D3.3 Teaching students

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Work Package / Task:

WP3 – Implementation of SDI and EO courses

T3.3 – Running courses to students

Short Description:

This report presents the outcomes of task 3.3 on delivering the revised and new SDI and EO courses and teaching students at the partner institutions about SDI, EO and related topics.

Keywords:

SDI, EO, courses, teaching, North Africa

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1. Introduction

1.1. The SEED4NA project

For many of the societal and environmental challenges that governments are facing, decision-makers strongly rely on spatial and earth observation data, to better target, monitor, and assess their actions and interventions. These data are now becoming more and more available, through the establishment of data infrastructures and platforms, which aim to improve the access to, sharing and use of data. The effective use of these data requires that professionals in the public, private and academic sector have the relevant knowledge and skills on spatial data infrastructures (SDI), earth observation (EO) and related technologies. This means that higher education institutions must have the knowledge and capacities to provide modern education to their students and offer professionals the right training programmes to raise the overall level of expertise in SDI & EO.

Initiatives to promote and coordinate the sharing of EO and spatial data are also emerging in the region of Northern Africa, at the local, national and regional level. Despite the growing availability and accessibility of data, there still are several barriers and challenges hindering the uptake and use of these data in policy making and implementation. Among these barriers and challenges is a lack of skills and knowledge on SDI and EO among practitioners, decision makers and other key stakeholders. Therefore, it is essential that academic institutions in the North African countries raise their capacities regarding SDI and EO.

The main objective of SEED4NA is to improve the quality of higher education in North Africa in the fields of SDI and EO, and to enhance its relevance for the labour market and society through the development of new and innovative SDI/EO curricula. The SEED4NA project aims to: 1) develop the required knowledge, skills and competencies on SDI & EO within partner universities; 2) help introducing modern SDI & EO courses in engineering and agriculture/forestry studies; 3) implement supporting relevant vocational training programmes; 4) help partner universities to support the development of SDI in their country and 5) promote a European approach to SDI & EO.

SEED4NA will result in the establishment of capable, well trained pools of experts within the involved North African academic institutions which will introduce a modern approach in academic and VET education on SDI & EO in their respective countries, thereby becoming promotors of SDI development and EO use.

1.2. Running SDI and EO courses

One of the main goals of the SEED4NA project is the introduction of new and/or revised courses on SDI, EO and related topics at the partner universities. Building further on the project curriculum defined and specified in the first stages of the project, several updated and/or new courses on SDI and EO are implemented at the eight partner universities of the project.

In the SEED4NA project, the implementation of SDI and EO curricula at the partner universities was structured around four main tasks:

- Task 3.1 – Localisation of curricula, which entails the preparation of the courses and related teaching materials
- Task 3.2 – Implementation of local curricula, which entails the formalization of the courses in the institutional study programs of the partner universities
- Task 3.3 – Running courses to students, which entails the delivery of courses to students, and teaching them about key SDI and EO topics
- Task 3.4 – Evaluation of implementation, which entails the evaluation of the courses

This report presents the outcomes of task 3.3. on offering the revised and/or new courses to students at the partner institutions. In the report, we briefly discuss the delivery of the courses at each partner institutions. For each of the courses developed or revised under SEED4NA, a detailed description is provided of the new teaching activities.

1.3. Structure of the document

This report is structured as follows. After this introductory chapter, the second chapter provides an overview of all the courses developed and implemented under SEED4NA. The third chapter discusses the process of delivering these new courses (or course components) to students at the partner universities, detailing all the teaching and learning activities implemented. The report ends with a short conclusion about the process of running the courses.

2. Overview of the SDI and EO courses

The table below gives an overview of the SDI and EO courses implemented at the eight partner universities in the context of the SEED4NA project. These include 14 revised courses and 13 fully new courses. Courses are provided at different study levels, as they include Bachelor (7), Master (15), Postgraduate (2), Phd (1) and Engineering (2) courses.

University	Courses	Study level	Update/New
Alexandria University (2)	Introduction to Remote Sensing and Earth Observation	MSc	Update
	Spatial Analysis, Modelling and Applications: Simulation in Urban Studies	MSc	New
Fayoum University (5)	Geographic Information System 1	BSc	Update
	Remote sensing in Agriculture	BSc	Update
	GIS and Spatial Database	MSc	Update
	Spatial Web Applications	PG	Update
	Mapping and Surveying	PG	Update
Ibn Zohr University (2)	Geoinformatics	BSc	Update
	Spatial Data Infrastructure	MSc	New
Institut Agronomique et Vétérinaire Hassan II (2)	Spatial Data Management	BSc	Update
	Advanced Photogrammetry	BSc	Update
University of Carthage (4)	Measurement and mapping of water resources using EO and advanced tools	MSc	New
	Hydrological sciences using Earth Data and Advanced Tools	MSc	New
	Smart water resources Management using EO data, ICT and the Internet of Things	MSc	New
	Assessment of soil and surface water pollution using Earth Data and Advanced Tools	MSc	New
University of Jendouba (3)	Application of Remote sensing & ICT in water management	MSc	New
	AI for remote sensing applications	Eng.	New
	Geostatistics	Eng	Update

University of Oran 1 Ahmed Ben Bella (4)	Spatial Big Data	MSc.	Update
	Application of Machine Learning to Satellite Imagery	PhD.	New
	Remote Sensing	BSc	New
	Global Navigation Satellite Systems	BSc	New
University Of Science And Technology Houari Boumediene (5)	Remote sensing and satellite imagery processing	MSc	Update
	Cartographic synthesis	MSc	Update
	GIS and remote sensing	MSc	Update
	GIS and data analysis I	MSc	New
	Space Geodesy	MSc	New

The aim of this report is to summarize the process of running these SEED4NA courses, i.e. the delivery of these courses to the students at the partner institutions. In the next chapter we will provided detailed information on the delivery of each of these courses.

3. Delivery of SDI and EO courses

This chapter provides an overview of the delivery of SDI and EO courses to the students. For each revised/new course, key information about its delivery to students is provided followed by a detailed overview of the course structure and course schedule.

3.1. Alexandria University (P6 – Egypt)

Course	**Introduction to Remote Sensing and Earth Observation**
Study program	Master of Science
Credits	3 credit hours
Academic year of implementation	Academic Year 2022-2023
Course period	Autumn Semester 2022
Duration	14 Weeks
Number of students	10

The course structure and schedule of the course was as follows:

1. Introduction to remote sensing and its process	**Lecture 1 [*12 October 2022*]:** Definitions, Remote Sensing Process, and Applications
2. Basic principles of RS	**Lecture 2 [*19 October 2022*]:** Electromagnetic energy and its interactions with the atmosphere and Earth's surfaces.
	Lecture 3 [*26 October 2022*]: Sensors and platforms and data acquisition. **Exercise [*26 October 2022*]:** Data exploration using Earth Explorer (USGS). **Assignment [*26 October - 9 November 2022*]:** Comparing different satellite sensors and presentations of outputs.
	Lecture 4 [*2 November 2022*]: Mapping cameras, imagery resolution, and band combination. **Exercise [*2 November 2022*]:** Band combinations.
3. Preprocessing techniques of remotely sensed data	**Lecture 5 [*9 November 2022*]:** Image preprocessing and enhancement. **Exercise [*9 November 2022*]:** image enhancement.
	Lecture 6 [*16 November 2022*]: Learning Unit 3 (Preprocessing techniques of remotely sensed data)- Image Interpretation

4. Processing of satellite imageries): Digital Image Classification	**Lecture 7-1 [*23 November 2022*]:** Introduction to Machine Learning and Digital Image Classification By this lecture, the students are given an introduction to the term paper by selecting a particular application of interest and start working on the preprocessing techniques followed by the application of digital image classification by the next lectures.
	Lecture 7-2 [30 *November 2022*]: Unsupervised and supervised Classification (explained with different algorithms). **Exercise [30 *November -7 December 2022*]:** Image classification In this lecture, continuous work on the term paper with guidance to the students about reporting and writing a research paper and its workflow and technical points.
	Lecture 8 [14 *December 2022*]: Accuracy assessment of image classification **Exercise [14 *December 2022*]:** accuracy assessment and computation of confusion matrix.
	Lecture 8 [21 *December 2022*]: Change detection.

Course	**Spatial Analysis, Modelling and Applications: Simulation in Urban Studies**
Study program	Master of Science
Credits	3 credit hours
Academic year of implementation	Academic Year 2022-2023
Course period	Autumn Semester 2022
Duration	14 Weeks
Number of students	10

The course structure and schedule of the course was as follows:

Learning unit	**Teaching**
1. Introduction to GIS &SDI and the benefits of spatial analysis	**Lecture 1 [*9 October 2022*]:** Principles of spatial analysis & modeling
2. Introduction to spatial analysis: the language of spatial analysis	**Lecture 2 [*16 October 2022*]:** Workflows and Applications. **Exercise and Assignment [16 October 2022 - *30 October 2022*]:** Model builder
3. Data exploration and working with query operations	
4. Spatial analysis operations and tools	**Lecture 3 [*23 October 2022*]:** Proximity Analysis - 1 **Exercise [*23 October 2022*]:** Closest Facility Operations.
	Lecture 4 [*30 October 2022*]: Proximity Analysis – 2 **Exercise [*30 October 2022*]:** Spatial Patterns and Kernel Densities
	Lecture 5 [*6 November 2022*]: Overlay Analysis **Exercise [*6 November 2022*]:** Streams and land use classifications, summarizing watershed lengths and land use amounts.
5. Spatial Statistics	**Lecture 6 [*13 November 2022*]:** Spatial Statistics **Exercise [*13 November 2022*]:** Spatial Autocorrelation, Optimized hot spot analysis, Optimized Outliers' analysis.
6. Network Analysis	**Lecture 7 [*20 November 2022*]:** Network Analysis **Exercise [*20 November 2022*]:** Service Area solver.
	Lecture 8 [*27 November 2022*]: Advanced Network Analysis-1

7. Advanced Network Analysis	**Exercise [*27 November 2022*]:** Location Allocation solver.
	Lecture 9 [*4 December 2022*]: Advanced Network Analysis-2 **Exercise [*4 December 2022*]:** The closest facility and OD cost matrix solvers. **Assignment [*4 December -25 December 2022*]:** Term Paper

3.2. Fayoum University (P7 - Egypt)

Course	**Geographic Information System 1**
Study program	Undergraduate - BSc. Agriculture (Soils and Water)
Credits	Credits in ECTS: 4
Academic year of implementation	The upgraded course was offered in the academic year 2022/2023
Course period	2nd Semester
Duration	*Full semester (14 weeks)*
Number of students	- The number of students during the academic year 2022/2023 was 29 Students - The number of students is not fixed - changes every year as per the number of students who apply to the course.

The course structure and schedule of the course was as follows:

Learning unit	Teaching
1.	Lecture [*week 8*]: Geodatabases. Exercise [*4th week]*: Building Geodatabase
2.	Lecture [*week 10*]: Geostatistics. Exercise [9th and 10th *week]*: Geostatistics examples/exercise
3.	Lecture [*week 11*]: Fundamentals of simulation models. Exercise [11th *week]*: Model Builder examples/exercise

Course	**Remote sensing in Agriculture**
Study program	Undergraduate- BSc. Agriculture (Soils and Water)
Credits	Credits in ECTS: 4
Academic year of implementation	The course was offered in the academic year 2023/2024.
Course period	1st Semester.
Duration	14 weeks
Number of students	- The number of students during the academic year 2023/2024 was 17 Students - The number of students is not fixed - changes every year as per the number of students who apply to the course.

The course structure and schedule of the course was as follows:

Learning unit	Teaching
1.	**Lecture [*Week 11*]:** Change detection and modeling. **Exercise [*Week 11]*:** Exercise on change detection.
2.	**Lecture [*Week 12*]:** Applications of tracking changes in agriculture and the environment, and application models in the field of agriculture, land, and water. **Exercise [*Week 12]*:** Exercise on change detection.
3.	**Lecture [*Week 13*]:** Basics of Google Earth Engine (GEE). **Exercise [*Week 13]*:** GEE exercise
4.	**Lecture [*Week 14*]:** Applications of Google Earth Engine (GEE). **Exercise [*Week 14]*:** GEE exercise

Course	**GIS and Spatial Database**
Study program	Master - Information Systems
Credits	Credits in ECTS: 4
Academic year of implementation	- The course is optional and depends on the registered students. Unfortunately, there were no registered students during the period after the upgrade approval.
Course period	The course is optional during the master's program.
Duration	14 weeks
Number of students	N/A

The course structure and schedule of the course was as follows:

Learning unit	Teaching
1.	**Lecture [*Week 9*]:** Fundamentals of simulation models. **Exercise [*Week 9]*:** Applications on simulation modeling.
2.	**Lecture [*Week 10*]:** Using Model Builder in Simulation Modeling **Exercise [*Week 10]*:** Examples of model builder
3.	**Lecture [*Week 11*]:** Using Python programming language in simulation modeling. **Exercise [*Week 11]*:** Examples of Python programming
4.	**Lecture [*Week 12*]:** Artificial Intelligence in GIS **Exercise [*Week 12]*:** Applications of AI

Course	**Spatial Web Applications**
Study program	GIS Postgraduate Diploma
Credits	Credits in ECTS: 4
Academic year of implementation	Academic year 2022/2023
Course period	2nd Semester
Duration	14 weeks
Number of students	8 Students

The course structure and schedule of the course was as follows:

Learning unit	Teaching
1.	**Lecture [*week 9*]:** Mobile Web Applications **Exercise [*week 9]*:** applications on Mobile Web Applications
2.	**Lecture [*week 10*]:** Dynamic Web-GIS interface developed using ArcGIS online. **Exercise [*week 10]*:** applications on Dynamic Web-GIS
3.	**Lecture [*week 11*]:** Geocoding. **Exercise [*week 11]*:** applications on Geocoding
4.	**Lecture [*week 12*]:** Programming languages for Web-GIS **Exercise [*week 12]*:** Applications on Programming Languages for Web-GIS

Course	**Mapping and Surveying**
Study program	GIS Postgraduate Diploma
Credits	Credits in ECTS: 4
Academic year of implementation	Academic year 2023/2024
Course period	Semester in which the course was/is offered: 1st Semester
Duration	14 weeks
Number of students	8 Students

The course structure and schedule of the course was as follows:

Learning unit	Teaching
1.	Lecture [*week 11*]: Use of AI in surveying and mapping. Exercise [*week 11]*: applications on using AI in surveying and mapping
2.	Lecture [*week 12*]: Use of AI in surveying and mapping. Exercise [*week 12]*: applications on using AI in surveying and mapping
3.	Lecture [*week 13*]: Advanced techniques in map production. Exercise [*week 13]*: applications on map production techniques

3.3. Ibn Zohr University (P8 - Morocco)

Course	**Geoinformatics**
Study program	Geology
Credits	2
Academic year of implementation	2022
Course period	4th semester
Duration	12 weeks
Number of students	70

The course structure and schedule of the course was as follows:

Learning unit	Teaching
1.	Lecture: GIS fundamentals Exercise: GIS fundamentals and Geodesy
2.	Lecture: GIS and reference systems Exercise: Data and georeferencing
3.	Lecture: Vector/Raster data Exercise: Digitalization and requests
4.	Lecture: Spatial analysis for vector/raster mode Exercise: Data analysis
5.	Lecture: RS fundamentals Exercise: RS fundamentals and application

Course	**Spatial Data Infrastructure**
Study program	Geology
Credits	2
Academic year of implementation	2023
Course period	3rd semester
Duration	10 weeks
Number of students	30

The course structure and schedule of the course was as follows:

Learning unit	Teaching
1.	Lecture: SDI definition and its applications Exercise: Noise map
2.	Lecture: Computer networks essentials Exercise: Open data portals
3.	Lecture: Architecture of network GIS Exercise: OGC standards
4.	Lecture: Data interoperability and semantics Exercise: ISO standards
5.	Lecture: Accessible and open applications, web services Exercise: Working with WMS, WFS
6.	Lecture: Development of web applications focused on spatial data and maps Exercise: Data publication

3.4. Institut Agronomique et Vétérinaire Hassan II (P9 – Morocco)

Course	**Spatial Data Management**
Study program	Surveying and Geomatics Engineer degree
Credits	2 ECTS
Academic year of implementation	2023
Course period	S4
Duration	30 hours
Number of students	68 Students

The course structure and schedule of the course was as follows:

Learning unit	Teaching
1. Spatial Big Data	Lecture [03/06/2023 , 03/08/2023]: Definition of the concept of Spatial Big Data Exercise [*Date of implementation]* :
2. Spatial Big Data Management	Lecture [03/09/2023, *03/16/2023 and 03/17/2023*]: Describe the modern approaches for spatial big data management Exercise [*03/16/2023]* : Introduction to Dask and parallel computing Exercise [*03/17/2023]* : Introduction to GeoParquet
3. Spatial Big Data Computing	Lecture [*03/23/2023*]: Introduction to Dask Geopandas Exercise [*03/23/2023]* : Notebook on using Dask Geopandas, Spatial Partitioning and Spatial Queries over Spatial Big Data
4. Spatail Big Data Visualization	Lecture [*03/27/2023*]: GeoArrow Exercise [*03/27/2023]* : Visualization with lonboard library and geoArrow for spatial big data

Course	**Advanced Photogrammetry**
Study program	Surveying and Geomatics Engineer degree
Credits	3 ECTS
Academic year of implementation	2023
Course period	S4
Duration	36 hours
Number of students	68 Students

The course structure and schedule of the course was as follows:

Learning unit	Teaching
1. Opportunities of Photogrammetry and Lasergrammetry integration	Lecture [03/06/2023]: Definition of the concept of Photogrammetry and Lasergrammetry integration
2. Integration Levels	Lecture [03/07/2023]: Describe the integration levels of Photogrammetry and Lasergrammetry
3. Integration approaches	Lecture [*03/07/2023*]: Describe and explain various integration approaches in Photogrammetry and Lasergrammetry integration Exercise [*03/13/2023]* : exercices on Integration approaches
4. Application	Lecture [*03/20/2023*]: Develop Application of Photogrammetry and Lasergrammetry integration Exercise [*03/202023]* : Applications of the integration process

3.5. University of Carthage (P10 – Tunisia)

Course	**Measurement and mapping of water resources using EO and advanced tools**
Study program	MSc Water Governance and Sustainable Development
Credits	2
Academic year of implementation	2022/2023
Course period	November - January
Duration	22h lectures + 9h practical activities
Number of students	6

The course structure and schedule of the course was as follows:

Learning unit	Teaching
1.	**Lecture/exercises:** The role of technology in water resources planning and management
2.	**Lecture/exercises:** The role of technology in water resources planning and management
3.	**Lecture/exercises:** GIS and geocomputation for water resource science and engineering
4.	**Lecture/exercises:** GIS and geocomputation for water resource science and engineering
5.	**Lecture/exercises:** Spatial data modelling for 3D GIS
6.	**Lecture/exercises:** Spatial data modelling for 3D GIS

Course	**Hydrological sciences using Earth Data and Advanced Tools**
Study program	MSc Water Governance and Sustainable Development
Credits	2

Academic year of implementation	2022/2023
Course period	November - January
Duration	22h lectures + 9h practical activities
Number of students	6

The course structure and schedule of the course was as follows:

Learning unit	Teaching
1.	**Lecture/exercises:** Introduction and basics of hydrology, water budget and hydrological parameters
2.	**Lecture/exercises:** Hydrological modelling concept and flow equations
3.	**Lecture/exercises:** Hydrological model construction

Course	**Smart water resources Management using EO data, ICT and the Internet of Things**
Study program	MSc Water Governance and Sustainable Development
Credits	2
Academic year of implementation	2022/2023
Course period	November - January
Duration	22h lectures + 9h practical activities
Number of students	6

The course structure and schedule of the course was as follows:

Learning unit	Teaching
1.	**Lecture:** • Concept of intelligence in the management of dynamic systems, • Intelligent management tools.
2.	**Lecture:** • Objectives and constraints of water resources management • Formulation of a water resources management problem
3.	**Lecture** • Resolution of a water resources management problem using multi-objective genetic algorithms**:**
4.	**Lecture:** • Notion of similarity and reduced physical models, • Connected sensor networks in a water resources management system
5.	**Lecture:** • Optimal control of pumps and regulating devices • Control algorithms and electronic cards
6.	**Exercise:** • Introduction: Presentation of the terms of reference (TOR) of the project. • Concept of an intelligent management system
7.	**Exercise:** • Implementation of a remote real-time data acquisition system

8.	**Exercise:** • Programming of the management problem and search for intelligent solutions
9.	**Exercise:** • Implementation of the intelligent solution in the management system

Course	**Assessment of soil and surface water pollution using Earth Data and Advanced Tools**
Study program	MSc Water Governance and Sustainable Development
Credits	2
Academic year of implementation	2022/2023
Course period	November - January
Duration	22h lectures + 9h practical activities
Number of students	6

The course structure and schedule of the course was as follows:

Learning unit	Teaching
1.	**Lecture:** Kinds of pollution (non-points and points, microbiological, physico and chemical)
2.	**Lecture:** Pollution parameters and indicators in water and soil
3.	**Lecture:** Assessment of the pollution using earth data observation and remote sensing • Basics of remote sensing and spatial data • Common remote sensing and earth observation portals • Typical applications in water and soil quality • EO data pre-processing • Mapping and visualization of spatial data • Image analysis
4.	**Lecture:** Calibration/validation and sensitivity analysis • Calibration and validation protocols • Accuracy assessment • Validation of water and soil quality state variables from EO data
5.	**Exercise:** Hands-on exercise on EO data acquisition from Google Earth Engine platform
6.	**Exercise:**

	Group work including elements of EO data processing, calibration/validation, accuracy assessment and derivation of pollution variables (examples from soil moisture, and water quality).
7.	**Exercise:** Group work including elements of EO data processing, calibration/validation, accuracy assessment and derivation of pollution variables (examples from soil moisture, and water quality)..
8.	**Exercise:** Group work including elements of EO data processing, calibration/validation, accuracy assessment and derivation of pollution variables (examples from soil moisture, and water quality)..

3.6. University of Jendouba (P11 – Tunisia)

Course	**Application of Remote sensing & ICT in water management**
Study program	MSc Climate Change & Water Management
Credits	2 ECTS
Academic year of implementation	2022/2023
Course period	October to January
Duration	12 weeks
Number of students	10

The course structure and schedule of the course was as follows:

Learning unit	Teaching
1.	**Lecture:** • Presentation of Application cases of RS, GIS, ICT and IoT for water management: floods, droughts, groundwater recharge, irrigation • Overview of the principles of RS and GIS tools **Exercise:** • Download and image analysis of Sentinel-2 from Earth Explorer portal
2.	**Lecture:** • Overview of the principles of smart sensors, IoT, Cloud, ICT • Concept and use of open data sets and geospatial platforms **Exercise:** • Download and image analysis of Sentinel-2 from Earth Explorer portal
3.	**Lecture:** • Project_Part 1: Irrigated areas mapping and water abstraction estimation from time series Sentinel-2 imagery **Exercise:** • Calculation of the reflection index (NDVI) and estimation of Evapotranspiration coupled with NDVI time series
4.	**Lecture:** • Project_Part 2: Irrigated areas mapping and water abstraction estimation from time series Sentinel-2 imagery

	Exercise: • Calculation of the reflection index (NDVI) and estimation of Evapotranspiration coupled with NDVI time series
5.	**Exercise:** • Calibration / Validation of the satellite estimate of Evapotranspiration • Simulation of the water balance at the plot scale
6.	**Exercise:** • Calibration / Validation of the satellite estimate of Evapotranspiration • Simulation of the water balance at the plot scale
7.	**Lecture:** • Presentation of student's projects **Exercise:** • Calculation of groundwater recharge though estimated Evapotranspiration
8.	**Exercise:** • Calculation of groundwater recharge though estimated Evapotranspiration
9- 12	**Exercise:** • Groundwater potential recharge mapping

Course	**AI for remote sensing applications**
Study program	Eng. Topography & Geomatics
Credits	2 ECTS
Academic year of implementation	2022/2023
Course period	September to December
Duration	11 weeks
Number of students	16

The course structure and schedule of the course was as follows:

Learning unit	Teaching
1.	**Lecture:** Introduction to JavaScript for Google Earth Engine ('Hello World', Variables, Arrays, Dictionaries, Functions) **Exercise:** Image Collection
2.	**Lecture:** Google Earth Engine Datasets and Image Collection **Exercise:** Image Collection
3.	**Lecture:** Google Earth Engine Datasets (Feature Collection) **Exercise:** Linear Regression NDVI
4.	**Lecture:** Linear Regression NDVI **Exercise:** Linear Regression NDVI
5.	**Lecture:** Charts **Exercise:** Charts
6.	**Lecture**: Land Cover Classification and Accuracy Assessment Overview **Exercise:** Charts
7.	**Lecture:** Supervised Land Cover Classification (Random Forest Classification Algorithm) **Exercise:** Supervised Land Cover Classification (Random Forest Classification Algorithm)
8.	**Lecture:** Overview of Time Series and Change Detection **Exercise:** Supervised Land Cover Classification (Random Forest Classification Algorithm)
9.	**Lecture:** Environmental Parameter Calculations **Exercise:** Change Detection Calculation and Mapping

10.	**Lecture:** Time Series Display of Environmental Data **Exercise:** Change Detection Calculation and Mapping
11.	**Lecture:** Change Detection Calculation and Mapping

Course	**Geostatistics**
Study program	Eng Hydraulic & Planning
Credits	2
Academic year of implementation	2022/2023
Course period	Semester V
Duration	8 weeks
Number of students	18

The course structure and schedule of the course was as follows:

Learning unit	Teaching
1.	**Lecture:** Precipitation time series and IDF curves
2.	**Lecture:** Spatial interpolation of precipitation **Exercise:** Application of spatial and temporal interpolation
3.	**Lecture:** Interpolation of continuous variables **Exercise:** Application of spatial and temporal interpolation
4.	**Lecture:** Interpolation of continuous variables
5.	**Lecture:** Variogram **Exercise:** Application of variogram models to data set of precipitation
6.	**Lecture**: Kringing **Exercise:** Application of kringing models to data set of precipitation
7.	**Lecture:** Kringing **Exercise:** Application of kringing models to data set of precipitation
8.	**Exercise**: Presentation of case study (filling gaps and missing data treatment)

3.7. University of Oran 1 Ahmed Ben Bella (P13 – Algeria)

Course	**Spatial Big Data**

Study program	MSc "Networks and Distributed Systems", Computer Science Department, UORAN1
Credits	1 ECTS
Academic year of implementation	2022-2023
Course period	Semester 3 (September-January)
Duration	12 weeks
Number of students	15

The course structure and schedule of the course was as follows:

Learning unit	Teaching
1.	**Introduction to Big Data** [Lecture on September 28th, 2022] : the 5 dimensions of Big Data (volume, velocity, variety, veracity, value), Concepts and terminology, fundamental characteristics, Data types, Business motivations, adoption and planning of migration to Big Data.
2.	**Big Data Storage – part 1** [Lecture on October 5th, 2022] : Parallel processing paradigms, Computer clusters, Distributed Files Systems (HDFS)
3.	**Big Data Storage – part 2** [Lecture on October 12th, 2022]: NoSQL database types (key/value, column, document, graph), Introduction to MongoDB **Introduction to MongoDB** [Exercise on October 12th, 2022]: installation and setup, creating a database of restaurants writing different queries to display all documents in a collection/fields in a document, find a restaurant with given properties.
4.	**Big Data Processing – part 1** [Lecture on October 26th, 2022]: Map-Reduce programming model, Hadoop framework, Examples of programs
5.	**Big Data Processing – part 2** [Lecture on November 2nd, 2022]: Spark framework, Spark cluster managers, Resilient distributed datasets, Application lifecycle, Persistence. Spark SQL
6.	**Introduction to Apache Spark (New)** [Exercise on November 9th, 2022]: using Apache Spark with the Python pySpark API on Jupyter Notebooks, finding unique words and a mean value, Analyzing real datasets, result visualization
7.	**Introduction to GIS (New)** [Lecture on November 16th, 2022]**:** Introduction (definitions and usages, components), Data Models (layers, coordinates, data attributes, vector data, raster data), Elements of Geodesy and Cartography (ellipsoid, geoid, geodetic systems), Cartography (types de maps, scale)
8.	**Spatial Analysis and Estimation (New)** [Lecture on November 23th, 2022]**:** Spatial Analysis Operations (examples, scope), Selection/Classification/Dissolve operations, Proximity functions, Overlay, Network analysis, Raster analysis, Spatial interpolation.

9.	**Spatial Databases (New)** [Lecture on November 30th, 2022]**:** query languages (spatial SQL), spatial index structures, geohash indexing, spatial join operators, introduction to PostGIS
10	**Spatial Database: PostGIS (New)** [Exercise on December 7th, 2022]**:** Creating a spatial database, Loading GIS data Into the database, Simple SQL, Geometries, Metadata, Spatial Queries, Spatial Relationships.
11.	**Spatial Big Data Processing (New)** [Lecture on December 13th, 2022]**:** Apache Sedona architecture, Spatial RDD, Spatial indexing, Spatial queries, Examples of use cases
12.	**Apache Spark with Sedona (New)** [Exercise on December 14th, 2022]**:** Install Sedona Python, Spatial SQL app, Load data from files, Create a Geometry type column, Load Shapefile and GeoJSON using SpatialRDD, Transform the coordinate reference system, Run spatial queries (range, KNN), result visualization

Course	**Remote Sensing**
Study program	Bachelor's program in Precision Agriculture (for second-year students)
Credits	3 ECTS
Academic year of implementation	The course was implemented in the first half of 2023
Course period	Second semester of the second Bsc. year
Duration	14 weeks
Number of students	12 students

The course structure and schedule of the course was as follows:

Learning unit	Teaching
8. Physics of Remote Sensing	**Lecture [*January 30, 2023*]:** *History and basic concepts in remote sensing*. This lecture covers the history and basic concepts of remote sensing. It explores the underlying physics principles behind the collection and interpretation of remote sensing data, as well as the evolution of this field over time. **Exercise:** *Download and image analysis of Sentinel-2 and Landsat 8 satellite systems from EarthExplorer portal*
	Lecture [*February 06, 2023*]: Electromagnetic Spectrum. This lecture provides a concise introduction to the study of the electromagnetic spectrum and its interactions within the field of remote sensing. It covers various topics including sources of electromagnetic radiation, irradiation, solar radiation, and the dual nature of electromagnetic waves and photons. The lecture explores wavelength in remote sensing, human perception of the environment through reflection, emission of thermal radiation from objects based on their temperature, and the phenomena of scattering, absorption, and refraction. It also examines the interactions of the electromagnetic spectrum with the atmosphere, vegetation, water, and surface objects, emphasizing the concept of spectral signatures. **Exercise:** *Opening and viewing a satellite image in QGIS*
9. Spectral Signature, In-situ measurements and Visual Image Interpretation	**Lecture [*February 13, 2023*]:** *Analyzing Spectral Signatures and Field Measurements.* This lecture delves into the analysis of spectral signatures and field measurements. It covers topics such as understanding the spectral characteristics of different materials and features, interpreting spectral data collected in the field, and utilizing spectral signatures for remote sensing applications. **Exercise:** *Simple change analysis in QGIS*
	Lecture [*February 20, 2023*]: *Sensors and remote sensing systems.* This lecture explores the various types of sensors and systems used in remote sensing. It covers the principles of operation, characteristics, and applications of

	different types of sensors, including optical, radar, and LiDAR sensors. The lecture aims to provide a comprehensive understanding of sensor technologies used in remote sensing data collection. **Exercise:** *Manipulating hyperspectral data in QGIS*
10. Platforms & Sensors	**Lecture [*February 27, 2023*]:** *Earth observation satellites, optical and radar sensors.* This lecture specifically focuses on Earth observation satellites and the optical and radar sensors used onboard these satellites. It provides detailed insights into the functioning principles of Earth observation satellites, their technical characteristics, and the types of optical and radar sensors used to acquire data. The lecture emphasizes the use of satellite data for remote sensing and Earth analysis. **Exercise:** *Analyzing Satellite Image Time Series (SITS) by means of web applications*
11. Remote Sensing Data Errors, Data Products and their Sources	**Lecture [*March 06, 2023*]:** *Image acquisition, resolution types and data collection techniques in the electromagnetic spectrum.* This lecture provides an overview of image acquisition in remote sensing and explores different types of resolution, including spatial and spectral resolution. It discusses the relationship between spatial signal, pixel size, and techniques for enhancing image details. The lecture explains the distinctions between multispectral and hyperspectral data and introduces the concept of temporal resolution. Additionally, it highlights the interpretation and analysis of spectral signatures for extracting information related to land cover, land use, and environmental conditions. The lecture aims to provide a comprehensive understanding of remote sensing data acquisition and analysis techniques. **Assignment [*Date of implementation*]:** *Reading material on Fundamentals of Remote Sensing* **Exercise:** *Analysis of SAR SENTINEL-1 (active remote sensing) data for flood mapping in SNAP*
	Lecture [*March 13, 2023*]: *Remote sensing data errors, geometric distortions and transformations of the geospatial data.* This lecture focuses on the sources of geometric and radiometric distortions in remote sensing data and explores techniques to correct them. It discusses the various sources of geometric distortion and provides examples of how they can affect the accuracy of geospatial data. The lecture also addresses radiometric distortions and introduces methods for correcting these errors in remote sensing imagery. Additionally, the lecture covers spectral indices and their significance in characterizing and analyzing remote sensing data. It explains the spectral characteristics of objects and how vegetation indices, such as the Ratio Vegetation Index (RVI) and Green Ratio Vegetation Index (RVI), can be used to assess vegetation health and density. The lecture also compares different vegetation indices, including the Tasseled Cap transformation and the Normalized Difference Built-Up Index (NDBI). Furthermore, it explores the Normalized Burn Ratio (NBR) for assessing fire severity and damage. **Exercise:** *Analysis of a time series of low resolution NDVI images in SPIRITS* **Assignment:** *Crowdsourced Data of a GreenSeeker Handheld NDVI Sensor for Generating an NDVI Map*
12. Trends Analysis	**Lecture [*March 20, 2023*]:** *Pre-processing and digital image processing*.

	This lecture covers the pre-processing and digital image processing techniques used in remote sensing. It includes topics such as image enhancement, noise removal, image registration, and geometric and radiometric corrections. The lecture aims to provide an understanding of the steps involved in preparing remote sensing data for analysis. **Exercise:** *BFAST : Breaks For Additive Season and Trend*
13. Machine Learning in Remote Sensing Data Processing	**Lecture [*March 27, 2023*]:** *Machine Learning for Classification of Geospatial Data*. This lecture focuses on the application of machine learning techniques for the classification of geospatial data. It covers topics such as different types of classification methods, including unsupervised and supervised classification. The lecture explores representative methods of supervised classification, such as pixel-based classification, and provides examples to illustrate the concepts. It also discusses the use of machine learning algorithms, including convolutional neural networks (CNNs), for classification tasks. Additionally, the lecture introduces the concept of object-based classification and discusses the process of segmentation for classification purposes. Furthermore, it explores the use of machine learning for land use and land cover data analysis. **Exercise:** *Supervised classification of multispectral satellite images and diachronic analysis*

Course	**Global Navigation Satellite Systems**
Study program	PhD, Computer Science Department, Faculty of Exact and Applied Sciences, UORAN1
Credits	/
Academic year of implementation	2021-2022
Course period	October 2022
Duration	6 Hours
Number of students	25

The course structure and schedule of the course was as follows:

Learning unit	Teaching
1.	**Introduction to Earth Observation and Remote Sensing** [Lecture on October 10th, 2022]: EO – Source of Data, Remote Sensing, RS Workflow, Examples of EO applications, Irradiation, Wavelengths in Remote Sensing, Interactions with Water/Vegetation/Surface Objects, Sensor Types, Panchromatic/Spectral/Hyperspectral Images, Spatial Resolution, Radiometric Resolution, Spectral Resolution, Temporal Resolution, Spectral signature of Objects, Satellite Missions for Remote Sensing.
2.	**Introduction to Deep Learning** [Lecture on October 11th, 2022]: Deep Neural Networks, Typical layers involved in CNNs, VGG-16, Resnet, Autoencoders, Stacked Autoencoders, Generative Adversarial Networks (GANs), optimization (gradient descent), Hyperparameters and algorithm tuning, Performance and error analysis; Ensemble and Transfer learning, Deep learning frameworks.
3.	**Deep Learning for Remote Sensing** [Lecture on October 17th, 2022]: Application fields, Image Classification (Land-use and land-cover classification), Multi-modal semantic segmentation, Multi-temporal analysis, Object detection, Change detection, Hyperspectral image analysis, Data fusion, Image scene classification, Generalization of CNN's deep features to RS, Scene classification with recurrent attention of remote sensing Images, Unsupervised spectral–spatial feature learning with stacked sparse autoencoder for hyperspectral imagery classification, conclusion and future trends

Course	**Global Navigation Satellite Systems**
Study program	Bachelor in Precision Agriculture, Biology Department, Faculty of Life Sciences, UORAN1

Credits	4 ECTS
Academic year of implementation	2023-2024
Course period	Semester 5 (September-December)
Duration	12 weeks
Number of students	13

The course structure and schedule of the course was as follows:

Learning unit	Teaching
1.	**Fundamentals of Satellite Navigation – part 1** [Lecture on October 2th, 2023]: Definition, GNSS applications, Performance characteristics, Development timeline, Introduction to GPS (history, constellations, and architecture).
2.	**Fundamentals of Satellite Navigation – part 2** [Lecture on October 9th, 2023]: GNSS orbits and Kepler's laws, GPS signals, A first intuition on receiver location and navigation equations. **Introduction to GNSS** [Exercise on October 9th, 2023]: quizzes on GNSS systems (GPS, Glonass, Galileo, Baidu), frequency bands, types of satellite orbits, applications in precision agriculture.
3.	**Coordinate Reference Systems** [Lecture on October 16th, 2023]: Cartesian/Spherical coordinates, Global Coordinate Systems (ECEF, ECI, ENU), Geoid and Datums, Heights **Coordinate Reference Systems** [Exercise on October 16th, 2023]: elliptical geometry, Keplerian parameters, GPS frequencies and signals
4.	**Time references and GPS time** [Lecture on October 23th, 2023]: Sideral/Solar time, Universal Time, International Atomic Time (TAI), Coordinated Universal Time (UTC), GPS Reference Time **Time references** [Exercise on October 23th, 2023]: Calculation of GPS time, time decoding from the navigation message
5.	**Coordinate Frame Transformations** [Lecture on October 30th, 2023]: Transformation between Cartesian coordinate frames, From Keplerian parameters to ECEF frame, Decoding the navigation message **Coordinate Transformations** [Exercise on October 30th, 2023]: DMS/DD notations, WGS84 ellipsoid model, conversion from ECEF to ENU, geoid height calculation.
6.	**GPS Performance and Analysis – part 1** [Lecture on November 6th, 2023]: Navigation equations (solve for 4 unknowns), Sources of error, pseudorange, navigation solution (assumed location, linearized navigation equations, iterative resolution) ENU/ECEF representation, geometry matrix

7.	**GPS Performance and Analysis – part 2** [Lecture on November 13th, 2023]: Reminder on Probability Density Function, Dilution of Precision (types, interpretation, and utility), Measurement Error Components, and Error Budget. **GNSS raw measurement from Phones** [Lab on November 13th, 2023]: presentation of GNSS Logger App for Android, basic usages, log files analysis, calculation of pseudoranges from satellite measurements data
8.	**GPS GNSS Positioning Modes – part 1** [Lecture on November 20th, 2023]: Positioning Modes (point/relative), Differential GNSS equations and errors, Carrier-phase measurements, Initial ambiguity Static/Fast Surveying, RTK, Dual-frequency GNSS, Satellite Based Augmentation System (SBAS) **GNSS Logger App** [Lab on November 20th, 2023]: calculation of pseudoranges from satellite measurements data
9.	**GPS GNSS Positioning Modes – part 2** [Lecture on November 27th, 2023]: Static/Fast Surveying, RTK, Dual-frequency GNSS, Satellite Based Augmentation System (SBAS) **GNSS Data Analysis** [Lab on November 27th, 2023]: GNSS data analysis: presentation of GNSS Analysis Matlab software, mission planner, Receiver C/No comparison.
10.	**GNSS Data Formats** [Lecture on December 4th, 2023]**:** RINEX format, NGS-SP3 format, RTCM SC-104 standards for DGPS services, NMEA 0183 format. **GNSS Data Analysis** [Lab on December 4th, 2023]: analysis example (car driving), analyzing ionosphere and troposphere errors
11.	**Other GNSS Systems** [Seminar on December 11th , 2023]**:** Students' presentations on Application of GNSS in Precision Farming (part 1) **GNSS Data Collection** [Lab on December 11th, 2023]: Labs on Garmin GPS receiver: collecting waypoint coordinates on an agricultural parcel.
12.	**GNSS Data Formats** [Lecture on December 18th, 2023]**:** Students' presentations on Application of GNSS in Precision Farming (part 2) [Assignment on December 18th, 2023]: quizzes on advanced GNSS modes

3.8. University Of Science And Technology Houari Boumediene (P14 – Algeria)

Course	**Remote sensing and satellite imagery**
Study program	Academic Master Biologie, Biodiversité et Ecologie Végétale
Credits	5
Academic year of implementation	2022-2023
Course period	Semester 1
Duration	10 weeks

Number of students	40

The course structure and schedule of the course was as follows:

Learning unit	Teaching
1.	Lecture [04 October] : Introduction to remote sensing definition and history/ Introduction to GIS
2.	Lecture [09 October] : Remote sensing and areas of use
3.	Lecture [16 October]: Physical bases of remote sensing Exercise [15 October]: Presentation of ENVI Software - Opening a satellite image with its spectral bands -Visualization of the spectral bands of a satellite image downloaded from USGS (digital count and histogram of images). - Construction of a standard ENVI file from the spectral bands downloaded from the USGS website. - Display of file characteristics on ENVI
4.	Lecture [23 october] : Interaction radiation atmosphere Exercise [October 22]: Georeferencing a Topographic map and Geometric corrections of the image
5.	Lecture [06 November] : Atmosphere radiation matter interaction Exercise [05 November]: - Continue referencing the satellite image - Extraction of a geographical area from the satellite image - Display of histograms of spectral bands and calculation of basic statistics on the satellite image
6.	Lecture [13 November] : Satellites and sensors Exercise [12November]: -Improvement of contrast and dynamic spreading of spectral ranges - Application of masks (thematic and geographical) Learn to make a colorful composition in natural colors and false colors
7.	Lecture [20 November] : The different satellite images and their digital spectral and spatial characteristics Exercise [November 19]: - Correlation between the channels and the choice of the best trichromy - Application of filters for image enhancement

8.	Lecture [29 November] : Spectral signatures of vegetation and certain elements on the ground surface Exercise [November 28]: Calculation of Ration and vegetation indices and comparison between them and their use Detection of the different elements of the ground surface from the histograms of the ROIs in each spectral band (exercise to be submitted as a report).
9.	Lecture [04 December]: Concept of Machine learning and Classification of satellite images (New learning) Exercise [03 December]: Image segmentation using two-dimensional histograms Classification of supervised and unsupervised satellite images (new learning) Study of the separability of ROIs
10.	Exercise [*10 December]* : Supervised classification of satellite images (new learning)

Course	**Cartographic synthesis**
Study program	Academic Master 'BIODIVERSITÉ ET ECOLOGIE VÉGÉTALE'
Credits	2
Academic year of implementation	Fall 2022
Course period	Semester 3
Duration	15 weeks
Number of students	40

The course structure and schedule of the course was as follows:

Learning unit	Teaching
1.	Lecture [18 September] : Introduction to GIS Exercise [3 October]: Installation of ArcGis software (Group G1)
2.	Lecture [25 September & 2 October] : Functionalities of GIS]: Exercise [10 October]: Installation of ArcGis software (Group G2)
3.	Lecture [9 and 16 October]: Cartographic projections and geographic information]: Exercise [17 October]: Getting used to the ArcGis software and georeferencing of maps (G2 Groups)
4.	Lecture [23 and 30 October] : Geographic databases: Exercise [24 October]: Creation of vector layers from Raster and development of databases group G1. (transformation of vector into Raster)
5.	Lecture [4 November] : Types of GIS representation Raster mode and vector mode. Exercise [31 October] : Creation of vector layers from Raster and development of databases) group G2 (transformation of vector into Raster)
6.	Lecture [11 November] : Application of queries (Map algebra on vector) Exercise [07 November] Group G1 : Practical exercises on database creation using ARCGIS
7.	Lectures [18 November] : Application of queries (Map algebra on vector) Exercise [15 November Group G2: : Practical exercises on database creation using ARCGIS
8.	Lectures [26 November] : SQL algorithm for maps and DEMs and their creation Exercise [22 November] Group G1 and G2: Mastering queries
9.	Lectures [04 December] Introduction to SDI

	Exercise [29 November] Case studies : Modeling Fire forest
10.	Lectures [11 December] : SDI Components/17 December [5 December] : Other Case studies on the use of GIS presented by students organized in groups
11.	Lectures [17 December] : Presentation of GNSS Positioning system. [11 and 18 December] : Other Case studies on the use of GIS presented by students organized in groups

Course	**GIS and remote sensing**
Study program	Master académique en Protection de l'environnement
Credits	5
Academic year of implementation	Fall 2023
Course period	Semester1
Duration	16 weeks
Number of students	45

The course structure and schedule of the course was as follows:

Learning unit	Teaching
1.	Lecture [23 September] : Introduction to remote sensing definition and history/ Introduction to GIS Exercise [October 10]: Installation of ArcGis software and ENVI software (Group G1)
2.	Lecture [08 October] : Remote sensing and areas of use / functionalities of GIS]: Exercise [October 17]: Installation of ArcGis software and ENVI software (Group G2)
3.	Lecture [15 October]: Physical bases of remote sensing / cartographic projections and geographic information]: Exercise [18 October]: Presentation of the ArcGis software and georeferencing of maps (G2 Group)
4.	Lecture [22 October] : Interaction of atmospheric radiation / geographic databases]: Exercise [October 25]: Creation of vector layers from Raster and development of databases) group G1
5.	Lecture [29 October] : Interaction atmosphere radiation matter / types of GIS representation Raster mode and vector mode. Exercise [01 November] : Creation of vector layers from Raster and development of databases) group G2 (transformation of vector into Raster)
6.	Lecture [05 November] : Satellites and sensors and Satellite image data Build an ENVI Standard file and calculate satellite image statistics. Calculate vegetation indices and the Brilliance index. Exercise [07 November] Group G1: Presentation of the ENVI image processing software and opening and displaying satellite images:

	Visualization of the spectral bands of a satellite image downloaded from USGS (digital count and histogram of images). Construction of a standard ENVI file from the spectral bands downloaded from the USGS site. Learn to make a colored composition and visualize the digital counts of each spectral band
7.	Lectures [19 November] : Spectral signatures of certain elements on the ground surface Exercise [22 October] Group G2: Presentation of the ENVI image processing software and opening and displaying satellite images: Visualization of the spectral bands of a satellite image downloaded from USGS (digital count and histogram of images). - Construction of a standard ENVI file from the spectral bands downloaded from the USGS site. Learn to make a colored composition and visualize the digital counts of each spectral band
8.	Lectures [26 November] : Preprocessing of image data (georeferencing, atmospheric corrections) improvement of images (contrast and filters) / SQL algorithm for maps and DEMs and their creation Exercise [29 November] Group G1: Study of the spectral signatures of some elements of the ground surface from the histograms of the ROIs in each spectral band (exercise to be submitted as a report). Image segmentation from two-dimensional histograms Calculation of NDVI and the Bright index as well as the Ratio
9.	Lectures [03 December] Vegetation and soil brightness indices Classification of satellite images (two-dimensional histogram) and Concept of Machine learning and (new learning)/ Concept of SDI (New learning) Exercise [07 December] Group G2: Study of the spectral signatures of some elements of the ground surface from the histograms of the ROIs in each spectral band (exercise to be submitted as a report). Image segmentation from two-dimensional histograms Calculation of NDVI and theBright index as well as the Ratio
10.	Lectures [10 December] : Supervised and unsupervised classification machine learning /17 December Presentation of GNSS Positioning system. [12 December] Lab on using TOPCON for both groups together

Course	**GIS and data Analysis**
Study program	Master of Geodesy and Cartography
Credits	4
Academic year of implementation	2022-2023
Course period	Semester 1
Duration	9 weeks
Number of students	13

The course structure and schedule of the course was as follows:

Learning unit	Teaching
1.	Definition of a GIS and the fields of application & Geographic information [22/02/2022]:
2.	Coordinate system and components of a GIS [1/03/2022]: Exercise [1/03/2022]: : georeferencing
3.	GIS functionalities [*8/03/2022*]: Exercise [8/03/2022]:: wedging
4.	Thematic analysis Semiology and Symbology [*15/03/2022*]: Exercise [15/03/2022] : digitalisation
5.	Data Editing and Topology [*22/03/2022*]: Exercise *[22/03/2022]:* How to create a shapefile and personal database
6.	Database management [12/04/2022]: Exercise *[12/04/2022]:* Analyse thematique Spatial Analysis
7.	Handling and treatment methods in GIS mise en page [19/04/2023] : Exercise [19/04/2023*]* : External data integration (Google Earth, Autocad)
8.	Exercise [26/04/2023] : Analyse spatiale : data processing by queries Layout
9.	Exercise [03/05/2023] : Analyse spatiale : traitement DEM

Course	**Space Geodesy**
Study program	Master of Geodesy and Cartography
Credits	5
Academic year of implementation	2023
Course period	Semester 3
Duration	10 weeks
Number of students	13

The course structure and schedule of the course was as follows:

Learning unit	Teaching
1.	Lecture [*24/09/2023*]: Artificial Satellite - an overview Exercise [*24/09/2023]*
2.	Lecture [*01/10/2023*]: Classification of satellites, orbits Exercise [01/20/2023*]*
3.	Lecture [*15/10/2023*]: GNSS Principles and Basics Exercise [15/20/2023*]* :
4.	Lecture [01/11/2023]: Types of measurements (code, phase and doppler) + observaton eqations Exercise [*01/11/2023]*
5.	Lecture [15/11/2023]: Positioning modes: absolute, relative, DGPS Exercise [*15/11/2023]*

4. Conclusions and next steps

After the design, development, preparation and formal acceptance of the SEED4NA courses, the courses could be offered to the students at the eight partner universities. This was a key step – and outcome – of the process of modernising education at the partner universities, by introducing SDI and EO topics into their educational programs. The aim of this report was to document this step in a standardized manner, by providing detailed information on the way SDI and EO education actually was delivered to the students, through new teaching and learning activities implemented at each of the partner universities.

The standardized descriptions of the execution of the SDI and EO courses provide insight into how SDI/EO education was offered to the students. Courses are structured into different learning units, which could consist of lectures but also practical exercises or assignments. In this way, the report not only provides documentation on the delivery of courses at the partner universities, but also guidance on how SDI/EO education could be designed and implemented.

Also included in this report are the number of students benefiting from SEED4NA, i.e. the number of students participating in each of the courses developed or revised under the project. In total, more than 650 students in the four partner countries were introduced into new and emerging topics related to SDI and EO. In this way, SEED4NA prepared these students to become the new generation of SDI/EO professionals, able to support or even lead future SDI and EO developments in the region of North Africa.

The number of students participating in the SEED4NA courses provides a first indication of the impact of the project. To better understand this impact, it is important to further evaluate the courses, in terms of their relevance, quality and overall impact. This evaluation should look at overall process of developing and implementing the courses, including the preparation of the course and course materials, the introduction of the course into study programs, the definition of learning objectives and the quality of teaching and learning materials. As part of the work package on implementing SDI and EO courses in the four partner countries, there will be a dedicated task on evaluating the implementation.