Business driven problem-based learning for academic excellence in geoinformatics / GEOBIZ
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Developing Innovative business - problem based cases

Deliverable 2.2

Version 1.0

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Work Package / Task:

WP2 – Development / Task 2.2 Developing Innovative business problem based cases

References:

Project description (Annex I to the Grant Agreement), the product from the task.

Short Description:

The Deliverable contains methodology of development of cases, as well as developed Innovative business problem-based cases.

Keywords:

Innovative business problem based case (BPBC)

Revision History:

Revision	Date	Author(s)	Status	Description
0.1	15-11-2020	Bojana Obrenovic	Working draft	BPBC development methodology. Developed Innovative business problem-based cases.
0.2	30-11-2020	Srđan Popović	Working draft	BPBC development methodology. Developed Innovative business problem-based cases.

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1 Introduction

Project “Business-driven problem-based learning for academic excellence in geoinformatics – GEOBIZ” includes fifteen academic and three business institutions. Business partner in the project (Gilab, Gauss and Land&Co) in cooperation with academic partners developed innovative business problem-based cases. The cases were identified and selected in the interaction between business and academic partners with a balance between business reality and implementability in the education process, with the goal to innovate and modernize the practical part of technologically advanced courses.

Innovative business problem-based cases grouped:

- GIS vector/raster analysis;
- Navigation and positioning - GNSS;
- Remote Sensing - EO - Copernicus, and product;
- Advanced GIS applications;
- Web mapping portals and applications;
- Sensor integration, UAV;
- Artificial intelligence;
- Geostatistics;
- Terrestrial Laser Scanning.

Developed cases are:

- Localized, using data from their own country wherever possible;
- Legally usable, allowed to be used by the owner or in the context of regulations protecting the use of personal and other information;
- Upgradable, a student can add their contributions to the cases (measurements, images, data, programmed application modules, etc.).

The methodology of developing innovative business problem-based cases include the next phase:

- Creating a survey for the business sector and carry out research;
- Analyze the result of the survey;
- List of minimal technical requirements;
- Developing the first phase of innovative business-problem based cases;
- Interaction with an academic partner and creation of the final version of cases.

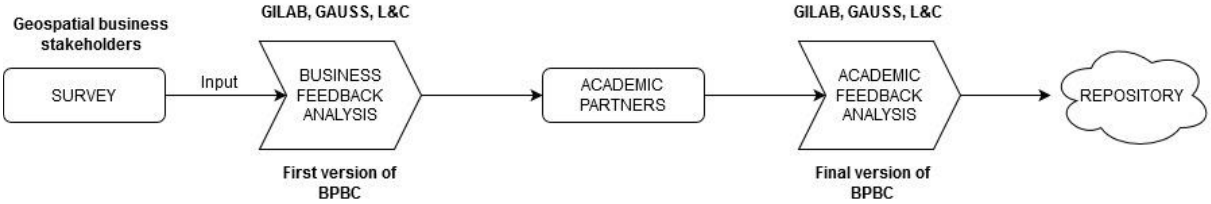
2 Review on methodology

The methodology of creating business problem-based cases (BPBCs) includes the next steps:

- A survey that relates to collecting relevant information from the business sector;
- Creating of the first (draft) version of business problem-based cases based on the result of the survey;
- Interaction with academic partners in the project to check implementability or include some other request regarding the first version of BPBCs;
- Creating the final version of Innovative business problem-based cases.

Developed cases based on business-academic cooperation designed in a manner to be continuously upgradeable by practical work of students and contributions from companies introduce the innovative approaches in education programs. Developed BPBCs were placed in a repository for further developing technologically driven geoinformatics courses and LLL courses. These business-driven problem-based cases should also create a repository of advanced and more complex cases as themes for Bachelor's and Master's thesis.

The following figure shows the process of the methodology used to develop BPBCs.



Picture 1: Methodology of BPBC creation

2.1 Survey

In order to analyze the state of the market in terms of end products, technologies, equipment, and the necessary experts to work with geospatial data in the business sector, a survey was conducted. The focus is on the business sector and the questionnaire was sent to companies, public governmental institutions, secretariats, etc. A link to the questionnaire was sent from the official e-mail of the GEOBIZ project.

The survey contains 46 questions from different areas of geoinformatics, which were identified by business partners in the project:

- GIS vector/raster analysis;
- Navigation and positioning - GNSS;
- Remote Sensing - EO - Copernicus, and product;
- Advanced GIS applications;
- Web mapping portals and applications;
- Sensor integration, UAV;
- Artificial intelligence;
- Geostatistics.

In addition to these groups of questions, the survey contains a set of **General** questions. The General set includes questions related to the end products, as well as questions related to the experts in terms of skills, knowledge, or possible lack of experts. As a follow up to all these questions, the survey also involves the **Other** section in which it is possible to describe a data collection technique that is not covered in the previous groups of questions.

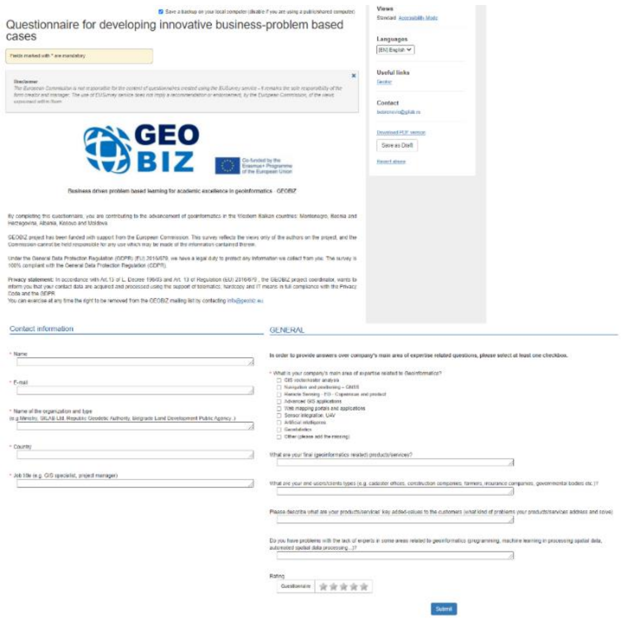
The questionnaire was published using an EU Survey. The questionnaire launched on 1 June and finished on 15 July. The survey was forwarded from the official e-mail of the GEOBIZ project. The total number of answers is 28. Considering the quality of the responses was poor, the survey took longer to gather relevant responses. Parallel to the survey, the business sector was preparing innovative business problem-based cases.

EUSurvey is an online survey management system for creating and publishing forms available to the public, e.g. user satisfaction surveys and public consultations. Its main purpose is to create official surveys of public opinion and forms for internal communication and staff management, e.g. staff opinion surveys and forms for evaluation or registration. EUSurvey provides a wide variety of elements used in forms, ranging from the simple (e.g. text questions and multiple-choice questions) to the advanced (e.g. editable spreadsheets and multimedia elements). The application, hosted at the European Commission's Department for digital services (DG DIGIT), is available free of charge to all EU citizens. Participants can modify a contribution after it has been submitted if they want to.

In the attachment, you can find a list of questions, also on this link you can find the questionnaire which is available by 31st December.

https://ec.europa.eu/eusurvey/runner/GEOBIZ_T22

Figure two shows the layout of the survey through the EUSurvey platform.



Picture 2: Questionnaire on EUSurvey

2.2 Result of the survey

The number of answers is 28. The answers are of poor quality, most often incomplete answers. The survey took longer than planned to gather the necessary information and was completed on July 15.

The table below shows the organizations that completed the survey and the country of origin.

NAME OF THE ORGANIZATION AND TYPE	COUNTRY
Land&co ltd	Albania
Institute of Geosciences, Energy, Water and Environment	Albania
Institute for Canton Planning	Bosnia and Herzegovina
Public Enterprise Electric Utility of Bosnia and Herzegovina	Bosnia and Herzegovina
BNPRO DOO SARAJEVO	Bosnia and Herzegovina
Sava river watershed agency Sarajevo	Bosnia and Herzegovina
Federal Ministry of Physical Planning	Bosnia and Herzegovina
GAUSS Center for Geospatial Research Sarajevo (GIS Center); Geoinformation Company	Bosnia and Herzegovina
Public Company Roads of Federation of Bosnia and Herzegovina	Bosnia and Herzegovina
University of Banja Luka, Faculty of Architecture - Civil Engineering - Geodesy	Bosnia and Herzegovina
DRAXIS SA	Greece
technical vocational education	Moldavia
Public Institution Information Technology and Cyber Security Service, Agricultural Information Directorate	Moldova
Ministry of Agriculture, Regional Development and Environment	Moldova
The Moldova State University, Faculty of Biology and Soil Sciences	Moldova
Forest administration	Montenegro
Kosovo Agency of Statistics	Republic of Kosovo
Sate Agency Moldova Water's	Republic of Moldova
Agency for Geology and Mineral Resources	Republic of Moldova
University " Dimitrie Cantemir"	Republic of Moldova
GDi Solutions Ltd Belgrade	Serbia
Belgrade Land Development Public Agency	Serbia
GILAB	Serbia
MapSoft DOO	Serbia
Republic geodetic authority	Serbia
GIS Solutions	Serbia
Rio Sava Exploration	Serbia
OpenGeoHub foundation	The Netherlands

Table 1: List of respondents

Most of the answers are from Bosnia and Herzegovina with eight answers, Moldova and Serbia per seven submitted responses. The number of responses by country is shown in Table 2, while Table 3 presents the number of reports by type of respondents: Companies, Public Governmental Institutions, or Universities.

COUNTRY	ANSWERS

Albania	2
Bosnia and Herzegovina	8
Greece	1
Moldova	7
Montenegro	1
Republic of Kosovo	1
Serbia	7
The Netherlands	1

Table 2: Overview of responses by country

KIND OF RESPODENTS	ANSWERS
Companies	10
Public Governmental Institutions	16
Universities	2

Table 3: Kind of respondents

As noted above, the aim of the survey was to analyze the business sector in terms of the need for experts, technical requirements, and possible shortcomings. The results of the survey include two responses from academic institutions. Business partners asked the one academic partner in the project - the University of Banja Luka to fill out a survey in order to create a case related to the field of Terrestrial Laser Scanning. The University of Banja Luka was interested in BPBC in this area.

2.3 Minimum technical requirements

In line with T2.2 required to provide the necessary information about the equipment for task 2.6, a list of the necessary equipment was created based on the results of the survey. This list was created before the first version of the use cases was completed. Since the survey lasted until July 15, it was necessary to submit a list of minimum technical requirements, before the first version of the BPBCs. All cases were created in accordance with the list of minimum technical requirements.

The minimum technical requirements were created according to the areas of Geoinformatics, according to which innovative business problem-based cases were creating. This list refers to the minimum hardware and software requirements. The emphasis was on open source solutions, as well as commercial solutions that are mainly used in practice - they are stated in the survey. This list is an input in the purchasing of equipment.

The list of minimum technical requirements is given in the attachments.

2.4 The final version of innovative business problem based cases

Using the information from the survey and the experience of all business partners, the first version of Innovative business problem-based cases was created.

The first version was sent to all academic partners in the project. Based on their proposals and suggestions, the final version was created.

Using the proposals of academic partners, a case related to Terrestrial Laser Scanning was created. This method of data collection was not mentioned by the respondents in the survey. The list of minimum technical requirements does not specify the equipment related to this method of data collection.
The total number of created Innovative business problem-based cases is 24.

In the attachment, you can find developed Innovative business problem-based cases. A list of developed cases is in the table below.

No	Name	Use Case ID	Courses (fields) assigned:
1	**Soil moisture for micro-locations**	GEOBIZ.UC.AGA.1	Advanced GIS application, Sensors, Data processing, Web cartography, Web GIS.
2	**Statistical Surveys I**	GEOBIZ.UC.AGA.2	Advanced GIS applications.
3	**Utility and Government Services**	GEOBIZ.UC.AGA.3	Advanced GIS applications.
4	**Register of Spatial Units and Addresses**	GEOBIZ.UC.AGA.4	Advanced GIS applications.
5	**Geovisualization in Spatial Epidemiology**	GEOBIZ.UC.AGA.5	Advanced GIS applications; Web mapping portals and applications;
6	**Modeling of house prices using machine learning**	GEOBIZ.UC.AI.1	Machine learning, Advanced GIS, Spatial data analysis, Real estate mass valuation.
7	**GPS for Topographic maps**	GEOBIZ.UC.GNSS.1	The cadastral survey, Cartography, GIS, Digital Topography.
8	**Development of an application for applying GNSS in agriculture**	GEOBIZ.UC.GNSS.2	Navigation and positioning GNSS, Advanced GIS applications, Programing, Sensors, Mobile GIS, Web GIS, Web cartography.
9	**Noise mapping using mobile devices**	GEOBIZ.UC.GS.1	Data Science, Cartography, Sensors, Web GIS, Web mapping portals.
10	**Mapping air quality**	GEOBIZ.UC.GS.2	Geostatistics.
11	**Digitization of paper urban planning maps**	GEOBIZ.UC.GVA.1	GIS/Vector raster analysis, Cartography, Introduction to GIS.
12	**Geological Assessment of Soil Stability**	GEOBIZ.UC.GVRA.1	GIS vector/raster analysis;
13	**Geodata for Urbanism and Spatial Planning**	GEOBIZ.UC.GVRA.2	GIS vector/raster analysis;
14	**Geomarketing Analysis for Banking Services**	GEOBIZ.UC.GVRA.3	GIS vector/raster analysis;

15	**Mapping and monitoring of aquatic environments using geospatial intelligence**	GEOBIZ.UC.RS.1	Remote Sensing, Artificial Intelligence, Geostatistics, Cartography.
16	**Land cover and land use mapping**	GEOBIZ.UC.RS.2	Remote Sensing; Web mapping portals and applications; Advanced GIS applications.
17	**Crop monitoring with Remote Sensing**	GEOBIZ.UC.RS.3	Remote Sensing, Artificial Intelligence, Geostatistics, Web cartography, Web GIS.
18	**Application of remote sensing data in mapping and monitoring forest**	GEOBIZ.UC.RS.4	Remote Sensing, Artificial Intelligence, Geostatistics, GIS/Vector raster analysis, Web cartography.
19	**3D measurement with a terrestrial laser scanner and object visualization**	GEOBIZ.UC.TLS.1	Terrestrial laser scanning.
20	**Geodata for Civil Engineering and Architecture Designing**	GEOBIZ.UC.UAV&TLS.1	Navigation and positioning - GNSS; Sensor integration, UAV; Terrestrial Laser Scanning
21	**UAV in urban planning and management**	GEOBIZ.UC.UAV.1	Photogrammetry, Sensors, UAV.
22	**Vectorization of 3D models of objects based on point clouds**	GEOBIZ.UC.UAV.2	Geovisualization, Point processing, GIS, UAV with sensors.
23	**3D Urban information models for assessment of the solar potential of buildings**	GEOBIZ.UC.WMP.1	Spatial Analysis, Data visualization, Data modeling, Web GIS, Web cartography
24	**Statistical Surveys II**	GEOBIZ.UC.WMP.2	Web mapping portals and applications.

Table 4: Developed Innovative business problem-based cases

3 Attachments

3.1 List of questions for survey

What is your company's main area of expertise related to Geoinformatics?

- GIS vector/raster analysis;
- Navigation and positioning – GNSS;
- Remote Sensing - EO - Copernicus and product;
- Advanced GIS applications;
- Web mapping portals and applications;
- Sensor integration, UAV;
- Artificial intelligence;
- Geostatistics;
- Other.

General

1. What are your final (geoinformatics related) products/services?
2. What are your end-users/clients types (e.g. cadaster offices, construction companies, farmers, insurance companies, governmental bodies etc.)?
3. Please describe what are your products/services' key added-values to the customers (what kind of problems your products/services address and solve).
4. Do you have problems with the lack of experts in some areas related to geoinformatics (programming, machine learning in processing spatial data, automated spatial data processing...)?

GIS vector/raster analysis

1. Which software have you been using for vector/raster analysis (e.g. QGIS, ArcMap, ArcGIS Pro, SAGA, Idrisi,..)?
2. What are the main input vector data (e.g. GPS points, digital plan...) and raster data (e.g. satellite imagery, DEM, drone data...) that you use in the analysis?
3. What are the products resulting from the analysis?
4. Do you develop software or plugins for vector or raster analysis? What programming language have you used (e.g. Python, R, JAVA...)?
5. What computer specification is needed to process vector or raster data?

Navigation and positioning – GNSS

1. Describe the equipment and software that you use (or intend to use) to produce navigation/positioning data and process it?
2. Which skills (knowledge) does your expert need to collect and process the data?
3. For which purpose do you use the navigation/positioning data (relate the data with your final products/services)?

Remote Sensing - EO - Copernicus and product

1. For what purpose do you use remote sensing data - what are the end products/services (e.g. Digital orthophoto, thematic maps - Vegetation maps, Energy maps, Water maps, Risk maps...)?
2. What skills (knowledge) does your expert need to use, process and analyze the data?
3. What satellite mission data do you use (e.g. Sentinel, Landsat, QuickBird, RapidEye...)?
4. Which software to process/analyze the data (e.g. Sentinel Toolbox, SAGA GIS, ORFEO Toolbox, GRASS, IDRISI) do you use?
5. What computer specification would be optimal for processing this data (e.g. intel i7; 16 GB RAM; 250+GB SSD)?
6. Do you use the cloud for storage and processing the data? Which cloud do you use?
7. Do you combine data from Remote Sensing with other geospatial data? Please describe it precisely (e.g. data fusion techniques using drone imagery for improving resolution of satellite imagery)?

Advanced GIS applications

1. What kind of GIS application do you develop – desktop, web or mobile applications?
2. For which kind of "smart" concepts do your company develop GIS applications (e.g. Smart cities, Intelligent transportation, Precise farming, Environment protection, Climate, ...)?
3. What programming language do you use to develop GIS applications? (e.g. Python, R, Java, C, C++)
4. Which database management systems do you use most often? (e.g. MS Access, Oracle, PostgreSQL, Microsoft SQL, MangoDB)
5. Which spatial data servers do you commonly use in your company? (e.g. ArcGIS Server (ESRI), Autodesk Infrastructure Map Server, GeoServer, MapServer, ERDAS APOLLO)
6. What standards for spatial data do you have experience with? (e.g. Inspire, ISO and CEN, OGC, W3C, standards by GIS software producer)
7. What are the most important functionalities that your application(s) provide (e.g. visualization of real-time sensor data, retrieval of alphanumeric data upon clicking on a map object, …)?

Web mapping portals and applications

1. What programming language do you use to develop backends for web/mobile applications? (e.g. Python, Java, Kotlin, JavaScript)
2. What framework do you use to develop backends (server side) for web/mobile applications? (e.g. Python Django, Java Spring, JavaScript Node.js)
3. What mapping servers do you commonly use in your company? (e.g. ArcGIS Server (ESRI), Autodesk Infrastructure Map Server, GeoServer, MapServer, ERDAS APOLLO)
4. What standards for spatial data do you have experience with? (e.g. Inspire, ISO and CEN, OGC, W3C, standards by GIS software producer)
5. What map client do you use for web mapping? (e.g. OpenLayers, Leafleat, Mapbox, ...)
6. If you develop mobile apps what do you use for development?

Sensor integration, UAV

1. For what purposes do you use a UAV (e.g. Digital Terrain Model, Digital orthophoto, crop health index map, vegetation map, risk map…)?

2. What software do you use to process data obtained using the UAV (e.g. AgiSoft, PIX4D...)
3. What kind of sensors do you use under the UAV method obtaining data?
4. Do you have experience with integrating sensors with a GIS application? Which kind of sensor is it? What is the app used for?
5. Do you combine UAV data with other spatial data? Please describe it more precisely.
6. What skills (knowledge) does your expert need to use UAV technology and process the data collected?

Artificial intelligence

1. Have you used any kind of machine learning models (e.g. support vector machines, neural networks, deep learning, decision trees, random forest, regression…) in processing spatial data and for what purposes (e.g. land cover classification, estimation of crop parameters, object recognition...)?
2. Do you have experience with developing some kind of AI algorithms or integration with some platform? Please explain in more detail what technologies you use (programming language, platform)?
3. What specific skills are required to work with Artificial Intelligence in geoinformatics?
4. What computer specification would be optimal for using these algorithms (e.g. intel i7; 16 GB RAM; 250+GB SSD)?

Geostatistics

1. Have you developed or used algorithms to predict some events based on spatial statistics and **for what purposes** (e.g. climate change, air pollution, different treatment of agricultural land based on the analysis of data from previous seasons...)?
2. Which programming language have you used to develop that algorithm (For example R)?
3. Do you use some programming language based on geostatistics to take some information? (For example R)?

Would you use algorithms related to these technologies in your business (if you haven't used it so far)?

3.2 Minimum technical requirements

Innovative business-problem based cases - Minimum technical requirements

GIS vector/raster analysis	**Software and technologies:** Free and open source: QGIS, SAGA GIS, GDAL, GRASS; Commercial: ArcGIS. **Operating system**: Ubuntu 20.04. LTS **Hardware:** Processor: Intel® Core™ i7/i5 8th Gen or newer 6 Cores/6 Threads RAM: 64GB Graphics Card: 4GB GDDR6 SSD: 1TB
Navigation and positioning – GNSS	**Equipment:** Trimble R8, Leica Viva GS14 & Leica Viva CS10 or CS15 **Software:** Commercial: Trimble Business Center, Leica Geo office
Remote Sensing - EO - Copernicus and product	**Software and technologies:** Free and open source: Sentinel Toolbox, Orfeo Toolbox, SAGA GIS, QGIS, GRASS, GDAL, R, Python **Operating system**: Ubuntu 20.04. LTS **Hardware:** Processor: Intel® Core™ i7/i5 8th Gen or newer 6

	Cores/6 Threads RAM: 64GB Graphics Card: 4GB GDDR6 SSD: 1TB **Cloud:** Commercial: OWH, AWS, Azure, Google. https://www.ovhcloud.com/en-gb/bare-metal/rise/rise-1/
Advanced GIS applications	**Programming language:** Python, SQL, R, Java, PHP, JavaScript. **DBMS:** Free and open source: PostgreSQL, Microsoft SQL Server Express, MongoDB. **Spatial data servers:** Free and open source: GeoServer, MapServer. **Operating system**: Ubuntu 20.04. LTS **Hardware:** Processor: Intel® Core™ i7/i5 8th Gen or newer 6 Cores/6 Threads RAM: 64GB Graphics Card: 4GB GDDR6 SSD: 1TB
Web mapping portals and applications	**Programming language:** Python, SQL, R, Java, PHP, JavaScript. **Framework:** Django Rest Framework (Python), Python Flask, ASP.NET Web API, ASP.NET Core, ASP.NET MVC, Laravel PHP, AngularJS, ReactJS. **Spatial data servers:** Free and open source: GeoServer, MapServer. **Map Client:** Free and open source: OpenLayers, Leaflet JS, Mapbox, MapStore.

	Operating system: Ubuntu 20.04. LTS **Hardware:** Processor: Intel® Core™ i7/i5 8th Gen or newer 6 Cores/6 Threads RAM: 64GB Graphics Card: 4GB GDDR6 SSD: 1TB
Sensor integration, UAV	**Software:** Commercial: AgiSoft, Pix4D. **Hardware:** DJI Phantom 4 Pro https://www.dji.com/phantom-4-pro/info
Artificial intelligence	**Programming language:** Python, R, GA, and MOGA / MATLAB. **Operating system**: Ubuntu 20.04. LTS **Hardware:** Processor: Intel® Core™ i7/i5 8th Gen or newer 6 Cores/6 Threads RAM: 64GB Graphics Card: 4GB GDDR6 SSD: 1TB
Geostatistics	**Programming language:** Python, R, GEE (Javascript) **Operating system**: Ubuntu 20.04. LTS **Hardware:** Processor: Intel® Core™ i7/i5 8th Gen or newer 6 Cores/6 Threads RAM: 64GB Graphics Card: 4GB GDDR6 SSD: 1TB

3.3 Innovative business problem-based cases

Use Case Identification and History			
Use Case ID:	GEOBIZ.UC.UAV.1		
Use Case Name:	**UAV in urban planning and management**	**Version No:**	Ver. No 1
End Objective:	Collection of highly detailed spatial data for urban management and development		
Created by:	Gilab DOO	**On (date):**	17 August 2020

Problem description:	Collecting accurate and meaningful information about the urban localities/environment with the maximum efficiency in terms of cost and time has become more relevant for urban, rural, and city-level development planning and administration. Data gathered with the drone is being used in mapping and modeling, helps in analyses of the urban form and building height for the city area. The outputs are orthophoto and 3D models. Urban planners can use orthophoto for mapping and getting relevant information for creating planning documentation. This allows urban planners to have an insight into the situation without going directly to a certain part of the city, but also to get more insight into complex spatial relationships.. 3D models provide information on the height of the roof, distances, etc. The drone derived outputs (orthophoto, 3D models) can be displayed through web portals (WMS, WCS services, APIs).
End users:	Urban planner, Inspectorate, etc.
Objectives and functionalities: (a result of the case)	• Ortophoto generation • 3D Urban Information Model generation • Mapping object on the orthophoto; • Overlap orthophoto, urban plan, and cadastral boundary service and making conclusion; • Making decisions based on the situation on the orthophoto and planning documentation; • Various spatial measurements (e.g. heights, distances, areas...
Input:	The boundary of the area of interest.

Methodology and technologies:	**Methodology:** • UAV Flight plan and image collecting; • Processing image; • Create cloud dense points and orthophoto; • Create a 3D model based on point cloud dense. • Modeling building with LoD = 2; • Measurement distance which relates to 3D models. • Web mapping for the dissemination of the results. **Software technologies:** <u>Commercial:</u> AgiSoft, Pix4D.
Technical requirements:	**Drone:** DJI Phantom 4 Pro **Computer specification:** Processor: Intel® Core™ i7/i5 8th Gen or newer 6 Cores/6 Threads RAM: 64GB Graphics card: 4GB GDDR6 SSD: 1 TB **Operating system**: Ubuntu 20.04. LTS **Cloud:** Commercial: OWH, AWS, Azure, Google.
Courses (fields) assigned:	Photogrammetry, Sensors, UAV.

Use Case Identification and History			
Use Case ID:	GEOBIZ.UC.UAV.2		
Use Case Name:	**Vectorization of 3D models of objects based on point clouds**	**Version No:**	Ver. No 1
End Objective:	Vectorization 3D models of objects and publication using CesiumJS and Google Earth. 3D models are created from point clouds that are the result of the ALS (Aero Laser Scanning) data collection method.		
Created by:	Gilab	**On (date):**	8 August 2020

Problem description:	Nowadays there are a plethora of approaches dealing with object extraction from remote sensing data. Airborne Laser Scanning (ALS) is a method for timely and accurate collection of spatial data in the form of point clouds which can vary in density from less than one point per square meter (ppsq.m.) up to in excess of 200 ppsq.m. Many algorithms have been developed which provide solutions to object extraction from 3D data sources as ALS point clouds. The goal of this case is to apply software solutions to extract 3D models of objects from point clouds and their presentations through Google Earth and Cesium.
End users:	Governmental institutions, civil engineers, architects, urban planners, citizens, etc.
Objectives and functionalities: (a result of the case)	• Extraction of 3D models of objects from point clouds; • Visualize 3D models using Cesium and Google Earth; • 3D city modeling.
Input:	Cloud point in ***LAS*** format.
Methodology and technologies:	**Methodology:** • Classification point clouds (Automatic, semi-automatic, and manual); • Vectorization of objects (manual, automatic with correction); • Adding textures to 3D models using appropriate software (e.g. SketchUp) ***optional step** • Preparation and publication of 3D models of objects in Cesium and Google Earth. **Software technologies**: <u>Free and open-source:</u> QGIS, CesiumJS. <u>Commercial:</u> LP 360 ArcMap; ArcGIS Pro; BENTLEY MICROSTATION V8i (with module TerraScan, TerraModeler, and TerraPhoto)
Technical requirements:	**Computer specifications:** Processor: Intel® Core™ i7/i5 8th Gen or newer 6 Cores/6 Threads RAM: 64GB

	Graphics card: 4GB GDDR6 SSD: 1 TB **Operating system**: Ubuntu 20.04. LTS
Courses (fields) assigned:	Geovisualization, Point processing, GIS, UAV with sensors.

Use Case Identification and History	
Use Case ID:	GEOBIZ.UC.AGA.1

Use Case Name:	Soil moisture for micro-locations	Version No:	Ver. No 1
End Objective:	Monitoring of soil moisture on micro-location using sensors through a web application.		
Created by:	Gilab DOO	On (date):	05 August 2020

Problem description:	Each soil has different physical and chemical parameters that require different ways of using and treating that soil. One of the properties of high interest in various industries is soil moisture. The monitoring of the soil moisture at micro-location is achieved using sensors that register that parameter. These sensors are placed according to a specific design to cover the area with the required number of sensors. The sensors are also placed at different depths in the ground, depending on the type of data required. Based on this data, prediction and visualization of micro-area are performed. Advanced GIS application is using the location of soil sensors and collecting relevant data from sensors through CSV format. Based on data from the sensors it is possible to visualize the situation on micro-location in regards to soil moisture. This data is powerful in land management, precise agriculture, science, etc.
End users:	Scientists, planners, and land managers, citizens, etc.
Objectives and functionalities:	• Creation of web application based on the Sensor observation network; • Web app containing sensor data including a map of sensors locations; • Dissemination of the observations in tabular and graphical format; • Data search (filtering) by location, time.
Input:	Sensor data about parameters and geolocations in CSV format;

Methodology and technologies:	**Methodology:**
	• Developing a GIS application for collecting and visualization data from sensors:
	  • Observation data representation;
	  • Developing geospatial models for visualization soil data from sensors;
	  • Graphical presentations of space-time data;
	  • Tabular presentations of the observations;
	  • Sensor Observation Services;
	  • Web mapping services.
	
	Programming language: R, Python, JavaScript.

Technical requirements:	**Computer specification:** Processor: Intel® Core™ i7/i5 8th Gen or newer 6 Cores/6 Threads RAM: 64GB Graphics card: 4GB GDDR6 SSD: 1 TB **Operating system**: Ubuntu 20.04. LTS
Courses (fields) assigned:	Advanced GIS application, Sensors, Data processing, Web cartography, Web GIS.

Use Case Identification and History			
Use Case ID:	GEOBIZ.UC.GS.1		
Use Case Name:	**Noise mapping using mobile devices**	**Version No:**	Ver. No 1
End Objective:	Creating a dynamic noise map based on data on noise level measurements acquired through a mobile application.		
Created by:	Gilab DOO	**On (date):**	25 September 2020

Problem description:	Noise pollution or unwanted and disturbing sound is a pervasive feature of modern life, mostly it comes from anthropogenic sources, including road traffic, airplanes, landscaping services, and construction. It can cause increased stress, cognitive impairment, and illness in humans and decreased fitness and altered behavior in wildlife. Comprehensive information on spatial and temporal distribution of noise is crucial to address the issue by relevant authorities and experts. Nowadays everyone can contribute to society using smartphone apps and its hardware which is very powerful and can be used in many ways to gather data. For example, using smartphone GPS and microphone through the sound meter app it is possible to gather valuable information in order to make an overview of noise impact in everyday life. Using available tech solutions and with the concept of crowdsourcing, it is now easier than ever for individuals to collectively contribute - whether with ideas, time, expertise, or funds - to a project or cause. Using data gathered this way, it is possible to analyze noise levels in different locations getting information about the main source of the noise presenting the whole aspect through different thematic maps.
End users:	Health agencies, Institutes for Environmental Protection, National or local governments, urban planners, citizens, etc.
Objectives and functionalities: (a result of the case)	Decision support through data visualization and modeling in urban planning and environmental protection. • End users can have better understanding of noise impact through interactive map on everyday life; • Making important decisions in urban planning; • Making decisions in regards to environmental protection based on monitoring the level of noise and dynamic of noise; • Informing the public about the noise level in certain parts of the city.
Input:	Noise data from different open-source mobile apps.
Methodology and technologies:	**Methodology:** - Collecting noise data using the mobile application (e.g. NoiseTube):

	• Noise data, sources, and strategy for observations; • Installing and calibrating application; • Data measurement; - Analyzing gathered data in GIS software; - Mapping noise data. **Software technologies:** Free and open-source: NoiseTube (application for measurement noise), QGIS. Commercial: ArcGIS.
Technical requirements:	**Computer specification:** Processor: Intel® Core™ i7/i5 8th Gen or newer 6 Cores/6 Threads RAM: 64GB Graphics card: 4GB GDDR6 SSD: 1 TB **Operating system**: Ubuntu 20.04. LTS
Courses (fields) assigned:	Data Science, Cartography, Sensors, Web GIS, Web mapping portals.

Use Case Identification and History			
Use Case ID:	GEOBIZ.UC.AI.1		
Use Case Name:	**Modeling of house prices using machine learning**	**Version No:**	Ver. No 1
End Objective:	Spatial prediction of house prices generated from a machine learning model.		
Created by:	Gilab DOO	**On (date):**	25 September 2020

Problem description:	The price of renting or selling houses is influenced by several basic factors: the area of the house, the number of bedrooms, location, accessibility to infrastructure, building materials, proximity to tourist attractions, etc. In addition to the basic parameters, the age of construction, the condition of the house, and the like can also be included. By applying machine learning, it is possible to predict and visualize the price of houses in a region or in a country and visualize the distribution of the prices. Finding the best model including spatial and structural information related to house prices data is a challenge.
End users:	Real estate agencies, engineers, investors, citizens, etc.
Objectives and functionalities: (a result of the case)	• Maps of the predicted prices of each house with available information used in the model (predictors); • Uncertainty map (spatial data) of the predicted prices; • Optionally, presentations of results as a web mapping app.
Input:	A spatial dataset with price information (price, bathrooms, date of information).
Methodology and technologies:	**Methodology:** Applying machine learning in spatial prediction of apartment prices: • Collecting and structuring house pricing data; • Studying and understanding the data of interests; • Summarizing the data set; • Converting data to treat it as a numeric feature/factor; • Generating new variables; • Splitting data into train and test data sets; • Computing a first model; • Visualizing price data across the different region; • Optimizing the baseline by implementing a tuner; • Engineering features; • Strategies for spatial cross-validation;

	• Comparison of a few models • Optimal presentations of the results. **Programming language:** e.g. R or Python.
Technical requirements:	**Computer specification:** Processor: Intel® Core™ i7/i5 8th Gen or newer 6 Cores/6 Threads RAM: 64GB Graphics card: 4GB GDDR6 SSD: 1 TB **Operating system**: Ubuntu 20.04. LTS
Courses (fields) assigned:	Machine learning, Advanced GIS, Spatial data analysis, Real estate mass valuation.

Use Case Identification and History			
Use Case ID:	GEOBIZ.UC.GS.2		
Use Case Name:	**Mapping air quality**	**Version No:**	Ver. No 1
End Objective:	Mapping air quality using geostatistical methods based on the available data.		
Created by:	Gilab DOO	**On (date):**	25 September 2020

Problem description:	Throughout the last two centuries, air quality and air pollution have been recognized throughout the world as pressing environmental issues. Today, smog is common in cities throughout the world. Pollution from industry and residential objects is monitored at different scales including municipality level, regional and national. Air quality data is defined by measuring variables such as ground-level ozone, carbon monoxide, sulfur dioxide, nitrogen dioxide, airborne particles or aerosols, and other relevant pollutants. These variables are measured at certain locations. Interpolation is a very useful feature when we want to predict the values of air pollutants at locations where no measurements have been made. Today, there is much publicly available information about air pollution which is measured at certain locations. Using that data, based on geostatistical (Kriging) interpolation, it is possible to predict air pollution at all locations.
End users:	Health agency, Institutes for Environmental Protection, citizens, etc.
Objectives and functionalities: (a result of the case)	• Predict the value of air pollutants at an unobserved location. • Creation of continual air quality maps.
Input:	Air quality dataset.
Methodology and technologies:	**Methodology**: Geostatistical (Kriging) interpolation: • Data preparation; • Sample variogram; • Fit a variogram; • Kriging interpolation (block kriging); • Conditional simulation; • Trend models (a population grid); • Multivariable geostatistics; • Spatiotemporal interpolation (a spatiotemporal variogram model). **Programming language**: R.

Technical requirements:	**Computer specification:** Processor: Intel® Core™ i7/i5 8th Gen or newer 6 Cores/6 Threads RAM: 64GB Graphics card: 4GB GDDR6 SSD: 1 TB **Operating system**: Ubuntu 20.04. LTS
Courses (fields) assigned:	Geostatistics.

Use Case Identification and History			
Use Case ID:	GEOBIZ.UC.RS.1		
Use Case Name:	**Mapping and monitoring of aquatic environments using geospatial intelligence**	**Version No:**	Ver. No 1
End Objective:	Modeling and monitoring of water quality parameters (e.g. temperature, turbidity, suspended solids, and chlorophyll concentration) from remote sensing data		
Created by:	Gilab DOO	**On (date):**	1 July 2020

Problem description:	The combination of remote sensing images with geospatial algorithms enables generation of data on water characteristics such as: temperature, turbidity, suspended solids, and chlorophyll concentration. These are important parameters to determine water quality. The use of geospatial intelligence for environmental monitoring presents several advantages, such as spatial coverage, which is limited in field monitoring campaigns due to access difficulties and costs, and the possibility to evaluate environmental conditions through time-series available on spatial agencies. Remote Sensing provides multitemporal data, which allows monitoring changes over time. This provides frequent spatial mapping for all waters. This combination positively impacts inland water monitoring concepts and provides regional and national authorities as well as reservoir stakeholders with an excellent information source to base their decisions and reporting on.
End users:	National or regional water administrations.
Objectives and functionalities: (a result of the case)	- Generation of models for automatic identification of water quality parameters from remote sensing data - Cartographic visualisation of time series of water quality maps;
Input:	Remote Sensing data: Sentinel (Sentinel 3, Sentinel 1, and Sentinel 2), Landsat, Modis satellite imagery.
Methodology and technologies:	**Methodology**: • Definition of the AOI (area of interest) for the project, either inland, coastal or marine waters; • Identification of the appropriate remote sensing data (based on requested temporal and spatial resolution) and the state-of-the-art models for a

	generation of the parameters of aquatic environment: e.g. temperature, turbidity, suspended solids, and chlorophyll concentration from EO data and (if available) in situ data; • Production of time-series of the data; • Visualization strategy and methods. **Software technologies**: Free and open-source software: Sentinel Toolbox, SAGA GIS, ORFEO Toolbox, QGIS, GRASS, IDRISI. Geospatial algorithms developed using R, Python, GDAL, or etc.
Technical requirements:	**Computer specification:** Processor: Intel® Core™ i7/i5 8th Gen or newer 6 Cores/6 Threads RAM: 64GB Graphics card: 4GB GDDR6 SSD: 1 TB **Operating system**: Ubuntu 20.04. LTS **Cloud:** Commercial: OWH, AWS, Azure, Google.
Courses (fields) assigned:	Remote Sensing, Artificial Intelligence, Geostatistics, Cartography.

Use Case Identification and History			
Use Case ID:	GEOBIZ.UC.RS.2		
Use Case Name:	**Land cover and land use mapping**	**Version No:**	Ver. No 1
End Objective:	Mapping and monitoring the classes of Land cover / Land use.		
Created by:	Gilab DOO	**On (date):**	4 August 2020

Problem description:	**Land cover** refers to the surface cover on the ground, whether vegetation, urban infrastructure, water, bare soil, or other. Identifying, delineating, and mapping land cover is important for global monitoring studies, resource management, and planning activities.Identification of land cover establishes the baseline from which monitoring activities (change detection) can be performed, and provides the ground cover information for baseline thematic maps. Detection of long term changes in land cover may reveal a response to a shift in local or regional climatic conditions, the basis of terrestrial global monitoring. **Land use** refers to the purpose and usage of the land areas, for example, recreation, wildlife habitat, or agriculture. These applications involve both baseline mapping and subsequent monitoring, since timely information is required to know what current quantity of land is in what type of use and to identify the land-use changes from year to year. There is nothing as practical and cost-efficient for obtaining a timely regional or global overview of land cover than remote sensing techniques. Remote sensing provides multispectral, multisource, and multitemporal information for accurate classification of land cover. The geospatial models for supervised and unsupervised classification allow automatic classification of LC/LU classes. The supervised classification requires the identification of specific classes in order to model and perform the LC/LU classification. The algorithm for supervisory classification requires the number of classes defined as in situ, the software will further perform the mapping of LC/LU classes. This data provides information on the class, changing class, prediction, and visualization of the possible changing of the class. That information could be disseminated using web mapping portals or GIS applications according to different user needs.
End users:	All levels of government, environmental agencies, researchers, and private industry, etc.
Objectives and functionalities:	- Web application for visualization of dynamic data such as land cover, an alert system to warn about land degradation, soil erosion, and similar;

(a result of the case)	- Prediction and visualization of certain changes in the land cover; -Visualization of the dynamic changing of the classes of land cover/land use.
Input:	Remote Sensing data: Sentinel (Sentinel 2 and Sentinel 3), Landsat, Modis satellite imageries.
Methodology and technologies:	**Methodology:** • Definition area of the interest (AOI) for monitoring; • Collection of reference (in situ) data and LC/LU nomenclature (system of classes); • Pre-processing of optical satellite images (to surface reflectance level) and cloud masking; • Creation of models for identification of LC/LU classes from time series of remote sensing data; • Prediction and visualization changes using the geospatial model. **Software technologies**: Free and open-source: Sentinel Toolbox, SAGA GIS, ORFEO Toolbox, QGIS, GRASS; Commercial: ArcMap.
Technical requirements:	**Computer specification:** Processor: Intel® Core™ i7/i5 8th Gen or newer 6 Cores/6 Threads RAM: 64GB Graphics card: 4GB GDDR6 SSD: 1 TB **Operating system**: Ubuntu 20.04. LTS **Cloud:** Commercial: OWH, AWS, Azure, Google.
Courses (fields) assigned:	Remote Sensing; Web mapping portals and applications; Advanced GIS applications.

Use Case Identification and History			
Use Case ID:	GEOBIZ.UC.RS.3		
Use Case Name:	**Crop monitoring with Remote Sensing**	**Version No:**	Ver. No 1
End Objective:	Mapping of crop types, crop monitoring during a season, yield prediction, productivity (management) zones mapping.		
Created by:	Gilab DOO	**On (date):**	5 August 2020

Problem description:	The global population expansion induces the need for more food production. As a result, the world food demand is expected to increase by 70% by 2050. However, at the same time there is a need to ensure the sustainable management and conservation of natural resources while taking actions to mitigate climate change. It is therefore essential to improve global agricultural production capacity, while ensuring its sustainability. IT means that agricultural practices, such as tillage, irrigation, crop growth monitoring and farm management have to be readjusted in the context of new geospatial technologies. Precision farming enables farmers and agronomists to access detailed information about critical indicators that define and/or influence the agricultural practices. This ensures a more cost-efficient input management, resulting in higher yields and wiser and sustainable land management. Crop monitoring parameters such as NDVI, LAI, Chl allow analyzing the status of the crops, supporting in the understanding of when to act, and how. Management zones are separate parts of a field where different amounts of products/materials should be applied. It ensures reduction of costs, maximization of the input efficiency, as well as a more sustainable soil management. Accurate forecasting of crop yield much before harvest is of great importance for many stakeholders in agriculture. Remote Sensing allows frequent data that gives periodic information in regards to crop attributes which allow remote monitoring crops on the field. Geospatial algorithms using EO data provide presented data. This data could be presented through web mapping portals, advanced GIS applications.
End users:	Farmers, agronomists, regional or national paying agencies, farmers' associations, researchers, etc.
Objectives and functionalities: (a result of the case)	• Generating information on: crop types for a specific area, crop monitoring parameters (e.g. NDVI, LAI, Chl,..), localized meteorological parameters (daily temperature and precipitation, monthly accumulated values, etc), yield estimation and management zones from remote sensing and meteorological data

	• The users can access the information through a web map application • The Web map application has the following functionalities: insert parcels, add information about parcels, retrieve values of time series of crop monitoring parameters by picking a point on map, retrieve values of localized historical meteorological parameters by picking a point on map, comparing two fields/ two points, management zones visualisation, yield prediction,
Input:	Remote Sensing data: Sentinel (Sentinel 1, and Sentinel 2), Landsat, Modis satellite imageries.
Methodology and technologies:	**Methodology**: • Developing an automatic processing chain for download and pre-processing and storage of the remote sensing and meteorological data; • Training the models for crop types mapping and yield estimation based on collected in situ data based on machine learning techniques; • Developing an algorithm for management zones detection from time series of NDVI data; • Developing of an automatic processing chain for generating: crop monitoring and meteorological parameters, management zones and yield prediction data; • Implementing web map application for dissemination of the information to the end-users. **Software technologies**: Free and open-source software: Sentinel Toolbox, SAGA GIS, ORFEO Toolbox, QGIS, GRASS, IDRISI. Geospatial algorithms developed using R, Python, GDAL, or etc.
Technical requirements:	**Computer specification:** Processor: Intel® Core™ i7/i5 8th Gen or newer 6 Cores/6 Threads RAM: 64GB Graphics card: 4GB GDDR6 SSD: 1 TB **Operating system**: Ubuntu 20.04. LTS **Cloud:** Commercial: OWH, AWS, Azure, Google.
Courses (fields) assigned:	Remote Sensing, Artificial Intelligence, Geostatistics, Web cartography, Web GIS.

Use Case Identification and History			
Use Case ID:	GEOBIZ.UC.RS.4		
Use Case Name:	**Application of remote sensing data in mapping and monitoring forest**	**Version No:**	Ver. No 1
End Objective:	Reduction costs of fieldwork in terms of forest inventory: mapping, classification, monitoring.		
Created by:	Gilab DOO	**On (date):**	4 August 2020

Problem description:	Remote Sensing data can be used to provide effective and efficient forest planning and forest management. Frequent satellite imageries use for: • mapping and classifying forest areas, mapping burnt areas of the forest; • monitoring forest health and growth, and erosion. Mapping forest areas, different forest types, and burnt areas can be done using different methodology and software solutions for mapping. Classifying types of forest can be supervised and unsupervised. This is being worked by applying existing software solutions or developing geospatial machine learning models for classifying forest types. Multitemporal data provides can be used for change detection analyses. Images of earlier periods are compared to recent scenes, to tangibly measure the differences in the sizes and extents of the clear-cuts or loss of forest. Monitoring the health of forests is crucial for sustainability and conservation issues. Vegetation indexes from multispectral data that monitor are: Normalized Difference Vegetation Index (NDVI), Leaf Area Index (LAI), and Leaf Chlorophyll Content. The index value must be within the allowed values for healthy vegetation. Based on vegetation index and comparing satellite images from different time series it is possible to make prediction and visualization erosion. The result of the mapping, classifying, visualization of the change, prediction possible situation in the forest should be presented through web mapping portals. Also, it can be combined with cadastral parcels or other vector data to better overview certain situations.
End users:	Ministry of Forests, Agencies for monitoring the area of forests, researchers, forest companies, other public or governmental institutions interested in the area of forest.
Objectives and functionalities:	- Mapping burnt area on satellite imagery;

(a result of the case)	- Time series of biophysical parameters for health monitoring; - Application remote sensing data for monitoring the health and the erosion (in terms of woodcutting and forest fire) of the forest; - Application for monitoring in an emergency situation and after (monitoring the area after an emergency situation concerning the growth of the new plants); - The potential problem can be avoided if certain parameters are monitored seriously.
Input:	Remote Sensing data: Sentinel (Sentinel 3, Sentinel 1, and Sentinel 2), Landsat, Modis satellite imageries.
Methodology and technologies:	**Methodology**: • Collection of reference (in site) data for training the models and validation; - Pre-processing of satellite images; • Definition project boundaries AOI (area of interest) of the forest for which is needed to monitoring health and erosion or measure and classification type of forests; • Develop machine learning model for supervised and unsupervised classification forest type; • Develop an algorithm for calculating vegetation index; • Develop web mapping portals for collecting relevant information and for visualization forest data. **Software technologies**: Free and open-source: Sentinel Toolbox, SAGA GIS, ORFEO Toolbox, QGIS, GRASS, GDAL, R, Python.
Technical requirements:	**Computer specification:** Processor: Intel® Core™ i7/i5 8th Gen or newer 6 Cores/6 Threads RAM: 64GB Graphics card: 4GB GDDR6 SSD: 1 TB **Operating system**: Ubuntu 20.04. LTS **Cloud:** Commercial: OWH, AWS, Azure, Google.
Courses (fields) assigned:	Remote Sensing, Artificial Intelligence, Geostatistics, GIS/Vector raster analysis, Web cartography.

Use Case Identification and History			
Use Case ID:	GEOBIZ.UC.GVA.1		
Use Case Name:	**Digitization of paper urban planning maps**	**Version No:**	Ver. No 1
End Objective:	Collection of data from paper urban planning maps in order to solve storage issues and enable efficient data access and retrieval		
Created by:	Gilab DOO	**On (date):**	10 August 2020

Problem description:	Today, all planning documentation is made in digital form. Also, almost all old plans, which were originally made in paper form, have been digitized, ie. exist in digital form (usually vector data). However, there are still paper planning maps that need to be digitized in order to combine them with other digital data, namely: Vector data (cadastral plans, topographic plans, GPS points, vector models, etc.) Raster data (aerial imagery, LIDAR, DEM/DTM, and other generated models, etc.) The result of the digitization process are vector data sets that can be displayed and edited in either a GIS environment or through a web map portal (WFS service).
End users:	Urban planner, Inspectorate.
Objectives and functionalities: (a result of the case)	• All urban planning maps in digital form; • Efficient access to and retrieval of urban planning spatial data; • Secure storage of valuable urban planning documents; • A better review of all urban planning data and improved decision making.
Input:	Scanned analog plan.
Methodology and technologies:	**Methodology:** • Georeferencing scanned plans; • Creating a database to store data; • Mapping features; • Create a WFS service; • Optionally, a publication of the results as web maps. **Software technologies**: <u>Free and open-source:</u> QGIS; <u>Commercial:</u> ArcMap.
Technical requirements	**Computer specifications:** Processor: Intel® Core™ i7/i5 8th Gen or newer 6 Cores/6 Threads RAM: 64GB

	Graphics card: 4GB GDDR6 SSD: 1 TB **Operating system**: Ubuntu 20.04. LTS
Courses (fields) assigned:	GIS/Vector raster analysis, Cartography, Introduction to GIS.

Use Case Identification and History			
Use Case ID:	GEOBIZ.UC.GNSS.1		
Use Case Name:	**GPS for Topographic maps**	**Version No:**	Ver. No 1
End Objective:	The end objective should be a digital topographical model of the measured area ready to be exported as a topo map.		
Created by:	Gilab	**On (date):**	20 August 2020

Problem description:	Topographic maps represent valuable resources when it comes to describing and analyzing information about construction sites and fields in general. Thanks to the topo maps, engineers have possibilities to plan and organize job activities in advance much easier than without it. In order to support important infrastructure projects, it is necessary to have up-to-date topographic maps that describe the construction site in the right way - combining information about terrain configuration and information about the available infrastructure. One of the ways of gathering spatial data in a fast way and with great precision is using GPS devices. This way precise data is gathered much faster than it would be done using other surveying terrestrial methods. Nowadays GPS devices can support almost every advanced user on the field, data gathered with this technique can be characterized as very precise and usable in almost every part of the industry. The end objective should be a digital topographical model of the measured area ready to be exported as a topo map.
End users:	Civil engineers, Architects; Urban planners; Geodetic and legal services; Inspectorates; Governmental institutions, citizens, etc.
Objectives and functionalities: (a result of the case)	Creating topographic maps for project planning, decision support, and project organization in accordance with different end-user necessities: • Creating cadastral topographic maps • Thematic phenomena mapping and visualization; • Urban planning; • Updated of existing topographic maps; • Analyzing field configuration in order to prevent natural disasters.
Input:	Cadastral information about certain parcel lots.
Methodology and technologies:	**Methodology**: • Registration and localization of GPS receiver; • Gathering data; • Data processing and classification; • Map creation.

	Software technologies: Free and open-source software: QGIS; Commercial: Trimble Business Center, Leica Geo office, ArcMap.
Technical requirements:	**Equipment:** Trimble R8, Leica Viva GS14 & Leica Viva CS10 or CS15 **Software:** Trimble Business Center, Leica Geo office
Courses (fields) assigned:	The cadastral survey, Cartography, GIS, Digital Topography.

Use Case Identification and History			
Use Case ID:	GEOBIZ.UC.GNSS.2		
Use Case Name:	**Development of an application for applying GNSS in agriculture**	**Version No:**	Ver. No 1
End Objective:	Application for monitoring tractors based on RTK GNSS in precision agriculture.		
Created by:	Gilab DOO	**On (date):**	10 August 2020

Problem description:	Precision agriculture is a highly effective farming strategy that allows farmers to better allocate inputs (e.g. seeds and fertilizers) and increase productivity while lowering costs and minimizing environmental impact. There are two main categories of solutions based on global navigation satellite system (GNSS) in the agriculture sector: **Low-technology GNSS** solutions are used for low-value crop cultivation (e.g. cereals), low accuracy operations (e.g. fertilizing and reaping), and for agro-logistic applications (e.g. land parcel identification and yield mapping). Most of these techniques rely on standard GNSS receivers complemented by free satellite-based augmentation services such as EGNOS in Europe. The level of accuracy achieved is below 1 meter, while pass-to-pass accuracy is +/- 15–30 cm. **High-technology GNSS** solutions are more costly and are typically used for high-value crop cultivation (e.g. potatoes and vegetables) or precision operations (sowing and transplanting). More advanced positioning technologies, such as local and regional Real Time Kinematics (RTK) systems or commercial satellite-based augmentation services. The levels of accuracy achieved are in the range of 2-10 cm with a pass-to-pass accuracy of +/- 2–3 cm. GNSS RTK is implemented in tractors and it is connected with applications. Through applications, farmers have received information in regards to tractor trajectory in real-time or in certain periods. The real-time (or post-real-time) location/time data is stored in the application's database and farmers can see the trajectories of the tractor equipped with GNSS receiver. Medium and large farms deploy several tractors at the same time. It is of crucial importance for them to track real-time positions of the tractors. By using the API for real-time import of location, farmers can see in the application the real-time locations of their tractors on the map of the platform.
End users:	Farmers.
Objectives and functionalities:	Enable farmers to access and analyze their machines trajectories during key field activities:

(a result of the case)	• Allow the farmers to know in real-time which machinery is being used and where it is on the field; • The farmer chooses a certain tractor and a certain period of time and the trajectory is displayed, possibly also with information related to fuel consumption.
Input:	GNSS data in real-time;
Methodology and technologies:	**Methodology**: • App development process; • Use of sensors in the app development; • Space-time data representations; • Space-time visualization and analysis; • Development of a geospatial model to display tractor location on the map in real-time; • Development of a geospatial model for printing detailed information about all tractors which are included in the farm. • Presentations of analytics based on trajectories. **Programming language:** Applications developed using R, Python, GDAL, Java, PHP, JavaScript or etc.
Technical requirements:	**Computer specification:** Processor: Intel® Core™ i7/i5 8th Gen or newer 6 Cores/6 Threads RAM: 64GB Graphics card: 4GB GDDR6 SSD: 1 TB **Operating system**: Ubuntu 20.04. LTS
Courses (fields) assigned:	Navigation and positioning GNSS, Advanced GIS applications, Programing, Sensors, Mobile GIS, Web GIS, Web cartography.

Use Case Identification and History			
Use Case ID:	GEOBIZ.UC.WMP.1		
Use Case Name:	**3D Urban information models for assessment of the solar potential of buildings**	**Version No:**	Ver. No 1
End Objective:	Open-source toolkit for gathering information on roofs' solar potential and visualization of the information in 3D web application.		
Created by:	Gilab	**On (date):**	1 July 2020

Problem description:	Globalization and fast technological changes have a very strong impact on city development. Developing services for solar energy assessment can contribute to society in order to use more green energy resources and live in healthier environments. Solar energy services enable users to find and visualize the monthly and annual irradiation maps over the area of interest. Using all gathered information about the object potential user is available to calculate how much resources is necessary to invest during some period of time and when the investigation becomes profitable. Energy dispersion and solar energy potential assessment deliver services that are able to calculate solar energy potential at high precision based on accurate 3D models of the urban landscape. Assess energy efficiency at an urban scale through the automatic generation of energy dispersion maps. Data should be assembled in CityGML format which has the ability to present them as 3D objects. As mandatory values are roof information (area and orientation), Solar irradiation, and information about the solar panel. Depending on roof type CityGML should combine different LoD models for calculation area. As a result of Solar potential and irradiation assessment raster maps will be produced. As a factor of influence, geographic factors like aspect, shading and orientation of the roof should be considered as well as position of the Sun. After analysis, the final product would be information about total costs, carbon savings, reduction of costs in the field of using energy from different sources as well as information about solar potential and energy loss from roofs and walls.
End users:	National or local governments, citizens, etc.
Objectives and functionalities: (a result of the case)	- Geoportal with 3D visualization (e.g. CesiumJS) of objects and roofs; - Assessment of cost reduction and return on investment; - All information is available after clicking on the roofs presented in 3D geoportal;

	- Graphical presentation of the results is available on the popup window; - Usage of solar energy for CO_2 emission reduction and a sustainable city environment.
Input:	DTM, DSM, CityGML (LoD).
Methodology and technologies:	**Methodology**: • Solar radiation modeling using GIS algorithms; • Definition and computation of solar irradiation raster maps for given day, latitude, surface, and atmospheric conditions; • 3D urban modeling using standard representations and CityGML; • Algorithms for automated modeling of roofs based on the point clouds or other relevant data; • Creating different LoDs for surface prediction and calculation using the CityGML application scheme. **Software technologies**: <u>Free and open-source software:</u> SAGA GIS, QGIS, GRASS Geospatial algorithms developed using Python, GRASS GIS, or etc.
Technical requirements:	**Computer specification:** Processor: Intel® Core™ i7/i5 8th Gen or newer 6 Cores/6 Threads RAM: 64GB Graphics card: 4GB GDDR6 SSD: 1 TB **Operating system**: Ubuntu 20.04. LTS
Courses (fields) assigned:	Spatial Analysis, Data visualization, Data modeling, Web GIS, Web cartography

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Use Case Identification and History			
Use Case ID:	GEOBIZ.UC.TLS.1		
Use Case Name:	**3D measurement with a terrestrial laser scanner and object visualization**	**Version No:**	Ver. No 1
End Objective:	3D measurement using a terrestrial laser scanner and 3D visualization of the object in order to monitor the object.		
Created by:	Gilab DOO	**On (date):**	10 August 2020

Problem description:	One of the methods for a quick and complete collection of 3D data is terrestrial laser scanning of different buildings and terrains. Currently, it is the leading survey technology providing a large amount of spatial data at large scale. Laser scanning data have a high quality and can be used in various fields, including topographic surveys and industrial environments. The raw data of the spatial information consist of data points in a point cloud system, numbering in the thousands, which can be processed and edited to create digital surface model visualizations, e.g. digital terrain models (DTM), 3D city models, road models, electricity channel models, 3D object models for cultural heritage preservation and historical documentation, etc. The main advantage of using laser scanning as a survey technique is that it provides complete facility in data acquisition and that it delivers 3D data. In this case, it is used to measure the object in order to monitor the deformation, process the results, create the models, and present the results.
End users:	Ministry of Culture, secretariats, architects, civil engineers, etc.
Objectives and functionalities: (a result of the case)	-Georeferenced 3D model of the building for measurement of characteristic points important in monitoring deformation; -Georeferenced 3D model of the building for the preparation and analysis of the reconstruction; -Collecting technical documentation on cultural and monumental heritage. - Identification of deformations.
Input:	Coordinates of points for georeferencing a 3D model of the object being captured.

Methodology and technologies:	**Methodology**: • Determining the coordinates of landmarks using GNSS; • Placement of measured marks for georeferencing 3D models of the object absolutely in space (taking into account the overlap of scans); • Determining the scan resolution; • Scanning the subject from different points of view (coordinates determine with GNSS); • Processing of individual scans (elimination of rough errors); • Registration of various scans in the point cloud; • Creating mesh; • The export of the points clouds to specific formats for further analysis in other 3D modeling software; • Creating mesh and solid models in software such as 3DReshaper. **Software technologies**: Commercial: Leica Cyclone 3D Point Cloud Processing Software; 3D Reshaper.
Technical requirements:	**Equipment:** Leica ScanStation P20, Faro Focus3D X330. **Computer specification:** Processor: Intel® Core™ i7/i5 8th Gen or newer 6 Cores/6 Threads RAM: 64GB Graphics card: 4GB GDDR6 SSD: 1 TB **Operating system**: Ubuntu 20.04. LTS
Courses (fields) assigned:	Terrestrial laser scanning.

Use Case Identification and History			
Use Case ID:	GEOBIZ.UC.AGA.3		
Use Case Name:	**Utility and Government Services**	**Version No:**	Ver. No 1
End Objective:	Design and development of a public register including data acquisition, entry, integration and web publishing		
Created by:	GAUSS DOO	**On (date):**	12 November 2020

Problem description:	To effectively service citizens, the local government and utility companies develop and maintain various public utility registers such as the register of communal containers, green areas, street lighting, local government property, water, and energy supply, CATV, telecommunication services, etc. This development involves the integration of different sets of spatial data and GIS software tools for their collection and updating. The public register aims to provide up-to-date information on utility facilities to carry out further development and maintenance of communal installations and spatial planning. The GIS project of a utility register (UR) includes the following tasks: development and implementation of a GIS application and UR database, migration of digital legacy data into the UR information system, including all records on utility survey, integration of UR with different data sources into a single database including access to real estate cadastre, orthophoto, and DTM via Web data services. Integrating different data sources into a single database involves converting data from different formats, projections, or reference systems, and adapting them to a prescribed data model. Accessing data in an application environment without their permanent and physical placement in a database implies integration at the application level, which is most effectively solved by accessing the data via Web services.
End users:	Local government departments responsible for management of communal infrastructure, public communal companies, utility companies.
Objectives and functionalities: (a result of the case)	Designed and developed a utility register
Input:	Address data, administrative boundaries, orthophoto, real estate cadastre, Web data services.

Methodology and technologies:	**Methodology**: Integration of spatial data sets includes: • making the inventory of available data, • analysing the data model and proposing data transformation procedures, • recognizing the external data sources and options for data access, • proposing the design for web solution and utility register application, • including access to data sources. Migration legacy data into UR database includes the following data transformation procedure: • clearing geometry data from legacy system (CAD files), • editing the contents of the drawing, • transformation lines in polylines and polygon objects • reducing duplicate content after conversion to the GIS • identification of the utility characteristics and input of attribute data • processing information of significance for the data quality (input metadata) • detailed control of the entire converted content WMS, WCS and WFS web services should be available to provide access to real estate cadastre, official maps, administrative boundaries and orthophotos. **Software technologies**: Commercial: ESRI ArcGIS Open Source: QGIS
Technical requirements:	**Equipment:** **Computer specification:** Processor: Intel® Core™ i7/i5 8th Gen or newer 6 Cores/6 Threads RAM: 64GB Graphics card: 4GB GDDR6 SSD: 1 TB **Operating system**: Ubuntu 20.04. LTS
Courses (fields) assigned:	Advanced GIS applications.

Use Case Identification and History

Use Case ID:	GEOBIZ.UC.AGA.2		
Use Case Name:	**Statistical Surveys I**	**Version No:**	Ver. No 1
End Objective:	Cartographic data processing for the spatial division of the sampling area (census circles and enumeration units for statistical survey)		
Created by:	GAUSS DOO	**On (date):**	12 November 2020

Problem description:	To update their statistical data sets, state agencies for statistics periodically conduct field data collection and perform calculations on the data. Cartographic agencies (geodetic services) usually prepare maps used to organize these works in the field. To collect statistical samples in the field (e.g., for the census of population and households), it is necessary to determine the boundaries of census circles and enumeration units correctly. The boundaries and number of households with their positions can be collected by mobile devices (GIS / GPS) and registered in a central geospatial database in real-time. Often, the original boundary data is displayed on paper maps that need to be digitized and updated. These maps need to be scanned and georeferenced, and then border vectorization and topological verification of the vectorized content should be performed. The boundaries of the polygons should be properly closed (without overlaps and gaps), and linked to the attribute tables with a textual description of areas (no. of enumeration unit, ID of census circle, settlement name). Enumeration units, census circles, and sample points (households) which are stored in a geospatial database should be used in statistical analysis and further research.
End users:	Statistical offices, companies specializing in surveying and statistical studies, state institutes and statistical agencies, etc.
Objectives and functionalities: (a result of the case)	• Collected field data (addresses and house numbers of residential and industrial facilities) stored in the database; • Axle lines and street names entered and stored in the database; • Scanned and georeferenced raster map of census units and statistical circles; • Vectorized polygons with topological control and entered related attribute data stored in the database.; • Boundaries of municipalities, settlements, local communities and cadastral municipalities stored in the database. • Designed new maps (for census) with updated census circles and enumeration units printed in PDF format.

Input:	Addresses and house numbers of residential and industrial facilities; scanned maps; orthophoto; boundaries of municipalities, settlements, local communities and cadastral municipalities;
Methodology and technologies:	**Methodology**: • Load and georeferencing of a raster map; • Vectorization of boundaries (census circles and enumeration units); • Geometric and topological control of polygons and correction; • Loading orthophotos; • Drawing street axes; • Enter street names and their annotations; • Import points (objects); • Map design with updated boundaries of statistical circles; • Print maps in PDF. **Software technologies**: Commercial: ESRI ArcGIS Open Source: QGIS
Technical requirements:	**Equipment:** Scanner **Computer specification:** Processor: Intel® Core™ i7/i5 8th Gen or newer 6 Cores/6 Threads RAM: 64GB Graphics card: 4GB GDDR6 SSD: 1 TB **Operating system**: Ubuntu 20.04. LTS
Courses (fields) assigned:	Advanced GIS applications.

Use Case Identification and History			
Use Case ID:	GEOBIZ.UC.WMP.2		
Use Case Name:	**Statistical Surveys II**	**Version No:**	Ver. No 1
End Objective:	Mapping and publishing of statistical survey data		
Created by:	GAUSS DOO	**On (date):**	12 November 2020

Problem description:	State statistical agencies, as well as companies engaged in statistical research, should present and publish the processed data sets in the form of a map. Map design implies experience and knowledge of the use of classification schemes, histograms, and the correct application of types and graphic elements of the map. Visualization of statistical data involves the use of maps, charts, diagrams, and tables, including work with images and multimedia data in graphics programs. Design principles, symbolization techniques, and multivariate displays are used to create and edit visual representations of geospatial data for a specific user type and purpose. Mapped statistics can be published as a single web map, via a geoportal, or as part of an enterprise WebGIS infrastructure for managing an organization's spatial data. Designing and publishing statistical data sets involves a wide range of activities and professional skills including knowledge of cartographic design, geospatial database, and use of data web services.
End users:	State institutes and agencies, companies specializing in statistical research, consulting companies for marketing.
Objectives and functionalities: (a result of the case)	• Designed map for presentation of statistics data set and printed in PDF format. • Thematic map (with diagrams and tables) published via the web
Input:	Statistical data sets, boundaries of municipalities.

Methodology and technologies:	**Methodology**: • selection and structuring of statistical data; • loading spatial units (municipal polygons) for cartographic presentation; • linking geometric data (spatial units) with attribute tables (statistics); • determining the type of map and classification schemes for visualization; • creating symbology and adding graphic elements; • preparing the template for printing and printing the map in PDF; • publishing the thematic map via the web. **Software technologies**: Commercial: ESRI ArcGIS Open Source: QGIS
Technical requirements:	**Equipment:** **Computer specification:** Processor: Intel® Core™ i7/i5 8th Gen or newer 6 Cores/6 Threads RAM: 64GB Graphics card: 4GB GDDR6 SSD: 1 TB **Operating system**: Ubuntu 20.04. LTS
Courses (fields) assigned:	Web mapping portals and applications.

Use Case Identification and History			
Use Case ID:	GEOBIZ.UC.AGA.4		
Use Case Name:	**Register of Spatial Units and Addresses**	**Version No:**	Ver. No 1
End Objective:	Registration and using spatial units, street names and house numbers		
Created by:	GAUSS DOO	**On (date):**	12 November 2020

Problem description:	The lack of an up-to-date address register causes various problems in everyday life, including an inability to deliver mail to the assigned address, inability to find the exact location for citizens and various public services (inspections, police, tax administration, etc.), and problems in organizing censuses; voting, etc. Various records of users of utility services (water supply, electricity, telecommunication services) in addition to identification data include their addresses for submitting bills and meter readings. A large number of various utility devices and installed equipment are related in an attributive sense to the addresses of facilities, buildings, or users. Therefore, the need to collect and update address register data is unquestionable. The project of address register for an administrative area includes: • design and development of GIS for address register management, • data collection (existing addresses and locations of facilities), • control of collected data, and • data entry into the registry database.
End users:	Local government departments responsible for management of address and spatial units registers.
Objectives and functionalities: (a result of the case)	Development of an address register including GIS application design and data entry.
Input:	Orthophoto, address data, collected field data on residental and industrial facilities, vector boundaries of settlements and municipalities, Web data services.

Methodology and technologies:	**Methodology**: Using the necessary topographic data, database of real estate cadastre and orthophoto it is necessary to provide: • collect data on facilities in the specified area of local government, • for each registered building, indicate which street the building number belongs to, • draw street lines, • linking attribute data (street names) and geometry (street lines) • define the polygons of the existing streets, • perform new object numbering, • design and print a map of streets and house numbers in PDF. **Software technologies**: Commercial: ESRI ArcGIS Open Source: QGIS
Technical requirements:	**Equipment:** **Computer specification:** Processor: Intel® Core™ i7/i5 8th Gen or newer 6 Cores/6 Threads RAM: 64GB Graphics card: 4GB GDDR6 SSD: 1 TB **Operating system**: Ubuntu 20.04. LTS
Courses (fields) assigned:	Advanced GIS applications.

Use Case Identification and History			
Use Case ID:	GEOBIZ.UC.AGA.5		
Use Case Name:	**Geovisualization in Spatial Epidemiology**	**Version No:**	Ver. No 1
End Objective:	Integration of environmental, demographic and health data sets for spatio-temporal presentation of epidemiological variables in order to prevent the spread of the epidemic;		
Created by:	GAUSS DOO	**On (date):**	12 November 2020

Problem description:	GIS can be used in many applications in the health area, including spatial epidemiology, disease spatial modeling, cluster or hot spot analysis, and as a tool for policymaking in public health. In spatial epidemiology. There are numerous examples of GIS applications with generic methods and tools in predictive emergence and spread models, early warning, surveillance, and monitoring infectious and spread scenarios modeling, which can be used by decision-makers for risk assessment, decision support for intervention, and public health policies. Spatial epidemiology is an area of epidemiology focused on the study of the spatial distribution of health outcomes, closely related to health geography. It deals with the description and examination of the disease and its geographical variations, taking into account demographic, environmental, socioeconomic, genetic, risk, and other factors. In a pandemic emergency, GIS can be an effective tool for analyzing epidemic data and reporting. It incorporates mechanisms for communication, analysis, and reporting epidemic situations. By continuously collecting epidemic data from public health sources, it can combine it with geographical, demographic, and related environmental data sets, process it using the selected analytical methodology, and display results arranged in the form of diagrams, attribute tables, interactive maps, and animations by geoportal. In addition to the techniques of geospatial analysis and the presentation of epidemiological data, various biostatistical methods can be simultaneously used to monitor and predict the spread of infection, and to evaluate the effectiveness of control measures taken to stop the epidemic.
End users:	Institutes for public health
Objectives and functionalities: (a result of the case)	The spatial and temporal monitoring of the epidemic spread through: • the collection of epidemiological and other data important for monitoring the outbreak of the epidemic and its spread, • spatio-temportal analysis of the virus spread rate and distribution of infectious, in order to identify the effectiveness of individual control measures.

Input:	Spatial units and address register data, population (sex, age, density), orthophoto, epidemiological variables (incidence, deaths, infectious, recovered, tested), health services and hospitals
Methodology and technologies:	**Methodology**: The following methods, techniques and tools for spatial-temporal presentation and exploratory data analysis can be used: • spatial filtering (geofiltering) of epidemiological data and their presentation using diagrams; • timeline tools (spatial-temporal data analysis); • a choropleth map for thematic data presentation; • info tools to display attached documents (diagrams, decisions, scientific data, reports); • biostatistical data processing (R, excel, QGIS). **Software technologies**: Commercial: ESRI ArcGIS Open Source: QGIS
Technical requirements:	**Equipment:** **Computer specification:** Processor: Intel® Core™ i7/i5 8th Gen or newer 6 Cores/6 Threads RAM: 64GB Graphics card: 4GB GDDR6 SSD: 1 TB **Operating system**: Ubuntu 20.04. LTS
Courses (fields) assigned:	Advanced GIS applications; Web mapping portals and applications;

Use Case Identification and History			
Use Case ID:	GEOBIZ.UC.GVRA.3		
Use Case Name:	**Geomarketing Analysis for Banking Services**	**Version No:**	Ver. No 1
End Objective:	Optimization of the ATMs' number and their spatial distribution.		
Created by:	GAUSS DOO	**On (date):**	12 November 2020

Problem description:	When defining ATM locations, most banks use geographical and demographic divisions with administrative units (municipal and settlement boundaries) which generally tell us where people live, work, and shop in certain areas. Information that also significantly affects the profitability associated with the location of an ATM is related to traffic flow prediction, customer behavior, people's movement habits, and competitive dynamics, but these factors are very often neglected. Any improvement in the process of geomarketing analysis leads to better optimization of the coverage of areas with ATM locations and their total number in the ATM network, which directly affects higher profitability. Therefore, banks very often hire consulting companies for statistical analysis and geomarketing services whose task is to optimize facilities (branches) including the ATM network to better position themselves in the market and reduce their costs. Geoinformatics and marketing experts in these companies use statistical and GIS tools, as well as operational research methods for market analysis and optimization of business activities.
End users:	Banks, ATM service companies, marketing consultants
Objectives and functionalities: (a result of the case)	Optimimum number of the ATMs and their coverage of research area.
Input:	ATM data, boundaries of municipalities and settlements, orthophoto, streets, demographic data for more age categories

Methodology and technologies:	**Methodology**: The following procedure can be performed to determine ATM locations: • defining and weighting the goals (criteria) of the ATM network, • identification of key locations for catchment areas, • creating a short list of candidate sites, • selection of sites based on adopted operational research model. The analytical procedure includes the following: • acquisition and entry of ATM data, • integration of spatial and statistical data for geomarketing analysis (addresses, spatial units, demographic data for target population categories), • spatial analysis and optimization of the number and spatial distribution of ATMs. **Software technologies**: Commercial: ESRI ArcGIS Open Source: QGIS
Technical requirements:	**Equipment:** **Computer specification:** Processor: Intel® Core™ i7/i5 8th Gen or newer 6 Cores/6 Threads RAM: 64GB Graphics card: 4GB GDDR6 SSD: 1 TB **Operating system**: Ubuntu 20.04. LTS
Courses (fields) assigned:	GIS vector/raster analysis;

Use Case Identification and History			
Use Case ID:	GEOBIZ.UC.GVRA.1		
Use Case Name:	**Geological Assessment of Soil Stability**	**Version No:**	Ver. No 1
End Objective:	Landslide registration and monitoring		
Created by:	GAUSS DOO	**On (date):**	12 November 2020

Problem description:	A landslide is a kind of natural disaster caused by various environmental processes including human activities and can cause huge damages. A landslide is related to seasonal prolonged heavy rainfall, improper drainage system, erosion, soil type, the magnitude of the slope and load of the sliding surface, and other triggering factors that can move and accelerate its sliding. To prevent landslides, geologists register their location, surface, and locality, and regularly monitor changes related to their condition, geotechnical characteristics of soil, precipitation, endangerment of nearby facilities and road infrastructure, and their other physical properties. There is no effective mitigation scheme for a landslide impact. A possible solution is to provide a reliable early warning system that is available to the public. For the development of such an efficient system, extensive monitoring of slope activity in a given area, and identification of potential failures are of particular importance. Various techniques are available to monitor and assess the stability of soil slopes including surface measurements, morphological analyses, and stability assessment. The most commonly used methods for soil slope monitoring are terrestrial laser scanning (TLS), global positioning systems (GPS), remote sensing (RS), and geographic information systems (GIS). For slope stability analysis and to estimate the land risk before issuing the building permissions, it is convenient to check soil stability using raster GIS.
End users:	Institutes of geology and geotechnics, departments of urbanism and construction in local government, institutes for urbanism and spatial planning
Objectives and functionalities: (a result of the case)	Design soil stability map for urban planning and to check soil stability for issuing the building permissions. Applying a slope stability map with a landslide register in GIS provides a reliable overview of processes related to soil instability that can be used for the purpose of landslide prediction during heavy rainfall.
Input:	lithological data, rock strength map (grid), DEM, orthophoto, landslide locations and attributes, municipal boundaries, settlements,

Methodology and technologies:	**Methodology**: Slope stability analysis using raster GIS includes: • preparation of a rock strength map (using lithological data for the research area); • making a slope map based on DEM (digital elevation model) data; • making a slope stability map (combination of data from previous maps); • verification of slope stability data by comparing its data with field samples; **Software technologies**: Commercial: ESRI ArcGIS Open Source: QGIS
Technical requirements:	**Equipment:** **Computer specification:** Processor: Intel® Core™ i7/i5 8th Gen or newer 6 Cores/6 Threads RAM: 64GB Graphics card: 4GB GDDR6 SSD: 1 TB **Operating system**: Ubuntu 20.04. LTS
Courses (fields) assigned:	GIS vector/raster analysis;

Use Case Identification and History			
Use Case ID:	GEOBIZ.UC.GVRA.2		
Use Case Name:	**Geodata for Urbanism and Spatial Planning**	**Version No:**	Ver. No 1
End Objective:	Geodata acquisition for development of urban project in GIS; spatial data analysis for urban /spatial plan development; public presentation of spatial plan in GIS; printing graphic excerpt from urban plan in GIS as an attachment for building permit.		
Created by:	GAUSS DOO	**On (date):**	12 November 2020

Problem description:	For urban plans and projects, it is necessary to collect large amounts of spatial data. Rapid and cost-effective methods of photogrammetric and LiDAR surveying are most often methods used for field data collection. Sensors for these methods can be mounted on drones, which is often a flexible and adaptable solution, especially for undeveloped and non-urban land. Land use planning is an activity that is realized within the development of a spatial plan, to identify the urban purpose of land, which best meets the existing criteria and set strategic goals. The land-use plan includes a multicriteria analysis of more identified factors, such as natural, economic, demographic, and others. The suitability of land for individual purposes can be determined based on the results of multi-objective and/or multi-criteria analysis. When all the studies for certain aspects of the spatial plan have been processed, before its final adoption, its public presentation to citizens and economic entities is carried out through a public presentation. Web presentation via a public geoportal is used as one of the ways of presentation. WebGIS can be an effective tool for this purpose. The adopted spatial plan, as well as urban plans, represents the basis of urban and rural development serving urban space management and its construction. When issuing construction permits, these plans are consulted, and excerpts from certain graphical representations in the GIS are submitted as their attachment.
End users:	Institutes for urbanism and spatial planning, departments for urbanism in local government.
Objectives and functionalities: (a result of the case)	Geodata collected for development of urban project in GIS. Multicriterial raster (grid) analysis for land suability assessment performed. Public presentation of spatial plan via Web.

	Printing graphic excerpt from urban plan (designed in GIS) as an attachment for building permit.
Input:	Orthophoto, DEM, urban infrastructure data, spatial plan, boundaries of settlements
Methodology and technologies:	**Methodology**: Geodata acquisition for development of urban project in GIS implies the following activities: • survey (flight) planning • terrain data collection • data processing and presentation • import data in GIS or CAD/BIM software • data integration with other spatial data sets in GIS The following natural factors can be used to assess the suitability of land for urban development: • natural accessibility (in relation to the center of the settlement), • slope - inclination of the terrain obtained as a result of field analysis, • relative height - height obtained by hypsometric relief analysis and treated as an indicator of thermal regime, • exposition - exposure of the relief surface to the sun, • land value (for agriculture or forestry), • vegetation cover (ecological) value - assessment according to topographic categories obtained, e.g., by analysis of satellite images. Spatial data that can be presented by grids related to each criterion. Applying map algebra over grids that are weighted in proportion to their importance, it is possible to conduct a multicriteria valuation of land for a particular urban purpose. **Software technologies**: Commercial: ESRI ArcGIS Open Source: QGIS
Technical requirements:	**Equipment:** **Computer specification:** Processor: Intel® Core™ i7/i5 8th Gen or newer 6 Cores/6 Threads RAM: 64GB Graphics card: 4GB GDDR6 SSD: 1 TB **Operating system**: Ubuntu 20.04. LTS
Courses (fields) assigned:	GIS vector/raster analysis;

Use Case Identification and History			
Use Case ID:	GEOBIZ.UC.UAV&TLS.1		
Use Case Name:	**Geodata for Civil Engineering and Architecture Designing**	**Version No:**	Ver. No 1
End Objective:	Indoor and outdoor data surveying and mapping for infrastructure facility design in civil engineering and architecture		
Created by:	GAUSS DOO	**On (date):**	12 November 2020

Problem description:	Geoinformation systems integrate many techniques and technologies for the collection, processing, and analysis of geospatial data, such as digital cartography, web mapping, satellite imaging, GNSS, laser (LiDAR) measurements, and digital photogrammetry. The latter three are of particular importance in architectural and construction design due to cost-effectiveness and rapid data collection. GNSS is a mature and widely used technology for collecting vector data. Due to obstructions in satellite visibility, this is not an ideal solution, but in combination with other measurement techniques, it is often the basic method of surveying and navigation. LiDAR has become an increasingly common and important source of information for generating high-quality digital surface models (DSM). It offers one of the most accurate and expeditious ways of mass gathering positional and altitude information to produce detailed DSM's. The data collected in this way contain a wealth of information about buildings, vegetation, streets, and various urban infrastructure objects in digital format, which enables their direct processing and production, both of high accuracy digital altitude models and many other structured data sets. Also, terrestrial LiDAR is increasingly used to collect positional information within buildings, where there are no competing technologies. For the design and construction of infrastructure facilities, it is necessary to use spatial data sets that provide a sufficient amount of information. The advantage of using UAV photogrammetric systems to obtain a digital terrain model, orthophoto, and 3D data is reflected in their flexibility in terms of time, cost, and accuracy. By combining UAV photogrammetric, LiDAR, and GNSS surveys, it is possible to provide quality data for almost every engineering task related to the design, construction, and supervision of infrastructure facilities. The choice of method and technology depends on the type of construction site, the correct assessment of task feasibility and costs.
End users:	Construction companies, architectural bureaus, surveying companies

Objectives and functionalities: (a result of the case)	Orthophoto, DEM, 2D map, 3D points cloud, control point coordinates, facility intersections and profiles, volume data
Input:	Coordinate system and map projection parameters, geodetic datum, flight plan, LiDAR data, areal images, GNSS data for post-processing, control point coordinates
Methodology and technologies:	**Methodology**: Indoor and outdoor data surveying and mapping for infrastructure facility design in civil engineering and architecture: • survey (flight) planning, • terrain data collection, • data processing and presentation, • import data in GIS or CAD/BIM software, • data integration with other spatial data sets in GIS. **Software technologies**: Commercial: AgiSoft, GeoSLAM Hub & Draw Open Source: QGIS, PC, MeshLab
Technical requirements:	**Equipment:** UAV for photogrammetry surveying, terrestrial LiDAR (e.g. GeoSLAM, Faro laser scanner), professional geodetic GNSS or GPS/GIS device **Computer specification:** Processor: Intel® Core™ i7/i5 8th Gen or newer 6 Cores/6 Threads RAM: 64GB Graphics card: 4GB GDDR6 SSD: 1 TB **Operating system**: Ubuntu 20.04. LTS
Courses (fields) assigned:	Navigation and positioning - GNSS; Sensor integration, UAV; Terrestrial Laser Scanning