BESTSDI CURRICULUM IMPLEMENTATION AT THE FACULTY OF CIVIL ENGINEERING IN SUBOTICA

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Summary: *This paper explains the reasons for the introduction of content related to spatial data infrastructure in studies of civil engineering and presents study levels, programs, modules and courses at the Faculty of Civil Engineering in Subotica which will be enriched with this content. The themes related to the theoretical and practical parts of the basic SDI course at civil engineering studies are highlighted, ensuring that the concept and components of spatial data, access to data, standards and directives of the European Union, as well as the possibilities of using, developing and maintaining of geospatial data in the field of civil engineering science and practice, are adequately presented to students.*

Keywords: *Spatial data infrastructure, Faculty of Civil Engineering, curriculum*

1. INTRODUCTION

The European Union finances projects, partnerships, events, as well as the learning mobility in the fields of education and training. The project "BESTSDI - Western Balkans Academic Education Evolution and Professional's Sustainable Training for Spatial Data Infrastructures", funded by the EU under the Erasmus+ program, is targeting the development, testing and implementation of the new higher educational curricula within the field of Spatial Data Infrastructure (SDI).
The Faculty of Civil Engineering in Subotica (FCE Su), as one of the partner institutions of the BESTSDI project, has conducted a survey of studies and analyzed the existing course curricula and the teaching materials, as well as the requirements of the economy and society, i.e. the labour market and stakeholders, and has selected the courses in which, the part of the BESTSDI curriculum, is going to be implemented. The implementation of the knowledge acquired within the BESTSDI project has been agreed in cooperation with the professors in charge for selected courses.

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This paper gives a basic information about the courses at the FCE Su selected to be enriched with SDI content. A theoretical and practical aspects of SDI concepts and components are briefly analyzed, and the importance of raising the knowledge of students in this area is emphasized.

2. STUDY PROGRAMMES AT THE FACULTY OF CIVIL ENGINEERING IN SUBOTICA

The Faculty of Civil Engineering in Subotica was founded on April 22, 1974 as part of the University of Novi Sad. During its existence the Faculty, through the improvement of curricula, the introduction of new study programmes/modules, as well as new levels of studies and a constant increase in the number and the quality of its teaching staff, tended to adapt both to contemporary trends in education, and to the market requirements. The first study programme offered studies at high level, i.e. lasting nine semesters, for majoring in Structural Engineering, and the first students obtained the title of "graduated civil engineer" in 1979. In the academic 1979/80, the second study program introduced the possibility of acquiring the title of "civil engineer" (higher level of education) after completing the first three years of common fundamentals. Those who wanted to gain a high level of education and the title of "graduated civil engineer", for the next two semesters attended classes for one of three offered majors: Structural Engineering (SE), Hydrotechnical Engineering (HE), or Transportation Infrastructure (TI), while the ninth semester was devoted to completing a graduation thesis. In the academic 1981/82, a third study program was introduced, in which the common fundamentals lasts for four semesters, after which the students could opt for the fifth "exit" semester to major in SE or HE, thus gaining a higher level of education. A high level of education required a continuation of studies, with a total of nine semesters, for majoring in SE or HE, with two sub majors: Irrigation and Drainage and Sanitary Hydrotechnics. Beginning with the 1988/89 academic year, through a fourth study program the duration of studies at high level was extended by one semester, and a TI major was reintroduced. The fifth study program, from 1992/93, abolishes studies at higher level and introduces the Urban-Communal Planning (UCP) major. In 1995, the Faculty organized postgraduate (in Serbian "magistarske") studies for majoring in SE or HE, lasting two years. The sixth study program was introduced in the academic 2002/03, bringing back the possibility of acquiring the title of "civil engineer" after completing three years of common fundamentals, at the student's own request. Studies at high level lasted for ten semesters, and after the common first three years, a choice could be made between four majors: SE, HE, UCP and TI.

Supporting the reform of higher education in Serbia in line with the Bologna Declaration, the main objective of which is to improve the employability and mobility of European citizens and increase the international competitiveness of European higher education [1, 2], in the academic 2006/07, the Faculty organized two levels of study - basic (undergraduate) and graduate (master, and from 2007/08, doctoral as well). The first study program started in the 2006/07 academic year and included undergraduate - Basic Vocational Studies in Civil Engineering in duration of 3 years and Basic (Bachelor) Studies in duration of 4 years, and Graduate (Master) Academic Studies for majoring in SE, Hydrotechnical and Environmental Engineering (HEE), TI and UCP.

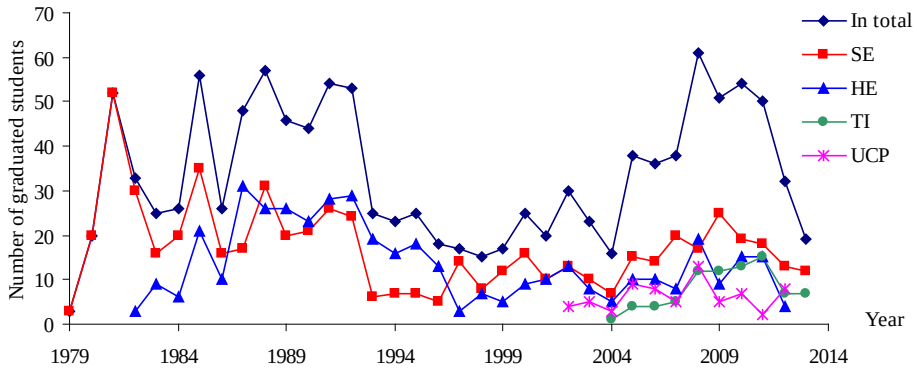


Figure 1. Number of students by years and majors who have completed a high level of education at FCE Su until the beginning of studies harmonized with the Bologna Declaration

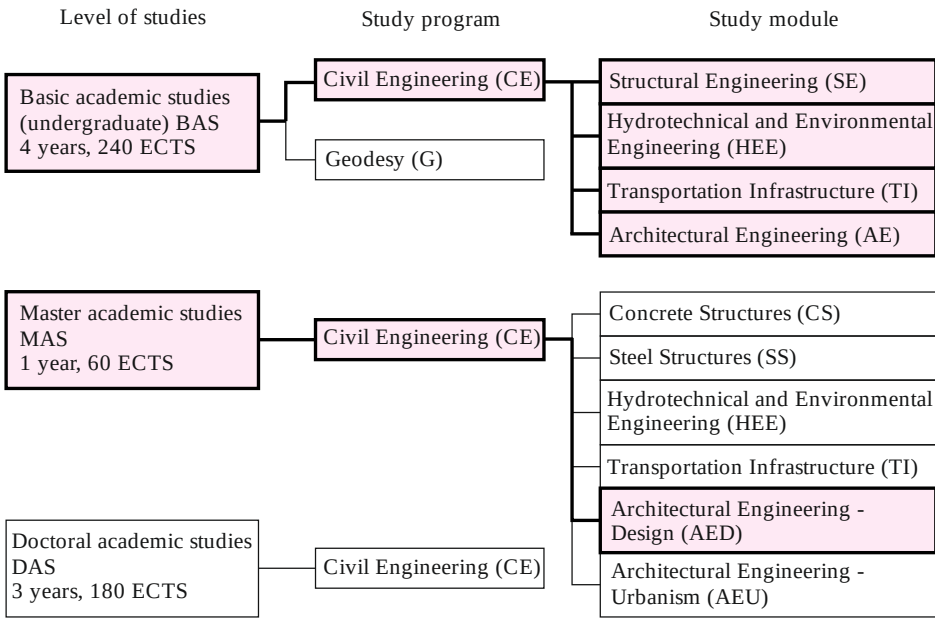


Figure 2. The current organization of studies on the FCE Su with marked locations for the implementation of the SDI curriculum within the BESTSDI project

Faculty of Civil Engineering in Subotica was one of the first 13 accredited faculties in Serbia. The first accredited study program, beginning with the academic 2008/09, allows students to enroll in Specialized Undergraduate Studies in duration of 3 years, Basic

(Bachelor) Academic Studies BAS (4 years), Graduate (Master) Academic Studies MAS (1 year) and Doctoral Academic Studies (3 years). At all levels of study, students can opt for majoring in Structures and Materials (SM) or HEE, with the following SM modules on MAS studies: Concrete Structures (CS), Steel Structures (SS), Transportation Infrastructure (TI) and Residential Design (RD). From the academic 2012/13 to date, studies at the Faculty are organized according to the second accredited study program, whose structure is shown in Figure 2. In the academic 2017/18, the Faculty has accredited the study program Geodesy (GEO) at the Basic Academic Studies level.

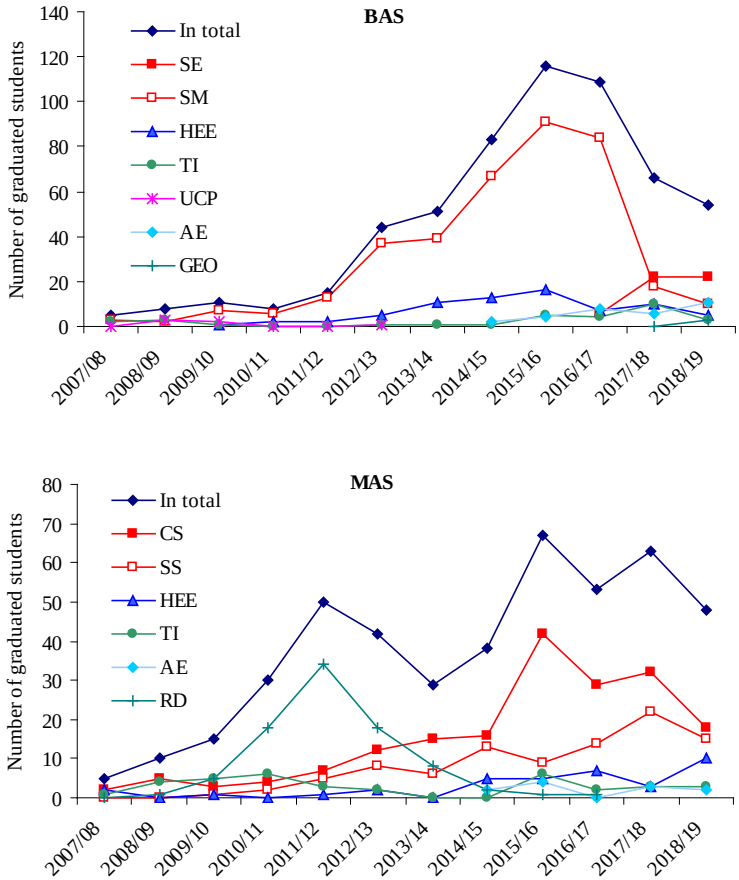


Figure 3. Number of students who graduated from FCE Su under BAS and MAS study programs until February 14, 2019

3. INTRODUCTION OF SDI INTO THE CURRICULUM

New rapid developments in the areas of digital technology and technologies related to observation of the earth from space affected the fields of collection, organization, access and dissemination of spatial information, too, resulting in the establishment of Spatial Data Infrastructure (SDI), i.e. technologies, polices, standards and human resources for collection, processing, storing, sharing and improving the use of spatial data. At the same time, this imposed a need for adapting the education and training system in order to provide the knowledge and skills required for experts in this field, as well as for users of the geographic information system (GIS) and SDI, including the experts in the field of civil engineering.

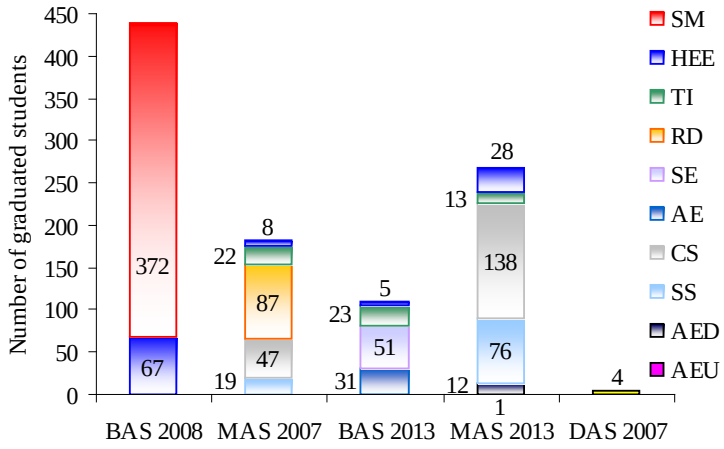


Figure 4. Number of students who graduated from FCE Su under accredited study programs after the academic year 2006/07, until February 25, 2019

With the objective of improving the quality of higher education in the fields of Geographical Science and Technology, SDI and Geodesy, as well as of improving the level of competencies and skills in higher education institutions by developing new education programs within these fields [3, 4], the BESTSDI project was accepted for funding by the European Commission, under the Erasmus+ program for Capacity Building in the field of higher education, and started in October 2016. The objectives of the BESTSDI project are to be achieved through development, testing and adaptation of new curriculum, courses, learning material and tools within the field of SDI [5].

In the first phase of this project, which brings together 16 academic partners from the Western Balkans countries (Albania, Bosnia and Herzegovina, Kosovo, Montenegro and Serbia) and program countries - Belgium, Croatia, Germany, Macedonia and Sweden, an analysis of the existing curricula and teaching materials has been conducted at partner institutions. At the same time, stakeholder surveys were carried out to analyze their needs. Based on the results of these analyses the design of the project curriculum was conducted. As a user of SDI, during this first stage of BESTSDI project, FCE Su decided to implement the BESTSDI SDI curriculum content through the enrichment of nine existing obligatory courses - eight on the undergraduate (at least one from each study

module) and one on the master level of study (Figure 2 and Table 1). The initial SDI learning building blocks [6, 7] whose parts are included in FCE Su curriculum are marked red in Figure 5.

Since the extent of changes of the existing courses did not exceed 30%, new accreditation was not needed, and thus the formal procedure to introduce SDI content at FCE Su consists of only two simple steps: the Teaching Scientific Council of the Faculty had to approve changes to the existing courses and then the Faculty had to inform the Commission for Accreditation and Quality Assurance about the approved changes. The preparation of content is performed by teachers and associates who prepare the teaching material using and adjusting the material provided through BESTSDI and/or LINKVIT. Through the BESTSDI project FCE Su has equipped one classroom with 16 new networked PCs. With an already established fast internet connection it is completely technically prepared for the implementation of the SDI curriculum content.

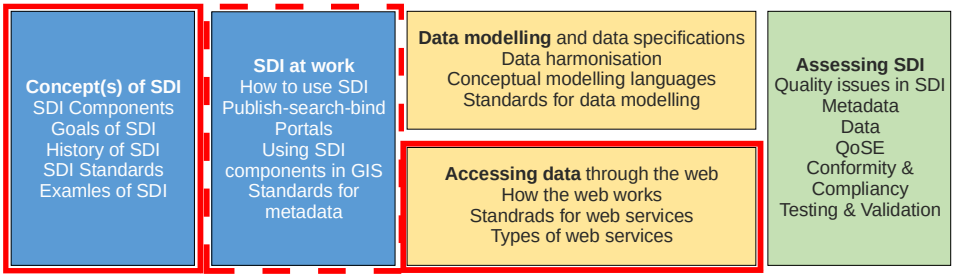


Figure 5. Initial SDI learning blocks. Marked are blocks whose parts are included in the FCE Su curriculum through the BESTSDI project

Table 1. Courses selected to be enriched with SDI curriculum content

Course	*Study level*	*Modules*	*Semester*
Geology and Petrology	*Undergraduate*	*SE, HEE, TI, AE*	*II*
Engineering Geology		*TI*	*VI*
Irrigation and Drainage		*HEE*	*VI*
Basics of Urban Planning		*SE, TI, AE*	*VI*
Building Heritage Protection and Revitalization		*AE*	*VIII*
Basics of Building Design		*AE*	*III*
Design of Multi-family Buildings		*AE*	*V*
Traffic Infrastructure and Space		*TI*	*VI*
Complex Synthesis Project	*Master*	*AED*	*I*

4. STRUCTURE AND CONTENT OF THE BASIC COURSE IN SDI IN THE FIELD OF CIVIL ENGINEERING

In order to fulfil requirements as per course curriculum, basic course in SDI is divided into two parts: theoretical part and practical exercises. The student should understand the concepts and components of SDI, list of SDI standards, services and best practices, the elements of the INSPIRE Directive on Data and Service Sharing, as some of the main course objectives. SDI represents a basis for spatial data discovery, evaluation, and application for users and providers within all levels of stakeholders, such as: government and public administration, the commercial sector, the non-profit sector, education and by citizens in general. It is recognized as a collection of technologies, policies and institutional arrangements that make easy access to spatial data. The technology includes: hardware, software, networks, databases and technical implementation plans. The policies and institutional arrangements are related to governance, data privacy & security, data sharing, and cost recovery.

In the theoretical part of the course, it is important to answer the fallowing questions: Why learn SDI?; Who builds standards?; How to access the data list of SDI services in Europe and Serbia?.

Why learn SDI? Knowledge in the field of SDI enables easy search of existing geospatial data and services, reduce time of data production and maintain data integrity and security. Each User of SDI can create and post metadata records efficiently, which leads to necessity of inventorying, locating, and assessing the quality of geospatial data.

Who builds standards? Standardization of data access implies several things: definition of model used for the data to be exchanged, adoption of an exchange format, agreement on data access protocols, etc. The standardization process usually has three levels in EU Member State. The standards are established at international level, then adopted at European level and finally implemented at national level. Main standardization bodies which provide geospatial standards are:

- International Organization for Standardization (ISO) series has been elaborated by ISO Technical Committee (TC) 211 in series 19100 – 19140. These standards are used for: geographic information, methods, tools and services for data management, acquiring, processing, analyzing, accessing, presenting and transferring between different users, systems and locations.
- Open Geospatial Consortium (OGC) which provide Geographic information/Geomatics standards. OGC is consortium of over 500 companies, government agencies and universities with primary goal to provide a framework for the development of OpenGIS standards.
- The Federal Geographic Data Committee (FGDC), known as standard's working group that develops or adopts geospatial standards for implementing the NSDI.
- World Wide Web Consortium (W3C), whose primary activity is to develop protocols and guidelines for the Web. W3C's standards define key parts of what makes the World Wide Web work.
- Organization for the Advancement of Structured Information Standards (OASIS) promotes production of worldwide standards for security, cloud computing, energy, content technologies, emergency management, and other areas.

How to access the data list of SDI services in Europe and Serbia? Open (government) data refers to the information collected, produced or paid by the public bodies (also

referred to as Public Sector Information) and made freely available for all users and for all type of purposes needed.

Web portal: "European Data Portal" (see: https://www.europeandataportal.eu/), provides European data for categories such as: agriculture, fisheries, forestry and food, transport, environment, Regions and cities, etc. National Web portal named (in Serbian): "Portal otvorenih podataka" (https://data.gov.rs/sr/) is a Serbian version of open data and above mentioned categories of data. Serbian NSDI geoportal "GeoSrbija" (see: www.geosrbija.rs Figure 6) is the national geoportal launched at the end of 2009. This geoportal provided online public access for discovery and view services for metadata, spatial datasets and services from the jurisdiction of the Republic Geodetic Authority and other public authorities.

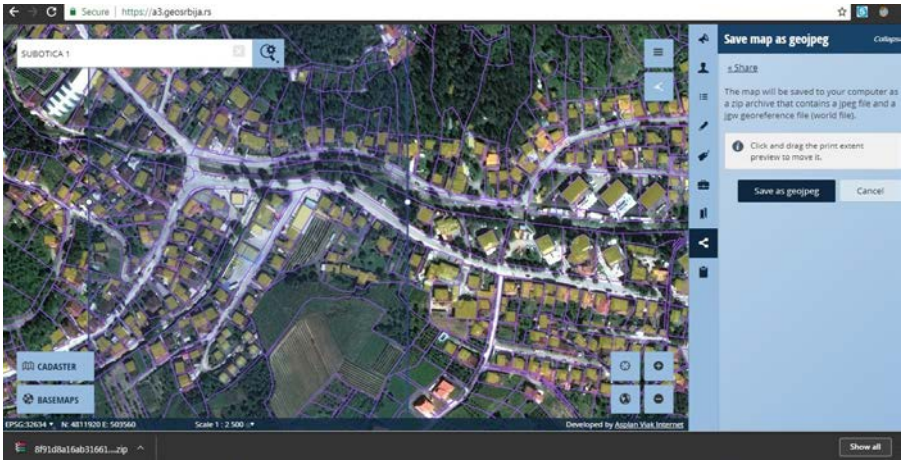
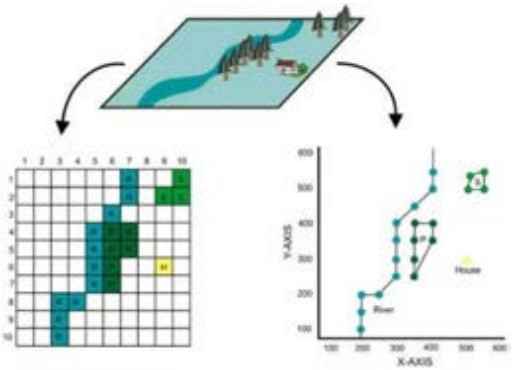


Figure 6. Serbian NSDI geoportal "GeoSrbija"

Purpose of the practical exercises within the basic SDI course is to upgrade theoretical knowledge of students and to learn them how to become a practical users of an SDI software. First of all, in the practical part of the course, students will be able to get information about software used for data processing. Available software are: Educational Version of commercial software, so as the Free and Open Source Software. For the fulfilment of the basic SDI course objective, professors who are in charge of these courses decided to use the QGIS software (https://qgis.org/en/site/).



Raster data *are stored as a grid of values. There are many satellites and the photographs they take are a kind of raster data that can be viewed in a GIS*	**Vector data** *is stored as a series of X, Y, coordinate pairs inside the computer's memory. Vector data is used to represent points, lines and areas.*

Figure 7. Difference between raster and vector data

QGIS is professional GIS (Geographic Information System) application, free and open source with advanced capabilities. It runs on Linux, Unix, Mac OSX, Windows and Android and supports numerous vector, raster, and database formats and functionalities. Students will learn how to download and install QGIS software, get familiar with it's Tutorials and Tips, make and learn a difference between raster and vector data (Figure 7), and finally to learn how to search, find and import GIS data into the software, i.e. use free Web Coverage Service (WCS) weather in raster of vector data format. Further on, students will make distinction among Web Coverage Service (WCS), Web Feature Service (WFS) and Web Map Service (WMS).

5. CONCLUSION

The Faculty of Civil Engineering in Subotica has a 45-year-long teaching tradition in the fields of structural engineering, hydrotechnical and environmental engineering, transportation infrastructure, urban-municipal planning, residential design and architectural engineering.

Latest developments in the areas of digital and the earth observing technologies imposed a need for adapting the educational system, including the studies of civil engineering, in order to provide the required up-to-date knowledge and skills. The BESTSDI project started in 2016, funded by the European Commission, under the Erasmus+ program. Its main objectives are to improve the quality of higher education in the fields of Geographical Science and Technology, SDI and Geodesy, as well as the level of competencies and skills in higher education institutions through the development, testing and adaptation of new curricula, courses, learning material and tools within the field of SDI. As a partner institution and a user of SDI, FCE Su decided to implement the SDI curriculum content through the enrichment of nine existing obligatory courses - eight on the undergraduate and one on the master level of study, using teaching material

developed through the BESTSDI project. These enrichments consists of a theoretical part and practical exercises. In the theoretical part the necessity of learning SDI will be explained, as well as who builds the standards and how to access the data list of SDI services in Europe and Serbia. In the practical part the students will be given information about the software used for data processing and will learn how to download, install and use QGIS software.

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ИМПЛЕМЕНТАЦИЈА BESTSDI КУРИКУЛУМА НА ГРАЂЕВИНСКОМ ФАКУЛТЕТУ У СУБОТИЦИ

Резиме: *У раду су објашњени разлози за увођење инфраструктуре просторних података као теме на студијама грађевинарства и приказани нивои студија, студијски програми, модули и предмети на Грађевинском факултету у Суботици који се обогаћују овим садржајем. Истакнуте су теме везане за теоријски и практични део курикулума, водећи рачуна да се на адекватан начин студентима представе концепт и компоненте просторних података, приступ подацима, стандарди и директиве европске уније као и могућности употребе, развоја и одржавања геопросторних података у области грађевинске науке и праксе.*

Кључне речи: *Инфраструктура просторних података, грађевински факултет, наставни програми*