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GEOINFORMATION AS A FORM OF PROMOTION OF SCIENTIFIC RESEARCH

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Introduction

In the contemporary world the amount of information is growing at an exponential rate. Currently, it is growing annually by 66%. This creates an ever growing problem of finding reliable information, including the results of research work. At the same time various systems facilitating search are emerging. A major part of the information generated is associated with the location and is called geoinformation. Using geoin- formation is important not only in various decision-making processes, but also constitutes the basis of effective management on various levels and facilitates the process of social consultation. Nevertheless, just as in the case of other information systems, geoinformation needs order and structure to serve its purposes in an efficient way. Spatial data infrastructure (SDI) is supposed to support access to geoinformation by means of cooperating information systems functioning in a hierarchical structure (global, regional, national and local). On top of the technological aspects, exceptionally important for the construction of SDI, come dedicated legal regulations, geomatic standards, data models and organizational structures jointly determining the directions of the development of infrastructure.

Infrastructure of spatial information is based on normative data, which are the basic resource generated by institutions in particular countries. This data should constitute basic information supporting decision-making processes. Searching for data in the area of SDI takes place by means of geoportals, which enable access to catalogue servers and displaying chosen information through map browsers. By assumption, normative resources of SDI are delivered by specialized, branch, scientific, public institutions, including scientific institutions. SDI provides great opportunities for access to reliable spatial data, which may be used in further research. At the same time it provides an interesting tool for the promotion of the results of scientific research. Catalogue services make it possible to search for collections of spatial data provided by network services (WMS, WFS) and geoportals make it possible to display these collections from various sources.

The goal of this article is to present the basic rules of functioning of infrastructure for spatial information, as well as to show in what ways available tools can be used to search for, analyze and exchange the results of scientific research. Technological progress enables multilevel integration of spatial information, on the local, regional and global scales. The form of presentation of data on maps constitutes a much more reliable tool than even the most complex descriptions. Promotion of scientific research by means of providing results with the use of network services constitutes a chance for research teams and at the same time brings measurable benefits to the developing information society. Thanks to an interdisciplinary approach, combining geoinformation from various areas (sources) gives the opportunity to recognize and analyze issues which wouldn't be noticed in considerations limited to a very narrow, specialist branch.

The main goal of scientific research has always been to support human creativity, set new horizons, but also to provide utilitarian solutions that could be used in practice. These notions are still valid, even in digital times. The question, yet to be answered, is whether it was easier to promote and implement the results of scientific research in times long gone, when books were the only form of communication, or whether it is easier now, in times when information is within arm's reach, when it is possible to learn about events that are taking place thousands of kilometres from the place in which we are located. Nowadays, users are bombarded with hundreds or thousands of gigabytes of information and the difficulty is to select useful and at the same time reliable pieces of information.

In the world of science it is assumed that the best form of promotion of research is publishing in specialist journals and presenting research results at conferences. What are the objective forms of verification of scientific achievements? The Hirsch index makes an attempt to assess the value of scientific works in an objective way. The index characterizes the scientific achievements of the author. In terms of assumptions, a similar system is the one based on the number of citations by other authors. Another form may be the number of applications of research in practice, that is, implementations and patents. The digital world in the age of the Internet provides scientists with yet another tool in form of websites and various applications where access to the results of research is global in character and is almost unlimited. In this case the results of research are verified by the number of users.

Scientific research can be divided into two basic groups: research solving a particular problem, usually a technical problem and research describing phenomena of a spatial character, usually in the area of natural sciences. This second group is usually associated with a particular location or presents the cove- rage of its dissemination. Enriching research with the element of geolocation makes it possible to greatly increase the scope of utilization of results achieved, as they can be presented on maps and be subject to spatial analysis with multiple criteria (Longley et al., 2006). The branch of science called geoinformation deals with collecting, acquiring, gathering, processing, transferring, analysis, and interpretation of geospatial data. Examples of geoinformation may be both phenomena associated with data concerning Earth (utilization of land, pollution of the environment, distribution of protected species), as well as with many other areas (spreading of diseases, results of elections, marketing analyses, crime indicators). Most often the element of location is geographical coordinates added to a standard database, but there can also be other location factors (addresses, postal codes, localities). Obviously, everything depends on the planned accuracy of the presentation of research results.

Geoinformation

The term geoinformation is a portmanteau word standing for geographical information. These words unequivocally define the scope of the term, including in the scope of geoinformation all information which has a reference to location or can be located in space. Geoinformation is information acquired by means of interpretation of spatial data (Gaździcki, 2001). Obviously, there are many more or less complex definitions of geoinformation and some of them refer to computer systems allowing the processing of geoinformation, that is, Geographic Information Systems (GIS). Technically speaking geoinformation is a database, where every entry is attributed to a location (e.g. in form of coordinates).

The utilization of geoinformation makes it possible to obtain a new factor for drawing conclusions and boosts possibilities for analysis. Just a bare piece of information about the spread of cases of cancer in a particular locality, gives only a small chance of finding the real reasons for the epidemic. Locating the places of residence of the affected people on maps through geolocation provides a new quality. However, it is only the juxtaposition of these results of research with other factors that gives tremendous opportunities. It may turn out that most cases of cancer are located in the area with elevated presence of carcinogenic particles. Only juxtaposing and overlaying these two elements on the map makes it possible to identify the real reasons for cases of cancer. Arriving at these conclusions without the utilization of geoinformation would be very difficult or even impossible.

Development of spatial information systems

Geoinformation is inextricably associated with systems of spatial information, which are the solution to the problem that has been troubling cartographers for centuries. They allow collection of any informational resources and presentation of only those that at a particular moment are needed by the user. This way it is possible to strike a balance between the amount of presented information and the legibility of a map. Achieving this effect was possible only thanks to the division of information into thematic groups (layers), stored as separate resources. The development of the systems of spatial information is invariably associated with technological progress in the area of information technology.

Even though the first concepts and solutions were implemented in the 1960s, the real emergence of systems of spatial information came at the end of the 1980s. At this time, thanks to the introduction of personal computers, GIS software attracted a broader group of users.

The advantages of GIS in the area of collecting, processing, analysis and presentation of geographic information attracted further groups of users. In the early phases, the use of systems covered mostly the areas associated with natural sciences (geology, forestry), but soon, further applications - in geodesy, spatial planning, as well as in telecommunications, gas distribution, healthcare, marketing and many others - were identified. Nowadays, it is possible to find an example of utilization of GIS in almost any area. The 1990s were above all the time of collecting resources under separate projects. Very often, the projects carried out by scientific units were commissioned by governments. Unfortunately, the basic problem with this technology was insignificant access to resources, in practice limited to the institution conducting a particular project.

Another stage in the development of geoinformation was the introduction of client-server technology at the end of the 1990s. This technology enabled group work and gathering information on a server. An extension of this solution was the n-layer architecture enabling work through the user's interface (desktop or www) and application server carrying out most of the data processing functions. Such solutions allowed dedicated corporate systems to be built managing huge resources of spatial data and at the same provided easy access for end users.

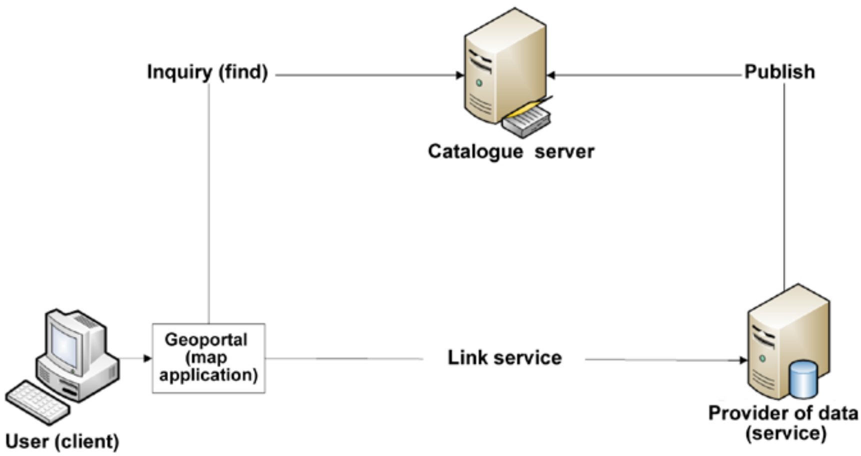
The rapid expansion of Internet technologies was another milestone in the construction of geoinformation solutions. The opportunities given by the Internet allow access to spatial data from anywhere the user is located by means of a browser. Thanks to this, current systems of spatial information have gone through a kind of metamorphosis and in the global dimension they are being replaced by Spatial Data Infrastructure (SDI). The basic rule of the infrastructure is local collection of data by branch units entitled to carry out the process and global access to the resources thanks to utilization of mobile technologies. This way data used by now mainly by experts become available for an unlimited group of users. This in turn brings the idea of information society to life.

Spatial data infrastructure

Scientific research, independent of the area of knowledge, is usually specialist in character and is targeted at experts. However, what currently is very important is the promotion of research, which is also one of the basic requirements in the area of proper management of a research project. Promotion itself is only the first step and the results achieved have to be presented so that they are legible and comprehensible not only for a small group of specialists, but also for the average recipient. Promotion is not only the idea of contractors themselves, but it is, in fact, imposed by the financing institutions. Thanks to the development of the Internet, forms of promotion have expanded greatly over recent years. Apart from websites, obvious in the age of Internet, spreading information about research projects, scientists more and more often resort to mobile solutions (Twitter, Facebook, YouTube) using the power of social media. The available technologies are developing at a tremendous pace. One day users find themselves in the world of web 1.0 and the next day they enter web 2.0 acquiring much broader possibilities of communi- cation and thus promotion, reaching new users. Geoinformation technology, just as with the whole Internet, has entered the mobile phase.

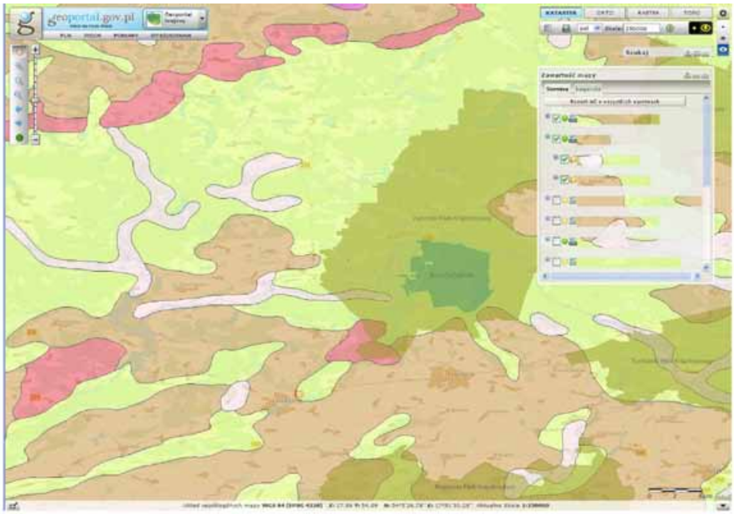
The utilization of spatial data infrastructure creates new opportunities for presentation and thus promotion of scientific research. The first step towards spreading geoinformation mechanisms was granting access to maps in the Google Maps service. Now, almost every user of the web takes advantage of these services planning a trip to another city or looking for a hotel for his holidays. It's no longer a problem to not only browse through maps, but also to obtain information covering the place we are interested in. This way we can take advantage of the benefits of spatial data infrastructure by making virtual journeys. However, map applications can also be a useful tool for work. Real estate agents are already using geoportal.gov.pl in their daily work, by searching for detailed information about property. Similarly, browsing Internet maps is an element of planning for many field research projects.

Picture 1. Basic elements of spatial data infrastructure.



Spatial data infrastructure is nothing else but using the possibilities of communication between various centres generating data. This is an expansion of the basic concept of GIS about the possibility of publishing online. The basic elements of the infrastructure are knots publishing spatial services (data), geoportals, and catalogue servers enabling search for data and services (Picture 1). Catalogue services constitute a kind of an advertising board which makes it possible to find out what and what kind of data and services are provided by whom. Thanks to this, it is possible to reach the source of spatial data fast. Taking advantage of network services (WMS, WFS) creators of data can publish appropriately prepared collections of data. Special geoportals serve the purpose of display (map applications), they allow the display of collections of spatial data coming from various sources (picture 2). Particular units present their resources and knowing their address, it is possible to display the data in one's own system, just as in a GIS application. However, in this case the process is based on an Internet browser. Achieving a desired result requires interoperation, that is, the cooperation of all elements of the system. Achieving this state is po- ssible only by defining appropriate legal and technological frameworks using geomatic standards (OGC). This way the user has access to any spatial data and can choose the data he wants to use himself and at the same time unwittingly exact quality from the services provided.

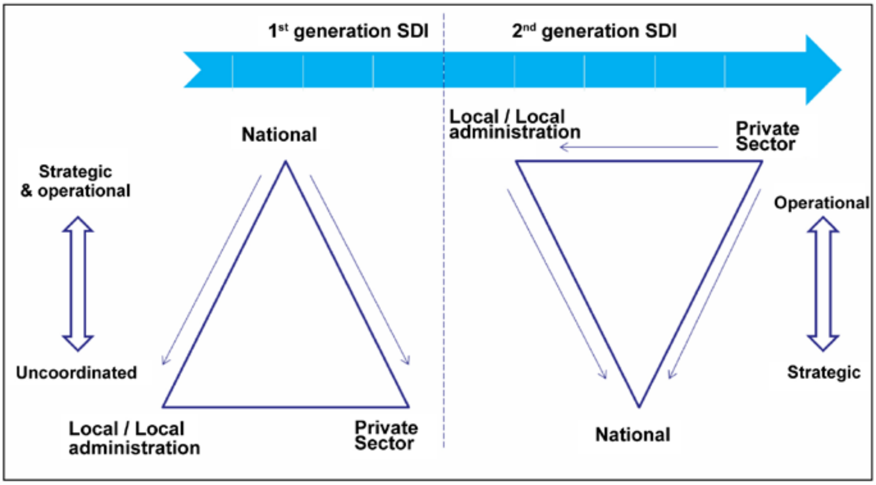
Picture 2. Set of various sources of geoinformation (geological map, landscape parks) at the geoportal.gov.pl website.



Just as the evolution of systems of spatial information in sciences associated with geoinformation, a gradual transition from traditional cartography and inventory of resources towards presentation and explaining the processes forming the environment and predicting future changes has taken place. To some extent this was a natural process; however, it has also been influenced by users, who demand processed information supporting planning and decision-making processes.

Just as in case of the transition from web 1.0 to web 2.0 we can observe the transformation of SDI from an infrastructure focused on the product towards a process. In the first case activities usually coordinated by a central unit, focused on collecting and integrating data. The second generation of SDI is inspired by the needs of users and operative actions take place on the local level (Figure 3). In this case data are a secondary element, as users are interested above all in practical utilization of information and functionality of applications. Nevertheless, the quality of data is always very important, in fact, high quality should be the norm, as even the best application provided with flawed data will become useless.

Picture 3. Role of local authorities, national administration and private sector in the development of 1st and 2nd generation of spatial data infrastructure (modified, according to Rajabifard et. al., 2006)[1].



Promotion of scientific research through geoinformation

More and more attention is paid to the usefulness of scientific research and its utilization. The application of geoinformation solutions and spatial data infrastructure provides many research teams with a new tool for promotion. They can pass on the results of research to a global repository. Users can reach for the data and use it in their further research, analyses or applications. Having access to various resources, new quality is created through value added to basic products.

New tool means new possibilities, but also new challenges. Above all, participating in a global infrastruc- ture means that the quality of products promoted is subject to verification by users. It is mainly high quality products that gain popularity in the web, as the group of users assessing the products is huge. It is also easy to share opinions. Nevertheless, satisfying requirements of quality is in itself an indicator of the utilitarian value of a research project and at the same time an important assumption for continuing and updating the research.

Spatial Data Infrastructure doesn't impose a model of access to data. Usually, data financed with public funds are available for free, but obviously, commercial providers of data may define the rules themselves also in this respect. By default, infrastructure is interdisciplinary in character and it doesn't restrict access to the publication of its data in any way, although obviously users have to satisfy certain technical criteria. The possibility of presenting interdisciplinary resources in one place may motivate research teams to solve new research problems, which up till now haven't been considered or have been ignored. It may turn out that other research teams will find new areas for the utilization of particular resources. Cooperation

1 A. Rajabifard, A. Binns, I. Masser, I. Williamson, The role of sub-national government and the private sector in future Spatial Data Infrastructures, International Journal of GIS 20 (7): 727-41, 2006.

between various, multidisciplinary and independent teams within the infrastructure opens the way to new opportunities and their scope is limited only by creativity.

Simplified rules for publication of collections of spatial data through Spatial Data Infrastructure also make it easier for regular users to present their data. Social enthusiasm leads to a situation in which groups of users create and present their own resources (Open StreetMap). This phenomenon is called „crowdso- urcing" and it is also gaining ever greater popularity in the area of spatial data. Combined with the resources provided by public services, this kind of grassroots activity constitutes a very interesting initiative which in a natural way supplements data on a local scale and on the other hand exacts quality standards through the verification of existing data. Obviously, it is necessary to be aware of the fact that as in the case of Wikipedia, there is a certain margin of error resulting from wrongly entered information.

Supporting decision-making processes

It would seem that spatial data infrastructure is above all about opening access to resources to various social groups, just as in case of other processes observed on the worldwide web. Undoubtedly, presenting research results through infrastructure provides global access to them, stimulating the development of the information society. However, from the point of view of scientists there is yet another, very important group of recipients. These are the officials and decision-makers on various levels, who need reliable and complete data to efficiently and correctly do their work. SID is a natural resource providing data for the processes of decision-making support. It is necessary here to pay attention to the fact that providing this group of recipients with appropriate tools satisfying their specific requirements may directly affect further financing of research.

Till now employees in public administration have had limited access to reliable geoinformation resources. The framework infrastructure of spatial data allows access above all to normative data[2], including referential topographic resources (geoportal.gov.pl, Google Maps). Topographic data are very important as they are the foundation for all location activities. Nevertheless, SDI is also a series of branch resources, which are only the basis of decision-making processes. Gaining access to such resources, decision-makers gain a new tool with an unprecedented analytical capacity. SDI are basic resources served mainly by public services. Decision-making processes very often require much more detailed and thematically complex data. At this moment research teams get a great chance to fill this gap and include research results in SDI. Obviously, participation in the infrastructure as such doesn't guarantee success, as the philosophy of the Internet is brutal and promotes only the best. Similarly, in this case users will take advantage of only those resources which are reliable and which guarantee that the decisions they make will be right. Nobody will ever use data presenting a hilly area as a potential flood plain. Similarly, highlighting contaminated land in places where detailed research doesn't reveal contamination will undermine the quality of data presented and automatically cause negative verification of the resource. It is necessary to be aware of the fact that information (especially negative information) spreads around the Internet at a tremendous pace.

2 T. Nałęcz, K. Michałowska, (in print): Terminologia określająca rejestry danych przestrzennych jako normatywne zasoby krajowej infrastruktury informacji przestrzennej, Roczniki Geomatyki, Warszawa.

Conclusion

Internet technologies affect every area of life and are bringing about significant changes. This is happening for two basic reasons: these technologies substantially speed up communication and contribute greatly to reducing the costs of many ventures through virtualization of processes. The effects of the abovementioned changes are apparent on the media market, for instance, where traditional publications are being gradually replaced with ever more popular digital equivalents. In the recent years there have been similar trends in the area of geoinformation. The best evidence of this is the emerging spatial data infrastructure.

The infrastructure is open in character and allows the addition of any collections of data, even though the framework is created by public institutions. These institutions are also responsible for providing normative data constituting the basis for the functioning of the whole system. The basic element of the infrastructure is achieving interoperability through cooperation of various technologies providing access to spatial resources. At the same time, within the framework of SDI, users are provided with free tools which they can use locally on their own computers (Internet browsers) and have access to global data resources.

The emerging SDI is also a huge chance for research teams, as by providing access to research results in the form of network services they can present their achievements. Scientists are given a ready environment in which they can present their results and be sure that they will be displayed in the right location. The basic advantage of this solution is that it is open and that any resources can be added to it. In one place it is possible to present data concerning mineral deposits, demographic data, dangers, spreading of epidemics and many others. Access to these thematically varied data brings measurable benefits to the developing information society opening amazing learning opportunities. Thanks to an interdisciplinary approach, combining geoinformation from various areas (sources) gives the chance to recognize and analyze matters which might otherwise remain unnoticed in considerations limited to a particular thematic subject.

Geoinformation is a huge chance for scientists as it opens the way to reach new users, especially in the area of support for decision-making processes. Nevertheless, it is necessary to be aware of the fact that only reliable information can be successful, as it is exposed to the direct critique of large groups of online users. This community very quickly and brutally verifies all shortcomings and praises only reliable sources of information.

Bibliography

1. Gaździcki J., Leksykon geomatyczny, Wyd. Pol. Tow. Info. Przestrzen., Warszawa, 2001,
2. Longley P., Godchild M., Maguire D., Rhind D., GIS Teoria i praktyka, Wyd. Naukowe PWN, Warszawa, 2006,
3. Nałęcz T., Michałowska K., (in print): Terminologia określająca rejestry danych przestrzennych jako normatywne zasoby krajowej infrastruktury informacji przestrzennej, Roczniki Geomatyki, Warszawa,

4. Rajabifard A., Binns A., Masser I., Williamson I., The role of subnational government and the private sector in future Spatial Data Infrastructures, International Journal of GIS 20 (7), 2006.

Websites

- OGC: Open Geospatial Consortium, www.ogc.org.