FuseGI - “Cooperation for fusing skills on Cloud-based Open GeoInformatics: Innovative Environmental Management”

IO2

Draft Curricula

Final Version 28/02/2021

AGREEMENT NUMBER: 2019-1-FR01-KA203-062767

Coordinator: UNIVERSITE D'AVIGNON

Leading Organisation of IO2: INSTITUTE OF INFORMATION AND COMMUNICATION TECHNOLOGIES – BULGARIAN ACADEMY OF SCIENCES

Participating Organisations in IO2: DEMOCRITUS UNIVERSITY OF THRACE, EE4S, INSTITUTE OF INFORMATION AND COMMUNICATION TECHNOLOGIES, MAISON REGIONALE DE L’ EAU, INTERNATIONAL HELLENIC UNIVERSITY, AVIGNON UNIVERSITY, HELLENIC FORESTS (OLYMPOS PC)

INTELLECTUAL OUTPUT 2 FINAL REPORT CREATION

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SUMMARY

AVIGNON UNIVERSITE, in cooperation with DEMOCRITUS UNIVERSITY OF THRACE, EE4S, INSTITUTE OF INFORMATION AND COMMUNICATION TECHNOLOGIES, MAISON REGIONALE DE L' EAU, INTERNATIONAL HELLENIC UNIVERSITY and OLYMPOS PC, has undertaken the implementation of the project entitled "***FuseGI – Cooperation for fusing skills on Cloud-based Open GeoInformatics: Innovative Environmental management"*** under the Agreement n° 2019-1-FR01-KA203-062767 with Agence Erasmus + France. (Call 2019 Round 1 KA2 - Cooperation for innovation and the exchange of good practices KA203 - Strategic Partnerships for higher education).

This report presents the implementation and the tangible results of Intellectual Output 2 "Draft Curricula".

This IO2 aims to deliver knowledge-based and gap oriented draft curricula that is incorporating all findings from the three countries (France, Bulgaria and Greece) where data has been collected and analysed in the field of Geoinformatics (GI).

IO2 builds upon the findings of IO1 "Research and field review" resulting in an architecture of draft curricula useful for the target groups evaluated in IO1. IO2 set the basis of all procedures related to the design and development of an innovative draft curriculum, utilizing best practices and efficiency from GIS program's that were found useful in the evaluated courses of the three target countries. The findings of IO2 were used as input data in IO3:"Virtual Learning Environment (VLE) platform" providing information for setting framework for IO4 courses selection and final curricula development (IO5).

ABBREVIATIONS

GI	Geoinformatics
GIS	Geographic Information Systems
IO	Intellectual Output
AF	Application Form

1 Introduction

1.1 Overall objectives, implemented activities and results of the FuseGI Project

The FuseGI consortium had identified a gap between what the academic world provides towards its teachings and what the environmental labor market requires in terms of Geographic Information Systems (GIS) skills. Skills that are nevertheless essential for environmental and health risks management.

The goal of this consortium was to conduct an in-depth study (qualitative and quantitative) on the subject and then to design, develop and make available an adapted online tool to fill this GIS skills shortage to students and young professionals for the needs of the labor market.

The FuseGI consortium is composed of experts in the fields of water management, forestry and health (from both the academic world and the private sector) as well as computer scientists capable of setting up and sustaining online training tools. It was therefore relevant from the perspective of the project. ERASMUS+ through the projects "Cooperation in innovation and exchange of best practices" was the ideal and most relevant framework to achieve a project in this direction.

The overall objectives of the FuseGI project were:

1. Establishment of a transnational, interdisciplinary and open collaboration between academia and industry within the EU to address the training needs in GIS for a better functionality and better environmental and health risks management.
2. Knowledge transfer and bridging of gaps in academic and professional experience of the partners in the use of GIS applications in different key environmental and health sectors.
3. Improved professional skills in the use of open GIS platforms for interdisciplinary collaborative data processing.
4. Development, implementation and validation of a virtual learning environment (VLE).
5. Design of the architecture of an adapted curriculum, corresponding to the needs of the market world, for master's degree courses.

Five transferable, innovative and tangible outputs:

IO1: Research and field review

IO2: Draft Curricula

IO3: Learning platform

IO4: Training toolkit

IO5: Final Curricula

1.2 Interrelations of project Intellectual Outputs

The concept and the methodological approach of the FuseGI project allowed strong interactions between all intellectual outputs. Each intellectual output represent an innovative, transferable and tangible result also as a necessary step for the project finalisation.

The following scheme (fig.1) represent the interrelations and connectivity of the FuseGI intellectual outputs.

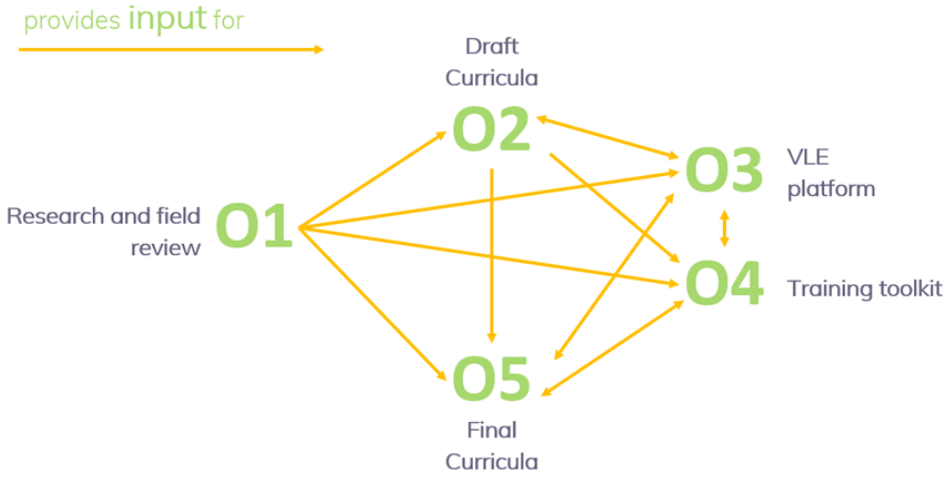

Figure 1 : Scheme of interrelations of FuseGI intellectual outputs

Intellectual Output 2 (IO2) has strong interactions with IO1, IO3, IO4 and IO5. The IO1 research and field review were used as input for the steps performed in IO2 emphasising on the recognized gaps in the geoinformatics field. IO2 was used as base information for IO3 and IO4 in order to prove which of the courses suggested as draft version fits the needs of the beginner, advanced, special types of students and young professionals defined in the AF of the project as target groups. The interaction with IO5 was the logical final step that the Draft curricula performed by its finalization and readiness for distribution in other Higher Educational Facilities.

1.3 Scope and Objectives of Intellectual Output 2

The scope of this intellectual output is to use best practices for lectures and practical courses, found in the country-based analyses for GIS courses prepared in France, Bulgaria and Greece. The IO2 summarizes all possible Design and Architecture for project GIS courses based on the country-based analyses and findings. IO2 main scope topics based on AF are:

- Analysis state of the art GIS concepts and technologies for Environmental Management
- Representation of content knowledge in the field of environmental-oriented professions, by using cutting-edge open ICTs
- Evaluation of usefulness or appropriateness of curricular features

By fulfilment of the main scope topics, the IO2 covers the objectives:

- Encompass the curricular experiences of all participating High Education Institutions,
- Act as a reference point for educational methods that develop GI and environmental management skills and knowledge in line with the needs of the learners and SMEs across EU,
- Support continuity of the learning experience and progression in learning experience working with a sequence of successively more complex ways of thinking about Environmental Management,
- Promote collaborative dialogue between academia, institutions, industries, teachers and learners, focused on identifying and responding to the educational needs of the participants in the area of GI and Environmental Management,
- Allow usage of use case studies/participants own cases through VLE,
- Include an interpretation framework for drawing inferences from student performance
- GIS program's efficiency for beginner, advanced, special types of students and young professionals.

1.4 Structure of Intellectual Output 2 report

The content of IO2 report is organized as shown below.

1st section describes the analyses performed for the GIS courses in France.

2nd section delineates the Greek GIS courses and the relevant analyses on them that are in place in the higher education schools.

3rd section represents the detailed analyses of the Bulgarian universities and the GIS courses that are taught in the specialized schools related to GI or Environmental Studies.

4th section suggests the draft curricula based on the analyses and best practices outlined in the first three sections of the report.

5th section is the link between the draft curricula and the system user requirements needed for the next step of the project with its special dedicated Intellectual Output 3.

1.5 Intellectual Output 2 Sub tasks

IO2 Sub task
Review and selection of GIS courses in France
Review and selection of GIS courses in Greece
Review and selection of GIS courses in Bulgaria
Analysis of results
First version of Draft Curricula
Review and final development of Draft Curricula

2 Draft Curricula Analyses

Based on the IO1 results the FuseGI consortia had to face the challenges coming from the different student's background. Thus a thorough research about course types, duration and content was started for each of the three countries – France, Bulgaria and Greece. It was found that the French Bachelor degree is with duration of 3 years, whereas Greece and Bulgaria are using 4 years to cover the Bachelor studies. The usage of ECTS points is very well developed in France and Greece, but this is not the case in Bulgaria. The geoinformatic courses are offered in French universities to greater number of departments, whereas Greece and Bulgaria are having modest representation of GIS courses in the different departments. The detailed analyses per country and some representative examples have been given in this section in order to represent better the three countries state of the art in the field of GIS education.

2.1 France

2.1.1 Objective

In order to be able to use the results of this panorama and correlate them with those of the questionnaire, the students sought to answer several questions. In particular, it was important to know **how many universities offer GIS courses in their curricula, the hourly volume of these courses and the credits they are worth**. It was also necessary to find out about the distribution of courses throughout the curriculum in the fields of health and hydrology, but also whether the expectations of the professional world regarding GIS knowledge were respected.

2.1.2 Method of investigation

The method of investigation established to know the **number of universities offering** GIS courses as well as **their hourly volume**, the **credits obtained through these courses** and the **year of study in which the student begins GIS** is very simple. First of all, it is necessary to list the different universities and identify each **training related to health or earth and water sciences**. It is then necessary to access each description of each of these courses and to record the data concerned.

Despite this method, which seems very simple, some difficulties were problematic during this study, such as the large number of universities and the very many courses offered in each of them. The websites of the **universities presenting the courses are sometimes incomplete**, essential **information is missing** or not updated despite the modifications of the models. Online **information is therefore very heterogeneous depending on the university**.

2.1.3 Results

More than 30 universities have been identified as having one or more courses in the fields of health or biology and earth and water sciences. These universities have a total of 76 different courses in the fields sought. Some of these courses offer GIS courses while others do not. The

results in the fields of health or biology are quite different from those obtained in the fields of earth and water sciences.

2.1.4 Health and biology curriculum

First of all, health courses are the majority in this study. Of the 76 courses identified in all fields, 50 concern health. However, only **54% of these courses have a GIS education**, either at the bachelor's or master's level **(Figure 2).**

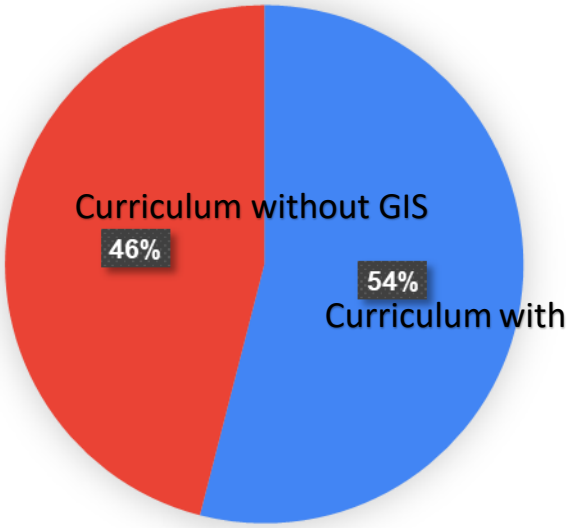

Figure 2 *: Pie chart showing GIS and non-GIS courses in health and biology.*

Looking more closely at the courses that have a GIS education, we see that only 15% of them start with the Bachelor's degree; the vast majority of these courses, 85%, are taught only for Master's level students **(Figure 3).**

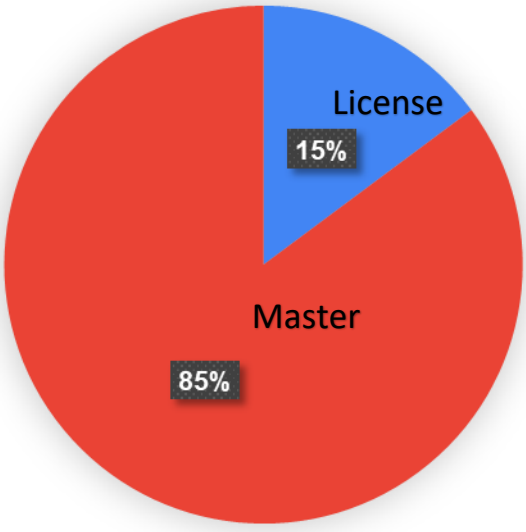

Figure 3 *: Pie chart showing GIS courses starting at the bachelor's and master's levels in health and biology.*

Looking at the number of hours of lectures, both theoretical and practical, devoted to GIS education, it can be seen that more than three-quarters of the courses that have provided this information, or 78%, spend 60 hours on GIS learning. The other courses devote half as many hours (12%) or 1/3 more (more than 90 hours for 10% of the curriculum) to the teaching of GIS (**Figure 4).**

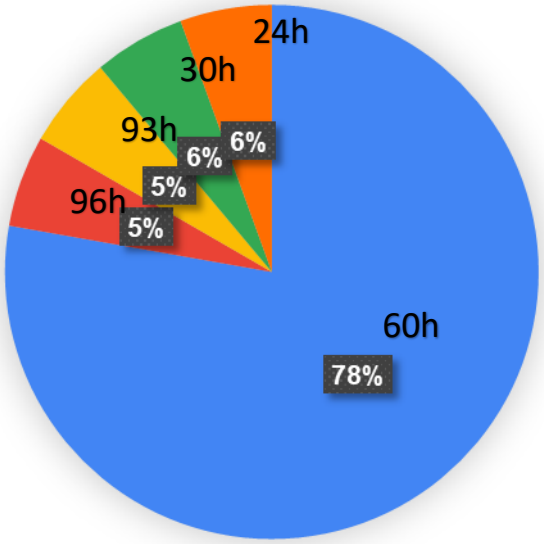

***Figure 4** : Pie chart showing the hourly volume of GIS courses in health and biology.*

Regarding ECTS, the European credit transfer and accumulation system, the curricula indicating the value of each of the GIS courses show that 56% of these are worth 3 ECTS. But for 38% of courses, they are higher than 5 ECTS **(Figure 5).**

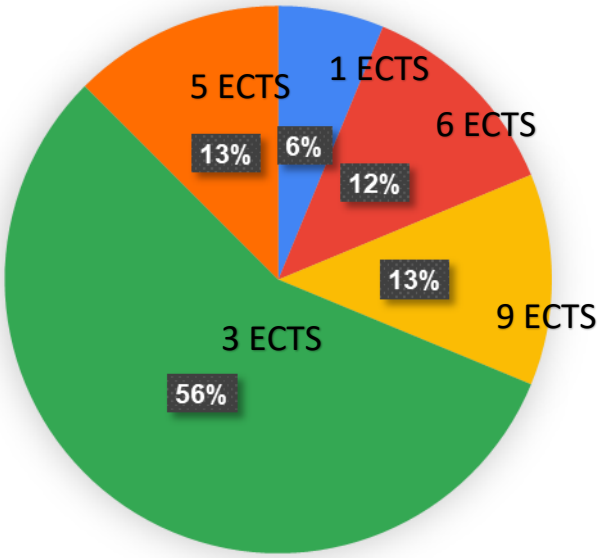

***Figure 5** : Pie chart showing European credits (ECTS) obtained through GIS courses for a course in the field of health and biology.*

In conclusion, half of the courses followed in the field of health or biology include GIS courses, but only 15% of them are offered from the Bachelor's degree. The hourly volume for this teaching is mainly 60 hours, for a value mainly of 3 ECTS.

2.1.5 Earth and water science curriculum

First of all, curricula in earth and water sciences are in the minority in this study. Of the 74 courses in all fields, only 26 are in this field. Nevertheless, almost all of these courses have a GIS education, i.e. 96% of the courses examined, both at the bachelor's and master's levels **(Figure 6).**

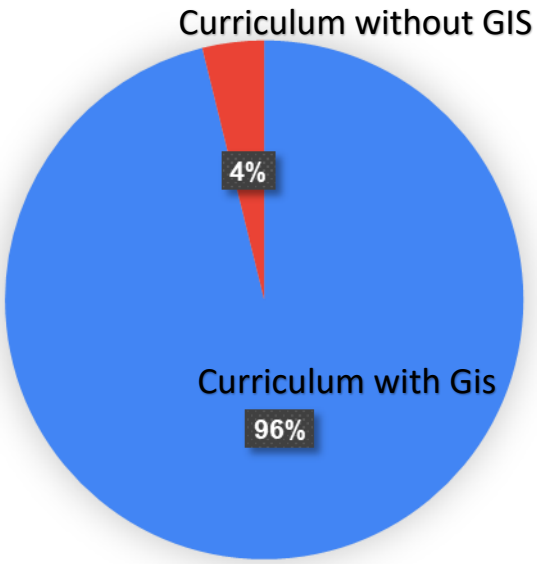

***Figure 6** : Pie chart showing courses with and without GIS courses in earth and water sciences.*

In addition, for courses with a teaching of GIS, 36% of them are offered from the Bachelor's degree, and the majority of these courses, or 64%, are taught only from the Master level **(Figure 7).**

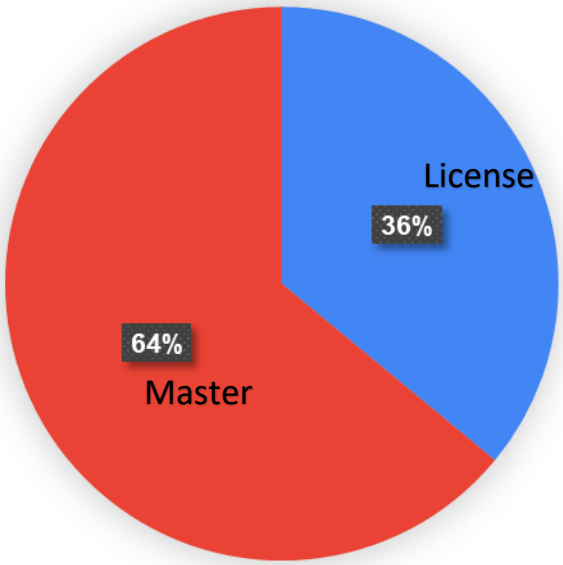

***Figure 7** : Pie chart showing GIS courses starting at bachelor's and master's levels in earth and water sciences.*

Regarding the number of hours of courses reserved for teaching GIS in these curricula, we find that 88% of the courses that have filled in this information devote less than 30 hours of courses to learning GIS. The other courses devote 40 hours or 52 hours of courses to GIS **(Figure 8).**

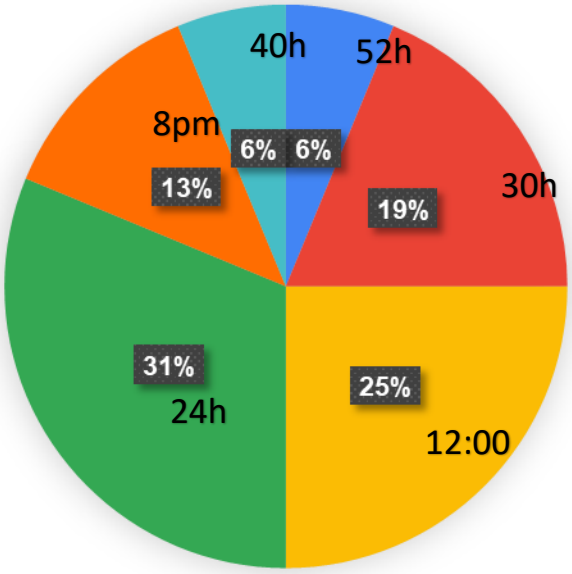

***Figure 8** : Pie chart showing the hourly volume of GIS courses in earth and water sciences.*

Regarding ECTS, the curricula indicating the value of each course show us that 43% of these are worth 3 ECTS. We also find that 29% of GIS learning courses are worth only 2 ECTS. 28% of the courses that have entered these data have a value greater than 4 ECTS **(Figure 9).**

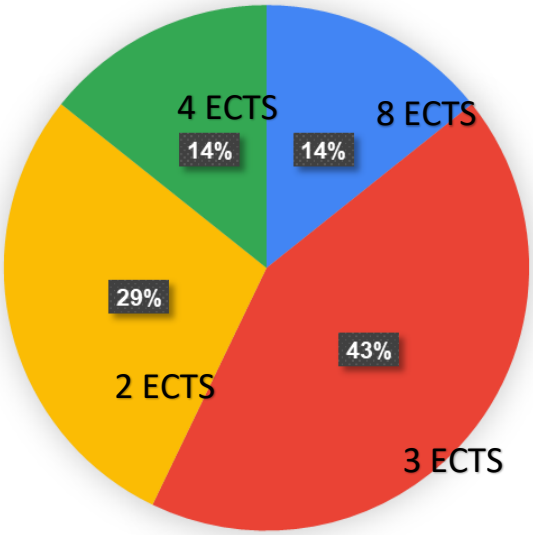

***Figure 9** : Pie chart showing European credits (ECTS) obtained through GIS courses for a course in the field of earth and water sciences.*

Almost all courses in the field of earth and water sciences offer education dedicated to GIS, but only 36% offer it from the Bachelor's degree onwards. Moreover, the vast majority of the hours proposed for this teaching are less than or equal to 30 hours, and are only 2 to 3 ECTS.

2.1.6 Case of the University of Avignon

When we study the case of GIS teaching at the University of Avignon, more specifically the GIS courses taught to students of the Master Hydrogeology, Soil and Environment (HSE), we see that before 2018 the hourly volume was constantly changing. Nevertheless, since 2018, the **hourly volume of these courses has only decreased**. Different causes could explain this phenomenon such as **budgetary or material problems**.

2.1.7 Summary and general findings of GIS education in France

In French higher education and in the fields of the project, **GIS teaching is quite widespread**, since it is present in 54% of courses in the fields of biology and health and in 96% of courses in the field of Earth and water sciences. However, in both fields and the majority of the courses offered, **GIS courses start at Master's level (for 85% of courses in the fields of health and biology and for 64% of courses in the field of earth and water sciences).** The time for GIS courses differs depending on the field of study. In the field of health and biology, **78% of courses offer 60 hours of GIS** courses, while **56%** of the courses offered **in the field of Earth and water sciences are carried out over 12 to 24 hours**. The content covered cannot therefore be equivalent.

While the teaching of GIS is less widespread in health and biology curricula than in earth and water sciences curricula, it is nevertheless given a more important place in terms of the volume of courses.

Regarding the credits reserved for these courses, **3 ECTS** are mainly attributed to GIS courses and this in both fields, precisely 43% in the field of Earth and water sciences and 56% in that of health and biology.

2.1.8 Comparison of results with the questionnaire

GIS courses are much more present in the fields of earth and water sciences than in the fields of health and biology. **More than 80% of earth and water sciences curricula contain one or more GIS courses**. On the contrary, only **54% of health and biology courses have one or more GIS courses**. They are also much more extensive in Master's level courses than in Bachelor's degrees.

When we compare the results of this study with those obtained by the questionnaire for teacher-researchers, we first note that almost all of the participants in the questionnaire come from the field of water or agroscience**,** while **more than half** of the courses **examined for the study of GIS teaching at university come from the field of health or biology**.

In addition, when we compare the results, we can highlight the similarities of the results of this study for the earth and water sciences curricula with that of the questionnaire. Indeed, more **than 80% of these courses have one or more courses targeting GIS learning**, these figures also correspond to the results obtained by the questionnaire for university teaching.

Regarding the level at which GIS is taught for the first time, these two studies show us that very few of the different courses start learning GIS in Bachelor's degree (36%). As with the questionnaire, this study tells us that nearly **64% of GIS courses are taught from a Master's degree**.

Despite many similarities between the two studies, the **results between the questionnaire** sent to participants and the **study of GIS courses in different curricula** for the fields of health and biology and the field of earth and water sciences **are difficult to correlate**. Indeed, the participants in the questionnaire are very few from the field of health while the study conducted by the students of L3 HSE shows a majority of training with GIS teachings in this field. It can therefore be considered that there is a gap of information concerning the field of health and biology and that we cannot extend all our conclusions to this field. More information would be needed.

Finally, as we pointed out using the case of the University of Avignon, models and learning dynamics evolve over time. This can create inconsistencies between the results of the two studies. Nevertheless, as the questionnaire and this study are recent, they are little affected by the changes in the learning models in the different curricula.

Nevertheless, it can be concluded that in French higher education and in the fields studied, the teaching of GIS seems essential since it is offered in a large majority of courses, all fields combined (68%). However, it does not seem essential enough to the sectors to offer it from the License and with a significant hourly volume. While in view of the answers to the questionnaire provided by professionals, the use of GIS is essential and daily, but there is very often an observation of shortcomings often linked to a lack of initial training.

Avignon University

Earth and water Sciences

Module: Geographic Information Systems (part of the UE Computer Tools)
Semester: 5
ECTS credits: 2.00
Teaching hours: 15h00 : 04h30 TDI : 10h30
Learning objectives: This module provides technical skills for the manipulation of geographical data (GIS)
Summary description of the content: The GIS CEU provides the concepts and technical mastery necessary for a basic use of GIS. The software used is free (Google Earth) or open source (QGis) allowing installation on students' personal workstations.
Expected work: Lectures and tutorials; creation of a mind map summarizing the concepts covered.
Prerequisites: No
Acquired skills:

- advanced mastery of the Google Earth tool
- geodetic systems and coordinate systems
- notions of vector and raster data
- basic mastery of the QGis tool:
- cartographic representation of digital and thematic data
- operations on attribute tables
- queries and basic spatial analysis
- creation and editing of shapefile vector objects

Hydrogeology, Soil and Environment
Module: Geographic Information System
CM: 10h00 - TP 10h00 (Total of 20H)
Objectives: Applied teaching dedicated to spatial analysis and digital cartography: 1) basics of geographic positioning: geodetic systems and coordinate systems, 2) integration of geographic data (vector and raster data formats, creation of vector layers, georeferencing and metadata writing), 3) cartographic information processing (spatial and attribute queries, geometry and topological editing of vector data, operations on raster layers).

University of Poitiers

No GIS courses in License level

Master on Hydrogeology and transfers

26H practical courses (TD)

Description: Environmental studies require the use of high-performance digital mapping tools (data acquisition, processing, map production). Students will learn how to build and update a spatialized database from field observations and cartographic data of various origins. Interrogate the information system and perform thematic analyses on these data. Produce cartographic documents (examples: vulnerability and risk maps). In this course the free software QGIS will be used. Study of concrete cases. Work on computer stations (group of 2) in TD/TP

Objectives: Use of a GIS for the evaluation of risks related to water uses, acquisition of data, definition of vulnerability and pressure indices, quantification of risks, mapping of results. Use of tools to test, compare and select management or development scenarios. Mastery of digital mapping tools

Acquired skills:

- Use of the main tools for acquisition and collection of spatialized data
- Know the geographic coordinate systems
- Produce results in the form of maps
- Knowledge of open access spatialized databases.

Montpellier University

No GIS courses in License level

M1 Water Sciences

3 ECTS, Total of 24H, 9H Master Courses, 15H practical courses

Description: GIS Practice course consists of a training in the practice of Geographic Information Systems, integrating the basic concepts concerning geographic information and the mastery of the free software QGIS. The majority of the course is devoted to an initiation through alternating lectures and practical exercises. At the end of the course, a personalized cartographic project allows students to remobilize the concepts seen previously. An introductory lecture with professionals allows to put into perspective the interest of GIS approaches in general hydrology.

The objectives of this course are:

- To train students in the basic concepts of GIS and spatial databases;
- To give the students a minimum know-how on a standard GIS tool: QGIS.

Evaluation: The map produced during the project and the associated metadata constitute the evaluation of the project.

Appendix 1 provides full list of the evaluated French Universities.

2.2 Greece

In Greece, after the reform in higher education in 2019, are located 23 Universities, which are consisted from over 70 Schools and approximately 400 Departments (Figure 10), which award degrees after 4, 5 (Engineering and agricultural schools) and 6 (medical schools) years of studies. Therefore, in Greece there are two types of degrees. The first one concerns the Departments with 4-years studies and 240 ECTS, which is acknowledged as Bachelor degree, and the second one, which is called Integrated Master, is awarded by the Departments with 5-years studies and has 300 ECTS.

Greek Universities accept every year 80,000 new students. This number corresponds to approximately 90% of the high-school graduates, as technical higher education institutions were merged with the Universities. The main aim of the Greek Universities analyses can be summarized as follows:

- Navigate through the complex Greek educational system
- Investigate all academic programs of all schools-Departments granting a Bachelor & Integrated Master degree
- Pinpoint all "pure" GIS courses & those including GIS methodology
- Perform simple descriptive statistics
- Cross-check each lesson's curriculum & present general findings

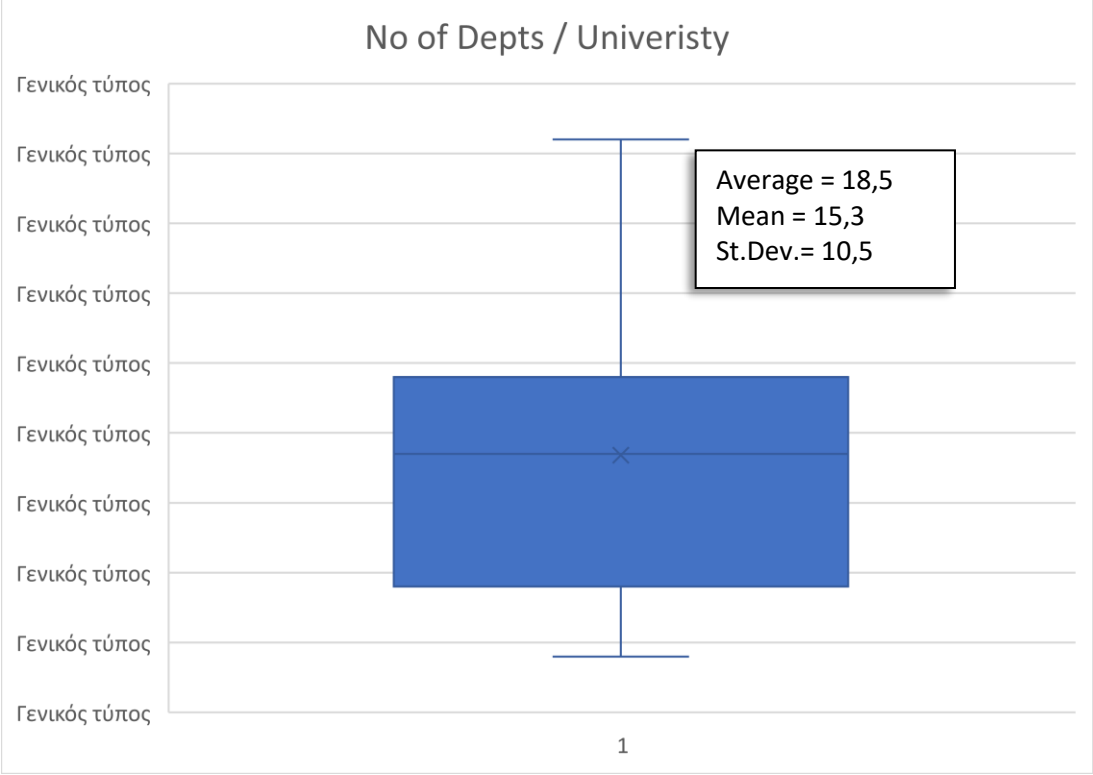

Figure 10 *: Number of Departments in Greek Universities.*

2.2.1 Results

In order to achieve all objectives a thorough research in all Greek Universities Departments' websites was performed, to find all relevant under and post-graduate courses related to GIS. From this extended review in all Greek University Departments, it was found that:

- Average courses per degree was 55
- The percent of the Departments including GIS lessons in their curriculum was 16% (64 out of 408) (Figure 11), 26 of them were Departments in Applied Sciences & Environmental Schools, 24 of them were Departments in Engineering schools, and the rest 14 Departments belonged in various other Schools.

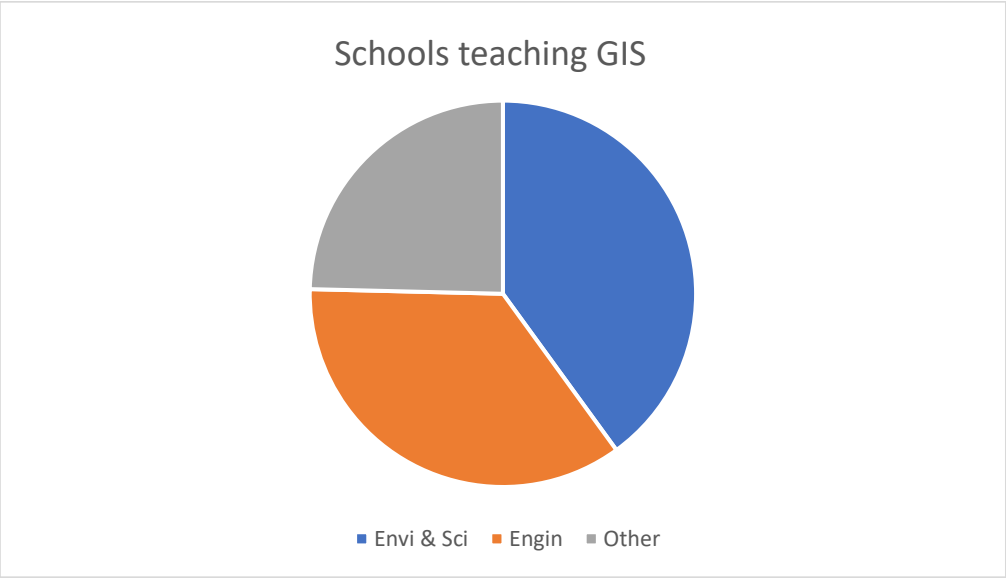

***Figure 11** : Departments with GIS courses in Greek Universities.*

In these 64 Departments the total number of GIS courses, in under-graduate studies, was 135 GIS lessons, from which 56 courses were included in Applied Sciences & Environmental Departments, 61 courses Engineering Departments and 18 courses in various other Departments (Figure 12).

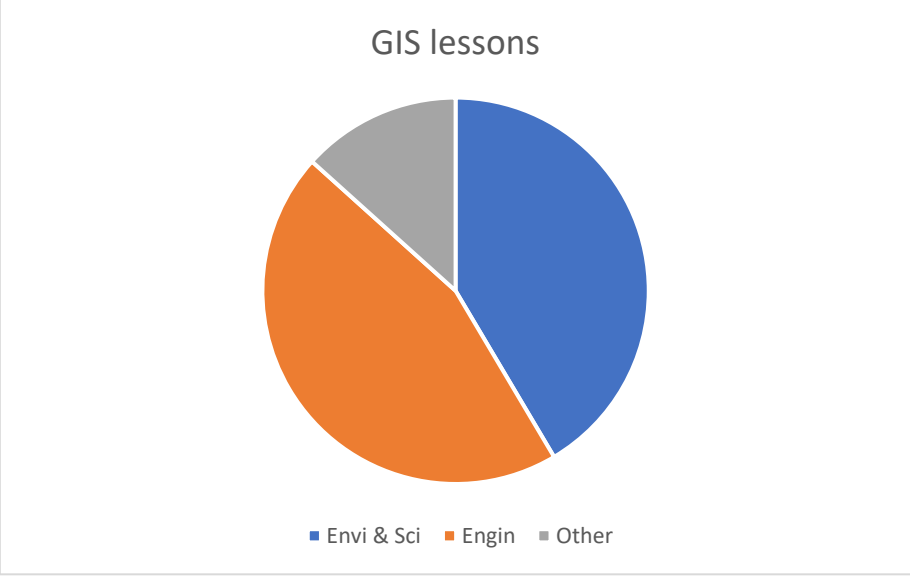

***Figure 12** : Allocation of GIS courses per specialty.*

Only 10 of the 64 Departments include GIS extensions (e.g. hydro-), Cloud GIS & other apps (e.g. img & sat. processing). Concerning GIS courses in post-graduate studies, 32 Departments were recorded to offer GIS courses in 39 Master & Postgraduate studies.

Of the Departments offering GIS lessons, it was found that GIS courses have a significant impact on the curriculum (Figure 13) as:

- Average of courses taught = 2,1
- Average ECTS per course = 4,5
- % of courses using extensions = 21,8
- Courses with applicable use in relation with business = 6
- % Hosting also Postgraduate & Master degrees with GIS use = 50

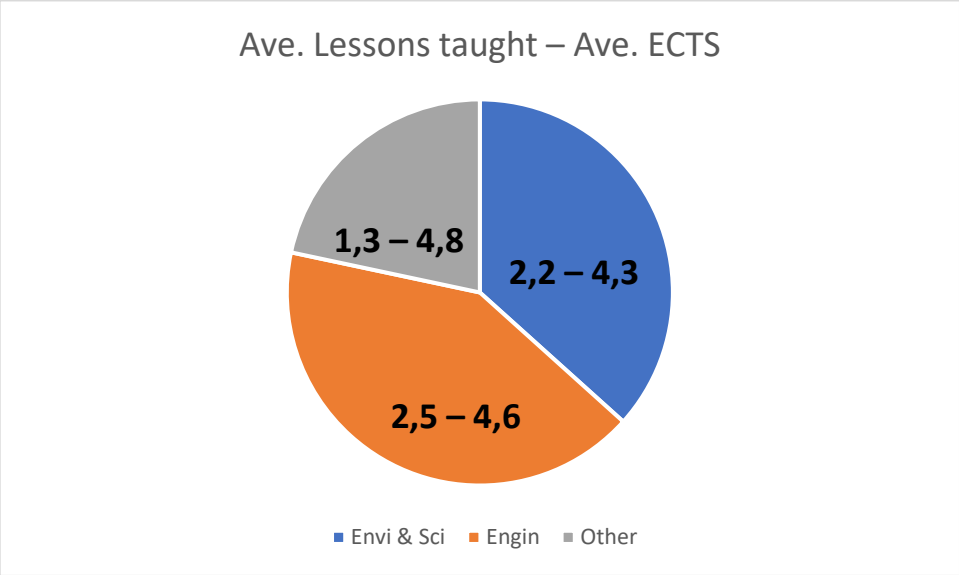

***Figure 13** : GIS courses' ECTS.*

Approximately 65% of the GIS courses offer in Greece Universities (Figure 14) are related with 3 main areas of interest of FuseGI (i.e., Forest, Health, Water), while a substantial 35% is mainly covered by courses related to Surveying Engineering and others (statistics, finance & management, maritime logistics etc). Most GIS courses are basic & introductory, but the courses are designed upon several fields of expertise.

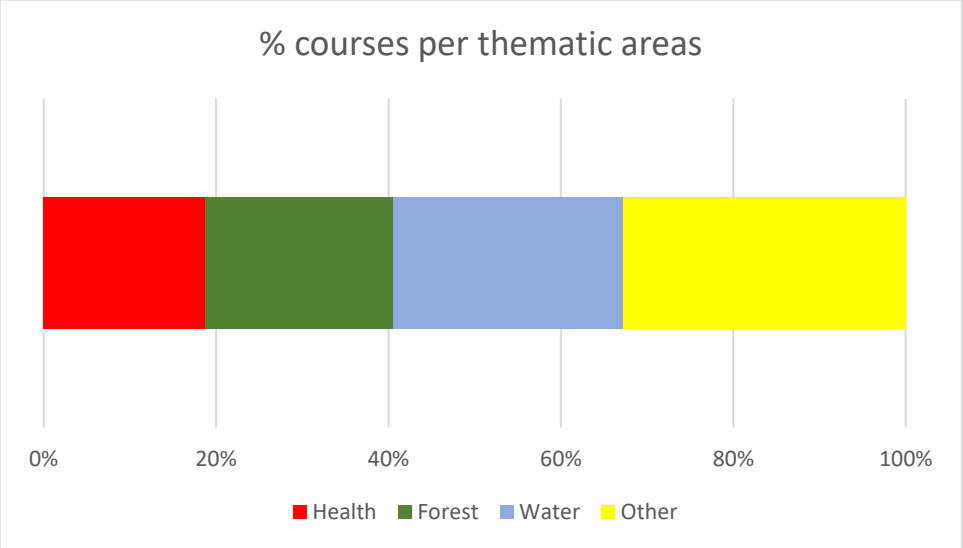

***Figure 14** : GIS courses per scientific area.*

2.2.2 Courses' Objectives

A variety of courses' objectives were recorded, which mainly include:

- Introduction to Geographic Information Systems (GIS) software environment.
- Learning to apply geometric transformations of digitized maps and check digitization accuracy. Introduction to Geographic Information Systems (GIS).
- Cartographic-geographical databases
- Drainage basin layout. Annual runoff estimation of the area. Determining the location of a dam. Design and calculation of the volume of the dam. Calculation of artificial lake capacity based on the altitude of the dam.
- Radiometric spatial and Fourier transform image enhancements.
- Composition of interactive internet thematic maps and their basic functions, through a suitable cartographic internet platform.
- Introduction to Landscape ecology.
- Convert map from vector to mosaic (grid) format and vice versa.
- Marine Geodesy, Climatic Models, Natural Disasters BIODIVERSITY Digital Terrain Models (DEM).
- Interpretation of satellite images, optical and digital processing, land use applications, mapping, crop identification, production forecasting, soil moisture, sampling methods, controlled and uncontrolled classification of physiographic data.
- Vegetation indicators, image sorting (supervised, non-supervised) and thematic map accuracy check.
- Emphasis on the requirements of Urban Planning and Spatial Planning. Distributed Geographic Information Systems, 2D and 2.5D imaging themes in specialized urban, spatial and environmental studies.

2.2.3 Courses' Methodology – Tools

GIS courses teaching include several teaching approaches and methods, which include lectures, laboratory lessons, distance learning, cloud, guides & manuals, ERDAS imagine, Arc map, Arc hydro, Q GIS, global datasets, modelbuilder, CAD, LAND SATS, SPOT, JERS, SIR, SENTINEL.

2.2.4 Summary and general findings of GIS education in Greece

1. GIS are teached mainly as a tool
2. Students are teached limited information about GIS professional applications and Extensions
3. GIS courses are core and elective courses, depending on the Department
4. Significance is recognized as they give an average of 4.5 ects
5. GIS courses are complete absent from studies in health, economics, pedagogy, philology, political science, law and arts.
6. Absent from entire institution
7. Surveying Engineers-Agronomists-Geographers have the most in pre- and post-degree degrees GIS

Aristotle University of Thessaloniki

Department of Agronomy and Surveying Engineering: Automated Cartography, Geographical Information Systems, Digital Soil Models, Water Resources Management:

- Operation of geometric transformation software in CAD system environments, raster image processing and PC input (scanner) and output (plotter) for automated map design.
- Introduction to GIS software environment.
- Cartographic-geographical databases.
- Cartographic interpolations, smoothing.
- Digital mapping database, vector structures, data raster, topology in vector data, vector spatial analysis, statistical analysis, spatial statistical analysis, combination of different levels of information of different geographical origins line sections, polygons, data and results uncertainty, metadata.
- Drainage basin layout. Annual runoff estimate of the area. Determining the location of a dam.
- Design and calculation of dam volume.
- Calculation of artificial lake capacity based on the altitude of the dam. Design and calculation of water supply networks for adjacent urban areas.
- Design and calculation of irrigation network. Design and calculation of a small hydroelectric power station. uncertainty of data and results
- Drainage basin layout.
- Annual runoff estimate of the area.
- Determining the location of a dam.
- Design and calculation of water supply networks for adjacent urban areas. Design and calculation of irrigation network.

Remote Surveillance, Digital Processing Of Televisional Images, Environmental Remote Surveillance:

- Digital remote sensing images. Internship with application of digital remote sensing methods in a specific area.
- Reduction of remote sensing images of high spatial resolution.
- Combination of timeless images, different resolution and different sensors. Radiometric improvements and geometric corrections of images.
- Radiometric spatial and Fourier transform image enhancements.
- Analysis of multispectral images in the main components, algebraic operations in the multispectral image.
- Acquisition of practical knowledge of using Digital Editing / Analysis Software of telescopic images for environmental applications.

Computer Applications In Topography, Geoinformatics I & Ii, Cartographic Visualization, Modern Mapping Systems: Non-Manafted:

- The contribution of informatics to topographic problems.
- Topographic calculations using a computer. Computer aided design and CAD software.
- Utilization of mosaic format files. GIS applications.
- Professional Practice and Applications. Composition of interactive internet thematic maps and their basic functions, through a suitable cartographic internet platform.

Department of Biology: Cartography - Theory: 1. Introduction to Landscape Ecology. 2. Metrics of landscape parameters., 3. Basic cartographic concepts, 4. Cartographic projections, 5. Thematic maps, 6. Analysis of cartographic data, 7. Methods of cartographic rendering, 8. Geographic Information Systems, 9. Mapping of flora and vegetation, 10. Ecological connectivity, 11. Systematic planning of nature conservation, 12. Views in space and time, 13. Climate change and changes in distributions Laboratory exercises: 1. Digitization of maps, 2.

Department of Geology: Geography, Digital Cartography And Geography. System Information, Information Technologies And Communication Technologies (Ict) In The Teaching Of Geology - Digital cartographic data structure (grid and vector). Convert map from vector to mosaic (grid) format and vice versa. Spatial presentation of cartographic data. GPS (Global Positioning System) satellite positioning system and its applications in geosciences. Structure and functions of GIS. Categories of imported data in a GIS (spatial, non-spatial), processing, analysis and export of data (maps, tables, etc.). Digital embossing models (DEM). Combination of remote sensing and GIS in the solution of geological problems, with emphasis on the GIS decision-making ability, leading to the rational management of the environment. Digital representations: The role of multimedia in creating multiple representations and visualizations for teaching / learning. Interactive environments: The structure and role of interactive technological environments (simulation, microcosm, modeler) in teaching / learning.

Department of Agriculture: Land Use Planning, Remote Sensing and Geographic Information Systems - Aerial photography data, photogrammetry principles, electromagnetic spectrum, spectral signatures of surface elements, interpretation of aerial photographs, applications in mapping and evaluation of soils and lands, remote sensing, natural resource exploration satellites, photographic and non-photographic photographic systems, technical data images, visual and digital processing, land use applications, mapping, crop identification, production forecasting, soil moisture, sampling methods, controlled and uncontrolled classification of physiographic data. Geographic Information Systems, geographic models, data entry and export, data format, geographic information analysis, applications.

Department of Forestry and Natural Environment: Geographical Environmental Information Systems:

- Characteristics of the electromagnetic.
- Historical evolution of Remote Sensing.
- Digital image display.
- Digital image correction.
- Improve image appearance and create a mosaic image.
- Image analysis and extraction of thematic information (creation of maps).
- Vegetation indicators, image sorting (supervised, non-supervised) and thematic map accuracy check.
- Collection and import of spatial data into a GIS.
- Geographic System of Coordinates and Cartographic Views.
- Projector Systems.
- Spatial data formats in a GIS.
- Geographical Databases.
- Working with boards.
- Spatial analysis.
- On-line GIS (Web GIS) and Cloud GIS.

Department of History and Archeology: Organization And Use Of Space In The Copper Age In Continental Greece, Theory And Method Of Prehistoric Archeology - Geographical designation. Natural environment and man theory of space – landscape. Methodological tools in landscape analysis: Geographic Information Systems (GIS), aerial photography, geoarchaeology. Computers and Archeology. Computer applications in archaeological research. Basic principles of statistical analysis. Geographic Information Systems.

Department of Spatial Planning and Development Engineering: Thematic Cartography

- Visualization of Geographical Data, Geographic Information Systems, Geoinformatics Applications, Cultural Geography and Anthropology of Space
- Special categories of thematic maps, composition maps, thematic maps of many variables, urban maps, spatial maps, program intervention maps, etc.
- Thematic Cartography and Geographic Information Systems.
- Introduction to the basic concepts of Geographic Information Systems (GIS).
- The acquisition of theoretical and practical knowledge in Geographic Information Systems (GIS), with emphasis on the requirements of Urban Planning and Spatial Planning.
- Distributed Geographic Information Systems, 2D and 2.5D imaging issues in specialized urban, spatial and environmental studies

Department of Economics: Space Economics - Standards for the distribution of cities by population size. Spatial structure of cities: Theories of urban land use. Models of internal organization of the city. Introduction to Geographic Information Systems (GIS).

Civil Engineering Department: Geodesy, SPECIAL ISSUES OF AUTOMATED DESIGN, Geomatics Preparation of studies of geospatial infrastructure systems, organization and management of geographic information systems and compilation of primary geometric documentation and backgrounds. Introduction to design in three dimensions. Elements of geographic information systems of satellite positioning technology. web-GIS and Cloud-GIS.

Annex 2 provides the full list of the extra universities that were evaluated for the IO2 Greek study.

2.3 Bulgaria

As in Greece and France, the conditions and frequency of GIS teaching in Bulgaria were studied in order to determine the share of GIS courses in the different university courses in Bulgaria.

2.3.1 The educational system in Bulgaria

Bulgarian universities that offer GIS courses in their bachelor's or master's degrees are very limited in number and little known. The ECTS system has been started to be used in the last several years. Thus elective courses are not available and 30 points per semester can be obtained only when all semester curricula is defended to both theoretical and practical exams. The Bachelor degree is 4 years = 240 credits. The Master degree can be 1, 1.5, 2 or 3 years based on the degree complexity the student wants to do (example: Bachelor in Cartography will have 1 year Master in Cartography, but Bachelor in Cartography will have to cover 2 or 3 years for a Master that differentiate much from the Bachelor degree basics). **Only 9 universities reported that they teach GIS courses in their bachelor's or master's degrees**. They are universities of geology, architecture, forestry, agriculture, economics and agribusiness. **Further information on GIS education in Bulgaria is detailed in ANNEX 1 of this synthesis report.**

2.3.2 Results

There are no universities in the field of health teaching GIS in Bulgaria. In most universities teaching GIS, there is a main course with some introductory parts and very basic exercises on the different GIS applications.

1. GIS Course Guidelines

Nevertheless, the Bulgarian National Education Plan has a guideline on how the GIS course should be given:

- An **introduction to GIS and different GIS software**, menus, tools, windows and settings,
- **Training on vector data**: basic graphic objects, thematic maps, different layers, cartographic elements, cartographic design such as the creation of a forest map,
- **Training on raster data**: types, georeferencing, computer decryption of forest areas, scanning from the screen, automated image analysis
- **Training on attribute data**: obtaining reports and creating new data via SQL queries to the GIS database for forestry.

2. Poor development of GIS

There are several reasons for the poor development of GIS in Bulgaria. Firstly, **there are no freely available digital GIS layers in Bulgaria**. In addition, **open-source software such as QGIS is not very popular** and ESRI (Environmental Systems Research Institute) products are too expensive for regular users or universities. Thus there is no coverage of Bulgaria as a whole, but there are GIS layers for online visualization for example.

Second reason is that there are not many Bulgarian universities that have GIS teachers, mainly because these experts usually are well-paid employees in private companies. There is lack of developed electronic platforms and GIS training modules in Bulgarian Universities even during the Covid-19 pandemic situation. Moreover, providing students and academic staff of

universities with opportunities for creativity and innovation in building an online learning environment, in line with students' needs, and the latest requirements for distance learning, is still far from international good practices.

2.3.3 Solutions

In order to meet the demand for GIS education in Bulgaria, solutions have been suggested for universities. The first is to **create a learning environment** that is accessible to people from faculties, whether students or university administration. Secondly, the **courses and exercises** taught in Bulgaria should be **simple** and have enough **core modules** to allow students to **gain experience in the GIS environment**. **Open source tools** should be considered as options since they are **free** and **open access**. In addition, the tasks assigned to students must correspond to the level of training and working conditions, but also **cover** the **minimum basics to enable them to work with data in a GIS environment outside the university**. Then, the GIS modules of a teaching platform will provide the basic knowledge as well as a first practical experience in working with GIS software. Finally, **GIS distance learning** is an optimal method for teaching and acquiring skills that enable students to solve practical problems in almost all known areas of knowledge in times of crisis.

2.3.4 FuseGI VLE platform implementation possibilities for HEI in Bulgaria

1. The learning environment should be accessible to:
    - Faculty, students and university administration through its own training platform;
    - System accounts for the users;
    - Complete system administration.
2. The studied software products should combine simplicity, but at the same time to have enough basic modules to grant experience to the students with GIS environment. Open-source tools should be also considered as options.
3. The tasks set to students must correspond to the level of training, the working conditions and cover the basic minimum for working with data in a GIS environment outside the University.
4. The electronic GIS modules in a selected platform provide basic knowledge in the field of GIS and initial practical experience in working with GIS software packages.
5. The teaching of GIS in the universities for different professional fields and specialties is the basis for the future professional development of the students and the use of GIS for analysis of spatially related data in specialized databases for a particular subject area.
6. GIS distance learning is an optimal method for teaching and acquiring skills by students to solve practical problems in almost any known field of scientific knowledge in times of crisis.

The Bulgarian Universities that have GIS courses in their Bachelor or Master degrees are very limited as number yet. The GIS is mainly used as supportive tool during the educational process. The universities that are having declared GIS courses in their Bachelor or Master degrees are:

1. Forestry University - Sofia
2. Architecture, Civil Engineering and Geodesy University - Sofia

3. Sofia University
4. Mining and Geology University – Sofia
5. South-West University – Blagoevgrad
6. University of Shoumen
7. Agricultural University of Plovdiv
8. Higher School of Agribusiness and Regional Development
9. Academy of Economics ´Dimitar A. Tsenov´
10. **No health-oriented Universities were found to teach GIS courses in Bulgaria**

2.3.5 Summary and general findings of GIS education in Bulgaria

In most cases there is one main course called Geographic Information Systems (GIS) with some introductory parts and exercises about different GIS applications along with basic options depending on the type of the study program.
The Bulgarian national Educational plan has a guideline how the GIS course should look like:

- Introduction to GIS and various GIS software packages - menus, tools, windows, settings.
- Working with vector data - mathematical basis, basic graphic objects, thematic maps, layers, map elements, cartographic design of forestry maps.
- Working with raster data - types, georeferencing, computer decryption of forest areas, digitalization from the screen, automated image analysis.
- Working with attribute data - structure, geocoding, data manipulation, obtaining reports and reports, creating new data through SQL queries to the GIS database for forestry. Data presentation.

The observed shortcomings for most of the Bulgarian universities that have GIS courses in their Curricula are:

- Development of electronic platforms and modules for GIS training in situations like Covid 19 are completely missing.
- Providing opportunities for students and academic staff of universities for creativity and innovation in building an e-learning environment in accordance with the needs of students and the latest requirements for distance learning are still far from good international practices.

Forestry University – Sofia

Department Forest management
History of University of Forestry: In 1923, the Department of Private Forestry was established at the Faculty of Agronomy in Sofia University (SU). In 1925 an independent Forestry division was identified, and by decree № 287 / 07.09.1925. The Faculty of Agronomy was renamed the Faculty of Agronomy and Forestry.
The Forestry Department at Sofia University merged with the Forestry Department at Plovdiv University and the Faculty of Forestry at Sofia University was founded. This faculty is among the 4 others that formed the basis of the establishment of the Agricultural Academy in 1947. That faculty existed only for one year. The faculties of Agronomy, Forestry, Veterinary medicine and zootechnics were separated from the University of Sofia from September 1948. On the following year the Faculty of Silviculture, which until then had a biological

specialization, was reorganized into a Faculty of Forestry with two departments – the Department of Forestry and the Department of Forest Industry.

The National Assembly of the Republic of Bulgaria issued a decree renaming the VLTI the University of Forestry on July 27, 1995, the VLTI was renamed, the University of Forestry. Since 1995, LTU has included 6 faculties, one of which is Forestry. On July 1995, the Higher Institute of Forestry was given the status of a university by the National Assembly of the Republic of Bulgaria. The Department of Forest Management was established in 1927 by Prof. Temelko Ivanchev, who became its first head. From 1946 to 1953 Prof. Mihail Venedikov was head of the Department of Geodesy at the same faculty of Sofia University. From 1953 until his death in 1973, he was head of the Department of Geodesy as part of the VLTI.

On first of February the Department of Forestry was merged with the Department of Geodesy and it became the Department of Forestry and Landscaping.

Disciplines: *Geographic information systems* - Within the discipline "Photogrammetry and remote sensing methods" during the period up to year 2000, demonstration exercises are made related to the development of software for remote sensing methods and GIS. In the academic year 2001/2002 it is the beginning of teaching the discipline "GIS in forestry" for the major "Forestry".
In the academic year 2005/2006 the course continues under the name "Geographic Information Systems" and is read in the major "Forestry" from FGS and "Landscape Architecture" from FELA, Master's degree. From the 2018/2019 academic year, the GIS discipline is also taught in the specialty "Plant Protection", Master's degree from the Faculty of Agriculture.
The course aims to provide knowledge about the use of geographic information systems that are used in the database management. They solve different types of tasks in the field of social management, administration, urban planning, public security, military management, energy, agriculture and others.
Their use in forestry, landscape architecture, ecology and environmental protection is also very useful and rational. The course includes the study of theoretical and practical issues related to the creation of databases in a GIS environment with graphical and attribute data. It is also envisaged to solve a number of practical tasks in forestry and other areas of teaching in LTU through analysis of spatially related data, as well as the creation of end consumer products.
Course content:

1. The Subject is compulsory. There is a possibility to be taught in other foreign language– English.
2. Technology for Geographic information management - key terms; GIS definitions; GIS capabilities and links with other technologies and scientific fields; GIS development.
3. Database concepts - types of data in GIS; entering the data during the construction of the database; concepts for space in GIS
4. GIS hardware components - Central processing unit; peripheral devices for recording and storing data; input-output peripheral devices.
5. GIS software components - low level software; GIS application software; special application software and tools for developing applications.

6. Spatial data models - models for structuring graphic data; models for structuring non-graphical data.
7. Coordinate systems and cartographic projections in GIS - the concept of the shape and size of the Earth; coordinate systems; cartographic projections; geodetic projections.
8. GIS and Remote sensing methods for Earth exploration - remote sensing methods for exploring the Earth as a source of geographical data; methods and tools for data processing and interpretation; interconnections and integration of GIS and Remote sensing methods.
9. New trends in the development of GIS - data life cycle; GIS interoperability; spatial data infrastructure; internet GIS; trends and future of GIS in environmental and forest management.

Department of Computer Systems and Informatics:

Department "Computer Systems and Informatics" is established in 1995. Department is formed within newly established then Faculty of Business management. Its original name is "Computer Science and Informatics". Its first head was Assoc. Prof. Emil Lazarov. During the period 1999 - 2016 the Head of the Department was Assoc. Prof. Boyanka Zhelyazova. During the period 2016 - 2020 the Head of the Department was Assoc. Prof. Radoslav Miltchev.

By a decision of the Faculty Counsel of 25.02.2020 Assoc. Prof. Radoslav Miltchev, PhD was approved as a Head of Department.

The Department of Computer Systems and Informatics provides training in the field of information technology for students of all majors of LTU.

Geographic information system in Tourism

The course aims to introduce students to the possibilities of geographic information systems as a modern information technology and as a tool to support decisions management in the field of business management. The main tasks of the course are aimed at preparing future business managers to use geo-information technologies for the needs of the economy, organization and management of business processes in the field of business management, to give students practical knowledge and skills to work with applied GIS software.

At the end of the GIS course, students will be able to solve a wide range of theoretical and practical problems related to the design, creation and use of general and thematic GIS projects, as well as their use in solving various tasks in the analysis of geo-spatial data. The course provides complex preparation for students of the general use of geo-spatial information, gives the connection of this knowledge and skills with modern methods of organization and business management activities. For the learning and the successful mastering of the study material in the course, students need a solid training in analytical geometry of 2-D and 3-D spaces, relational data model, statistics, computer systems, as well as basic knowledge in the field of the economy, organization and management of the company's activity in the conditions of the market economy. The course has a practical orientation, aims to provide the necessary minimum theoretical knowledge about the nature of GIS as a modern and dynamic interdisciplinary scientific field, the nature and structure of GIS as a modern information technology, geospatial data models, the use of 2- D and 3-D coordinate systems and projections in computer modeling of geographical processes and phenomena, learning the basics of geo-statistics.

The planned laboratory exercises and the system for monitoring and form of assessment of the acquired knowledge and skills are aimed at mastering the basic operations in GIS, at the

creation and use of GIS projects with the help of the software package ArcMap 10.x. The course consolidates, complements and enriches the knowledge and experience of students learned in the disciplines related to the study of modern information technology (computer systems, management databases, computer networks), while providing them with the necessary competencies for practical use of GIS in their work as economists in the field of tourism.

Course content :

1. Improving the qualification of students is related to the acquisition of basic theoretical knowledge and practical skills for working with geographic information systems, which will provide the opportunity to develop further these abilities.
2. To prepare specialists in the field of GIS technologies, through the acquisition of professional skills and competencies, via modern Information and Communication Technologies, specialized software and modern high-tech laboratory for training;
3. Improving the quality of training through the use of a modern platform to facilitate communication between all participants in the process, including representatives of the target business group**.**
4. Study of the existing appropriate practices and approbation of the accumulated experience in solving scientific and scientific-applied problems in the field of "Geographic information systems"

The course is taught for the following faculties and specialties:

Faculty of Business Administration, major "Ecology and Environmental Protection", master's degree - full-time and part-time

Faculty of Business Administration, major "Alternative Tourism", bachelor and major "Management of Alternative Tourism", Master.

Software packages such as ArcGIS and ArcMap 10.x are used in the course.

Management information systems (is extra course taught in the same disciplines)

The course aims to introduce students to the basic methods and tools for the creation, maintenance and development of management information systems for the needs of business management; the future economists have to learn basic skills and habits for systematic analysis of the management structure and functional model of company management; to give practical knowledge of students for assessment and analysis of the effectiveness of the implementation and operation of business information systems. For studying and successful implementation of the material underlying the course students need a basic knowledge of computer technology, informatics and the foundations of a market economy. The course has practical aims to build students mostly practical skills, which are tailored educational content, exercises and planned system for monitoring and evaluation of knowledge and skills. Discipline strengthens, and enriches the knowledge and experience of the students learned in the courses Macroeconomics, Computing, Database management, GIS and Global networks and telecommunications.

Annex 3 provides the full list of the extra universities that were evaluated for the IO2 Bulgarian study.

3 FuseGI Draft Curricula

Based on the Grant Agreement obligation to "Design & Architecture" Draft Curricula the FuseGI consortia partners dedicated major efforts to compile full scale informative country reports with all peculiarities that the three educational system have. The main difference observed was that France and Greece have more developed GIS courses taught to students in more universities. The level of knowledge covered in these courses could be basic, intermediate and advanced. However, the descriptions and details available in Both France and Greece were very scattered and only teachers from the University educational system could get more detailed information on the course content. In Bulgaria was observed quite the opposite situation. The number of universities covering the GIS disciplines were only 9. The level of the courses was mainly basic, but the description provided about the course content online was giving all needed details, with no need to ask in addition anyone from the University system in Bulgaria. Thus, the Draft Curricula was organized into two types of courses - Basic and Advanced, because intermediate level was mainly available in France. In the basic part of the curricula were decided to be placed general courses of GIS that are estimated of 3 ECTS, whereas advanced courses are estimated to 4 ECTS.

3.1 FuseGI Draft Curricula Basic Courses

Based on the IO1 questionnaire results and the IO2 findings about the French, Greek and Bulgarian educational systems was decided that the Draft Curricula should have 8 basic courses and 7 advanced ones. The content of each course was evaluated based on the available information from the IO2 outcomes and the mixed teams of University teachers and GIS researchers that FuseGI consortia has.

3.1.1 Geographic information systems

Course overview	Provision of knowledge about the use of geographic information systems that are used in the database management. By solving different types of tasks in the field of social management, administration, urban planning, public security, military management, energy, agriculture and others. The systems can be used in forestry, landscape architecture, ecology, economy, environmental protection, architecture, water management, soil monitoring etc. The course includes the study of theoretical and practical issues related to the creation of databases in a GIS environment with graphical and attribute data. It is also envisaged to solve a number of practical tasks in forestry and other areas of teaching in LTU through analysis of spatially related data, as well as the creation of end consumer products.
Course Objectives	An introduction to the GIS software, stressing basic operation of popular GIS packages in open source format.

	Topics covered include system navigation, data display, data download, and printing public domain and user-created geographical data sets.
Course Structure	- Technology of Geographic information management - key terms; GIS definitions; GIS capabilities and links with other technologies and scientific fields; GIS development. - Database concepts - types of data in GIS; entering the data during the construction of the database; concepts for space in GIS - GIS hardware components - Central processing unit; peripheral devices for recording and storing data; input-output peripheral devices. - GIS software components - low level software; GIS application software; special application software and tools for developing applications. - Spatial data models - models for structuring graphic data; models for structuring non-graphical data. - Coordinate systems and cartographic projections in GIS - the concept of the shape and size of the Earth; coordinate systems; cartographic projections; geodetic projections. - GIS and Remote sensing methods for Earth exploration - remote sensing methods for exploring the Earth as a source of geographical data; methods and tools for data processing and interpretation; interconnections and integration of GIS and Remote sensing methods. - New trends in the development of GIS - data life cycle; GIS interoperability; spatial data infrastructure; internet GIS; trends and future of GIS in environmental and forest management.
Course Estimated Duration	8 hours
Presence of the course in the evaluated countries	All three countries have such course with small differences in the topic content (open or paid GIS tools is the difference)

3.1.2 Introduction to GIS and remote sensing methods

Course overview	The course aim is to introduce students to the opportunity to the basic concepts and possibilities for application of geographic information systems (GIS) and remote sensing methods in solving a wide range of practical tasks. During

	the seminars, students can develop skills to work with the most common software programs in the field of GIS and processing and interpretation of satellite images. Students participate in seminars with assignments dealing with issues in the field of development of geographic information technologies and remote sensing methods.
Course Objectives	An introduction to the use of remotely sensed data for the study of human and environmental phenomena. Image-processing software is used to analyze satellite images; raster GIS is used to explore a variety of geographical modeling, spatial, and data presentation techniques. After the course the students should be able to explain: - explain the basics of geographic information systems (GIS) and related areas such as geodesy and remote sensing - select and acquire both primary and secondary spatial data for use in GIS - manage, and analyse digital data in raster and vector formats - describe how common analytical methods and techniques work - create and present a GIS project.
Course Structure	- Issues related to the nature and development of GIS, GIS databases, satellite platforms and satellite information, processing, analysis and interpretation of satellite images. - Modeling in GIS. - Various aspects of Geoinformatics such as coordinate systems and projections, spatial data models and their structure, spatial database technology, data supply for geographic information systems: digital maps, digitizing, and surveying with geodetic instruments, basic cartographic methodology, basic geodesy; basic remote sensing, thematic classification of multispectral data.
Course Estimated Duration	9 hours
Presence of the course in the evaluated countries	All three countries have such course with small differences in the topic content (open or paid GIS tools is the difference)

3.1.3 GIS in regional management

Course overview	The course aim is to introduce students to the possibilities for application of geoinformation systems and technologies in regional planning and management. At the

	end of the training students will be able to use specialized GIS software products to solve social, economic and environmental problems in the field of regional planning and sustainable development.
Course Objectives	- This course describes the various mapping techniques used for urban planning and management. Main objectives for the students is to: - Choose and possibly develop appropriate methods for geospatial framework for data collection and processing for better urban planning, - Use geo-information science and earth observation technology to generate, integrate, analyze and visualize spatial data, - Formulate and carry out independent research in the general field of Geinformatics, possibly as part of a multi-disciplinary research and development project.
Course Structure	- Creation of geobases for separate thematic directions in the regional planning (inventory and assessment of the natural resource potential of the environment, of the demographic situation and the human resources, of the social and technical infrastructure, natural and anthropogenic risks, etc.) - Spatial analysis and modeling of different types of land use; Solving practical tasks with the help of GIS, related to the selection of the most suitable areas for the implementation of different types of activities, according to pre-selected criteria (Land Suitability Analysis). - Using GIS in order to predict economic, social and environmental consequences of - Using GIS in the development of strategic plans for regional development - Mastering visualization techniques and compilation of cartographic and other graphic materials in GIS environment, which are an integral part of the documentation of regional development plans
Course Estimated Duration	8 hours

Presence of the course in the evaluated countries	All three countries have such course with small differences in the topic content (open or paid GIS tools is the difference)

3.1.4 Remote methods and GIS

Course overview	The course aim is to introduce students to the features of applying remote sensing methods in a GIS environment. There are possibilities and requirements to the information which is received from GIS for solving the main technological tasks in remote sensing surveys: georeferencing and transformation of digital multichannel images, methods for analysis and interpretation of space and aerial images and their areas of application. The specifics of extracting thematic information from multi-channel images, filtering of index raster images owing to GIS are part of the course.
Course Objectives	The objectives that the students need to cover from point of view of competences acquired by this course are to emulate a real study case, design and perform the following tasks: - Search and download images from a public catalog. - Apply an image correction process over the images. - Create RGB band combinations. - Calculate indexes, such as NDVI, NDWI, NBR. - Apply cloud masks. - Create image mosaics. - Obtain LST from thermal bands. - Execute a supervised classification process
Course Structure	- Unification of the received data with the requirements of the GIS environment. - Geomorphological mapping by space images. - Analysis of water basins. - Study of snow cover and ice. - Study Vegetation and agricultural plantations.
Course Estimated Duration	9 hours
Presence of the course in the evaluated countries	All three countries have such course with small differences in the topic content (open or paid GIS tools is the difference)

3.1.5 Application of GIS in ecology and environmental protection

Course overview	The course aim is to show the growing role of GIS in the field of planning, management and environmental

	protection. The lecture course develops the knowledge from the basic GIS course in fundamental theoretical areas of the bachelor's degree. All knowledge is directly focused on the systems for mapping, management, analysis and decision support in the management of territories that have local, regional or global distribution.
Course Objectives	The objectives of this course is to lay a firm foundation for the **successful** use of GIS by introducing students to the ways that digital maps from GIS can be created, symbolized, and used in visualizations to solve problems and serve as communication tools in environmental science and beyond. Through this course, students gain fundamental skills in cartography and spatial analysis with an environmental focus through hands-on work. But equally importantly, they gain understanding of the technological and societal implications that these tools have on 21st Century society and how students can chart their own pathway forward using these tools and perspectives. The main objectives are listed as follows: - Identify ways in which GIS, maps, and geo-visualizations are providing a common language and framework for communication and solving problems. - Apply cartographic design principles such as symbology, color, and classification methods to create, modify, and critically evaluate effective maps and visualizations. - Analyze environmental and other data spatially with web GIS tools using a variety of techniques, including visualization, filtering, map overlay, routing, mean center, and proximity. - Demonstrate how to create and map data from spreadsheets, from GPS data, from field surveys, from joining data, and from pre-existing maps. - Identify how society influences mapping, and how mapping influences society, through data availability, data quality, map projections, crowdsourcing, location privacy, the Internet of Things, and design, and examine the connections between Christian ethics, GIS, and environmental science. - Create multimedia 2D maps and 3D scenes that effectively communicate an environmental issue, event, or theme, via results of a research investigation.
Course Structure	- Theoretical bases: fundamental topics for construction and implementation of GIS related to the environment, various applications of remote

	sensing methods for mapping, monitoring and research of the environment in a GIS environment (Modeling of: ecosystems, biosphere dynamics, wildlife, biodiversity, etc.) - Seminar lectures with the participation of students: Students are placed in a real situation, presenting their vision for creating a future GIS project in the management of a predetermined area and its integration in the field.
Course Estimated Duration	9 hours
Presence of the course in the evaluated countries	All three countries have such course with small differences in the topic content (open or paid GIS tools is the difference)

3.1.6 Application of GIS in spatial planning

Course overview	The course aim is to consolidate the obtained knowledge and expand experimental knowledge and skills to work in the field of science. The lecture course "Application of GIS in spatial planning" is to provide scientific training in analyzing, organizing the planning of the entire activity of the suburban area or a settlement of different categories, their management and solving urbanization. and other territorial problems
Course Objectives	- The main objectives are set for the territorial and settlement development with the structure of the out-of-town territory - urbanized, agricultural, forest, disturbed territories and territories occupied by the technical infrastructure, etc. and their presentation, analysis, planning and management through GIS. - The topics explain the localization of the structure of living, landscaping, cultural and historical heritage, sports and recreation, social services, technical infrastructure and their presentation, analysis, planning and management through GIS.
Course Structure	- Land Use Planning and Management - Crime Mapping and Analysis - Solid Waste Management - Urban Infrastructure and Utilities - Urban Transportation - Spatial Planning
Course Estimated Duration	8 hours

Presence of the course in the evaluated countries	All three countries have such course with small differences in the topic content (open or paid GIS tools is the difference)

3.1.7 GIS land cover modeling and conservation

Course overview	The course aim is to provide knowledge and skills for entering processing and analytical data on land cover and land use in GIS. The course has a strong practical focus on the interpretation of available data on the needs of agriculture, forestry, environmental protection, landscape planning, management of protected areas.
Course Objectives	Conservation refers to the protection, management, and restoration of natural resources including the plant and wildlife communities that inhabit the environment. Conservation efforts focus on addressing threats to the natural environment such as global climate change, habitat loss, pollution and deforestation, which can cause the biodiversity of earth to be threatened through habitat fragmentation and species extinction. GIS enables conservation professionals to access and utilize current, historical, and time series information relevant to conservation, including data on species occurrences, ecosystem conditions, watershed boundaries, and land-use patterns. When using GIS, data are contained in layers that can be overlaid with one another to identify relationships between wildlife and landscape patterns. This enables resource managers and public and private landowners to visualize where sensitive habitats occur, where conservation practices may need to be implemented and ultimately what protection strategies are effective.
Course Structure	- The widespread use of remote sensing methods (satellite and aerial photography and multispectral imaging) makes it possible to collect reliable information on the Earth surface. Based on the spectral features of different territories, their classification is performed for different research and practical purposes. Through the lecture course students get to be introduced to the goals, methods and tasks of land cover modeling and land use. - Different classification schemes are elaborated in detail on the work with the CORINE nomenclature as the main tool for environmental monitoring in Europe.
Course Estimated Duration	9 hours

Presence of the course in the evaluated countries	All three countries have such course with small differences in the topic content (open or paid GIS tools is the difference)

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3.1.8 Spatial databases and GIS programming

Course overview	The course aim is to provide specific knowledge and skills to improve the performance of ArcGIS/or QGIS extra libraries/, by creating new toolbars and adding scripts. The students will cover: - Basic concepts related to spatial data, which are the main content of maps - Introduction to programming: students will gain the necessary theoretical and practical knowledge. Some languages which are used for GIS programming, will be discussed. - Using custom applications Students learn how to download scripts and other ArcGIS-compatible applications written in various programming languages.
Course Objectives	A spatial database is the backbone of a successful organization or website/web-GIS service that depends upon maintaining and using data pertinent to locations on Earth. Spatial Database Management, capabilities specific to Relational Database Management Systems (RDBMS) and Geographic Information Systems (GIS) programming are combined to teach students to create, maintain, and query spatial databases in both desktop and enterprise environments. Learn the basics of Standard Query Language (SQL) and database design/normalization, the specifics of managing spatial data in an open-source technologies context (Postgres/PostGIS).
Course Structure	1. Applications in GIS 2. Geospatial Programming and Software 3. Development using tools based on: - Amazon Web Services - ArcGIS Pro - ArcSDE/Multiuser Geodatabases - PostgreSQL/PostGIS - QGIS - SQL
Course Estimated Duration	11 hours
Presence of the course in the evaluated countries	All three countries have such course with small differences in the topic content (open or paid GIS tools is the difference)

3.2 FuseGI Draft Curricula Advanced Courses

3.2.1 Cartography

Course overview	The course aim is to provide the students with knowledge in cartography. By its nature the course is comprehensive and covers the following cartographic subjects: theoretical cartography, design and mapping, general geographic and thematic mapping, space mapping, cartographic research methods and history of cartography. In the practical lessons are developed problems covering the material of the lectures along with mastering and usage of GIS software. At the end of the course is expected the development of a project in which the students apply their knowledge and skills in editing, drafting, and modelling the maps.
Course Objectives	This course provides a comprehensive overview of conceptual and technical design topics related to dynamic mapping, topics typically considered under the cartographic research thrusts of Interactive Cartography and Geovisualization. Specifically, it discusses user interface (UI) and user experience (UX) design as applied for web maps, drawing from research and practice on Human-Computer Interaction, Information Visualization, Usability Engineering, and Visual Analytics, perspectives that students are unlikely to receive in other GIS courses. The course emphasizes mapmaking over map use and the design of interfaces to maps rather than the maps themselves.
Course Structure	1. Course Introduction: Organization & Influences 2. Introduction to Cartography: Mapmaking/Map Use, 3. Projections I: Geodesy & the Geographic Coordinate System, 4. Projections II: Projection Mechanics & Distortions, 5. Generalization I: Map Scale & the Cartographic Problematic, Generalization II: Generalization Operators 6. Typography I: Label Appearance 7. Typography II: Label Placement 8. Putting it Together: Visual Hierarchy 9. Putting it Together: Visual Balance & Map Elements 10. Symbolization I: The Visual Variables 11. Symbolization II: Overview of Thematic Map Types 12. Terrain Representation

	13. Choropleth Maps I: Normalization 14. Choropleth Maps II: Classification 15. Choropleth Maps III: Color Theory 16. Proportional Symbol Maps 17. Dot & Dot Density Maps Dasymetric Maps 18. Isoline Maps I: Interpolation 19. Isoline Maps II: Design Considerations 20. Cartograms 21. Flow Maps 22. Final Project Preparation 23. Final Project Presentations
Course Estimated Duration	12 hours
Presence of the course in the evaluated countries	All three countries have such course with small differences in the topic content (open or paid GIS tools is the difference)

3.2.2 Mobile GIS

Course overview	The course aim is to provide basic theoretical and practical knowledges for the development, use, maintenance and application of the Mobile GIS. This discipline is related to other studied disciplines with respect to solving various tasks for determine the location and navigation when working with mobile devices together with the use of geodata, mobile and web services with geospatial data. The knowledge can be useful for the future engineer surveyors in their further practice, especially if they want to work in the field of geoinformation systems and technologies.
Course Objectives	Consumer mobile GIS applications, such as Google Maps, Google Earth, Waze, and Zillow, have put the basic GIS capabilities in everyone's hands. This course focuses on enterprise mobile GIS, which offers a much wider variety of capabilities. Students learn the foundational principles, in-depth knowledge, and state-of-the-art technologies to manage, design, and implement mobile GIS projects. This course teaches students how to design GIS data, layers, maps, and smart logics for online and offline spatial data visualization, data collection, assets and users tracking, and field operation coordination based on Esri's mobile GIS products or similar open source options, including Survey123, Field Maps, QuickCapture, AuGeo, ArcGIS 360 VR, AuGeo, ArcGIS Earth, Indoors, and AppStudio. The course explores the popular types of applications and the frontiers in mobile GIS, including location-based services

	(LBS), volunteered geographic information (VGI), virtual reality (VR), and augmented reality (AR)
Course Structure	This course introduces students to concepts in: 1. Mobile GIS technology, 2. GPS theory, 3. Integration of GPS and GIS data 4. Plan and implement field surveys 5. Use of GPS devices and associated software 6. Integration of GPS acquired data with existing GIS data
Course Estimated Duration	14 hours
Presence of the course in the evaluated countries	Greece and France provide such courses and best practices were observed in this two countries analyses

3.2.3 Digital Cartography and GIS

Course overview	The course aim is to introduce students to the methods and techniques for creating cards in a digital environment. Particular focus of the course is the preparation of data for digital mapping; the use of geographical analysis in a GIS environment in data collection and data preparation; data cleansing from topological errors, etc. The creation of specific cartographic works is studied in a digital environment, as interactive and animated maps in order to help students become more efficient at creating maps in digital environment.
Course Objectives	Students are exposed to the latest digital survey gear and integrated techniques with applications in geosciences, geography, cartography and environmental science. Instrumentation includes both static and real time kinematic GPS (global positioning system) and autolock servo-driven electronic total station. Detailed precision survey data are combined with geo-referenced maps and imagery in GIS software.
Course Structure	1. Introduction to remote sensing, cartography, digital mapping, and geovisualisation 2. Geospatial data sources, data formats, and databases 3. Introduction to GIS, for example, ArcGIS/ArcGIS Pro and/or QGIS 4. Geospatial data analysis 5. Designing and creating a map 6. Mobile GIS and apps 7. Visual communication

Course Estimated Duration	16 hours
Presence of the course in the evaluated countries	Greece and France provide such courses and best practices were observed in this two countries analyses

3.2.4 Map Projections

Course overview	The course aim is to introduce students to the necessary mathematical and geodetic foundations for the computation and use of map projections. The distortions caused in the map projections are considered from qualitative and quantitative point of view. The graduates will be able to solve questions related to setting parameters of a projection by GIS, will be able to decide on the best projection for the plotted area, the scale and the purpose of the map, and will analyze the mathematical basis of the designed maps. The exercises aim to provide expertise and skillful use of map projections with the aid of the modern software systems, as well as establish knowledge for taking right decisions.
Course Objectives	Students will: 1. investigate the effect on a surface when changing from a 3-D surface to 2-D 2. recreate a 3-D surface from a 2-D map 3. explain the effects of different map projections by comparing map projections with representation of Earth's land and water on a globe
Course Structure	1. Coordinates: Cylindrical, Spherical and Polar -- Illustrated and described; plus conversion formulae. 2. Errors in Maps - data quality standards. 3. Error, Accuracy and Precision; types of errors; sources of inaccuracy and imprecision; problems of propagation and cascading; beware of false precision and false accuracy; dangers of undocumented data; principles of managing error. 4. Map Projection Overview - Illustrated and described selected map projections: Cylindrical (Behrmann Equal Area, Mercator); Pseudocylindrical (Mollweide, Sinusoidal); Conic (Albers Equal Area, Stereographic);Azimuthal (Orthographic, Stereographic); etc.

	5. Modified UTM Grid Projections -- Article on applications for field and computer generated coordinate systems.
Course Estimated Duration	14 hours
Presence of the course in the evaluated countries	Greece and France provide such courses and best practices were observed in this two countries analyses

3.2.5 Remote Sensing for Monitoring and Estimation of Disasters and Crises

Course overview	The course aim is to introduce students to the peculiarities of applying the methods for processing, interpretation and use of images obtained in remote sensing surveys. In the course students must focus on possibilities and requirements to the information which is obtained during remote sensing surveys in order to monitor, to prevent and respond to various disasters, accidents and to track processes over time.
Course Objectives	Disaster and crisis management planning and monitoring is structured around the disaster management cycle model. The cycle consists of four stages – reduction, readiness, response and recovery. Remotely sensed data can provide a valuable source of information at each of these stages, helping to understand spatial phenomena, and providing users with objective data sources for decision making. The challenge with disaster management is that the inherent unpredictability and range of hazards does not allow for a single all-encompassing solution to be developed and explored. Instead, there are a multitude of different remote sensing platforms and sensors that can and should be employed for image acquisition.
Course Structure	1. Existing Products and Services 2. The Dartmouth Flood Observatory and NASA's Near Real-Time Flood Mapping 3. The Global Flood Detection System 4. The Global Flood Monitoring System 5. Other Rapid Mapping Systems for draughts, fires, storms 6. Automated SAR Flood Mapping with ESA's G-POD 7. Rapid Flood Mapping from NOAA's VIIRS Sensor 8. The EC Copernicus Programme capabilities for monitoring of crisis 9. The Global Flood Partnership
Course Estimated Duration	12 hours
Presence of the course in the evaluated countries	Greece and France provide such courses and best practices were observed in this two countries analyses

3.2.6 Thematic Mapping and GIS

Course overview	In this course the main aim is to provide students with information about geographic data, their nature and acquisition methods. Topography. Terrestrial Survey Methods - chain and compass, plane table, prismatic compass, theodolite. Maps and their classification. Map characteristics and features; Thematic symbolization; positioning of objects on map. Properties of map projection; projection types; Extrinsic and Intrinsic problems; Map reference system- latitude, longitude and other systems. Basic principles of cartography. Cartographic communication process
Course Objectives	The objectives to be achieved with this discipline are the acquisition of knowledge to make and use thematic maps by applying geographic information systems (GIS), achievement of better understanding and usage of the knowledge gained in the cartography courses and map projections, knowledge for analysis and synthesis of geographical and statistical information needed to create thematic maps using GIS, evaluation of the achievements in the discipline, formation of respect for GIS, sharing of geographic data, visual aesthetic and presentation.
Course Structure	1. Basic Principles of Geospatial Technology, Survey, Thematic Mapping and Cartography 2. Earth features and phenomena, Earth Resources and Resource Management 3. Principles of Aerial Remote Sensing and Photogrammetry 4. Satellite, Microwave and thermal infrared Remote Sensing 5. Statistical data analysis and Spatial statistics 6. Computer Programming and Database Management 7. Digital Image Processing, Correction and Interpretation 8. Dgital Elevation Modelling and Global Positioning System
Course Estimated Duration	13 hours
Presence of the course in the evaluated countries	Greece and France provide such courses and best practices were observed in this two countries analyses

3.2.7 GIS using Open Source Software for water management

Course overview	The course aim is to develop GIS for small water body management in the necessary consequence, as follows:

	Choice of layers; Data base design for water body management; Digitalization of Map Sheet; Digitalization of structural drawings; Comparison of layers and attributive tables; Use of standard hydrological software for assessment of water body's hydrological characteristics.
Course Objectives	The course objectives are oriented towards more specialized users that work in the water sector. The main objectives after the course which each participant should have obtained are: 9. Thematic mapping 10. Basic data processing and editing 11. Basic geoprocessing and analysis 12. DEM processing and catchment delineation 13. Find open source software and open data
Course Structure	- Georeference scanned maps - Digitize vectors - Import tabular data - Join attribute tables - Interpolate points to a raster - Apply map algebra - Delineate streams and catchments - Find and use Open Data - Calculate the percentage of land cover per subcatchment - Design catchment maps
Course Estimated Duration	15 hours
Presence of the course in the evaluated countries	Greece and France provide such courses and best practices were observed in this two countries analyses

3.3 FuseGI Draft Curricula Conclusions

All FuseGI Draft Curricula suggested courses cover a wide range of GIS knowledges that could be elaborated in about 2 semesters if the respective university would have the facilities and the teaching staff to perform such complex GIS education.

The courses provided can be also formed as separate courses with profound agenda covering one or even two years of Bachelor degree. Specialised Master degree that is more oriented to young professionals that will develop their carrier in geoinformatics is also one good option to implement and further develop the courses from the basic and advanced sestion of IO2.

IO2 findings have been done as an original research part of FuseGI project in order to achieve all objectives described in the Grant Agreement. The courses design was done based on the outcomes found as shortcomings in the Bulgarian, Greek and French universities after the IO1 conclusions and results.

4 Innovation, Tangibility and Transferability

IO2 “Draft Curricula” comes second in the AF described outcomes in the FuseGI project. This intellectual output provides the basis on which the research and analyses done in IO1 materialize in curricula that can be tested, evaluated and fine-tuned through the VLE and the tools that came next in the FuseGI project as intellectual outputs. IO2 development was based on a thorough analyses done by the three teams of France, Greece and Bulgaria. The design and structure of IO2 Draft Curricula summarises knowledge collected from many different sources (including different languages of the courses evaluated).

4.1 Innovation

Intellectual output “IO2 Draft Curricula” innovation capacity can be summarised as follows:

- Original summary of GIS courses status for three countries – France, Bulgaria and Greece having the pros and cons described at once with possible improvements suggestions.
- Novel comparison between three countries GIS higher education status in one language (normally GIS courses in France, Bulgaria and Greece are taught only in the local languages thus good practices or shortcomings are not possible to be observed).
- Newly produced Draft Curricula of two types of courses (Basics and Advanced) which cover the needs of students from Bachelor, Master or even young professional’s level.

4.2 Tangibility

IO2 main outcome is to produce a draft curricula, which can be used by any HEI, in order to cover the gap between the knowledge provided in under-graduate studies and market needs, concerning the use of GIS in environment and health management. In that sense, IO2 main result is tangible and could have significant impact in European HEI. All results per country are available in English and each country analyses is done in the local language – French, Greek and Bulgarian. The best practices found in GIS courses that are taught in the 3 analyzed countries and the knowledge gaps observed in IO1 results materialized into building up of the Draft Curricula. Collecting, analysing and summarising the French, Bulgarian and Greek GIS courses curricula state of the art with its pros and cons per country is a valuable information that many teachers can use long after the FuseGI final report.

4.3 Transferability

The "Draft Curricula" output (IO2) constitutes a perfectly transferable output, that can be used by Universities, SME, Academic Labs. This output is fully developed based on the research conducted on the topic of GIS courses per country (covering France, Bulgaria, Greece) and per course structure analysis.

- The Draft Curricula can be used in each of the three countries in its combined version in English, or each of the local reports can be used as country based report for the local teachers needs
- The Draft Curricula can be used as best practices transfer for SME companies that want to educate their young professional using knowledge based approaches
- The Draft Curricula can be tested and implemented fast to audience that is evaluated as beginners or advance GIS users. That is why the curricula are divided in two parts applicable for almost every user that can be interested in the GIS subject.
- Last but not least, the documented findings of this output can be used as the initial basis for building different curricula of the broader knowledge domain (toward training future professionals on environmental sciences), which are exploiting the main principles promoted by this work, but also being adapted to the special requirements of any specific educational program.

5 Annex 1 - Additional French Universities analysed in IO2

University	Department/Degree	Degree type (BSc/MSc)
Avignon University	BSc in Earth and Water Sciences, MSc in Hydrogeology, Soil and Environment	BSc/MSc
Diplôme délivré par AgroParisTech, localisation Montpellier Agropolis	Specialized MSc in Water Management	MSc
Diplôme délivré par AgroParisTech, localisation Montpellier SupAgro	MSc in Water Sciences in Water and Agriculture	MSc
Faculty of Angers	BSc in Geoscience and Environment	BSc
Faculty of Angers	Master Bio-Geosciences	BSc
Faculty of Angers	Medicine	BSc
Faculty of medicine and pharmacy	Medicine	BSc
Faculty of medicine Lyon Est	Medicine	BSc
Faculty of Tours	BSc in archaeology	BSc
Faculty of Tours	Degree in geography and management	BSc
Faculty of Tours	Master in Sustainable Culture, Landscape and Phytovalorization	MSc
Faculty of Tours	MSc in Environmental and Urban Law, Environment	MSc
Faculty of Tours	Master Hydrosystem and Watersheds	MSc
Faculty of Tours	Medicine	BSc
Grenoble Faculty of Medicine	Medicine	BSc
Paul Sabatier	Medicine	BSc
Sorbonne University	Professional License Resources and Water Quality	BSc
Sorbonne University	BSc in Earth Science	BSc
Clermont Auvergne University	Certificate of Orthoptist Capacity	BSc
Clermont Auvergne University	Agronomy Pro License	BSc

Clermont Auvergne University	BSc in Life Sciences	BSc
Clermont Auvergne University	MSc in Plant Biology	MSc
Clermont Auvergne University	MSc in Environmental Management	MSc
Clermont Auvergne University	MSc in Environmental Management	MSc
Clermont Auvergne University	MSc in Public Health	MSc
Clermont Auvergne University	MSc in Public Health	MSc
Clermont Auvergne University	MSc in Public Health	MSc
Clermont Auvergne University	Master of Earth and Planetary Sciences, Environment	MSc
Côte d'Azur University	Medicine	BSc
d'Aix-Marseille University	Medicine	BSc
Bordeaux University	Medicine	BSc
Bourgogne University	BSc in Earth Sciences	BSc
Bourgogne University	Master of Earth and Planetary Sciences, Environment	MSc
Bourgogne University - AgroSup Dijon	MSc in Business Management and Innovative Technologies for Agricultural Equipment	MSc

Franche-Comté University	Master Géoressources, géorisques, géotechnique (CMI)	MSc
Franche-Comté University	MSc in water and soil quality and treatment	MSc
Franche-Comté University	Master Health Host Graft	MSc
la Réunion University	Medicine	BSc
Lille Henri Warembourg University	BSc in Earth Science	BSc
Lille Henri Warembourg University	Medicine	BSc
Limoges University	Medicine	BSc
Lorraine University	Medicine	BSc
Montpellier University -Faculty of Medicine Montpellier-Nîmes	MSc 3S (Statistics and Health Sciences)	MSc
Nantes University	Medicine	BSc
Pascuale Paoli University	Medicine	BSc
Picardie Jules Verne University	Master Agrosciences, environment, territories, landscape, forest	MSc

Picardie Jules Verne University	MSc Agrosciences, environment, territories, landscape, forest	MSc
Picardie Jules Verne University	MSc Agrosciences, environment, territories, landscape, forest	MSc
Picardie Jules Verne University	MSc Agrosciences, environment, territories, landscape, forest	MSc
Reims Champagne-Ardenne University	Geography and development degree	BSc
Reims Champagne-Ardenne University	Medicine	BSc
Rennes 1 University	BSc in Earth Sciences in Geosciences	BSc
Rennes 1 University	MSc in Public Health Evaluation and Prevention of Occupational Risks	MSc
Rouen Normandie University	MSc in Environmental Management	MSc
Rouen Normandie University	MSc in Environmental Management, Management of Biodiversity in Terrestrial Ecosystems	MSc
Rouen Normandie University	Master Environmental Management, Sustainable Management of Hydrogeosystems	MSc
Strasbourg University	MSc in Geology and Dynamics of the Earth	MSc
Strasbourg University	MSc in Engineering and Geosciences for the Environment	MSc
Strasbourg University	Master in Earth Physics	MSc
Strasbourg University	Medicine	
University Versailles Service Centraux University	BSc in Geography and Planning	BSc
Antilles University	Medicine	BSc
Lyon 2 University	MSc in Water Science	MSc

Paris Descartes 5 University	MSc in Public Health and risks related to the general environment	MSc
Paris Descartes 6 University	MSc in Public Health and risks related to the hospital environment	MSc
Paris Descartes 7 University	MSc in Public Health and risks related to the professional environment	MSc
Paris Descartes 8 University	Master of Computer Science Course Machine Learning for Data Science	MSc
Paris Diderot 7 University	IUD Clinical Epidemiology in Pediatrics	MSc
Paris Diderot 7 University	BSc in Earth Science in Environment AND Earth	BSc
Paris Diderot 7 University	MSc in Risks and Environment Course Spaces and Environments: Ecological Territories	MSc
Paris Diderot 7 University	MSc in Risks and Environment Environmental Science and Engineering - Indoor and Outdoor Atmospheres (PRO)	MSc
Paris Diderot 7 University	MSc in Risks and Environment Environmental Science and Engineering - Heritage Materials in the Environment	MSc
Paris Diderot 7 University	Master of Earth and Planetary Sciences	MSc
Paris-Est Créteil University	Medicine	BSc
Paris-Saclay University	Masters with the common core "Political Economy and Institution Mention"	MSc
Sorbonne Paris-Nord University	Medicine	BSc

6 Annex 2 - Additional Greek Universities analysed in IO2

Agricultural University of Athens

Department of Agricultural Economics and Development: Geography Information Systems - Introduction to Geographic Information Systems. 2. Archives, Databases for geographical data. 3. Introduction to topology. 4. Coordinate systems and cartographic projections. 5. Spatial data models. 6. Digital relief display models. 7. Import, verify, store and retrieve geographic data. 8. Elements of spatial data structures. 9. Pre-processing of geographical data. 10. Transactions on geographical data. 11. Spatial interference methods (geostatic and non-geostatic). 12. Access to Geographic Databases via the World Wide Web. Geographic Information Systems Software Laboratory.

Department Of Natural Resources And Agricultural Engineering: Geographical Information Systems, Applications Of Geographical Information Systems In The Environment -Basic concepts. Introduction to Geographic Information Systems. ii.Geographic Data: Quality and Sources of Errors. Data entry in GPS. iii.Storage of data: Files, File Types, Database Models iv. Vector and Grid Structures v. Coordinate Systems and Cartographic Projections x. Spatial Interference - Spatial Interference Methods.
Analysis and perception of the area. ii .Methodology of displaying geographical information by species and application. iii. Digital Soil Models (DTM) iv. Spatial Models v. application of GIS for the assessment of the risk of soil degradation.

Democritus University of Thrace

Department of Forestry and Management of Environment and Natural Resources: Geographic Environmental Information Systems, Forest Land Registry - Modern software applications in forest research and practice, introduction to geographic information systems and their uses. Understanding the processes and dynamics of spatial changes in the environment through the innovative application of geospatial methods and tools such as geographic information systems.

Department of Production and Management Engineering: Advanced Database Issues, Eco-Informatics - Interoperability, Time series and Geographic Information Systems, Database, Databases and licenses, Complex systems

Department of Environmental Engineering: Geographic Information Systems - GIS, Geographic Information Systems in the study of Climate Change

University of Athens

Department of Geology and Geoenvironment: Geographical Information Systems And Remote Sensing Principles, Space Techniques And Geographic Information Systems In Geosciences, Geomorphology, Geological Mapping, Natural Disasters, Introduction, Acquaintance, Processing Of Geographic Data, Use, Course Tools.

National Technical University of Athens

Department of Agronomy and Surveying Engineering: Geographical Information Systems, Geoinformatics Principles and Geographic Information Systems, Digital Cartography, Urban Planning Methods and Applications, Marine Geodesy, Photo Interpretation-Remote Sensing Applications.

Department of Architectural Engineering: Introduction to geographic information systems in urban and spatial planning

Department of Mining and Metallurgical Engineering: Geographical Information Systems, Geological Mapping & Tectonic Analysis

Department of Civil Engineering: Geographic Information Systems - Data management, techniques, projection systems, Databases, the cartographic processing of results, maps, graphs, etc. the basic data analysis procedures both in vector format and in grid format. Extraction of physiological characteristics of the catchment area Spatial integration of point variables (IDW, kriging, cokriging). Spatial distribution of solar radiation. Stereo flow estimation. Model implementation in model builder. Estimation of flood magnitudes. Extraction of hydrograph by the method of isochronous curves

Aegean University

Department of Geography: Introduction to Geographic Information Systems, Geographic Information Systems Applications, Special Topics in Geographic Information Systems

Department of Environment: Introduction to Cartography and GSP

7 Annex 3 - Additional Bulgarian Universities analysed in IO2

Architecture, Civil Engineering and Geodesy University – Sofia

The University of Architecture, Civil Engineering and Geodesy is located in Sofia, Bulgaria. It was founded in 1942 as a Higher Technical School following a decree issued in 1941. In 1945 it was transformed into a State Polytechnic. In 1953 the Institute of Civil Engineering (ISI) was formed, which in 1963 was renamed the Higher Institute of Civil Engineering (VISI), and in 1977 - the Higher Institute of Architecture and Construction (VIAS). On July 21, 1995, by a decision of the National Assembly, VIAS was transformed into the University of Architecture, Civil Engineering and Geodesy (UACEG).

Faculty of Geodesy

The Faculty of Geodesy at UACEG provides training for students in the three educational - qualification degrees: "Bachelor", "Master" and "Doctor" in the professional field “Architecture, Civil Engineering”

The Faculty of Geodesy at UACEG is the only one in the country and as such is the main and leading unit for providing the needs of the country with employees in the fields such as geodesy, cartography, cadastre, photogrammetry, remote sensing survey of the soil, real estate evaluation, agricultural land development and real estate, management of European infrastructure projects, land management, ecology and environmental protection.

The Faculty of Geodesy at UACEG provides for all students, PhD students and lecturers a basic and specialized software for work - MS Office, MS Excel, MS Power Point, MS Visio, MS Visual Studio, all Autodesk products and solutions for the professional field "Architecture, Construction and Geodesy ”, Quantum GIS, TPLAN, TOBEL, CADIS, Leica Office, products and solutions of ESRI and Bentley (for the territory of UACEG), Trimble Business Center (for the territory and bases of UACEG), MKAD (for the territory of UACEG) , specialized solutions and software developments of lecturers from the faculty and the university.

Department of Photogrammetry and Cartography

The department was founded in 1942 as a department of the Division of Surveying Engineering at the Higher Technical School under the name "Photogrammetry, Topography and Cadastre". In 1945, the Department of Photogrammetry and Topography was established from this department, which in 1948 adopted the name “Photogrammetry and Cartography.” The GIS training is organized in the Department of Photogrammetry and Cartography.

Remote methods and GIS

The course aims to introduce students to the features of applying remote sensing methods in a GIS environment. There are possibilities and requirements to the information which is received from GIS for solving the main technological tasks in remote sensing surveys: georeferencing and transformation of digital multichannel images, methods for analysis and interpretation of space and aerial images and their areas of application. The specifics of

extracting thematic information from multi-channel images, filtering of index raster images owing to GIS are part of the course.

Course content:

1. Unification of the received data with the requirements of the GIS environment.
2. Geomorphological mapping by space images.
3. Analysis of water basins.
4. Study of snow cover and ice.
5. Study Vegetation and agricultural plantations

The course is taught for the following faculties and specialties:

Faculty of Geodesy, major "Geodesy - regulated profession", bachelor - full-time study

Cartography

The course aims to provide the students with knowledge and skills in cartography. By its nature the course is comprehensive and covers the following cartographic subjects:
theoretical cartography, design and mapping, general geographic and thematic mapping, space mapping, cartographic research methods and history of cartography. In the practical lessons are developed problems covering the material of the lectures along with mastering and usage of GIS software. At the end of the course is expected the development of a project in which the students apply their knowledge and skills in editing, drafting, and modelling the maps.
The Subject is compulsory. There is a possibility to be taught in other foreign language– English.

The course is taught for the following faculties and specialties:

Faculty of Geodesy, major "Geodesy - regulated profession", bachelor - full-time study
Faculty of Photogrammetry and Cartography, major "Land Management and Management", Bachelor - full-time study

Mobile GIS

The course aims to provide basic theoretical knowledge and practical skills for the development, use, maintenance and application of the Mobile GIS. This discipline is related to other studied disciplines with respect to solving various tasks for determine the location and navigation when working with mobile devices together with the use of geodata, mobile and web services with geospatial data. The knowledge and skills can be useful for the future engineer surveyors in their further practice, especially if they want to work in the field of geoinformation systems and technologies.

Course content:

1. The course is elective, there is a possibility to be taught in other foreign language– English.
2. Determining the location and navigation when working with mobile devices.

The course is taught for the following faculties and specialties:

Faculty of Geodesy, Department Surveying and Geoinformatics, major Geodesy, Master - full-time study

Digital Cartography and GIS

The course aims to introduce students to the methods and techniques for creating cards in a digital environment. Particular focus of the course is the preparation of data for digital mapping; the use of geographical analysis in a GIS environment in data collection and data

preparation; data cleansing from topological errors, etc. The creation of specific cartographic works is studied in a digital environment, as interactive and animated maps in order to help students become more efficient at creating maps in digital environment.

1. The course is compulsory, there is a possibility to be taught in other foreign language– English.
2. Data analysis in GIS environment
3. Practical realization of the students theoretical methods in disciplines such as Cartography and Map projections

The course is taught for the following faculties and specialties:

Faculty of Geodesy, department "Photogrammetry and Cartography" , major "Geodesy - regulated profession", bachelor - full-time study

Map Projections

The course aims to introduce students to the necessary mathematical and geodetic foundations for the computation and use of map projections. The distortions caused in the map projections are considered from qualitative and quantitative point of view. The graduates will be able to solve questions related to setting parameters of a projection by GIS, will be able to decide on the best projection for the plotted area, the scale and the purpose of the map, and will analyze the mathematical basis of the designed maps. The exercises aim to provide expertise and skillful use of map projections with the aid of the modern software systems, as well as establish knowledge for taking right decisions.

The course is compulsory, there is a possibility to be taught in other foreign language– English.

The course is taught for the following faculties and specialties:

Faculty of Geodesy, department "Photogrammetry and Cartography", major "Geodesy - regulated profession", bachelor - full-time study.

Navigation Cartographics

The course aims to digest knowledge and skills for making and using navigation maps, through the geographic information systems (GIS) app. Achieving a better understanding and application of the knowledge gained from the disciplines of cartography and map projections.

Course content:

The course is elective with a possible training in foreign language.

The course is taught for the following faculties and specialties:

Faculty of Geodesy, department "Photogrammetry and Cartography", major "Geodesy – regulated profession", master's degree - full-time form of study.

Remote Sensing for Monitoring and Estimation of Disasters and Crises

The course aims to introduce students to the peculiarities of applying the methods for processing, interpretation and use of images obtained in remote sensing surveys. In the course students must focus on possibilities and requirements to the information which is obtained during remote sensing surveys in order to monitor, to prevent and respond to various disasters, accidents and to track processes over time.

1. The course is elective, possible training in foreign language**.**
2. Extraction of statistical and other type of information from satellite images
3. Classification and interpretation of images via methods of remote sensing survey to obtain operational information

The course is taught for the following faculties and specialties:

Faculty of Geodesy, department “Photogrammetry and Cartography”, major "Geodesy – regulated profession", master's degree - full-time form of study.

Thematic Mapping and GIS

The objectives to be achieved with this discipline are the acquisition of knowledge and skills to make and use thematic maps by applying geographic information systems (GIS), achievement of better understanding and usage of the knowledge gained in the cartography courses and map projections, knowledge for analysis and synthesis of geographical and statistical information needed to create thematic maps using GIS, evaluation of the achievements in the discipline, formation of respect for GIS, sharing of geographic data, visual aesthetic and presentation.

1. The course is compulsory, possible training in foreign language.
2. Analyzing and synthesizing the flows of geographical and statistical information necessary for the creation of thematic maps through GIS.
3. Formation of attitude towards GIS, sharing geographical data, visual aesthetics and presentation.

The course is taught for the following faculties and specialties:

Faculty of Geodesy, department “Photogrammetry and Cartography”, major "Geodesy – regulated profession", bachelor’s degree - full-time form of study.

Department Surveying and Geoinformatics

The department was founded in 1942 under the name "Geodesy and Astronomy as a result of the Law on Higher Technical Education in 1941 ". In 1945 the name is changed to Geodesy. In 2001, this department is divided into two independent departments : Geodesy and Geoinformatics and Applied Geodesy.

Geographic information system

The course aims to give students the necessary knowledge on the contemporary perception and the application areas of GIS. These data are necessary for learning and implementation of various concepts and models for storage and representation of data and/or information for land and property planning and management. The main part of the subject is oriented towards the practical use of GIS as a technology, for identification of the specific fields of application of the degree programme “Land and Real Estate Management and Planning”. The course coverage is in compliance with the syllabi of the courses Programming and Application of Computer Systems, Surveying, Data Bases and Graphical Systems.

The course is compulsory, possible training in foreign language.

The course is taught for the following faculties and specialties:

Faculty of Geodesy, Department of Geodesy and Geoinformatics, major "Structure and management of land and property", bachelor’s degree - full-time study

Geoinformatics - Part II

The course aims to gain knowledge about the trends in the development and application of the Geographic information systems (GIS), to acquire additional knowledge and skills for creating and using digital models of the territory, to get acquainted with functions fordata analysis and learn to apply them in solving specific problems. The obtained knowledge and skills the students will be able to apply in practice - in establishing, implementing and using GIS technology as well as other disciplines taught in the Geodetic faculty.

The course is compulsory, possible training in foreign language.

The course is taught for the following faculties and specialties:
Faculty of Geodesy, Department of Geodesy and Geoinformatics, major "Structure and management of land and property", bachelor's degree - full-time study

Geoinformatics - Part III

The course aims to continue the training course in Geoinformatics II and is in accordance with the program in Geoinformatics I. The students will study topics related to the design and development of WEB GIS and the exchange and presentation of spatial data on the Internet. In the seminars, students will develop a project in which they will apply what they have learned from the lecture. The project is related to the application of web GIS technologies.

1. The course is compulsory, possible training in foreign language
2. GIS software architecture, as a continuation of the topics of Geoinformatics II
3. Technologies for GIS development, in accordance with the course in Geoinformatics I (databases) and II (algorithms).

The course is taught for the following faculties and specialties:
Faculty of Geodesy, Department of Geodesy and Geoinformatics, major "Structure and management of land and property", master's degree - full-time study

GIS using Open Source Software

The course aims to develop GIS for small water body management in the necessary consequence, as follows: Choice of layers; Data base design for water body management; Digitalization of Map Sheet; Digitalization of structural drawings; Comparison of layers and attributive tables; Use of standard hydrological software for assessment of water body's hydrological characteristics.
The course is optional, possible training in foreign language.

The course is taught for the following faculties and specialties:
Faculty of Geodesy, Department of Geodesy and Geoinformatics, major " Water Supply and Sewerage", bachelor's degree - full-time study

Department Hydraulics and Hydrology

GIS Application and ArcGIS

The course aims to introduce to the field of geographic information systems and the application of an integrated family of ESRI Inc. ArcGIS software products. In the first part of the course the students learn the basic concepts of geographic information systems and become familiar with the functionality of the software. The second part of the course represent in details the powerful tools and capabilities of GIS to support and optimize the management, operation and maintenance of water supply networks, irrigation facilities and water resources management. GIS systems that are used in daily operations of leading water operators in Bulgaria are demonstrated.

1. The course is optional, possible training in foreign language.

The course is taught for the following faculties and specialties:
Faculty of Geodesy, Department "Hydraulics and Hydrology", major " Water Supply and Sewerage", bachelor's degree - full-time study.

Sofia University

Faculty of Informatics and Mathematics

Geographic information systems for developers: The course is elective.
The course is taught for the following faculties and specialties:
Faculty of Mathematics and Informatics, specialty "Informatics", master's program "Computer Graphics" - full-time study.

Faculty of Geology and Geography
The Faculty of Geology and Geography of Sofia University has existed since 1963. The existing Faculty of Biology, Geology and Geography was divided into Faculty of Geology and Geography and Faculty of Biology. However, studies in geology at the University began in 1891 with the opening of the major Geology. The degree programmes in Geology and Geography were set up at Sofia University at the end of the 19th century. They form the basis of education and research in the fields of Geology and Geography in Bulgaria.

Department Cartography and GIS

Applications of GIS in electronic geography: The course is elective.
The course is taught for the following faculties and specialties: Faculty of Geology and Geography, major "Geography", master's program "Regional and Political Geography" - part-time study

GIS in regional management
The course aims to introduce students to the possibilities for application of geoinformation systems and technologies in regional planning and management. At the end of the training students will be able to use specialized GIS software products to solve social, economic and environmental problems in the field of regional planning and sustainable development.
Course content :

1. The course is compulsory.
2. Creation of geobases for separate thematic directions in the regional planning (inventory and assessment of the natural resource potential of the environment, of the demographic situation and the human resources, of the social and technical infrastructure, natural and anthropogenic risks, etc.)
3. Spatial analysis and modeling of different types of land use; Solving practical tasks with the help of GIS, related to the selection of the most suitable areas for the implementation of different types of activities, according to pre-selected criteria (Land Suitability Analysis).
4. Using GIS in order to predict economic, social and environmental consequences of
5. Using GIS in the development of strategic plans for regional development
6. Mastering visualization techniques and compilation of cartographic and other graphic materials in GIS environment, which are an integral part of the documentation of regional development plans

The course is taught for the following faculties and specialties: Faculty of Geology and Geography, Department of Cartography and GIS, major "Regional Development and Policy", bachelor - full-time study

Modeling Regional Systems

The course aims to provide students with basic knowledge about the nature of regional systems, their structure and spatial behavior, as well as the connections and interactions that are formed within these systems. The course focuses on the use of concepts for modeling and spatial modeling for the needs of research, planning and management of regional systems. Students will gain basic skills and knowledge necessary for constructing different types of models.

1. The course is elective.
2. Different theoretical situations related to the modeling of land use, transport systems, socio-economic systems, various problems related to the management and protection of the environment, etc.
3. Using GIS as a working environment for the development and testing of spatial models.

The course is taught for the following faculties and specialties:

Faculty of Geology and Geography, Department of Cartography and GIS, specialty "Regional Development and Policy", bachelor - full-time study

Remote (Aerospace) Research

The course aims to introduce the students to the basic concepts, technology and application of GIS in solving a wide range of tasks; with the principles of remote sensing surveys of the soil, the formation of digital satellite and aerial images, as well as the main points of processing and extracting of information. We use a specialized computer program for processing multispectral satellite images Micro MSI and original images from the satellite platform LANDSAT TM. At the end of the course, students should be able to apply the acquired knowledge and practical skills in the construction and use of specific applications of geographic information systems.

The course is elective.

The course is taught for the following faculties and specialties: Faculty of Geology and Geography, Department of Cartography and GIS, major "Regional Development and Policy", bachelor - full-time study

Introduction to GIS and remote sensing methods

The course aims to introduce students the opportunity to the basic concepts and possibilities for application of geographic information systems (GIS) and remote sensing methods in solving a wide range of practical tasks. During the seminars, students develop skills to work with the most common software programs in the field of GIS and processing and interpretation of satellite images. Students participate in seminars with assignment dealing with issues in the field of development of geographic information technologies and remote sensing methods.

Course content :

1. The course is elective.

2. Issues related to the nature and development of GIS, GIS databases, satellite platforms and satellite information, processing, analysis and interpretation of satellite images shall be addressed.
3. Modeling in GIS.

The course is taught for the following faculties and specialties: Faculty of Geology and Geography, Department of Cartography and GIS, major "Geology", bachelor - full-time study

Mobile GIS and positioning systems

Faculty of Geology and Geography
Department of Cartography and Geographic Information Systems
Scientific adviser: Assoc. Prof. Dr. Alexander Kotsev
Scientific specialty: 02.16.03 Cartography (incl. Thematic geographical mapping)

The course is taught for the following faculties and specialties: Faculty of Geology and Geography, major "Geography", master's program "Geographic Information Systems and Cartography", profile "GIS"

Online GIS

The course aims to introduce students to spatial data on the Internet and how to work with it. Upon completion of the course, students will know and acquire skills in the use of basic technologies (based on free code) and standards for the exchange of geographical data (WMS, WFS, SOS, CSW, GML, GeoJSON).

The course is taught for the following faculties and specialties: Faculty of Geology and Geography, major "Geography", master's program "Geographic Information Systems and Cartography", profile "GIS"

GIS applications in environmental management

The course is taught for the following faculties and specialties: Faculty of Geology and Geography, major "Geography", master's program "Geographic Information Systems and Cartography", profile "GIS"

Applications of GIS in socio-economic research

The course is taught for the following faculties and specialties:

Faculty of Geology and Geography, specialty "Geography", master's program "Geographic Information Systems and Cartography", profile "GIS"
Faculty of Geology and Geography, Master's Program "HUMAN RESOURCES MANAGEMENT" - full-time study

Bachelor degree : Geospatial systems and technologies

The bachelor program "Geospatial Systems and Technologies" covers four-year training course. This degree prepare specialists in the field of geographic information systems and related technologies with theoretical knowledge and practical skills. The curriculum includes compulsory and elective disciplines from various scientific and applied fields : Earth and social sciences, mathematics, computer science, information systems, regional development, spatial planning and more.

Successful graduates will be considered as highly qualified specialists in the collection, processing, analysis, modeling, visualization and application of geospatial data and

information necessary for informed decision-making in various fields - environmental protection, effective use of natural resources, human resources and business management, etc. Graduates can work in scientific organizations, state and municipal administrations, private businesses or non-governmental sector.

These course aims to prepare highly qualified specialists for some of the most intensively developing scientific and technological fields, such as geoinformation technologies, responsable for collecting, processing, analyzing, modeling and visualization of geographically referenced data and information. To successfully solve significant environmental, demographic, urbanization and resource-related problems, it is necessary to combine knowledge and skills from different fundamental and applied sciences.

This bachelor degree has both theoretical and practical orientation. It focus on the latest trends in geoinformation science (geoinformatics) and derived technological areas, providing knowledge and specialized skills with focus on different types of geospatial systems and technologies - geographic information systems (GIS), remote sensing systems (RDS), global navigation satellite systems (GNSS), etc. An interactive way of learning is applied.

There are three groups of disciplines - compulsory, elective and optional. During the process of the training students will obtain knowledge related to the geographical area, the processes and phenomena that develop in it, as well as specialized knowledge and skills related to the use of information technology, geographic information systems, remote data collection methods and information about the state of the Earth, global navigation satellite systems, etc. Students gain theoretical knowledge and skills in order to use quantitative methods for spatial analysis, to build and manage databases, to collect, process, analyze and visualize digital geoinformation resources, to develop Internet-based applications and more. The main directions of the course focus on the Earth sciences, computer sciences, planning and management of the territory, as well as basic presentation and communication skills, which will successfully position the graduates of this bachelor program on the labor market. There is an opportunity for students to choose disciplines according to their interest, expanding and deepening their knowledge and skills in individual direction.

Professional competencies:

Students graduate with a bachelor degree and a professional qualification "Specialist in Geospatial Systems and Technologies". They have professional skills in the field of collection, processing, analysis and visualization of geospatial data and information, supporting decision-making in various areas of life and management. Graduates have theoretical knowledge and practical skills for:

- Collection and processing of geospatial data and information,
- Organization of geospatial data in databases and their management,
- Analysis and modeling of geospatial data and information,
- Work with GIS and development of various geoinformation products and computer applications, incl. web based,
- Solving a wide range of various problems and type of territories by using modern geographic information systems and technologies.

Professional integration :

The growing demand for highly qualified specialists in this field is caused by the information needs of the society and by the rapid development of science, information systems and technologies. Successful graduates of this bachelor program can be integrated in the public sector (state and local administrations, research organizations), IT industry, consulting companies and other companies whose mission and activities are related to regional and

spatial planning, design and construction of infrastructure systems, environmental protection and a number of other areas where geospatial information is a key component of their activities.

Geographic information systems Part I: The course is compulsory.
Introduction to Earth remote sensing: The course is compulsory.
Geographic information systems Part II: The course is compulsory.
Graphic design and visualization of spatial data: The course is compulsory.
Web application and GIS servers: The course is compulsory.
Application of GIS in the management of natural resources: The course is elective.
Business application of GIS and geospatial information: The course is elective.
Application of data and information from remote sensing: The course is elective.
Mobile GIS: The course is elective.
Digital processing of aerospace information: The course is elective.
Satellite meteorology and climatology: The course is elective.
Web GIS applications – workshop: The course is elective.

Master degree : Geographic information systems and cartography
Focus, goals: The graduates of the major are prepared for various managerial and expert positions in the state and local administration in consulting and production companies, as well as in the structures of the civil society, such as:

- civil servants
- in district and municipal administration,
- in non-governmental organizations,
- in public and private companies dealing with:
- creation and maintenance of spatial databases;
- consulting in the field of mapping, cadastre and site management ;
- qualified specialists in research, design and consulting centers, public opinion research agencies;
- lecturers in universities and colleges.

Training Participation in the development, application and monitoring of national and international projects related to the construction of specialized databases of spatial data and cartographic materials, as well as data obtained through the use of unmanned aircraft system. The modular structure of the master's program proposes specialization in specific problem areas : **(1) Cartography, (2) Geographic information systems, (3) Satellite remote sensing and (4) Unmanned aircraft system**. The masters will be educated in the following main directions :

1. Research and mapping of the natural environment, management of natural, human, infrastructural and economic resources at different territorial levels;
2. Thematic geographical mapping ;
3. Geographic information systems, spatial analysis and modeling ;
4. Remote methods for research of the environment, natural resources and management of natural and anthropogenic crisis situations, including through the use of unmanned aerial systems for acquisition of various spatial information.

The thematic content of the knowledge and skills in these areas includes:

- Compilation of analytical and synthetic maps both in analog and digital form (Digital / ComputerCartography).
- Collection and processing of geospatial data and their computer modeling, including via the use of mobile GIS, unmanned aerial systems, GPS-registration and coordinate binding of objects and layers of the lens GIS environment;
- Creation and use of geographical databases and metadata (including vectorization of relief, hydrographic network, road network, infrastructure of settlements, land cover and land use, recreational areas, industrial zones, sources and degree of environmental pollution and etc.).
- Creation of digital cartographic representations of natural and anthropogenic geographical objects and phenomena, including and multimedia representations based on virtual models (2,5-Dgrid and TINDEMs, 3-Dvisualization, etc.).
- Creation of problem solving GIS applications in the field of environmental management and use of natural resources, regional development and management of the territory, analysis and assessment of transport accessibility for different areas, web-based GIS applications, etc.
- Processing, analysis, evaluation, interpretation and application of remotely received data (satellite and aerial images and information obtained using unmanned aerial systems) and their integration into GIS databases.
- Creation of specialized GIS applications (in the field of archaeological research, management of renewable energy resources, crisis management, etc.) using both commercial software products (for GIS and remote sensing) and open source software products (OpenGIS) such as QuantumGIS (QGIS), GrassGIS and others.

Geographic information systems: The course is compulsory.
Satellite systems and satellite information: The course is compulsory.
Geoinformatics: The course is compulsory.
Unmanned aerial vehicles: The course is compulsory.

Gis Profile:
Application of GIS in environmental management: The course is elective.
Application of GIS in socio-economic research: The course is elective.
Mobile GIS and global positioning systems: The course is elective.
Online GIS: The course is elective.
The courses are taught for the following faculties and specialties: Faculty of Geology, specialty "Geology and Geoinformatics - GGI", bachelor - full-time and part-time education.

Mining and Geology University – Sofia

The University of Mining and Geology "St. Ivan Rilski" has existed as an independent educational institution since 1953. For these 60 years it has established itself as a education and research center, where engineers in geological, mining and electromechanical specialties are educated. The good combination of general engineering training with more closely

profiled knowledge and skills gives a great range of opportunities for integration of its graduates in the country and abroad. Since the establishment of the university, more than 22,000 engineers have been educated in geology, mining, energy and raw materials, civil and industrial construction, environmental protection, etc.

Faculty of Geology - GPF

Major „Geology and Geoinformatics" (GGI), full-time education

The major also prepares engineers in the field of geoinformation technologies (GIS) and remote sensing methods, which are a powerful tool for analysis, interpretation and storage of geospatial information. Students have access to the latest Esri and Datamap products, the latest professional versions of their software products in ArcGIS and MapInfo for monitoring, mapping, 3D-visualization, processing and sustainable management of all types of data. The wide application of GIS in the economy and infrastructure of modern society provides graduates with unlimited opportunities for professional integration.

Introduction to GIS: The course is compulsory.

Fundamentals of geoinformatics: The course is compulsory.

Global satellite navigation systems: The course is compulsory.

GIS and spatial analysis: The course is compulsory.

GIS documentation of linear infrastructure sites: The course is compulsory.

Processing of geological information in GIS: The course is compulsory.

Master's degree in Geoinformatics, full-time education

This master degree prepares specialists in geoinformatics to carry out activities in the field of traditional and remote methods in geology - compiling conventional and specialized geological maps using GPS and GIS systems for collecting, processing, storing and promoting geological information. It is focused on the basic training in geology and geoinformatics in the educational-qualification degree "bachelor" and guarantees the development of the most modern skills and knowledge for conducting effective regional-geological research.

Specialists can be integrated in activities related to computer processing of geological information, mapping, forecasting and monitoring of natural risks. Graduates receive an educational qualification degree "master" with a professional qualification "master engineer in geoinformatics”.

South-West University - Blagoevgrad

Geographic Information Systems

The program aims to prepare employees who can meet the requirements of Bulgarian and European institutions in order to work with spatial data. A wider range of theoretical knowledge and practical qualifications in the field of GIS and remote sensing will help learners to solve their professional problems in the field of geography, ecology and environmental protection. This is the main prerequisite for achieving the educational goals is the structure and content of the curriculum.

The courses are organized in two groups - compulsory and elective.

The profiling disciplines are grouped into three main groups - fundamentals and principles of GIS; GIS data collection sources; modeling in the middle of GIS. This provides a training related to basic issues and the practical use of Geographic Information Systems. Elective courses are divided into two groups, which provide training in different areas of GIS.

Well-mastered knowledge will open an opportunity for successful future integration for students in their professional field. Graduates can find their success in various administrations, various departments, where GIS technology is used to visualize, process and analyze geospatial information.

Spatial databases and GIS programming

The course aims to provide specific knowledge and skills to improve the performance of ArcGIS, for example, creating new toolbars, adding scripts and more.

Course content:

1. The course is compulsory.
2. Basic concepts related to spatial data, which are the main content of maps
3. Introduction to programming: students will gain the necessary theoretical and practical knowledge. Some languages which are used for GIS programming, will be discussed.
4. Using custom applications Students learn how to download scripts and other ArcGIS-compatible applications written in various programming languages. They also learn how to use them.

The course is taught for the following faculties and specialties: Department of Geography, Ecology and Environmental Protection, Faculty of Natural Sciences and Mathematics, Master's Program in Geographic Information Systems

Organization and management of GIS projects

The course aims to introduce students to the processes of planning, implementation, testing, completion of GIS projects, interoperability of spatial data and opportunities for their exchange.

Course content:

1. The course is compulsory.
2. Theoretical foundations:
    - Importance of GIS and Geographic Information Science in the modern world
    - GIS project planning
    - The role of geographical data and information and the need for their management
    - Interoperability of spatial data
    - Main components of a GIS project
    - GIS project management and implementation.
3. The practical classes include developing a joint project of the students and developing skills for teamwork.

The course is taught for the following faculties and specialties: Department of Geography, Ecology and Environmental Protection, Faculty of Natural Sciences and Mathematics, Master's Program in Geographic Information Systems

Application of GIS in natural geography

The course aims to provide students with practical skills in the use of GIS methods and software capabilities. The course is cleared of unnecessary theoretical load.

Course content:

1. The course is elective.
2. The types of source information and the techniques for their introduction into GIS.

3. Methods and approaches in the construction of thematic layers in GIS on the basis of the entered source information.

The course is taught for the following faculties and specialties: Department of Geography, Ecology and Environmental Protection, Faculty of Natural Sciences and Mathematics, Master's Program in Geographic Information Systems

Application of GIS in socio-economic geography

The course aims to upgrade the knowledge and skills of the bachelor's degree in GIS and socio-economic geography and provides specialization of future masters in regional geographical research of socio-economic processes and systems in order to better manage the territory. The obtained theoretical knowledge and practical skills in the field of GIS and remote sensing will help future professionals to solve professional problems in the field of socio-economic research.

Course content:

1. The course is elective.
2. The first is dedicated to the social field, with two main emphases:
   - demographic resources as its active country
   - social infrastructure and services.
3. The second section focus on the problems of economic processes and subjects, their territorial localization, the establishment of interactions between:
   - economic structures
   - the structuring of their territorial organization
   - forms at local, regional and national level.

The course is taught for the following faculties and specialties: Department of Geography, Ecology and Environmental Protection, Faculty of Natural Sciences and Mathematics, Master's Program in Geographic Information Systems

Application of GIS in ecology and environmental protection

The course aims to show the growing role of GIS in the field of planning, management and environmental protection. The lecture course develops the knowledge from the basic GIS course in fundamental theoretical areas of the bachelor's degree. All knowledge is directly focused on the systems for mapping, management, analysis and decision support in the management of territories that have local, regional or global distribution.

Course content:

1. The course is elective.
2. Theoretical bases: fundamental topics for construction and implementation of GIS related to the environment, various applications of remote sensing methods for mapping, monitoring and research of the environment in a GIS environment (Modeling of: ecosystems, biosphere dynamics, wildlife, biodiversity, etc.)
3. Seminar lectures with the participation of students: Students are placed in a real situation, presenting their vision for creating a future GIS project in the management of a predetermined area and its integration in the field.

The course is taught for the following faculties and specialties:

Department of Geography, Ecology and Environmental Protection, Faculty of Natural Sciences and Mathematics, Master's Program in Geographic Information Systems

Application of GIS in spatial planning

The course aims to consolidate the obtained knowledge and expand experimental knowledge and skills to work in the field of science. The lecture course "Application of GIS in spatial planning" is to provide scientific training in analyzing, organizing the planning of the entire activity of the suburban area or a settlement of different categories, their management and solving urbanization. and other territorial problems.

Course content:

1. The course is elective.
2. The first module is dedicated to the subject, tasks and main goals are set for the territorial and settlement development.
3. The second module provides the masters with the structure of the out-of-town territory - urbanized, agricultural, forest, disturbed territories and territories occupied by the technical infrastructure, etc. and their presentation, analysis, planning and management through GIS.
4. The third module combines topics in order to explain the localization of the structure of living, landscaping, cultural and historical heritage, sports and recreation, social services, technical infrastructure and their presentation, analysis, planning and management through GIS.

The course is taught for the following faculties and specialties :

Department of Geography, Ecology and Environmental Protection, Faculty of Natural Sciences and Mathematics, Master's Program in Geographic Information Systems

GIS land cover modeling and conservation

The course aims to provide knowledge and skills for entering processing and analytical data on land cover and land use in GIS. The course has a strong practical focus on the interpretation of available data on the needs of agriculture, forestry, environmental protection, landscape planning, management of protected areas.

Course content:

1. The course is elective.
2. The widespread use of remote sensing methods (satellite and aerial photography and multispectral imaging) makes it possible to collect reliable information on the Earth surface. Based on the spectral features of different territories, their classification is performed for different research and practical purposes. Through the lecture course students get to be introduced to the goals, methods and tasks of land cover modeling and land use.
3. Different classification schemes.
4. Emphasis is elaborated in detail on the work with the CORINE nomenclature as the main tool for environmental monitoring in Europe.

The course is taught for the following faculties and specialties: Department of Geography, Ecology and Environmental Protection, Faculty of Natural Sciences and Mathematics, Master's Program in Geographic Information Systems

Medico-geographic mapping ; Introduction to GN SS (Global Navigation Satellite System) and navigation mapping

The course aims to expand the theoretical knowledge of students in the field of Global Navigation Satellite Systems, especially working with GPS receivers, preparation and execution of measurements, and processing of results.

Course content:

1. The course is elective.
2. Introduction to space geodesy: definitions and basic principles. Coordinate systems - definitions and transformations; Global navigation systems. GNSS - Movement of satellites. Ephemeris.
3. Global Positioning System - system overview and basic positioning principle. GPS configuration -Space part; Control part; Custom part. Types of measured quantities. Measurement processing. Absolute and relative location determination. Sources of errors.
4. Other global systems GLONASS, GALILLEO, EGNOS, WAAS, LORAN
5. Navigational mapping - "Navigational mapping" aims to provide in-depth knowledge and skills in the use of navigation technologies in geoinformation and cartographic aspects.

The course is taught for the following faculties and specialties: Department of Geography, Ecology and Environmental Protection, Faculty of Natural Sciences and Mathematics, Master's Program in Geographic Information Systems

GIS of soil resources: The course is elective.

The course is taught for the following faculties and specialties: Department of Geography, Ecology and Environmental Protection, Faculty of Natural Sciences and Mathematics, Master's Program in Geographic Information Systems

Information Technology and Ecology

Department of Geography, Ecology and Environmental Protection - Faculty of Science

The master's program provides the opportunity to upgrade already obtained fundamental knowledge and to build skills for the application of information technology in ecology and environmental protection, to provide knowledge and skills in the field of modern ecology, ecological modeling and programming of natural and anthropogenic processes. and forecasting the dynamics and risk for natural components and human society, as well as for the development and implementation of relevant projects funded by various EU programs**.**

The curriculum allows, depending on the combination of elective courses and the development of the thesis on a specific topic in the second semester, to achieve additional, more specialized specialization, ensuring the successful adaptation of future masters to the conditions of the dynamic labor market in Bulgaria.

Important conditions for achieving the goals of the master's program are the rich pedagogical, research and practical experience of the teachers providing the training. The availability of lecture and computer rooms, modern licensed, specialized and educational software and a library fund guarantee a high level of training in the program. Different cognitive methods will be used in the training - talk and discussion, task development and multimedia presentation, e-learning methods and more.

Graduates of the master's program can be integrated as experts and employees in various fields of applied ecology - science, legislation and executive activity; in institutes, universities, administrations, agencies, non-governmental organizations, etc.

Computer Cartography and Geographic Information Systems - Cartography and GIS

The course aims to introduce students to the basic principles of creating and using cards. It is intended for those who have not studied the main disciplines "Cartography and Geographic Information Systems" in a bachelor's degree.

The topics are grouped in modules concerning fundamental theoretical directions, which aim to provide specific knowledge about : the main aspects of GIS - hardware, user software, types and structures of data; database and modern methods for data storage and management; spatial and network analyzes.

A computer with a video projector, educational videos, specialized GIS software (ArcGIS), visual materials (boards, diagrams and maps) are used to illustrate the lecture material, some of which are developed as course and diploma works of students. A computer multimedia laboratory is used for the practical exercises.

Course content:

1. The course is compulsory.
2. Work in a digital environment with specialized software for mapping and using maps
3. The first part is entirely dedicated to cartography and aims to introduce students to basic theoretical issues, reference local and global systems, coordinate systems, map projections, cartographic signs and methods for mapping geographical objects and phenomena.
4. Topics on the nature of topographic and thematic maps and their creation in a digital environment.
5. General concepts for building and integrating GIS.

The course is taught for the following faculties and specialties: Department of Geography, Ecology and Environmental Protection, Faculty of Natural Sciences and Mathematics, Master's program "Information Technologies in Ecology".

University of Shoumen

Faculty of Technical Sciences

In 2004, the Academic Council of the University of Shumen "Bishop Konstantin Preslavski" decided to open a Faculty of Technical Sciences (FTN). After positive evaluations of the accreditation procedures, the Faculty of Technical Sciences was established by Decree № 37 / 27.02.2006. of the Council of Ministers of the Republic of Bulgaria.

The main goal of the Faculty of Technical Sciences is to prepare highly qualified specialists in the field of technical sciences for the needs of the region and the country, able to be successfully integrated into the labor market in the conditions of strong competition at home and abroad. This goal will be realized by performing the following tasks:

- to create and disseminate academic knowledge in the fields of technical sciences
- to prepare engineers with bachelor's and master's degrees in the professional fields of National Security, Communication and Computer Engineering, Architecture, Civil Engineering and Geodesy and General Engineering
- to conduct fundamental and applied research in these professional fields;
- to prepare PhD student in the scientific majors "Automated systems for information processing and management", "Corporate security", "Administrative security", "Organizational security", "Radar and radio navigation", "Communication networks and systems", "Application of the principles and methods of cybernetics in different fields of science "," General, higher and applied geodesy "," Cartography "," Photogrammetry and remote sensing methods "," Land management ";

All professional fields have successfully passed the program accreditation and have received a very good grade for a period of six years from NEAA. Four departments have been

established in the structure of the Faculty: "Security Systems Management", "Communication and Computer Engineering", "Geodesy", "Engineering Logistics". There are 40 lecturers working on a basic employment contract at the Faculty, of which 11 are professors, 15 associate professors, 6 chief assistants and 10 assistants.
The training of students and doctoral students is conducted in sixteen specialized laboratories, equipped with modern computer, measuring equipment and application software. The academics conduct effective research through participation in national and international scientific forums and the participation of intra-university and national projects. Partners of the Faculty are many scientific organizations and companies from the country and abroad.
Every year the faculty and students actively participate in the International Mobility Program "ERASMUS +". A student branch of the International Organization of Electrical and Radio Engineering Engineers (IEEE) has been established and operates at the Faculty.

Department of Geodesy
Bachelor's degrees:

1. Communication and information systems
2. Radio communication equipment and technologies
3. Geodesy
4. Security system

Master's programs (after Bachelor):
Communication and information systems - master's program Communication and information systems
Geodesy - Master's program in Geomatics
Master's programs (after Professional Bachelor):
Communication and information systems - master's degree Communication and information systems

Agricultural University Plovdiv

The Faculty of Plant Protection and Agroecology was established in 1983 and is the first in the of the Agrarian University to receive accreditation in 1998.
Faculty of Plant Protection and Agroecology - Provide two majors:
"Plant protection" - accurate and part-time training (in Bulgarian and English),
"Ecology and use of the Sabbath" - accurate and part-time training.
Master degree "INFORMATION SYSTEMS AND TECHNOLOGIES IN PLANT PROTECTION"
The master's degree combines knowledge and skills in plant protection, informatics and computer science. The interdisciplinary nature of the master's degree aims to educate young people who will be able to study natural processes and phenomena related to crop protection, to apply modern information methods, models and software for processing and analyzing data about them, to have systematic thinking and knowledge in solving complex issues related to technological and production problems, as well as human health and environmental protection.
The disciplines in the field of Information Systems and Technologies are aimed at acquiring knowledge and skills for management, organization, access, data extraction and analysis.
Graduate students have real opportunities in:

- IT sector, with an emphasis on applications in plant protection;
- Business and consulting companies;

- Universities, research institutes and research laboratories;
- Public administration and local government;
- International organizations and institutions.

School disciplines :

Management and business information systems

The course aims to introduce students to the types, features and main hardware and software components of modern information systems.

Course content:

1. Transaction processing systems
2. Expert systems
3. Decision support systems
4. The functional capabilities of the Business Information Systems are considered

The course is taught for the following faculties and majors

Faculty of Plant Protection and Agroecology, Department of Agroecology and Environmental Protection, Master's Program "Information Systems And Technologies In Plant Protection"

Higher School of Agribusiness and Regional Development

Master's program "Management of Municipalities"- Major "Regional Planning and Development"

Disciplines

GIS and landscape maps in the regional government

The course is taught for the following faculties and specialties:

Major "Municipal Management" with specialization "Regional Planning and Development"

Major "Municipal Management" with specialization "Regional Planning and Development"

Academy of Economics ´Dimitar A. Tsenov´

Business information systems and technologies

The major aims to provide scientific and technical knowledge, practical skills and habits in the field of operating systems, databases and computer networks. The focus is on business information systems and their design, participation in the management of information resources in order to use them more efficiently, Internet technologies and software engineering.

No health-oriented Universities were found to teach GIS courses in Bulgaria