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Integration of geoinformation

Motto: Professor Helmut Moritz is a pre-eminent, world-class geodesist and geophysicist who has made an everlasting personal contribution to the study of our Earth as a planet. His greatness as a scientific leader in the field of Earth sciences, as confirmed both by his outstanding achievements in research and his dedicated service in the highest posts of international scientific organizations, has never clouded his shrewd attitude towards the practical functions of geodesy in advancing human civilization. Prof. Moritz has moreover always impressed me with his greatly sophisticated thoughts and deliberations, weaving a fascinating panorama of the philosophy of the Earth sciences. It therefore gives me great pleasure to dedicate this modest sketch, mainly addressing functional aspects of the study of the Earth and the geographical environment, to our Brilliant Master and Friend on the occasion of his anniversary.

Introduction

The theory and practice of geoinformation systems (GIS) now stretch back several decades. In the latter half of the 20th century the GIS field witnessed intensive development, one might even say it *flourished*. The systematic processing of geographic information – i.e. information about the Earth in the broadest sense, thus the term "geoinformation" – became possible mainly thanks to the emergence and rapid advancement of information technology, or IT. The two fundamental pillars upon which IT rests, mathematics and electronics, likewise laid the foundations for the dynamic development of GIS. These two fundamental fields stem from differing *origins*.

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Mathematics is a *classical* field of science that has long been a subject of study, enjoying success long before the potential *advent* and development of IT. Already in ancient times mathematical knowledge enabled mankind to calculate the shape and dimensions of the Earth, which was of course an *early* precondition for the further development of knowledge about our planet and its position within the wider Universe. Recent discoveries in North Africa have evidence that around 4,000 BCE, long before the heyday of planimetry (*planar* geometry) in Greece, mankind already knew how to solve triangle problems, a crucial skill for keeping a kind of land cadastre. Nowadays, too, such cadastral records constitute an important component of GIS – or on a local level, even its core element.

Electronics, on the other hand, is a new (young) field, which saw its foundations laid in recent centuries and which developed in the past few decades. It forms the technological basis for modern telecommunications, key for the development and functioning of geoinformation of arbitrarily broad scope. Without electronics and without telecommunications it would not have been possible to *conquer space* and to launch into orbit the satellite systems that have given GIS two fundamental new capabilities. The first such capability involves methods and techniques used on the Earth's surface based on satellite technologies (i.e. GPS and other systems), while the other capability involves the recognition and study of terrestrial objects, the positioning of points and therefore of entire objects and phenomena on the Earth's surface – and to a certain extent also under the surface and in the atmosphere – using imagery obtained from satellites. This latter capability is called satellite remote sensing.

Geoinformation has already developed an extensive body of research literature and popularizing literature, as well as numerous fields of widespread practical application.

The role of integration

The thematic scope of information about the Earth and our geographical environment, as is well known, is very broad (wide, large). Moreover, typical complications arise from the following circumstances:

- the nature of the input data and information used in GIS, which can generally be divided into two classes. The first embraces *hard* information, pertaining to relatively stable objects, of fixed or free position within geographic space. The second category of data and information is of a *soft* nature, it pertains to objects of imprecise shape/outline and highly variable (dynamic) position, or more precisely motion, in space;

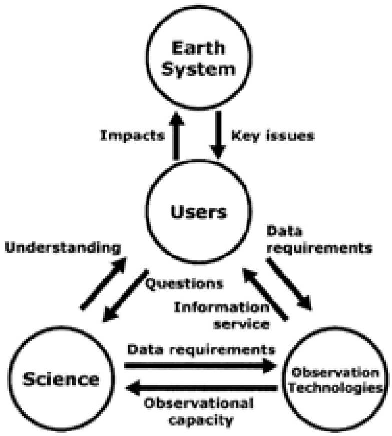
- the desirable, logically motivated precision of identifying position in geographic space;
- the frequency of collecting the input data and information for GIS (measurements, registration, observation, database entries);
- the large number of institutions participating in collecting, processing, and tailoring input information for GIS. The main institutions processing geoinformation are as follows: public geodesic services (central and local governmental); surveyors licensed to perform geodesic work; geodesic research units; public agencies of a geological, hydrological, hydrogeological, and geophysical nature plus research units and licensed specialists in these same fields; public agencies dealing with meteorology, agriculture, forestry, urban planning and statistics; and – *last but not least* – environmental inspection and protection services.

In tandem with this multiplicity of authors of geoinformation, there is likewise a multiplicity of geoinformation users. The point is that the *end* users of GIS frequently are not – and cannot or should not be – the authors and suppliers of geoinformation. The end users of GIS expect *integrated information*, because predominantly only such information is full-valued (*holistic*) and – perceived comprehensively – only such information meets users' needs. This is an opinion I base on my own experience as well: in 1994 I directed work on developing a preliminary concept for national GIS in Poland; in 1998-2001 I participated in extensive work on a concept for GIS, the results of which gained recognition at a European conference held in Potsdam in 2001; and during the decade 1994-2003 I organized a cycle of annual conferences on national GIS *in practice*. I am currently coordinator of the "Geoinformation" Research Network drawing together 4 Institutes of the Polish Academy of Sciences and 9 ministerial institutes.

The GEOSS Program – Global Earth Observation System of Systems

This program of worldwide scope, actively developed for five years now, was conceived as a integrator of programs in various areas addressing the main segments and factors in the progress of civilization that are related to the Earth and its geographical environment. GEOSS integrates the following objectives and areas: DISASTERS – reducing the toll of lives taken by natural disasters and the economic aftermath of natural catastrophes; HEALTH – the impact of environmental factors on health and well-being; ENERGY – the development and improvement of energy resource management; CLIMATE – diagnosing, forecasting, and reducing climactic impacts and adapting to them; WATER CYCLE – water resource management; WEATHER – diagnosing and forecasting the weather; ECOSYSTEMS – managing and protecting ecosystems; AGRICULTURE – supporting sustainable agriculture; BIODIVERSITY –monitoring and preserving biodiversity; COMMONALITY ANALYSIS – general problems of collecting and using spatial information.

The scheme by which integrated geoinformation functions and is utilized is depicted in the accompanying figure.



Other programs – GMES, INSPIRE

Global Monitoring for Environment and Security, or GMES, is an EU program that has been in operation since 2001. It is geared towards observing and evaluating the natural environment in terms of its condition, safety, and its impact on the conditions of human life. This program integrates all fields and agencies competent on such issues. In Poland, there is particularly close collaboration between the State Environmental Protection Monitoring service (under the Ministry of the Environment), the ministerial Institute of Geodesy and Cartography, and the Space Research Centre of the Polish Academy of Sciences. A particularly great role in this program is played by the methods and techniques of Satellite Remote Sensing.

INSPIRE – Infrastructure for Spatial Information in the European Community

The objective of this EU program, currently in the implementation stage in the EU member states, is to establish a common infrastructure that will ensure the substantive and technological compatibility of GIS in the EU. Work in the individual countries is based on a directive adopted by the European Parliament and Council of the EU on 14 March 2007. This directive is meant to be transposed into the national legal systems no later than the third quarter of 2008. Work now underway in Poland, mainly of a legal nature, concentrates mainly on preparing the draft of a national law that will be subsequently fleshed out by executive degrees. It is obvious that the Earth sciences, including geodesy, have an important place and great role to play in the implementation of that directive, especially through metainformation.