Study guide for the Master’s programme Geo-information Science and Earth Observation

2025-2026

Full version (October 2024)

Contents

Introduction

You can contribute to creating a liveable and sustainable healthy planet and solve some of the world's most pressing challenges - such as climate change, food and water security, land scarcity, and natural disasters - by mastering the acquisition, analysis, and processing of geo-information and earth observation data.

We cannot design a sustainable future without using geospatial information (fig 1). For example, we currently live in a digital society that is being geo-enabled by vital and ubiquitous earth observation data and geographic information. Consequently, we must use and manage, with the help of artificial intelligence, the vast quantities of earth observation and geospatial data available for real-time decision-making, monitoring the environment, finding & assessing our earth's resources, tracking species occurrences, quantifying ecosystem services, mapping health risks, analysing land-use patterns and predicting the changing climate. In short, a purpose of this programme is to help societies become geo-enabled.

Our planet is changing and we need to know where it is changing to understand how it is changing to design or engineer solutions for the changes that affect the sustainability of our society and living environment. This is the 'science of where': where changes are taking place, where stakeholders are affected, where solutions are most effective, and where we find the resources needed to support these solutions.

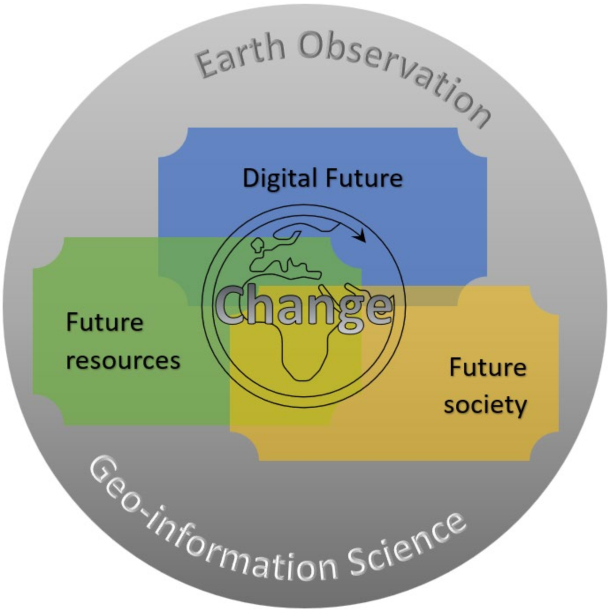

Figure 1: designing a sustainable future with geospatial science, data and technology

This international Master's programme, taught fully in English, is open to a diverse audience of all backgrounds. What all participants have in common in an interest in tackling global challenges with geospatial technologies. The programme equips you with the geospatial skills needed to address the global challenges of today and tomorrow, finding solutions through local actions. You will gain the theoretical knowledge, develop the technical skills, and data competencies to leverage geospatial technologies and data such as remote sensing, to address complex problems and engineer, design or develop innovative and sustainable solutions.

During the programme you will develop a variety of technical and professional skills. There is a global demand for experts in earth observation and geographic information sciences with advanced skills in GIS, applied remote sensing, and data science, including artificial intelligence (AI) and machine learning. During your study you will enhance your technical, digital and investigative capabilities while also taking into account the social and cultural context of the future society in which you will be applying these skills. This will enable you to translate technical knowledge into the actionable decisions that aid the policymakers to sustainably manage our future resources.

As a graduate of this programme, the skills and knowledge you acquire will enable you to work across disciplines for various national and international organisations. You'll have opportunities to connect with industry professionals through an extensive alumni network, guest lectures, internships, and career fairs. Whether you aspire to harness the latest geospatial technologies or innovate new ones, join us to acquire the skills needed to meet the growing demand in this exciting field.

The master's programme Geo-information Science and Earth Observation offers you pathways that can be tailored to achieving a diverse range of career goals with a personalised educational experience. We have created these pathways under four interrelated themes that enable us to use the expertise of the ITC faculty to address the future challenges. These themes are: GeoAI, Resources Security, Disaster Resilience and Urban & Land Futures (fig. 2). Each of these themes use digital innovations to address the future challenges and solutions for the sustainability of our earth's resources and society.

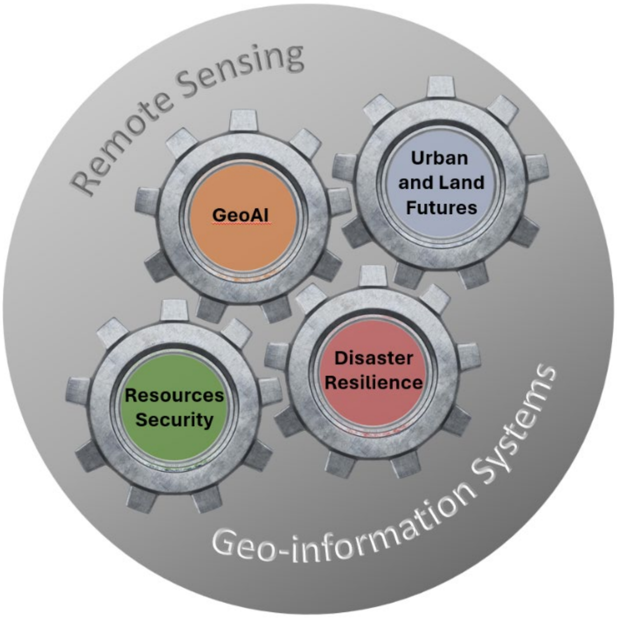

Figure 2: the interlinked themes of M-GEO, representing the future challenges, technologies and solutions for the sustainability of our earth's resources and society

Based on your personal interest, motivation, prior completed education and expertise, you can choose a learning pathway from a variety of themes as entry points into the programme where you will learn the latest skills and domain knowledge. A learning pathway follows a sequence of teaching and learning that starts with your personal interest and motivation (fig.3). The programme starts with fundamental skills development, ensuring that all participants have the same base level of skills and knowledge about geo-information science and earth observation. Based on your intertest or career aspirations, you then choose a thematic field to enhance your domain knowledge and learn to apply your skills within that context. You will complement your programme by a personal choice of elective courses that will further enable you to deepen or broaden your knowledge and skills and work on your professional development. Your studies will culminate in an individual research project where you will be able to apply what you learned.

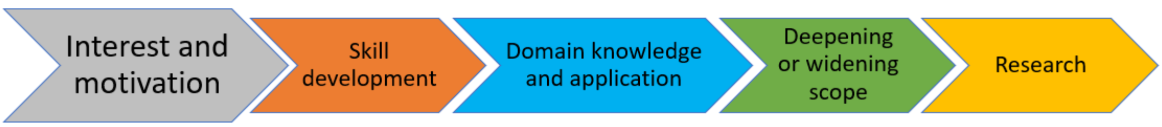

Figure 3: the sequence of learning pathways in M-GEO

Admission to the programme

Admission requirements

To be admitted to the Master’s in Geo-information Science and Earth Observation, you should have a bachelor’s degree or an equivalent qualification from a recognised university or accredited institution in a discipline related to the programme. We warmly welcome recent graduates, working professionals, midcareer individuals, and career changers. Working experience in a related field is not necessary but considered preferential.

Academic criteria

- A Cumulative Grade Point Average (CGPA) of 3.0 or higher on a 4.0 scale, or
- Upper Second Class standing or higher.

Note: a Lower Second Class standing may be accepted based on evidence of relevant professional experience and/or other further academic development.

Language requirements

Success in your studies requires a high level of English proficiency. Therefore, prospective students with an international degree must meet the English language requirement. As proof that you meet this requirement, you will be asked in the application procedure to upload one of the requested language certificates:

- IELTS (academic) with an overall band score of at least 6.0 (with a minimum sub-score of 6.0 for speaking and writing) and certificates not older than two years.
- TOEFL iBT (internet-based) with an overall score of 80 (with a minimum sub-score of 20 for speaking) and certificates not older than two years. Please note that the University of Twente does not accept the MyBest scores of the TOEFL test.
- Cambridge C1 Advanced Formerly known as; Cambridge English Advanced (CAE), obtained with an A, B or C grade.
- Cambridge C2 Proficiency Formerly known as; Cambridge English Proficiency (CPE) obtained with an A, B or C grade.

You are exempted from the English language requirement if you hold:

- a relevant bachelor's degree from an accredited academic institution in the Netherlands
- if you are a national of one of the countries in this list (PDF)

a three-year bachelor's degree in Australia, Canada (English-speaking part), Ireland, New Zealand, UK or USA. When your awarding institution is in one of these countries, but your teaching institution was not, you are not exempted. The same rule applies to distance (online) education.

See our website for full information: https://www.itc.nl/education/admission/

Admission process

When you apply for the programme, you will apply for general admission to the programme. During the process you will be requested to indicate your interest in one of the thematic lines of the programme. Your academic records will be assessed based foremostly on whether your prior education and experience will allow you to complete the programme within two academic years.

Once admitted, you are in the diving seat! A the start of the programme you can reevaluate your interest and crystalize your choice of learning path. Your study adviser will help you make your choices.

If your admission request is rejected, you will receive this rejection with a justification. If you are admitted, you are admitted to the general programme.

See our website for full information: https://www.itc.nl/education/how-to-apply/

Structure of the programme

Programme name	Geo-information Science and Earth Observation
RIO	1015O6874
Duration	Two academic years, divided over 4 quartiles each
ECTS	120
Language	English

Within each quartile, all courses run over 10 weeks according to the academic calendar of the University. The start and end dates of all courses in a quartile are therefore the same. Within each week of a quartile, the study load per course can vary. The average study load per week is, however, always around 42 hours.

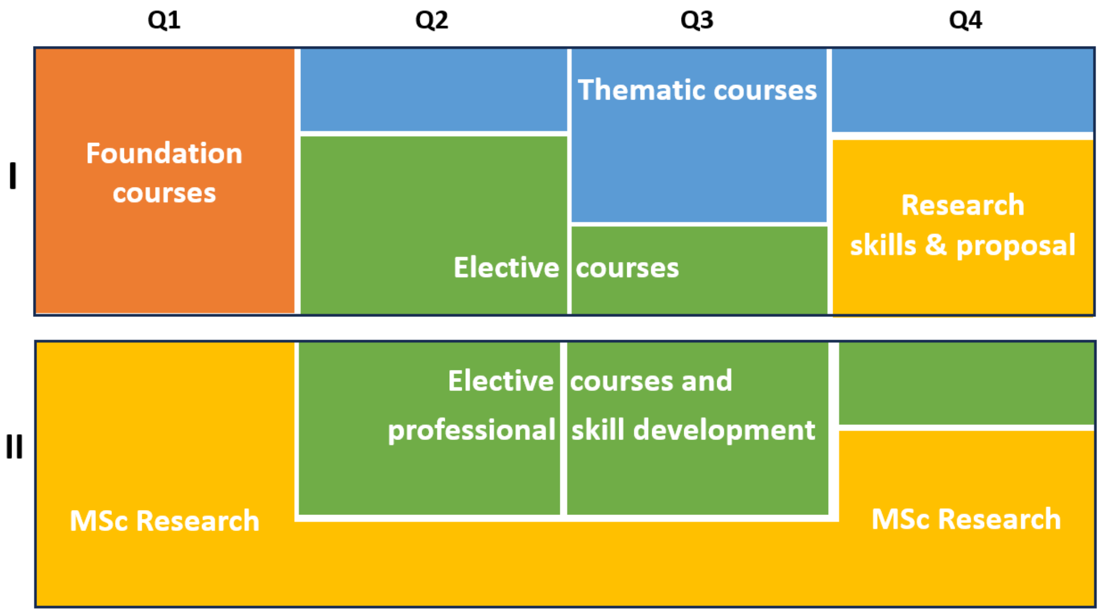

Figure 4: Structure of M-GEO

Our programme is structured with four interlinking components:

1. **Foundation courses** (20 EC). Here you will learn the essential geospatial skills to enable your personal learning pathway throughout the full programme. Foundation courses are compulsory for all students in the programme. They ensure that all programme participants, who come from diverse backgrounds, arrive at the start of the second quartile with a common level of knowledge and skills that is necessary to continue in the programme. The 15 EC foundation courses in the first year are complemented with 5 EC of professional skills courses, that are taught in the second year (see fig. 4). These courses are essential to let you meet the additional demands of the labour market that go beyond technical skills and domain knowledge.
2. **Thematic courses** (20 EC). The programme offers four thematic lines that cater for specific background and/or career interests. These themes (Disaster Resilience, Geo-AI, Resource

Security, and Urban Futures, see below) offer domain area application for the foundation skills. To complete the programme you must pass four thematic courses (20EC)

3. **Electives courses** (35 EC). We offer a range of electives that will enable you to further advance your technical skills, broaden your areas of interest including the opportunity to gain additional experience through an internship or choose course to further develop your professional skills. In the first year, you choose 15 EC of elective courses that deepen or broaden the scope of the thematic line you follow. In the second year, you complement your programme with 20 EC of elective courses that you need to do your research, broaden or deepen your scope further or gain professional experience through an internship. Which courses will eventually be offered in the curriculum, depends on demand. Because most courses partially depend on group work and interactive discussions, courses can only be offered if there are more than five participants.
4. The **Research phase** (45 EC) contains a compulsory research skills course (5 EC) for all students in the programme, offered in Q4, which guides you into your research proposal writing, (5 EC). In the second year, you develop your MSc research proposal into an MSc thesis, 35EC). With the individual MSc research thesis writing you will be able to apply what you have learned in the programme to a research project of your choice.

Thematic lines of M-GEO

Students must take 20 EC thematic courses. These courses are offered under the following **thematic lines**:

- **Disaster Resilience:** for students who wish to leverage geo-information and earth observation technologies for disaster related risk reduction, preparedness, response and resilience, in order to study and do subsequent research on disaster-related aspects, related to monitoring, prediction and decision making.
- **GeoAI:** for students who are interested in integrating geographic and earth observation data with AI and machine learning, to analyse critical environmental and societal challenges, including urban expansion, food security, disaster management, or climate change. It focuses on processing vast geospatial datasets for insights into location-based phenomena and trends.
- **Resources Security:** for students who wish to use geo-information and earth observation technologies to explore either water, food, ecosystems, critical raw materials and energy topics, for their availability, quality as well as their interaction, interconnections and sustainable use.
- **Urban and Land Futures:** for students who wish to use geo-information and earth observation technologies to understand and address social, environmental, economic and land tenure challenges in urban and regional areas. The focus is on applying innovative geospatial solutions to develop people-centric and digitally informed strategies, supporting the transition towards safe, healthy, liveable, resilient, and just urban and land futures.
- **Spatial Data Science:** for students who do not want to be restricted to a single theme but develop the necessary skills while tailoring their learning to achieve their career goals. You can only develop your own thematic line with the help your study adviser.

Programme Learning Outcomes

Students should, upon completion of the programme, be able to:

- connect the state-of-the-art scientific knowledge and methods used in geo-information science and earth observation to an application domain.

- Analyse problems from a geospatial perspective by taking into account the relevant temporal, social and cultural context in which these problems occur.

- acquire, create, transform and/or fuse geographic and earth observation data into useable and contextualized actionable information.

- Design, implement and evaluate tools and solutions for geospatial problems, taking into account the relevant temporal, social and cultural context to which they apply.

- Critically reflect on the ethical implications and academic integrity of their own actions and work.

- Independently conduct scientific research, contributing to knowledge development in the field of geo-information science and earth observation.

- Critically reflect on their own scientific work and that of others, to come to a judgement of the status of the work and how it could be used and improved or extended.

- Communicate their work to specialists and non-specialists in the scientific and professional field, using appropriate communication channels and taking into account open science principles and the relevant social and cultural context.

- Function cooperatively and empathically in culturally and disciplinarily diverse teams.

Assessment vision and policy of M-GEO

The full vision on testing and assessment for the faculty ITC, is available in the document "Assessment Policy Faculty Geo-Information Science and Earth Observation – ITC"

For M-GEO, the main elements of our assessment policy are following the assessment policy for the higher education accreditation system of the NVAO: "the programme must have (accreditation standard 3) an adequate system of student assessment in place". For M-GEO the means we ensure that:

- The student assessments are valid, reliable and sufficiently independent;
- The requirements are transparent to the students;
- The quality of interim and final examinations is sufficiently safeguarded and meets the statutory quality standards;
- The tests support the student's own learning processes.

<u>The purpose of testing and assessment</u> is: to allow students in the programme to demonstrate that they have, either individually or in groups, obtained the knowledge and skills taught in the programme to the level that is described in the learning outcomes of the courses.

To accomplish this, the programme has formulated clear final qualifications that meet international standards. The starting points are the domain-specific framework and the Meijers criteria or the Dublin Descriptors. M-GEO has established a relationship between the final qualifications and the learning objectives of the units (courses) in the curriculum. These learning objectives are formulated concretely and specifically, according to Bloom's taxonomy. Consequently, a firm relationship exists between the final qualifications, the learning objectives and the assessment of the learning objectives.

Within M-GEO, the selected test methods are consistent with the instructional methods and the learning objectives, following the principle of constructive alignment. Ultimately, this results in tests that are well-spread in time and a balance is maintained in each course between summative and formative purposes and individual and group testing.

Within the programme, there is room for experimentation with new test methods like competence-based testing, testing practical skills, etc. Also, methods like self-assessment and peer feedback are options. Digital testing is implemented related to the usefulness and practicality of this method and in accordance with the philosophy of the University on digital testing.

The quality of the examiner is reflected in the quality of the test. The test competency of examiners and the quality of tests are the programme director's responsibility. The Examination Board supervises the quality of the tests and examinations

Test Quality

It is essential that each test strives to fulfill the quality criteria for assessment:

Transparency: the students are clearly informed on how and what they are going to be assessed prior to the test. Clear information is available for students on when and what tests are scheduled. This includes information about the deadlines for assignment submissions and the size/estimated workload. The course coordinator is responsible for providing this information as early as possible to the students in the course, but never later than the second week of the course. Re-programming a test is only possible after clearance of the Examination Board.

Validity: the test covers the learning objectives. In validity, content (congruent with the learning objectives), level (of difficulty) and representativeness play a role.

Reliability: the test makes a meaningful distinction between the students who have a good or less good command of the learning objectives. The quality of the test plays a role here (distinctive character, minimal chance of gambling, clarity), the circumstances under which the test is administered (standardization and objectivity) and the way in which the results are assessed (objective, not random, accurate).

Manageability: A test should be doable: A maximum of one test per day is allowed. A written test should not commence within 24 hours of the start of the previous written test.

Test plan

Often, courses are graded by combining results from more than one test. In these cases, a test plan is necessary. In a test plan, the learning objectives of the course/module are represented and related to all the tests. In addition, the test methods are described, as well as the weight they have regarding the final grade. The test plan guarantees the consistency of the test with the learning objectives. The examiner is responsible for filling out the test plan. The test plan is considered valid when:

- Each course offers a mix of test methods that enables the examiner to assess the level of knowledge attained by the student as well as the authenticity of any submitted work.
- Each test is related to one or more specific learning objectives of the course.

Authenticity of submitted work

Within M-GEO, we follow the University guidelines for academic fraud and plagiarism. This includes the restrictions put on the use of generative AI. Examiners will always use software to check submitted written assignments for (self-)plagiarism. The student must be able to demonstrate that the submitted work is authentic and that the use of generative AI falls within the given restrictions. As a consequence, each assignment must be accompanied by clear guidelines or restrictions on the use of generative AI.

If the examiner cannot immediately assess the authenticity of the work, oral tests can also be used as an additional means to ascertain this.

Group assessment

A group assignment implies the collaboration of one or more students with the aim of achieving a specific result. With a group assignment, the student is also tested for mastery of secondary skills, such as collaboration, research, analysis, decision making, applying, designing, presenting, advising, evaluating and improving. The following aspects have to be considered:

- Clear expectations in instructions and guidelines for the students. Instructions for the grading, including rubric and weighing of various components (if applicable).
- The individual and the group components are assessed using an assessment framework derived from the learning objectives.

Oral tests

The task of the examiners is to make an objective assessment. Because each candidate is examined individually, it is difficult to guarantee comparability between students. As a result, there is often a difference between the mutual evaluation of teachers. There are a number of things that examiners must do to overcome most of this:

- A second examiner is present to enhance the objectivity of the assessment. Otherwise, a recording of the conversation must be made. All exam questions are written down, to ensure all students are assessed on exactly the same questions.
- An answer model for expected answers is prepared to use during the test;

Avoid uncertainty with the candidate: indicate whether questions are asked to clarify the answer or to gauge the insight. Let the candidate know whether, in addition to substantive criteria, other elements, such as the language used or the structure of the answer, are included in the assessment.

Student well-being and support

Career choices and study trajectories are demanding for every student. The choices to be made with uncertainties about the future and the need to perform are the pressures that many students experience during their academic programmes. At the University of Twente we are very much aware of these things and we do our best to prevent or to mitigate them. We have a team of professionals that will do this together with you. We will provide you with:

- Transparent communication during your application process
- Assistance in obtaining the necessary visa and making travel arrangements
- A guaranteed accommodation offer
- Assistance with health insurance and banking issues
- A soft landing in your study programme with a well-structured introduction programme that informs you about the basics of student life in the Netherlands

For this you can count on a study advisor and a mentor to be available to you for academic issues whenever you need them, and a student affairs team that is ready to help you with anything else.

Furthermore, the university offers a variety of self-help and moderated courses related to well-being.

Transitional arrangement

The curriculum for the MSc programme Geo-information Science and Earth Observation has significantly changed with the start of the academic year 2025-2026. These changes will affect students:

1. That have started the programme in 2024 and still need to pass courses from their first academic year.
2. That have started the programme before 2024 and still need to pass courses from the old curriculum.

The purpose of this transitional arrangement is to ensure that these students do not experience any adverse effects of this change.

Ad 1: students who still need to pass courses from their first academic year are entitled to:

- one more test opportunity for all the courses they still need to pass for the academic year 2024-2025.

These additional test opportunities must be taken within the academic year 2025-2026. These students can also request approval from the examination board to replace the missing course(s) with course(s) from the new curriculum.

Ad 2: students who have started the programme before September 2024 are entitled to:

- one more test opportunity of only one course of their first academic year they still need to pass and,
- one more test opportunity for all the courses they still need to pass from their second academic year.

These additional test opportunities must be taken within the academic year 2025-2026. These students can also request approval from the examination board to replace the missing course(s) with course(s) from the new curriculum.

Furthermore, for all students who have started their programme before September 2025 count that:

- The MSc research proposal and thesis writing remains 45 EC in total
- Internships receive 10 EC.

The study adviser will gauge the interest and requirements of students to achieve their study plans before the end of the academic year 2024-2025 to ensure that the transitional arrangements can be implemented without any problems.

Course descriptions

The courses within the curriculum are individually described in the detailed guide. They are ordered per thematic line. At the start of each thematic line section, a rationale for the thematic line is given along with an overview of the potential courses in it and the different predefined learning pathways based on a selection of these courses.

Although it is difficult to represent all the different learning pathways in this study guide, we have made an effort to provide the courses that should be followed. Some courses in the programme are shared between learning pathways. The themes and pathways are explained and schematically represented in the curriculum outline. Eventually, an online version of this study guide will allow students to filter course descriptions to only see the courses relevant to their preferred learning pathways. In this document, the courses for each thematic line and learning pathway.

Each course description starts with a summary of the course content, followed by the most important course details as summarised below:

Quartile	Indicating in which quartile of which academic year the course is offered
Date	The start and end date of the course
Thematic Line	Titles of the thematic lines that offer the course
Learning Pathway	Names of the predefined learning pathways that include the course
Credits (EC)	Study load of the course in ECTS
Learning outcomes	The specific learning outcomes of the course, that contribute to the achievement of the programme learning outcomes will be added in the next study guide update (June 2025)
Tests	The basic test plan, indicating the type of tests in the course and their respective weights will be added in the next study guide update (June 2025) A balanced mix of testing methods is used in each course. At least two of the following testing methods will always be applied in each course: Written tests (digital or analogue) Written and practical assignments Oral tests (with or without a preceding presentation) To assess the progress of the student in achieving the learning outcomes an element of formative feedback and assessment is also included.
Entry requirements	Although each course is in principle open for all students in the Master of Science degree programme. Some expectations to prior knowledge or followed courses can exist. These will be added in the next study guide update (June 2025)

Foundation courses

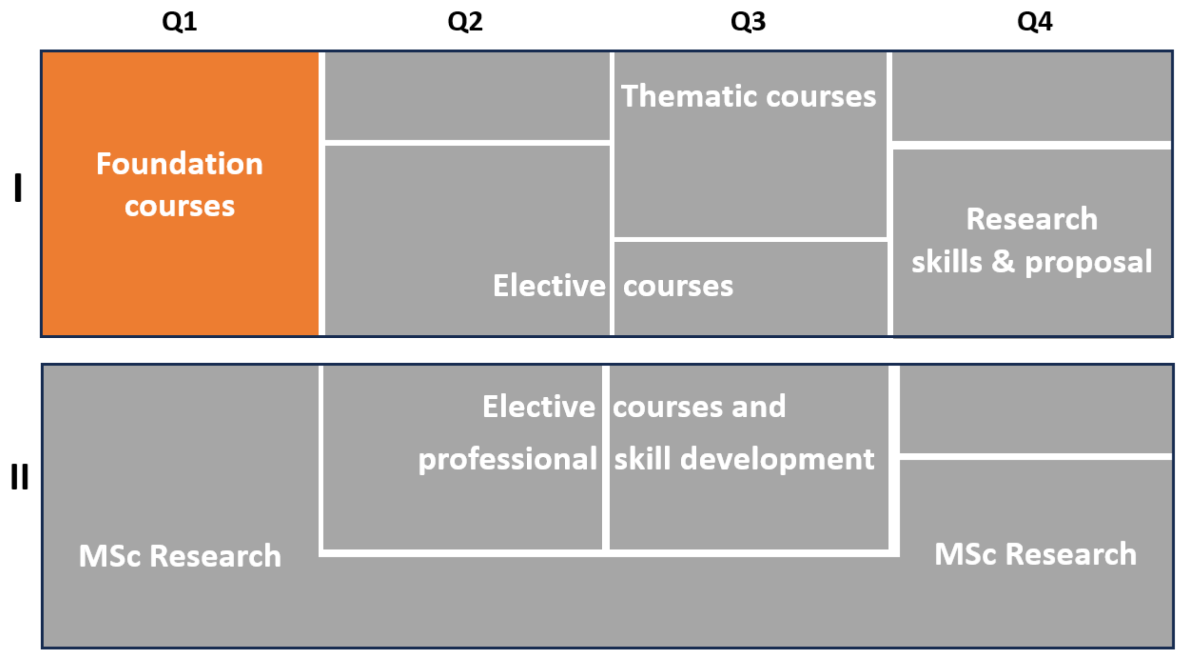

Figure 5: Foundation courses in M-GEO

Foundation courses are compulsory for all students in the programme. They ensure that all programme participants, who come from diverse backgrounds, arrive at the start of the second quartile with a common level of knowledge and skills that is necessary to continue in the programme. They will enable your personal learning pathway throughout the full programme.

Each course is 5 EC. Three courses are offered in the first quartile and one is offered in the second quartile:

- Fundamentals of GIS and Earth Observation
- Fundamental Spatial Data Engineering and Innovations
- Fundamental Programming for Geospatial Analysis

During the first quartile, when you follow the foundation courses, you will be given the opportunity to explore the variety of themes and learning pathways that are available in the programme. Based on your experiences with the foundation courses, you will know which techniques and skills you would like to develop further and in which thematic area you would like to apply them. About two months into the programme you will, therefore, have to make the choice under which theme you will follow which learning pathway. The study adviser can help you with this if needed.

Fundamentals of GIS and Earth Observation

Quartile	Year 1: Q1
Date	01 September 2025 - 07 November 2025
Thematic Line	All
Credits (EC)	5

Course content:

This course is designed to provide students with the foundational knowledge and skills in these critical geospatial technologies necessary in this programme. The course provides a comprehensive introduction to the principles, techniques, and applications of remote sensing (RS) and Geographic Information Systems (GIS), emphasizing their integration to solve real-world problems. The main course content consists of:

Introduction to RS and GIS: The course begins with an overview of RS and GIS, exploring their, core concepts, and significance in various fields such as environmental monitoring, urban planning, agriculture, and disaster management.

RS Fundamentals: Students will learn about different types of RS systems, focusing on optical passive sensors included in satellite and airborne platforms, as well as the electromagnetic spectrum's role in data acquisition. Participants are exposed to key preprocessing steps such as radiometric and geometric corrections ensuring data quality.

GIS Basics and Data Handling: Interlinked with RS, comes the introduction of GIS principles, spatial data models, and database management. Students will engage in hands-on exercises to collect, input, and manage spatial data, learning essential techniques like digitizing, GPS, and attribute data collection.

Image Interpretation and Classification: Students will gain skills in interpreting RS imagery, performing both visual analysis and supervised image classification, and assessing classification accuracy.

Spatial Analysis and Integration: The course integrates RS data with GIS to enhance spatial analysis capabilities. Students will practice GIS analytical techniques, such as buffer and overlay analysis, combining data acquire from geoportals and processing flows.

Practical Applications and Project Work: Along the course there is a “cumulative” project-based learning of choice, where students are exposed to RS and GIS techniques of at least one learning path, while practicing the instructed methodology. Collaborative projects and specific case studies will reinforce theoretical knowledge and practical skills, preparing students for professional applications.

Fundamental spatial data engineering and innovations

Quartile	Year 1: Q1
Date	01 September 2025 - 07 November 2025
Thematic Line	All
Credits (EC)	5

Course content:

Geospatial problem solving for addressing societal challenges employs a wide variety of theories, methods, and tools, each applicable to a specific type or aspect of the problem solving process. All approaches, however, involve the acquisition, processing, and dissemination of data in one form or another. The Geoinformation and Earth Observation specialist must, therefore, be equipped with the necessary skills to find, use, preserve, and disseminate geospatial data. This course introduces conceptual models, analysis tools, and infrastructure for representing and analysing geographic phenomena in computer systems. The course covers both spatial and temporal aspects of the observed phenomena. Fundamental concepts of spatial representation including geometric primitives, topology, multidimensionality, spatial autocorrelation, graphs and networks, will be introduced in the context spatial data management. By the end of the course students should be able to interact with local or remote data resources using a variety of technologies including SQL and common web service APIs (e.g. OGC WMS, WFS, WCS, REST). The student should therefore become familiar with common of data formats used in GIS and EO. Students will also learn to apply elementary data transformations (analysis) to obtain data in the appropriate structure for dissemination and presentation in both static and dynamic spatiotemporal visualizations. Applications in urban and land futures planning will be used in examples and exercises throughout this course. Learning units are organized so that concepts and methods from various knowledge categories are combined into a wholistic skill set that a student can use to solve a specific geospatial problem.

Fundamental Programming for Geospatial Data Analysis

Quartile	Year 1: Q1
Date	01 September 2025 - 07 November 2025
Thematic Line	All
Credits (EC)	5

Course content:

In an increasingly data-driven world, proficiency in data analysis and geospatial data processing has become a crucial skill set. This course is designed to equip students with the fundamental tools and techniques required to navigate the complex landscapes of data analysis, descriptive statistics, geospatial data handling and machine learning techniques using Python. Python, with its extensive libraries and versatility, is the go-to language for professionals in data science, geography, environmental science, urban planning, and beyond.

This 5 EC course offers a comprehensive introduction to Python, enabling students to master the basics of programming so that they feel comfortable tackling data visualisation and geospatial data processing. With Jupyter Notebooks, an interactive environment widely used by data professionals, students will gain hands-on experience in writing Python code, analysing data, and visualising results.

The course is structured into five modules, each focusing on a critical aspect of Python for data analysis. Beginning with Python programming fundamentals, students will build a strong foundation before moving on to descriptive statistics and data visualisation techniques. The course then delves into geospatial data, where students will learn to handle and analyse vector and raster data, followed by a module on advanced manipulation and visualisation of tabular data. The course culminates in an integrated project where students will apply their knowledge to solve a real-world problem, combining geospatial and tabular data for a comprehensive analysis.

By the end of this course, students will not only have mastered the essential skills in Python programming and data analysis but also be prepared to tackle complex data-driven challenges in GIS and Earth observation.

Thematic line: GeoAI

The programme offers four thematic lines that cater for specific background and/or career interests. The purpose of these thematic lines is to provide students from a certain educational background or work experience with an application domain in which they can apply their newly gained knowledge and skills. A thematic line also can provide students with a clear idea of their future career with the necessary focus. Under a thematic line, all courses are organized that provide the latest knowledge and skills available in the field. Each thematic line therefore offers dedicated learning pathways to support specific career goals.

GeoAI, or Geospatial Artificial Intelligence, is the integration of artificial intelligence (AI) and machine learning techniques with geographic information systems (GIS) and geospatial data. GeoAI enables the automated analysis and interpretation of large and complex spatial datasets, like satellite images, UAV data, radar, local sensor data etc. facilitating the extraction of meaningful patterns, trends, and insights. By combining AI's ability to process and analyse vast amounts of data with GIS's spatial analysis capabilities, GeoAI can enhance decision-making across various domains, such as urban planning, environmental monitoring, climate change and disaster management. It allows for more efficient processing of geospatial data, better predictions, and the discovery of new spatial relationships that might be difficult or impossible to detect through traditional methods.

In today's data-driven world, organizations like municipalities, utility companies, and corporations rely on spatial data for tasks such as housing, climate adaptation, and energy transition. You might want to learn how to design data structures and integrate diverse information to create valuable insights. You can learn to translate management needs into data products, such as digital twins and geo-services, supporting geo-solutions development.

GeoAI, teaches you the necessary programming knowledge and skills to acquire, retrieve, clean, and explore various geospatial datasets to create maps, models, systems, and graphics that help other stakeholders make better-informed decisions. You can furthermore learn to enhance user engagement by creating data visualizations, dashboards, and virtual reality experiences. Using 3D and VR, you ensure intuitive, functional, and visually appealing user interfaces. You can play a vital role, using machine learning and deep learning to convert sensor data into actionable information. By integrating technologies like computer vision and photogrammetry, learn to create 3D geoinformation models for BIM, digital twins, and flood modelling, addressing challenges like urban expansion, disaster management, and climate change.

All students choosing GEO-AI will follow these thematic courses:

	Theme courses
Quartile 2	- Volunteered Geographic Information and Geo Citizen Science - Quantitative RS - Scientific Geocomputing
Quartile 3	- 3D Geoinformation Engineering - Geospatial Databases Engineering - Machine Learning for Geospatial Sciences
Quartile 4	- Advanced ML for Geospatial Sciences

Q1	Q2 -GEOAI	Q3	Q4
Foundation 1	**Theme courses** VGI and GCS Quantitative RS	**Theme courses** Machine Learning for Geospatial Sciences	**Theme course** Advanced Machine Learning for Geospatial Sciences
Foundation 2	**Theme course** Scientific Geocomputing	**Theme courses** 3D Geoinformation Engineering Geospatial Databases Engineering	**Research** MSc research proposal writing
Foundation 3	**Elective courses** Geovisualisation and A/VR Big Geo Data Geostatistics Radar Remote Sensing	**Elective courses** Geoweb Apps and Services & SDI Geospatial Analysis & Time Series Laser Scanning UAV for Earth Observation	**Research** Research skills

Figure 6: The courses of the different learning pathways under the GeoAI theme

Under this thematic line, three pathways exist. To follow a pathway, two out of three recommended electives should be chosen:

GeoAI Pathways	**Pathway electives**
Geospatial Data Engineer/Visualizer	- Big Geo Data - Geovisualisation and A/VR - Geoweb Apps and Services & SDI
Geospatial Analyst	- Geostatistics - Big Geo Data - Advanced Geospatial Analysis & Time Series
Remote Sensing Specialist	- Radar Remote Sensing - Laser Scanning - UAV for Earth Observation

GeoAI: theme courses

Quantitative Remote Sensing

Quartile	Year 1: Q2
Date	10 November 2025 – 30 January 2026
Thematic Line	Resources Security GeoAI Disaster Resilience
Credits (EC)	5 or 2.5

Course content:

Remote sensing is a unique tool to observe the Earth system, and to quantitatively monitor a variety of key atmospheric, land and ocean variables by measuring radiation reflected or emitted by the earth or atmosphere. With the availability of more and more remote sensing data from various types of instruments with different spectral characteristics, temporal and spatial resolutions, the field of quantitative land remote sensing is advancing rapidly. This course provides an overview of Earth Observation from Space by describing basic concepts of orbits and viewing from space, instrument characteristics as well as exploring the electromagnetic radiation ranges used by remote sensing devices, like in the VIS, NIR, SWIR, TIR atmospheric windows and active and passive Microwave regions, but also within atmospheric absorption bands. Radiative transfer equation and atmospheric correction for signal correction are discussed and practiced.

Attention is given to space and ground segments, operational (meteorological) satellite programmes within the ocean and sea ice, land and atmospheric domains and the retrieval of various space based observations of geophysical variables and their availability in cloud repositories and online processing platforms, and their retrieval.

Also attention is given to calibration and validation, related to instrument calibration (before launch, on board and vicarious calibration) but also to bias adjustment of long term data records and the need of validation when using the geophysical variables obtained through space based observations.

NB: depending on the thematic line chosen, this course is to be followed for either 2.5 or 5 EC

Scientific Geocomputing

Quartile	Year 1: Q2
Date	10 November 2025 – 30 January 2026
Thematic Line	GeoAI
Credits (EC)	5

Course content:

With the advancements in LLM and AI it becomes important to not just be able to programme or code, but also to make appropriate use of these new technologies to develop reproducible code. Recent advancements in information-gathering technologies have resulted in the production of high volume, diverse and versatile spatial data. Satellite imagery, Unmanned Aerial Vehicles (UAV), Global Positioning Systems (GPS), GPS-enabled handheld devices, and Location-based Social Networks are generating various spatial and spatiotemporal data on a daily basis. Such a diversity of data has opened a new window toward tackling a wide range of significant problems that had been out of reach a decade ago.

Dealing with such voluminous and versatile data sources and extracting information and knowledge from those datasets requires exploiting methods and building custom solutions beyond those already provided by off-the-shelf GIS tools. The ability to construct custom solutions and techniques is an essential capability of the Geoinformatics specialist, who should be competent in addressing geospatial problems through scientific programming. Scientific programming allows us to access different data sources, manipulate the underlying data, and freely apply different sorts of analysis to our data. Scientific Geocomputing is a course in which you will learn basic scientific programming concepts, focusing on spatial data manipulation, analysis, and visualization.

The course starts with an introduction to Python syntax, its data, and control structures. In parallel, you'll learn about solution strategies and algorithmic thinking so that you can improve your problem-solving skills. You will get familiar with several libraries that are used to manipulate high-dimensional data in the data science community. The course introduces you to the most important programming libraries that can handle and analyze spatial data in raster and vector formats. Also, you will learn about spatial database management systems (SDBMS) and how you can store, retrieve, and manipulate spatial data in such a system. You will learn about data visualization and how you can present the outcomes of your analysis in the form of maps, graphs, and charts using programming libraries. We will discuss the scientific side of programming by introducing literate programming, which emphasizes code documentation, and the FAIR principles of scientific data management, which apply to data and code.

Volunteered Geographic Information and Geo Citizen Science

Quartile	Year 1: Q2
Date	10 November 2025 – 30 January 2026
Thematic Line	Urban & Land Futures GeoAI
Credits (EC)	2.5

Course content:

The concept of (public) participation in geospatial research has a long tradition. However, the adoption of Web 2.0 technologies facilitates the generation and sharing of and collaboration on digital content with a geospatial component, and has therefore expanded possibilities and practice. This course gives an overview of its history and new developments, on examples of successful and unsuccessful projects to identify criteria for sustainable crowdsourcing or volunteering, including issues of privacy and ethical research. It is particularly relevant for eliciting and arguing the needs, interests, and positions of any stakeholder that incorporates or directly works with the public. A main focus lies on the technologies that enable new forms of participatory sensing, and techniques to assess and improve the quality of such data.

Geospatial Database Engineering

Quartile	Year 1: Q3
Date	02 February 2026 - 17 April 2026
Thematic Line	Urban & Land Futures GeoAI
Credits (EC)	2.5

Course content:

Geospatial database engineering is the professional suite of activities that is needed to develop, realize and maintain a usually large database system that holds geospatial data sources that service usually a sizeable user community.
Wherever large geospatial datasets, especially comprising vector data, are shared between professional users the technology to apply is a geospatially enabled database management system (sdbms). Its purpose is to serve as a reliable data store for its community of users, and provide a resource of agreed upon and documented quality.
This course teaches how to initiate such a database system, bring in external data, curate the data, and put in place guards against data incorrectness, invalidity, incompleteness and inconsistency.
It next addresses how conceptual descriptions of functions that must become part of the system's application programming interface can be implemented using the programming

facilities that the sdbms offers. We look into the coding paradigm of set-based programming, and make use of mathematical logic and comprehension schemes, which are typical of SQL.
Specific attention will be paid in this course to computing with geospatial vector data. This also requires understanding of the OGC Simple Feature model, ISO 19125. Various techniques will be introduced to test and validate, correct and improve vector data, and we discuss a number of typical problem situations and template solutions to them.
The course will bring to the student understanding of how to approach these challenges and skills to resolve them.

Machine Learning for Geospatial Sciences

Quartile	Year 1: Q3
Date	02 February 2026 - 17 April 2026
Thematic Line	GeoAI Disaster Resilience
Credits (EC)	5

Course content:

This course is designed to guide you through the intersection of machine learning and geospatial sciences, providing you with the expertise to address pressing societal and environmental challenges. You will be introduced to the foundations of supervised and unsupervised learning algorithms, exploring their applications in the geospatial domain. You will learn popular learning algorithms to address various inference tasks, such as clustering, regression and classification.
From satellite imagery to GIS datasets you'll master the tools and methodologies required to preprocess, analyze, integrate and visualize them. You will gain the skills needed to extract meaningful patterns and insights from these geospatial datasets.
Feature extraction and engineering are critical steps in building effective machine learning models. You will explore techniques to transform raw geospatial data into relevant features enabling your models to learn and predict more effectively.
Clustering techniques, for exploratory spatial data analysis, will be introduced to help you to discover hidden structures and trends within geospatial datasets.
Classification and regression methods like decision trees, random forests, support vector machines and neural networks are pivotal machine learning tasks that you'll apply to a wide array of geospatial problems. Whether it's land use classification, predicting environmental changes, or estimating spatial variables like temperature or population density, you'll develop models that provide precise and actionable insights.
Throughout the course real-world case studies will demonstrate the transformative impact of machine learning on geospatial sciences. You'll work on projects that tackle contemporary issues such as urban planning, environmental monitoring, and disaster management.
By the end of this course, you will be adept at applying machine learning techniques to geospatial sciences.

3D Geo Information Engineering

Quartile	Year 1: Q3
Date	02 February 2026 - 17 April 2026
Thematic Line	GeoAI
Credits (EC)	2.5

Course content:

This course is meant for students who want to get into the field of geospatial data acquisition, processing, and application using state-of-the-art spaceborne, airborne, and terrestrial sensors and technologies.
This course provides students with significant knowledge on how to utilize active and passive imaging sensors, and laser scanning for collecting high-resolution 3D geospatial data. The main use of the 3D geoinformation obtained through this course is the creation of Digital Twins. By understanding and implementing Digital Twins, students will be able to enhance decision-making in urban planning, infrastructure maintenance, environmental conservation, and emergency response, etc.
During the course, students will investigate aircraft and drone vehicles that are equipped with imaging sensors and laser scanners (LiDAR) for creating highly accurate 3D models of terrain and structures. Students will learn the benefits of the integration of 3D products from photogrammetry and laser scanning and how it will create more precise 3D geoinformation for engineering applications, spatial analysis, and 3D visualization.

Advanced Machine Learning for Geospatial Sciences

Quartile	Year 1: Q4
Date	20 April 2026 – 03 July 2026
Thematic Line	GeoAI
Credits (EC)	5

Course content:

Building on the foundations laid in the Machine Learning for Geospatial Sciences course, this advanced program delves into the forefront of machine learning and deep learning technologies tailored for geospatial applications. Here, you will explore sophisticated models and techniques that enable the analysis of both spatial and spatio-temporal data, addressing complex real-world challenges with precision and insight.

The course begins with an in-depth exploration of advanced machine learning algorithms, designed to handle the unique complexities of geospatial data. You will learn to apply these algorithms to model intricate spatial patterns and relationships, enhancing your ability to derive meaningful insights from diverse geospatial datasets.

Deep learning algorithms, known for their capacity to process large and complex datasets, will be a significant focus. You will master techniques for analyzing geospatial imagery, recognizing patterns, and making accurate predictions. Algorithms like Recurrent NN, Transformers and Graph NN empower you to extract detailed and valuable information from high-resolution and divers geospatial data.

Handling spatio-temporal data requires specialized approaches. You will learn advanced methods for analyzing time series data, predicting temporal changes in geospatial phenomena, and help understanding the dynamics of processes such as weather patterns, urban growth, and environmental shifts.

State-of-the-art architectures and methods will be introduced, highlighting their remarkable ability to capture and model complex dependencies in data. You will explore their application in geospatial sciences, particularly in tasks requiring attention mechanisms to focus on relevant spatial regions or temporal sequences.

An important component of this course is Explainable AI (XAI), ensuring transparency and interpretability of your models. You will learn techniques to make complex models understandable, fostering trust and facilitating informed decision-making in geospatial applications. We will discuss the ethical implications of AI in geospatial sciences, emphasizing the importance of responsible data use, privacy concerns, and the societal impact of AI-driven decisions.

By the end of this course, you will be proficient in leveraging advanced machine learning and deep learning techniques for geospatial sciences, equipped to tackle sophisticated spatial and spatio-temporal challenges ethically and transparently. Join us to advance your expertise and contribute to the transformative power of AI in geospatial sciences!

GeoAI: elective courses

Geovisualisation and A/VR

Quartile	Year 1: Q2
Date	10 November 2025 – 30 January 2026
Thematic Line	GeoAI
Credits (EC)	5

Course content:

This course Geodata Visualization covers aspects of geo-visual analytics, in particular, with respect to timeseries of movement data of people, animals, and goods. The objective of this course is to learn how to prepare and integrate, transform, and visually analyse the data to reveal spatio-temporal patterns and trends. Participants will, based on the methods introduced, develop visual environments for answering questions related to a real-world scenario. These visual environments will combine interactive and dynamic map and diagram displays with a focus on user-centred design.

Big Geo Data

Quartile	Year 1: Q2
Date	10 November 2025 – 30 January 2026
Thematic Line	GeoAI
Credits (EC)	5

Course content:

Thanks to the digital, mobile and sensor revolutions, massive amounts of data are becoming available at unprecedented spatial, temporal, and thematic scales. This leads to the practical problem of transforming big geo datasets into actionable information that can support a variety of decision-making processes. In this respect, scalable geodata science workflows are not only key to process big geospatial datasets, but also to share the obtained information and knowledge and to ensure the reproducibility of the results. To handle and analyse massive amounts of potentially heterogeneous spatio-temporal data, GIS specialists and researchers need to 1) understand the particular characteristics of big geodata, 2) learn to work with scalable data management and processing systems, and 3) develop distributed but robust data mining and machine learning workflows. This course aims to provide the necessary know-how by presenting theories, methods, and techniques to build scalable solutions for handling and analysing big geodata, and develop the necessary skills through hands-on practical and code-along sessions.

Geostatistics

Quartile	Year 1: Q2
Date	10 November 2025 – 30 January 2026
Thematic Line	GeoAI
Credits (EC)	5

Course content:

The premise of the course is motivated by the recent advancements in geoinformation data acquisition and storage and their intended use for evidence-based planning and monitoring. The spatial references of geoinformation data may be attributed to the exact locations of measurements or over a fixed set of contiguous regions or lattices. This course seeks to handle the three main classes of spatial data/processes: geostatistical data/spatially continuous process, lattice data/discrete process, and point pattern data/point process. Such data appear common in diverse application fields like environmental science, agriculture, natural resources, environmental epidemiology, and so on. The aim is to present methods that can be used to explore and model such data. Naturally, data vary in space and in time; hence data close to each other(either in space or time) are more similar than those farther. Geostatistical modelling based on the variance and/or covariances and interpolation (kriging) in space and time will therefore be introduced.
The methods will be extended and applied to data aggregated over contagious regions. The uncertainty is quantified, and attention will be given to making maps showing the probabilities that thresholds are exceeded. Attention is also given to optimal sampling and monitoring. Further, data that arise out of the occurrences of events; thus point pattern data will be considered. The significance of exploring the first and second-order properties of point patterns in diverse application domains like environmental and disaster (like earthquakes) modelling will be explained and applied. The last focus will be on lattice data; in principle, this kind of data consists of observed values over a set of fixed contiguous regions. This kind of data is rather easy to acquire and is mostly applied in health studies where data aggregation is a standard form of protecting locational privacy.

Radar Remote Sensing

Quartile	Year 1: Q2
Date	10 November 2025 – 30 January 2026
Thematic Line	GeoAI
Credits (EC)	5

Course content:

Radar Remote Sensing is different from optical Remote Sensing and offers unique opportunities in observing and monitoring the Earth surface. This course provides an overview of technology and applications related to radar remote sensing. Specifically, Synthetic Aperture Radar (SAR) and advanced methods building on SAR are considered: InSAR (Interferometric Synthetic Aperture Radar), DInSAR(Differential InSAR), Time Series InSAR, PolSAR (Polarimetric SAR) and PolInSAR. The students will learn how to choose, handle and pre-process the SAR images and apply advanced methods for information extraction from these images. Various examples of applications (such as land use land cover classification and land subsidence) will be provided. The quality of obtained results will be discussed in relation to the type of SAR data and choices made during the analysis. The course offers an opportunity to specialize in one of the advanced SAR methods during a practical project.

Laser Scanning

Quartile	Year 1: Q3
Date	02 February 2026 - 17 April 2026
Thematic Line	GeoAI
Credits (EC)	5

Course content:

Airborne, terrestrial and mobile laser scanning are modern technologies to acquire and monitor the geometry of the Earth's surface, objects above the surface like buildings, trees and road infrastructure, and even building interiors. This course provides an overview of the state of the art of these techniques, potential applications, like digital terrain modelling and 3D city modelling, as well as methods to extract geoinformation from the recorded point clouds.

Advanced Geospatial Analysis & Time Series

Quartile	Year 1: Q3
Date	02 February 2026 - 17 April 2026
Thematic Line	GeoAI
Credits (EC)	5

Course content:

No description available yet (new course).

Geoweb Apps and Services & SDI

Quartile	Year 1: Q3
Date	02 February 2026 - 17 April 2026
Thematic Line	GeoAI
Credits (EC)	5

Course content:

No description available yet (new course).

UAV for Earth Observation

Quartile	Year 1: Q3
Date	02 February 2026 - 17 April 2026
Thematic Line	GeoAI
Credits (EC)	5

Course content:

The use of Unmanned Aerial Vehicles - UAVs (or drones) has surged in the last two decades, leading to remarkable changes in several remote sensing applications. However, the development of best practices for high-quality UAV mapping is often overlooked representing a drawback for their adoption in different domains. UAV solutions then require an interdisciplinary approach, integrating different expertise and combining several hardware and software components on the same platform. This course aims to deliver both theoretical and hands-on knowledge to acquire, process and interpret UAV data. The course addresses three specific and alternative application domains: precision agriculture, water management and scene understanding. The basics of UAV mapping using visible, multispectral and thermal images will be given in the first module of the course. After this first module, the students will be asked to select one of the different application domains.

Thematic line: Urban & Land Futures

The programme offers four thematic lines that cater for specific background and/or career interests. The purpose of these thematic lines is to provide students from a certain educational background or work experience with an application domain in which they can apply their newly gained knowledge and skills. A thematic line also can provide students with a clear idea of their future career with the necessary focus. Under the thematic line all courses are organized that provide the latest knowledge and skills available in the field. Each thematic line therefore offers dedicated learning pathways to support specific career goals.

Within Urban and Land Futures (ULF) thematic line, students will acquire the knowledge and skills to understand and address social, environmental, economic and land tenure challenges in urban and regional areas. The focus is on applying innovative geospatial solutions, including city digital twins, to develop people-centric and digitally informed strategy supporting the transition towards safe, healthy, liveable, resilient, and just urban futures.

From an urban perspective, ULF equips you to address urbanization, resource depletion, and climate change challenges through advanced geo-information sciences and participatory planning. You'll learn to model, assess, and develop strategies for resilient, equitable, and inclusive cities.

From a land perspective, ULF equips you to address global land tenure challenges by developing cadastral maps, land registries, and land records. With over 70% of land parcels worldwide unregistered, efficient land administration is essential. The curriculum emphasizes data-informed spatial planning, integrating real-world case studies and a people-centric approach.

Key topics include urban governance, stakeholder analysis, multi-actor coordination, and sustainable urban development, with real-world applications such as digital twins, ecosystem services, and nature-based solutions. With expertise in Digital Twins, graduates can model urban environments, contributing to better land governance and decision-making. ULF aligns with Michael Batty and Wei Yang's vision for a digitally-driven future in spatial planning.

All students choosing ULF will follow these thematic courses:

	Theme courses
Quartile 2	- VGI and Geo Citizen Science - Urban and Land Futures
Quartile 3	- Designing Urban and Land Information Systems - Geospatial Databases Engineering
Quartile 4	- Urban and Land Future Studio

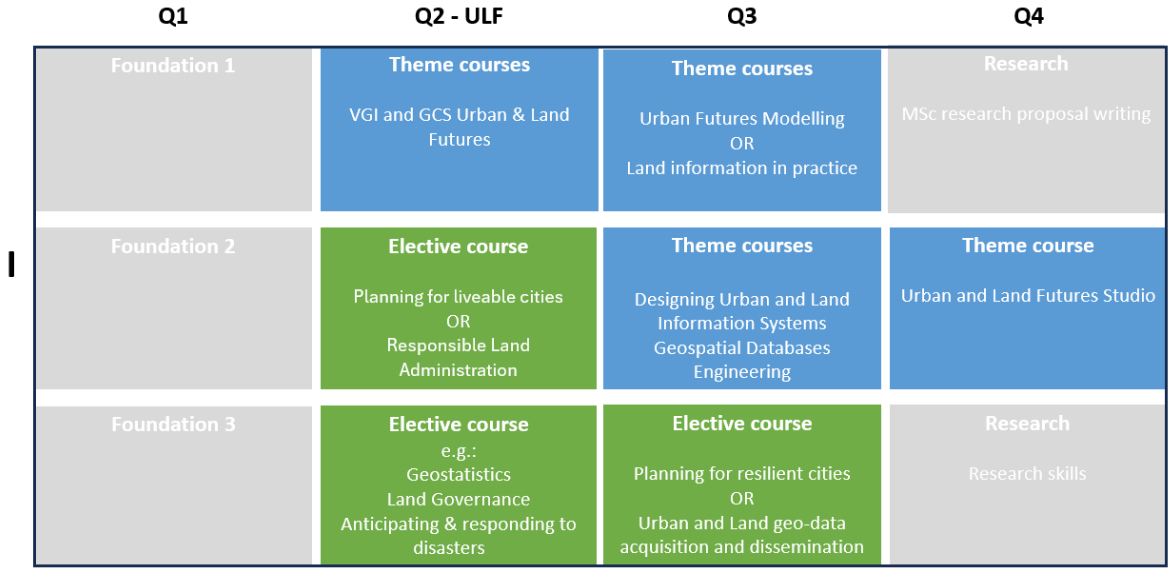

Figure 7: The courses of the different learning pathways under the Urban and Land Futures theme

Under this thematic line, two pathways exist. To follow a pathway, all recommended electives should be chosen:

ULF Pathways		**Pathway electives**
Planning for Liveable and Resilient Cities (Urban planner/data analyst)	Q2	- Planning for liveable cities
	Q3	- Planning for resilient cities - Urban Futures Modelling
Making Cities and Land SMART (Land information specialist)	Q2	- Responsible Land Administration
	Q3	- Land information in practice - Urban and Land geo-data acquisition and dissemination

In the second quartile there is an additional 5 EC general elective space under this theme.

Urban and Land Futures: theme courses

Volunteered Geographic Information and Geo Citizen Science

Quartile	Year 1: Q2
Date	10 November 2025 – 30 January 2026
Thematic Line	Urban & Land Futures GeoAI
Credits (EC)	2.5

Course content:

The concept of (public) participation in geospatial research has a long tradition. However, the adoption of Web 2.0 technologies facilitates the generation and sharing of and collaboration on digital content with a geospatial component, and has therefore expanded possibilities and practice. This course gives an overview of its history and new developments, on examples of successful and unsuccessful projects to identify criteria for sustainable crowdsourcing or volunteering, including issues of privacy and ethical research. It is particularly relevant for eliciting and arguing the needs, interests, and positions of any stakeholder that incorporates or directly works with the public. A main focus lies on the technologies that enable new forms of participatory sensing, and techniques to assess and improve the quality of such data.

Urban and Land Futures

Quartile	Year 1: Q2
Date	10 November 2025 – 30 January 2026
Thematic Line	Urban & Land Futures
Credits (EC)	2.5

Course content:

The management of space is one of the big challenges that human societies have to deal with. Competing claims over the use of finite resources have pushed human societies to develop institutions, technologies and paradigms that help manage these competing usages. Challenges like increasing urbanization, the depletion of land and other natural resources, and climate change make this management of space ever more urgent.
The governance of land and urban development is essential when considering development approaches to support sustainable futures. As a concept, governance encapsules (1) Multi level co-ordination and multi-faceted problems; (2) Multi actor networks, and (3) Multi-instrumental steering mechanisms. This implies that an understanding of problems, actors and steering mechanisms involved in the governance of land and urban development is necessarily focused

on the context in which a certain problem is placed and how it can be addressed by the governance settings available.
In this course we focus on key concepts of land and urban governance. The aim is for the student to gain a background in (challenges of) governance of land and urban development, that will influence how individuals, organizations and institutions work towards urban and land futures. An additional challenge in the course is inviting the students to reflect, discuss and imagine different land and urban futures.

Geospatial Database Engineering

Quartile	Year 1: Q3
Date	02 February 2026 - 17 April 2026
Thematic Line	Urban & Land Futures GeoAI
Credits (EC)	2.5

Course content:

Geospatial database engineering is the professional suite of activities that is needed to develop, realize and maintain a usually large database system that holds geospatial data sources that service usually a sizeable user community.
Wherever large geospatial datasets, especially comprising vector data, are shared between professional users the technology to apply is a geospatially enabled database management system (sdbms). Its purpose is to serve as a reliable data store for its community of users, and provide a resource of agreed upon and documented quality.
This course teaches how to initiate such a database system, bring in external data, curate the data, and put in place guards against data incorrectness, invalidity, incompleteness and inconsistency.
It next addresses how conceptual descriptions of functions that must become part of the system's application programming interface can be implemented using the programming facilities that the sdbms offers. We look into the coding paradigm of set-based programming, and make use of mathematical logic and comprehension schemes, which are typical of SQL.
Specific attention will be paid in this course to computing with geospatial vector data.
This also requires understanding of the OGC Simple Feature model, ISO 19125. Various techniques will be introduced to test and validate, correct and improve vector data, and we discuss a number of typical problem situations and template solutions to them.
The course will bring to the student understanding of how to approach these challenges and skills to resolve them.

Designing Urban and Land Information Systems

Quartile	Year 1: Q3
Date	02 February 2026 - 17 April 2026
Thematic Line	Urban & Land Futures
Credits (EC)	2.5

Course content:

With expanding urban settlements, increasing demand for resources, and exacerbating environmental challenges, the complexity of future urban and regional systems is expected to increase. Information systems for planning and managing land use policy implementation will therefore become indispensable tools in the urban planning and land administration toolboxes. In this course students learn to think in systems terms and use systems analysis and design methods to not only describe the functionality of an information system but, perhaps more importantly, to describe the data, information structures, processes, states, and state evolutions of interest within the urban and/or regional system under consideration. The course introduces the software process as a project implementation methodology. Analysis and design approaches are introduced in the context of this overarching structure. First students will learn to analyse requirements documents to conceptualize a system's purpose and boundary. Additional information from the domain and requirements documents will be used to develop a conceptual model of the domain and identify user actions and processes within the domain. UML class diagrams will be used to structure concepts. UML use case diagrams and activity diagrams will be used to analyse user intentions, actions, and the information system's responses. Finally UML state machines will allow student to describe the set of states that can be occupied by all or part of the system being modelled. The modeling constructs introduced are applicable to both the information system and the real world domain. Examples will help clarify how to apply the tool in both contexts.

Urban and Land Futures Studio

Quartile	Year 1: Q4
Date	20 April 2026 – 03 July 2026
Thematic Line	Urban & Land Futures Disaster Resilience
Credits (EC)	5

Course content:

Addressing current and future societal challenges or urban areas around the world requires integrating thinking and insights where space, society and technology intersect. This new geo-socio-technical approach to of solving urban and land problem demands a new way of working and indeed re-conceiving of the tools and methods that inform our solutions to these challenges. Advancements in planning support and decision making technologies have enabled evidence-based scenario planning but failed in engaging a broad range of non-experts in future-oriented planning practice that accounts for deep uncertainty and complexity of societal challenges.

In this studio course, student groups engage in challenge-based learning of a real-world spatial problem setting. Geospatial and participatory technologies for systematic analysis of locational phenomena and spatial characteristics will be applied in combination with methods for eliciting local experiential knowledge of residents and other societal actors to disentangle wicked problem settings and underlying root causes and to develop visions of a sustainable urban and land future. Goal of studio-based learning approach is to provide a policy making authority with integrated insights and inspiration for new methods for producing sage, and to co-design together with them future-oriented strategies and interventions in an inclusive manner.

In this course students are exposed to various lab facilities of ITC and learn how to make use of them for data collection, stakeholder interaction and collaborative planning and decision making.

Urban and Land Futures: elective courses

Responsible Land Administration

Quartile	Year 1: Q2
Date	10 November 2025 – 30 January 2026
Thematic Line	Urban & Land Futures
Credits (EC)	5

Course content:

Land Administration encompasses four fields i.e. land tenure, land use, land value and land development. These four fields are also referred to as land management practices. This course focuses on the land management practices in the context of the policy frameworks and sustainable development. The land management paradigm is used a guiding framework. The land management paradigm stresses the relationship between land policy and the four land administration functions i.e. land tenure, land value, land use and land development – and the wider societal goals. As such, legal frameworks, institutions, processes, interventions, successes and challenges are discussed in the context of social, economic, environmental pillars of development. Further, how these land management practices also link with emerging issues such as climate change are also discussed. The course therefore addresses both conventional and innovative ways of land management, promoting a paradigm shift towards responsible land administration. The course relates state-of-the-art scientific knowledge to students' experiences, perceptions and country context.

Planning for liveable cities

Quartile	Year 1: Q2
Date	10 November 2025 – 30 January 2026
Thematic Line	Urban & Land Futures
Credits (EC)	5

Course content:

"Planning for Liveable Cities" critically addresses inequalities within urban areas by analysing concerns about social equity, quality of life, health and well-being and urban competitiveness in light of urban development patterns and strategies. Tensions and trends in planning for these visions and ideals is discussed. Different tools are introduced and applied to analyse these patterns. Students will engage with various scales of analysis, applying geospatial solutions to develop people-centric and digitally-informed strategies that support the transition towards more equitable, healthy, and just urban futures. By capturing and understanding diverse forms of knowledge related to intra-urban variations in quality of life, the curriculum aims to create a deeper understanding of these patterns. This is crucial for targeting deprived areas and formulating effective area-based and people-based policies.

Planning for Disaster Resilient Cities

Quartile	Year 1: Q3
Date	02 February 2026 - 17 April 2026
Thematic Line	Urban & Land Futures Disaster Resilience
Credits (EC)	5

Course content:

Both hazard types and frequency, as well as built-up areas and cities are dynamically changing, resulting from climate and global changes. In April 2024, displacing 600.000 people in Brazil due to floods, having hottest day records already in Europe and in Asia are clear examples to the shifting hazard patterns. In such dynamic environments, the interdependency among the risk components amplifies the impact of disasters. In such an environment, disaster risk is constantly changing, and there is a definite limit to our capacity to foresee the failures resulting from unexpected interactions between interdependent components. Indeed, the intensity and extent of the challenges make clear that achieving resilient cities is everybody's business. Scientists, stakeholders and citizens are faced with the challenge to adapt their disaster risk reduction plans but lack the understanding and tools to account for the cross-sectoral impacts and dynamic nature of the risks involved. In this course, we follow the socio-technical approach in complex city systems and investigate the ways to contribute to cities' resilience. The main problem in disaster risk management is providing static measures to a dynamically changing system. In this course you will learn looking at the nature of risk as a 'dynamic' concept rather than a static one. You will focus on multi-hazard risk assessment and dynamic risk reduction measures on various sectors.

Land Information in Practice

Quartile	Year 1: Q3
Date	02 February 2026 - 17 April 2026
Thematic Line	Urban & Land Futures
Credits (EC)	5

Course content:

Land administration has long been executed through state-based agencies such as cadastral departments, land registry offices, ministries of land, or local governments with their own analogue or digital data repositories. These organizations do not act in a vacuum but within larger institutional fields and forces.

The broader environment of land governance, in which public organizations operate, is characterized by the interactions of multiple state and non-state actors, formal and informal practices, a multitude of regulatory frameworks and increasing global interconnectivity. This environment has been witnessing public sector reforms and increased adoption of (geo)Information and Communication Technologies (ICT),including automatization techniques, mobile device-generated data, crowdsourcing and advanced remote sensing technologies. In many places, more established forms of organizing meet the latest technological developments. While some organizations are beginning to digitize paper-based workflows, others may function through highly automated and digitized processes. At the same time, information technologies and digital data are not merely neutral tools, but they reflect, transport and transform the practices and values of organizations and institutional fields.

It is important therefore to understand and learn how to describe, explain, and assess organizational change in response to changing environments, (geo-)ICT implementation using workflows and related forms of data sharing, uses and dissemination.

Urban Futures Modelling

Course details:

Quartile	Year 1: Q3
Date	02 February 2026 - 17 April 2026
Thematic Line	Urban & Land Futures
Credits (EC)	5

Course content:

Understanding urban dynamics and urban growth is crucial for strategic long-term planning of infrastructure, economic development, environmental sustainability, social equity and overall urban resilience. At its core, the interaction between land use and transportation plays a pivotal role in shaping urban dynamics, and such interactions and dynamics can be most efficiently understood by modelling.

Modelling urban dynamics and growth involves the use of various theoretical frameworks that captures transportation infrastructure affects land use patterns and vice versa. In this course, the students will not only be introduced with theories about land use and transportation interactions, but also knowledges and techniques of implementing models that encodes the interactions quantitatively. Several modelling frameworks (to be specified) will be introduced to simulate travel decisions and behaviours, mobility and accessibility, land use land cover changes. On top of developing the modelling capacity, the students will also be trained to assess and interpret the modelled scenarios, so that to link the modelling into the practical context of urban planning and policy making.

Geo-data Acquisition and Dissemination

Quartile	Year 1: Q3
Date	02 February 2026 - 17 April 2026
Thematic Line	Urban & Land Futures
Credits (EC)	5

Course content:

No description available yet (new course)

Thematic line: Resources security

The programme offers four thematic lines that cater for specific background and/or career interests. The purpose of these thematic lines is to provide students from a certain educational background or work experience with an application domain in which they can apply their newly gained knowledge and skills. A thematic line also can provide students with a clear idea of their future career with the necessary focus. Under the thematic line all courses are organized that provide the latest knowledge and skills available in the field. Each thematic line therefore offers dedicated learning pathways to support specific career goals.

The thematic line "Resources Security" is designed to equip students with the expertise needed to address critical global challenges related to the sustainable use and management of natural resources, including water, energy, ecosystems, and critical raw materials. This thematic line offers three dedicated learning pathways—Natural Resources Security, Water Resources Security, and Geological Remote Sensing—each tailored to meet the needs of students with varying academic backgrounds and career aspirations. The thematic line prepares students for roles in diverse sectors like public policy, research, consultancy, and industry, where they can become specialists in areas like water management, environmental conservation, geological surveys, mining & exploration, and resource monitoring. Through core courses and specialized elective options, students will gain advanced remote sensing, resource modelling, and impact management skills, positioning them for successful careers as hydrologists, environmental geoscientists, water and health specialists, or remote sensing geologists.

All students choosing Resources Security will follow these thematic courses:

	Theme courses
Quartile 2	- Quantitative RS
Quartile 3	- Modelling and Mapping - Impact Monitoring & Management
Quartile 4	- Lab & Fieldwork Skills

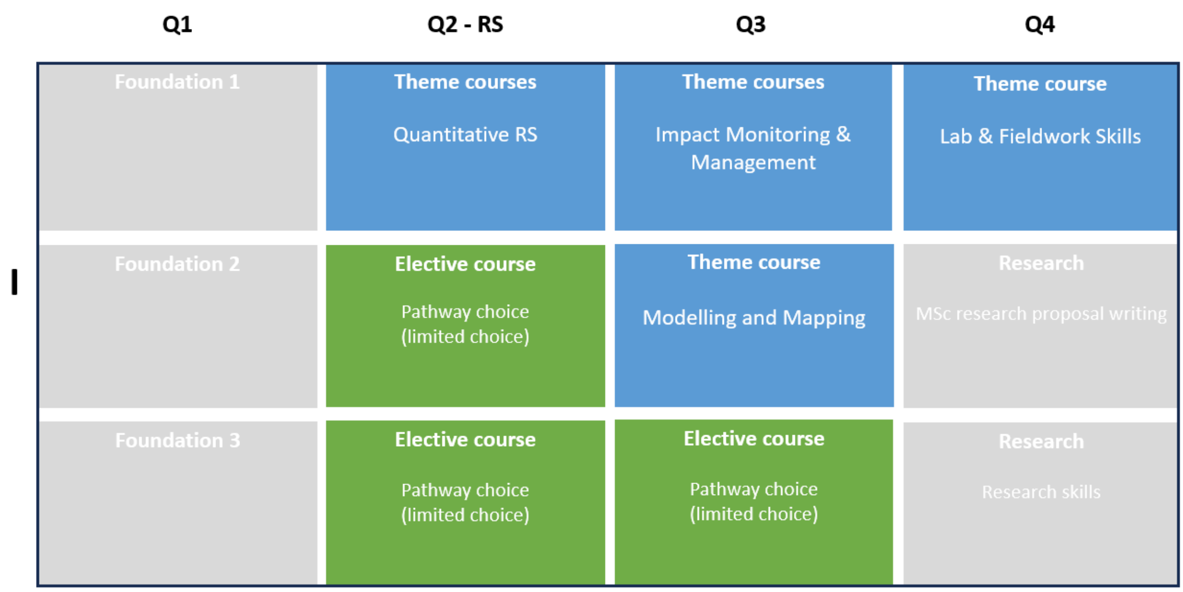

Figure 8: The courses of the different learning pathways under the Resources Security theme

Under this thematic line, three pathways exist. To follow a pathway, all recommended pathway electives should be chosen:

RS Pathways		**Pathway electives**
Natural Resources Security	Q2	- Fundamentals in Natural Resources Management - 5EC limited choice (see below)
	Q3	- 5EC limited choice (see below)
Water Resources Security	Q2	- Water Cycle in the Anthropocene - 5EC limited choice (see below)
	Q3	- 5EC limited choice (see below)
Earth Resources Security (Geological remote sensing specialist)	Q2	- Earth Processes and Society - Thermal infrared remote sensing
	Q3	- Geological Remote Sensing for Regional Mapping

In the second quartile there is for some pathways a limited choice option available. In these quartiles a choice has to be made out of a limited set of recommended courses.

RS Pathways		**For each pathway choose one of the courses listed in each quartile**
Natural Resources Security	Q2	- Quantitative remote sensing of vegetation parameters - Spatial Analyses of ecosystem services - Water and Carbon dynamics in ecosystems
	Q3	- EO and GIS for Strategic Environmental Assessment and Environmental Impact Assessment - Environmental monitoring with integrated EO data and satellite image time series - Species distribution and environmental niche modelling - Earth Observation for modelling of primary productivity and plant growth
Water Resources Security	Q2	- Observing and quantifying surface water in a changing world - Satellites for GeoHealth - Water and Carbon Dynamics in Ecosystems
	Q3	- EO for catchment hydrology and hydrological modelling - EO for integrated management of coastal and inland water - EO for modelling of primary productivity and plant growth

Resource Security: theme courses

Quantitative Remote Sensing

Quartile	Year 1: Q2
Date	10 November 2025 – 30 January 2026
Thematic Line	Resources Security GeoAI Disaster Resilience
Credits (EC)	5 & 2.5

Course content:

Remote sensing is a unique tool to observe the Earth system, and to quantitatively monitor a variety of key atmospheric, land and ocean variables by measuring radiation reflected or emitted by the earth or atmosphere. With the availability of more and more remote sensing data from various types of instruments with different spectral characteristics, temporal and spatial resolutions, the field of quantitative land remote sensing is advancing rapidly. This course provides an overview of Earth Observation from Space by describing basic concepts of orbits and viewing from space, instrument characteristics as well as exploring the electromagnetic radiation ranges used by remote sensing devices, like in the VIS, NIR, SWIR, TIR atmospheric windows and active and passive Microwave regions, but also within atmospheric absorption bands. Radiative transfer equation and atmospheric correction for signal correction are discussed and practiced.

Attention is given to space and ground segments, operational (meteorological) satellite programmes within the ocean and sea ice, land and atmospheric domains and the retrieval of various space based observations of geophysical variables and their availability in cloud repositories and online processing platforms, and their retrieval.

Also attention is given to calibration and validation, related to instrument calibration (before launch, on board and vicarious calibration) but also to bias adjustment of long term data records and the need of validation when using the geophysical variables obtained through space based observations.

NB: depending on the learning pathway chosen, this course is to be followed for either 2.5 or 5 EC

Impact monitoring and management

Quartile	Year 1: Q3
Date	02 February 2026 - 17 April 2026
Thematic Line	Resources Security
Credits (EC)	5

Course content:

The earth surface is a dynamic environment that constantly undergoes change. Various process interact at various time scales, ranging from minutes in atmospheric processes to days in land processes and even millions of years in geological processes. Monitoring of natural resources therefore deals with monitoring of a changing earth surface cover. Even when observing geological processes, the observational environment still changes by the minute.

In this course, remote sensing is applied for monitoring changes in land cover and land use, covering both system drivers (e.g., changes in land use) and response variables. Attention is given to linking the physical world with ethical and social considerations, environment and social aspects of technology, consulting different stakeholders in the management of the resources.

Modelling and Mapping

Remote Sensing for Environmental Modelling: Integrating Data and Ecosystem Dynamics

Quartile	Year 1: Q3
Date	02 February 2026 - 17 April 2026
Thematic Line	Resources Security
Credits (EC)	5

Course content:

Monitoring of physical and chemical atmospheric, land and ocean variables with remote sensing requires an understanding of Earth's ecosystems. Understanding of systems can be based on expert knowledge, experimental relations or physical relations, and this understanding can be captured in a descriptive model. Models are to understand, detect, predict, and describe interactions within and between ecosystems and the atmosphere across scales that range from local to global.

Remote sensing can be used for parameter input in models, but also for spatial and temporal interpolation or extrapolation. This course provides an introduction to knowledge-driven, data-driven and physical modelling, starting with appropriate model selection given a specific problem or data availability. The course therefore deals with basic concepts and boundary conditions. Much emphasis is on integration of remote sensing observations into models, and selecting optimal object / pixel / time based mapping method for a given problem

Lab and fieldwork skills

Quartile	Year 1: Q4
Date	20 April 2026 – 03 July 2026
Thematic Line	Resources Security
Credits (EC)	5

Course content:

Fieldwork is often an essential component to acquire reference data for calibration and validation of the remotely sensed observations. This course provides skills and techniques to plan, execute and report on field observations. The course starts with an introduction to in-situ field measurement devices and lab equipment, and demonstrates standard operational procedures when analysing samples in the laboratory. Subsequently, students have to design their own field data collection based on a self-defined objective, e.g. which parameters are required and how to conduct sampling, which instruments are required, how to measure, sampling procedures and storing of samples. Considering focus group interviews how to prepare the questionnaires and review of ethical considerations. Another element would be the timing related to eventual satellite overpass or image acquisition in the terrain and collection of available information from installed in-situ measuring devices.

Being well prepared, a 3 day fieldwork is envisaged for practical collecting data in a fieldwork area with participants from multiple disciplines: water, natural and earth resources.

Once back, the data collected has to be analysed in the lab or subject to further processing. In the end, students are required to present their results obtained and have to report on the procedures applied, reflect on the quality of obtained results, and describe their analysis conducted into more detail.

Resource Security: elective courses

Natural Resources Management Fundamentals

Quartile	Year 1: Q2
Date	10 November 2025 – 30 January 2026
Thematic Line	Resources Security
Credits (EC)	5

Course content:

Global change, caused by growing population densities and rising economic production levels, is increasingly placing pressure on scarce land resources. These changes do not always contribute to sustainable development and often increase the pressure on the natural resources that we depend on. Our impact on the environment is immense, and we are fast approaching several tipping points. Without proper management, these environments and the natural resources they provide will be depleted and degraded, sometimes irreversibly. They will no longer be able to provide society with essential services (water, food, carbon sequestration, temperature and rainfall regulation, pest regulation etc.).

The course begins from a global perspective, introducing key global challenges, namely food security, climate change, biodiversity and habitat loss. Students are invited to a discussion on major organisations and conventions aiming to address these challenges.

A systems approach is the only way to present the various relationships essential in natural resources research. The paradigm of landscape ecological systems and landscape spheres (e.g. geosphere, hydrosphere, biosphere, atmosphere, anthroposphere) will be used for the description and analysis of patterns and processes in earth systems. A critical element in understanding the boundaries, the parts, and the flows of a system for managing natural resources is the choice of relevant metrics or indicators.

The course continues with the fundamental ecological concepts. Different ecosystem types are discussed, with particular attention to forests. In addition to being biodiversity hotspots, forests are carbon sinks and regulate climate. After gaining a solid foundation in forest ecosystems, students will search for and identify appropriate forest indicators to assess and monitor environmental processes, such as degradation and deforestation, pests and diseases and carbon loss. Examples of these processes are demonstrated for Mediterranean, temperate and tropical forests, respectively.

A different type of system introduced in the course concerns food. Current food systems face many food security and sustainability challenges. How people produce, process, and consume food is unsustainable, causing many environmental problems such as water shortage and deforestation. To feed the whole world while addressing climate change and safeguarding biodiversity, a thorough understanding of the different components, processes, and outcomes of food systems is needed.

Water Cycle in the Anthropocene

Quartile	Year 1: Q2
Date	10 November 2025 – 30 January 2026
Thematic Line	Resources Security
Credits (EC)	5

Course content:

Water and energy are fundamental for life on Earth, their variations, trends, and extremes are sources for drought extremes, heat waves, heavy rains, floods, and intensive storms that are increasingly threatening our society to cause havoc as the climate changes. Better observations and analysis of these phenomena will help improve our ability to understand their physical processes and to model and predict them. Earth Observation technology is a unique tool to provide a global understanding of essential water and energy variables and monitor their evolution from global to basin scales. The focus of this course is on the physical principles of how electromagnetic signals are applied to monitor these essential variables by spaceborne sensors, and learn tools and methods to collect, process, and visualize Earth observation data of surface solar radiation, evapotranspiration, precipitation, soil moisture, and terrestrial water storage. Furthermore, students will learn how to retrieve the essential water/climate variable – soil moisture from Earth observation data, applying the radiative transfer theory.

Earth Processes and Society

Quartile	Year 1: Q2
Date	10 November 2025 – 30 January 2026
Thematic Line	Resources Security
Credits (EC)	5

Course content:

The Earth is a complex, dynamic system that not only provides us with a habitat but also supplies the resources essential for sustaining modern society and ensuring our survival. The various components of the Earth System, including human activities, interact across space and time, with changes in one part potentially affecting all others in intricate and often unpredictable ways. These interactions determine the overall health of our planet and present challenges such as natural hazards, resource limitations, and constraints on societal growth. Earth observation from space, combined with advanced geoscience techniques, is vital for understanding how the planet works and for monitoring its health and state. This course is designed to equip students with the concepts and tools needed to comprehend the fundamental aspects of the Earth System. It will cover key geodynamic processes, their interactions, and their links to natural hazards and resource availability. Students will also learn modern techniques for imaging the Earth's surface and subsurface, with a focus on their significance in planetary monitoring, hazard assessment and management, and the sustainable exploration and use of natural resources. The students will be able to choose the topics for their assignments from a list of case studies relevant to the course's goals. By the end of the course, students will have a deep understanding of the complex natural processes and feedback mechanisms between the Earth's interior, near-surface dynamics, and activities relevant to society. They will also gain the fundamental technical skills necessary to develop innovative solutions to the societal challenges posed by global environmental change and to capitalize on opportunities in the transition to global sustainability.

Geological remote sensing for regional mapping

Quartile	Year 1: Q3
Date	02 February 2026 - 17 April 2026
Thematic Line	Resources Security
Credits (EC)	5

Course content:

Earth observation satellites generate large amounts of geospatial data that are freely available for society and researchers. Technologies such as cloud computing and distributed systems are modern solutions to access and process big Earth observation data. This course is on processing remote sensing data from operational and historic missions in an online platform, with a specific emphasis on earth science applications. The application to Earth sciences will help you to recognize landforms in images, determine Earth's surface composition and derive various physical parameters from the Earth's surface.

Thematic line: Disaster Resilience

The programme offers four thematic lines that cater for specific background and/or career interests. The purpose of these thematic lines is to provide students from a certain educational background or work experience with an application domain in which they can apply their newly gained knowledge and skills. A thematic line also can provide students with a clear idea of their future career with the necessary focus. Under the thematic line all courses are organized that provide the latest knowledge and skills available in the field. Each thematic line therefore offers dedicated learning pathways to support specific career goals.

The Disaster Resilience theme represents viable learning paths for students focused on disaster risk reduction, disaster preparedness, disaster response and resilience, also linked to climate change, in order to gain viable skills and knowledge for various Disaster resilience-related job profiles (see below). This thematic line allows students to focus their study and subsequent research on disaster-related aspects, related to monitoring, prediction, emergency response, and related decision making, by following combinations of modules also from the other three thematic lines outlined above. In addition, the theme ensures continued interaction between the educational activities and the active and incoming investments and projects related to natural hazards and risk, and the work of ITC's Center for Disaster Resilience (CDR).

All students choosing Disaster Resilience will follow these thematic courses:

	Theme courses
Quartile 2	- Intro to hazard risk & resilience - Intro to data driven modelling
Quartile 3	- Weather & Climate

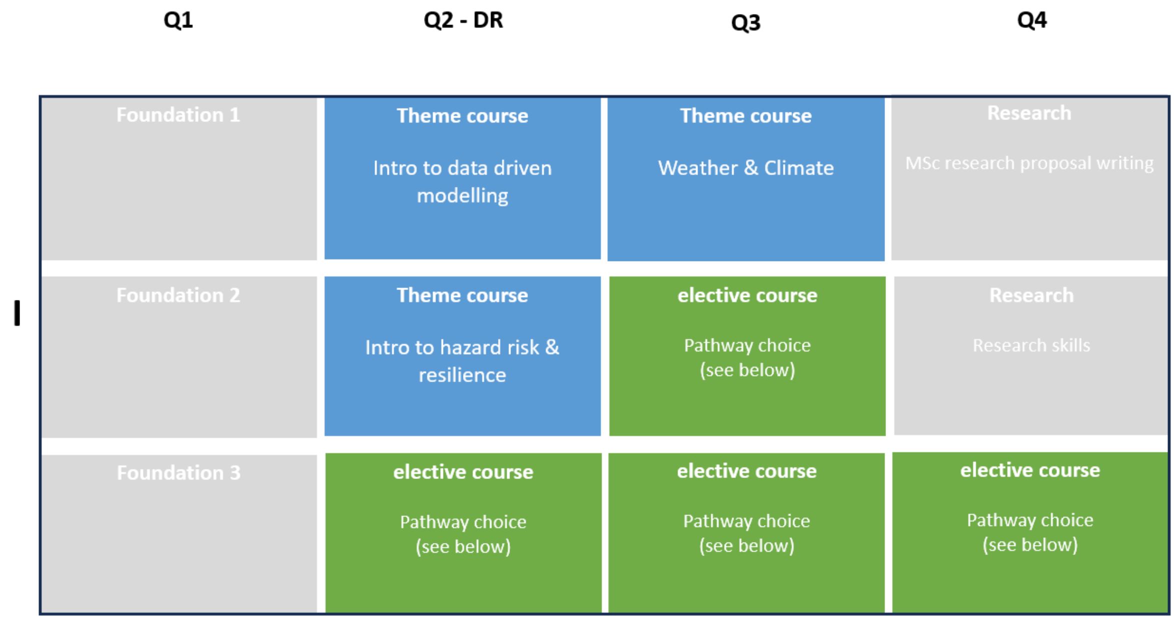

Figure 9: The courses of the different learning pathways under the Disaster Resilience theme

Under this thematic line, three learning pathways exist. To follow a pathway, all recommended pathway electives should be chosen:

DR Pathways		**Pathway electives**
Disaster Resilience Manager	Q2	- Anticipating and responding to disasters - Choice: Earth Processes OR Water Cycle in the Anthropocene
	Q3	- Planning for Disaster Resilient Cities
	Q4	- Urban & Land Future Studio
Disaster Resilience Modeler	Q2	- Scientific Geocomputing OR Earth Processes
	Q3	- Physically-based Modelling - Multi-hazard risk assessment
	Q4	- Land Change Modeling OR Programming
Disaster Resilience Data Analyst	Q2	- Quantative Remote Sensing
	Q3	- Machine Learning for Geospatial Sciences - Geodata Acquisition and Dissemination
	Q4	- Advanced Machine Learning

Disaster Resilience: theme courses

Introduction to Hazard, Risk & Resilience, and the Role of Geodata

Quartile	Year 1: Q2
Date	10 November 2025 – 30 January 2026
Thematic Line	Disaster Resilience
Credits (EC)	5

Course content:

This course will provide a fundamental introduction to natural hazards and the disaster risk concept, as well as the role of geomatics, in particular remote sensing (RS). It builds on the knowledge students gained in the foundation courses on basic RS and GIS principles as well as statistical methods, and expands it. The course aims at creating a knowledge base for the other hazard modelling and risk management courses and electives in the Disaster Resilience thematic line, by enabling the students to develop an understanding of the main geohazard types and their - mainly geomorphological - origins, and all relevant conceptual aspects of disaster risk. Students will learn how geo-information and geomatics tools are uniquely suited to study, monitor and quantify each aspect of risk and disasters. Following an introduction to the main hazard types and their core properties, students will work in groups to dissect past disaster events to discover the nature and properties of the underlying hazards and vulnerabilities, and learn how in particular RS provides comprehensive and specifically tailored means to gain insights into the risk components for different hazards and environmental settings. The course is mandatory for all 3 pathways within Disaster Resilience (managing, modelling, data analysis), and is closely coupled with the course Introduction to Data-Driven Hazard Modelling. Particular attention will be given to the generation of input data for hazard modelling, including image-based indices and topographic derivatives, and information extracted from UAV/drone imagery. Relevant background information on soils, geology and landforms as drivers of hazards will also be provided. The course concludes with a section on risk reduction and resilience creation concepts.

Introduction to Data-driven Hazard Modelling

Quartile	Year 1: Q2
Date	10 November 2025 – 30 January 2026
Thematic Line	Disaster Resilience
Credits (EC)	5

Course content:

The identification and assessment of natural hazards is a crucial component of disaster risk management. This course will focus on the modelling of natural hazards, with an emphasis on hydro-meteorological hazards (e.g., floods, landslides and erosion). Starting from the relevant natural phenomena and their causes, the generation of historical inventories of hazardous phenomena will be discussed. From the cloud-based generation of the hazard inventories and their interpretation, the course will expand on the main methods and tools to assess the susceptibility and hazard at different scales. The course will provide the foundation for predictive approaches with a particular focus given to statistical models of multivariate nature. The latter will combine the spatial and temporal dimensions. The use of empirical models will further investigate runout patterns to estimate areas under threat.

Weather & Climate

Quartile	Year 1: Q3
Date	02 February 2026 - 17 April 2026
Thematic Line	Disaster Resilience
Credits (EC)	5

Course content:

Weather is everywhere. The weather has an impact on the earth surface, and on everything that is on that surface: vegetation, soil, water availability, humans, etc. Many natural hazards have extreme weather conditions and events as a trigger, like droughts, floods, heat-waves, and rainfall-induced landslides. For example, agricultural production is dependent on weather conditions, as extreme weather events, like a tropical cyclone, might cause irreversible damage to crop or to land, and lead to less harvest. Similarly, the extent and magnitude of the urban heat island effects are largest under hot, stable weather conditions, causing severe health impact. And, as global climate change poses huge challenges to society as these extreme weather conditions are increasing in severity and frequence, we have to understand the relation between weather and natural hazards.

Fortunately, the weather is continuously monitored worldwide, by satellites and ground stations at minute, daily or monthly scales. As well weather is observed in various meteorological parameters. Many meteorological datasets are freely accessible, being an enormously rich source for weather information. Long time series of these weather parameters allow us to build climate information services; how did the weather and extreme events change in the past? Similarly, the output of various climate models is freely accessible on a worldwide scale. When analyzing and visualising this weather and climate dataset, one gets insight into the various weather conditions and extreme events, that are potentially linked to natural hazards, now and in the future.

This course provides knowledge on weather data sources and tools to analyze the interaction between the weather and earth surface processes in time and space. The challenge will be to link this climatic information to non-meteorological data to learn how hazards might be changing under climate change conditions.

Disaster Resilience: elective courses

Quantitative Remote Sensing

Quartile	Year 1: Q2
Date	10 November 2025 – 30 January 2026
Thematic Line	Resources Security GeoAI Disaster Resilience
Credits (EC)	5 or 2.5

Course content:

Remote sensing is a unique tool to observe the Earth system, and to quantitatively monitor a variety of key atmospheric, land and ocean variables by measuring radiation reflected or emitted by the earth or atmosphere. With the availability of more and more remote sensing data from various types of instruments with different spectral characteristics, temporal and spatial resolutions, the field of quantitative land remote sensing is advancing rapidly. This course provides an overview of Earth Observation from Space by describing basic concepts of orbits and viewing from space, instrument characteristics as well as exploring the electromagnetic radiation ranges used by remote sensing devices, like in the VIS, NIR, SWIR, TIR atmospheric windows and active and passive Microwave regions, but also within atmospheric absorption bands. Radiative transfer equation and atmospheric correction for signal correction are discussed and practiced.

Attention is given to space and ground segments, operational (meteorological) satellite programmes within the ocean and sea ice, land and atmospheric domains and the retrieval of various space based observations of geophysical variables and their availability in cloud repositories and online processing platforms, and their retrieval.

Also attention is given to calibration and validation, related to instrument calibration (before launch, on board and vicarious calibration) but also to bias adjustment of long term data records and the need of validation when using the geophysical variables obtained through space based observations.

NB: depending on the learning pathway chosen, this course is to be followed for either 2.5 or 5 EC

Machine Learning for Geospatial Sciences

Quartile	Year 1: Q3
Date	02 February 2026 - 17 April 2026
Thematic Line	GeoAI Disaster Resilience
Credits (EC)	5

Course content:

This course is designed to guide you through the intersection of machine learning and geospatial sciences, providing you with the expertise to address pressing societal and environmental challenges. You will be introduced to the foundations of supervised and unsupervised learning algorithms, exploring their applications in the geospatial domain. You will learn popular learning algorithms to address various inference tasks, such as clustering, regression and classification.
From satellite imagery to GIS datasets you'll master the tools and methodologies required to preprocess, analyze, integrate and visualize them. You will gain the skills needed to extract meaningful patterns and insights from these geospatial datasets.
Feature extraction and engineering are critical steps in building effective machine learning models. You will explore techniques to transform raw geospatial data into relevant features enabling your models to learn and predict more effectively.
Clustering techniques, for exploratory spatial data analysis, will be introduced to help you to discover hidden structures and trends within geospatial datasets.
Classification and regression methods like decision trees, random forests, support vector machines and neural networks are pivotal machine learning tasks that you'll apply to a wide array of geospatial problems. Whether it's land use classification, predicting environmental changes, or estimating spatial variables like temperature or population density, you'll develop models that provide precise and actionable insights.
Throughout the course real-world case studies will demonstrate the transformative impact of machine learning on geospatial sciences. You'll work on projects that tackle contemporary issues such as urban planning, environmental monitoring, and disaster management.
By the end of this course, you will be adept at applying machine learning techniques to geospatial sciences.

Anticipating and Responding to Disasters

Quartile	Year 1: Q2
Date	10 November 2025 – 30 January 2026
Thematic Line	Disaster Resilience
Credits (EC)	2.5

Course content:

Much of the MGEO Disaster Resilience thematic line focuses on hazards and risk, especially on relevant concepts and different modelling approaches. Together this builds the ability to assess multi-hazard risk in a given area, and to model specific hazard processes. The attention of this present course is on actual disaster events, specifically on how to anticipate them to minimize the adverse consequences, and on how to improve post-event response and recovery. In terms of preparing for an actual event we will focus on the concept of early action/ anticipatory action, focusing on the different actors and their roles, but also relevant early warning systems that provide information on impending, in particular hydrometeorological events. The technical and organisational aspects of converting early warning information into impact assessments will be addressed, and how such information is used in preestablished trigger models that set in motion last-minute activities on the ground that can help communities prepare for the disaster event, and reduce losses. Immediate disaster response, in particular damage assessment, is already addressed in the Introduction to Hazard, Risk & Resilience course. Here we will focus on the subsequent disaster recovery, addressing how affected communities can learn from the event and build-back-better, and what role different stakeholders play in this process. We will further review how geoinformation, in particular remote sensing data, can be used to assess and characterise both physical and functional recovery.

Planning for Disaster Resilient Cities

Course details:

Quartile	Year 1: Q3
Date	02 February 2026 - 17 April 2026
Thematic Line	Urban & Land Futures Disaster Resilience
Credits (EC)	5

Course content:

Both hazard types and frequency, as well as built-up areas and cities are dynamically changing, resulting from climate and global changes. In April 2024, displacing 600.000 people in Brazil due to floods, having hottest day records already in Europe and in Asia are clear examples to the shifting hazard patterns. In such dynamic environments, the interdependency among the risk components amplifies the impact of disasters. In such an environment, disaster risk is constantly changing, and there is a definite limit to our capacity to foresee the failures resulting from unexpected interactions between interdependent components. Indeed, the intensity and extent of the challenges make clear that achieving resilient cities is everybody's business. Scientists, stakeholders and citizens are faced with the challenge to adapt their disaster risk reduction plans but lack the understanding and tools to account for the cross-sectoral impacts and dynamic nature of the risks involved. In this course, we follow the socio-technical approach in complex city systems and investigate the ways to contribute to cities' resilience. The main problem in disaster risk management is providing static measures to a dynamically changing system. In this course you will learn looking at the nature of risk as a 'dynamic' concept rather than a static one. You will focus on multi-hazard risk assessment and dynamic risk reduction measures on various sectors.

Urban and Land Futures Studio

Quartile	Year 1: Q4
Date	20 April 2026 – 03 July 2026
Thematic Line	Urban & Land Futures Disaster Resilience
Credits (EC)	5

Course content:

Addressing current and future societal challenges or urban areas around the world requires integrating thinking and insights where space, society and technology intersect. This new geo-socio-technical approach to of solving urban and land problem demands a new way of working and indeed re-conceiving of the tools and methods that inform our solutions to these challenges. Advancements in planning support and decision making technologies have enabled evidence-based scenario planning but failed in engaging a broad range of non-experts in future-oriented planning practice that accounts for deep uncertainty and complexity of societal challenges.

In this studio course, student groups engage in challenge-based learning of a real-world spatial problem setting. Geospatial and participatory technologies for systematic analysis of locational phenomena and spatial characteristics will be applied in combination with methods for eliciting local experiential knowledge of residents and other societal actors to disentangle wicked problem settings and underlying root causes and to develop visions of a sustainable urban and land future. Goal of studio-based learning approach is to provide a policy making authority with integrated insights and inspiration for new methods for producing sage, and to co-design together with them future-oriented strategies and interventions in an inclusive manner.

In this course students are exposed to various lab facilities of ITC and learn how to make use of them for data collection, stakeholder interaction and collaborative planning and decision making.

Physically-based Hazard Modelling

Quartile	Year 1: Q3
Date	02 February 2026 - 17 April 2026
Thematic Line	Disaster Resilience
Credits (EC)	5

Course content:

The aim of this course is to enhance the student's understanding of the physical processes that cause natural hazards, the methods and the physically-based modelling approaches for hazard analysis, to the point at which students are able to use them with their own data. As the processes of selected natural hazards, including flooding, landslides and earthquakes, are explained, the students will be introduced to fundamentals of the underpinning science and engineering. Model data requirements and data collection will be treated, as well as the evaluation of uncertainty of input data on simulation outputs. Modelling principles and assumptions, possibilities and limitations will be discussed with the aim that students can make a proper selection of models for a given situation and critically reflect on the results, in order to support hazard analysis as input to risk management and mitigation.

The research phase

The Faculty ITC Research Programme is formulated under the following interlinked research themes:

- 4D-Earth
- Acquisition and quality of geo-spatial information (ACQUAL);
- Forest Agriculture and Environment in the Spatial Sciences (FORAGES);
- People, Land and Urban Systems (PLUS);
- Spatio-temporal analytics, maps and processing (STAMP);
- Water Cycle and Climate (WCC).

These research themes and activities form the subject framework and organizational structure in which Master's students conduct their individual research. Students have to make a choice of the envisaged MSc research topic during the fourth quartile of the first year. For more information about the content and scope of the Faculty ITC Research Programme, please visit: http://www.itc.nl/research-themes

The purpose of the MSc research phase is; i) to deepen the knowledge and skills of the students within the research themes; ii) to help students to define their own MSc Research Proposal, and iii) to facilitate students to individually write a concise, logical and well-structured thesis.

The first stage of this individual project is spent on developing an MSc Research Proposal with support and feedback from staff and peers. Parallel to the proposal writing, skills will be taught to enable students to demonstrate their ability to independently design a research and help them keep momentum in writing. A Proposal Assessment Board will assess the MSc Research Proposal based on a written proposal, a presentation and an oral defence. The Proposal Assessment Board decides if the proposal is acceptable, as one of the conditions to continue with the MSc Research phase.

The second stage of the MSc research phase is dedicated to the execution of an individual research project. Each student works independently on the basis of the approved research proposal. Where relevant, students can, with the help of their supervisors, set-up and conduct for instance fieldwork for data collection. Regular individual progress meetings with the supervisors will be held to facilitate the progress on the research and thesis writing, and records of the progress will be kept.

The resulting theses produced in our programme are generally of very high quality and often receive awards. For many students in our programme, writing a high quality thesis is a steppingstone towards an academic career and a PhD.

The research phase has three components. They are compulsory for all students in the programme:

- Research Skills course (5 EC)
- MSc research proposal writing (5 EC)
- MSc research and thesis writing (35 EC)

The research phase starts in Q4 of the first year and continues until the end of the second year. The MSc research proposals are presented/defended at the end of Q4 of the first year, the completed research and written theses are presented and defended at the end of Q4 of the second academic year.

The Research skills course is offered parallel to the MSc research proposal writing in order to both teach you the skills of research proposal writing and to help you keep momentum with writing.

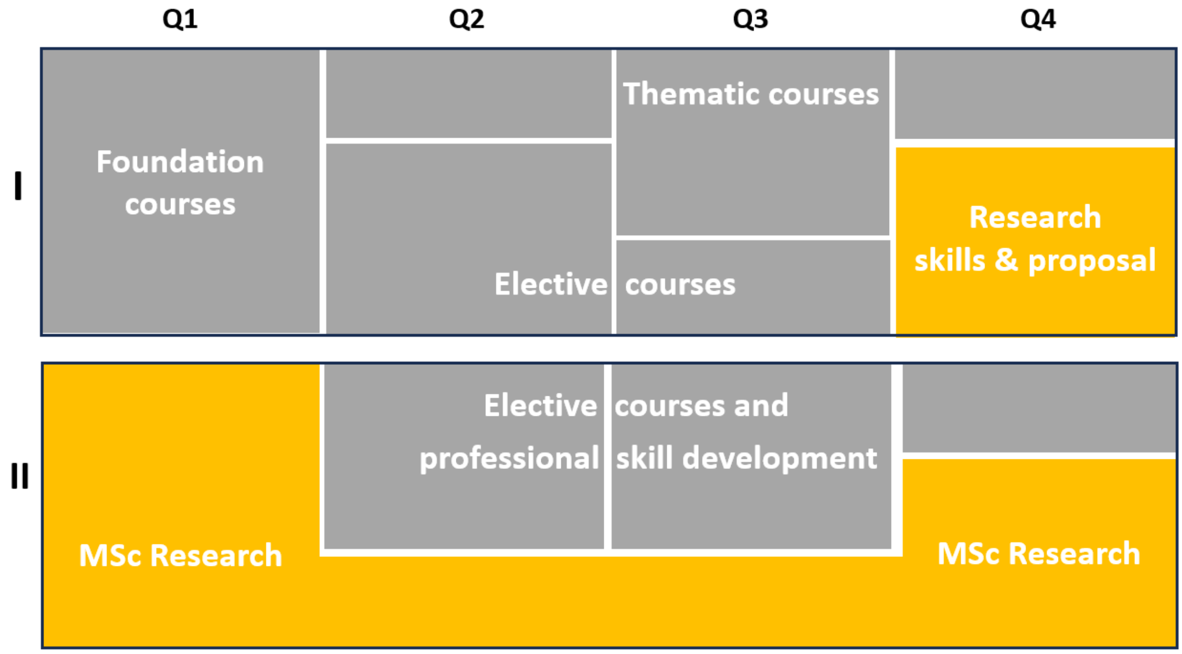

Figure 10: the research phase in M-GEO

Proposal and thesis writing is done individually under the supervision of a team of assigned academic staff. The research proposal writing will result in a pass/fail. The MSc research and thesis writing, together with the proposal writing (with a pass), will lead to a grade with a combined weight of 40 EC.

In the first quartile of the second year, no other mandatory courses are offered. This is to allow you to kickstart the MSc research. For some, this can be a good period to collect research data and do some fieldwork. Others can be working further on their methodologies, models or data analyses.

Research phase courses

Academic Research Skills

Quartile	Year 1:Q4
Date	20 April 2026 – 03 July 2026
Thematic Line	All
Credits (EC)	5

Course content:

The course is designed to equip students with the critical skills necessary for conducting research in the field of geo-information sciences. This course covers a range of methodologies, tools, and techniques that are essential for effective research in and with geospatial data analysis, remote sensing, geographic information systems, and spatial data modelling.

Key components of the course include:

1. **Literature Review and Scientific Writing:** students will be guided in conducting thorough literature reviews, identifying research gaps, and synthesizing existing knowledge. The course also covers best practices in scientific writing, helping students to communicate their findings concisely to an academic audience.
2. **Research Methodologies:** students will explore both qualitative and quantitative research methods, focusing on how to design and execute studies that address complex spatial problems. Topics include, defining a manageable research problem, hypothesis and research question formulation, research design, data collection strategies, and ethical considerations in research.
3. **Project Management and Proposal Writing:** This prepares students to manage research projects, from planning to execution, including the writing of their research proposal and time management.

By the end of the course, students will have the skills to independently conduct high-quality research, contributing to the field and addressing real-world geospatial challenges.

MSc research proposal writing

Quartile	Year 1:Q4
Date	20 April 2026 – 03 July 2026
Thematic Line	All
Credits (EC)	5 (these will be awarded upon successfully defending the MSc research and thesis writing in the 2nd year)

Course content:

he Faculty ITC Research Programme is formulated under the following interlinked research themes:

- 4D-Earth
- Acquisition and quality of geo-spatial information (ACQUAL);
- Forest Agriculture and Environment in the Spatial Sciences (FORAGES);
- People, Land and Urban Systems (PLUS);
- Spatio-temporal analytics, maps and processing (STAMP);
- Water Cycle and Climate (WCC).

These research themes and activities form the subject framework and organizational structure in which Master's students conduct their individual research. Students have to make a choice of the envisaged MSc research topic during the fourth quartile of the first year. For more information about the content and scope of the Faculty ITC Research Programme, please visit: http://www.itc.nl/research-themes

The purpose of the MSc research phase is; i) to deepen the knowledge and skills of the students within the research themes; ii) to help students to define their own MSc Research Proposal, and iii) to facilitate students to individually write a concise, logical and well-structured thesis.

The first stage of this individual project is spent on developing an MSc Research Proposal with support and feedback from staff and peers. Through the MSc Research Proposal, the students should demonstrate the ability to design an independent research. A Proposal Assessment Board will assess the MSc Research Proposal based on a written proposal, a presentation and an oral defence. The Proposal Assessment Board decides if the proposal is acceptable, as one of the conditions to continue with the MSc Research phase.

Proposal Writing

- Introductory lectures on:
    - MSc Research phase process
    - Ethical considerations in MSc research
    - Methodology
- Optional, theme-specific tutorials
    - Formulating sub-objectives and research questions
    - Data collection methods
    - Data analysis methods

MSc research and thesis writing

Quartile	Year 2: Q1-Q4
Date	All year
Thematic Line	All
Credits (EC)	35 (+ 5 from MSc research proposal writing in the 1st year)

Course content:

The Faculty ITC Research Programme is formulated under the following interlinked research themes:

- 4D-Earth
- Acquisition and quality of geo-spatial information (ACQUAL);
- Forest Agriculture and Environment in the Spatial Sciences (FORAGES);
- People, Land and Urban Systems (PLUS);
- Spatio-temporal analytics, maps and processing (STAMP);
- Water Cycle and Climate (WCC).

These research themes and activities form the subject framework and organizational structure in which Master's students conduct their individual research. Students have to make a choice of the envisaged MSc research topic during the fourth quartile of the first year. For more information about the content and scope of the Faculty ITC Research Programme, please visit: http://www.itc.nl/research-themes

The purpose of the MSc research phase is; i) to deepen the knowledge and skills of the students within the research themes; ii) to help students to define their own MSc Research Proposal, and iii) to facilitate students to individually write a concise, logical and well-structured thesis.

The second stage of the MSc research phase is dedicated to the execution of an individual research project. Each student works independently on the basis of the approved research proposal. Where relevant, students can, with the help of their supervisors, set-up and conduct for instance fieldwork for data collection. Regular individual progress meetings with the supervisors will be held to facilitate the progress on the research and thesis writing, and records of the progress will be kept.

The activities include:

- Deepening of literature review, including assessment of the usability of literature and previous research;
- Collection of relevant data. If appropriate, preparation and execution of fieldwork to collect primary data required for the research;
- Data processing and analysis
- Active participation in seminars and activities of the research theme under which the MSc research resorts;
- Preparation of a final manuscript of the MSc thesis
- A critical review of the quality, use, usefulness and ethical considerations of the data and results, as well as the learning process;

Halfway between the proposal defence and the planned thesis defence, a Mid-term presentation is given by the student to show the progress made. This is a formative assessment, offering feedback on the achievements but predominantly designed to let the student show their grasp on what is still to come.

A Thesis Assessment Board will finally assess the written thesis and an oral defence.

Professional skills development courses

To help you develop professional skills that are appreciated in the work field, a set of elective courses is offered in the second or final quartile of the second year (see fig. 13). You should choose at least **5EC** out of these **professional skills courses**. These courses are essential to let you meet the additional demands of the labour market that go beyond technical skills and domain knowledge.

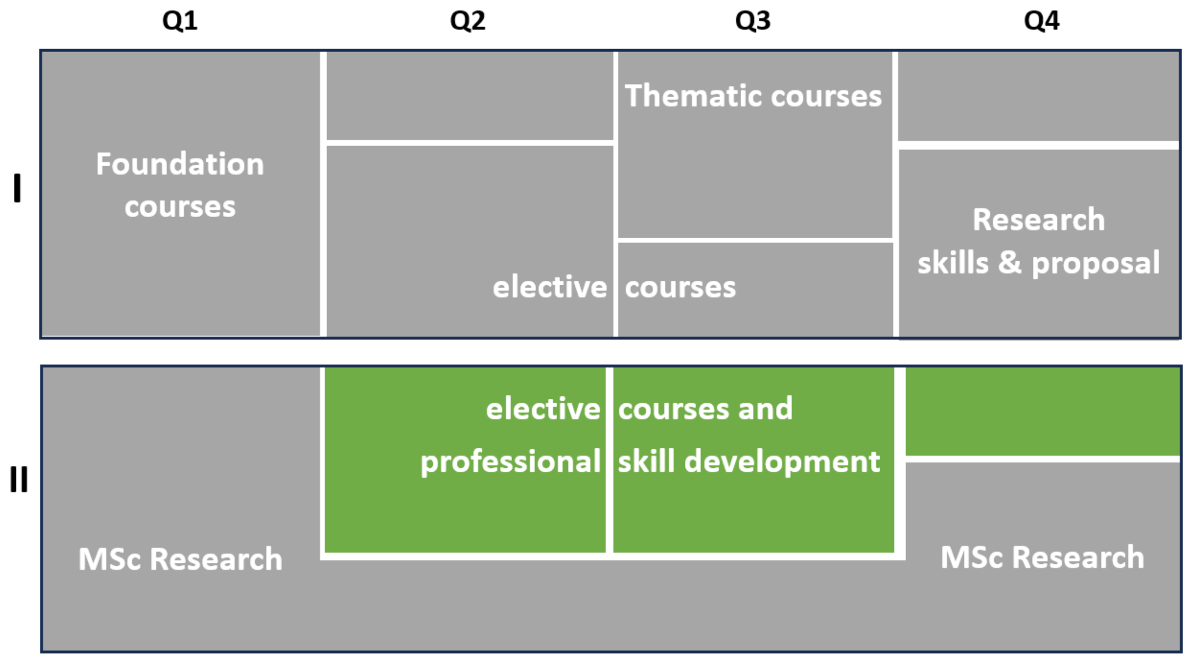

Figure 11: elective courses in the second year of M-GEO

These often called ‘soft skills’ will enhance your chances to secure a job after graduation. These skills include:

- **Communication:** Effective communication skills, both written and verbal, are essential for explaining technical findings to non-specialists, writing clear reports, and collaborating with diverse teams, including stakeholders from various disciplines.
- **Open science and data management:** gaining hands-on experience and best practices in data management, the creation of FAIR data, and learn how to properly archive geospatial datasets, document research processes, and share your work openly with the scientific community according to OGC standards.
- **Teamwork and Collaboration:** Many projects in our field are multidisciplinary and require collaboration with experts in fields like urban planning, environmental science, and IT. The ability to work well in a team, share ideas, and integrate diverse perspectives is vital.
- **Project/Time Management:** Effective time management is necessary for balancing multiple projects, meeting deadlines, and ensuring that all aspects of a research project or task are completed on time.
- **Adaptability to innovation:** The field of geo-information science is rapidly evolving, with new tools, technologies, and methodologies emerging regularly. Professionals must be adaptable, willing to learn, and able to apply new techniques to their work.

(choose a minimum of 5EC out of these courses)

Geospatial innovations

Quartile	Year 1: Q2
Date	10 November 2025 – 30 January 2026
Thematic Line	All
Credits (EC)	2.5

Course content:

This course offers an exploration of contemporary innovations in geo-information science, including advanced satellite technologies, high-resolution earth observation data, and emerging data analytics techniques. Students will debate recent breakthroughs such as artificial intelligence applications in geospatial analysis, real-time data processing, and the integration of geospatial data with big data frameworks. The course will also cover the latest developments in remote sensing technologies and their applications in environmental monitoring, urban planning, and disaster management. A significant component of the course involves reflecting on how to equip themselves for future work field demands.

Effective Communication for Geospatial Professionals

Quartile	Year 2: Q4
Date	19 April 2027 – 02 July 2027
Thematic Line	All
Credits (EC)	2.5

Course content:

The course is designed to equip students with an understanding of the complex, multifaceted world of geospatial data. This course emphasizes the ethical, legal, and privacy implications involved in the dissemination of spatial data. Students will develop a critical perspective on the responsible use of geospatial data, ensuring that they can navigate the often challenging landscape of data compliance in their professional practice.
Students will engage with current debates surrounding the ethics of geoscience, particularly focusing on concerns relevant to the different themes of the programme to foster multi-disciplinary understanding. Through these discussions, students will learn to recognize the ethical dilemmas that arise in geospatial data communication.
A significant component of the course is dedicated effective communication of spatial data and information to diverse audiences. Students will learn how to communicate complex spatial data and insights through visual means, tailoring their presentations to meet the needs of both technical and non-technical stakeholders. The course provides hands-on experience with various visualization tools and techniques, ensuring that students can proficiently convey

geospatial information in a clear, impactful manner. By the end of the course, students will have a solid foundation in the ethical, legal, and technical aspects of spatial data communication.

Introduction to Technical Communication:

- Overview of the importance of communication in technical fields.
- Understanding the audience: technical vs. non-technical stakeholders.
- Identifying common communication challenges faced by technical professionals.

Principles of Clear Communication:

- Simplifying complex technical information without losing accuracy.
- Techniques for breaking down and structuring information logically.
- The use of analogies, visuals, and examples to clarify complex concepts.

Writing for Technical and Non-Technical Audiences:

- Adapting writing style and content for different audiences.
- Best practices for clarity, conciseness, and coherence in technical writing.

Verbal Communication and Presentation Skills:

- Effective presentation techniques: engaging diverse audiences.
- Speaking clearly and confidently about technical subjects.
- Using visuals (charts, maps, infographics) to support verbal communication.

Practical Applications and Case Studies:

- Analyzing real-world examples of successful and unsuccessful technical communication.
- Peer feedback sessions to refine communication techniques.

Project Management Essentials for Geospatial Professionals

Quartile	Year 2: Q1
Date	01 September 2026 – 01 November 2026
Thematic Line	All
Credits (EC)	2.5

Course content:

Understanding project management principles is crucial for handling geo-information projects. This course covers planning, execution, monitoring, and closing projects, along with time management and team coordination.

Project Management in Geo-Information Sciences:

- Overview of project management principles and their importance in geo-information projects.
- Key terminology and concepts in project management.
- Understanding the unique challenges of managing geo-information projects.

Project Planning and Initiation:

- Defining project scope, objectives, and deliverables.

- Prioritizing tasks and managing time effectively within the project lifecycle.
- Risk assessment and mitigation strategies specific to geo-information projects.

Monitoring and Evaluation:

- Techniques for monitoring project performance and ensuring quality control.
- Conducting project evaluations and documenting insights.
- Best practices for archiving project data and documentation for future use.

Collaboration and Teamwork in Multidisciplinary Environments

Quartile	Year 2: Q4
Date	19 April 2027 – 02 July 2027
Thematic Line	All
Credits (EC)	2.5

Course content:

Geo-information projects often involve collaboration across different disciplines. This course enhances skills in teamwork, collaboration, and conflict resolution, enabling better coordination in multidisciplinary settings.

Building Effective Teams:

- The roles and expertise of different disciplines involved in geo-spatial projects (e.g., urban planning, environmental science, computer science).
- Team dynamics: roles, responsibilities, and the importance of diversity.
- Techniques for fostering trust, respect, and open communication within teams.

Collaborative Problem-Solving:

- Strategies for effective communication between technical and non-technical team members.
- Tools and techniques for collaborative decision-making and ensuring alignment across disciplines
- Case studies highlighting successful multidisciplinary collaborations.

Project Coordination and Management in Multidisciplinary Teams:

- Techniques for coordinating tasks and responsibilities across different disciplines.
- Challenges and opportunities in multidisciplinary teamwork.
- Best practices for managing multidisciplinary meetings and keeping teams focused.

Open Science and Data Management for Geospatial Research.

Quartile	Year 2: Q1
Date	01 September 2026 - 07 November 2026
Thematic Line	All
Credits (EC)	2.5

Course content:

This course provides graduate students with the essential skills and knowledge to effectively manage, share, and archive geospatial data in the context of open science. The course covers the principles of open science, emphasizing transparency, reproducibility, and collaboration in research. Students will gain hands-on experience using GitHub for version control, collaborative coding, and spatial data project management.

Key topics include best practices in data management, the creation of FAIR (Findable, Accessible, Interoperable, and Reusable) data, and strategies for long-term data archiving. Through practical exercises, students will learn how to properly archive geospatial datasets, document research processes, and share their work openly with the scientific community according to OGC standards. By the end of the course, students will be equipped to apply open science principles to their research, ensuring their work is accessible, reproducible, and impactful.

Internship

Optional within the programme is the possibility to do an internship. Although not part of the professional skills development courses, this can be a great opportunity to gain professional experience. You can start an internship anywhere during your second year, as long as you fulfil the entry requirements. You will plan you internship together with your internship coordinator and your study adviser.

Quartile	Year 2: Q1-Q4
Date	All year
Thematic Line	All
Credits (EC)	15

Course content:

The internship is a credit-bearing experiential activity in a professional work environment. Its primary purpose is to integrate knowledge and theory with practical applications and skill development in a host organization. The internship focuses on executing specific tasks of a project or research related to the integration of geo-spatial knowledge within the context of a host/client organization. It involves spending part of the second year working at a company/organization as part of a team.

It is the responsibility of a student to organize and execute an internship. The internship coordinator provides feedback and guidance in the process.

The internship may be conducted within consultant companies, government agencies, research institutes, NGOs or intergovernmental organisations in the Netherlands or abroad. ITC has a working relationship with these organisations and has made agreements on the possible placement of interns. The student will be able to apply for an internship topic based on interests and preferences and will develop this topic into an internship project plan (IPP) prior to the start of the internship.

During the internship, the student will receive guidance from a daily supervisor in the organisation concerned. A member of the ITC scientific staff who is an expert on the area of the internship topic will be assigned as ITC internship supervisor. At the end of the internship, the student will have to hand in an internship report (IR) in which the results and experiences are discussed and which reflects on the learning that has been achieved during the internship. The supervisor of the host organization will give feedback on the professional skills using the Host Evaluation Form (HEF).

Students choosing to carry out internships will have the opportunity to:

- Develop working knowledge in the operationalization of geo-information science;
- Learn new practical skills and gain confidence in entrepreneurial and professional settings;
- Practice communication and teamwork skills;
- Establish a network of professionals;
- Boost their career prospects;
- Become a more motivated life-long learner.

Second year: elective courses

To complete the 120EC of courses of the programme, you have to choose additional elective courses, next to the mandatory foundation, thematic and elective courses belonging to your chosen learning pathway. These courses are offered in the 2nd, 3rd and 4th quartile of the year (fig.13). The set of courses available in these quartiles are accessible to both 1st and 2nd year students.

Because most courses depend on interactive discussions and groupwork, only courses that have five or more participants are offered.

Below are some examples of some of the most common elective courses to be offered in the programme are:

3D Modelling for city digital twins

This course equips students with knowledge of various 3D city and building modelling methods using geospatial data, serving as a foundation for Digital Twins. Students will practice creating and interpreting 3D models through applications like GIS, BIM, image-based modelling, gaming, and VR/AR. The curriculum combines theory and hands-on activities, allowing students to learn and apply different 3D modelling techniques across multiple platforms. Additionally, students will complete a 3D modelling/Digital Twin assignment, providing practical experience in developing their own models based on geospatial information.

Economics and finances for geosciences

Economic assessments, including the quantification of various impacts, are becoming crucial tools for policy and decision-making across many domains and regions. Geospatial data plays a key role in building evidence for these assessments. Thus, geospatial experts must understand economic and financial tools to enhance the application of geospatial data in decision-making. This course introduces Economics and Finance concepts relevant to geoscience, linking them to the MGEO program's focus areas. As global challenges like climate change and resource depletion intensify, there is a growing demand for professionals who can create sustainable, transdisciplinary solutions. Topics covered include climate change, environmental economics, and spatial finance.

EO for modelling of primary productivity and plant growth

Plants have been vital to Earth's history, accelerating the water cycle, enabling soil formation, and producing oxygen through photosynthesis. They serve as the primary sink for carbon dioxide and are a key source of food. Climate change impacts plant functioning, while land cover changes also influence Earth's surface properties and climate. To achieve sustainable land cover, ecology, and food production, it's essential to quantify plants' roles in Earth's climate.

This course provides tools for quantifying processes in terrestrial vegetation using remote sensing signals, including reflectance, chlorophyll fluorescence, and thermal remote sensing, combined with in situ data. Participants will explore plant physiology, radiative transfer models, and plant trait retrieval from satellite data, particularly Sentinel and FLEX missions. They will also work on mini-projects related to vegetation, such as companion planting, water productivity, and deforestation impacts

Land Use Transport interactions

The interaction between land use and transport is intricate and dynamic, with each influencing the other. This course explores key theories behind this interaction and their modelling foundations, focusing on spatial interaction theory. This theory is crucial for studying optimal service locations, accessibility analysis, simulation, forecasting, and network management. Students will learn about network modelling and spatial interaction for accessibility analysis using GIS. They will also conduct a scenario study to assess the impacts of land use and transport policy strategies in the Netherlands. Offered jointly to ITC and CEM students, this course is part of a collaborative effort between the ITC and ET (CEM) faculties.

Modelling Multi-Hazard & Risk

This course focuses on modelling dynamic multi-hazard risks from hydro-meteorological and geological sources, such as landslides, floods, and debris flows. It teaches participants to evaluate how these risks evolve over time, using quantitative methods to estimate spatial distribution of potential losses. The course covers hazard interactions, integrated physically-based models like OpenLISEM Hazard, and tools for analyzing multi-hazard risks. Students gain hands-on experience with this model to forecast and assess risks. The course includes modelling multi-hazards, which involves using OpenLISEM Hazard for scenarios involving extreme rainfall, and analyzing multi-hazard risk.

Quantitative Remote Sensing of vegetation parameters

This course focuses on extracting quantitative information about vegetation canopies from remote sensing data, emphasizing leaf area index and phenology. It covers definitions, field measurement techniques, and estimation methods using remote sensing data. Students will learn through interactive lectures and practical exercises, employing multispectral and hyperspectral data to model these parameters. The course is divided into two parts: the first explores lab and field measurements, statistical approaches, and radiative transfer model inversion, while the second addresses phenology and the calculation of phenological metrics from time-series data. A field visit will provide hands-on experience, and students will complete a final assignment in the last two weeks.

GeoHealth

This course focuses on bringing together epidemiology, spatial data science, spatial analysis and geospatial technologies. Students will learn through interactive lectures, practical exercises, group discussions, employing a variety of health and environmental data to map health risks, identifying hotspots using spatial statistical methods, raster modelling, suitability analysis and ecological models. Students are introduced to a variety of topics and concepts centred around how geospatial information and technologies can be used for addressing health and disease. Three main facets of public health will be covered: **health risk** – understanding where and when risks are and who may be affected; **health response & services** – examining accessibility to healthcare and inequalities; and **health communication & decision making –** communicating risks and the role of digital information and tools in providing information and aiding the decision-making process that includes data structures and ethics.