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State-of-the-art about fundamental methods and tools of spatial analysis and of processing of territorial information within the social sciences and humanities
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SUMMARY

This report presents a state of art according to some contributions from members of the WP4M (J.C. Foltête, C. Tannier, K. Ostir, S. Ormaux…). The report is organized in relation with three objectives: to analyse, to simulate, and to manage information thanks to a GIS.

1. METHODS FOR ANALYSE

Within the methods for analyse, territories are mostly analysed by using spatial frameworks where space is divided into discreet spatial units. Social, demographic, economic or environmental data are aggregated into these units. Statistical methods are then used to analyse the territorial content which is defined by the variables.

Two main families of statistical methods are usually distinguished: exploratory methods and inferential methods.

Exploratory methods

The exploration of a territorial data is commonly based on factors analyses which allow identifying their main structure. Such structure is resumed by factorial axes that are computed and interpreted to "compress the more important part of information contained in the data table. Two main methods can be used: main component analysis (PCA) in the case of quantitative data, multiple correspondence analysis MCA) in the case of quantitative data. Another way of analysing consists in defining a typology of spatial units. This approach can be applied from raw data or can be considered as a step following a factor analysis. The objective is to summarize the information, by describing spatial units with a simple set of categories. Such an approach is then focused on the observation of spatial units and spatial zoning more than processes and relationships between variables. Principal methods used are k-means and hierarchical classification.

A territorial typology is a genuine communication tool which leads to show a single map whose interpretation does not need specific knowledge.

Inferential methods

The second type of analysis method belongs to the inferential methods, where the analysis is focused on a precise character that one tries to explain thanks to others characters. In a more simple vision, two kinds of methods are available. First is the regression ones, that is used if the interesting character is quantitative. The second is the discrimination ones, if it is a qualitative character. This approach leads to compute estimated values of the variable of interest and to extract residual values by comparing reality and the model. These residues are extremely important because they show the local specificities of each spatial unit.
If these residues constitute spatial aggregates, it means there is a geographical effect, for example a structural opposition between two different cultural regions, or located into different physical contexts.
Both kind of methods are not strictly separated and can be jointly used. A classical combination consists in first exploring a structure by means of factor analysis, in order to define the main structural features and to precise the assumptions, and secondly studying a more precise subject that needs an inferential method.

2. METHODS FOR SIMULATION

For thirty years, the research in social sciences has been interested in the elaboration of tools which allow simulating the territories spatial dynamics. These simulation tools were developed thanks to the progress of the computer sciences. The conception of spatial simulation tools involves the modelling of the phenomena which are analysed.
A model can be defined as a summarized representation of an object, in order to work on it.
Considering the case of spatial simulation modelling, there are two requirements:
- The model should integrate the spatial dimension: material distance, social distance, perceived distance, topological distance. Spatial dimension can also appears through the attributes of the places or through some indicators which describe the places: indicators of satisfaction, indicators of attractiveness
- The spatial simulation model should allow testing many scenarios according to different assumptions.

Such an approach is very different from traditional approaches which consider generally three scenarios: continuation of the trend, optimistic scenario, and pessimistic scenario.
Indeed, the interest of the spatial simulation is not genuinely its prediction ability, but its ability to test many factors combinations, many interactions types which are too complex to be analysed without any simulation tool. So, a simulation model can be used to develop the knowledge, but also to help the decision-making in the field of territorial management.
There are different kinds of simulation models, static models, dynamic models.... Most of the researchers consider that three types of spatial models can be used to support participative approaches:
- The first models that were developed have a mathematical nature. They come from physic and chemistry and deal with self-organizing processes.
- Another type of models belongs to the distributed artificial intelligence field. Such models focus on emerging properties of complex systems (cellular automata, multi-agent system…).
- The third type of model is based on the fractal geometry use. Here the fractal geometry gives the basic principles that determine the spatial growth of a system.

3. INFORMATION MANAGEMENT THANKS TO A GIS

A geographic information system (GIS) is a system for capturing, storing, analyzing and managing data and associated attributes which are spatially referenced to the earth. In the strictest sense, it is a computer system capable of integrating, storing, editing, analyzing, sharing, and displaying geographically-referenced information. In a more generic sense, GIS is a tool that allows users to create interactive queries (user created searches), analyze the spatial information, edit data, and present the results of all these operations. The power of a GIS comes from the ability to relate different information in a spatial context and to reach a conclusion about this relationship. These tools are used more and more by sciences of territory, and more particulary within the framework of territorial intelligence.
Today, Internet mapping technology enables the delivery of dynamic maps, data from Geographic Information Systems, and associated metadata over the Internet. Web browser is used as a client on the user's side and therefore no additional installation and download is necessary. It may be accessed from desktop and portable computers, and through a variety of mobile and wireless devices, such as cellular phones, personal digital assistants, ultra mobile computers, and advanced positioning systems. It can enable publication of high-quality interactive maps, with the ability to query, manipulate, and interact with data. Normally it can display both raster and vector data structures, enabling the dissemination of a wide variety of

data types, for example satellite imagery, topographic survey data, excavation plans, and geophysical data. Maps may also be linked to databases and other information sources, allowing it to be visualised and queried. The system can also be extended to link to other resources and allow photographs, video, sound or further information to be displayed for particular features of the map. Internet GIS technology is composed of several components – the internet GIS server hardware and software, and server application that produces the output on user's side. The basic idea is to deliver a map to the remote user: user can display himself a map that is prepared on the server and sent to him via the internet. Since this map is not a static one, user can interact with it, producing desired view and performing desired functions. User needs only an internet connection and an internet browser, and sometimes also a plug in that has to be downloaded and installed. No other special software is needed.
For example, Grand archaeological and other cultural sites are usually a magnet for tourists. Tourism flow management presents a formidable opportunity for internet based GIS, because on a large scale, tourism planning can play an important role in the protection of archaeological sites. For example, some sites can be over-visited while others have not yet been discovered by tourists. One way to protect sites is to divert tourism to other locations. Which sites to develop for tourism should be decided not only on the basis of the cultural and natural interest but also on their ability to support tourism. For both, natural and cultural areas of interest, a tourism carrying capacity can be calculated using GIS. However important, this is only one example how GIS can be used and play an important role in protecting natural and cultural heritage. Integration of GIS and internet enables attraction of broader audience ranging from scientists, regional planners, local communities and tourists, and provide them with suitable data and tools to reach their objectives. Therefore, it is not surprising that there are numerous cases of applying internet GIS for cultural environmental management.

Beyond of these forms of uses of the GIS, those are used within the frame work of the participative governance; one speaks besides about participative GIS (PPGIS).
A PPGIS is an information system coupled with participatory mechanism, mobilizing geographic information and/or geospatials technologies, partly developed by (and for) the public, with the purpose to boost public participation in the context of local land planning and development processes.

Public participatory geographic information science is a study of the uses and applications of geographic information and/or geographic information systems technology used by members of the public, both as individuals and grass-root groups, for participation in the public processes (data collection, mapping, analysis and/or decision-making) affecting their lives.

CONCLUSION

All these methods seem well-adapted to design tools that are usable by territorial actors. But the transformation of the generic methods into territorial management tools requires a genuine transposition process. It also requires taking into account the available data and the action temporalities.