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**BESTSDI**

BESTSDI – Western Balkans Academic Education  
Evolution and Professional's Sustainable Training for  
Spatial Data Infrastructures

*With the support of the Erasmus+ program:  
Higher Education – International Capacity Building  
N° 574150-EPP-1-2016-1-HR-EPPKA2-CBHE-JP*

# **BESTSDI** Report on Spatial Data Infrastructure (SDI) in Bosnia and Herzegovina for the year of 2018

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Project Description

## **Short Description:**

Annual BESTSDI IPP Report serves to strengthen ties with SDI stakeholder in partner countries, raise visibility of the project, provide information to Project Advisory Committee (PAC)

## **Keywords:**

National Report, SDI, annual, stakeholders, PAC

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## 1. Introduction

The application of the project "Western Balkans Academic Education Evolution and Professional's Sustainable Training for Spatial Data Infrastructures" - BESTSDI is accepted for funding within the invitation for the ERASMUS + KA2 Capacity Building and Higher Education Program in 2016. The project is worth 978,166.66 € and is one of the 147 selected among 736 applications submitted.

The project coordinator is the Faculty of Geodesy, University of Zagreb, and the project partners are:

- Catholic University Leuven (B),
- University in Split (CR),
- Ss. Cyril and Methodious University of Skopje (MK),
- Bochum University of Applied Sciences (D),
- Polytechnic University of Tirana (AL),
- Agricultural University of Tirana (AL),
- University in Banja Luka (BiH),
- University in Mostar (BiH),
- University in Sarajevo (BiH),
- University in Tuzla (BiH),
- University for Business and Technology Prishtina (Kosovo\*),
- University in Montenegro (MN),
- University in Belgrade (RS),
- University in Novi Sad (RS) i
- University of Prizren „Ukshin Hoti“(Kosovo\*).

The associated project partners are:

- Federal Administration for Geodetic and Property Affairs of FBiH (BiH),
- Republic of Srpska Republic Administration for Geodetic and Property Affairs (BiH)
- Republic of North Macedonia Agency for Real Estate Cadastre (MK)

The goal of the BESTSDI project is to improve curricula at the partner universities through the introduction of the concepts of spatial data infrastructure (SDI) and e-government, as well as the expansion of the concepts of “smart” cities, “smart” ecosystem management, digital markets and all other areas of human activity based on the SDI.

The courses included in the project will relate to two types of students: students with the specialization in managing basic geospatial data (geodesy, geoinformatics, etc.) and students at other faculties using the SDI concepts, such as: spatial and urban planners, environmental engineers, forestry engineers, geographers, engineers of mining and geology, civil engineers, architectural engineers, agricultural engineers, etc. The duration of the project is 3 years starting from October 15, 2016.

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\* This designation is without prejudice to position or status, and is in line with UNSC 1244 and the ICJ Opinion on the Kosovo declaration of independence.



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The annual reports on the spatial data infrastructure within the BESTSDI project provide the information on the activities carried out through the coordination tasks within the T5.3 work package.

This report includes a description of the current state of the Spatial Data Infrastructure (SDI) in Bosnia and Herzegovina (The Republic of Srpska, The Federation of Bosnia and Herzegovina and Brčko District), the representation of the SDI concepts in higher education in BiH (The Republic of Srpska, The Federation of Bosnia and Herzegovina and Brčko District) and the project requirement analysis of BESTSDI. Through the status of Geospatial Data Infrastructure, the following are considered: legislation, organizational aspect (bodies and responsible institutions), technical organizations (web, geoportal, prospectuses) on spatial data infrastructure in the Republic of Srpska, the Federation of Bosnia and Herzegovina and Brčko District, key institutions and administrative bodies, business sector, educational institutions, and end-users - local governments and self-governments, public companies, citizens, etc. The role of the University in SDI is described in relation to its development from the academic aspect and in terms of the presence of SDI in study programs. Below is the information regarding curriculum development through the support of the BESTSDI project at the universities participating in this project, as well as the analysis of the current state and scope of the SDI involvement in curricula and life-long learning programs. At the end of this report, the analysis of BESTSDI project requirements is given, as well as an Overview of the Report on Spatial Data Infrastructure (SDI) in Bosnia and Herzegovina for 2017, the recommendations of individuals and institutions participating in the SDI in the Republic of Srpska and the Federation of Bosnia and Herzegovina based on the reviewed Report and conclusions.



## 2. Condition of Geospatial Data Infrastructure in Bosnia and Herzegovina

In the Republic of Srpska (RS) and the Federation of Bosnia and Herzegovina (FBiH) there are laws and other legal acts which regulate the use of spatial data and the issue of development and strengthening of the spatial data infrastructure in both entities. In the Republic of Srpska (RS) and the Federation of Bosnia and Herzegovina (FBiH) there are laws and other legal acts which regulate the use of spatial data and the issue of development and strengthening of the spatial data infrastructure in both entities. The main document for the SDI development in both entities is the INSPIRE Directive, along whose definitions and recommendations other documents and the European Union acts are used, as well as state-level laws (connected to authorship and access to information), and laws in force in FBiH and RS, which define the way of collecting, storing, processing and presenting spatial data (general regulations, regulations in the field of geodesy and real estate cadastre with accompanying regulations, SDI regulations, regulations in the area of spatial planning, regulations governing access to public sector information in FBiH and RS, environmental regulations, water regulations, regulations on agricultural land, regulations on forests, regulations on statistics, regulations and acts related to sharing and exchanging data at entity and cantonal levels and many others). In the Brčko District, there are currently no acts which regulate the SDI issue in detail.

In the Republic of Srpska, the SDI is defined within the Law on Survey and Cadastre of the Republic of Srpska ("The Official Gazette of the Republic of Srpska", No. 6/12). The act that will further define this issue is the Geospatial Data Infrastructure Strategy of the Republic of Srpska, which is in the process of adoption by the Government of the Republic of Srpska. In the Federation of Bosnia and Herzegovina, the issue of the spatial data infrastructure is regulated by the Decree on the Spatial Data Infrastructure of the Federation of Bosnia and Herzegovina ("The Official Gazette of the Federation of Bosnia and Herzegovina No. 85/14) and the Spatial Data Infrastructure Strategy of the Federation of Bosnia and Herzegovina.

Based on the First National Report for Bosnia and Herzegovina within the BESTSDI project, the responses of the participants in the development of the geospatial data infrastructure in the Republic of Srpska (response of the Republic of Srpska Republic Administration for Geodetic and Property Affairs) and in the Federation of Bosnia and Herzegovina (response of Federal Administration for Geodetic and Property Affairs and the Federal Ministry of Development, Entrepreneurship and Crafts) as well as discussion within a joint workshop between BESTSDI and IMPULS project held in April 2018, it is concluded that there are significant activities and legal acts that rely on the previously mentioned documents regulating the SDI issue. This creates the impression that there is a significant need for better communication, better cooperation between



the SDI Development Council and the SDI Council in order to implement SDI in RS and FBiH more efficiently.

The Republic Administration for Geodetic and Property Affairs of the Republic of Srpska and the Federal Geodetic Administration participate in the IMPULS project through which it is necessary to accelerate the development of innovative INSPIRE services and the establishment of interoperability of data and services. The special significance of the project is reflected in the professional and financial help to both geodetic administrations in the process of establishing and implementing the SDI:

Within the IMPULS project, the annual analyses and reports are given related to the current situation and improvement of the SDI issue in the Republic of Srpska and the Federation of Bosnia and Herzegovina, both in legal and in the technical - organizational sense. The aim of this project is to establish a modern and functional framework for sharing spatial data in accordance with regional and international standards. (<https://www.lantmateriet.se/sv/Om-Lantmateriet/Samverkan-med-andra/impuls/about-the-impuls-project/>). Within the mentioned IMPULS project reports, the following important facts can be concluded:

- In BiH, partially there are specific laws and legal acts that, as such, regulate SDI (in RS, the SDI issue is regulated by law through one Chapter, which is not a separate act, whereas in FBiH there is an SDI Regulation that carries the weight of the legal act until the law is passed and which can be considered as an independent act).
- There are strategic documents: FBiH has adopted the SDI Development Strategy and the SDI Council of FBiH has adopted a 3-year plan that relies on this strategy in the part of its short-, medium- and long-term goals; in RS, the draft of this strategy and the establishment of the SDI Development Council are in progress.
- There are appointed coordinators for establishing, implementing and maintaining the SDI at the level of both entities. Geodetic Administrations are a contact point for the SDI and stakeholders in both entities.
- Since there are no separate laws dealing with this area, legal mechanisms are not yet defined between the contact point, individual participants / stakeholders and all other entities involved in the development and use of SDI in RS, while in FBiH this issue is regulated through the SDI Regulation.
- In FBiH and RS, there are sets of data that are harmonized in accordance with the INSPIRE rules. In FBiH, seven sets of data have been harmonized: administrative units, elevation, geographical names, orthophoto shots (images), population density, hydrology and geology (the last three are not published in the metadata catalog). In RS, the realization of harmonizing 6 sets of data in accordance with the INSPIRE rules is in progress until June 30, 2019. These sets are: administrative units, geographical names, orthophoto, hydrography, roads and digital height model.



- FBiH has developed a metadata catalog. On the SDI Council's website for FBiH, there is a catalog developed in accordance with the INSPIRE Directive and the regional IMPULS project. The metadata catalog is not currently in use in RS.
- FBiH is currently developing an application that will allow SDI entities to register themselves in the Entity Register, as well as their data sets in the Spatial Data Source Register
- FBiH is currently developing the Metadata Editor application, which will allow SDI entities to write metadata about their data sets via the Internet. Metadata Editor complies with the INSPIRE specifications
- The technical guide for the Regional Metadata Profile has been published. Accordingly, the metadata for harmonized data sets (overview and download) are published at the region level through the IMPULS project.
- The Federal Administration for Geodetic and Property Affairs has harmonized seven data sets. A Schematron validator has been developed. Sharing data through WFS service as GML has been enabled. In the Republic Administration for Geodetic and Property Affairs of RS, the process of harmonizing 7 sets of data is in progress. As a platform, Erdas Apollo is used. The service is being developed as WMS and WFS for the given data sets.

## **2.1. Development of National Infrastructure of Geospatial Data in the Republic of Srpska and the Federation of Bosnia and Herzegovina**

For many years, the Republic of Srpska and the Federation of Bosnia and Herzegovina have been coordinating the development of entity spatial data infrastructures through their activities. Being a part of the European family, both SDI contact points took over the issue of establishing and implementing the SDI in accordance with the INSPIRE directive and its recommendations, based on which they will further develop and harmonize guidelines, technology solutions, define institutional agreements and provide the possibility of sharing information with the SDI entities and other countries that use this type of standardization. The development of the SDI certainly contributes to the development of the concept of e-government, which is supported through numerous projects. Sharing and applying spatial data can be beneficial to a large number of users, especially to administrative bodies at all government levels. Such structured data should be available to all participants in the SDI development: private commercial enterprises, universities and research centers for education and research, non-governmental sector for more active participation in democratic processes, and citizens who will benefit from a large number of services derived from well-planned spatial data infrastructure.

Both entities have formed key bodies for the establishment and implementation of the SDI: the SDI Development Council and the SDI Council (and their working groups). Through the activities of the key bodies, it has been found that many participants in the SDI development have data which are not structured and are developed by different standards. It has been established that spatial data services are not functional or connected. There is a small number of data sets that is actually developed in accordance with the INSPIRE directive recommendations. Additionally, there are a





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few data sets that sharing services are available for, as well as developed metadata catalogs. This leads us to conclusion that data exchange is at an insufficient level.

From March 14, 2007, the European Parliament and the Council 2007/2 / EC Directive on the Establishment of Spatial Information Infrastructure in the European Union (INSPIRE) provides detailed recommendations with which it is necessary to harmonize Laws and other legal acts relevant to the spatial data of all participants in the development of the SDI both in RS and FBiH. Within the SDI development, the academic community in the institutional sense is currently engaged to a lesser extent, which is related to the lack of curricula in this field. The BESTSDI project greatly contributes to raising awareness about the need for a different approach to the education of personnel that works with spatial data, as well as the need to educate experts who are not just geodetic / geoinformatics professionals who work with spatial data. It is precisely for this reason that the involvement and participation of all stakeholders (SDI entities) in the SDI development is important, from education institutions which profile this specific staff to the SDI participatory institutions that employ this kind of personnel.

## **2.2 Participants in the development of National Infrastructure of Geospatial Data**

The Republic Administration for Geodetic and Property Affairs of the Republic of Srpska and the Federal Geodetic Administration are the participants of the regional Impulse Project whose goal is to establish the SDI in all participating countries. A Memorandum of Cooperation was created which gives guidelines for the establishment of the SDI in the Western Balkan countries. The document titled "Recommendations for a Regional Metadata Profile" has been issued, which provides guidelines for creating metadata, validating and creating metadata service. In Lisbon, geodetic administrations, as the contact points of the SDIs of the Western Balkan countries, have committed to work together on the development of the SDI and signed an agreement on the policy of data sharing through the IMPULS project.

In both entities, entities involved in the development of the SDI have a legal obligation to establish and keep records of data that have an impact on space. Numerous analyses have determined the heterogeneity of these data, which are usually not structured. Gathering information, processing and making data available through various information systems is in accordance with the constitutional jurisdictions within the scope of all government levels. Cantons and local government units (municipalities / cities) are not usually able to independently establish spatial data infrastructure through independent projects. Here are a couple of rare examples of local communities and institutions participating in the SDI development that have established the SDI in accordance with the issued rules mostly through donor projects (Bijeljina City, The Federal Bureau of Statistics, the BH-Gas Company for Production and Transportation, The Sarajevo Canton Development Planning Institute, Hadžići Municipality, The Federal Ministry of Development, Entrepreneurship and Crafts, through the project of Creating an Information System with the web portal of business zones in FBiH, etc ).

Very rare are the projects that were systematically organized, such as the cadastral data record project, implemented by the entity administrations for geodetic and property affairs based on a unique methodology and technology. For collecting and maintaining spatial data sets at the entity



level, line ministries or institutions are responsible, which are, according to the INSPIRE directive annexes, the official institutions in charge of spatial data.

In a number of institutions, the projects have been initiated or are initiated for the establishment of spatial data base important for the scope of their responsibility, but few have developed the spatial data infrastructure that can be directly used for the SDI. Bijeljina City has an infrastructure developed in accordance with the INSPIRE rules and the corresponding legal acts of the Republic Administration for Geodetic and Property Affairs (GARS) compatible with the GARS decisions. According to the level of availability of spatial data and the capacity for servicing the users in accordance with the INSPIRE Directive, i.e. the readiness to implement the SDI, these institutions can be classified into 4 categories:

- Institutions that publish and maintain a spatial data web service
- Institutions that have the capacity to service spatial data
- Institutions that use web services for spatial data from other institutions
- Institutions that do not use web services.

Based on the general assessment, there is a very small number of institutions in BiH that could be classified in the first or second category based on the level of readiness for the SDI implementation. A slightly higher number of institutions is in the third category, whereas the dominant number of institutions is in the fourth category, which do not have enough capacity necessary for organizing and establishing the spatial data infrastructure.

The situation related to the capacity availability for the establishment of the SDI at lower levels of administration is also very heterogeneous. The institutions responsible for the collection and maintenance of spatial data sets at the level of local governments are mostly institutions for spatial planning, various directorates and public utilities for electric and water supply, telecommunications, road maintenance, and municipal services. There is a great contrast and dispersion in terms of capacity for the SDI development, so that some institutions in larger urban centers (Sarajevo, Banja Luka, Tuzla, Mostar) have functional spatial information systems with well-trained staff and a significant spatial data base, whereas for most institutions this is not the case.

### **2.3. The role of University in the development of National Geospatial Data Infrastructure**

In the development of the geospatial data infrastructure in Bosnia and Herzegovina, universities must have one of the key roles. Given the insufficient knowledge and opportunities provided by the SDI concept, it is necessary in various ways to promote and educate the personnel who will adequately integrate these concepts in all areas of work and activities of different state institutions, as well as private entities through which standardization and adequate exchange of data will be enabled. Surely, to make this possible, it is necessary to modify the curricula and adapt them to the needs of the economy, especially those of specific subjects, in order to provide a quality staff that will enable the implementation of these requirements. In addition to training new staff, it is also necessary to organize courses for life-long learning that are tailored to the needs of business entities.



As a stakeholder related to the establishment of the SDI (legal, economic, technical framework), in both the Republic of Srpska and the Federation of Bosnia and Herzegovina, the Council for the SDI Development, i.e. the SDI Council was established. It is important that representatives of the academic community, in addition to the basic role of raising awareness about the importance of the SDI through regular classes and courses, are additionally involved in the activities of both geodetic administrations in the process of establishing the SDI.

Within the academic community, the following higher education institutions actively participate through various SDI development projects:

- Faculty of Architecture, Civil Engineering and Geodesy of the University in Banja Luka
- Faculty of Civil Engineering in Sarajevo
- Faculty of Agriculture in Banja Luka
- Faculty of Natural Sciences and Mathematics
- Faculty of Forestry in Banja Luka
- Faculty of Agriculture and Food Sciences in Sarajevo
- Faculty of Mining, Geology and Civil Engineering in Tuzla
- Faculty of Science and Education in Mostar
- Other higher education institutions

Although the universities are involved in such projects, it can be said that they do not participate sufficiently and their potential is not used in terms of cooperation with domestic institutions that are currently in charge of the development of the SDI in BiH.

University curricula do not contain a sufficient number of subjects and teaching topics that are relevant for the development and use of the SDIs. Their improvement (which is the goal of the BESTSDI project) would create preconditions for launching new research projects and more active university cooperation with the public and private sectors in this area. By extending curricula with subjects in this field, the teaching process would be more appropriate and in line with the market needs, whereas educated experts would be more prepared for the challenges of applying new geoinformation technologies, standardization in the field of work and management of geospatial data, as well as the application of concepts defined by the geospatial data infrastructure.

### **3. BESTSDI project results**

The aim of the BESTSDI project is to increase awareness of the importance of the SDI through forming new studies, courses and improving existing curricula at the Universities of the Western Balkans. Project activities aim to establish a bigger representation of subjects in the curricula in all educational institutions which are in some way the users of spatial data. The project tends to connect teaching staff, share experiences to make additional value, and create curricula that can be adapted for teaching. This achieves two goals: training of teaching staff through summer schools and creating the basis for forming new study programs and changing the existing ones. Within the project activities, dissemination on the best practices in the SDI learning is done, as well as the content of already developed courses, experience in introducing new courses and training courses for professionals within the framework of life-long learning programs. Through previous dissemination, the activities were carried out that were primarily connected to the targeted



environment of participants in the SDI development, all in order to establish the necessary foundations for the participation of partner universities. The project provides equipment for the implementation of modernized curricula at partner universities in order to adequately realize teaching both theoretically and practically at the academic level within the studies at partner universities and life-long learning courses. Additionally, through the project, a Memorandum for Understanding will be established between the project partners in order to have a formal framework for future exchanges and harmonization of curricula, learning materials, mobility at partner institutions, etc. The exchange of students and staff will be promoted through project activities and information on activities carried out by partners addressed by partner universities.

### 3.1. BESTSDI delivered products

Within the project activities, a number of surveys have been systematically accessed in order to make a comprehensive analysis of the current situation in partner countries, starting with the academic community to business entities with a strong need for staff with the adequate SDI knowledge. On the basis of these researches, the future activities were established and built into the project results. For these purposes, 6 researches were made, and 17 documents were submitted, which served as the basis for the realization of the previously defined project goals. For the purpose of informing the wider community about the project activities, 12 BESTSDI Info and 2 BESTSDI Newsletter were created. Within the framework of cooperation with the SDI contact points, as well as with all participants in the SDI development in partner countries, the national reports for 2017 were created through the project for Albania, Bosnia and Herzegovina, Kosovo, Montenegro and The Republic of Serbia regarding the SDI.

These reports provide an overview of the current situation and some basic recommendations for future action of the academic community. It is primarily a document based on which all those interested in the SDI development would have the opportunity to give their opinion on the needs related to this development and hence for the future needs connected to the competencies of the staff necessary for the SDI development in the partner countries. Within the project, a project curriculum has been developed which is differentiated into those who acquire basic knowledge of the SDI, advanced SDI course, life-long learning (LLL) courses and specific topics concerning the SDI. During the second year of the project realization, materials were created for the topics that will be available through the aforementioned modules (Table 1).

**Tabela 1. Adaptation of project curriculum**

Module	Topic
Module 1. SDI concepts and principles	The usage of spatial data in different application domains: examples of spatial data (sets) and applications;
Module 1. SDI concepts and principles	Existing barriers to access and use spatial data: non-harmonisation, licensing and pricing, restricted use, ...;
Module 5. SDI Assessment and Quality Issues	Quality and Experience of a Service: how well does a service work from a user perspective (the way it is organised and can be used, portrayal, ...) and from a technological perspective, i.e. against standards or specifications (availability, capacity and performance);



Module 2. SDI at Work	Introducing the publish-search/find-bind paradigm by using single points of access (portals) to distributed data and services;
Module 9. SDI Application Development	Different approaches and different steps in applications development: the need to start with a well thought and good design;
Module 9. SDI Application Development	Methods for requirements analysis in GI including the definition of work processes and data flows, functional and non-functional requirements;
Module 9. SDI Application Development	The design of usable user interfaces to support the many interactions in the work process: using mock-ups to create a first visual outline of the intended interfaces;
Module 2. SDI at Work	The role of metadata in SDI, the different types of metadata (discovery, evaluation and usage) and the standards they are built upon (ISO 19115, ISO 19119 and ISO 19139);
Module 3 SDI Data Modelling and Data Harmonization	Comparing existing data sets or data models against specifications;
Module 3 SDI Data Modelling and Data Harmonization	Methods and steps for data transformation and the definition of syntactic and semantic transformation rules;
Module 5. SDI Assessment and Quality Issues	Overview of tools and environments to perform testing and validation;
Module 7. Technological Trends	SDI to improve sharing and exchanging data, but taking into account sensitive information by using secure access mechanisms and protection of (spatial) features.
Module 9. SDI Application Development	Some examples and exercises to identify use cases given a pre-defined work process for different actors;
Module 9. SDI Application Development	Methods for mapping and describing business/work processes to identify the activities, the actors and interactions that take place, and the role of data and geographic information in those processes in particular;
Module 9. SDI Application Development	What are and how do Agile development methods work, such as Scrum: the interactive approach through the organisation of sprints;
Module 1. SDI concepts and principles	Different types of SDI and different models: hierarchical or network based, connecting distributed resources;
Module 1. SDI concepts and principles	Different components of SDI: data, metadata, access mechanisms, standards, people and organisations, institutional and legal aspects ...;
Module 2. SDI at Work	How to evaluate whether a data set or a service is of the required quality and is fit for purpose (fit for intended use);
Module 3 SDI Data Modelling and Data Harmonization	Reading and using the UML conceptual modelling language (including how to read application schema’s);
Module 3 SDI Data Modelling and Data Harmonization	Modelling our universe of discourse: spatial, temporal and other aspects;
Module 4. SDI Access Mechanisms	Fundamentals on how the WWW works, the technology stack and protocols used, its basic operations and the importance of URI’s, URL’s and URN’s;
Module 5. SDI Assessment and Quality Issues	The difference between QA of spatial data production and data products (in terms of accuracy, completeness ...) and QA of SDI components;
Module 5. SDI Assessment and Quality Issues	The difference between QA and conformity/compliancy with standards and specifications in the context of SDI;
Module 6. Non-technological Developments	Overview of different license and business models for the distribution of spatial data (including the Creative Commons framework);
Module 6. Non-	The Open Data movement and the application of Open Data principles in



technological Developments		the context of SDI in different countries of Europe;
Module 7. Technological Trends		Overview of the major developments and trends as defined by UN-GGIM and OGC (with focus on technological trends);
Module 7. Technological Trends		3D/4D geospatial data: space and time including the provision of examples on: moving objects in space (eye-tracking), agent-based modelling (indoor/outdoor); augmented reality (looking to the past and into the future); etc.
Module 8. SDI for Thematic Applications		Analysis of differences and commonalities between different data sets and identification of specific challenges to link/integrate them;
Module 8. SDI for Thematic Applications		Visit to and exploration of specific platforms and tools: small assignments to access and use the available information/data.
Module 9. SDI Application Development		What are Application Programming Interfaces (API’s) and what are geospatial API’s: examples of how they are used in the context of SDI;
Module 9. SDI Application Development		Zooming in on different geospatial API’s such as OpenLayers, OpenStreetMap, Leaflet, etc. Smaller exercises to use these environment to carry out simple GIS tasks.
Module 3 SDI Data Modelling and Data Harmonization		Data harmonisation and semantic interoperability;
Module 3 SDI Data Modelling and Data Harmonization		The role of ontologies and vocabularies;
Module 2. SDI at Work		The role of catalogues and catalogue services, and the concept of harvesting catalogues;
Module 5. SDI Assessment and Quality Issues		Detailed QA and quality control issues related to metadata and catalogues: problems and issues that might occur, including examples and how to solve them;
Module 6. Non-technological Developments		Authoritative spatial data and official registries and/versus volunteered geographic information and crowdsourcing.
Module 8. SDI for Thematic Applications		Overview of relevant European Directives and national legislation in the thematic (and related) fields;
Module 3 SDI Data Modelling and Data Harmonization		Explaining and analysing examples of product specifications and INSPIRE data specifications in particular (examples to be chosen depending on the field of interest);
Module 6. Non-technological Developments		Geospatial data and their integration with other data/information for different applications;
Module 1. SDI concepts and principles		Main geospatial standards, the standardisation process and relevant standardisation bodies;
Module 5. SDI Assessment and Quality Issues		Methods for testing and validating harmonized data against data specifications including examples;
Module 7. Technological Trends		The influence of huge amounts of data on the way we work (big data): cloud computing; workflow and provenance; big data analytics; big data coming from social networks/media; etc.
Module 7. Technological Trends		New ways to publish and use geospatial data on the web by making use of semantic web technology such as linked data: examples and small exercises on usage and implementation;
Module 4. SDI Access Mechanisms		Architecture patterns and overview of the Service Oriented Architectures used in most SDI’s, based on at least three tiers: data, applications (clients) and services;
Module 3 SDI Data Modelling and Data Harmonization		Encoding mechanisms and data exchange formats (including XML, GML and RDF);
Module 4. SDI Access		OGC web service interfaces for accessing, discover, download, visualize,



Mechanisms			process ... geospatial data;
Module 4. Mechanisms	SDI Access		Detailed explanation and discussion on how WMS, WFS and CSW work, including examples from INSPIRE;
Module 6. Technological Developments	Non-		E-Government processes and the location enablement their G2C, G2B and G2G interactions;
Module 6. Technological Developments	Non-		Analysis of typical e-Government processes and modelling them using the BPMN (standard) language;
Module 3. Modelling and Harmonization	SDI Data and Data		Data quality and validation of transformed data.
Module 4. Mechanisms	SDI Access		Exercises to set-up different type of OGC web services such as WMS/WMTS, WFS, CSW.
Module 8. Thematic Applications	SDI for		Approaches to make the linking and integration of disparate data resources from the same application field including some exercises;
Module 2. SDI at Work			Providing examples of good geoportals and open data portals and discuss the characteristics of good portals (rich content, multiple providers, ...).
Module 5. Assessment and Issues	SDI Quality		What is Quality Assurance in the context of SDI's and how does the quality control process work?
Module 5. Assessment and Issues	SDI Quality		Introducing aspects related to value, cost/benefits and performance management in the context of SDI's.
Module 3. Modelling and Harmonization	SDI Data and Data		ISO 19100 series of standards: reference model, spatial schema, temporal schema, rules for application schema, portrayal, data product specification, ...;
Module 4. Mechanisms	SDI Access		Web services: what are they; what can they do; how do they work and what are different types of web services;
Module 4. Mechanisms	SDI Access		Overview of support of OGC web services in popular GIS software;
Module 6. Technological Developments	Non-		How to share spatial data to a maximum degree, while protecting sensitive information (such as personal information);
Module 8. Thematic Applications	SDI for		Identification of specific metadata initiatives and specifications, and different ways to handle and describe the metadata;
Module 8. Thematic Applications	SDI for		Analysing metadata records and comparing them with basic discovery metadata collected in SDI catalogues;
Module 2. SDI at Work			Provide examples and 'simple' exercises to search for specific data sets and services, to correctly evaluate the content of the metadata record and to bind the data in a GIS desktop or other application;
Module 1. Concepts and principles	SDI concepts and principles		Examples of existing SDI's, their evolvement over time and comparison worldwide.
Module 5. Assessment and Issues	SDI Quality		SDI assessments: different methods to compare and benchmark SDI implementations;
Module 7. Technological Trends	Technological Trends		Major programmes to support better and more data, more accessible and easy to use: Copernicus and GNSS, Galileo, ...
Module 1. Concepts and principles	SDI concepts and principles		SDI's as answer to resolve those barriers: facilitating access, stimulating sharing and optimizing use;
Module 5. Assessment and Issues	SDI Quality		Exercise to explore different SDI's and evaluate them based on one or more methods and to compare results;
Module 7. Technological Trends	Technological Trends		New ways of data acquisition and new data sources: UAV's; Image-based Mobile Mapping, Laser scanning, Crowd Sourcing and VGI; etc.
Module 3. SDI Data	SDI Data		Difference between conceptual, logical and physical data models;



Modelling and Data Harmonization		
Module 4. SDI Access Mechanisms		Discussing the need for elaborating a good strategy for service implementation: how to implement portrayal, how to organise layers (in case of WMS); potential issues of performance; ...
Module 6. Non-technological Developments		Detailed overview and comparison of relevant European (and national) legislation with regard to GI and other public sector information: INSPIRE, PSI, Aarhus & Access, ...;
Module 8. SDI for Thematic Applications		Overview and analysis of specific spatial data models and comparison with the relevant INSPIRE specifications: examples of existing data sets;

### 3.2. BESTSDI SDI project curriculum

Within the BESTSDI project, a comprehensive curriculum structure has been developed that addresses the needs of the consortium in general and which should cover the needs for educating all participants in the SDI development. Consequently, the harmonization of the curriculum between the different participants was done (Table 1).

**Table 1. Adaptation of the project curriculum**

Basic content selected existing curricula	SDI for	Universities of Geodesy		Other faculties		Total
		Responses	Percentage (%)	Responses	Percentage (%)	Percentage (%)
SDI concepts		7	100	5	50	<b>70</b>
SDI in progress		6	86	3	30	<b>53</b>
Data modeling		7	100	7	70	<b>82</b>
Access to data		6	86	6	60	<b>70</b>
SDI assessment		5	71	4	40	<b>53</b>

As a basis for creating a new curriculum, a previous metadata analysis was done about the existing course programs, modules and courses at partner institutions, the existing learning materials and individual requirements of partner institutions. Therefore, a structure was created: the basic curriculum (the curriculum that all partners want to offer) (Figure 1.)





## Main structure: initial / basic

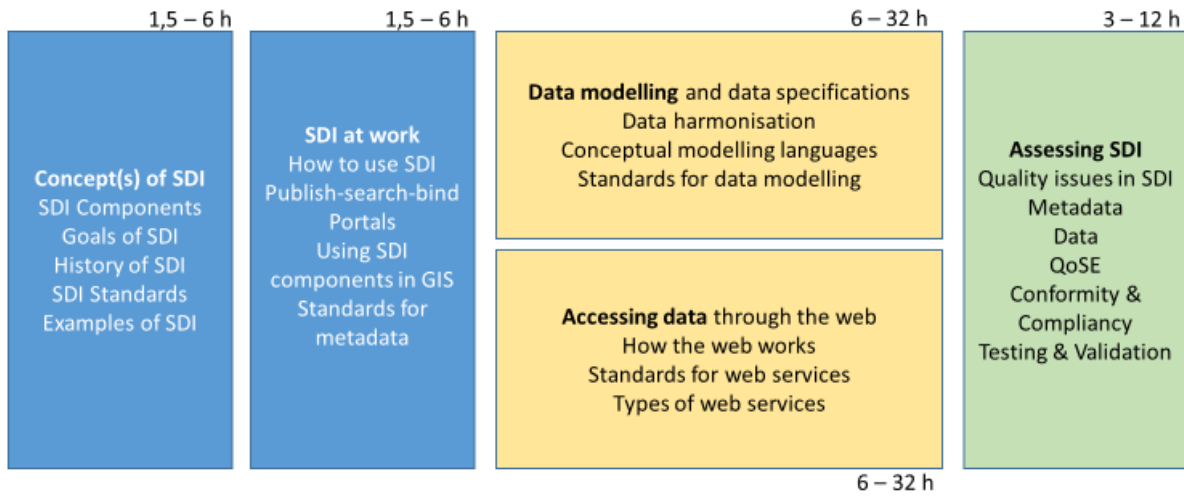


Figure 1 Basic curriculum structure

In addition to the main, the basic structure of the advanced SDI curriculum has been made, which primarily refers to the part of geodetic faculties and will be studied there (Figure 2).

## Main structure: advanced

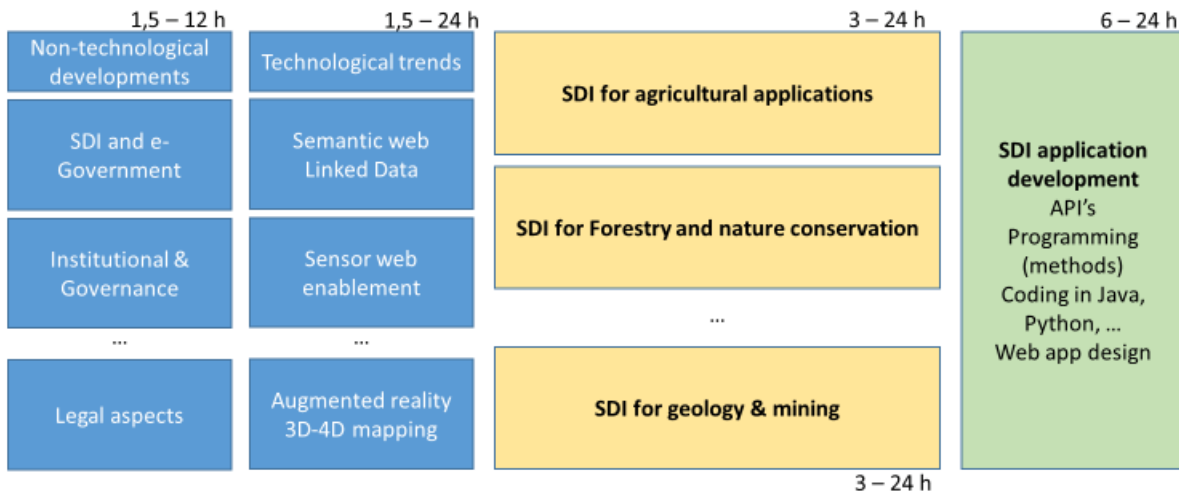


Figure 2 Advanced curriculum structure

In addition to the basic and advanced curriculum, the materials for the curricula of innovative and specific SDI topics have been created.



## 4. Implementation of SDI curriculum

Within the project activities, an analysis of the existing subject curricula at partner universities was made, which served as the starting point for the preparation of new proposals and the adaptation of the new subject curriculum solutions. Based on the preliminary metadata analysis about the courses concerning the spatial data infrastructure, some conclusions and recommendations can be given for the existing curricula and the development of new specific SDI curricula for partner countries (Figure 3). It was found that:

- Spatial data are represented in the subject curricula, but the geospatial data infrastructure is not usually recognized as a topic in learning materials.
- It is necessary to recognize and promote the SDI aspects that are more recognized by users and communities.
- Master studies should be the main target level for the new BESTSDI curricula.
- At the beginning, the SDI courses will be offered as elective courses, primarily due to administrative procedures related to the updating and accreditation of new study programs and subject curricula.
- Subject curricula will be restructured in order to better present what is included in courses (summaries and learning outcomes).
- The SDI is mainly represented in the elementary form (at the election level).
- Benefits, cases of use and the SDI applications lack in geodesy.
- It is necessary to put Geo-Information System (GIS) in a wider context to achieve the use of technology in decision-making at all levels.

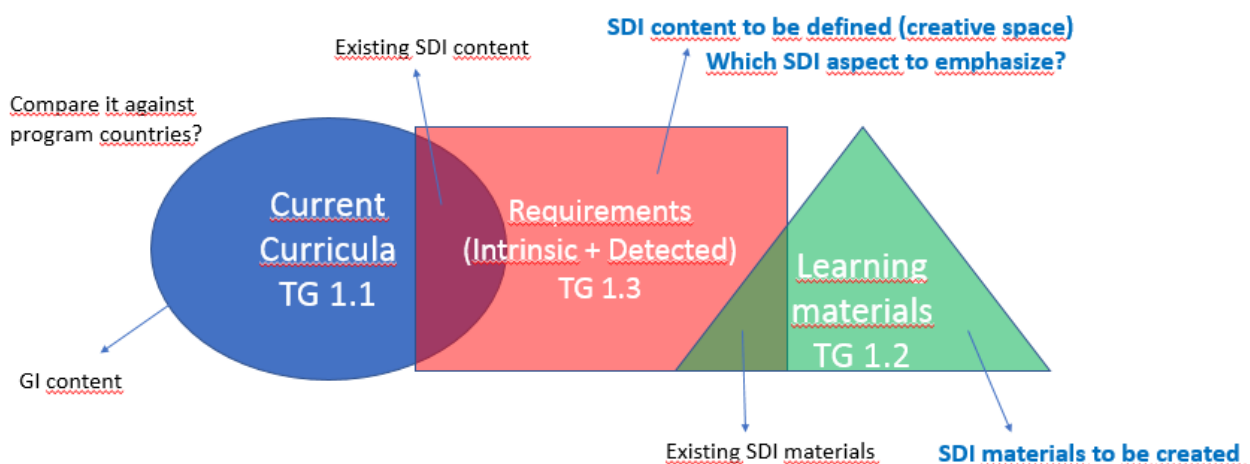


Figure 3 Establishing new curricula

An analysis of the current situation raised the issue of improving the existing subject curricula. The following were analyzed:

- a) to what extent existing subject curricula correspond to their purpose



b) to what extent students are able to participate in the SDI development after completing their studies and

c) whether the materials offered are suitable for users.

The proposals for the implementation of the new curricula related to the SDI and INSPIRE are defined by the project subject curriculum:

1. Geospatial Data Infrastructure
2. Spatial Data Infrastructure
3. Geo-Information Infrastructure
4. Topographic models
5. Real Estate Valuation
6. Geo-Information Systems
7. Geoecology and heritage conservation
8. General Cartography
9. Applied Cartography
10. Thematic mapping
11. GIS (Geo-Information System)
12. Geospatial data base
13. Spatial and urban planning
14. Sustainable use of natural resources and environmental protection systems
15. Commasation
16. Cadastre
17. Underground infrastructure detection
18. Basics of remote detection and image processing
19. Active Geodetic Reference Network
20. Basics of mathematical cartography
21. Structural geomorphology
22. Geodiversity and geological heritage

#### 4.1. Infrastructure of Spatial Data in study programs

The specific goals of the BESTSDI project are to develop, test and adapt new subject curricula, courses, learning materials and tools within the SDI field. By incorporating the SDI and other modern concepts based on spatial data and information, students in new courses will gain knowledge to more efficiently manage spatial data and services for the SDI users once they are in the job market. In parallel, the project also introduces the SDI and related concepts in undergraduate and postgraduate studies at academic institutions which form profiles that are recognized as someone who develops and / or uses the SDIs. During 2018, the universities in BiH agreed on the plans for the implementation within the academic year of 2018/2019. (Table 2).

**Table 2. Implementation of the SDI at the Universities in BiH**

Ordinal number	Faculty	New study program	Subject
1.	Faculty of Agriculture and Food Science,	-	Basics of Cartography in Spatial Plannig GIS Basics



	UNSA		Application of GIS in Agro-Ecological Zoning Land Valuation Land Commasation
2.	Faculty of Civil Engineering, UNSA	-	WEB GIS GIS in Spatial Planning Geo-visualization Spatial Data Bases and SDI Transport and Infrastructure Planning
2.	Center for Interdisciplinary Studies, UNSA	Protection against natural disasters	GIS Spatial Data Bases and SDI
4.	Faculty of Architecture and Civil Engineering, UNIBL	-	Integrated Survey Systems
5.	University in Mostar	yes	

Additionally, education raises awareness about the benefits of well-organized, harmonized and accessible spatial data. The project partners agreed on using and taking over courses, course metadata, structure and learning materials. In this context, the specific goals of the project are to develop appropriate subject curricula, courses and their content for both target groups (SDI providers and SDI users) at academic institutions, as well as elective life-long courses. This involved the development of:

- Mandatory SDI course for undergraduate study programs in geodesy;
- SDI modules for postgraduate geodesy and geoinformatics programs;
- Components of the SDI user course (full courses are not required) for undergraduate study programs at partner faculties;
- SDI elective courses for the graduate study program of partner faculties (SDI users)
- Development of sustainable training courses (life-long education) of a wide range of professionals

Considering it is about courses in a specific domain offered in sometimes very similar studies at various institutions across the region, in a data set of 220 courses described by metadata, duplications or very similar courses are expected, which in some way describe topics that refer to the SDI or INSPIRE. The analysis found that there is the same number of courses on partner projects (Table 3).

**Table 3. Same subjects at partner universities in BiH**

<b>Name of course</b>	<b>Number of occurrences</b>
Survey	2
Engineering Geodesy	2
Geo-Information Systems	3
Photogrammetry	2
Cartography	3
Satellite geodesy, Positioning and Navigation	2
Cadastral	2
Geodesy	2
Commasation	2



Remote Detection	2
Physical Geodsy	2
Geo-spatial Data Bases	2

## 4.2. Spatial Data Infrastructure in Life-Long Learning Courses

One of the tasks defined within the BESTSDI project goals is the establishment of life-long learning (LLL) courses. This concept is insufficiently represented in Bosnia and Herzegovina and certainly presents an important part of educating the staff in the field of spatial data infrastructure. In the joint workshop of the IMPULS and BESTSDI projects in April 2018, the importance of LLL courses was discussed. Most stakeholders have expressed a great need for life-long learning in order to train staff who will adequately be able to implement the SDI within their authority. Within the BESTSDI project, three courses for life-long learning are currently being proposed, which will be carried out in 2019:

1. Basics of SDI for Providers - A course that introduces beginners to the SDI concepts and technology for spatial data providers (engineers who produce new spatial data sets based on observation and measuring or on spatial analysis of the existing data. Through this course, beginners will acquire knowledge about: understanding and explaining the SDI concepts and components, understanding the main chapters of the INSPIRE Directive, identification and description of principles, concepts and characteristics of web services, understanding and describing OGC standard specifications for CSW, WMS, WFS with practical use, use of web services for downloading data within the GIS applications or web maps.
2. Setting-up of OGC Web Service - A course that introduces learners to service settings (WMS, WFS, CSW) for spatial data providers. Through this course, learners will acquire knowledge about: settings for creating web services, configuring and setting up WMS, operational WFS and CSW and testing quality of their characteristics and attributes.
3. In 2018/2019 at the University in Sarajevo – the Center for Interdisciplinary Studies, a new study program began titled “Protection against Natural Disasters“, which partially uses the developed curricula within the BESTSDI project for the following courses: GIS and Spatial Data Bases and the SDI. Both of these courses are intended for beginners, i.e. they contain only basics. At the same time, it is planned that, in addition to regular classes, the Spatial Data Base and the SDI course will be used for LLL in this school year.

The Faculty of Agriculture and Food Science will also conduct three LLL courses in 2019. The target group is the administration of the municipality and the ministries in the agricultural sector. The focus will be on the SDI in agriculture, land management, etc. The course participants will acquire basic knowledge about the SDI concept and principles, and will be informed about applied approaches in the agricultural sector. The purpose of organizing such courses is primarily reflected in the inadequate education of staff in this field, the importance of this issue in establishing e-government and constant changes in technological solutions that can be used to effectively implement the decisions defined by this issue.



## 5. Conclusion

Within the report for 2018, the basic remarks regarding the state of the Spatial Data Infrastructure (SDI) in the Republic of Srpska and the Federation of Bosnia and Herzegovina were given, with a review on the SDI in higher education and the analysis of the BESTSDI project requirements. The role of the university was pointed out in the National Infrastructure Protection Plan (NIPP) related to its development from the academic point of view in terms of the SDI presence in study programs. The report provides information on participants in the development of Geo-Spatial Data Infrastructure and their future role.

As was the conclusion within the Report for 2017, through this report it can be concluded too that universities in BiH do not participate sufficiently in raising awareness and development of SDIs and that their potential is not used in terms of cooperation with domestic institutions currently responsible for the SDI development. Curricula at partner universities do not have sufficiently developed topics relevant to the development and application of SDIs. By using new- developed and improving existing curricula (which is the goal of the BESTSDI project), preconditions would be created for launching new research projects and intensifying university cooperation with the public and private sectors in this area.

A survey conducted within the project for the purpose of requirement analysis showed that there is a real need for a certain level of knowledge in the field of geoinformation management issued by the INSPIRE, which further points to the need for the adaptation of curricula in the area of establishment and development of the SDI. Based on this analysis, a BESTSDI project curriculum proposal for different categories was created from basic to advanced SDI education. The particular emphasis has been placed on the development of life-long learning materials to ensure not just the improvement of educating professionals already employed, but also to envisage that we will always be able to improve the state of the SDI development through continuous training of staff working on its development.

Looking at the current higher education status regarding the presence of the SDI in curricula, it can be concluded that in BiH there is experience and knowledge gained through the introduction and realization of existing geoinformatic subjects and topics. They should serve as a quality basis and a good starting point for introducing changes and creating new curricula adapted to the trends of the SDI development. As a part of the activities for 2018, adequate preparations have been made in order to start new topics and subjects at the following universities from the academic year of 2018/2019: University in Sarajevo (The Faculty of Civil Engineering and the Faculty of Agriculture and Food Science), University in Tuzla (The Faculty of Mining, Geology and Civil Engineering), University in Banja Luka (The Faculty of Architecture, Civil Engineering and Geodesy). University in Mostar (The Faculty of Science and Education) will start a new master program. University in Banja Luka (The Faculty of Architecture, Civil Engineering and Geodesy) is in the process of accrediting the new study program of Geodesy for the first cycle of studies. If formal procedures are completed by the beginning of 2018/2019, then not only will the new topics and subjects be introduced in the first cycle of the SDI studies, but the entire study program will be modernized with topics related to the SDI through a number of subjects.



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**BESTSDI**

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