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GIS at school

Guidebook for biology, geography, and science teachers

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EduGIS Academy in a nutshell
Introduction
Dear Reader,

On many occasions, you must have wondered how to enhance biology or geography lessons in the way that will not only make them more interesting for your students but also facilitate acquiring new knowledge and skills. With great pleasure we present to you this guidebook of using GIS by school teachers, in which you will find the answer to that question – proposals for using geoinformation technologies (GIS) in geography, biology and environmental education classes.

What does GIS mean? The acronym stands for Geographic Information Systems. It involves analyses of geographic data, the result of which is information, also called geoinformation. Simply put, geoinformation is information about the world saved in the digital format so it can be read later to determine the location and the characteristics (called attributes) of a specific object, e.g. a natural one. Geographic information is usually presented in the form of maps that show us the object or phenomenon: its type, extent, location, diversity, continuity, intensity and other properties.

Modern media, especially the Internet, use geoinformation almost constantly, for example as satellite orthophotomaps showing the location and extent of various events (e.g. natural disasters), weather maps, maps with results of elections or other important events. Finally, we use geoinformation when we look for places where we’d like to go on a trip, weekend, or holidays. In these situations we eagerly use information portals that allow us to track routes on a map and look at other people’s travel reports. Both we, adults, and students are used to geoinformation even though we’re not always aware that this specific form of information shown on maps is named that way.

Geoinformation can be helpful for the teacher working with students. It makes it easier to understand processes occurring in the natural environment. It leads to seeking, determining and analyzing relationships between different elements of the natural environment and between the natural environment and societal and economic phenomena and processes. It teaches how to draw conclusions and look for causes of these phenomena. It is especially important when we try to show the students the non-trivial secrets of statistics, methods of analysis and presentation of quantitative data describing phenomena and processes occurring in real space.

Using geoinformation was the main subject of the EduGIS Academy project carried out by the UNEP/GRID-Warsaw Centre from January 2010 to June 2011 together with experts, teachers and teaching methodology consultants coming from all over Poland who cooperated within the EduGIS Working Group. Experiences gained from this project as well as its major results are collected in this guidebook.

The project was implemented in cooperation with teachers from Norway. Meetings of the Polish teachers with their colleagues from Gjøvik allowed for exchange of experiences and were the source of inspiration for both parties, resulting in increased competencies of all (both Polish and Norwegian) teachers with respect to teaching methods.
The Polish teachers’ ideas for lessons using geoinformation technologies were received with great interest by Norwegian students and were highly valued by the Norwegian teachers.

Meeting of the EduGIS Working Group and the Norwegian teachers at the Gjøvik University (Norway) (source: UNEP/GRID-Warsaw Centre).

From left: Elżbieta Wołoszyńska (UNEP/GRID-Warsaw), Rune Ødegård (Gjøvik University), Hanna Habera (Mazovian Municipal Teacher Training Center, Radom Department), Anna Janowska (Public Junior High School in Świerże Górne), Monika Ruszczecka (UNEP/GRID-Warsaw), Trond Henriksen (Gjøvik High School), Magdalena Machinko-Nagrabecka (UNEP/GRID-Warsaw), Urszula Depczyk (Warsaw Centre of Educational Innovation and Training), Agnieszka Chrząstowska-Wachtel (John Paul II Family Alliance High School in Warsaw), Renata Sidoruk-Sołoducha (School complex no. 77, Bolesław Prus Junior High School no. 19 with bilingual classes in Warsaw), Ewa Bryndza (Communications School Complex in Gliwice; Gliwice Didactic Centre.), Sverre Stikbakke (Gjøvik University), Mirosława Rogala (John Paul II Junior High School no. 1 in Sochaczew.), Joanna Poręba-Kwiatkowska (Jan Kochanowski High School Complex no. 6 in Radom; Radom Teacher Training Centre), dr Witold Lenart (Faculty of Geography and Regional Studies, University of Warsaw; deputy director of the University Centre for Environmental Studies), Karsten Johansen (Gausdal High School)

Training materials that were developed by the EduGIS Academy are available online at the project website: http://www.edugis.pl. The “For teachers” tab includes supplementary material for this guidebook, including e.g.: student work sheets, review of online resources with GIS applications, data available to the stu-

Being in Norway was very important to me. I appreciate and thank the Norwegian colleagues for such a well-prepared visit. We had the opportunity to see how Norwegian schools look like, how lessons are being conducted. Comparing curricula and textbooks was very interesting, too, as was the approach to teaching. I particularly liked the practical, utilitarian approach to teaching geography in Norwegian schools, which is very scarce in Poland. Problems with oil spills, landslides, avalanches – excellent.

Agnieszka Chrząstowska-Wachtel,
John Paul II Family Alliance High School in Warsaw
dent and teacher, e-learning training courses, films about the EduGIS Working Group visit to Norway. These materials are available under the CC-BY-NC-ND Creative Commons license. It means, dear Reader, that you may share them with your students (Share-alike), under the following conditions:

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We hope that you’ll be inspired by this guidebook and that it will help you implement geoinformation technologies in your classes.

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**Special thanks**

At this point we would like to warmly thank all the people that made this publication possible. It is the collective work of the EduGIS Working Group: teachers and teaching methodology consultants, experts, and the team of the UNEP/GRID-Warsaw Centre.

Special thanks are being extended to our friends from Norway. They showed us how much joy and satisfaction can be derived from working with students who consciously and wisely use geoinformation technologies. They also drew our attention to the importance of the selection of appropriate lesson topics, that is including issues close to the student’s heart. It might concern the most valuable natural resources, environmental assets, or potential problems and threats resulting either from natural environmental processes or from unwise human activity.

*Monika Rusztecka*
*Elżbieta Wołoszyńska*
*UNEP/GRID-Warsaw Centre*

*We dedicate this guidebook to the students themselves. We hold great faith in the modern youth. We hope that their involvement and commitment, combined with the desire to broaden their knowledge and skills and supported by the great work of the teachers, will shape the future society – responsible for its environment and understanding the need to preserve natural resources for future generations.*
Why should we teach geography and biology with the help of geoinformation technologies?
Why should we teach geography and biology with the help of geoinformation technologies?

Witold Lenart, Ph.D., Faculty of Geography and Regional Studies, University of Warsaw; deputy director of the University Centre for Environmental Studies

Geography and biology are sciences that derive the biggest amount of information from the surrounding world. This world, despite the fact that it constantly changes, still changes at a slower pace than the rising need for environmental information. Gathered by (or with the involvement of) a huge number of observers, interpreters and measuring tools, the databases are still lacking – they become outdated too quickly, or inaccurate enough to leave a margin for subjective prognoses and “interpolations”. Let the clearest proof of this be our current efforts to collect data on areas potentially exposed to flooding. Available topographic maps with terrain elevations that can be read with accuracy of tens of centimeters are not enough. We need information better by an order of magnitude. We need information in the scale of thickness of a sandbag.

Another situation, clearly showing such a need, is the hurried process of completing the information about animate natural resources within the NATURA 2000 areas. We have set up this network and now we should know very well what types of economic activity are possible there, given the overriding need of protecting the taxa and ecosystems. In both cases it is necessary to collect and organize the wealth of already existing information, supplementing it with first-hand data, and creating information systems suitable to be used both on the national and local scales – such as the smallest river basins, habitats, or wildlife refuges.

In both cases there is a very important requirement – the necessity to collect and share the data so it could be constantly improved and made more detailed to keep up with changes in the environment, including its anthropogenic transformations. Let’s notice the basic feedback loop – the more information, and thus the more accurate decisions made with the help of this information, the more pressing becomes the need to include in the data packages even the smallest changes in environmental trends. After all, we have to control the changes that we cause, consciously or not. Just the above could be an important argument for a wider introduction of geoinformation in schools, just as no one doubts the need for IT education in general.

The question arises what segment of geoinformation, especially with respect to the basics of methodology, should be taught in the school? It is obvious that only a small and rather constant share, given the amazing progress in this emerging scientific field. However, it is worth noting that computer sciences, increasingly popular school. in their practical application use more and more examples related to geoinformation which integrates knowledge, brings up the issue of decision-making, and is rich in content.

Let’s focus on a computer system designed to process and analyze geographic (spatial) information – GIS (Geographical Information Systems). In the school setting, the
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The meaning of this term is somewhat different than the operational meaning. The goal of education is, in every case, achieving the desired level of knowledge and formation of certain attitudes in the student. In the industrial, operational, sense, there is a need for operational efficiency and accessibility. This discrimination is, in the case of GIS, particularly important and could be compared, perhaps with some exaggeration, to controversies caused by the declared needs in the field of environmental (e.g. waste management) or automotive (traffic safety) education. Simply said, the school education and “upbringing” does not explicitly include any “package” of operational goals, and ICT and GIS technologies usually confine themselves to such purposes. Fortunately, it only makes it hard but not entirely impossible to use these tools in formal education. In discussions on this topic, which is an eternal dilemma of the school, the focus should be on teaching GIS not only as a simple tool but also utilize it for other purposes.

Geographic Information Systems, in the technological context, are a combination of elements of remote sensing and photo interpretation, computer cartography, computer systems supporting the design and planning, databases and monitoring systems, and finally, in the broad sense, information and communication technologies (ICT). In middle and high schools there is no chance to familiarize the students with the rapidly growing number of computer programs. However, there is a rising need to understand the possibilities of using GIS in learning about the world and identifying the increasingly complex environmental problems. Here we are faced with an inevitable contradiction: the student does not have any opportunity to obtain theoretical knowledge on the basics of GIS, but should see how GIS techniques are being used. It is a known dilemma, similar to the one experienced for a long time in the cases of photography, medicine, or computers. It is important, however, to introduce to the schools a couple of modified approaches that will help, or even make possible, the use of GIS.

The basic question is the description of location. In contemporary schools, in both geography and biology lessons, the simplest methods of localization are being used – usually topological, with the help of “known” landmarks, areas or trails. Even the geographical names are used more sparingly than this. Let’s put it clearly – it’s the worst possible “introduction to the GIS world”. It is much better to use, even simple, local coordinates. Of course we assume that the use of geographic coordinates, the universal system of location description (flat, but also spherical coordinates), should grow. It should also be made easier thanks to the recent fast familiarization of the young people with GPS navigation.

It is necessary to increase the number of opportunities for the student to see the origin and contents of the databases. The best method is to create local, school and students’ spatial data resources. This way they could be analyzed, even if in a simple way. Despite concerns, a well-executed school program allows for a quick use of such analyses as opportunities to increase the knowledge about both the topic and the tool itself. Basics of statistics, cartography and knowledge of natural processes listed in the official school curriculum – although they belong to the more difficult topics – are sufficient.
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Another methodological “leap” is a possibility to use fairly simple models of the environment. In schools, established for decades and clearly visible in textbooks, does exist a method of synthesis of natural processes in the form of diagrams and models (spatial distribution changes, chronological, conceptual). The process of creating a model of the natural environment with the use of GIS is rather obvious. The entry point is the environment itself, and the source of our knowledge is direct observation (rather than e.g. internal discovery). At the stage of collecting the measured and other data we create simple environment model with separate units, well and unambiguously described attributes, relationships and temporal references. It is worth noting that we have the whole range of typological units to use. This is a particularly important issue for the school which, in the case of geography and biology, rather “frivolously” delimits space. The environment model also involves a slightly tougher question of “data model”. GIS methodology, probably not fully accessible to students, strongly influences this. But at least the division into vector and raster data should be understandable. The issue of geometry (especially in 3D) and temporal structure is even more complicated. The last stage of model construction is defining file parameters for the storage medium. It shouldn’t cause much trouble for the school with a computer lab.

So, in the case of GIS, we have the opportunity to “reconcile” the cognitive needs with barriers in the technical and theoretical knowledge. This is a huge educational advantage.

The basic answer to the title of this chapter can be seen in the following scheme. If we assume that the Geographic Information Systems are (at least for now) only a new method of discovering the world, then before it reconstructs our understanding and

Influence of geoinformation technologies on education process (source: Witold Lenart, Ph.D.)
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Awareness of the environment as such, it will certainly introduce a deeper recognition and understanding of processes. This is an objective important for the school. We can list countless examples of using GIS to show the complexity of processes in various environments – biotic, abiotic, anthropogenic, and, most importantly, the environment treated as a whole. Very useful opportunities are created by the spatial-temporal analyses of threats and changes in the environment, from simple highway noise emissions, through the possible degradation of the coast as a result of a tanker accident, all the way to consequences of the climate change. The possibility to use such analyses-scenarios leads to the fast growing need for information. It is a very important result, expected from the process of teaching. Let’s just notice the societal effect of such a need: strengthening democracy, expanding civic responsibility, building skills for objective criticism and control.

Not without significance is the fourth part of the graph – acquiring professional qualifications. It is estimated that the spatial questions will, in the near future, have a crucial impact on decision-making in the (hopefully) peacefully developing world. GIS techniques and their derivatives will become an everyday, mandatory tool of the decision-making process, integrally linked to a computer.

Outlined above, the rather positive opinion about the possibility of introducing GIS into schools does not negate the clearly visible deficiencies, of which the most serious is the usual reluctance on the part of all actors of the learning process to quickly adopt new ideas. But it should be noted that the science curricula lack the theoretical base. We still observe, with respect to biology and geography, the predominance of illustrated methods and lack of open scenarios, i.e. ones in which it is possible to use regionalhips or other specifically selected information layers. It results from the rather traditional presentation of data on attributes – that is, the characteristics of spatial objects and the relations among them. This is an outcome of the tendency for “quick generalization” of the discussed phenomena in order to write down the most obvious formulas for learning.

While describing the characteristics one can notice the rarity of using absolute scales, especially the interval scales, in favour of rather arbitrarily quoted nominal scales of various origins. Too often the attributes are arranged according to arbitrary scales, official ones, or even ones not related to the object characteristics or any environmental unit. What is even more lacking is the application of the most basic calculations of probability in constructing the scales, although there are positive exceptions, both in textbooks and in the school practice. It is desirable to introduce, in specific examples, spatial relationships and temporal characteristics of the objects. In part this is a result of difficulties in determining natural borders, and then their classification as scales. This theoretical task is not that alien to the need of schools. The border is not only the result of spatial analysis, since the nature itself knows no strict borders, but is also a societal – and thus also economic, political and psychological – border. GIS truly challenge the school on the issue of better delineation of these borders.

Paradoxically, the Geographic Information Systems lead to the increase in the potential for sensible, reflection-based teaching, without explicit, final answers, even thought
it uses a quantitative apparatus. It is simply a new understanding of the world, due to the introduction of the tool that immediately allows for the presentation of examples from this very world. It immediately sparks the development of a school database and – consequently – produces a problem of access to external data, for example from the National Environmental Monitoring system, international conventions, European Union, integrated services, special administration, etc. But, most of all, it raises the issue of the school’s own resources and resources of students at home and their surroundings (here the local governments have their role). The problem of access to data is, as mentioned earlier, an issue embedded in widely understood societal conditions, but also philosophical ones – after all, here the dilemmas about boundaries of reality are born. Finally, there is a complex aspect of responsibility of the school, teacher and student for the space and the information thereon.

Thus, education with the use of GIS and ICT should find its application as a group of methods of discovering the world in all scales of time and space (here the theoretical elements should be embedded in mathematics, physics and geography), as a method of solving natural and societal problems (applicable mostly to geography, biology and aggregated courses comprising both of these subjects), and as a way to present spatial phenomena (extensive capabilities for almost all subjects). GIS and ICT also have a place in the technical and economic education.

Examples of GIS applications especially useful in teaching could make a long list. Generally speaking, it’s all about the following aspects:

- credible identification and quantification;
- identification of phenomena and processes;
- objective introduction of predictors – the possibility of predicting the course and consequences of phenomena and processes;
- evaluation and control;
- fast and lasting documenting;
- ongoing verification and multiplication.

More specifically, e.g. in physical geography a visually attractive palette of possibilities is available to analyze layers of information separately and collectively, as well as new methods of presenting the structure of the environment, verification of valorization methods, and a very serious extension of the range of information. In turn, in ecology, GIS analyses are very useful for assessing biodiversity, state and changes in populations, analyses of migration corridors and barriers, presenting protected areas and their functions, establishing conditions for the development of eco- and agrotourism etc.

Today, needs for protecting the environment that involve the use of GIS in school are the following: waste management reform, new ways of water management, flood and wastewater protection, de- and afforestation, supply of thermal energy from local and renewable sources, organic farming and harvesting of raw materials for construction.

The decision-making aspect seem to be of particular value. In schools, appropriate decision-making models in the form of scenarios and examples should be used, from simple to complex, while utilizing the procedures of making such decisions and while
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using GIS databases and techniques. For example, organization of transport for mass public events, evacuation in cases of emergency situations, distribution of biomass sources that could be used for energy production, planning of actions promoting healthy food, designating areas for reintroduction of endangered species, choosing a trip route for friends from abroad, etc.

Wider introduction of GIS to schools, especially for teaching biology and geography, should be not only useful educationally and practically but also attractive. It should also be a good occasion for identifying talented students and their evaluation. GIS in schools should set the opportunities for further education in this field. It will create a chance for the emergence of a new, needed profession, as well as an opportunity for an individual business.

Therefore, there is a lengthy list of needs concerning:

- guidebooks for schools, as long as textbooks have a limited amount of contents regarding GIS;
- free sharing of scenarios containing GIS methodology;
- declaration by different operators on access to data;
- close cooperation with local governments in order to use spatially-related decision-making mechanism as best practices;
- further progress in computerization of schools;
- inclusion of GIS and ICT in the higher vocational education system;
- introduction of metadata, i.e. data describing data.

This will reduce the still high barriers to the widespread use of GIS in schools.
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Student competences related to the use of GIS in the classroom

Monika Rusztecka, UNEP/GRID-Warsaw Centre

An essential element required for building the knowledge-based society, well prepared for contemporary challenges, is early and proper development of students’ interest in the surrounding world and their competences in studying it. The youth should be motivated and prepared to explore fields important in the knowledge-based economy, so in the future they will become competent, well-educated and creative professionals.

Results of surveys carried out in schools indicate that students do well in explaining natural phenomena (knowledge) but not so well in integrating knowledge and skills in order to understand the global phenomena or to solve problems. During lessons the students often receive already processed information instead of having to discover it through solving problems, interpreting and analyzing data, formulating hypotheses, planning and executing experiments, drawing conclusions. Consequently, the students often can’t cope with situations requiring independent, creative thinking.

As already mentioned in the Introduction, in the EduGIS Academy project we presented to the teachers an alternative way of conducting biology and geography classes – one that engages the students in learning through modern geoinformation technologies. Before the exemplary scenarios included in this publication were prepared, we had focused our attention on the analysis of two issues that formed the basis of planning of the work with the student, namely, on the determination of:

- place of geoinformation in the biology and geography core curricula;
- key student competences with respect to applying geoinformation and geoinformation tools in secondary schools.

In the core curricula, biology and geography teachers won’t, in fact, find any direct reference to the use of geoinformation technologies, e.g. using GIS software or web applications with a similar functionality as research tools. Only in the geography educational goals at the fourth education stage (10th–12th year of education) there is a mention about acquiring, processing and presenting information on the basis of various sources of geographic information, including information and communication technologies and Geographic Information Systems (GIS). In the contents of courses and specific requirements we won’t, however, find any references to any specific means of use of geoinformation tools or spatial data, nor references to concrete topics which should be covered using geoinformation technologies. Moreover, we won’t find information about students’ competences that should be acquired as a result of using GIS. Therefore, we adopted the key assumption that geoinformation technologies are, when used by the teacher and the student, primarily a cognitive tool. They help the student to discover and understand the world, facilitate a better understanding of natural and socioeconomic phenomena through data analysis and data presentation on the map and in the
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form of graphs and three-dimensional visualizations. They allow for presentation of spatial phenomena in a scalable way – either in a more detailed (more accurate, larger scale), or more general (more general, smaller scale) context. Remember that learning to use GIS software shouldn’t be a goal in itself, but should serve as a method of solving specific tasks, pointing to the sources of data or verifying their reliability, accuracy, and relevance.

Given the above assumptions, we analyzed the teaching content for geography and biology at the 3rd and 4th educational stage (7th–9th and 10th–12th years of education, respectively) with respect to the possibility of using available GIS software, applications, data, and methods. What skills and competences are being acquired by students using GIS in school? We can divide them into three main groups:

- related to reading and understanding the contents presented on maps – proficiency in handling maps, 3D visualizations, photographs, charts;
- related to identification of spatial relationships and links, especially in nature;
- related to data analysis and formulating conclusions.

Undoubtedly, when teaching with the help of GIS, the ability to perceive and determine spatial relationships is crucial. Bednarz (2001) states that key competences comprise perceiving space (including recognizing spatial distribution), identifying shapes, correlations between spatially distributed phenomena, visualizing maps from verbal descriptions, sketching maps, comparing maps, layering, and aggregating map objects.

Among skills related to map reading and understanding, Bednarz lists the following:

- determining map information layers and decomposing the map into separate layers – identifying components of map presentations, including reference, background and thematic layers;
- aggregating data – indicating means of generalizing map contents;
- correlating data – indicating map contents that are interrelated and interdependent (e.g. soil type and habitat fertility);
- evaluating spatial distribution of phenomena: either regularity (e.g. higher population density in urban areas compared to rural areas), or randomness (e.g. occurrence of natural disasters such as fires);
- assessing similarities between objects (e.g. vegetation types within the same climate zone in various locations on Earth);
- forming hierarchies between objects (e.g. identifying various parts of the river, its tributaries and finally the borders of the river basin);
- map measurements (e.g. distance, area, calculations according to the map scale or even taking into account map projection).

In the group of competences that are challenging to the student and have direct relation to science subjects (physics, chemistry and mathematics) are skills associated with spatial data and databases. Here we can find primarily:

- classifying data – quantitative and qualitative methods;
- reading, on the map, the results of these classifications (e.g. regarding continuous and discrete phenomena);
Why should we teach geography and biology with the help of geoinformation technologies?

- sorting the data in the ascending or descending order, identifying maximum and minimum values, determining mean values;
- formulating queries – i.e., simply speaking, the ability to search the data according to specific criteria: value, data attribute, boundary conditions.

Using GIS in school can be an excellent way to prepare the students for teamwork. Most importantly, we should mention the enormous potential hidden in the joint students’ effort in solving research problems, preparing reports, maps and presentations, or executing research projects at all their stages: from formulating a research problem, through stating a hypothesis, data gathering, data analysis in order to verify the hypothesis, up to the presentation of the results in various forms: maps, graphs, online displays.

The list of student GIS competences was prepared in the tabular form and is available on the project website: http://edugis.pl/pl/dla-nauczyciela/grupa-robocza-edugis. It includes 59 specific skills that have been linked to specific contents of the biology and geography teaching curricula. We encourage you to find them in the scenarios developed by the EduGIS Working Group. This list is not complete, closed or finished. We are, Dear Reader, hoping that you’ll continue to develop it according to your own experiences and achievements of your pupils.

Sources:
School GIS competences in the European context (links active as of 20 June 2011):
1) United Kingdom:
GIS for schools, ESRI company, the British branch:
http://schools.esriuk.com/overview/curriculum.asp
2) Norway:
Student GIS competences within Naturfag (Animate Nature) subject block:
http://www.naturfag.no/artikkel/vis.html?tid=1246067
3) European iGuess project website:
Proposal for a European standard of GIS competence, p. 34:
Geoinformation sources (tools and data) available to teachers
Overview of geoinformation tools
and data available to the teacher

Elżbieta Wołoszyńska, UNEP/GRID-Warsaw Centre

Computer skills such as using a spreadsheet or a text editor, as well as web applications – these have been honed for many years during information-communication (ICT) classes. Thanks to them it is possible to easily and quickly search, process and analyze data and draw conclusions. When looking from this angle, geoinformation technologies (GIS) are not anything new on the Polish education market. The only difference is that when we speak of GIS we mean a specific sort of data: data having a direct reference to the geographic space (therefore, they are often referred to as spatial data). Thus, their analysis often requires applying appropriate tools (programs, applications) that will present (visualize) the area in which we are currently located, and at the same time show us relationships between its individual elements. This function is perfectly executed by digital maps. For example, when we invite friends to our summer place, we can send them an e-mail with the accurate description of the travel route (road numbers, turns, landmarks, distances, etc.). But it will be much easier if in our e-mail we include a link to a map application with the route already marked! Such methods of presentation are also used by the media, both by television and the Internet media since, according to the classic maxim, a picture is worth a thousand words.

Therefore, a lot indicates that also You, Dear Reader, have long been an active recipient and user of products that are being created with the use of geoinformation technologies. It’s time to become an active user of these technologies themselves! In this chapter, we will try to shortly describe available geoinformation tools and list places where you should look for detailed information on ways and possibilities of using them when working with your students.

ABC of geoinformation tools

Working with spatial data is similar to photography in the sense that to make a good picture you don’t have to use professional equipment (or software). Start learning from “compact” solutions and slowly delve into the secrets of geoinformation: starting from browsing available data sources and compiling required information from the ready-to-use data, up to creating your own data collections and sharing them with interested recipients. By all means, please make sure that your students are well aware of the issue of credibility of sources, as well as quality and up-to-dateness of data resources available on the Internet! Make them accustomed to use data derived from trustworthy, official sources such as state agencies/institutions, reputable research and academic centres, etc.
First... browsing online data

It is common knowledge that the Internet is an extremely rich source of information. Its rapid development meant that geoinformation technologies enabling presentation of spatial data online (i.e. web-GIS) developed just as quickly. This role is played by map applications. They show detailed thematic information, usually on the background of an orthophotomap (prepared on the basis of aerial or satellite photos) or a topographic map. Functionality of such maps is aimed mainly at browsing available data or searching for necessary information, e.g. determining a route (how to get to school from home), finding a specified object (where is the nearest health facility) or getting detailed information about it (what is its exact address). It is possible to make simple measurements such as distance or area and often also generate a link to a specific map view in order to send it by e-mail to another person who then can open the link and see on his/her own computer exactly the same thing we see on ours. These applications are free and easy to use. The scope of presented information is extremely diverse, both with respect to themes (from general sites like Google Maps [http://maps.google.pl](http://maps.google.pl), to specialized ones, e.g. concerning pollution – like Eye on Earth [http://eyeonearth.cloudapp.net](http://eyeonearth.cloudapp.net)) and coverage (e.g. services on the national scale: map of State Forests [http://www.lasy.gov.pl/mapa](http://www.lasy.gov.pl/mapa), regional scale: map website of the City of Warsaw [http://www.mapa.um.warszawa.pl/mapa](http://www.mapa.um.warszawa.pl/mapa) etc.). The decision what (and how) is being presented is made by the author/s of the site. To use these services you need an Internet browser and Internet connection.

A distinct kind of map application is the geoportal. It allows not only to view data provided by the site author, but also combine them with thematic maps from external sources available via the so-called network services (WMS – Web Map Service).

Geoportals also provide spatial data from official sources – collected by state agencies and institutions. Using them, we have the guarantee that the data is up-to-date and reliable, and students get to know the tools that professionals use every day. In Poland, the function of the national geoportal is performed by Geoportal.gov.pl [http://maps.geoportal.gov.pl/webclient](http://maps.geoportal.gov.pl/webclient) maintained by the Head Office of Geodesy and Cartography.

Due to the rapid development of the Internet, the number of map applications and geoportals grows daily. Deciding on using them, you should remember a few rules:

- check if the address of the website hasn’t changed since your last visit and if it works properly;
- test the application using a few computers at the same time to make sure that the school Internet connection is fast enough;

Teachers should not worry about language difficulties that arise when working with foreign geoportals. A good solution is to cooperate with the foreign language teacher, or to take advantage of students’ own language skills.

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Communications School Complex in Gliwice;
Gliwice Didactic Centre
Geoinformation sources (tools and data) available to teachers

- if possible, give the address to the students in advance, so they may see the website before the lesson. This way during the lesson you won’t be learning how to use the application but instead focus on the lesson’s topic.

Second ... a field trip with GPS and gathering and visualization of your own data

Viewing data available in map applications or on geoportals can be a perfect introduction to the next step on the geoinformation pathway – gathering your own data and creating a database to store them. Most often the data come from the measurements made in the field, e.g. with a GPS receiver. Such devices, apart from navigating to the target (and along the planned route), also make it possible to record locations (geographic coordinates) of selected points, and also save information about the route we’ve travelled. Themes of the gathered data can be adjusted to suit the lesson’s topic, e.g. collecting the information about tree species growing in the neighborhood. The gathered data can then be viewed in a computer using one of the available applications, such as Google Earth: http://earth.google.com. The free version of the allows for importing GPS-saved data and displaying them on the background of an orthophotomap with additional thematic information such as pictures or other multimedia materials, 3D models of buildings, etc. Data from the GPS receiver can be also saved in a file – it makes the process of sharing the results of work among students much easier.

Third ... data analysis, i.e. GIS software

When implementing most lessons’ topics, you can successfully use the tools described above in the first and second step. They are easy to use and the students are eager to use them not only at school. However, if we want to extend the range of opportunities to work with spatial data it’s worth reaching for desktop-type GIS software installed directly on the user’s computer. Among them is the free program Quantum GIS: http://www.qgis.org. It allows not only for viewing data, but also for their thorough analysis and preparing own thematic maps, for example a choropleth map. Thus, we have the opportunity to prepare maps containing information defined by ourselves and not imposed by the author of the map site. The condition for using GIS software is access to spatial data stored as files or in a database. It is less and less of a problem, since many institutions decide to share their resources for free for educational purposes. An excellent source of information is for example the ESA School Atlas which we’ll talk about in the next chapter. If you decide to use GIS software during classes remember to install it in advance on work stations where your students will work and make sure the applications work properly.

EduGIS Knowledge base – a guidepost for seekers

The geoinformation tools presented above are only a small proportion of available applications and programs available on the web. How to find the best didactic tool that
will help in completing the topic of the lesson? Take advantage of the EduGIS Knowledge Base available at the project website under the *For teachers* tab: http://www.edugis.pl/en/for-teachers/edugis-knowledge-base. It contains constantly updated information on Internet websites containing educational materials for teachers and students, with themes concerning geography, nature, and information and geoinformation technology. Resources of the database can be browsed in two ways: according to the category of educational material (e.g. database, interactive map, GIS application, GIS-games) or according to teaching contents (biology or geography). Search results also contain information about specific requirements of the core curriculum of the subject, fulfillment of which can be achieved with a given resource. There is also a possibility to add new links to the database. We encourage you, Dear Reader, to actively participate in expanding the EduGIS Knowledge Base.

**It is never too late to learn, or the e-learning platform of the EduGIS Academy**

As the famous saying goes, the hardest thing is to start. If you’re interested in one of the geoinformation tools presented above but you don’t know how to use it, we invite you to take advantage of the *EduGIS Academy e-learning platform*: http://mapserv.gridw.pl/edugis/dmz/. After completing a short registration form you’ll gain access to educational materials developed during the project. You’ll know how to use map applications and the Geoportal.gov.pl website. Separate courses are devoted to the use of GPS receivers and working with Google Earth. This knowledge will be helpful in organizing outdoor activities for the students. Also presented, step by step, is the handling of Quantum GIS: displaying data, combining data from external sources, analysis of collected information, or preparing thematic maps.
Geoinformation technologies are a living and evolving field. Available spatial data resources or geoinformation software/applications change rapidly and constantly increase in numbers. That’s why it is so important to share your own experience with interested educators. This chapter is closely connected to the lesson scenarios (plans) and commentaries provided by our teaching methodology consultants. Lesson plans are a rich source of information about available applications and spatial data resources, at the same time showing their practical application in specific topics. Moreover, comments from our project experts allow for a broader and sometimes non-standard look at the use of specific tools.

Mirostawa Rogala, John Paul II Junior High School no. 1 in Sochaczew

The course on the EduGIS Academy e-learning platform devoted to preparing thematic maps (source: UNEP/GRID-Warsaw Centre)
Earth observation satellites as a valuable source of information about the planet. European Space Agency educational programs on the example of the ESA School Atlas

Michał Krupiński, Earth Observation Team, Space Research Centre, Polish Academy of Sciences

http://gmes.cbk.waw.pl/

Our whole science is primitively childish compared to the real world – but still it is the most precious thing we have.

Albert Einstein

Our world has always provoked controversies. Starting with the shape of the Earth we live on, through the boundaries of its continents, ending with phenomena which the human eye and mind were hardly ever able to understand. Today, we possess knowledge based not on myths and superstitions, but on science – science created by humans that were not only smart, not only outstanding in their specialization, but who were also led by the desire to comprehend the world, who were actively pursuing answers, who did not feel satisfied with “I do not know”, who looked with passion at the universe as an invaluable source of adventures and experience. This is what biology and geography lessons should teach us – inspiration. As explorers and discoverers, we would visit the farthest reaches of our planet, attentively observing its changing environment, analyzing behaviors, and drawing conclusions that would surprise more than one student bored by the school routine.

Satellite image of the Earth as seen by the SPOT satellite (source: ESA School Atlas)
It was this curiosity that lifted the air the first daredevil who dared to answer the question: how does it look like from above? The answer, confirmed by two centuries of enthusiast wanting to soar as high as possible, led us to the point where the European Space Agency (ESA) shows us the world seen from above, the world that a human floating in space above our planet would see.

The ESA School Atlas is not only a source of knowledge but also of amazing adventure that many years ago would seem impossible for most of us. It is an excellent example and proof that no graphical program can create an image better than the reality. If one picture is worth a thousand words, then this Atlas is a comprehensive encyclopedia of knowledge and inspiration.

What can we find in the Atlas?

The entire publication consists of three elements: the full-colour atlas, a book for the teacher, and two DVDs with data and suggested exercises. Supplementing these materials is a website prepared by the ESA: www.eduspace.int where you can find data, applications, descriptions, animations and exercises. Resources are grouped according to the age and experience of users, beginning with simple animations all the way to exercises in astrophysics.

The general structure of the Atlas resembles traditional geographic atlases, but differences can be seen from the very beginning. We learn about the usefulness of satellites, how they work, for what satellite images can be used, how to update maps, create three-dimensional models of the Earth’s surface, or what is GIS and remote sensing. Next, we approach the Earth as a whole, learning the concept of plate tectonics, cloud cover, temperature, climate zones, pollution, and natural hazards. As in any geographic atlas, also here we have a section devoted to every continent. The difference is that we see maps in the form of satellite images. We can see real images of the Earth’s surface, such as we could see from hundreds of kilometers above. The ESA introduced the division into several thematic groups whose boundaries are not clear-cut and their contents complement each other. In the Atlas, we will find issues such as tectonics, geology and geomorphology, atmosphere, climate and weather, hydrology, natural hazards, forests,
agriculture, urban areas, energy and industry, changes in the Earth’s surface, transportation, tourism, and the world’s natural and cultural heritage.

The ESA School Atlas consist of nearly 300 pages, each with about four satellite images, which gives us an impressive number of over 1000 images. Each picture is thoroughly described and includes two sample exercises for the student. Exercises of the first type can be done independently based on the Atlas or printed materials (DVDs contain the entire Atlas in the form of PDF files that can be printed and distributed among students during the lesson). Exercises of the second type are those for which you need a computer and free software provided by the ESA, and they are accompanied by step-by-step instructions. With these applications, everyone can conduct research and analyses of satellite images. Even if there’s no computer in the classroom, these exercises can be used as homework.

What exercises does the ESA offer us?

The first group of exercises, not requiring access to a computer, resemble those we know from school and which we have been doing in the classroom. The advantage of the ESA Atlas is the visual aspect: the real satellite images which give us more information than an ordinary map. In addition to that, the authors propose various experiments. In the very first chapter, we get the recipe for our own meteor impact crater, and even a simulation of a meteoroid’s collision with the Earth! All you need is some flour, some cocoa, a slingshot, and a stone. What’s the next step? On a flat surface we put an A3-size sheet of paper, prepare a 3-cm thick layer of flour, with a thin cocoa layer over it. Then we grab the slingshot and stone, load and... shoot! With our own eyes we will see how a small stone can create a large crater. There are over 150 large impact craters identified and investigated around the Earth. Like all other structures on our planet, they are being eroded, some are covered with vegetation and were discovered only in satellite images. Thanks to them we can, for example, determine the crater dimensions (using a scale and a ruler, or tools provided in the computer program itself), or how its creation affected the surrounding area. This

Manicouagan Crater in Canada seen from Landsat satellite
(source: http://www.esa.int)
is just a brief example from a rich set of exercises in which everyone will surely find something interesting.

The ESA School Atlas is not just another publication serving merely as a device to present textbook knowledge to the class. It’s a theory and practice in one, based not on stereotypical scripts but rather on the quest to spur interest and initiative for continuous growth. Nowadays, knowledge is reduced by the students to merely material elements that you either have or not. Thus, it is necessary to show the young people that science is not an object, but an adventure in which the best assessment of our experiences is made by ourselves. This Atlas is a great incentive to start this unusual, or even amazing, journey.

In order to purchase the Atlas (including the additional materials), contact the Geospace International Gmbh in Salzburg:

Geospace GmbH
Schön Straße 13
1050 Vienna, Austria
E-mail: office@geospace.at
www.geospace.at
Lesson scenarios (including a methodological commentary) prepared by the EduGIS Working Group
Lesson scenarios (including a methodological commentary) prepared by the EduGIS Working Group

Lesson scenarios (a.k.a. lesson plans) are scripts assisting the teachers in their class work, facilitating planning, preparation and carrying out lessons with students. These scripts allow to verify whether all essential elements of a lesson are appropriately exposed, and at the same time allow for quick modifications (e.g. by removing unnecessary elements and introducing new ones) in order to adapt the lesson to the knowledge and skills of the students with whom the teacher is currently working.

Undoubtedly, an important role of the scenarios lies also in their facilitating communication between teachers, and in the exchange of ideas on how to organize interesting, extraordinary and inspiring lessons. For this reason, preparation of exemplary scenarios for geography and biology lessons that include information-communication technologies (ICT) and geoinformation (Geographic Information Systems – GIS) was one of the key activities carried out by the EduGIS Working Group. We wanted to show the educators who are just starting their adventure with modern technologies in environmental education that this road can be not only easy and enjoyable, but above all very fascinating. Especially if we actively engage the students through taking an appropriate educational approach.

Typical geography lesson at a high school in Gjøvik (source: UNEP/GRID-Warsaw Centre)
Problem Based Learning in the modern school

Elżbieta Wołoszyńska, UNEP/GRID-Warsaw Centre

Tell me and I will forget,
Show me and I may remember
Involve me and I will understand
Confucius

The classic Polish proverb says “What little Johnny does not learn, big John will not know”. This is a wise statement, but the most important is its interpretation in relation to the teaching process taking place in schools. Its essence should not be simple acquisition of the greatest amount of knowledge determined by the core curriculum of the subject. The essence is to develop the ability to use it in practice – using such methods that will allow the young, absorbent minds to develop their interests and cognitive skills.

One of the teaching methods that meets these goals is Problem Based Learning. It first appeared in didactics in 1950s. The basis of students’ acquisition of new knowledge and skills is independent problem solving, both theoretical (“discovery” – most commonly understood as discovering the cause or effect of a phenomenon thanks to the knowledge about how it proceeds) and practical (“invention”, “construction” – practical implementation of applications so far only theoretically known to the students). The young people take the roles of researchers who are put in the situation where they are forced to ask questions and formulate hypotheses and verify them in the course of an analysis.

We can divide the process of problem solving into the following steps:

- noticing the difficulty – finding that there is a problem/vagueness/inconsistency;
- identification of difficulties, that is, formulation of the problem;
- searching for possible ideas for the solution (formulation of a hypothesis);
- evaluation of the ideas (verification of the hypothesis);
- formulating conclusions – choice of a proper solution (consolidation of acquired knowledge and skills).

In this method the role of the teacher, who plays the role of a mentor – supervisor (organizer, coordinator) of the students’ work, is crucially important. In moments of hesitation, the teacher leads the youth along the appropriate path of thought, points to the sources of new knowledge and supports them with her/his own knowledge and experience.

Research approach in teaching science subjects (biology, geography, ecology) was a key assumption of all scenarios prepared in the EduGIS Academy project. The lessons are based on formulating research hypotheses by students and then, during the classes,
on pursuing the solution to the specified problem. Such an approach is in line with the requirements of modern teaching, seen both in the core curricula of science subjects and in various initiatives introducing new forms of education, e.g. student science projects introduced in Junior High Schools.

Efficient implementation of the research process during biology or geography lessons is supported by carefully chosen teaching tools and methods. In the modern school, a big role belongs to geoinformation – a set of educational tools helping the young people describe, conduct research upon, and analyze objects and phenomena in space. The young scientists learn how to correctly acquire, process, and analyze data and present their results in a way that is clear and understandable. The division of the process into these elements is reflected in the proposed scenarios. The range of available geoinformation tools (interactive maps, map applications and geoportals, GIS software, satellite navigation tools) is more and more abundant and this, too, is reflected in the scenarios. At the same time, technical capabilities of schools are on the rise. It allows for selecting suitable means of teaching, adapted to the needs of the students, sparking their interest and curiosity, understandable to the young members of the information society, and thus ensuring the best educational effect.

Problem Based Learning in sciences, with the help of rapidly developing geoinformation technologies, is currently successfully used in many countries. It is also used by the Norwegian teachers from schools in Gjøvik and Gausdal (the schools cooperating in the project). Students follow the research process, learn through discovery, and classes are conducted according to the principle: observe, study, learn. And thus the teaching ideal, defined centuries ago by Confucius, is being attained.

Sources
Kupisiewicz Cz., 2000, Dydaktyka ogólna (General Didactics), Oficyna Wydawnicza (Publishing house) „Graf-Punkt“, Warsaw
Wichowska M., Nauczanie programowane i problemowe w aspekcie procesu nauczania wielostronnego (Programmed and Problem Based Learning in the context of multilateral teaching), http://polanki.republika.pl/art3.html
Walat A., 2007, O akonstrukcjonizmie i ośmiu zasadach skutecznego uczenia się według Seymoura Paperta (On constructionism and eight principles of effective teaching according to Seymour Papert), Meritum 4(7)

The visit to Gjøvik and Oslo brought valuable knowledge and, most importantly, was the clash with realities of the Norwegian school. I really liked the consistent preparation of the Norwegian teachers for work with the computer and interactive whiteboard. School and university buildings, their equipment, widespread availability of technology and online services supporting teaching (portals for schools) are truly impressive. [I noticed] clear division of roles – the teacher plans and organizes the students’ work, but learning is their task and responsibility. We had too few opportunities to observe activities and interactions between students and teachers, but we could really benefit from the Norwegian calmness, control and restraint when it comes to issues of education.

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Lesson scenarios (including a methodological commentary) prepared by the EduGIS Working Group

Lesson plan template with comments

Anna Woźniak, methodology consultant in biology

All lesson scenarios (plans) prepared by the EduGIS Working Group were based on the standard template developed in the project. It contains some constant elements of the class work: determining the group of students to whom the scenario is directed, time and place of execution, or operational objectives and used methods and techniques. The particularity of it derives, however, from the combination of Problem Based Learning in sciences and possibilities offered by modern geoinformation tools. For this reason, the description of each lesson was divided into three phases.

- introductory, in which a research question/hypothesis is formulated;
- implementation, in which data is acquired, processed and analyzed, and results of this analysis is presented – which constitutes an essential element for finding possible solutions, followed by an assessment of proposed ideas (verification of the hypothesis/answer to the research question);
- summary, in which conclusions are presented and proper solutions chosen.

Supplementary materials assisting the teacher have been added to the template. Dear Reader, if you appreciate the template, we encourage you to use it!

Subject

Formulated in an attractive (intriguing) and understandable way. It should not be too long and should define precisely what will be discussed/which problem will be solved during the class.

The ideal topic should define (1) the content of the lesson, (2) means of action (skills) and (3) educational aids (information resources).

Example subjects:
Predicting (2) life expectancy in Poland (1) based on statistical data (3), or
Predicting (2) the extent of floods in the Vistula basin (1) using GIS (3).

Or in a different way (for those who do not like schemas), e.g.:
Let’s check how long we would live.
Who likes floods?

Target group

(information in the form of icons next to the titles of respective scenarios)
To whom we address the lesson and what is the age of the students.
Lesson scenarios (including a methodological commentary) prepared by the EduGIS Working Group

Location and time of the lesson

(information in the form of icons next to the titles of respective scenarios)

Place where the classes are conducted e.g.: the classroom, a nature reserve behind the school, a meadow along the river etc. You can also give the name of the specific location – e.g. a national park, or – if this turns out to be a large area – a specific spot within this area. Estimated time of the class, e.g. “3 hours for the field study + 1 hour in the classroom”.

The main goal of the lesson

Define the main goal of the lesson – what is the main result of the lesson for students. You can use the following sample wording:

- getting to know ...
- familiarizing with ...
- deepening knowledge on ...
- implementation of ..
- taking care of ...
- fostering ...
- interpretation of ...
- recognition of ...
- shaping of ...

Operational objectives

Knowledge

What is the scope of information that will be gained by the students?

Skills

What kinds of formal skills will be acquired?

GIS skills

Skills associated with using by the students of geoinformation tools and techniques such as map applications, geoportals, GIS software e.g. Google Earth, Quantum GIS, GPS devices, etc.

Attitudes

How will the lesson impact on the students’ attitudes (e.g. raise awareness on environmental values), make them more sensitive and emphatic towards the needs of other people.
You can formulate the operational objectives with the use of “operational” verbs – both with respect to new and old (but perfected) competencies. List of verbs expressing actions useful for the formulation of operational objectives can include the following:

analyze
appoint
argue
arrange
ask
assign
avoid
bring
build
calculate
call
change
classify
close
collate
communicate
compare
conclude
construct
control
convince
count
create
criticize
decrease
define
describe
detail
detect
determine
develop
diagnose
directed
discuss
distinguish

do
draw
edit
encouraged
estimate
evaluate
exchange
explain
explore
facilitate
fill
forecast
formulate
found
generalize
group
help
identify
illustrate
include
inform
inoculate
interfere
interpreted
introduce
isolate
judge
justify
keep
lead
link
localize
manipulate
mean
measure
mobilize
model
modify
narrate
observe
obtain
oppose
organize
participate
pave
pave
perform
place
plan
plot
practice
prepare
present
prevent
provide
purified
put
quote
reconstruct
reduce
remove
reply
see problems
select
separate
set
show
simplify
solve
sort
spread
state
store
stress
Lesson scenarios (including a methodological commentary) prepared by the EduGIS Working Group

Teaching methods/techniques

A short description of teaching methods and techniques to be applied during the lesson. An important issue is to choose the most adequate techniques that will allow to attain the goal of the lesson. Planned ways of teaching should be adapted to the level of skills of the group and take into consideration differences between the students’ skills and knowledge level (e.g. if the lesson recapitulates the previously gained knowledge and/or skills, or it is a new subject and new knowledge and/or skills).

Organization of the students’ work

The form of work should be adjusted to the level of knowledge of the group, the selection should also take into account the amount of material available for the students and lesson timing:
- group work (significant is the number of students in the team and the grouping system: imposed or voluntary);
- individual tasks;
- collective work (whole class).

Educational aids

List of materials planned to be used during the lesson (including attachments).

List of educational aids should also cover geo-information tools, Internet resources and available applications, geoportals, multimedia applications, surveying devices, etc. that could be applied during the lesson.

Description of the lesson

Initial phase

(commitment, interest in the subject, motivation)

Introduction to the subject
- Orientation on the subject of the lesson. The main goal of this phase of the lesson is to make the students curious by showing one example situation, a short experiment or a few images so that the students become aware of the problem.
Organizational issues – the division of the class into groups, handing out necessary materials.

Recognition and formulation of the research problem
- Formulation of research problem; defining a hypothesis – a statement that requires confirmation.
- Formulation of the subject (you can reiterate the hypothesis).

Implementation phase
(subject development)

Data acquisition
Selection of one of three methods depending on the purpose of the lesson:
- 1st method: materials are prepared by the teacher (printouts, multimedia presentations, tables etc);
- 2nd method: materials are acquired by the students from the Internet (step-by-step instruction “how and where the students should acquire the data”);
- 3rd method: data collected during field studies (fieldwork scenario required; work with the field worksheets or PDA devices).

In this part of the lesson the teacher should make the students aware that:
- the use of materials from the Internet requires acknowledgement (providing references on data sources) – it is a good opportunity to reiterate the issues of e-ethic;
- data collection should be treated only as one of the steps in achieving the goal. It must not be a goal of the lesson. The teacher should always have in mind that the goal of the lesson is to verify the hypothesis based on data analysis.

Data processing and analysis
Analysis of data (sorting, comparing the obtained information) in order to answer the research question (or verify the hypothesis).

Data presentation
Presentation of the results of the performed analyses in the form of thematic maps, tables, graphs.

Solving the formulated research problem
Conclusions – the answer/answers to the research problem, verification of the hypothesis (instruction / information on the presentation of results is necessary).

Summary phase
Presentation of the results and conclusions formulated by the groups / lesson participants – general conclusions according to the instructions prepared by the teacher on how to prepare a summary presentation and what should be synthesized and/or generalized.
Lesson scenarios (including a methodological commentary) prepared by the EduGIS Working Group

Homework

Should always be purposeful, with direct and clearly formulated commands (for example: answer the question ... replace, search and write, etc.). The homework may aim at:
• consolidation of the new knowledge (or skills);
• preparation for the next class.

Evaluation

The teacher solicits feedback on the effects and attractiveness of classes – important in order to improve the lessons. Evaluation forms for students are available as additional materials to the scenarios on the project website.
Lesson scenarios

The following section contains over a dozen proposals for lessons developed by the practitioners (teachers and teaching methodology consultants – members of the EduGIS Working Group), and verified during real classes. Every interesting idea for a biology or geography lesson with the use of geoinformation tools was marked with appropriate symbols, allowing for easy identification of:

- level of education (G – Junior High School, L – High School – 7th–12th year of education)
- subject (geography, biology);
- type of class (class with one computer to be used by the teacher, field classes, computer lab with computers available for students);
- duration: number of teaching units allotted to each type of class (one icon symbolizes one 45-minute-long lesson).

Every scenario has a section called “Educational aids” with information about education tools that should be used during the class. When an aid is referenced in the scenario, it is done by using an appropriate numerical designation, e.g. [1]. There are also additional materials – work sheets, presentations, instructions for the students, evaluation questionnaires etc. – available on the project website http://www.edugis.pl/en/ (“For Teachers” tab).

Dear Reader, the versatility of the scenarios’ topics and the extent and degree of difficulty of the tools ensure that among them you will find a proposal suitable for your purposes. Under some of the scenarios we included comments and tips about ways to add variety to classes by using other available GIS tools.

Enjoy!
Brazil – the country of rainforests and overpopulated cities

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The scenario was prepared in accordance with the High School core curriculum for geography, specifically considering the part that says that the student distinguishes the main characteristics and causes of cultural and ethnic diversity of South America (10.11), is aware of the conflict of interests between the environmental effects of the Amazon Forest’s deforestation and its economic use, and defines the characteristics of development and problems of big cities in Brazil (10.12). It has been carried out by the 3rd year (8th year of education) Junior High School students.

Execution of the scenario requires proper technical facilities (good Internet connections to download data), and efficient work by the students. If the class can’t be held in a computer lab, the data can be acquired by the students before the lesson and presented by the teacher during the class, e.g. in the form of PowerPoint slides. Based on the data, the students perform an analysis and draw conclusions. In such a case, the tasks are carried out using the work sheet, and a multimedia presentation may be assigned as a part of homework.

The main goal of the lesson
Developing skills to describe and explain the relationships and dependencies between human activities and the natural environment.

Operational objectives

Knowledge
The student:
– understands the concept of: selva, plantation, monoculture, favela, latifundium, interior;
– describes, based on the map, the location of Brazil and its capital;
– locates main geographical regions of Brazil on the map;
– presents the origins of Brazil’s population;
– lists causes of growth of Brazil’s population;
– determines the characteristics of development and problems of Brazil’s large cities;
– gives examples of influence of environmental conditions on the national economy.

Skills
The student:
– explains the causes for uneven distribution of population and cities;
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- explains causes of cultural and ethnic diversity of Brazil’s population;
- points to links between the natural environment and development of Brazil’s agriculture and industry;
- identifies a conflict of interests between the environmental effects of deforestation in the Amazon Forest and its economic use;
- uses various sources of information;
- reads thematic maps;
- draws conclusions;
- recognizes regularities.

GIS skills
The student:
- finds locations on the map;
- finds information on geoportals, websites;
- uses tools to navigate on the map;
- analyzes satellite images;
- assesses up-to-dateness of data;
- downloads information and documents from various sources;
- uses Google Earth;
- determines regularities and coincidences in the arrangement of phenomena;
- determines links and coexistence in space;
- uses acquired data in a multimedia presentation.

Attitudes
The student:
- realizes the value of the natural environment;
- works in a team.

Teaching methods/techniques
- Expository method (valorization) – film presentation.
- Independent inquiry and knowledge gaining – work with the source material, gathering, selection and verification of data obtained from the Internet.

Organization of the students’ work
Teamwork (2–3-person groups), collective work.

Educational aids
- educational movie Brazylia (Brazil) (4 min) DVD, Wyd. Pedagogiczne (Pedagogical Publishing House) Operon [1];
- movie showing the deforestation process in the Rondônia state in Brazil [2];
Lesson scenarios (including a methodological commentary) prepared by the EduGIS Working Group

- orthophotomap of Brazil available on the country’s geoportal [http://www.geoportal.com.br](http://www.geoportal.com.br) [6];
- Google Earth application [http://earth.google.com](http://earth.google.com) [7];
- statistical data acquired from the Brazilian Institute for Geography and Statistics (IBGE) [http://www.ibge.gov.br/english/](http://www.ibge.gov.br/english/) [8];
- computers, multimedia projector;
- software for creating multimedia presentations, e.g. PowerPoint.

### Description of the lesson

#### Introductory phase

**Introduction to the subject**
- spurring interest – DVD movie *Brazil* (4 minutes) by Operon;
- formulation of the lesson topic;
- organizational matters – dividing the students into teams.

**Recognition and formulation of the research problem**

Why is the population and economy of Brazil unevenly distributed?  
How does the human economy impact on the Amazon rainforests?

#### Implementation phase

**Data acquisition**

Data are obtained by the students from the Internet (under the guidance of the teacher and according to instructions). All teams work according to the adopted plan and prepare, in the form of a slideshow, their conclusions about the selected topic. The students are aware of the need to observe copyrights.

- The students search the Internet for data on the ethnic structure of Brazil, its colonization and internal migrations [8].
- The students read information on the distribution of crops and mineral resources in Brazil from interactive maps [3].
- The students find city plans and compare the spatial arrangement of Brasilia and Sao Paulo [4] [5] [6] [7].
- They search for city plans and compare physiognomy of the cities Brasilia and São Paulo.
- Using Google Earth, they track the course of the road BR230 – Transamazonica be-
between Itaituba and Altamira. They find relationships between the road network and forest coverage.

- Based on the movie, they describe the deforestation process in the Rondônia state in western Brazil [2].

**Data processing and analysis**

Data analysis and processing (sorting and comparing the obtained information) in order to answer the following questions:

- What factors caused the fact that a half of Brazil’s population lives in the area up to 500 km away from the eastern coast, which constitutes only 10% of the country’s area?
- Why is the population of Brazil ethnically diverse?
- What is the uniqueness of the urbanization processes in Brazil?
- Why is the Amazon Forest called “The lungs of the Earth”?
- What is the role of the Amazon rainforest in the economy of Brazil? What are the consequences of the rainforest’s economic usage?

**Data presentation**

The students write down the solutions to tasks on the Power Point slides. Team representatives present answers to the posed research problems.

**Solving the formulated research problem**

The uneven distribution of the Brazilian population was caused by historical, environmental and economic factors.

The exploitation of the Amazon Forest’s mineral resources and its economic development contributed to the destruction of rainforests.

**Summary phase**

The students evaluate the economic operations in the Amazon Forest from the viewpoint of an inhabitant of Brazil and inhabitant of Europe.

**Homework**

The Amazon gathers the interests of travelers. Give the names of Poles who popularize this region in books and movies.

**Suggestions for modification of scenario regarding the use of GIS tools**

A valuable source of information, both about the spatial layout of Brazilian cities and the deforestation problem in the Amazon region is the European Space Agency (ESA) School Atlas and spatial data attached to the Atlas on the DVD: satellite photos and thematic data in the vector format. The Atlas includes, among others:

- satellite photos with an easily visible advance of deforestation process in the Rondônia state (images from years 1972, 1986, 2000);
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- satellite photos of a section the Rondônia state with information about land use and clearly visible settlement network (vector data);
- satellite photos of Brasilia and São Paulo, including their suburbs and also including the division of city sections into zones according to their function (vector data).

Both satellite imagery and vector data can be collected using the Quantum GIS program. This task can be done independently by the students, or it can be completed before the class by the teacher. In that case, the students concentrate on the analysis, and not on the technical aspects of software usage.

Satellite image of São Paulo with additional information about functionality zones of the city – presentation using Quantum GIS (source: The European Space Agency School Atlas)

Additional materials to the scenario
- student work sheet.
What determines the appearance of the cities of Europe and the world?

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The topic about physiognomy of European and world cities is intended for the 2nd year High School Students (11th year of education) with the advanced geography course. The proposed scenario is best realized in a computer lab with access to the Internet.

The main goal of the lesson

Learning major physiognomic types of cities.

Operational objectives

Knowledge

The student:
– explains the concept of the physiognomy of a city;
– lists physiognomic types of cities and their characteristic features;
– recognizes and characterizes factors (environmental, historical, cultural) that have influence on the diversity of city physiognomy.

Formal skills

The student:
– recognizes various physiognomic city types based on source materials: photographs, city plans, aerial and satellite images (Google Earth, country geoportals, school ESA atlas) and descriptions;
– describes characteristic features of cities with a given type of physiognomy;
– shows on the world’s map examples of cities with the indicated physiognomic type;
– compares environmental, historic and cultural determinants of development of cities on different continents;
– browses in the Internet (also foreign websites) for multimedia presentations, films, information on characteristics of selected world’s cities;
– presents homework results on a school website (do you know that.../ our city, our capital...).

GIS skills

The student:
– uses Google Earth to: search for a given location, view satellite photos, learn additional information on a given city (access to photographs, 3D models of buildings), identify built-up areas in a city;
Lesson scenarios (including a methodological commentary) prepared by the EduGIS Working Group

– uses foreign geoportals that offer access to maps, orthophotomaps of a given area;
– uses map applications (OpenStreet Map, Google Maps) to learn city plans;
– uses Quantum GIS software to view spatial data and analyze the determinants of spatial development of a selected city (cultural and historical factors, environmental factors);
– uses Quantum GIS software to:
  • open a saved project;
  • switch information layers on and off;
  • change the display styles of individual layers;
  • open attributes tables.

Attitudes
The student recognizes equivalence of all physiognomic city types, understands their cultural and civilization diversity.

Teaching methods/techniques

● Working with source materials:
  – acquisition and selection of data from the Internet (map applications, Google Earth);
  – analysis and interpretation of data (use of geoportals, also foreign ones);
● working with maps in the atlas, locating objects on the wall map;
● working with an atlas of satellite photos;
● working with spatial data and GIS software (basic range/level);
● moderated discussion.

Organization of the students’ work
Collective, team, individual.

Educational aids

● Computers with Internet access – at least one per team;
● Quantum GIS software http://www.qgis.org [1];
● European Space Agency School Atlas and spatial data attached to the atlas on the DVD: satellite photos and thematic data in the vector format [2];
● Google Earth http://earth.google.com [3];
● map applications [4], including:
  – OpenStreet Map http://www.openstreetmap.org;
  – Google Maps http://google.maps.pl;
● country geoportals, including:
  – Polish national geoportal http://maps.geoportal.gov.pl/webclient/ [5];
● geographic atlases.
Lesson scenarios (including a methodological commentary) prepared by the EduGIS Working Group

**Description of the lesson**

**Introductory phase**

**Introduction to the subject**
Introduction of a “city look” topic by the teacher – slide presentation/multimedia presentation:
- basic terminology (the city, physiognomy of the city, city functions);
- historical basis for the city development: ancient, medieval, baroque city, a city during the industrial revolution – the impact of changing functions of cities on their shape;
- city functions according to Burgess (a modern city);
- examples of diversified city physiognomies (the impact of historical factors).

**Recognition and formulation of the research problem**
The students, on the basis of their knowledge and presentation done by the teacher, formulate a research hypothesis: cities of the world differ from one another in their physiognomic features. Their formation was influenced both by cultural and historical, as well as environmental factors.

**Implementation phase**

**Data acquisition**
- The students are divided into 7 teams.
- Each team randomly picks a city for which a „business card” will be prepared (Cairo, Dubrovnik, Warsaw, Beijing, Sydney, Santiago de Chile, Chicago).
- The teams are searching for materials using educational aids [2], [3], [4], [5].
- The teacher helps the students find the necessary sources of data, e.g. addresses of foreign geoportals.
- The students focus their attention on:
  - acquiring information about general city physiognomy;
  - identifying parts of the city whose built-up areas differ clearly from the rest;
  - determining cultural-historical and environmental factors that influenced the city’s physiognomy.

**Data processing and analysis**
- The students analyze the acquired data and select the data which show the most characteristic features for a given physiognomic city type.
- The teacher asks the students to indicate which sources yielded the most information (a) only photos, for example, on Google Maps, or in the ESA Atlas, (b) only text, for example textual descriptions of a given city and its history, (c) both photos and text, for example geoportals – showing pictures of cities in the form of orthophoto-maps that allow viewing additional information, e.g. environmental data.
The teacher asks to run GIS software (the presentation shows the possibilities of working simultaneously with both satellite or aerial photos and thematic data).

The students open the project and, following the instructions given by the teacher, analyze the spatial development of Bern in Switzerland (the students do not know what city they analyze).

On the basis of the analysis of the satellite images and thematic data the students guess the physiognomic type of the city and what had the greatest impact on the development of this city in different periods. If necessary, they use additional information obtained from the Internet.

**Data presentation**

- Similarly, as with the city of Bern, the students present “business cards” of their selected cities using data found in the Internet.
- Using various applications (Google Earth, mapping applications, geoportals) the students comment on selected functional areas of the city, and on the factors that played the greatest role in shaping this city.
- Representatives of other teams try to determine the physiognomic type of the city being presented.

**Solving the formulated research problem**

Verification (confirmation) of the research hypothesis:
World cities differ from one another in their physiognomic features. Both cultural-historical and environmental factors have impact on their development.

**Summary phase**

The students evaluate which of the presented cities have the clearest urban layout. What do all city types have in common? Where do the differences come from?

**Homework**

Determine what characteristics of our country capital are visible in its physiognomy. In the case of a clear urban layout of your home town – present its characteristics. The best supported answer may be put on the school website in the section „Do you know that our city...?“.
Analysis of socioeconomic differences in the development of the world with the use of GIS

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The presented scenario is an extended script encompassing the wide topic of socioeconomic differences in the world’s development. The class is planned for two teaching units, assuming that both the teacher and the students worked previously with the Quantum GIS program and freely handle its basic functions, and also have no problems working with spreadsheets and changing file extensions.

It is important that geography classes be not used to learn Quantum GIS. This skill should be gained during IT lessons (about 4.5 hours of classes introducing the Quantum GIS program completed before this class). As interdisciplinary cooperation, the geography teacher could ask the IT teacher to cover a part of the topic during IT classes involving downloading and preparing data by students. The geography teacher should be able to assume that skills such as working with spreadsheets, operations on tables, and changing file extensions have been mastered by the students during their IT classes.

This scenario includes „helpful tips” in a few places, which, in case of difficulties, could speed up progression through some stages of the lesson. For example, there could be a problem with the Internet connection during the lesson, or problems may occur when working with tables.

The main goals of the lesson

- Increasing awareness of differences in socioeconomic development of various countries of the world.
- Understanding what measures (indicators) are used to describe socioeconomic development.
- Understanding the reasons behind classifying countries into different groups depending on the level of their social and economic development.
- Acquiring skills on using GIS to analyze socioeconomic development of the world.

Operational objectives

Knowledge
The student:
- knows indicators of socioeconomic development;
- knows what values these indicators assume for countries with different development levels;
Lesson scenarios (including a methodological commentary) prepared by the EduGIS Working Group

- lists socioeconomic characteristics of countries with different levels of development;
- gives examples of countries with different levels of development;
- discusses causes of differences in socioeconomic development of the world.

**Formal skills**

The student:
- formulates a hypothesis explaining grouping of countries depending on different levels of their socioeconomic development, and possible reasons of these differences;
- divides the indicators into societal and economic and judges their usefulness for an analysis;
- chooses appropriate indicators for distinguishing different levels of socioeconomic development;
- classifies and groups countries according to various indicators, e.g.: HDI, GDP per capita, average life expectancy, literacy, health expenditure in relation to GDP, proportional employment in main economic sectors, proportion of GDP created by each of the main sectors of the economy;
- compares levels of socioeconomic development between various countries;
- determines causes of differences in socioeconomic development among various countries;
- evaluates hypotheses and draws conclusions;
- judges the usefulness of GIS to analyze socioeconomic development of the world.

The student actively uses the Internet:
- searches and finds information at foreign (English) language websites.
- gathers (acquires) desired information from selected websites.

The student uses ICT tools:
- uses spreadsheet tables;
- adds, deletes, changes data in the tables;
- saves acquired data in various formats;
- sends and receives data files;
- uses e-mail in order to send and receive files;
- creates multimedia presentations.

**GIS skills**

The student uses the Quantum GIS program:
- launches an already installed Quantum GIS program;
- adds base and thematic (vector) layers to the display;
- navigates on the map;
- uses basic tools;
- opens the attribute table;
- edits the attribute table;
- uses attribute table queries (creates queries to select the data);
- creates new layers from base layers and adds them to the display;
- merges external tables with the attribute table;
Lesson scenarios (including a methodological commentary) prepared by the EduGIS Working Group

- chooses an appropriate method (choropleth maps) to analyze and present data;
- classifies data using the program’s tools and functions;
- analyzes data using geoprocessing tools.

The student uses GoogleEarth:
- launches an already installed GoogleEarth application;
- flags selected objects with the „add flagged places” tool;
- adds layers.

**Attitudes**

The student:
- shows sensitivity for unequal development of countries;
- sees the need to help the least developed countries by the wealthiest ones;
- formulates proposals of assistance to the countries of the Poor South.

**Teaching methods/techniques**

Exhibitory methods:
- introducing the topic to the class by the teacher using a short multimedia presentation.

Lecturing methods:
- briefing;
- instructions.

Problem-based methods:
- work with Google Earth – adding data;
- work with databases (Internet) – acquiring data;
- work with Quantum GIS – analyzing data;
- work with text (HDI Report);
- moderated discussion;
- brainstorming session.

**Organization of the students’ work**

Collective, team-work, individual self-tasks.

**Educational aids**

- Quantum GIS program, version 1.6.0 Copiapo [http://www.qgis.org](http://www.qgis.org)[1];
- Google Earth application [http://earth.google.com](http://earth.google.com)[2];
- data about the world’s political division from the Global Administrative Areas website [http://www.gadm.org/world](http://www.gadm.org/world) (data in the vector format);
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- HDI indicator (2007) [4];
- GDP per capita indicator in USD (2007, simplified data) [5];
- average life expectancy at birth indicator (2007) [6];
- statistical data from the UNEP’s GEO Data Portal [7]:
  - healthcare expenditure as a share of GDP (2007);
  - agriculture’s share in GDP (2007);
- the article: Polska po raz pierwszy krajem o bardzo wysokim poziomie rozwoju społecznego (Poland is, for the first time, a highly societally developed country [8];
- tables showing values of the HDI indicator;
- work sheet;
- instructions for the student on acquiring and processing statistical data;
- introductory presentation to the lesson;
- Atlas Geograficzny Świat, Polska, (Geography atlas of the world, Poland), published by PPWK;
- textbook Geografia na czasie, część 2, Geografia społeczno-ekonomiczna świata i Polski (Modern geography, part 2: socioeconomic geography of the world and Poland; basic range).

Description of the lesson

Introductory phase

Introduction to the subject

- Welcoming the class, organizational issues, starting the lesson with a very short instructional briefing. In the beginning every student takes a seat next to a computer, turns it on, logs on and prepares for work. The students start Google Earth right away.
- Introducing the topic to the class by a moderated discussion with the students, during which the teacher shows the multimedia presentation and the students flag in Google Earth both the underdeveloped and developed countries shown on the titled photos.

“Safety ropes”:

- To speed up marking countries, the students can be divided into two teams; one team will be marking rich, and the other team poor countries.
- If there is a problem with Google Earth, the teacher can instruct the students to carry out the exercise on a wall map (by attaching color adhesive sheets) or use a pre-made picture with already flagged countries.
Lesson scenarios (including a methodological commentary) prepared by the EduGIS Working Group

Recognition and formulation of the research problem

Formulation of research problems:
Can we (and how) compare levels of countries’ socioeconomic development?
What are the causes of differences in development levels of various countries?
Which countries’ inhabitants live better (safer, more comfortable) lives?

- Based on the finished task, the presentation and moderated discussion, the students formulate the research hypothesis: countries of the world are different in regard to their social and economic development. The world can be divided into the Rich (Wealthy) North and the Poor South. This diversity is caused by unequal economic growth and environmental, historical, cultural, and political factors.
- The students remember (knowledge acquired during the 7–9th year of education) what measures (indicators) are used to quantify the level of socioeconomic development. With the use of the brainstorming technique, they list examples of such indicators. The class, with the help from the teacher, chooses indicators that will be used to verify the formulated hypothesis.
- The students work independently, each of them using a computer. The teacher shows, easily visible to all students, addresses of webpages that will be used to acquire data.

Implementation phase

Data acquisition

- The teacher divides the class into groups and decides what indicators each group will acquire.
- The teacher explains how to gather and prepare data. S/he reminds that any source of data needs to be acknowledged. The students should be given written instructions.
- The students obtain data:
  - **Group I** – HDI (Human Development Index) [4];
  - **Group II** – GDP per capita in USD [5];
  - **Group III** – average life expectancy at birth [6].
- The students prepare data according to the instructions, save files in the proper format (dbf) and send them to the other groups and the teacher.

“Safety ropes“:
The teacher has prepared data files in the following formats:
- in the case of Internet access problems, the teacher gives the students data in the spreadsheet format;
- if the students have serious problems with preparing the data, the teacher gives them pre-made files in the dbf format.

- The students start individual work, open Quantum GIS and conduct preparatory work (check the coordinate system, assign the name and save the project).
Lesson scenarios (including a methodological commentary) prepared by the EduGIS Working Group

- The teacher reiterates the need for frequent saving of the project.
- The students follow the instructions and add vector layers (political borders) to the project, which were prepared by the teacher and are stored in a designated folder.
- The students collect the data (healthcare expenditure, agriculture’s share in GDP) from the GEO Data Portal (UNEP’s geoportal). They unpack and save the data in an appropriate folder.
- The students add another layer to the map view.
- The students merge the data from attribute tables with data in the dbf format that were prepared earlier, during the teamwork stage of the lesson, all according to the instructions. Ultimately, they should add three layers to the view.
- The students save the projects and the teacher assigns homework. The students, prior to the next lesson, have to read a shortened fragment of the HDI Report and answer the questions.

End of the first teaching unit.

Data processing and analysis

Start of the second teaching unit.

- The teacher recalls the topic of the lesson and the research hypothesis formulated by the students.
- Selected students present their homework before the class and draw first conclusions regarding the societal development.
- The students open the projects saved on the previous lesson and start data analysis.
- The students identify data indicating economic development and data indicating societal development.
- The students create choropleth maps for all layers with selected indicators. Limits of classes of indicator values should be divided according to the schoolbook, geographical atlas, and HDI Report.

“Safety ropes”:
- The students have earlier (during another class) prepared map legends (the so-called styles). Now they only have to apply the styles to subsequent choropleth maps.
- The teacher has prepared map legends (styles) and makes them available to the students as needed.

- The teacher checks the accuracy of the choropleth maps and asks for a preliminary verification of the research hypothesis.
- Based on the maps, the students collectively verify the research hypothesis and determine the geographical distribution of countries with different levels of development.
- The students save maps presenting different indicators, transfer them to a multimedia presentation, and note the conclusions.
- The teacher asks the students to choose two indicators for the analysis of correlation: one showing societal development and one showing economic development.
Lesson scenarios (including a methodological commentary) prepared by the EduGIS Working Group

- The students select two indicators and start the analysis. They open the attribute table separately for each indicator and create queries leading to the selection of developed and underdeveloped countries.
- The students add the four newly created layers to the project view and, using geoprocessing tools (search for common parts), perform the correlation analysis.
- The students collectively draw conclusions about the correlation between societal and economic development and add them to the multimedia presentation.

Data presentation
Selected students present the results of the analysis. They provide examples of countries belonging to the four groups. Remaining students check the information. The class discusses the results of data analysis.

Solving the formulated research problem
The students provide causes of the uneven socioeconomic development of the world. They verify the research hypothesis and write the conclusions in the multimedia presentation.

Summary phase
Selected students show the multimedia presentation to the class, in which they show their research hypothesis, analysis of development indicators, finishing with the conclusions and evaluation of the research hypothesis. The students point to (suggest) solutions to the problem of uneven socioeconomic development of countries.

Homework
Homework is assigned after the first lesson and before the second. The students are asked to read the abbreviated version of the HDI Report and answer the questions (filling out the first part of the student work sheet).

Additional materials to the scenario:
- student work sheet;
- tables presenting HDI values;
- instructions for the students.
The scenario was prepared for the 2nd year of Junior High School students (8th year of education), it is suitable for a classroom with only one computer available for the teacher. It is assumed that the material was prepared by five teams, according to the instructions, during the class preceding the lesson (during a computer lab class). In the case a computer lab is available, the data downloading stage can also be conducted during the lesson. It should be noted, however, that this might extend the duration of the lesson.

The main goal of the lesson

Teaching the skills of describing and explaining connections and relationships between distribution of population and the natural environment, economy, and societal processes.

Operational objectives

Knowledge
The student:
- understands the concepts: population density, depopulation;
- specifies the average population density in Poland;
- lists the specifics of population distribution in Poland;
- names and points on the map of Poland areas with high and low population density;
- lists factors favoring high population density (natural, economic, historical);
- names causes of uneven population distribution.

Formal skills
The student:
- uses various sources of information;
- computes population density of a given area;
- reads and interprets population density maps and numerical figures showing variation in densities;
- characterizes, based on a map, the population density in Poland (including his/her own region);
- shows examples – based on various Polish regions, including her/his own – a relationship between population density and environmental, economic, historical (including internal migrations) conditions and human economic activity.
Lesson scenarios (including a methodological commentary) prepared by the EduGIS Working Group

The student actively uses the Internet and ICT tools:
– downloads information and documents from various sources;
– saves the data in spreadsheet tables, organizes the data;
– uses obtained data in a multimedia presentation.

GIS skills
The student:
– searches for information in the on-line Local Data Bank maintained by the Central Statistical Office of Poland, the national geoportal, and other relevant Internet websites;
– judges up-to-dateness of data;
– determines regularities and randomness in distribution of phenomena.

Attitudes
The students realize problems of inhabitants living in low- and densely populated regions.

Teaching methods/techniques
● Exhibitory method (valorizing) – a presentation introducing the topic of the lesson.
● Lecturing method – instructional lecture (preparation of data before the lesson).
● Independent discovery of knowledge – work with source materials: acquisition, selection, verification and analysis of Internet-derived data.
● Discussion.

Organization of the students’ work
Individual, teamwork, collective.

Educational aids
● Statistical data downloaded from the Local Data Bank maintained by the Central Statistical Office of Poland (GUS) http://www.stat.gov.pl/bdl (saved in a spreadsheet format or as printouts) [1];
● Google Earth application http://earth.google.com [2];
● Interactive atlas of Poland (IGiPZ PAN) http://maps.igipz.pan.pl/aims/home_pl.htm – maps of population density of rural areas, studies showing the population dynamics in the years 2002–2007, thematic sources e.g. hypsometric map, hydrology map, map of natural resources, map of protected areas, map of quality of agricultural land, land use map [3];
Lesson scenarios (including a methodological commentary) prepared by the EduGIS Working Group

- multimedia presentation (photos, instructions for students);
- multimedia projector, computer, projection screen;
- work sheets and instructions for student teams;
- Świat w liczbach (World in numbers), a GUS (the Central Statistical Office of Poland) Statistical Yearbook publication;
- geography atlas Polska, kontynenty, świat (Poland, Continents, World), publishing house Nowa Era.

### Description of the lesson

#### Introductory phase

**Introduction to the subject**

Before the lesson – organizational matters – dividing the class into 5 teams, instructions for the teams, distribution of necessary materials.

During the lesson:
- welcoming the class;
- defining objectives of the lesson;
- introduction to the discussion: name a place in Poland where you would like to live. Justify your choice.

Based on the presented photos, the students write in their student work sheets factors that could influence the distribution of population. The students appropriately classify the factors in the table (into natural, economic and historical).

**Recognition and formulation of the research problem**

Formulation of the research hypothesis: what determines the population distribution in Poland?

#### Implementation phase

**Data acquisition**

Materials found by the students (under teacher supervision) in the Internet (according to the “step by step” instructions) during additional classes [1], [3], [4]:
- Team no. I Population density of the world, Europe and Poland.
- Team no. II Population density in respective voivodeships.
- Team no. III Population density of the Mazovian Voivodeship by districts (powiat – LAU-1).
- Team no. IV Population density of the districts by municipalities (gmina – LAU-2).
- Team no. V Population maps.

The students are aware of the need to respect copyrights.
Lesson scenarios (including a methodological commentary) prepared by the EduGIS Working Group

Data processing and analysis
Subsequent tasks for the students are displayed on the screen. The students note their answers and conclusions in their student work sheets.

The students:
● define the concept of population density. They compute the population density of their own city;
● analyze data (segregation, comparison, processing the data in order to answer the research hypothesis) – population density of the world, Europe and Poland’s voivodeships, the Mazovian Voivodeship, a selected city;
● analyze population density choropleth maps of the Mazovian Voivodeship and Poland;
● determine the characteristics of population distribution in Poland during a discussion: population distribution is not uniform – the highest concentration can be found in the south, and the lowest in the north-eastern and north-western parts of the country. Population concentration has the form of a triangle with the base lying along the southern border and the apex in the neighborhood of Gdańsk;
● analyze thematic maps from the geographic atlas and maps displayed on the screen, looking for evidence to support the hypothesis;
● make comparative interpretation of the population density and economic maps. The students analyze factors behind the differences in population of different regions.

Data presentation
Selected students formulate conclusions based on the analysis of statistical data presented in the form of a PowerPoint slideshow.

Solving the formulated research problem
The students name causes of uneven distribution of population of Poland. They list the factors favoring high population density:
● natural – lowlands, mild climate, fertile soils, abundant freshwater sources, rich natural resources;
● economic – exploitation of resources, access to the sea, important transportation routes, jobs in agriculture and industry, big cities;
● historical – security, economic and political activity, migrations, settlement on new lands, border changes;
and factors hindering settlement: swamps, areas with lots of surface water, large forest complexes, mountainous areas with harsh climate and high altitude variation.

Summary phase
The students:
● draw a general conclusion that population distribution is a complex outcome influenced by all factors: natural, economic and societal.
Lesson scenarios (including a methodological commentary) prepared by the EduGIS Working Group

- present factors influencing the population density of selected regions in the form of short descriptions of places marked on the map of Poland in Google Earth (Mazovian, Silesian, Lubuskie, Podlaskie, Warmian-Masurian, Lublin, Lesser Poland voivodeships) [2];
- specify the problems of people inhabiting both densely and sparsely populated areas
- name causes of depopulation of the latter areas;

### Homework

Search for information about the beginnings of your city (preparation to the next lessons).

**Additional materials to the scenario:**
- student work sheets;
- instructions for student teams.
Floods in the Vistula River basin on the example of Wilków commune (Lublin Voivodeship)

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The scenario was designed for High School students attending an advanced geography course. For undisturbed progression through the task, access to computers and a good Internet connection are required. The classes are planned for two teaching units – although, depending on the needs and possibilities, the schedule can be modified and the students asked to do a part of the work at home, or a part of the lesson may be dropped altogether.

The main goal of the lesson

Analysis of the causes of floods in the middle part of the Vistula River basin.

Operational objectives

Knowledge
The student:
– knows the specific traits of the Vistula and its basin;
– knows types of river valleys and their components;
– knows types of river regimes;
– knows the causes and time of occurrence of floods in Poland.

Formal skills
The student:
– reads information from a climatograph;
– reads hypsometric and topographic maps, recognizes terrain forms;
– searches for information based on source materials (a PowerPoint presentation and PDF attachment);
– finds spatial relationships in the natural environment;
– compares information using different forms of presentation;
– synthesizes and determines causes of floods;
– displays and browses relevant websites.

The student uses the YouTube portal:
– watches the movie about the 2010 flood in Wilków commune.
The student uses ICT tools:
– uses the PowerPoint presentation *Powódzie w dorzeczu Wisły (Floods in the Vistula basin)*;
– uses graphics software and software for making multimedia presentations, e.g. PowerPoint.

**GIS skills**
The student:
– evaluates usefulness of data with regard to their purpose;
– freely uses geoportals.

The student uses Global Mapper:
– locates Wilków commune;
– analyzes the simulation of the flood wave;
– analyzes terrain profiles along a parallel;
– analyzes the contour map.

The student uses Google Earth:
– measures the distance and area.
– navigates on the map, reads true altitude.

The student uses a meteorological site WeatherOnline:
– searches and compares meteorological data for Opole Lubelskie district and selected areas in southern Poland (current and archival data for May and June 2010).

The student uses Global Monitoring for Environment and Security (GMES) data:
– analyzes satellite photos of the selected municipality during the flood;
– reads hypsometric maps;
– finds relationships between the terrain and distribution of floodplains based on the example of Wilków commune (simulation of floodplain reduction).

The student uses the national geoportal maintained by the Head Office of Geodesy and Cartography:
– locates Wilków commune;
– analyzes and compares topographic maps with raster maps and orthophotomaps;
– finds relationships between the elements of the natural environment.

**Attitudes**
The student notices the devastating effects of flooding and realizes the need to help flood victims.

**Teaching methods/techniques**
– Lecturing methods.
– Seeking (activating) methods.
Lesson scenarios (including a methodological commentary) prepared by the EduGIS Working Group

- Working with source materials: acquisition and selection of web data.
- Verification of the research hypothesis and formulation of conclusions.

**Organization of the students’ work**

Collective, teamwork.

**Educational aids**

- Multimedia presentation *Floods in the Vistula’s basin* [1];
- Google Earth application [http://earth.google.com](http://earth.google.com) [2];
- meteorology websites supplying weather data from the time of the flood, and archival data [7]:
  - Weather Online [http://www.weatheronline.co.uk/weather/maps/forecastmaps?LANG=en&CONT=ukuk&R=150](http://www.weatheronline.co.uk/weather/maps/forecastmaps?LANG=en&CONT=ukuk&R=150);
  - weather forecasts presented by the Interdisciplinary Centre for Mathematical and Computer Modeling of the Warsaw University (*Interdyscyplinarne Centrum Modelowania Matematycznego i Komputerowego Uniwersytetu Warszawskiego*) [http://new.meteo.pl](http://new.meteo.pl),
  - [http://www.klimadiagramme.de/](http://www.klimadiagramme.de/);
- a movie about the flood in Wilków commune [http://www.youtube.com/watch?v=0UXj4XXNsH8&feature=related](http://www.youtube.com/watch?v=0UXj4XXNsH8&feature=related) [8].

**Description of the lesson**

**Introductory phase**

The teacher recalls characteristic traits of the Vistula River basin and presents types and causes of floods in Poland with the help of the multimedia presentation [1].

**Recognition and formulation of the research problem**

What were the reasons of the great flood in Wilków commune in 2010?
Implementation phase

Data acquisition
The teacher:
● splits the class into 2–3-person groups, each with their own computer;
● moderates a discussion on the topic of possible causes of the flood in Wilków commune;
● with the whole class determines the proceedings of an analysis based on Internet resources;
● presents websites used to gather data.

Data processing and analysis
● The students open Global Mapper [3]:
  – open the site GREAT FLOOD in Commune Wilkow, Poland;
  – familiarize themselves with Wilków commune head’s announcement about the flood;
  – locate Wilków commune;
  – locate individual villages in Wilków commune.
● The students watch the movie on YouTube [8], municipality inhabitants’ account of the flood and their observations on the causes of the flood. The students watch the life of the flood survivors.
● The students use Global Mapper:
  – familiarize themselves with the animation on the spread of the flood wave correlated with the water levels in Vistula (120–125 meters above sea level);
  – assess the influence of terrain on the scale of the flood;
  – analyze the terrain profile along the 51°15’ N parallel running through Wilków;
  – analyze the contour map.
● Based on the Head Office of Geodesy and Cartography map geoportal [4], the students:
  – analyze the surface water network;
  – analyze characteristics of the Vistula River valley and its tributaries (Chodelka river) in the area of Wilków commune;
  – acquire information about the regulation of Vistula;
  – gather data about terrain (land relief). Read maximum and minimum true altitudes, give absolute altitudes (elevations);
  – check land cover (vegetation, buildings) by combining the orthophotomap and the topographic map and changing their transparency;
  – measure the distance from the river bank to the nearest buildings.
● The students analyze meteorological conditions occurring during the flooding in May/June 2010 using archival data from the WeatherOnline website [7].
Lesson scenarios (including a methodological commentary) prepared by the EduGIS Working Group

- The students analyze climatographs [7] of selected cities located in the middle part of the Vistula and its tributaries: Warsaw and Zamość, and find the period of heaviest precipitation.
- Using Google Earth, the students observe the area of the commune after passing of the flood wave on 25th June 2010 [2]. They measure the area of the largest depression; analyze maps showing recommendations for drying out the flooded areas [6].
- After analyzing source materials, the students determine the cause-effect relationships between the various elements of the natural environment occurring in Wilków commune that contributed to the occurrence of floods, resulting in the conclusions about the regularities of flood occurrence in the middle part of the Vistula River basin.

Data presentation
Preparation of 3–4 slides showing the causes of the 2010 flood in Wilków commune, which will finalize the earlier presentation.

Solving the formulated research problem
Formulating the conclusions on the basis of the analysis of source materials. Naming causes of the floods: environmental (highest precipitation from May to July, swelling of the rivers with rainfall, terrain, wide flat river valley, land cover, animal influence) and anthropogenic (development of human settlements within the natural river floodplain, lack of supervision of the dikes).

Summary phase
Presentation of teamwork results. Selection of slides that best demonstrate solving of the research problem.

Homework
None

Additional materials to the scenario:
- Introductory presentation *Floods in the Vistula River basin.*
The specificity of the presented scenario stems from the fact that it was prepared for the group of Polish and Norwegian youth who met in Warsaw at the EduGIS Academy workshop in March 2011. Consequently, the scenario’s content is supposed to allow the Norwegian students to learn about diversity of the Polish landscape, and allow the Polish students to systematize and verify their knowledge. Both groups were actively participating in the class due to the use of an interactive tool for creating hypsometric profiles.

The main goal of the lesson

Getting to know main terrain features in Poland.

Operational objectives

Knowledge
The student:
- explains and remembers the concepts of: lowland, upland, depression, mountains, true and absolute altitudes, denivelations;
- lists major tectonic-stratigraphic units and geophysical regions of Poland;
- knows and lists factors influencing terrain in Poland;
- lists elements of the geographic environment and processes dependent on terrain, e.g.: hydrographic structure, soil erosion, land use.

Formal skills
The student:
- recognizes various types of terrain in Poland based on source materials: photos, aerial and satellite photos (Google Earth, national geoportal) and descriptions;
- describes characteristic features of given types of terrain;
- points on a map the extent of main tectonic-stratigraphic units and terrain zones.

GIS skills
The student:
- uses Google Earth for: searching for a given location, browsing satellite images, getting familiar with additional information about a region;
- uses map applications, e.g. Google Maps;
- knows how to make a hypsometric profile by selecting appropriate profile contours using the Geocontext-Profiler tool.
Lesson scenarios (including a methodological commentary) prepared by the EduGIS Working Group

Attitudes
The student:
– makes sure that contour lines are accurately marked;
– cooperates well with the team.

Teaching methods/techniques
● Working with data sources:
  – acquisition and selection of online data (Google Earth);
  – data analysis and interpretation (using geoportals).
● Working with maps from atlases, a wall map (localizing objects on the map, land relief).
● Moderated discussion.

Organization of the students’ work
Collective, teamwork, individual.

Educational aids
● Computers with Internet access – 2-3 persons per computer;
● interactive whiteboard;
● presentation introducing to the lesson’s topic [1];
● geological map of Poland, scale 1:1 000 000, available at the geological portal IKAR maintained by the Polish Geological Institute: http://ikar2.pgi.gov.pl/mvs_viewer/mapviewermvs.jsf?width=1067&height=590&firstpageload=true&resources=map:ags@http://ikar2.pgi.gov.pl/services/MGP1MLN/MapServer [3];

Description of the lesson

Introduction to the subject
● A short presentation by the teacher [1].
● Analysis of the physical map of Poland: determination of leading characteristics of Poland’s terrain. Question: why is it the way it is?

Recognition and formulation of the research problem
The students, based on their own knowledge and the teacher’s introduction, formulate the research hypothesis: terrain features are determined by its geological structure.
Implementation phase

Data acquisition

Data processing and analysis
- The students prepare a meridian hypsometric profile according to the instruction: make a hypsometric profile linking the Baltic coast with the southern border, so that the striped nature of the topography of Poland is clearly visible. The choice of starting and ending points of the profiles is limited as follows:
  Team I – 14°30’ E to 16°00’ E;
  Team II – 16°00’ to 17°30’ E;
  Team III – 17°30’ E to 19° E;
  Team IV – 19° E to 21° E;
  Team V – 21° E to 23° E.
- The students analyze maps [2] [3] and determine the course of the profile using the Geocontext-Profiler tool [4].

Data presentation
The students present the profiles indicating subsequent types of terrain and most important factors that shaped it. Photos can be added to the presentation.

Solving the formulated research problem
Confirmation of the research hypothesis:
Terrain topography of Poland was influenced by its geological past.

Summary phase
- The students, working in teams, determine which of the three main characteristics of the Polish terrain is in their opinion the most important: lowland character, sloping towards north-west, striped structure; they give reasons for their opinion.
- Team representatives briefly present opinions of the teams.

Depending on the pace of the lesson, if there is enough time, recognition of various types of subsequent stripes of terrain can be made based on the teacher’s description.

Homework
None
Warsaw – the natural environment. Did it determine spatial development of the city?

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The idea of a lesson about Warsaw was supplementing the scenario by Joanna Poręba-Kwiatkowska about the characteristics of Poland’s terrain. This scenario was also prepared for the Polish and Norwegian youth that met during the EduGIS Academy workshops in March 2011. This influences the specificity of the scenario’s content and arrangement.

Materials for the lesson should be prepared before the lesson by the teacher using the Quantum GIS program. The general requirement for conducting this scenario is familiarity of the teacher with the software and savviness in using it. The computer lab’s Internet connection has to be sufficiently fast for the students to freely navigate the project which constantly access data from external servers (WMS layers). The teacher conducting the lesson assumes that the ability to work with geoportals and basic ability to handle Quantum GIS are already gained by the students (e.g. during IT classes). The work is eased by the availability of a multimedia whiteboard.

The main goal of the lesson

- Learning about the influence of the natural environment of Warsaw (with special consideration for geological structure, terrain and hydrography) on its spatial development. Learning the patterns connecting the natural environment and human economic activities.
- Learning what factors and processes shaped the terrain of Warsaw.
- Understanding linkages within the environment and interactions between humans and the environment.
- Developing skills needed to use GIS tools to analyze the natural environment of Warsaw.

Operational objectives

Knowledge
The student:
- knows geological structure, terrain and hydrography of the Mazovian Plain;
- knows the location of Warsaw in Poland and on the Mazovian Plain;
- describes the geological structure of the Warsaw Syncline, the Mazovian Syncline, terrain of the Warsaw Valley, and the centripetal drainage system;
- knows terrain forms present within the Warsaw area, knows the process of their creation and what factor influenced it. Knows the material of which they are composed.
- knows elements of a river valley;
Lesson scenarios (including a methodological commentary) prepared by the EduGIS Working Group

- discusses environmental causes of diversity in spatial development of Warsaw;
- knows the barriers and advantages offered by the natural environment facilitating or hindering the processes of settlement and economic activity;
- knows human influence on the natural environment of Warsaw;
- is aware how humans, due to the growing technical capabilities, change the natural environment of Warsaw;
- is aware of the consequences that may affect the population of Warsaw as a result of construction in the lowest-lying fluvial terraces of Vistula.

Formal skills
The student:
- presents a hypothesis concerning the influence of the natural environment of Warsaw on the city’s spatial development;
- acquires and processes information available on geoportals;
- is able to interpret terrain profiles created online with a geo-context tool;
- analyzes geological maps;
- compares maps, geological profiles and draws conclusions regarding geological structure, terrain and groundwater;
- draws conclusions regarding dependences occurring in the natural environment;
- verifies a research hypothesis and draws (formulates) conclusions;
- assesses usefulness of GIS tools for learning about the natural environment of Warsaw and conducting analysis of dependences between the natural environment and spatial development of Warsaw.

The student actively uses the Internet:
- searches (and finds) information on Polish and foreign (English) websites;
- efficiently navigates through websites;
- acquires (downloads) needed information from selected websites.

The student uses ICT tools:
- uses online Geocontext-Profiler to create a terrain profile of selected areas;
- in order to collect data, anonymously handles maps available on the geoportal: KAMPINOS FOREST landscape genesis.

GIS skills
The student uses the Quantum GIS program:
- launches the pre-installed Quantum GIS program;
- opens and adds layers to the display;
- navigates on the map;
- uses basic tools;
- uses the “information” tool;
- changes the style of displayed layers, for example their transparency.
Lesson scenarios (including a methodological commentary) prepared by the EduGIS Working Group

The student uses geoportal.gov.pl:
– opens geoportal.gov.pl;
– chooses and opens correct map layers, sets map transparency;
– deftly uses tools available on the geoportal;
– navigates on the map;
– registers and adds new layers.

Attitudes
The student:
– is aware and able to list problems related to misuse and overuse of the natural environment;
– acknowledges the need to take action to protect environmentally valuable areas of Warsaw;
– presents propositions for protecting areas threatened by flooding.

Teaching methods/techniques

● Exhibitory methods:
   – introduction to the lesson topic in a short multimedia presentation.

● Lecturing methods:
   – briefing;
   – instructions.

● Problem methods:
   – working with geoportals – acquiring and analyzing data;
   – working with Geocontext-Profiler – making terrain profiles;
   – working with the Quantum GIS program – data analysis;
   – working with pictures, geological profiles and animated maps;
   – moderated discussion.

Organization of the students’ work
Collective and teamwork.

Educational aids

● Quantum GIS program, version 1.6.0 Copiapo http://www.qgis.org [1];
● topographic maps, orthophotomap, map of flood hazard (geoportal maintained by the Head Office of Geodesy and Cartography) http://maps.geoportal.gov.pl/webclient/ [2];
● geological map of Poland, scale 1:50 000 (Polish Geological Institute) – WMS service available to be displayed in Quantum GIS http://ikar2.pgi.gov.pl/services/SMGP_50/MapServer/WMSServer [3];
Lesson scenarios (including a methodological commentary) prepared by the EduGIS Working Group

- topographic maps of Poland, scale 1:50 000 (Head Office of Geodesy and Cartography) – WMS service available to be displayed in Quantum GIS http://sdi.geoportal.gov.pl/wms_topo/wmservice.aspx [4];
- animated maps showing the genesis of the Kampinoska Forest landscape http://folk.ntnu.no/opach/ [6];
- old maps of Warsaw in the form of calendar pages (website of the Property Management of the Capital City of Warsaw, Department for Vistula River Waterfront Development) http://www.wislawarszawska.pl/?mode=news&nid=317 [8];
- instructions for students.

Description of the lesson

Introductory phase

Introduction to the subject

- Welcoming the class, organizational issues, starting the lesson.
- At the beginning, the students take seats next to the computers, turn them on, log in and prepare for work.
- Short introductory lecture including a quiz.

Introduction to the topic of the lesson with the moderated discussion during which the teacher shows a multimedia presentation with a quiz about Warsaw. The students locate Warsaw on the map of Poland, mark it on the map displayed by the teacher on an interactive whiteboard. The students answer the questions about the natural environment of Warsaw and its origin. They acquaint themselves in that way with general knowledge about Warsaw’s natural environment. The students recall what factors facilitate and what hinder the settlement processes.

Recognition and formulation of the research problem

Formulation of the research problem: what are the main characteristics of Warsaw’s natural environment, especially its geological structure, terrain and hydrography? Did the natural environment determine spatial development of Warsaw? What are the environmental causes of the variety in spatial organization of the city? Did the geological structure, terrain and hydrography affect the distribution of functions among the areas of the city, and its physiognomy?
Lesson scenarios (including a methodological commentary) prepared by the EduGIS Working Group

Based on the presentation and completed quiz, the students take part in a discussion moderated by the teacher, resulting in formulation of the research hypothesis: the natural environment determined spatial development of the city.

The students recall (knowledge gained during the 3rd educational stage) what are the elements of the natural environment. They choose 3 such elements – geological structure, terrain and hydrography – to study the dependencies postulated in the research hypothesis.

The class, with the teacher’s help, formulates tasks required to verify the research hypothesis and decides on the activities such as:
- analysis of the topographic map and orthophotomap [2];
- elaboration of topographic profiles [5];
- analysis of animated maps [6];
- analysis of the geological map with the help of the Quantum GIS program [3];
- analysis of the aerial photos of Warsaw [7];
- analysis of the old map of Warsaw [8].

The students work in pairs. The teacher presents the tasks on the interactive whiteboard.

Implementation phase

Data acquisition
- The teacher splits the class into 2–3 person groups.
- The teacher instructs the students how to work. The students should be given written instructions explaining how to handle the tools that will be used during the lesson.
- The students acquire data and information needed to verify the research hypothesis.
- The students work in pairs. Every pair works at their own computer.
- The teacher asks the students to write down the most important facts and to select illustrations that will later serve to verify the research hypothesis.
- Material gathered and prepared by the students should be shown in a short presentation.

Data processing and analysis
- The students analyze maps of Warsaw:
  – topographic map and orthophotomap from the website geoportal.gov.pl. Also, they open a layer showing areas threatened with flooding [2];
  – animated maps from the geoportal: Kampinoski Forest landscape genesis [6].
- The students make a topographic profile of the Vistula valley with the Gecontext-Profiler tool [5].
- The students analyze aerial photos [7] and old maps of Warsaw [8].
- The teacher checks the accuracy of the analysis and profiles and asks for a preliminary verification of the research hypothesis. The teacher checks the material prepared by the students for the presentation.
Lesson scenarios (including a methodological commentary) prepared by the EduGIS Working Group

- The students, based on the map, pictures and profile analysis, conduct a preliminary verification of the research hypothesis, describing the natural environment of Warsaw and determining its influence on the city’s functions.
- The students discuss in the class and draw conclusions.
- The students prepare materials for the multimedia presentation and write down conclusions.
- The teacher asks the students to choose two representatives to present the conclusions.

Data presentation
Selected students present the outcome of their analysis. Remaining students check the answer given by their colleagues and correct them or supplement as needed.

Solving the formulated research problem
The students describe the natural environment of Warsaw – especially its geological structure, terrain and hydrography. They verify the research hypothesis: the natural environment determined spatial development of Warsaw. They give the results of the analysis and enter the conclusions into the multimedia presentation.

Summary phase
Selected students show on the class forum the multimedia presentation with the research hypothesis, present the results of their map analysis, pictures, and terrain profiles. The students present the conclusions and verification of the research hypothesis.

Homework
None

Additional materials to the scenario:
- instruction for the students;
- introductory presentation (lecture with a quiz).
Diversity of the natural environment of the Tatra National Park

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The presented scenario can serve a dual task. For one, it is the implementation of one of the topics of the core curriculum. It can also constitute an independent introduction to a planned field trip. Targeting High School students attending the advanced geography course allows for treating the classes as a kind of regional geography lesson – requiring a simultaneous analysis of both physical and socioeconomic aspects of geography.

The main goal of the lesson

Getting to know tourist assets of the Tatra National Park along a designed Western Tatras – High Tatras route.

Operational objectives

Knowledge

The student:
– knows geological history of the Tatra Mountains;
– lists characteristic elements of alpine topography;
– recognizes the characteristics of karst areas;
– knows what determines the tourist attractiveness of an area;
– notices the relationships between the geological structure and landscape;
– knows particularities of animate and inanimate nature of the Tatra National Park;
– describes altitudinal zones of the Tatra National Park.

Formal skills

The student:
– calculates the changes in temperature with changing altitude;
– compares the topographic map and orthophotomap;
– reads and interprets the topographic map;
– assesses the usefulness of GIS in plotting tourist routes;
– assesses the usefulness of GIS in estimation of dangers for tourists in Alpine environments;
– learns the process of cartographic generalization;
– presents dominant species of High and Western Tatras.
GIS skills
The student uses GoogleEarth:
– reads the true altitude of a place.
– uses the PANORAMA 360° function;
– marks routes;
– uses contour profiles.

The student uses the geoportal of the Tatra National Park:
– adds thematic layers to the display;
– navigates on the maps;
– plans trip routes;
– changes the map scale according to the theme;
– makes measurements;
– locates geographic objects;
– reads geographic coordinates;
– uses information about geographic objects;
– measures distance and area using GIS tools.

Attitudes
The student sees the need to protect the natural environment of the Tatra National Park.
The student knows the rules of behavior in the national parks.

Teaching methods/techniques
● Exploratory methods.
● Working with source materials: gathering and selection of data from the Internet.
● Verification of the research hypothesis and formulating conclusions.
● Discussion.

Organization of the students’ work
Teamwork.

Educational aids
● the Tatra National Park geoportal http://www.geoportaltatry.pl/portal/ [1];
● Google Earth http://earth.google.com [2];
● student work sheets [3].
Lesson scenarios (including a methodological commentary) prepared by the EduGIS Working Group

Description of the lesson

Introductory phase

Introduction to the subject
The teacher and the students recapitulate knowledge from the previous lesson about the geological history, division, and landscape features of the Tatra Mountains. The teacher reminds the students of the existence of altitudinal zones and the specificity of the Tatra National Park.

Recognition and formulation of the research problem
Judge whether diversity of the Tatra National Park is a tourist attraction.

Implementation phase

Data acquisition
The teacher gives addresses of relevant websites, divides the class into teams, distributes student work sheets (every team performs the same tasks). The teacher presents the tools of the Tatra National Park geoportal and means of information gathering.

Data processing and analysis
Processing of data is described in the student work sheet.

Data presentation
None

Solving the formulated research problem
The students notice the dominant species found in the High and Western Tatras. Data analysis is a confirmation of the attractiveness of this area. The students learn about peculiarities of the Tatra National Park.

Summary phase

The students:
- present tourist attractions of the Tatra National Park;
- state the characteristic features of the natural environment that determine the alpine terrain of the High Tatras and karst terrain of Western Tatras;
- know how to plan the route of an alpine trip;
- are aware of dangers that tourists face in the Tatras.

Homework
Plan any trip route in the Tatras and justify your choice.
Proposals for modifying the scenario for using GIS tools:
During the introduction to the lesson, while repeating information about the Tatra Mountains’ geological history, take advantage of the European geology geoportal One Geology (http://onegeology-europe.brgm.fr/geoportal/viewer.jsp). On the satellite image you can easily spot the curved Carpathian mountain range. Additionally, the students can display and analyze information on the geology of Europe, focusing on the connections between the Tatra’s geology and other European geological structures.

Geology of the Polish Tatras shown against geological structures of Europe (source: One Geology geoportal)

Additional materials to the scenario:
- student work sheet.
What are the natural and cultural values of Puszcza Kozienicka (Kozienicka Forest) (a field trip project)

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The project was developed as an idea for a field trip for Junior High School students, combining elements of field work with a lesson in the lab. Field classes (3 teaching units) are preceded by a short introduction in the computer lab. The summary phase is also planned to take one teaching unit in the computer lab. The extent of the trip can be modified according to the age of students and time available for the class.

The main goal of the lesson

Fostering interest in natural and cultural values of Puszcza Kozienicka (Kozienicka Forest).

Operational objectives

Knowledge
The student:
- lists protected areas in the Mazovian Voivodeship;
- identifies NATURA 2000 areas in the Mazowsze (Mazovia) region with special emphasis on Puszcza Kozienicka;
- lists places of historical and cultural importance in a selected part of the forest;
- knows strictly protected plant species living in Puszcza Kozienicka.

Formal skills
The student:
- uses Internet-based sources of information;
- reads and interprets information available on appropriately selected thematic maps;
- presents, in the form of a multimedia presentation, natural and cultural values in the area of Puszcza Kozienicka.

GIS skills
The student:
- searches for data on geoportals;
- selects objects based on their location;
- uses electronic maps of Puszcza Kozienicka;
- navigates on electronic maps (uses map tools);
- uses a GPS receiver – register points, navigates to points, locates points.
Attitudes
The student:
– notices natural and cultural values of his/her own region;
– works in a team;
– is responsible for the natural environment of his/her own region.

Teaching methods/techniques
● Lecture.
● Working with source materials – acquisition, selection and verification of data gathered from the Internet.
● Field observations.
● Multimedia presentation.

Organization of the students’ work
Teamwork, collective work.

Educational aids
● Computer with access to the Internet;
● topographic maps, an orthophotomap and a map of protected areas (geoportal of the Head Office of Geodesy and Cartography) http://maps.geoportal.gov.pl/webclient/ [1];
● map of forested areas in Poland (State Forests) http://www.lasy.gov.pl/mapa [3];
● Kozienicki Landscape Park (Kozienicki Park Krajobrazowy) website http://kpk.przyroda.org [4];
● educational trail Królewskie Źródła (Royal Springs) from the Forest Tourist Guide (State Forests) http://www.czaswlas.pl/obiekty/krolewskie-zrodla-1115 [5];
● Google Earth http://earth.google.com [6];
● GPS receiver with the user manual;
● digital camera;
● student work sheet.

Description of the lesson
Introductory phase
Introduction to the subject
A mini lecture – introduction to the topic and presentation of lesson objectives. Explaining lesson proceedings, dividing the class into teams (5 persons each), reading the user ma-
nual of the Garmin GPSMap 60CSx GPS receiver. Explanation of what is GPS and how the satellite navigation system works.

**Recognition and formulation of the research problem**
What are the natural and cultural values of the selected area of Puszcza Kozienicka?

**Implementation phase**

**Data acquisition**
In the computer lab, the students acquire data about culturally and naturally interesting places in Puszcza Kozienicka. The students use map applications [1]–[4].

In the computer lab, as a team, they plot the trip route in Puszcza Kozienicka (for example, into Królewskie Źródła Reserve):
- determine the latitude and longitude of the starting point of the trip (a parking lot by the Radom-Kozienice highway);
- determine the latitude and longitude of the trip’s destination point (Królewskie Źródła reserve);
- select the remaining points of the trip route (5 points at the most) based on the webpage [5] and Google Earth [6] – for example, the monument of soldiers of the 31st Kaniowski Rifle Regiment, the narrow gauge railway embankment, meanders of the Zagożdżonka river, the Zagożdżonka river gorge, beaver traces, a pedunculate oak (Quercus robur) and black alder (Alnus glutinosa), protection of the forest from pests etc.;
- measure the length of the planned trip using Google Earth.

Field work – teamwork, every group has the same task.
- The teacher gives out to every group the student work sheets and instructions: the abbreviated user manual of the Garmin GPSMap 60CSx receiver.
- The teacher explains the tasks and means of operation of the GPS receiver.
- The students register the starting point (parking lot), naming it *start* and engage the tracking option.
- Navigating to consecutive pre-selected points of the teaching route. At every point of the route, they register, using the GPS, location (geographic coordinates) of the point, photograph the information boards and selected interesting natural/cultural objects.
- With the use of the GPS receiver, they register the photographed objects and fill out their student work sheets.
- The students register the destination point (Królewskie Źródła) and, with the help of the GPS receiver, determine the length of the trip route.
Lesson scenarios (including a methodological commentary) prepared by the EduGIS Working Group

Data processing and analysis
Every team uploads the gathered points and tracks to Google Earth. The teams consecutively add, to successive points, descriptions from their work sheets, and pictures (visualization of data gathered during field work).

Data presentation
Subsequent teams of students present their trip routes and registered points. Every group relates to the trip project and the extent to which its tasks have been implemented.

Solving the formulated research problem
The selected area of Puszcza Kozienicka (Królewskie Źródła Reserve) has high natural and cultural values that are described and illustrated with photos from the trip.

Summary phase
The students make one common multimedia presentation showing the natural and cultural values of the area of Puszcza Kozieniecka selected for the class (Królewskie Źródła Reserve). While preparing the presentation, they use information sources from the web and data acquired by all teams during fieldwork.

Homework
Fine-tuning descriptions of photos taken by the teams during the field trip (using available sources of information)

Proposals for modifying the scenario regarding the use of GIS tools
Currently, due to increased access both to GPS receivers and web applications, exchanging files with trip routes and places worth visiting became more popular. Many people have already gathered around this idea, creating numerous social networking sites that are worth mentioning to the students (see below). Including the students in a nationwide or even a worldwide group of users should help spark their interest in the topic (it’s an occasion to show off the results of their work), and at the same time teach responsibility for the quality of shared information (nobody likes to download incomplete or wrong data). Portals worth mentioning are, among others:

- Trail.pl project portal, whose main goal is collecting data about all tourist trails in Poland. The website allows for adding information about a trail, accompanied by e.g. photos of interesting places and also for uploading GPS receiver files with the trail route marked http://trail.pl;
- BikeBrother, serving mostly bicycle enthusiasts. It is possible to both download existing trip routes and upload your own http://gps.bikebrother.com;
- a biking community portal Czasnarower.pl – here, you can also download ready tour routes, as well as describe your own biking impressions http://www.czasnarower.pl.
Data recorded by the GPS receiver can be easily saved in the required GPX format, using free software such as GPSBabel (http://www.gpsbabel.org). Another way is to import data from the receiver to GoogleEarth (the students should have done this during the class) and subsequently save them in the KML format, which is readable by GoogleEarth. The students can freely share files. It is also possible to compare their results to the results from earlier years.

Additional materials to the scenario:
- student work sheet.
Air – a life-giving mixture of gasses or a poison that knows no borders?

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The scenario presented below is aimed at the 3rd year Junior High School students (9th year of education) and fulfills the core curriculum section regarding global and local environmental problems. Using multiple data sources concerning air pollution allows the students to get acquainted with a variety of forms of data presentation, e.g. map applications or interactive charts.

The main goal of the lesson

Getting familiar with the problem of air pollution.

Operational objectives

Knowledge
The student:
- lists components of the atmospheric air;
- shortly characterizes the role of oxygen and carbon dioxide in life processes;
- describes the structure of the atmosphere;
- lists causes of air pollution;
- presents causes and consequences of global warming;
- lists consequences of pollution for living organisms;
- lists methods of protecting the air against pollution;
- lists renewable energy sources.

Formal skills
The student:
- analyzes data and graphs of carbon dioxide (CO₂) emissions, both in the country and worldwide;
- compares CO₂ emissions in Poland in the years 1990 and 2004;
- specifies which Eurasian countries emitted the largest and which the smallest amount of this gas into the atmosphere in the years 1990 and 2004;
- reads yearly emissions of CO₂ in three cities in a selected voivodeship – in the years 1990 and 2010;
- estimates whether the CO₂ emission in these cities is rising or falling;
- lists causes of the direction of this change;
Lesson scenarios (including a methodological commentary) prepared by the EduGIS Working Group

- lists causes of increase in the atmospheric concentration of CO₂.
- lists gasses contributing to the greenhouse effect;
- estimates consequences of the global climate change;
- analyzes data and graphs concerning emissions of selected polluting gasses.

The student actively uses the Internet and ICT tools:
- searches for data (concerning the above issues) on English language websites;
- displays and browses relevant websites;
- selects data on CO₂ emissions;
- using programs for multimedia presentations like PowerPoint or Prezi, presents conclusions regarding means to decrease emissions.

GIS skills
The student:
- searches for information (concerning the questions found in work sheets) using databases and/or geoportals on both Polish and foreign websites;
- sorts data;
- classifies data;
- assesses reliability of data.

Attitudes
The student sees the need to protect the natural environment.

Teaching methods/techniques
- Lecture.
- Working with source texts – gathering, selection and verification of information obtained from the Internet.
- Practical tasks – completing a multimedia presentation, filling out crossword puzzles.
- Discussion.

Organization of the students’ work
Teamwork and collective.

Educational aids
- Presentation *Air – a life giving mixture of gasses, or a poison that knows no borders?* [1]; current air quality data from the countrywide monitoring network presented as graphs and interactive maps: links to data gathered in each voivodeship by various institutions, compiled on the website of the Meteorology Group, Division of Environmental Protection and Management, Faculty of Environmental Engineering, Warsaw University of Technology (Zespół Meteorologii, Zakład Ochrony i
Lesson scenarios (including a methodological commentary) prepared by the EduGIS Working Group

*Kształtowania Środowiska, Wydział Inżynierii Środowiska Politechniki Warszawskiej*

http://meteo.is.pw.edu.pl:8080/meteo/oa/monitoring [2];

- interactive map showing the world’s atmospheric concentration of carbon dioxide (The Southern and Eastern Africa Consortium for Monitoring Educational Quality SACMEQ) http://www.sacmeq.org/statplanet/StatPlanet.html [3];

- information about air pollution (Wikipedia)
http://pl.wikipedia.org/wiki/Zanieczyszczenie_powietrza [4];

- formation of the greenhouse effect— an animation (Scholaris – a knowledge portal for teachers) http://www.scholaris.pl/zasob/efekt,cieplarniany,3 [5];


- crossword puzzle;

- work sheet Air – a life giving mixture of gasses, or a poison that knows no borders?

- exemplary presentations made by the students during the class What can be done to reduce air pollution [1hdvOnahic-k/zanieczyszczenie-powietrza-rady/].

### Description of the lesson

#### Introductory phase

**Introduction to the subject**

Introduction lecture – a multimedia presentation [1] providing:

- definitions of the air, atmosphere, and air pollution;

- types of air pollution;

- causes of air pollution;

- consequences (for humans, animals and plants) of air pollution;

- information on smog;

- information on the greenhouse effect.

Dividing the class into 3–4-person teams, distribution of student work sheets.

#### Recognition and formulation of the research problem

The research problem formulated by the teacher: is air a life-giving mixture of gasses or a poison that knows no borders?

#### Implementation phase

**Data acquisition**

Using selected websites [2]–[6] the students, grouped in 3–4-person teams, look up information to answer the following questions:

- What causes the increase of CO₂ concentration in the atmosphere?

- What other gasses contribute to the greenhouse effect?

- What could be the consequences of global warming?

- What was the Polish CO₂ emission in years 1990 and 2004?
Lesson scenarios (including a methodological commentary) prepared by the EduGIS Working Group

- Which of the Eurasian countries emitted the biggest and which the smallest amount of this gas into the atmosphere in the years 1990 and 2004?
- Select any region (and any 3 cities within) and specify the annual amount of CO₂ emission.
- Determine the trend (rising or falling). What could be the cause of it?

Data processing and analysis
The students, working in teams, analyze and segregate data (compare the acquired data) in order to answer the research hypothesis (lesson topic); answer the questions from the student work sheets; solve the thematically related crossword puzzle with the help of websites specified in the Educational aids section. The teams also make a presentation on the topic: what can be done to reduce air pollution?

Data presentation
Each team presents their answer to the questions from their student work sheets and the solved crossword puzzle.

Solving the formulated research problem
A short discussion aimed at drawing conclusions regarding the lesson topic: air – a life-giving mixture of gasses or a poison that knows no borders?

Summary phase
Presentation of work done by the student teams.

Homework
Briefly answer the following questions:
- The Hawksworth-Rose scale – what is it and what is it used for?
- Using the website http://meteo.is.pw.edu.pl:8080/metoe/oa/monitoring [2] select any voivodeship and, inside it, any two cities, and determine the emission of SO₂ into the atmosphere in the last two years (2009 and 2010).
- Show the connection between the amount of SO₂ in the atmosphere and the Hawksworth-Rose scale, based on the information from the second question and the exemplary Hawksworth-Rose scale (http://niezapominajki.pl/Obrazki/skala%20porostowa.bmp).

Suggestions for modification of the scenario regarding the use of GIS tools
An excellent source of information about the state of the environment in Europe is the European Environment Agency – EEA. It is interested in issues related to biodiversity, climate change, land use, water resources, and air pollution. A specialized data gathering centre (http://www.eea.europa.eu/themes/air/dc) is responsible for collecting data from numerous institutions and organizations from all over Europe. The information is
then presented in the form of interactive maps and data browsers (currently nine available), databases and static maps (591), and information about indicators (17), mainly in the form of graphs.

**Additional materials to the scenario:**
- student work sheet.
The lesson was prepared for the 3rd year Junior High School students (9th year of education) who have access to a computer lab during biology classes. Nevertheless, thanks to an earlier preparation of materials, the lesson can be successfully carried out in a class equipped only with one computer available for the teacher. In such a case, the students draw mind maps on paper, and transfer them to computers during additional classes or at home.

The idea for the class is also an excellent opportunity to establish cooperation with the ICT teacher. ICT lessons provide a great opportunity for the students to get acquainted with software for creation of mind maps. If that happens, the actual biology class will go much more smoothly.

The main goal of the lesson

Understanding causes of a decline in biodiversity and dangers stemming from it.

Operational objectives

Knowledge

The student:

– explains the term “biodiversity”;
– lists factors influencing the condition of ecosystems;
– names examples of human activities leading to a decline in biodiversity;
– names examples of extinct and endangered species.

Formal skills

The student:

– discusses reasons behind extinction of species;
– groups the reasons of extinction into direct and indirect;
– analyzes graphs showing changes in species populations over the centuries;
– analyzes causes of a decline in biodiversity and predicts its consequences;
– predicts consequences of drainage of wetlands;
– analyzes the impact of hunting on the environment;
– assesses the impact of monocultures on the environment.
GIS skills
The student:
– acquires and analyzes data from the Internet,
– analyzes maps presented during the lesson.

Attitudes
The student is aware of emerging threats to biodiversity, understands his/her role in caring for the environment, and feels responsible for own actions in this regard.

Teaching methods/techniques
● Directed talk.
● Discussion.
● Brainstorming.
● Mind map.

Organization of the students’ work
Teamwork, individual.

Educational aids
● Biodiversity in Poland educational multimedia CD package published by the UNEP/GRID-Warsaw Centre (http://www.gridw.pl) – animations and maps concerning the topic of biodiversity [1];
● FreeMind program for creating mind maps http://freemind.sourceforge.net [2];
● instructions for preparing mind maps [3];
● additional materials regarding causes of threats to biological diversity [4];
● additional materials regarding effects of the decline in biological diversity [5];
● student work sheet;
● biology textbooks Puls życia (Pulse of Life), published by Nowa Era.

Description of the lesson
Introductory phase
Introduction to the subject
Organizational matters, presentation of a few selected sections from the introductory animation O co tu chodzi? (What this is all about) [1].

Recognition and formulation of the research problem
What are the causes and what will be the consequences of a decline in biodiversity?
Lesson scenarios (including a methodological commentary) prepared by the EduGIS Working Group

Implementation phase

Data acquisition
Data are being acquired by the students as the previous lesson’s homework (illustrations of extinct species) and found by the teacher on the web. Information obtained from the Biodiversity in Poland CD program by UNEP/GRID-Warsaw.

Data processing and analysis
Entering the obtained data into the student work sheets. Analysis of this information and of information provided by the teacher (or working with the program Biodiversity in Poland, depending on technical circumstances).

- Analysis of materials related to causes of the loss in biodiversity [4].
- Viewing the illustrations of extinct and endangered species (textbooks, atlases).
- Presentation of the map Przeksztalcenia antropogeniczne powierzchni Ziemi (Anthropogenic transformation of the Earth’s surface) [1].
- Preparation of the mind map (using the FreeMind program [2]): Causes of the decline in biodiversity – teamwork (instructions [3]).
- Analysis of graphs related to consequences of the decline in biodiversity [5].
- Presentation of maps: Synanthropization and Level of preservation of natural plant communities [1].
- Preparation of the mind map (with the help of the FreeMind [2] program): Effects of the decline in biodiversity – teamwork (instructions [3]).

Data presentation
Presentation of the teams’ work – prepared mind maps: Causes of the decline in biodiversity and Consequences of the decline in biodiversity.

Solving the formulated research problem
Discussion on the presented mind maps.

Summary phase
The students’ conclusions after the presentation of the mind maps (writing down the most important conclusions in the student work sheet).

Homework
Prepare a presentation in PowerPoint entitled Individual actions aimed at slowing down the decline in biodiversity.

Suggestions for modification of the scenario regarding the use of GIS tools
Studying and protection of biodiversity are, apart from the topics of climate change, land use, water environment and air pollution, one of the main fields of activity of the
European Environment Agency. A specialized data collection center (http://www.eea.europa.eu/themes/biodiversity/dc) is responsible for collecting data about the state of biodiversity in Europe. The information is then presented in the form of interactive maps and data browsers (4 available), databases and statistical maps (395), and information about indicators (35), mostly in the form of graphs.

**Additional materials to the scenario:**
- student work sheet;
- instructions for preparing the mind map *Causes of the decline in biodiversity*;
- instructions for preparing the mind map *Effects of the decline in biodiversity*;
- additional materials regarding causes of threats to biological diversity;
- additional materials regarding effects of the decline in biological diversity.
Getting familiar with biodiversity of the Middle Vistula Valley

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The classes are planned as a field trip for a 10-person student team participating in a biology interest group – hence the much prolonged time of the classes:

- 2 teaching units in the classroom – preparation for the trip (in the preceding week);
- 4 hours (about 5 teaching units) – a bicycle trip along the banks of Vistula (section Świerże Górne–Piotrkowice);
- 2 teaching units in the classroom – summary of field classes.

However, the scenario idea can be also used in everyday work with all students. The whole assignment, including the documentation, can be treated as a student educational project in accordance with the new requirements for Junior High School students.

The main goal of the lesson

Perfecting the skills of observation of the natural environment and recognizing changes occurring therein.

Operational objectives

Knowledge
The student lists species inhabiting the aquatic environment, biological indicator species, and species inhabiting land biocenoses of the Middle Vistula Valley.

Formal skills
The student:
- recognizes species occurring in different biocenoses;
- identifies species of plants and animals with the help of atlases and species identification manuals (keys);
- perfects the following skills: observation of organism in their natural environment, comparing information from various sources, drawing conclusions – based on the study results;
- documents results of own studies and observations.

GIS skills
The student:
- uses Quantum GIS software;
- prepares a map with the trip route;
Lesson scenarios (including a methodological commentary) prepared by the EduGIS Working Group

- assesses the length of the route;
- uses a GPS receiver in the field, registers observation points;
- inputs data from the GPS to Quantum GIS.

**Attitudes**
The student:
- respects safety rules during field classes;
- exercises caution when riding a bicycle and while in the vicinity of a water body;
- adheres to teamwork principles;
- learns to be responsible for results of teamwork;
- realizes the negative effects of human activity;
- understands his/her own role in caring for the environment.

**Teaching methods/techniques**
- Directed talk,
- Brainstorm,
- Observations.

**Organization of the students’ work**
Teamwork, collective.

**Educational aids**
- Documentary movie *Dolinami Rzek (Along the river valleys)*, the episode about Vistula, Planete channel [1];
- Quantum GIS program [http://www.qgis.org][2];
- topographic map of Poland, scale 1:50 000 (Head Office of Geodesy and Cartography) – a WMS service address for reading in Quantum GIS [http://sdi.geoportal.gov.pl/wms_topo/wmservice.aspx][3];
- map of protected areas in Poland (General Directorate for Environmental Protection) – a WMS service address for reading in Quantum GIS [http://wms.gdos.gov.pl/geoserver/wms][4];
- thematic maps of the Mazovian Voivodeship from the Atlas of Mazovia (Office of the Mazovian Voivodeship Surveyor) [http://www.bgwm.pl/atlas_mazowsza.htm][5];
- GPS receiver and its user manual;
- printed terrain maps with trip route marked (one for each group);
- work sheets no. 1–5 (one per two students);
- camera;
- atlases, guides and keys for species identification;
- binoculars;
- measuring equipment: pH meters, thermometers (one set for one to five students, depending on circumstances).
Lesson scenarios (including a methodological commentary) prepared by the EduGIS Working Group

Description of the lesson

Introductory phase

Introduction to the subject
- Watching the movie *Wisla (Vistula)*.
- Preparation and printing a map with the marked trip route (map no. 1).
- Familiarization with atlases and keys for identification of plant and animal species (bio-indicators species, farming plants, aquatic plants, plants associated with humans, animal atlases).
- Showing the students the publications that will be taken on the trip; short information about their rules of use.

Recognition and formulation of the research problem
What kinds of biocenoses occur in the surveyed area and what factors influenced their formation?

Implementation phase

Data acquisition
Making field observations and completing the student work sheets according to the instructions.

Data processing and analysis
Analysis of gathered data in order to answer questions in the student work sheets.

Data presentation
Each team’s representative presents results of every research step (based on the team’s student work sheets) to the rest of the trip participants.

Solving the formulated research problem
Each team’s representative answers the research question – after the field classes, the students should have prepared answers to questions no. 1, 2, 3 from the student work sheet no. 5. The remaining questions from the student work sheet no. 5 are to be answered during the summary phase in the class.

Summary phase

Every team:
- enters to the Quantum GIS program [2] data from their GPS receiver (track and waypoints);
- uses photos taken in the field to summarize the classes;
- works with the student work sheet no. 5 and draws conclusions regarding causes and effects of changes occurring in biocenoses of the Middle Vistula Valley;
Lesson scenarios (including a methodological commentary) prepared by the EduGIS Working Group

- using Quantum GIS, compares the topographic map [3] and map of Natura 2000 areas [4];
- analyzes maps of plant communities of the Middle Vistula Valley, a historical map – Vistula in the past [5], and draws conclusions regarding the direction of changes occurring in the observed biocenoses.

The above information (student work sheet no. 5) will be used by the students for the preparation of a PowerPoint multimedia presentation summarizing the final outcomes of their work.

**Homework**

Assembling comprehensive documentation of the trip in order to prepare a portfolio.

**Proposals for modifying the scenario regarding the use of GIS tools**

If there is no possibility of using Quantum GIS, it’s worth trying Google Earth (http://earth.google.com). It allows the students both to upload data from their GPS receivers and to analyze them on the orthophotomap background. The data can be also saved in the KML format. This way, the students can share the results of their work with others. It’s also easy to put together the results generated by students in various years, and create a kind of a map showing changes in the natural environment over a specified period.

**Additional materials to the scenario:**
- student work sheets no. 1 –5.
A large city nature reserve on the example of Kabacki Forest

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The presented scenario was based on Las Kabacki (Kabacki Forest) Reserve located on the southern outskirts of Warsaw. However, the idea can be used to analyze the state of any similar, attractive natural place near a large urban agglomeration where population is migrating to the outskirts of the city. Classes based on the scenario can be conducted with the 3rd year Junior High School students, on biology lessons covering the issues of protection of the natural environment, or at a meeting of an interest group (any class, depending on the interest group’s program of work). Unrestricted students’ access to the computer is crucial during the lesson but the teacher should download necessary materials before the class just in case of unexpected technical problems.

The main goal of the lesson

- Deepening knowledge about nature protection and means of preventing the degradation of the natural environment.
- Shaping the skills of formulating conclusions based on the analysis of source materials.

Operational objectives

Knowledge
The student:
- defines the concept of a nature reserve;
- lists objects deciding on the natural, historical and recreational values of Kabacki Forest;
- lists examples of negative consequences of the human influence on a natural reserve;
- lists examples of activities supporting the protection of Kabacki Forest.

Formal skills
The student:
- analyzes zoning plans;
- formulates conclusions based on the analysis of source materials;
- notices problems resulting from the implementation of the sustainable development idea.
Lesson scenarios (including a methodological commentary) prepared by the EduGIS Working Group

The student actively uses the Internet:
– uses the Internet search engine(s);
– searches for information on specified websites.

### GIS skills
The student:
– searches for data on geoportals;
– analyzes information from the Internet databases, interactive maps and geoportals;
– locates objects on digital maps, navigates on the maps and uses available tools.

### Attitudes
The student:
– shows respect towards nature;
– understands the need to protect nature;
– feels responsibility for the state of nature in the neighborhood;
– develops interest in nature, its beauty and diversity;
– takes action in order to protect nature in his/her own neighborhood.

### Teaching methods/techniques

- Working with source texts: acquiring, selection and verification of information gathered on the Internet.
- Discussion using the brainstorming method.

### Organization of the students’ work
Individual, collective.

### Educational aids
- Computer with Internet access;
- interactive map of places worthy of attention in Poland (polskaniezwykla.pl website) [1];
- online localizer Targeo.pl – connections to Kabacki Forest [2];
- localizer of important and interesting places Miplo.pl – Kabacki Forest [3];
- orthophotomap of Kabacki Forest (Google Maps website) [4];
- thematic maps of Kabacki Forest (City Forests – Warsaw) [5];
Lesson scenarios (including a methodological commentary) prepared by the EduGIS Working Group

- maps available for download as PDF files (Downloads tab): general overview map of the buffer zone and proposed wildlife corridors in the vicinity of Kabacki Forest, map of the areas and sites accessible for scientific, educational and tourist purposes, map of environment protection activities, situational map, map of external threats [http://www.lasymiejskie.waw.pl/index.php?option=com_docman&task=doc_download&gid=3&Itemid=156][6];
- online map of Warsaw, including orthophotomaps of Warsaw from the years 2005, 2008 and 2010 (Warsaw City Hall – the Historic Warsaw website) [http://www.mapa.um.warszawa.pl/mapa/Mapa.aspx?service=Today][7];
- satellite images of Ursynów (the Warsaw’s southern borough including Kabacki Forest) from 1987 (Ursynow.org.pl website) [http://www.ursynow.org.pl/index.php?q=gallery&g2_itemId=4423][9];
- aerial photo of Kabaty from 2007 (Online Encyclopedia – Wikipedia) [http://pl.wikipedia.org/wiki/Kabaty][10];
- results of a survey concerning recreational activities of Warsaw’s inhabitants (Instytut Badawczy Leśnictwa, Zakład Ekonomiki i Polityki Leśnej – Forest Research Institute, Department of Forestry Economics and Policy) [http://www.mos.gov.pl/g2/2009_12/21fa01c2c4295607a0da825ccec59fd9.pdf][11];
- results of a survey gauging opinions of Ursynów inhabitants about the management of Kabacki Forest in the context of its recreational purposes [http://www.ankietka.pl/wyniki-ankieta/27185/ocena-zagospodarowania-lasu-kabackiego-dla-potrzeb-rekreacji-w-opinii-mieszkancow-ursynowa.html][12];
- Wikipedia [http://pl.wikipedia.org]:
  - information on nature reserves [http://pl.wikipedia.org/wiki/Rezerwat_przyrody][13];
  - information on Kabacki Forest and its current situation [http://pl.wikipedia.org/wiki/Rezerwat_przyrody_Las_Kabacki_im._Stefana_Starzyńskiego][14];
- scientific information portal BIOLOG (The Biologist) – information materials on nature reserves [http://www.biolog.pl/nauka-45.html][15];
- article by Janeczko E., Woźnicka M., Zagospodarowanie rekreacyjne lasów Warszawy w kontekście potrzeb i oczekiwań mieszkańców stolicy (Management of Warsaw forests as recreational areas in the context of needs and expectations of the capital’s inhabitants) – the graph: preferred forms of recreation in various forest complexes [http://cepl.sggw.waw.pl/wydawnictwa/sim23_pdf/119_SIM23.pdf][16];
- presentation by Wójcik R., Territorial forms of protection and their impact on forest management concerning the management of a nature reserve (Generalna Dyrekcja Ochrony Środowiska – General Directorate for Environmental Protection) [http://www.ibles.pl/szkolazimowa/II_ZSL/II_ZSL_referaty/R_Wojcik.pdf/at_download/file][17];
• nature protection plan for Kabacki Forest, Downloads tab (Lasy Miejskie – City Forests, Warsaw)
  [18];
• student work sheet.

Description of the lesson

Introductory phase

Introduction to the subject
The teacher presents the results of a poll conducted on a random, representative sample of 500 residents of Warsaw, regarding their preferred recreational activities [11]. This survey provided information that allowed for drawing the following conclusions:
• 41% of respondents said that during last year they visited forests less than once a month;
• 58% of respondents said that they visited forests on weekends;
• 28% of respondents visited Puszcza Kampinowska (Kampinowski Forest), 24% Kabacki Forest, 11% Bielański Forest.
The teacher emphasizes a big interest in Kabacki Forest and then presents the topic of the lesson.

Recognition and formulation of the research problem
Research problem: can good functioning of a valuable natural object be reconciled with the needs of local residents and tourists?

Implementation phase

Data acquisition, processing and analysis
• After the presentation of the poll results, the teacher formulates the first tasks for the students. They have to explain why Kabacki Forest is a valuable natural object and a tourist attraction. On the digital maps the students:
  – locate the object and assess ways of getting there [1] [2];
  – search for places of interest e.g. natural objects (natural monuments, landscape features such as the Vistula escarpment, didactic routes), historical (old Biuro Szyfrów – Cipher Bureau, historical forester’s house, 1987 plane crash site, national remembrance places). They find on the map and determine the location of additional attractions – culture parks, the botanical garden, bicycle paths etc. [3]–[5];
  – explain the term landscape reserve [13] [15].
The students enter the results into their student work sheet.
• The next task concerns ways of spending time by the visitors to Kabacki Forest, and concluding how it impacts on the state of Kabacki Forest [12] [16].

• The next task concerns land use planning around Kabacki Forest. The students use orthophotomaps of Warsaw from 2005, 2008 and 2010 [7] and archival aerial photos [8] [9] [10], encompassing the whole Kabacki Forest – including its southern part and adjacent areas. Places with a dynamically growing number of buildings over these 5 years can be easily seen – including areas right next to the forest. The students enter the results into their student work sheet.

• The last task in this part of the lesson concerns drawing conclusions about opportunities and dangers to proper functioning of the forest in harmony with the needs of people and the need to protect this valuable natural object. The students analyze maps [5] [6] and documents related to the Kabacki Forest protection plan [18]. Also, it is worth checking the presentation about managing the reserve [17] and information about the current situation of Kabacki Forest [14]. The students enter the results into their student work sheet.

Data presentation
According to task no. 6 in the student work sheet.

Solving the formulated research problem
According to the instructions from the student work sheet (individually by every student after finishing the tasks).

Summary phase
The teacher splits the class into two random groups: group I – enthusiasts, group II – grumblers.
The students from the first group are supposed to present arguments supporting the idea that Kabacki Forest can function well despite the fact it is located in the large city, and the second group’s job is to argue that it doesn’t have a chance to survive in the large city. The discussion should be conducted as a brainstorming session. Every argument is written on the blackboard by the student who submits it and under the appropriate category (“chance” or “threat”). The group receives one point for every argument. Once the arguments have been exhausted, the teacher gives a chance for bonus points – enthusiasts can add to the list of threats, and grumblers to the list of chances. The bonus is that for every such argument the group receives two points. The group with the highest number of points is the winner.

Homework
Leaflet or poster You’re also responsible for Kabacki Forest.
Proposals for modifying the scenario regarding the use of GIS tools

In the introductory phase of the lesson, during the acquisition of basic information about the Las Kabacki reserve, it is worthwhile to use the Geoportal.gov.pl website: (http://maps.geoportal.gov.pl/webclient). After entering the keyword „Kabacki” into its search engine the students will be automatically directed to the proper location. Using additional sources of data (available through WMS) they can determine the borders of the reserve, or get acquainted with the economic activity in the protected area and its immediate neighborhood.

The national geoportal maintained by the Head Office of Geodesy and Cartography is the main source of spatial information about our country, helpful for students not only during classes but also in everyday life (on the website, there is information available about, among others, land plots and other thematic data). Promoting its use among the youth is a worthy goal.

Location of Las Kabacki reserve in topographic map – presentation in Geoportal.gov.pl application (source of data: WMS service of Central Geodesic and Cartographic Centre and General Directorate for Environmental Protection)

Additional materials to the scenario:
• student work sheet.
Biodiversity on the example of trees and shrubs of Saska Kępa and your place of residence

Renata Sidoruk-Sołoducha, School complex no. 77, Bolesław Prus Junior High School no. 19 with bilingual classes in Warsaw, rsoloducha@poczta.onet.pl

The presented scenario combines elements of working in the field (2 teaching units) and in the class (2 teaching units, a short 15-minute introduction, and a summary). It fulfills the core curriculum requirements regarding plant taxonomy (classification rules, identification and review of the diversity of organisms). It is aimed at the 1st year Junior High School students (7th year of education), and the difficulty of the tasks was chosen correspondingly.

Classes carried out according to this scenario should be conducted prior to classes covering the characteristics of angiosperms and gymnosperms.

The main goal of the lesson

Familiarization with the vegetation of Saska Kępa (a subdivision of Warsaw).

Operational objectives

Knowledge
The student:
– explains that trees and shrubs are perennial plants with the woody stem;
– lists differentiating features of trees and shrubs;
– compares the attributes of gymnosperms and angiosperms.

Formal skills
The student:
– identifies selected tree and shrub species;
– recognizes – on the basis of leaves, fruits and bark – five species of trees and three species of shrubs growing in the vicinity of the school;
– makes observations of plants and the study area (see the student work sheet);
– documents the observations in the form of a map of the area;
– prepares a mini herbarium and a multimedia presentation.

The student actively uses the Internet and ICT tools:
– displays and navigates appropriate websites;
– presents identified tree species and their localization with multimedia presentation programs, for example PowerPoint;
Lesson scenarios (including a methodological commentary) prepared by the EduGIS Working Group

– searches for information about tree and shrub species on Polish and foreign websites.

**GIS skills**
The student:
– registers location of objects (trees, shrubs) with a GPS receiver;
– handles the GPS receiver;
– works with Google Earth – for example: locates streets where the selected objects are located, names places, changes labels into plant pictures.

**Attitudes**
The student notices the beauty of his/her homeland’s nature.

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**Teaching methods/techniques**

In the classroom:
● discussion;
● chat;
● work with a computer.

In the field:
● direct observation;
● field work;
● work with a GPS receiver.

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**Organization of the students’ work**

Work in 3–4 person teams.

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**Educational aids**

● Computers with Internet connection;
● Google Earth application [http://earth.google.com](http://earth.google.com) [1];
● GPS receivers (one per each 3–4 person team), including the user manual;
● Internet keys for identifying plant species [2], including:
  – atlas of Polish trees [http://www.drzewapolski.pl/Drzewa/atlas_drzew.html](http://www.drzewapolski.pl/Drzewa/atlas_drzew.html);
  – descriptions of coniferous trees [http://iglakopis.w.interia.pl](http://iglakopis.w.interia.pl);
  – descriptions of deciduous trees [http://drzewopis.w.interia.pl](http://drzewopis.w.interia.pl);
  – lexicon of weeds [http://unkraut.rheinmedia.de/cgi-bin/unkraut_ausgabe.cgi?partner=liz_pl&sprache=pl](http://unkraut.rheinmedia.de/cgi-bin/unkraut_ausgabe.cgi?partner=liz_pl&sprache=pl);
● guides for identification of tree species e.g.: Rostański K., Drzewa i krzewy (Trees and shrubs);
tools for marking tree leaves: markers, A4 white paper sheets, adhesive tape;

other reference materials:
- Głuch G., *Rysujemy, malujemy, drzewa poznajemy* (We draw, paint, and learn about trees), Forest Publishing house;
- Głuch G., *Plansze dydaktyczne – wybrane gatunki drzew* (Educational charts – selected tree species);
- Bachofer M., Mayer J., *Spotkania z przyrodą. Drzewa* (Encounters with nature. Trees), Multico;

educational game *Piotruś botaniczny* (Peter the Botanist);

student work sheets;

Cameras.

### Description of the lesson

#### Introductory phase

**Introduction to the subject**

- Organizational matters: gathering the students in the class for 15 min., dividing them into 3–4-person teams. Reminding them of safety rules during field work and teamwork, rules for using a GPS receiver. Distribution of student work sheets, explaining criteria of their evaluation. Discussion on the multimedia presentation (result of the students’ work) and its evaluation criteria.

- Reminding the rules of using Google Earth [1]: familiarization with the studied area.

- The teacher leads the students to the first spot: introduction to the lesson topic – the teacher explains the goal of the lesson. A short directed discussion about detailed (operational) goals is conducted by the teacher.

**Recognition and formulation of the research problem**

What species of trees and shrubs dominate the Saska Kępa area?

#### Implementation phase

**Data acquisition**

Teams of students follow the tasks described in their student work sheets.

**Data processing and analysis**

- Recognition of tree and shrub species with the use of Internet keys for identification.
- Downloading data from GPS units to Google Earth.
- Localization of the streets on which selected objects are located.
- Assigning names to objects, changing labels into plant pictures.
- The students make a presentation using tree and shrub pictures taken during the field work.
**Data presentation**
Representatives of the teams present to the class their results and conclusions in the form of filled student work sheets, mini herbaria (A4 sheets with identified plant species), and multimedia presentations.

**Solving the formulated research problem**
Answering the question: what tree and shrub species dominate in the Saska Kępa area (for example: lindens, maples...)?

**Summary phase**
The students are provided with sets of playing cards as in the traditional Piotruś game. On some cards are pictures of leaves and fruits, while on the others names of species. The thirteenth card (“Piotruś”) is a species name of a shrub (or its picture) that is not present on the remaining cards. The team that first completes the round of Piotruś and correctly links pictures to names receives a bonus in the evaluation.

**Homework**
Answer in the form of a short note (3 bullets) in your exercise book: what is the role of trees in the urban environment?

**Proposals for modifying the scenario regarding the use of GIS tools**
If the students easily handle the computer, it is worth including in the class some tasks with the Quantum GIS program (http://www.qgis.org). It enables fast importing of data stored in a GPS receiver. These data can be combined with other thematic data (available through WMS services), which definitely expands the range of possibilities to analyze the collected information.

**Additional materials to the scenario:**
- student work sheets.
Lesson scenarios (including a methodological commentary) prepared by the EduGIS Working Group

Theory versus practice.
A commentary on the biology lesson plans

Anna Woźniak, methodology consultant in biology

Biology lesson plans (scenarios) proposed by the EduGIS Working Group contain many examples of planning and carrying out tasks when educating students in GIS.

Often, the observation method is used during biology classes, and its crucial element is documenting the observation. Most of the time, the observation is done in the field, and in that case the object or phenomenon should be linked to the area in which it occurred. This task is made easier with the use of a GPS receiver (allowing for a quick recording of the place’s location). Renata Sidoruk-Sołoducha, in her scenario Biodiversity on the example of trees and shrubs of Saska Kępa and your place of residence proposes tasks aimed both at learning how to recognize tree species, how to use the GPS receiver, and how to document the location of natural objects on a traditional paper map. Results of classes conducted by the author of this scenario indicate that the use of the GPS receiver in such situations allows for a more precise localization of the observed object, and, above all, captures much higher interest in the young people.

Example task:
Try to find, among the encountered specimens, one of the following six species of trees and identify their location on the map of Saska Kępa. Record the objects’ location using the GPS receiver:

- oak (Quercus sp.)
- lime/linden (Tilia sp.)
- beech (Fagus sp.)
- rowan (Sorbus sp.)
- horse chestnut (Aesculus sp.)
- birch (Betula sp.)

Combining field work with computer lab classes, the students can further refine the documentation about the location of the observed objects, and create their own information layer. It is well worth combining these two types of classes, as it gives the students the opportunity to show the results of their work to the whole class. At the same time, it reinforces the students’ awareness that field work is an integral part of nature research, and not only a break from the traditional school routine.
Example task

Upload the data from the GPS receiver into the Google Earth program. Determine the location of the registered objects (street), name them (e.g. ‘oak’), and assign to them thumbnails of images that you have taken.

Results of the observations can also be documented in observation sheets. The students record not only the geographic coordinates of a given point (latitude and longitude determined using the GPS receiver), but also other characteristics of the observed object. An example of such a task is given in the scenario by Anna Jackowska entitled *Getting familiar with the biodiversity of the Middle Vistula Valley.*

Example task

**Ornithological observations**

Date of the observation: .................................................................

<table>
<thead>
<tr>
<th>No.</th>
<th>Species name</th>
<th>Latitude</th>
<th>Longitude</th>
<th>Habitat</th>
<th>Number of individuals</th>
<th>Behavior</th>
<th>Photo (number)</th>
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Interactive maps and geoportals are also a valuable means of teaching, allowing the students to quickly and easily find interesting natural or historical objects. It is also easy to identify the options (routes) of getting to these places. Remember to include not only the link to the selected map application but also a brief description of what can be found on that website. Young people using the Internet are nowadays flooded with a huge number of links and often have problems with both the choice of appropriate sources of information, and with the proper description of the sources that were used when carrying out a task. Tasks requiring the use of map applications are proposed for classes conducted in the computer lab and are described in the scenario by Anna Woźniak *Large city nature reserve on the example of Kabacki Forest.*

Example tasks

Find interesting places in Kabacki Forest. Use the following websites:

- Localizer of important and interesting places Miplo.pl – Kabacki Forest  

- Orthophotomap of Kabacki Forest (Google Maps website)  

- Thematic maps of Kabacki Forest (City Forests – Warszawa)  
  [http://www.lasymiejskie.waw.pl](http://www.lasymiejskie.waw.pl), including:
Lesson scenarios (including a methodological commentary) prepared by the EduGIS Working Group

- Interactive maps (Maps tab): economy, tourism, fire prevention [link]
  - Maps available for download as PDF files (Downloads tab): general overview map of the buffer zone and proposed wildlife corridors in the vicinity of Kabacki Forest, map of areas and sites accessible for scientific, educational and tourist purposes, map of environment protection activities, situational map, map of external threats [link].

Write down the results in the table:

<table>
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<tr>
<th>Natural objects</th>
<th>Historical Objects</th>
<th>Additional attractions</th>
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A slightly more complex educational tool is the GIS software such as Quantum GIS. In Anna Janowska’s scenario, a map with the planned bicycle trip route is used. It could be prepared using Quantum GIS both by the teacher and the students themselves, who would have an opportunity to hone their skills of settlement searching, route planning, and creating their own information layers.

Bicycle trip made by the students, presented on the topographic map of Poland in the scale 1:50 000 (topographic map available via WMS [link]).
Lesson scenarios (including a methodological commentary) prepared by the EduGIS Working Group

Many institutions make their maps available for non-commercial purposes. Teachers, while planning classes, may choose thematic, up-to-date maps even of small regions. They can be a basis for student analyses and illustrate the topics presented by the teacher. In Anna Janowska’s scenario *Getting familiar with the biodiversity of the Middle Vistula Valley* there is a proposal for using such a resource from the website of the Department of Geodesy and Cartography of the Mazovian Voivodeship Marshall’s Office in Warsaw.

**Example task:**


<table>
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<tr>
<th>What type of land dominates the research area?</th>
<th>Map of of agricultural land valorization</th>
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An important complement to the classes is homework. It may include the preparation of students to the next lesson, or consolidation of skills practiced in the class. An interesting homework task may be e.g. finding relevant portals, websites with data or databases, and presenting the results of that search to the whole class. The students can also prepare maps with planned trip routes, or printouts of thematic maps, and in this case...
way complement the topic of the class, or hone the skills acquired during the lesson. In the scenario by Renata Sidoruk-Sołoducha entitled *The air – a life-giving mixture of gases, or a poison that knows no borders?* we have an example of a task aimed at consolidating skills acquired at the lesson.

**Example tasks**

- Using the website [http://meteo.is.pw.edu.pl:8080/meteo/oa/monitoring](http://meteo.is.pw.edu.pl:8080/meteo/oa/monitoring) select any Voivodship and, inside it, any two cities, and determine the emission of SO₂ into the atmosphere in the last two years (2009 and 2010).

Designing similar tasks, biology teachers shape the following skills among the students:

- finding the right portals, websites with data, and databases;
- navigating and browsing useful Internet websites;
- browsing and searching for information on geoportals;
- identifying locations on the map;
- selecting objects based on their location;
- online observation of changes in statistical data / phenomena;
- interpreting aerial, radar, and satellite images;
- using the GPS receiver (acquiring data, connecting to the computer, uploading data).

Also, GIS technologies facilitate the task of achieving the core curriculum goals of the 3rd educational stage (Junior High School, 7th–9th years of education):

- searching, using and creating information – the student uses various sources and methods of acquiring information, including information-communication technologies;
- reading, analyzing, interpreting and processing text, graphical and digital information;

and also the core curriculum goals of the 4th (High School, 10th–12th years of education) educational stage:

- knowledge of organisms at different levels of taxonomic organization;
- searching, using and creating information;
- reasoning and argumentation;
- attitude towards nature and the environment.
Theory plans practice. 
A commentary on the geography lesson

Małgorzata Witecka, methodology consultant in geography, Computer Assisted Education and Information Technology Centre
Monika Rusztecka, Piotr Mikołajczyk, Ph.D., UNEP/GRID-Warsaw Centre

Nowadays, teaching geography that does not take into account the existence, usefulness and dynamic development of geoinformation technologies could be considered outdated if not even archaic. Some of the advantages of including GIS in the teaching process include the opportunity to present and analyze (show the relationships), in a short time, many aspects of a lesson’s topic, and also the opportunity to link theoretical knowledge with the specific, real places in the world. Geographic Information Systems (GIS), present in many areas of human activity and woven into the teaching process, can strengthen – or sometimes even discover – the sense of learning. They allow the students to travel virtually to places that are remote and inaccessible to them, learn about objects and phenomena, and follow processes happening in the world.

Lesson scenarios (lesson plans) presented in this chapter describe the use of GIS tools in training various skills, require different methods, give a chance to get a broader perspective on the discussed issues. They include tasks that are easily adaptable to the needs of particular groups of students, according to their education level, knowledge or interests. It should be remembered that geoinformation technologies are a very flexible and versatile means of teaching, with advantages that manifest themselves not only in the geography/computer lab, but also in the field. Below are some examples of using GIS in various types of classes.

Field classes

One of the basic types of activity in the “real space” that can benefit from the use of GIS tools is a field trip. From the planning phase, all the way to the summary and evaluation we hone skills that are often overlooked when implementing the standard core curriculum. In addition to the purely cognitive aspect of such classes, they also teach students organizational skills. On the surface it might look like the students are passive receivers of prepared lessons. Such myth is dispelled by the lesson scenario by Hanna Habera What are the natural and cultural values of Puszcza Kozienicka. It concerns planning and executing a trip to one of the most beautiful forests in Poland. Already at the preparation stage, the students use GIS applications and various information resources to acquaint themselves with the terrain they will traverse. For example, the website of the Forest District Kozienice maintains a tourist map of the District with objects – both natural and historical – displayed over it. Also, Ewa Bryndza’s scenario. Diversity of the natural environment of the Tatra National Park shows how valuable online map applica-
Lesson scenarios (including a methodological commentary) prepared by the EduGIS Working Group

Lessons are for preparing field classes. The already mentioned geoportal maintained by the Tatra National Park is very abundant in resources and allows, thanks to the interactive map, to adjust the displayed contents to the objectives and topic of the classes, or even to the needs of a specific, individual user.

Even when planning a short trip in a nearby area, it’s worthwhile to use applications with data of a general nature. A popular tool among teachers using GIS in the classroom is the Google Earth application. In the case of the scenario *Diversity of the natural environment of the Tatra National Park* the possibility of displaying three-dimensional images of the Earth’s surface was very helpful when discussing the diverse Tatra mountainous terrain. This scenario also utilizes the function of displaying panoramic views from selected points. It gave the opportunity for accurate, albeit only virtual, planning of the trip, and also – already at this stage – for making first observations and findings, while having an attractive substitute for communing with a real Alpine landscape. Another useful function is the distance measurement tool which, combined with the information about the terrain, is very valuable in determining the length, difficulty and duration of the route in relation to available time and students’ capabilities (also in the context of safety of the students).

Another very interesting proposal is to use resources available on the national geoportal [http://www.geoportal.gov.pl](http://www.geoportal.gov.pl). It contains geospatial data, orthophotomaps, aerial and satellite maps, and various thematic maps – sociological, hydrographic, topographic, national borders, data from the National Register of Geographic Names and many others. They can be displayed as layers uploaded from external resources (via the so-called network services e.g. data browsing – WMS, web map service). Students get an inspiring and satisfying feeling of using professional websites and spatial information resources that were created with the “serious” specialist use in mind. This makes the young people more motivated to follow instructions and complete school tasks.

Another valuable didactic tool for field classes is a GPS receiver. Using GPS receivers is very attractive for students, as it combines learning with fun. Finding your way in the field is usually easy for a limited group of students gifted in these matters, so GPS receivers provide an opportunity for everyone to locate themselves in space, as well as to demonstrates the relationships between the real space and the map. In Hanna Habera’s scenario *What are the natural and cultural values of Puszcz Kozięnicka* the students eagerly use GPS to record the location of selected objects, and to navigate to the target (place/object).

Trip scenarios often expect that the students create a new information layer concerning the route (and/or the topic) of the trip, locations recorded in the field and their descriptions (with photo images). With today’s technology, the photos can be easily attached to the results of the students’ work. Tasks of this type train the skills of organizing collected information and sharing acquired knowledge.

**Classroom activities – Poland and the world**

Going outside is an excellent way to explore nature. However, it isn’t always possible, if only because of distance, nature of the phenomenon, or the chronology of events
Lesson scenarios (including a methodological commentary) prepared by the EduGIS Working Group

– sometimes to understand reality one should go back to the past. A perfect example would be lessons based on archival materials accessible thanks to the Internet. This is a new quality, the opportunity to compare modern photos of the Earth’s surface to images from earlier periods, which are successively placed on the web. Such a possibility is created by Google Earth with its Historical Imagery tool. On the regional scale, excellent archival data concerning the Vistula valley in Warsaw is available on http://www.wisła-warszawska.pl and http://www.samper.pl/warszawa_z_lotu_orla/ websites. Agnieszka Chrząstowska-Wachtel used them in her scenario entitled Warsaw – the natural environment. Did it determine spatial development of the city? In this scenario, the students, using archival information, try to figure out on their own how the natural environment affected the development of the city.

Analysis of topographic profiles is often used not only in teaching physical geography. When considering the impact of the natural environment on human activity (and vice versa), topographic profiles can be one of the more useful means helping students to draw the right conclusions and understand the issues being discussed. The Geocontext-Profiler program allows for creation of topographic profiles of any place on Earth, including the bottoms of seas and oceans. It speeds up the progress of a class, gives flexibility in conducting the lesson and helps to quickly create profiles tailored to the lesson’s topic. Thus, attention can be focused on the analysis and not on the tedious preparation of the profile. Terrain is closely related to geology, so access to geological maps of a region is a valuable complement of the results of a profile’s analysis. The quality of maps available on the Polish Geological Institute website is not only very high, but also these map resources are incomparably richer than the material available in a school atlas.

Both Agnieszka Chrząstowska-Wachtel in her scenario Warsaw – the natural environment. Did it determine spatial development of the city? and Joanna Poręba-Kwiatkowska in her scenario Features of Poland’s terrain use the profile analysis. Today’s youth, expecting rapid information transfer, is very well attuned to using numerous sources of knowledge in the time span of one lesson. This also applies to the online, digital map resources. Thanks to these maps, the students can easily create their own presentations, prepare materials published e.g. in a newspaper or on the school website, etc.

A professional program that could be useful for school classes is the Global Mapper. Based on the plentiful data collected on the portal (results of sample transformations and spatial data analyses) teachers and students can, for example, have a lesson about the course and causes of floods in the Vistula river basin. Such a lesson was proposed by Ewa Bryndza in the scenario Floods in the basin of the Vistula River on the example of Wilków commone (Lublin Voivodeship). Using data from commercial portals and tools for visualization of these data provides an opportunity to practice skills of reading and analyzing maps. Free use of commercial resources is admittedly limited, but for educational purposes is often quite sufficient, and gives the assurance that the in information is of high quality and reliable.

Analysis of causes and effects of Vistula flooding, the course of which the students could follow in the media, carried out on the material acquired from reliable and profes-
sional sources, brings science closer to everyday life. An important aspect of this lesson is raising awareness that geographical knowledge used to plan human activities may limit economic impacts of disasters periodically occurring in nature. Links to videos showing passing of the flood wave and its crest are a valuable supplement to the classes, giving the students the impression that science can be interesting and closely linked to reality.

Statistics also helps organize an enormous amount and variety of data. Data analysis is an important part of teaching geography both at the Junior High School and High School level. Science that is based solely on learning processed statistical data will bring results only in the case of the brightest and most ambitious students. Training skills of handling data, calculation on their basis of new variables in order to analyze demographic, societal and economic situation of a region brings much better results that are long-lasting because they are closely connected to the real world.

Statistical data are available online at the Central Statistical Office (http://www.stat.gov.pl) website. Worth recommending are also, for example, data gathered on the Wiking publishing house website and thematic maps posted on the map server of the Institute of Geography and Spatial Management of the Polish Academy of Sciences. Because these suggested resources are reliable and up-to-date and have a high educational value, lessons on statistics are not boring and sometimes might trigger individual exploration. Pointing the students to reliable sources of knowledge, stressing the importance of data quality results in a critical stance towards contents available online, and is an important task of the modern school teacher.

Preparing data necessary for a geography lesson in the computer lab makes the students realize the great variety of data, teaches them ways to store them and train the skills of organizing, presenting and analyzing information. In this case, cooperation between geography and information technology teachers is invaluable. Without their help, the students often feel overwhelmed by the sheer amount of available data and tools and, in effect, refrain from preparing data in the appropriate format. But with support, the students carry out tasks quickly and willingly. Processing available statistical data, calculating new values with the help of a computer etc. is easier, so the focus can be put on the proper formulation of hypotheses and not on the calculations themselves. Such a way of work is assumed in scenarios prepared by Agnieszka Chrząstowska-Wachtel (Analysis of socioeconomic differences in the development of the world with the use of GIS) and by Mirosława Rogala (Population distribution in Poland).

Among the proposed scenarios are ones that use Quantum GIS – a desktop geoinformation program that makes it possible to manage spatial data, create own data (information layers), use GPS data, perform spatial analyses, and create maps. The last point is very important when working with older students. School in which the student only ab-
sorbs educational material does not prepare for independent acquisition of knowledge and creative thinking, and exactly these qualities are expected from the young people on the labour market. Quantum GIS allows for creating own maps and, as such, helps in both shaping and discovering talents, as well as, due to the higher involvement of students in creating a map, gives a bigger chance for faster and more efficient learning in line with the maxim that humans learn best by doing. The teacher plays a very important role in working with such a program. It is not necessary to know everything about the use of the program, the students often are better at simply handling the program itself – which often results in the withdrawal of the teacher and his/her reluctance to use it. However, the experience of teachers that overcame this barrier are unequivocally positive. The student is proud of being able to help the teacher in technical matters, and at the same time expects support and help from the teacher when it comes to the substance of the topics being covered with modern technologies. Using Quantum GIS is proposed in scenarios prepared by Agnieszka Chrząstowska-Wachtel *Analysis of socio-economic differences in the development of the world with the use of GIS* and *Warsaw – the natural environment. Did it determine spatial development of the city?* and also by Joanna Poręba-Kwiatkowska *What determines the appearance of the cities of Europe and the world?* Apart from the analysis of pre-made maps, these scenarios involve creation of new thematic layers. The student becomes a co-author of the presented map, understands how this map is created and how it can be used to present various kinds of data, or for visualization and analysis of phenomena and processes occurring in space – quite often quite far away. Using GIS to visualize geographic information (and the amount of data that can be used to learn about the world and its problems is huge) allows for perfect familiarization with remote regions. For example, the website [http://www.earthobservatory.nasa.gov/](http://www.earthobservatory.nasa.gov/) contains many images documenting phenomena occurring on Earth, including human activities and their effects on the Earth’s natural environment. Images are up-to date, sometimes updated weekly, which makes it possible to enrich the lesson contents with very interesting and current materials unavailable in applications like Google Earth.

Joanna Poręba-Kwiatkowska’s scenario *What determines the appearance of the cities of Europe and the world?* proposes using the Open Street Map application, while Mirosława Rogala’s scenario *Brazil – country of rainforests and overpopulated cities* suggests using resources from the website [http://www.brasil-turismo.com](http://www.brasil-turismo.com). These sources are important not only because of their content, but also because they show the student how complex is the process of gathering data about the world and that every one of us can be a co-author of such portals by joining the communities engaged in updating information about regions they live in. Not without importance is also the fact of being immersed in a foreign language environment and an opportunity to practice foreign language by networking within the international community contributing to the portals’ resources.

The authors of the scenarios propose an evaluation of classes that includes an assessment of the quality of information sources done by the students themselves. In a
Lesson scenarios (including a methodological commentary) prepared by the EduGIS Working Group

situation where we can use a lot of GIS applications and multiple sources of online information, it’s worth checking which sources are accessible to a specific group of students. That way we can create a database of sources that are best suited for our curriculum and educational level. Working with interactive maps of Poland and the world can begin from simpler applications and gradually include more and more GIS tools. Every student group is unique and requires adaptation of didactic methods and means; every teacher has a distinctive, individual style of work and is the creator of his/her own lessons.

A different perspective

The presented scenarios propose using many applications and portals, but it’s worth remembering that nothing prevents you from using only one or two. It will shorten the time needed for planning the class. Classes don’t have to be carried out in the computer lab – they can be conducted in a room with one computer and interactive whiteboard or an ordinary projector. In such cases, the teacher can more closely supervise the lesson – all students work together analyzing the data and formulating conclusions. I would recommend such a solution in the case of Joanna Poręba-Kwiatkowska’s scenario *What determines the appearance of the cities of Europe and the world*, especially if your class is composed of students with large differences of skills, or if the group isn’t independent and we don’t have access to a computer lab. Such a form of work is also appropriate if we’re only starting to learn data analysis and searching for sources.

Hanna Habera’s scenario *What are the natural and cultural values of Puszcza Kozienicka (Kozienicka Forest)* is an example of a flexible approach, where you can freely modify its components. Data (images and descriptions) gathered during a field trip can be published on Picasa Web Albums. Picasa also allows for identifying locations: place the photo was taken/data gathered can be marked on a map by simply dragging the photos onto appropriate spots on the map. The link to such a gallery posted on the school’s website or e-learning platform will have a tangible educational value and will show the students’ involvement.

Another idea for field classes is gathering information about how didactic routes are prepared – both in terms of the content (whether there are information boards and how understandable and content-rich they are, etc.) as well as the navigation (direction indicators, markings) and infrastructure (adequate number of trash cans, benches, picnic places and the condition of this infrastructure). Such actions can bring tangible benefits in areas that lack the infrastructure facilitating the preservation of nature.

Undoubtedly, students become more involved if they solve problems and verify hypotheses using GIS and acquiring information from various sources. They can record results of their own observations; create maps supplemented by presentations, descriptions, photos.

Hanna Habera, Mazovian Municipal Teacher Training Center, Radom Department
Ewa Bryndza’s scenario *Diversity of the natural environment of the Tatra National Park* also can be adapted to the use with an interactive whiteboard. It’ll make it much easier to analyze the landscape visible on the photos, especially if we want to focus on the alpine features, altitudinal zonation, etc.

The scenario prepared by Mirosława Rogala *Brazil – country of rainforests and overpopulated* cities presents two research problems. It is possible to limit the lessons’ topic to either the influence of human activity on tropical rainforests of Amazon, or to uneven distribution of population and economy in Brazil. Both cases make for interesting lessons that give students an opportunity to show their perceptivity, ability to use sources, perform analyses and draw conclusions. Data available online provide an opportunity to compare the area of forests over the time span of many years and allow for an analysis of the process of rapid deforestation and encroachment of human activity into the tropical rainforests area.

The above tools and applications can be used in many other ways and to cover entirely different topics. The prepared scenarios can become the basis of very interesting Junior High School projects. Students’ activity, formulating hypotheses and their verification with the help of the GIS technology bring a lot of satisfaction, spur interest and facilitate the presentation of the project’s results, especially these concerning the students’ immediate neighborhood (with the use of regional portals).

The proposed scenarios give an opportunity for an individual approach to all geographical topics. They can be used in a limited extent, or they can fill the whole lesson. Every teacher works with a different group of young people; therefore the planned course of lessons have to be constantly modified. Among the contemporary youth there are often very gifted students, who nevertheless have specific dysfunctions. The practice shows that if we wisely include modern information technologies (including geoinformation) into the teaching process, a much bigger share of our students will benefit from such lessons and, what’s even more important, will enjoy participating in them. The variety of proposals can also be used by the teachers to work and prepare their own lesson scenarios that take into account their specific situation when it comes to technical capabilities of the geography lab, suited for the group they will work with and the pace of work during the lesson. It doesn’t seem possible that the modern school might completely lack geospatial technologies, given that contemporary humans cannot do without them regardless of profession and interests.
Lesson scenarios (including a methodological commentary) prepared by the EduGIS Working Group

How to start an adventure with GIS?
A few valuable tips and tricks.

Anna Woźniak, methodology consultant in biology
Elżbieta Wołoszyńska, UNEP/GRiD-Warsaw Centre

What most often concerns teachers who think about introducing new educational methods to their classes? Lack of financial resources for refitting the lab, making it possible to actually use the new methods; risk that the overloaded curricula won’t allow for the new content; doubts whether they will manage to learn how to use new, unknown technologies with which the students are already more familiar. Such doubts can also appear in the case of GIS. However, experience shows that introducing GIS into teaching science subjects can be easy and fun for the teacher as well as very attractive and inspiring for the student. Do you want to know how to do that? Here are some simple tips and tricks.

**Rule no. 1: GIS is only a tool**

Spatial information is the basis of teaching geography, but it’s also not anything new in biology. It’s an inherent part of knowledge in these two disciplines. Geographic objects, including the natural ones, do not exist in vacuum. They depend on space which is always, from the methodological standpoint, described in the same way, regardless of technical means used for its presentation (simple situational sketch, school atlas map, interactive map, geportal or specialized software). Remember that geoinformation technologies are only a tool allowing for faster and better understanding of the topic. It’s easier for the students to locate and record natural objects in the field. They also have access to up-to-date information. They can watch the selected phenomena on-line. Thus, we do not add new contents to the curriculum, but in fact we facilitate the teaching process of the already existing contents.

GIS tools, like most other teaching methods, can be freely chosen depending on the school capabilities, the type of topic being taught, and age and skills of students. They can be used during field work, computer lab classes, classes in a biology lab (equipped with a computer and multimedia projector), homework, and/or students’ educational projects. Don’t put away the school atlas but try to skillfully combine it with modern teaching methods. Your students can only benefit from it!

**Rule no. 2: strengthen cooperation with other teachers and educators**

You may wonder how the students are supposed to acquire knowledge and skills in using these tools, so that geography and biology lessons are focused on the substance rather than technicalities? Join forces with other teachers, especially with colleagues who teach information technologies (IT). Persuade them to include in their classes some popular ICT tools (spreadsheets, programs for creating multimedia presentations), and GIS (map applications, geoportals, GIS software). Establish a common schedule of clas-
Lesson scenarios (including a methodological commentary) prepared by the EduGIS Working Group

... ses, so that during the IT class the students will learn tools that they will later use in biology or geography classes. Invite involvement of other teachers, for example a history teacher. History is also one of the subjects that strongly relate to geographic space. Show the students just in how many aspects of their life GIS can be useful.

Establish cooperation with the staff of institutions involved in environment protection in your area: employees of national and landscape parks, foresters. Organize joint activities and field trips. These partners often have access to equipment that is not readily available in school: measuring equipment or GPS receivers. They are usually happy to lend it for the classes, so that the young people can learn how to operate it.

Finally, go ahead and share gained experiences with educators from other countries. Get involved in building an international community of people interested in using geoinformation in school. By doing this, you will not only deepen your knowledge of geoinformation and establish new, interesting contacts, but you will also sharpen your language skills. An excellent example of such a range of possibilities is digital-earth.eu: a dynamically growing European Comenius network. It was created with the purpose to facilitate and support cooperation of not only teachers and methodology advisors but also employees of research and higher (academic) institutions, authorities, non-governmental organizations, and business companies gathering spatial data – in short, all those for whom using GIS in education is close to their hearts. In the near future the main “node” of the network will be established at the European Centre of Excellence in Salzburg (Austria) – a place to organize meetings, workshops, and conferences. A network of accredited national and regional Centres of Expertise will be established all over Europe; their role will be to facilitate sharing, among interested parties, information resources, educational tools and ideas on how to use them in class work. Joining the network is entirely free of charge, and members can apply for subsidies to support their activities. So go ahead and register your school today! Detailed information can be found on the following websites:

http://www.eurogeography.eu/digital-earth.html;

Rule no. 3: don’t be afraid of technology

Are you afraid that your students will better cope with technology than you? Remember, this is an absolutely normal thing, and can be exploited in a skilful way for the benefit of the students themselves. Young people are open to new technologies. They easily operate computers. They must function well in the future as members of the information society. If you can allow the students to learn the skills of acquiring,
collecting, integrating, analyzing, verifying, transferring and sharing spatial data describing our world and phenomena occurring in it, and simultaneously make the classes interesting, it’s certainly worth it! Let the more knowledgeable students help and guide their less advanced colleagues, or show new solutions to the whole class. Give the students more freedom to work with modern technologies and you will see how correct is the popular maxim that a person learns best through play. And if there is still any technological anxiety in you, get in touch with the IT teacher and ask for a short brush-up course.

**Rule no. 4: use equipment available outside of your classroom/lab...**

The cooperation with the information technologies teacher can also result in easier access to a computer lab (in case you don’t have computers in your own subject lab). And this is an excellent opportunity for the students to independently carry out tasks according to your pre-made instructions. Classes in the computer lab can be an introduction to field work, a field work follow-up, or an independent lesson. During such classes, the students, working with an interactive map or a geoportal, can display information layers, search for objects, measure the area and distance. Using the free Google Earth application they search for settlements, plan trip routes, upload data gathered during field work, create their own information layers (points, lines, images) and navigate all around the digital globe.

**Rule no. 5: ... and also one that you can access every day**

But what can be done if, despite many attempts, the IT teacher won’t cooperate with us? Well, not all GIS classes have to be carried out in a computer lab. It is data that is important, not computers. It is absolutely sufficient if the biology or geography lab is equipped with a multimedia projector (or an interactive whiteboard). Illustrate the presented issues with data acquired from Internet databases, interactive maps, or other cartographic materials available on geoportals. The students can present results of their work using the projector. Encourage them, invite them to stand up not only to ask them questions, but also to allow them to show off their work.

**Rule no. 6: don’t let technical problems surprise you**

Be aware that every piece of equipment can sometimes fail. However, if you anticipate such occurrences like a power outage or failure of the Internet connection, you won’t be surprised during the class. Think in advance about such possibilities. Copy the appropriate amount of information from Internet databases, take screenshots of interactive maps and geoportals. You can then use them as resources during the class. Based on them, the students can make spatial analyses, find relationships between natural objects, and interpret data. Work with analog materials during the class and ask students to get acquainted with digital applications as homework.
Lesson scenarios (including a methodological commentary) prepared by the EduGIS Working Group

**Rule no.7: conduct field classes**

Learning natural subjects without field classes is like a driving course without actual driving practice, or a cooking course without the participants even touching the cooking utensils. Just as the purely theoretical knowledge of traffic rules won’t make anyone a good driver, and knowing hundreds of recipes will not make a great cook, teaching biology or geography without observations, measurements and individual studies done by the student in the field won’t allow for any direct contact with plants and animals in their environment. Direct contacts with the surrounding nature not only make new knowledge but, above all, bring a change in attitudes and behaviors of students. A young person becomes more sensitive to the beauty of the surrounding nature, learns proper relations with it, and is more willing to take action to protect it.

The supreme goal of all field activities organized by biology/geography teachers is direct learning about objects and phenomena in their natural environment. Such classes are effective, attractive and interdisciplinary. The effectiveness of this form of teaching comes from the fact that young people experience nature with all their senses. A rich source of experience translates into increased interest in presented issues and greater students’ motivation for absorbing knowledge.

In the case of such classes, interdisciplinary integration comes very naturally. In the field, topics from various subjects interpenetrate and complement each other. Natural objects that are the main focus of interest during biology classes are located in a specific geographic space and are linked to abiotic factors and products of human activity. This gives the student a possibility of comprehensive and rational exploration of the world through phenomena and processes occurring in the natural environment, and not from the perspective of scientific disciplines or school subjects. During field work the students acquire and hone practical skills. The most important are:

- carrying out deliberate and planned observations of natural objects and phenomena;
- focusing attention on specific objects;
- using didactic resources and tools;
- taking measurements, appropriate recording and graphical presentation of them;
- assessment of the condition of the natural environment;
- planning activities aimed at preserving the natural environment;
- teamwork.

Equally important are changes in attitudes. Teaching should shape appropriate behavior in the public space, motivate to protect the natural environment, develop ethics and promote active ways of spending leisure time close to nature.

Carrying out field classes spells additional efforts to organize them. However, for the students they are fun, instructive, competitive, and give an opportunity to experience nature and learn outside of the school building. Students become independent, active, involved, interested, and resourceful. Field classes are also an excellent opportunity to
learn modern tools. It mostly means GPS receivers, which are a big attraction for the students. They quickly learn to operate them and are happy to carry out tasks that require using them. GPS receivers can be used in various field games, where students have to navigate specified routes or to some natural objects. They are also excellent for documenting observations performed in the field. Thanks to them, the students can accurately determine the location (latitude and longitude) and record measurement points or observed objects, and record the travel route, also measuring its distance.

**Rule no. 8: organize activities for students involving GIS... in their own homes**

After returning from school, students very often spend time in front of the computer. Help them spend it constructively. Using Internet databases, interactive maps, geportals, or even GIS software for preparing information for the next lesson can be an excellent homework idea. The students, individually or in small teams, can make their own analyses consolidating knowledge and skills acquired during the classes, and later present their conclusions to their classmates.

**Rule no. 9: begin with a small group of students**

Remember, if you are not comfortable enough with introducing GIS at standard lessons, don’t give up on these technologies completely. Use them when working with students that are exceptionally interested, for example those who take part in interest groups, or come up to you asking for an interesting topic for their junior high school project. Geoinformation occupies a special place in the students’ educational projects. Junior high school students who, under the decree of the Minister of National Education of 20th August 2010, are subjected to the new general core curriculum, are required to participate in the implementation of a junior high school educational project which is supposed to be a collective and planned students’ activity aimed at resolving a specific problem using various methods. The problem can be defined by the students themselves, or given by the teacher. It should be of interest to the students, and solving it should be a challenge for them. Therefore, it is worth reaching for accessible and attractive technologies motivating the students to deepen their knowledge and seek creative solutions.

In a student research project, GIS can be used in the goal-determination and planning stage, in carrying out planned activities, or in presentation of results. Projects that can be considered student-friendly should involve the area they live in, a place they know and which is close to them. Additionally, such topics help awaken interest in the condition of the local environment and the local community.

In the case of geography, defining a research problem whose solving could involve GIS is very easy, as almost every geographic topic has a spatial reference. In the case of biology, the most interesting issues where you can apply geoinformation technologies are: biodiversity, biogeography, ecology, environment protection, health and disease.

GIS technologies allow students implementing a project to:
• analyze and compare historical maps with current topographic maps and orthophotomaps;
• access current data regarding spatial planning and management;
• locate settlements and interesting natural objects on interactive maps;
• plan routes;
• use GPS receivers for thorough documentation of field observations and studies;
• display GPS data in Google Earth or Quantum GIS applications;
• create own information layers;
• compare current data on their own region with data on any other place on Earth.
Thanks to these activities, the students gain and develop problem-solving skills for typical and non-typical, theoretical and practical situations, interpreting and evaluating facts, analysis and synthesis.

Rule no. 10: do not get discouraged too easily

Don’t be discouraged by the initial impression that geoinformation is secret knowledge. Start learning it, and then start implementing the simplest features. Use available e-learning courses, find information on the Internet, draw knowledge and the experience from other users, try to find a teacher in your area who already uses GIS to teach, and ask for advice. Invest your time, but not money. Start using geoinformation technologies with free tools, there is a great selection of them. Access to many on-line teaching aids is free for the student or teacher, and they are just a few mouse clicks away. They do not take up space (sometimes just some hard disk space), so there’s no need for shelves or hangers, there’s no cleaning or maintenance. And, at the same time, we have quick access to them. Within a few minutes you can browse a plentitude of information and make the right choice in selecting even the most unusual and up-to-date didactic aids needed for carrying out your classes.
School with GIS – an opportunity for the student’s development

Witold Lenart, Ph.D., Faculty of Geography and Regional Studies, University of Warsaw; deputy director of the University Centre for Environmental Studies

Any developments in the school system should always aim at benefitting the students, and, more broadly, the whole society. From this standpoint, the advantages of introducing GIS are easily visible and obvious. They are presented in the second chapter of this publication. To sum them up from the viewpoint of a school graduate, we should list four factors:

1) strengthening the objective and accurate perception of the world (with our senses enhanced with new technologies) that is beneficial for building the student’s attitudes;
2) inspiring, stronger (motivation-wise) connection of thoughts, plans and activities with the environment, region, country (also understood as the homeland in the spiritual, abstract sense). Using GIS builds a very positive relationship with nature, society and democracy, showing their necessary coexistence within one space;
3) improving knowledge, both simple and deeper, of terrain in all scales, because space in various dimensions and its attributes will be the object of many GIS examples;
4) building good attitudes towards material values and strengthening the importance of information, including spatial information, that has real, economic value. This stems from the fact that we live in times where space quickly becomes valuable, depending on how it is possibly recognized from the utilitarian point of view.

Geoinformation technologies are one of the cheaper ways to satisfy the curiosity about the world. It doesn’t bother with borders, travel expenses, simplifies time management. For the user, it is a convenient and attractive tool. It fits with the principles of sustainable development where material consumption is limited in favor of intellectual and spiritual activity. These benefits may turn into actual material profits, if we mention the rapidly growing needs to use GIS and ICT methods.

Another positive (in large part also for the student) consequence of introducing GIS to teaching biology and geography is accelerated interest to use computers. Such interest is widespread among school youngsters. Information technology lessons are everywhere at the top of the list of requested extra-curricular activities. Fascination with the capabilities of computer hardware, Internet, multimedia applications, information databases, community websites will find another imagination-sparking and learning-friendly use. It is worth noting that GIS tools are to a large extent created with Windows OS in mind. It means that there are no barriers to the expansion of GIS usage onto all interested
parties, including school students. The advantage of Windows lies in the unification in operation of various applications achieved by the graphical user interface which allows for simultaneously running more than one program, and taking over management of external devices. In short, the student can quickly set up a personal GIS lab at home. It’s a possibility that was unbelievable just a dozen years ago. The number of available spatial data processing functions numbers almost a hundred. We have a super-attractive offer for students interested in computer sciences, which means practically all young people. A new direction of development of those programs are multimedia – including using video, audio and computer graphics, etc. in geoinformatics.

Finally, the connection between GIS and satellite navigation (GPS) is worth noticing. It is yet another fascination of the youth that could be strengthened by the school with benefits to the students’ personalities. Maps of the road network, sea and air routes etc. can be viewed on the computer monitor with ever richer contents describing the travelled areas. Soon, this tool will become widely used not only by professionals.

Of course, fascination with information techniques and computers brings well-known threats that can’t be ruled out in the case of GIS. However, thanks to these techniques being intrinsically connected to reality, uncritical dependence on products of technology is less likely. Geoinformation technologies require continuous verification of obtained information and making syntheses with the surrounding world, knowledge about nature, moral standards and, finally, always necessary for education, common sense.
EduGIS Academy in a nutshell

**Project goal:** dissemination of geoinformation technology (GIS) applications in teaching science subjects and environmental education.

**Project duration:** January 2010 – June 2011

**Project coordinator:** UNEP/GRID-Warsaw Centre, Branch of the National Foundation for Environmental Protection

**Implementation team:** the EduGIS Working Group established in the project and made up of teachers and teaching methodology consultants from across Poland, experts in teaching biology and geography, experts in the field of Geographic Information Systems (GIS)

**Activities in the project:**
- The EduGIS Working Group workshops:
  - 8–9 April and 13–14 September 2010, Warsaw – GIS training workshops;
  - 13–16 June 2010, Rąbka near Łeba – workshops with students – participants of the GLOBE Program annual field event – the GLOBE Games (approx. 200 students).
  
  Deepening knowledge and skills in using geoinformation tools, verification of alternative teaching methods: classes based on a scenario developed in the project.

- Study visits – the EduGIS Working Group visiting Gjøvik (Norway), and the Norwegian teachers’ and students’ visit to Warsaw:
  - 5–9 December 2010, Gjøvik
  - 7–11 March 2011, Warsaw

  Sharing experience in teaching with the use of geoinformation (GIS) tools, demonstration lessons and field work with a group of Polish and Norwegian students.

- National workshops entitled *GIS at school*
  22–23 March and 8–9 June 2011, Warsaw

  Raising qualifications of the participants (more than 50 geography and biology teachers and educators involved in environmental education) in applying ICT and GIS, gathering opinions on the proposed uses of these technologies, etc.

- The *GIS at school* conference summarizing the project: 10 June 2011 in Warsaw

  Presentation of practical possibilities of using geoinformation when working with the student (exemplary lesson plans employing GIS elements prepared by the EduGIS Working Group members, as well as the EduGIS Academy educational materials for teachers: the portal, EduGIS Knowledge Base, e-Learning course); presentation of other projects with similar themes carried out in Europe.

**Results of the project** (materials available on the project website [http://www.edugis.pl](http://www.edugis.pl)):
- biology and geography lesson plans involving geoinformation;
- list of GIS skills that students should hone during the classes;
- the EduGIS Knowledge Base – information about useful websites, geoportals, available GIS tools and data that the teacher can use in the classroom;
- educational portal including an e-Learning module and a discussion forum (devoted a.o. to the use of GIS software and map applications);
- this guidebook: *GIS at school*. 
This publication has been produced in the frame of the project

Akademia EduGIS
www.edugis.pl

implemented by

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