it is introduced into the database and linked to the graphics database. So we know where and when people are building. It doesn't matter if it is a single house or a big project with several houses. We take note of everything that will change the land occupation. With this kind of rigorous analysis we can know the building trends for the project's area.



The first phases of the project were dedicated to the acquisition and integration of data for the three major domains (Statistical Information, Municipal Data and Land Use Cover). After this preparation phase, the next one is dedicated to the exploration of the GIS and to the production of the indicators, thematic cartography and result analysis.

To test the methodological structure it was established a pilot area corresponding to the orthophoto of Montijo and the surrounding area. This area was elected as pilot area because of its diversity in terms of territorial occupation, with a mix of several types of spatial patterns. The use of the 125/190 orthophoto was extremely useful for different reasons, among which: the photointerpretation criteria were revised at least 5 times during this pilot test; and, conflicts between data were clarified.

The GIS was used to build several analyses that produced maps, tables and other kind of results. The analysis structure is based in two different levels referring to the information domains: Census, Land use and municipal data. In the first level we have the production of results inside each information domain. For example the production of indicators regarding the Census information or the land use. In the second level of analysis we have the production of indicators that mix one or more information domain. For example the production of land use data according to census track or a new population density according to urban areas.



The first list of possible variables that could be created using the project's GIS was, more or less, around the 300 aggregated in some domains like simple, integrated, evolution and so on. The idea is to build an indicator system that will be upgraded in "real time". Every year considering municipal information, every key year considering land use information and also with Census information.

The data to be produced by the analysis can be simple – referring only to one variable – or it can be complex when some variables are used to create a new one. Regarding the thematic structure we have 6 main categories:

- General
- Urbanistics
- Socioeconomics
- Land Cover
- Evolution
- Synthesis

Next we will present some plots made during the pilot study phase. They illustrate the three main information categories (Land cover, Census data and Municipal data).

FIG. 12 - LAND COVER

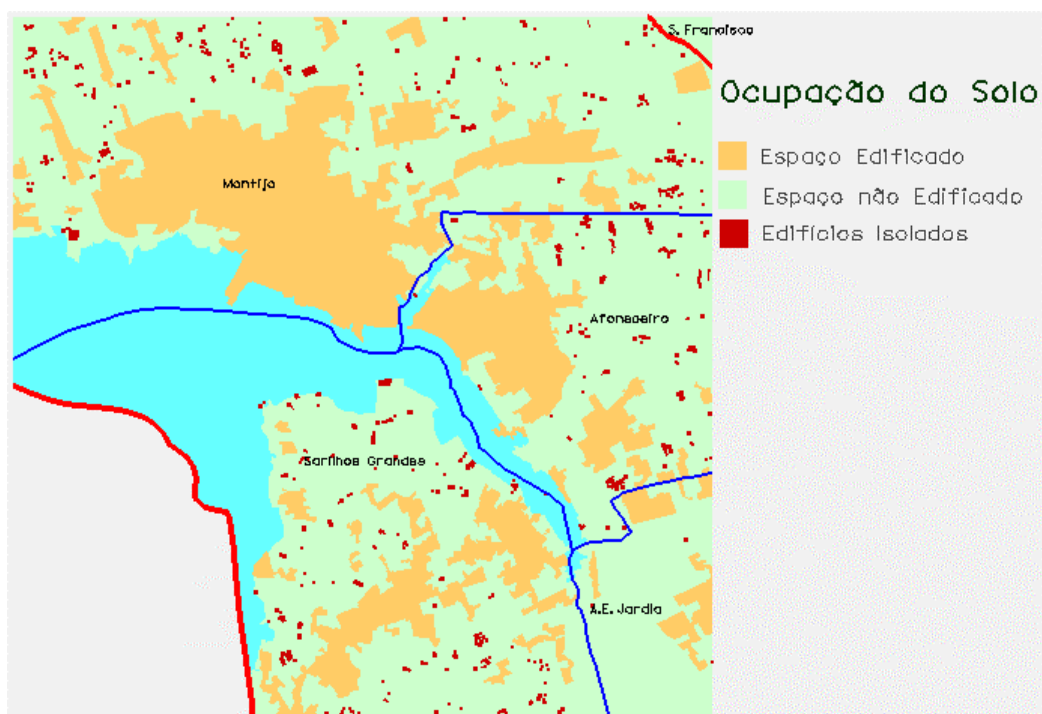
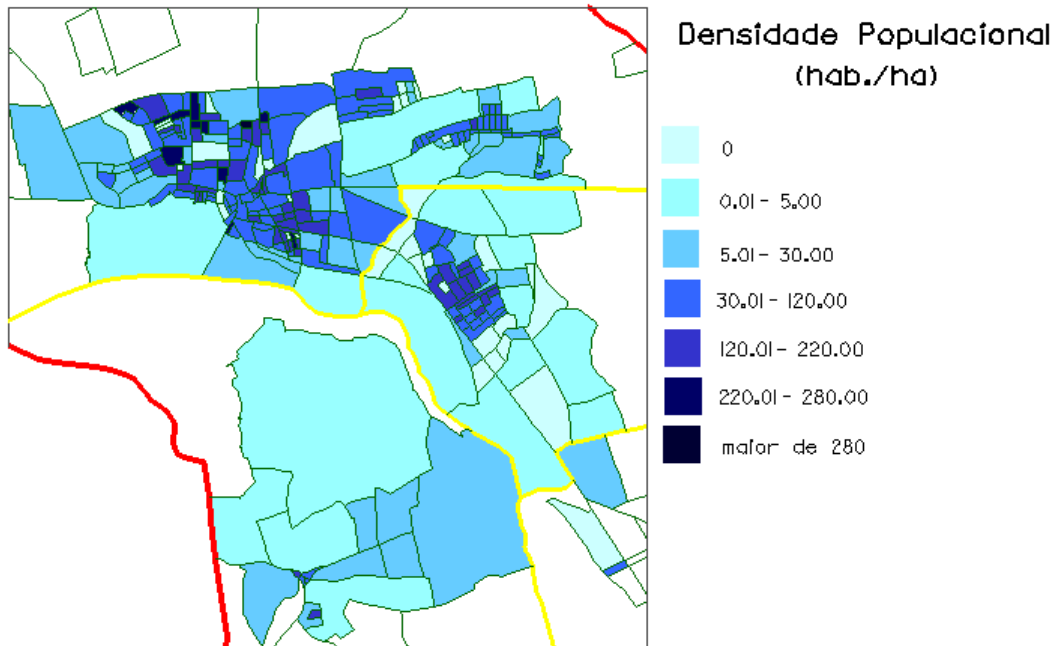
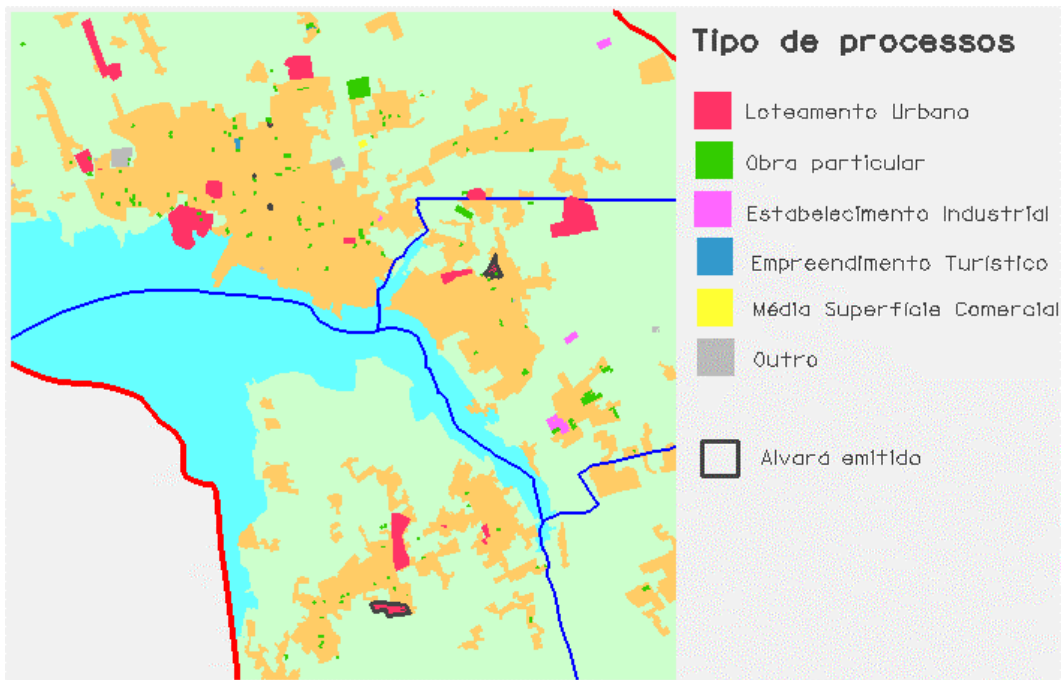


FIG. 13 - POPULATION DENSITY**FIG. 14 - MUNICIPAL DATA**

3.3. Lisbon and Tejo's Valley Atlas

As we already have said, the lack of information can be a very strong barrier to the development of GIS applications in every field and, of course, in Regional Science. By

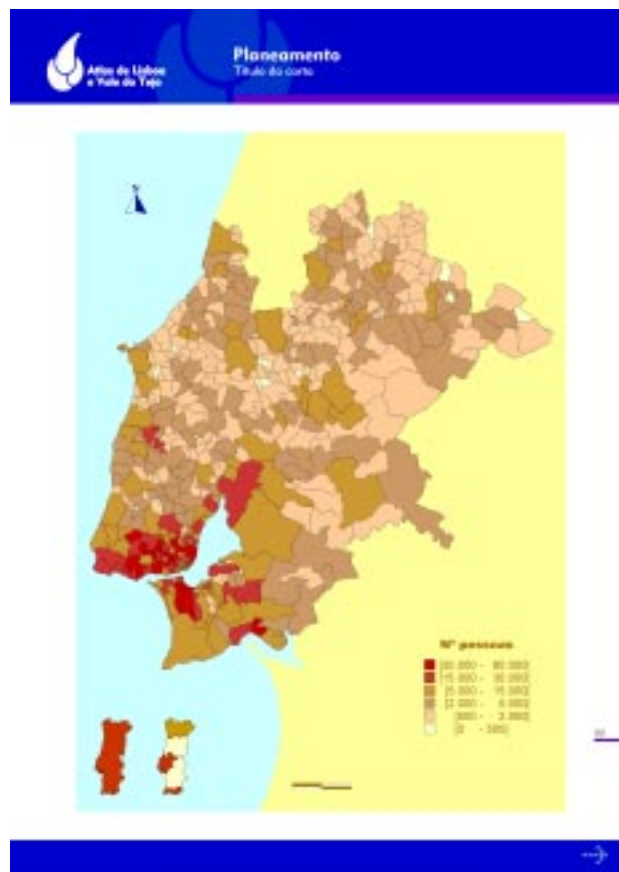
recognising this barrier we have started a project to build a digital atlas for the capital region of Portugal.

The Atlas was build by using a GIS which means that the information of this atlas is available for any other kind of application. This together with the publication of the Atlas are the two main objectives of the project.

The Atlas will be available in mid September, and it covers several themes:

- General Issues
- Environment and Physical Geography
- Land Use and Land Cover
- Demographics and Population
- Housing
- Economic Activity
- Infrastructures
- Planning

FIG. 15 - EXAMPLE



3.4. Development Potential

If the to initial projects have a very high physical component this last one is more dedicated to the social and economics domains.

The main idea is to build up a GIS that can support a model of development potential evaluation working in an interactive basis. The fact of being supported by a GIS enables the user to build dynamic scenarios according to the different agents perspectives or to evaluate the impact of any change in the systems conditions, as for instance the impact of a new road.

This GIS will enable to respond according to three different logic:

- Localisation
- Classification
- Evaluation

An agent that is working according to a **localisation logic**, like an enterprise searching for a site for a new plant, will use the system to execute a query to find the places that meet its criteria. It is the traditional site selection logic working. This logic can also help local entities to promote its territory to potential investors or to create specific investment rules.

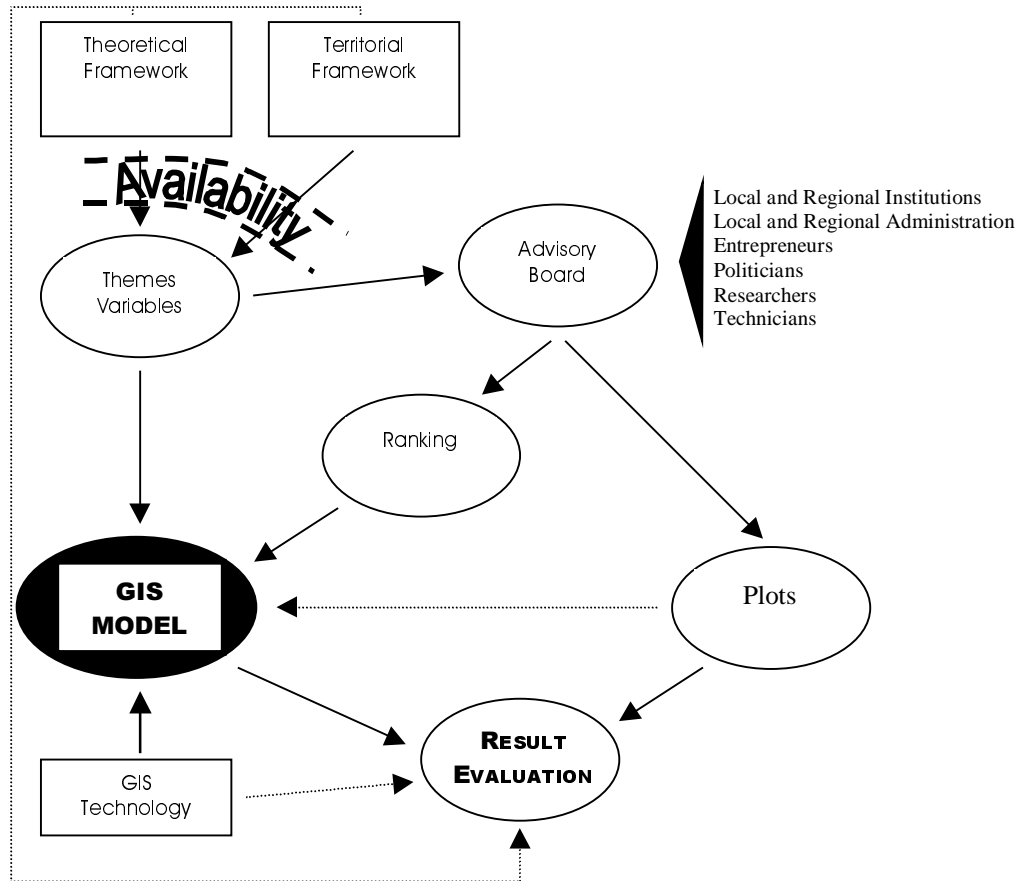
A **classification logic** assumes that the GIS will be use by local authorities to create territorial rankings. The idea is to use the system to support the analysis/diagnosis and the establishment of specific development policies.

In an **evaluation logic** the system will use a specific scenario. Then, one or more than one of the criteria used by the model will be changed and the result of this modification will be measured by the system. By this type of utilisation it is quite easy to measure the impact of new infrastructures or other kind of investment.

The next figure describes the project's core methodology. After a theoretical discussion and brief characterisation of the region we are able to select the major themes/variables that will be submitted to an advisory board for ranking. This board constituted by a team of individuals from several backgrounds will also create some plots of the most

expected areas in terms of regional growth. Then the information will be integrated in the GIS model and the results will be evaluated.

FIG. 16 – PROJECT'S METHODOLOGY



4. CONCLUSIONS

GIS are quite well studied in terms of applications for planning and environmental studies. Also there are several applications in infrastructure field – AM/FM applications. The Regional Science applications for GIS are still, perhaps, one of the less studied themes. Maybe the reasons are in those barriers that we have referred earlier in this paper. Maybe not.

One evidence that we can not deny after the four examples presented here is that GIS potential can be of great usefulness in Regional Science. For once Geography can make the difference. As Geographers can easily understand GIS technicians language and Regional Science experts they can for sure make the connection between these two interesting fields.

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