

Monika Mika\*

## **Thematic Map as a Basis for the World's Geoinformation System in Chronological Approach**

### **1. Introduction**

The term thematic map began to be widely used in the twentieth century, but maps of this kind have been developed much earlier. The first thematic maps appeared in Europe in the late seventeenth century. These included maps of ocean currents, winds, vegetation or variations of the magnetic declination in marine areas. In the early thematic cartography English astronomer Edmund Halley in 1701 created a map of isolines, which presented the magnetic declination in the area of the Atlantic Ocean.

Socio-economic maps, as one of the types of thematic maps began to be issued later than the natural map. The methods for obtaining and compilation of statistic data were then unknown. In 1782, the economic map of Europe has been issued, that is seen as the first map of the type of socio-economic map. The author of it was August Crom. The map contained 56 point symbols (signatures), which depicted agricultural and industrial products, but also natural resources [10].

Maps based on statistical data prepared on the basis of censuses, began to be created in the twenties of the twentieth century. The dot maps were created then, showing the distribution of population, population density cartograms, etc. Subjects of maps have been and are nowadays chosen having regard to the problems facing humanity in the period. They provide a sense of historical records of past eras, and are an essential element of geoinformation for its users.

Since the beginning of its existence the map has been a major source of geo-information in the world surrounding people. In a further part of the paper the evolution of maps is presented (with particular emphasis on thematic maps). The steps of the analysis are the study of the history of the geoinformation systems elements formation from the simplest forms to complex informatic systems. The problem is presented on the background of the development of cartography as a science of the art of mapping.

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\* University of Agriculture in Krakow, Faculty of Environmental Engineering and Land Surveying, Kraków, Poland

## 2. The Beginnings of the Cartography as the Origin of Geoinformation Systems

In the context of this study the origin of geoinformation systems in the world are the achievements in the field of ancient cartography. Large contributions to the development of this field of science had the Greeks, Romans and Chinese people. Greek scholar, Claudius Ptolemaeus, in his work *Geography* as the first adopted the cartographic projection system. Meridians on a round Earth converged at the poles, and parallels were appointed based on the longest day of the year. It was not the most accurate system, but it had the advantage of a homogeneity. The world map created on that basis presented also Eastern Europe, including the area in which the present Poland is situated. The Arab scholars willingly used the works of Ptolemy, while the Europeans discovered it only in 1409 when it was translated from Latin [1].

Greek scholars were excellent theoreticians in the field of geography and cartography, but the Romans better used this knowledge in practice. In times when the Roman Empire reached the highest power, the geographical knowledge has evolved as it seems by carrying out conquests. Examples are the Roman military maps and road maps with marked cities, roads, routes and distances between them. They were used for communication and can be called the first geoinformation systems. They were a valuable source of geoinformation, serving, among others, for military purposes.

Also in ancient China, there were maps – made around 2000 BC in wood, silk and paper. There are historical materials, showing that the first cartographic office was established there already around the second century AD. Compared to other ancient countries – China was a leader in the field of cartography. Unfortunately, there are not many details or map images from this period

## 3. Geoinformation in the Middle Ages

The Middle Ages was a period in history in which the development of many scientific disciplines including cartography was hampered. The roundness of the Earth was questioned and the belief that the Earth is flat returned. The major role in promoting this belief played the Church, in whose interest was to keep people in low social awareness, at the elementary level of knowledge about the surrounding reality. With the implementation of such principles – it could freely interfere in every aspect of human life and impose its own image of the world.

Therefore, the maps of the early Middle Ages had little in common with reliable forms of geoinformation. They did not have any coordinate system. They resembled simplified schemes. The world presented on them was rectangular, round, oval, or disk or shell-shaped [1].

An important phenomenon in medieval cartography was the appearance of sailing maps called compass maps. This type of map was a source of valuable knowledge in navigation and constituted an important chapter in the history of the

formation of geoinformation systems. The development of these maps resulted from the use of magnetic compass, which became common about 1,200. These maps also called rhumb maps or portolanas did not have a cartographic grid made up of meridians and parallels, but had directional lines that spread radially from the center points of wind roses. The oldest compass map dates from the late thirteenth century.

The development of cartography accelerated with the prevalence of paper and printing around the fifteenth century. From the fourteenth century graphic technique of woodcut developed, and since the fifteenth century copperplate technique.

#### **4. Renaissance as the Age of the Geoinformation Development**

At the turn of the fifteenth and sixteenth centuries, there was a revolution in the field of cartography. New lands and civilizations were discovered. There was the development of sailing and with it the need for increased production of maps and atlases. Geographical discoveries had a great impact on the change of the world cartography.

Important centers of cartographic production were Italy, Netherlands, and Antwerp, where specialists were coming from all the Europe. Precisely in Antwerp in 1570 Abraham Ortelius issued work *Theatrum Orbis Terrarum*, which was the prototype of today's atlas [10].

A scholar, who wrote a history of cartography for this period, was Gerard Mercator, who was the author of the globes, large wall maps, as well as an atlas of the world. He created a new type of cartographic mapping, which was named after his name the Mercator grid [5]. This is a cylindrical, elongated and conformal projection, where the meridians and parallels intersect at right angles. An important feature of this projection is fixed azimuth reference, line called rhumb line that intersects all meridians at the same angle. On the map it appears as a straight line, which facilitated especially sailors having fixed course of ships.

#### **5. Seventeenth and Eighteenth Century – Period of Intensive Development of Cartography in the World**

During this period the first detailed topographic maps that were drawn with respect to the triangulation and by field situational and astronomical measurements were produced. Amsterdam was the center of cartography of the period, because the best specialists of cartography worked there. They created wonderful maps and atlases. One of the best was a voluminous *Atlas Maior*, developed by Joan Blaeu. It is known even nowadays as a work of great cartographic craftsmanship [3].

Thematic maps for the first time appear at the turn of the seventeenth and eighteenth century. The background of these maps were adequate general geographical

landscape elements. The first thematic map was published in 1701. Its author was E. Halley (Fig. 1), and it represented the distribution of magnetic declination. An example of another map from this period is shown in Figure 2.

The introduction in France in 1799 of the metric system was of great importance for the development of cartography of the world. This system quickly spread to other European countries [3].

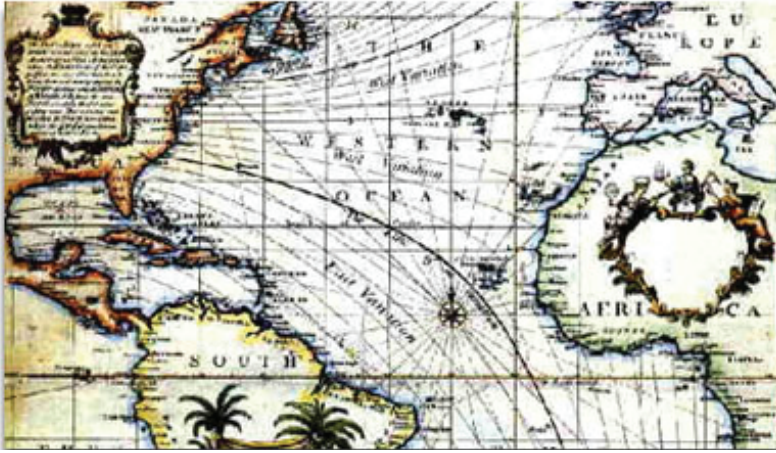


Fig. 1. Map of distribution of magnetic declination by Halley, 1701  
Source: [2]



Fig. 2. Map of Nova Totius Terrarum 1608 AD  
Source: [1]

## **6. The Nineteenth Century – Period of Topography Development**

During this period the method of dashed presentation of the lie of the land on the map was established. This method had several variants. One of them assumed, that to plasticise image the hatch of the slopes must be combined with shading, and dorsal lines must be characterized by bright color. Subsequent modification of the method began to illustrate the lie of the land using the system of shadows like on a photograph of the area of the side or oblique lighting. [3]. One can say, that these methods were an attempt to introduce three-dimensional images on map drawing, so in some sense the prototype of the Digital Terrain Model.

This age also brings the ability to create topographic maps at larger scales using plane table and telescopic alidade. In reproducing of the color maps the use of color lithography and later offset printing began [3]. During this period, cartographic projection of the German mathematician Carl Friedrich Gauss (cylindrical, transverse and conformal) was developed. The author used it to calculate the results for the triangulation of Hanover. In the later years of the nineteenth century Louis Krüger improved this projection. The resulting projection is known today as the Gauss–Krüger and is also used nowadays [3].

The nineteenth century is mainly the period of the intensive development of thematic cartography. At that time, all kinds of thematic maps were created and the basic methods of cartographic presentation of content were developed. According to [10] during this period the level where it was possible to make large-scale studies especially geological and soil maps was reached. These maps had analog form.

## **7. The Twentieth Century as the Period of Development of Modern Techniques in the Geoinformation Environment**

In the century, a number of inventions improved the creation of maps. The methods of data collection to some cartographic studies changed. Electronic measuring techniques in geodesy developed, a new branch of science was created – satellite geodesy based on GNSS satellite navigation systems. With the development of computer science, most cartographic works have been modernized. The time of data processing and preparation of maps, especially thematic maps was shortened. Collection of a vast amount of geospatial data on computers has contributed to the creation of full-fledged Geographic Information Systems (GIS).

## **8. The Twenty-first Century – Geoinformation Society**

In the twenty-first century geoinformation accompanies a man almost in everyday life (from car navigation to mobile telephony). Photogrammetry, the remote sensing, laser techniques (scanning) are developing. With more perfect software

data are processed for the map. With the development of the Internet – interactive maps, atlases and virtual globes are created. A geoinformation system is defined as: a network-integrated set of computer hardware, software, data, research methods and specialists, which elements operate in an institutional context [9]. The concept of the interactivity of maps appears. It means that the user can interact with the visualization of the data on the map, that is can change the view layer, do measurements on the map, adjust camera settings, etc. [7]. The concept of the atlas (previously identified a set of paper maps in the form of a book) is extended to the definition of the atlas media. This is an atlas information system, which is the collections of systematic files planned in electronic form, that allow making decisions and obtaining information in a user-oriented communication system [7]. In many atlases a user can add diagrams, symbols, points or the effects of 3D visualization imitating reality. In addition to interactive maps and multimedial atlases a new kind of globe is created. A globe in the classic sense is a scaled model of the Earth or another celestial body in the form of a sphere. An interactive globe is a model of the Earth in the form of a virtual sphere, called in the literature also a hiperglobe because it gives the opportunity to use the multimedia [8].

## 9. GIS and Contemporary Cartography

Theoretical principles of creating GIS are derived from cartographic knowledge. Without the existence for centuries principles of maps design, cartographic generalization and methods of spatial data mapping – these systems may have never existed in the world. An essential component for GIS technology is a computer hardware with a geoinformation software. Geo-information systems (GIS) are applicable to the description, explaining, and predicting the spatial distribution of geographical phenomena. GIS is a type of software, as well as the part of science, in which the methodology for solving research problems is developed [6]. One of the biggest advantages of geoinformation systems is the ability to show the analysis of quantitative and qualitative results on the map (eg, cartograms, cartodiagrams).

Nowadays, the technique of GPS/GNSS may be used to create certain types of thematic maps. For the purpose of hiking maps, for example, cheap and easy to use handheld GPS receiver Nautiz X7 can be used. After recording the results of field measurements, the results can be transmitted from the device to the appropriate program (eg. Quantum GIS), in which a map can be developed. The next step may be publication of the results on the website, used locally for information purposes. Also, use ready-made maps (eg Open Street Map) can be used and a point or vector layers can be put on a developed thematic map. Map creation time (depending on the developed subject and the size of the measured area) is tens of minutes of downloading the data in the field and a few hours at the computer in the office. An example of such thematic map is shown in Figure 3.

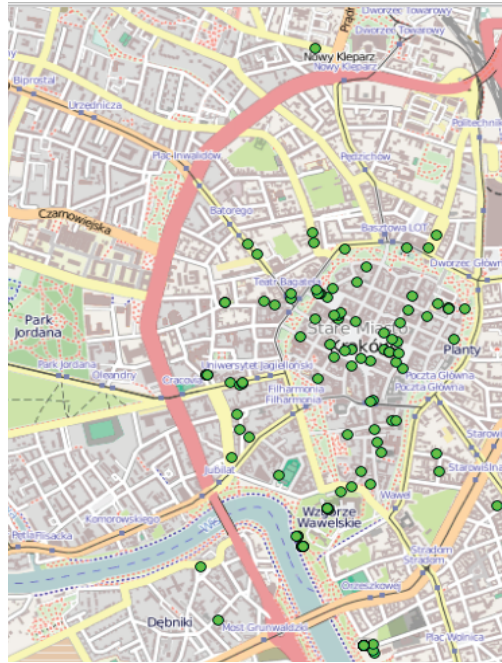


Fig. 3. Map of plaques in the Old Town of Krakow

Source: [4]

The above example represents a big simplification of the issues related to the creation of modern maps, but it seems that by the simplicity of the methodology used to develop a thematic map it shows how big breakthrough came through the ages (From woodcuts or clay tablets to today created and widely used interactive overview or tourist maps). Also, technical and legal cartographical standards in the world vary, based on information systems to give the user the exact geographic information in increasingly shorter time.

## 10. Recapitulation and Conclusions

Maps for centuries have been the main source of geo-information, as in a simple and logical way they present space and the phenomena surrounding people. The ubiquity of cartographic images proves the role of maps in the lives of people through the ages. Continuous development of new technologies of mapping causes significant facility for both their creators and users. This does not change the fundamental goal of creating a map – which is to provide reliable and accurate spatial information. Created are Geoportals of local, national or global range. They are available from any web browser and surprise us with larger studies accuracies.

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