Geographic Information Systems

Paula Remoaldo
University of Minho, Portugal

Vitor P. Ribeiro
University of Minho, Portugal

Hélder Silva Lopes
University of Minho, Portugal

Sara Catarina Gomes Silva
University of Minho, Portugal

INTRODUCTION

One of the main challenges of the 21st century are caused by the large amount of geospatial information through a GIS. Throughout time there have been many attempts to define Geographic Information Systems (GIS). Yet there is no consensus on define it and restrict it to one definition is limited. In the acronym - Geographic Information Systems - the geographic refers to the Earth's surface and near-surface, therefore, all human production and activity, and non-human are possible spatialization in GIS.

GIS is recognized as an analytical and decision-making tool with many uses in different fields. Likewise it is used in many industries plus commercial, education or government. It is powerful for

- Land administration,
- Statistical mapping,
- Transport,
- Network and environment management,
- Remote sensing images,
- Water/waste management,
- Maintenance and management of public lighting,
- Regional and urban planning,
- Tourism planning,
- Healthcare planning, and in
- Crime and security management.

DOI: 10.4018/978-1-5225-2255-3.ch301

In broad terms GIS is a special class of information systems that keep track not only of events, activities, and things, but also their location. Computerization has opened a vast new potential in the way people communicate, analyze our surroundings and take decisions. The available data represent layers of the real world that can be stored, processed and presented later to answer future needs (Bernhardsen, 2002).

In the process of acquisition, processing and spatial representation there is the involvement of a multiplicity of inputs and outputs that can be managed on databases, which invariably seek analytical and graphical spatial embodiments. In the graphical display, vector or raster elements can be chosen, depending on the degree of specificity of the database and the type of expected results.

These databases can be collected at different scales and using a plurality of data types, including population census, aerial photography or satellite imagery. It allows to address multiple operating phases of the planning management process in a multiscale perspective with the challenge to meet more effective and efficient solutions. Due to this, nowadays it is frequently used as a spatial decision support system (SDSS) (Crossland, 2005).

Well-designed GIS should be able to provide a good computer system, because traditional GIS are intended to users operating on local servers. Traditionally GIS includes hardware and software. The hardware are the physical parts of the

computer itself and associated peripherals (e.g., plotters and printers); and the software is interoperable, supporting the many data formats (in the infrastructure life cycle) and implementation may be custom-designed for an organization.

Even so a GIS can have two types of groups typically called as "GIS carries" and "GIS users", which are respectively responsible for the management and analysis. The heart of GIS technology is the ability to conduct spatial analysis, overlay data and integrate other solution and systems. Geoprocessing operations facilitate to link or merge data, spatial characteristics of data; search for particular characteristics or features in an area, update data quickly and cheaply and model data assess alternatives (maps, graphs, address lists, reports and summary statistics) tailored to meet particular needs.

Nonetheless GIS feature a number of operational advantages and have allowed the proliferation of new fields of endeavor in open access systems across multiple forms of acquisition, management, interpretation and spatial information analysis. This can be seen in the first item of the present paper where the background and GIS starting point is explored. The main goal of this paper is to underwrite the concept of GIS evolution and to identify new paths to accommodate recent scientific approaches with extensive range of application possibilities.

THEORETICAL BACKGROUND: THE STARTING POINT

GIS is the advent of a new stage of cartography. The evolution of this type of system is relatively recent, between the 50s and 60s of the XX century, but knowledge and technology have grown rapidly recently. The emergence of technological systems with computerized cartographic application arose from the need of the resolution of certain military problems and public administration domains. Many contributors and diverse influences concerning concepts and principles, data and issues of spatial infrastructure, software vendors, application areas, allowed a cohesive growth (Figure 1). GIS organizational structure is as diverse well as the multitude of roots from which it originated multitude of proprietary and public domain GIS software packages (Hendriks, 2005). Nowadays, applicability of this type of systems widened for commercial, non-profit and academic areas.

The mid 1960s witnessed the initial development of GIS in combining spatially referenced data, spatial data models and visualization. The actual roots of GIS are complex and difficult to determine (Miller & Goodchild, 2015).

Most authorities cite the Canada Geographic Information System (CGIS), designed around 1964, with a project led by Tomlinson (Bruno & Giannikos, 2015; Mordechai et al., 2008; Tomlinson, 1967). The objective was to obtain means for summaries and tabulations of areas of land from the Canada Land Inventory. For the registration of this lands, was made a massive federal-provincial effort to assess the utilization and potential of the Canadian land base. CGIS arose from the need to answer the challenges to measure accurately the areas of irregular geographic patches of homogeneous utilization and to overlay/compare different themes (Goodchild, 2006).

The period of the 1970s was characterized by rapid evolution, and ability of computer mapping automatic using data format and the solution of a wide range of technical issues. In the 1980s, democratization of access to computer allowed expand use of GIS. These innovations led to the first commercial viability of GIS, started to become popular as a standard computer application in government departments, universities, and private corporations. Accordingly, the ability to select, sort, extract, classify and display geographic data on the basis of complex topological and statistical criteria was available to users (Goodchild, 2006; Pourabbas, 2014).

The 1990s saw map analysis and modeling advances in GIS, and these systems became real management information tools as computing power increased. During this decade, the Open