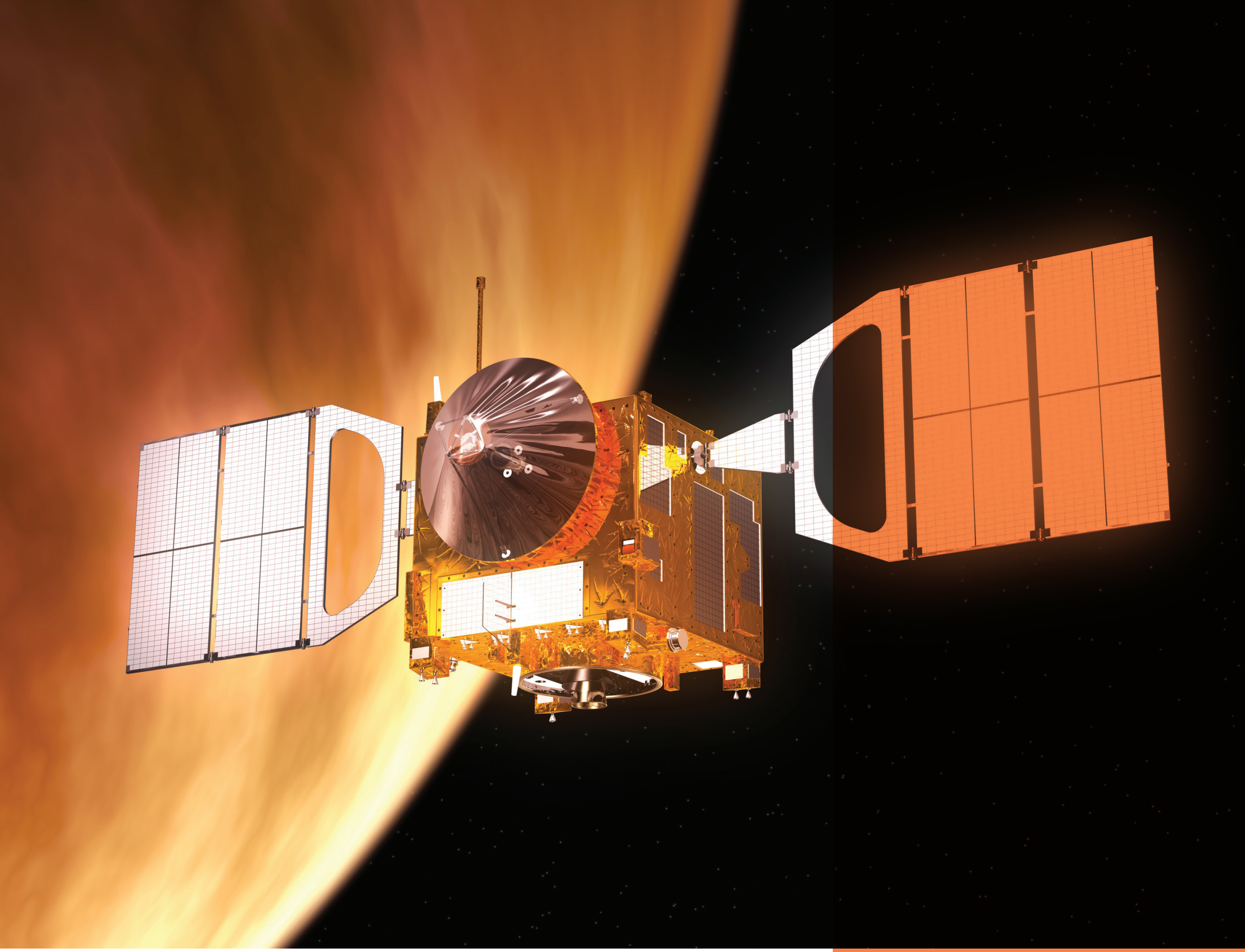

GIS IN HIGHER EDUCATION IN POLAND
CURRICULUMS, ISSUES, DISCUSSION

edited by Iwona Jażdżewska

WYDAWNICTWO
UNIWERSYTETU
ŁÓDZKIEGO

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GEOMATICS EDUCATION OF FORESTERS AT AGRICULTURE UNIVERSITIES

GEOMATYKA W NAUCZANIU LEŚNIKÓW NA UCZELNIACH ROLNICZYCH

Geomatics Education Within the Framework of Forestry Training Course at the University of Agriculture in Krakow, the Poznań University of Life Sciences and the Warsaw University of Life Sciences

The main place of work for foresters is a forest – a biologically active space. Geomatics allows measurement and documenting of forest space at varied levels of detailing – from a single tree, through stands (forests) to a forest complex and landscape. Geomatics technologies and the data gathered by means of such technologies are used for expanding the knowledge of how nature functions, so they become the foundation for decision making to the extent of forest management. They are also an important tool for nature and forest education and social communication (Grzegorzewicz 2001, 2002, Olenderek 2002).

After World War II, the issues of acquiring, processing, visualising and sharing spatial information in the analogue form were taught to forestry students in the course of classes and lectures on surveying and photogrammetry as well as forest management. They were using a splendid textbook "Forest surveying" by Zbigniew Łabęcki (Łabęcki 1978) as well as several other publications and textbooks on surveying (measurement) and photogrammetry. The first mentions of spatial and geographic information systems (GIS) appeared in lectures – at the Faculty of Forestry at the Warsaw University of Life Sciences (SGGW) – by Heronim Olenderek, the author of the "Concept and technology of drawing numerical forest maps" (Olenderek 1982). The development of the GIS education and later introduction of those systems into forestry was influenced by the seminar organised at the Faculty of Forestry at the SGGW in 1990, during which Jack Dangermond presented the paper entitled "ARC-INFO geographic information system". The Faculty received free licenses for the first fully professional software package, which allowed to launch IT lab classes with individual workstations. In the sixties, more precisely in the academic year 1965-1966 (Kozikowski 1967), photogrammetry was introduced into the curriculum for foresters, in its classical meaning of a science dealing with the acquisition of information concerning the size, shape, and location of objects based on measurements of photographic images. It is difficult to pinpoint the exact moment when remote sensing entered the curriculum in its initial narrow form of photointerpretation as allowed by the technology available at the time. It should probably be considered to be the moment when first papers on this topic were published by Jerzy Mozgawa (Mozgawa 1977) as elements of knowledge taken from scientific research always had an impact on classes for forestry students. It was then that first master's theses on this topic were written (Tab. 6). The development of geomatics techniques contributes to the conversion of photogrammetry and remote sensing from the analogue form into the digital one. Satellite positioning systems GNSS as well as aerial (ALS) and terrestrial laser scanning (TLS) systems enter that area of interest.

The first Polish studies on photogrammetry in the field of forestry were written by Tadeusz Gieruszyński (1948), Mieczysław Stanecki (1951) and Krzysztof Rudzki (1964). Photogrammetric issues (later also remote sensing issues – first in curricula, and also then in the name of subject) were included in textbooks by Dmochowski (1963), Olenderek and Piekarski (1969), Piekarski (1996, 2nd ed. in 2001), Adamczyk and Będkowski (2005, 2nd ed. in 2007), Okła (2010, 2013), and Będkowski and Piekarski (2014).

Upon the arrival of "the GIS era", the primary source of structured information about spatial and geographic information systems for over a decade was Jerzy Gaździcki's texbook entitled "Geographic Information Systems" (Gaździcki 1990). The GIS systems had sparked the interest of the State Forests for years, resulting in the launch of works on the State Forest Information System (SILP) in 1991. One integral part of the system is a spatial information database in the form of a digital forest map (LMN). This is also when the first study for foresters was created under the title "Spatial Information System in the State Forests – User Manual for the digital forest map" (Okła 2000). The implementation of the map lasted for many years and was completed on March 10, 2010 when it was installed in the last Polish forest district (Olenderek T. 2014). This long implementation resulted, among others, from the specific nature of forestry – the introduction of the LMN to a large extent involved new forest management plans which are sent to districts once every 10 years. The first and so far only academic textbook for foresters referring directly to the subject of the GIS was developed at the Poznań University of Life Sciences , formerly called the August Cieszkowski Agriculture University (Miś et al. 2001). In the following years, the State Forests contributed to the creation of a comprehensive two-volume textbook entitled "Geomatics in State Forests" (Okła 2010, 2013). It was prepared with the input from employees of the State Forests as well as the forestry faculties in Kraków, Poznań, Warsaw and the Forestry Research Institute in Warsaw. The textbook is available in its entirety in the Internet[1]. Along with other textbooks on photogrammetry and remote sensing, that has been mentioned earlier, it is the basic material for foresters studying the issues related to the GIS, photogrammetry and remote sensing as well as geomatics. In 2011 a new Manual for forest managemen[2], was published, the third volume of which was devoted to the principles of mapping forests (Wiśniewska et al. 2011). Those issues had always been present in previous editions of manuals for forest management but they had not been so prominent. For the first time, a professional catalogue of objects and symbols was prepared for the purposes of printing digital maps. It is important to mention that "forest" specialists in the GIS become authors of studies that transcend the professional community of foresters. For example, the textbook entitled "Handbook for trainees in LIDAR product use" (Wężyk 2014) was prepared for the purposes of trainings in the field of the most advanced geomatics technologies in the Computer System of Protection against extraordinary threats, while the Forest Research Institute has launched an internet-based social project "Laser Explorers" aimed at finding new archaeological sites (Zapłata et al. 2014).

Foresters find employment not only in the National Forests but also in the Offices of the Forest Management and Geodesy, national and landscape parks, Directorate for Environmental Protection, state and local government, institutions of forestry services, forest education, universities and research institutes, woodworking factories, and others. They are competing for these job vacancies with graduates from numerous other natural science courses – landscaping, biology, geography, spatial management, environmental engineering, environmental protection, agricultural and forest technology, wood technology, tourism and recreation, production engineering, and others. (Paschalis et al. 2014b, Grzywacz 2014). They are no strangers to unemployment, either. In the case of analyses and discus-

1 Corporate Portal for State Forests. http://geomatyka.lasy.gov.pl/web/geomatyka/nauka_public

2 State Forests: http://www.lasy.gov.pl/publikacje/copy_of_gospodarka-lesna/urzadzanie/iul

sions on that topic (Przybylska 2003), there were proposals to reform the studies and expand the curriculums by means of subjects that facilitate professional start, not only in forestry: legal and economic subjects, spatial development and computer science, including the GIS. Challenges for our country include clear development trends in the world (Mozgawa et al. 2001): the increasing importance of science and education, transformation of knowledge into production resources, development of information technologies, transformation of the production activities of many sectors (e.g. mining, metallurgy, and forestry) and the development of new jobs – mainly to the extent of computer sciences. As far as geomatics is concerned, graduates of forestry should (Olenderek H. 2014): have knowledge in measurement methods and the basics of instrumentation, data processing and assessment of data accuracy; be able to use modern technologies – conduct measurements of forest space and present their results using maps and photographs; have social competences – be able to work in a team and serve different roles in it, be aware of the need for continuing education, and complete their tasks with appropriate quality and diligence, and be able to prioritise them.

The profile of a graduate defines a set of competences gained throughout education that serve as the basis for an employer to employ a person equipped with expected skills (Kraśniewski 2011). The profile of a forestry graduate, which serves as a brief list of the most important effects of education (knowledge, skills, social competences), expanded with potential employment opportunities, is considered to be clearly formulated and well-suited to future professional challenges that foresters will face.

The educational standards for individual courses and levels of education at the beginning of this century (Regulation 2002) assigned 3400 hours to forestry (single degree, graduate studies), including 1900 hours for:

- 4 general education subjects (min. 380 hours),
- 14 core subjects (min. 655 hours), including the "forest surveying" (min. 45 hours),
- 13 major subjects (min. 865 hours), including "photogrammetry and geographic information systems" (min. 30 hours).

The educational standard for part-time studies, referred to as vocational studies, included fewer hours for "forest surveying" (40) but the same number of hours for photogrammetry and the GIS as in the case of full-time studies. Curriculums for individual subjects included the following for "forest surveying": surveying, elevation and mixed measurements for forestry and environmental protection purposes; measurement methods;

surveying equipment. The "photogrammetry and GIS" curriculum included: acquisition of photogrammetric images, stereoscopic effect; photogrammetric equipment and mapping methods; classification of spatial information systems; computer cartography; hardware and software packages.

With the introduction of two-cycle studies (Regulation 2007), Bachelor's studies (engineering) included 2400 hours (210 ECTS), with a core group of min. 210 hours (21 ECTS), and 660 hours of major subjects (67 ECTS). Major subjects were divided into 8 scopes of teaching, including "geomatics in forestry". The contents of geomatics education: surveying measurement methods; global positioning systems; forest cartography; photogrammetric imaging and satellite imaging – utilisation; interpretation and digital processing of photographs and images. Spatial information systems; digital forest maps; digital terrain modelling; spatial analyses. Education was meant to result in skills and competences allowing the graduates to comprehend the specifics of acquiring spatial data concerning forests as well data processing and visualisation.

Master's studies (900 hours, 90 ECTS) included the core group of min. 30 hours (3 ECTS) and the major subjects of at least 210 hours (22 ECTS). Again, were eight scopes of education distinguished, including "geomatics in forestry". "Geomatics" training includes the integration of different sources of spatial data concerning forest environment. This results in skills and competences in analysing spatial data concerning forests.

Currently, according to the act (Act 2005), Bachelor's forestry studies (engineering) last 7 semesters, while Master's degree studies last 3 semesters. The advanced education reform in 2011 introduced the National Qualifications Framework – NQF, and the centrally ordained educational standards ceased to apply. Curriculums autonomically created by the universities are now based on the NQF as well as new conditions that have to be met by the description of the curriculum and qualifications (Regulation 2011a, 2011b). Eight areas of education were distinguished. In the descriptions of learning outcomes that have to be reached in the R. area, i.e. agricultural, forest and veterinary sciences (the Annex 7 to the Regulation 2011b), the issues related to geomatics are not explicitly referred to. We can say that these outcomes are merely related to geomatics.

The Annex 9 to the Regulation (2011) contains a description of learning outcomes leading to the engineering competences. Almost all outcomes in the form of knowledge and skills listed here are related to geomatics (we will not list them due to their volume), but similarly to the Annex 7, there are not direct references.

Subjects (modules, according to the current terminology) related to geomatics are currently present at all three levels, including postgraduate studies. Individual institutions use various module names, numbers of hours and composition of the curriculum. The purposes of these modules also differ – those may be classes for all students or electives. In a sense, students choose their future careers when they enrol in specialisations. Their number at the SGGW varies between several and a dozen, with some enjoying a lot of interest from the students. For many years, the most often chosen specialisations at the SGGW have included "the use of geographic information systems in forestry" (Porter 2003).

Proper geomatics education is thus included in a specialisation with numerous modules and hours (Tab. 3). The most important thing is, however,

Tab. 1. "Geomatic" modules mandatory for all students at the Faculty of Forestry, Poznań University of Life Sciences.

Module name	Education level (1, 2)	Number of hours in basic/extended version in full-time and part-time studies		
		lectures	classes	fieldwork
Forest surveying	1	12/18 (8/10)	12/21 (12/15)	6/6 (0)
Geomatics	1	10/16 (10/15)	30/44 (10/20)	0 (0)
SILP	1	6/10 (4/5)	24/35 (16/20)	0 (0)
Forest management	1	18/30 (15/20)	18/36 (20/35)	24/24 (0)
GIS in environmental protection	2	15 (9)	15 (9)	0 (0)
Environmental monitoring	2	15 (9)	15 (9)	0 (0)
Planning for Nature Conservation	2	10(9)	15 (9)	0 (0)

Source: Own calculations

Tab. 2. "Geomatic" modules mandatory for all students at the Faculty of Forestry, Warsaw University of Life Sciences.

Module name	Education level (1, 2)	Number of hours in basic/extended version in full-time and part-time studies		
		lectures	classes	fieldwork
Forest surveying	1	15 (10)	15 (10)	24 (18)
GIS	1	6 (5)	20 (10)	
Photogrammetry and Remote Sensing	1	10 (6)	13 (12)	
Geomatics in forestry	2	10 (12)	30 (15)	
Digital Processing of Remotely Sensed Data	2 – FIT	10	20	
Forest Information Systems	2 – FIT	8	20	
Spatial Analyses	2 – FIT	10	20	
Monitoring of Rural areas by RS Techniques	2 – FIT	15	15	
Forest Photogrammetry	2 – FIT	10	20	
GIS II	2 – FIT	10	20	
Map Editing	2 – FIT	10	20	
Research and teaching methods in forestry	3	18 (6 monographic lectures)		

Source: Own calculations

Tab. 3. The modules included in "Geoinformation technologies" specialization in first-degree studies at the Faculty of Forestry SGGW in Warsaw.

Module name	Number of hours of classes
Modern methods of measurement of the forest	30
Methods of spatial analysis in GIS	30
Digital methods in remote sensing	30
Photogrammetry and remote sensing in forest management	30
Cartographic methods of presentation	15
Elements of applied cartography	15

Source: Own calculations

that the participants of the "geomatics" specialisation write theses on that topic. Currently, the specialisation, named "Geoinformation technologies" has been launched only for full-time first and second degree studies at the Faculty of Forestry at the SGGW. The topics of these theses at three

Tab. 4. Theses (engineering and master's) related to geomatic subjects written at the Faculty of Forestry, University of Agriculture in Kraków (March 2015). Columns: surveying, photogrammetry, remote sensing, cartography, GIS (and SIS), GNSS (satellite navigation systems), ALS (aerial laser scanning) and TLS (terrestrial laser scanning), OTHERS (e.g. legal matters).

Years	GEO	PHOTO	RS	CART	GIS	GNSS	ALS	TLS	others	total
2001-2005		4	3		4	2				13
2006-2010			3		2	1	3	7		16
2011-2015		4	8		5	1	14	14		36
total		8	14		11	4	17	11		65

Source: Own calculations

Tab. 5. Theses (engineering and master's) thematically related to geomatic subjects written at the Faculty of Forestry, Poznań University of Life Sciences (March 2015), symbols as in Tab. 4.

Years	GEO	PHOTO	RS	CART	GIS	GNSS	ALS	TLS	others	total
2001-2005					4					4
2006-2010			4	1	10			3		18
2011-2015			4		2		2	7		15
total			8	1	16		2	10		37

Source: Own calculations

forestry faculties (Tab. 4, 5, 6) refer directly to surveying measurements, GNSS (GPS) systems, photogrammetry and remote sensing, spatial analyses using the GIS environment, terrestrial and aerial laser scanning, land register, etc. However, the SGGW has noted a decreasing interest in the GIS issues and geomatics in general.

Another form of engagement includes participation in scientific clubs (science camps, annual GIS Day events, conferences, etc.), as well as summer schools (Stereńczak and Będkowski 2009, Stereńczak et al. 2012, Wężyk and Szostak 2013, Wężyk et al. 2015). Universities also organise training courses and training sessions that most often involve the GIS software.

Geomatics education was also provided at the SGGW between 2002/2003 and 2008/2009 within the framework of postgraduate studies entitled "The use of GIS in forestry and environmental protection" (Będkowski 2004, 2006). The seven editions of those training courses had more than a hundred participants, mostly employees of the State Forests. The classes (approx. 270 hours) were conducted mainly by university personnel, including non-forestry related ones as well as representatives from the geomatics industry. At the SGGW in Warsaw as well as the UP in Poznań and the UR in Kraków geomatics is also included in other postgraduate training courses (from several to a dozen hours).

Tab. 6. Theses (engineering and master's) thematically related to geomatic subjects written at the Faculty of Forestry, Warsaw University of Life Sciences (March 2015), symbols as in tab. 4.

years	GEO	PHOTO	RS	CART	GIS	GNSS	ALS	TLS	others	total
until 1961	20									20
1961-1965	9	1								10
1965-1970	7	2								9
1971-1975	10									10
1976-1980	11	6	3							20
1981-1985	11	1	3							15
1986-1990	8	2	6	1	1					18
1991-1995	10	6	6	4	15					41
1996-2000	3	7	14	1	19	5			6	55
2001-2005	4	9	11	8	60	10			1	103
2006-2010	5	5	5	7	39	4	1	1	9	76
2011-2015	9		5	5	10	2	8		7	46
total	107	39	53	26	144	21	9	1	23	423

Source: Own calculations

Doctoral studies, both full- and part-time, that are aimed at writing doctoral dissertations in geomatics, are attended by few people. Some people prepare their theses outside of the university system. In recent years, every year approx. 2 to 5 people have defended their dissertations at the Faculty of Forestry at the SGGW.

In Kraków, geomatics education started in 1995/1996, while in Poznań – in 1997/1998 (Okła 2010). At the Faculty of Forestry, the University of Agriculture in Krakow, students become familiar with geoinformation technologies in the course of full-time and part-time studies of both levels as a part of "Introduction to geomatics in forestry" and "Geomatics in forestry" courses. As a part of optional subjects, the University offers: "Geomatics – map creation and presentation", "Using geodata in master's theses", "Mapping using GNSS technology", "Aerial and satellite remote sensing" and "Aerial and terrestrial laser scanning". For several years, the following training courses have also been offered: Introduction to Geomatics, Global Navigation Satellite Systems, Digital Photogrammetry, Remote Sensing for CEEPUS and ERASMUS students.

At the Poznań University of Life Sciences, classes in individual modules are offered in the basic and extended variant (Tab. 1). Due to the ongoing changes to curriculums, there have been significant shifts in the number of hours of geomatics training in recent years. They include "Photogrammetry and remote sensing" and "GIS", previously (until 2013/14) offered to the first year students, that have been combined into one subject, "Geomatics", and the number of hours devoted to lectures (extended version) was reduced from 40 to 16 hours. "Geomatics", previously taught to the second year student, became to be offered to the first year students and replaced by "GIS in environmental protection".

The SGGW in Warsaw includes classes in Polish in the course of both full-time and part-time studies at both levels of education (Tab. 2). For several years, full-time studies in English have also been offered in the field of the Forest Information Technology (FIT), being a joint undertaking of the Forestry Faculty at the SGGW and the Hochschule für Nachhaltige Entwicklung in Eberswalde, Germany. Students from different countries and continents begin studies in Eberswalde, continue in Warsaw, and can choose where to continue their third and fourth semesters. The emphasis is put on the issues of processing various forestry data using computer methods and tools.

Geomatic education of foresters is also supported by the cyclical conference "Geomatics in State Forests", formerly "GIS in State Forests". It is organised by the General Directorate of State Forests and the Department of Forest Management Planning, Geomatics and Forest Economics at the Warsaw University of Life Sciences in Warsaw. Every 2 years, participants from the State Forests, geomatic companies as well as universities and research institutes gather at the Center for Nature and Forestry Education in Rogów. One of the discussion panels is usually devoted to the GIS academic teaching and training. In this regard, the conference serves the purpose similar to the German GIS-Ausbildungstagung (Bill 2013, 2014) conferences organised since 1993, at which various experts in various areas of economy, education and science discuss the GIS education at various levels, from early primary schools to universities.

Unfortunately, we have been noticing some unfortunate phenomena that might hamper geomatics education. Students, the educational system and the personnel are all to blame. Students have considerable difficulty in operating software in English. It would seem that the right solution would be to use language packs, which has been welcomed by the students. However, we think that learning some topics in Polish affect the future opportunities as the GIS technologies are tightly connected to the English language. There is also a lack of the GIS classes with fieldwork, especially as far as measurement data acquisition and processing are concerned, as well as verification of obtained data in real life. The GIS knowledge should be reinforced through students' own work and assigned tasks, which is only possible during classes. As it turns out, homework does not have the desired effect as students fail to install the software that they have been provided with, while teachers have to struggle with plagiarism more and more often. Public workshops with such software are of little use. Each year, we have to simplify the GIS classes due to the plunging levels of knowledge and preparation of high school graduates. It is difficult to attract interest from a young person to the technology of a digital forest map and related vast advantages to economy, when numerous similar solutions are already implemented in a steadily growing field of smartphones. The quality of geomatics education is also impacted by the system of staff evaluation at the university. There will be no academic teachers really involved in teaching if the periodic evaluation fails to include their contribution to preparing new subjects, contents, materials, class description, textbooks, as well as the number of classes. These are time-consuming tasks that require not only being up-to-date with the latest solutions, but also huge amounts of technical work related to the preparation and testing of new curriculums.

Technological development which results in new things constantly emerging in the field of data processing is one of the external factors. Those trends also have to be reflected in forestry education. Carpenter and Snell (2013) predict that the next decade will bring a revolution in the field of the GIS – spatial data will be more and more accurate and collected at a lower cost, the importance of the GNSS will grow, and data will be used in a cloud. Users will be interested in 3D or 4D data available in real time (e.g. observation of dynamic phenomena using satellite systems with stereoscopic coverage and direct distribution to end users). Traditional photogrammetry will also significantly change, with IT specialists involved with computer vision having more and more to say (Przywara 2012). The boundary between photogrammetry, remote sensing and the GIS is blurring, with 3D modelling becoming an important field of geodata usage. The data will be obtained using laser scanning or unmanned aerial vehicles (UAV). Network technologies (web, cloud) currently have a large impact on the production, placement, distribution, and approval of cartographic products and data (ICA 2013). However, quantity is not always quality. We can say that the world, fortunately mainly the virtual one, is overloaded with not necessarily good maps. It seems that attracting the user is more important than constructing a useful and relevant product. Yet in 2013, almost 1 million pages used the functionality of Google Maps (Field and Cartwright 2013). Education in the field of spatial information sciences is helped by distance learning tools (e-learning), so-called open source software, but also by open standards and publicly available data (open data), creating a new quality of teaching. It is possible, that students will more and more often seek geomatics knowledge in the Internet-based education platforms that will emerge in projects similar to ELOGeo (Mitasova and Schweik 2013), which was aimed at creating a framework for transferring knowledge and conducting practical classes, exchanging and preparing teaching methodologies, tools, curriculums and materials.

Geomatics in foresters' professional work

We can get some idea of the importance of geomatics in foresters' work by looking at the results of research as a part of "Determining the university curriculum requirements that include the needs of forestry management in the 21st century", completed by the IUFRO Task Force – Education in Forest Sciences (Paschalis at al. 2014a). This research was related to the curriculums and their methods of execution, and was meant to determine the current and future trends in their development. In a study by Gruchała et al. (2014a), we will find that as far as professional knowledge is concerned, the State Forests' employees have indicated biggest gaps in their knowledge of silviculture, SILP (close to geomatics) and forest protection, such as 53.0%, 49.0% and 40.7%, respectively (answer "5" – I need it the most). In this context, the GIS and geomatics are not that bad (Tab. 7). The result may be interpreted in two ways: no deficiencies were indicated, as the respondents thought they were sufficiently educated or, more probably, they had no need to use geomatic knowledge and skills. The survey was conducted mainly among field employees.

Tab. 7. Deficiencies in geomatic and related expert knowledge according to State Forests employees – a selection (Gruchała et al. 2014a)

Scope of knowledge	I do not have any deficiencies [%]	Percentage of indications in the various levels of assessment [%]				
		1 – I need it at least	2	3	4	5 – I need it the most
SILP	5.7	2.8	5.7	15.3	27.2	49.0
GIS	7.9	10.0	12.4	21.8	25.7	30.1
geomatics	9.0	15.3	15.4	24.1	22.5	22.7

Source: Own calculations

Employees of the State Forests were also asked, in which areas of knowledge personal skills should be improved in order to increase their efficiency at work. Respondents indicated primarily (the answer 5 – I need it most) dedicated computer systems (36.9%) and silviculture (29%), while the GIS and geomatics scored 28.4% and 23.4%, respectively (Tab. 8).

Tab. 8. GIS and geomatics as areas of knowledge crucial to improving the efficiency of work, in which skills should be improved according to surveyed employees of State Forests (Gruchała et al 2014a)

Scope of knowledge	Percentage of indications in the various levels of assessment [%]				
	1 – I need it at least	2	3	4	5 – I need it the most
GIS	14.8	13.5	20.4	22.9	28.4
geomatics	19.7	15.2	20.7	21.1	23.3

Source: Own calculations

The answers to questions concerning the most and least useful knowledge learned at the university, including expert knowledge are also interesting (there were 43 areas to choose from). Respondents reluctantly indicated useless knowledge, arguing that "all knowledge a person gains influences development and we are not able to predict all circumstances that we can face in our profession." The forest surveying, geomatics and SILP were found to be more useful by a relatively large number of respondents – 47, 72 and 49 indications, respectively (out of 4275), overtaking the history of forestry (1), hydrology (1), non-commercial use of the forest (2), global forestry (3), phytosociology (4), environmental protection (6), meteorology (9), social communication and public relations (10), ergonomics (11), plant physiology (12), forest transport (15), construction (19), forest productivity (20), theory of machines (24), soil science (25), partition law (31), accounting (38), timber science (40), zoology (40), field survey (41). There were also 20 "I don't know" answers.

In every modern economic organisation there is a need for continuing education. The State Forests' employees were asked (Gruchała et al 2014b) whether and how their knowledge should be improved. Four possibilities were given and more than one could be selected. Most people pointed to courses and training (866), slightly fewer of them – to postgraduate studies (589), followed by university studies (136), and other (147) forms. Among the 48 areas of expertise geomatics, the GIS and forest digital map (in total) were listed relatively frequently, e.g. in the case of training courses and training sessions only computer science was more often indicated.

Summary

Issues related to forest measurement, data processing, visualisation and sharing have been included in forestry studies since the beginning of advanced education, of course as much as the then times permitted. From simple measurements, through forest surveying and photogrammetry, we have reached modern methods of processing remote sensing imagery, GNSS satellite positioning systems, GIS, ALS and TLS. All those technologies "in real time" enter our curriculums and, as a result, the professional practice of foresters. A dedicated group of experts, academic teachers, supported by the State Forests, takes care of it.

We are aware that we can and should change a lot in geomatics education. On the one hand, the development is forced by rapid technological changes, while on the other, we should remember about the circumstances we work in: insufficient preparation of our students to tackle geomatics, unsatisfactory number of teaching hours in our modules, decreasing interest from our students, lack of factors that would motivate the staff to really commit to teaching.

It should also pay attention to the consequences of the NQF (Korpetta and Olenderek 2014):

- new terminology is emerging (for describing curriculums).
- formalisation and precision in describing curriculums,
- various levels of detailing of the learning outcomes (adopted by individual universities),
- a good way to increase bureaucracy in advanced education,
- university decides whether or not to teach geomatics (it used to be mandatory),
- we continue to teach geomatics... exclusively in specialisations.

The GIS is or soon will be present in all fields of study related to the processing of spatial data (Bill 2013). Therefore we need to put a lot of effort to make the students aware of the fact that the ability to use digital maps is now a necessity, both when they start working for the State Forests and somewhere else, in sectors related to all kinds of spatial data analyses.

It is necessary to gradually transform classes dedicated to map editing towards utilitarian use of digital maps in forestry practice, taking into account realistic tasks performed in the State Forests. Our curriculums should include the use of spatial data services, field usage of digital maps in mobile devices in order to gain knowledge concerning the forest and, more widely, nature. We should also remember that geomatic data, including the GIS, not only educate students to the extent of software related to digital maps but is a perfect way to reinforce knowledge of computer technologies as a whole.

Challenges for future educators will include the already visible changes to geomatics technologies, the development of the Internet, mobile applications, universal access to various spatial data and software. Users are becoming creators of spatial information. Just as digital cameras have enabled almost everyone to take pictures and video, and the Internet has allowed for publishing and distributing one's own writing, we will soon be creating and sharing spatial information en masse, which will be vastly supported by software and cloud computing.

To conclude, a slightly humorous take on geomatics in forestry – a short poem written by Łukasz Kwaśny in 2015:

A forester meets… – geomatics.
What is this strange technique?
Earth in the front, ticking in the back,
it even touches space technologies.
Surveying and remote sensing,
with DEM this is a party!
GPS in hand, tablet on your arm,
and the whole forest is in your GIS.
And when the forest is burning…
When stumps get bugs…
Do not take chances, send a drone.
Let it take pictures for you.
There are countless possibilities.
Use them, forester!

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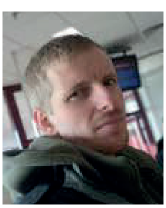

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The idea for this publication was born in June 2015, during a meeting of Polish teachers involved with Geographic Information Systems. The meeting was initiated by the Department of Geoinformation, Faculty of Geographical Sciences, University of Łódź, which received a grant to organize it. The discussion and presentations from academic teachers representing various universities in Poland were very interesting and sometimes heated. It would be advisable for other educators to familiarise themselves with the aspects of GIS education among Polish geographers, foresters, surveyors and other users. The experience of Geoinformation education in Poland is still modest, so the views of people who have been involved at Polish universities with it since the 1990s should be interesting to readers.

Geographic Information Systems (GIS) – the integration of environmental and climate issues as an important factor for economic development and quality of life – an innovative second-degree studies. Akronim GIS-E-QL: GIS for environment and quality of life

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Project objectives: The main aim of the project is to start-up attractive and innovative second-degree studies – geoinformation in mutual cooperation of the FGS and the FMCS, students education, improving the competence of academic teachers, conference organization, publishing, cooperation with practitioners and establishing contacts with partners from Norway. This aim is consistent with the "Analysis of the economy's demand for graduates in key field of strategy in the context of the Europe 2020" 2012 and "Strategy for development of higher education in Poland 2020", in the field of promoting innovative courses, formed collectively with practitioners, raising awareness of the environment. Joint actions of educators and practitioners, supported the by the strengthening of university's hardware, software and spatial data, will ensure a high quality project. The existing cooperation with practitioners indicate that further training is necessary and they would like to see postgraduates in their institutions. The final beneficiaries of the project will be the students and the academical teaching staff and indirectly the economy of the region. Students who graduate will be the main recipient of the project, the next will be teaching staff who will have contact with the practices and Norwegian partners with similar interests. In broad terms the project will benefit Polish and European economy and environment

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