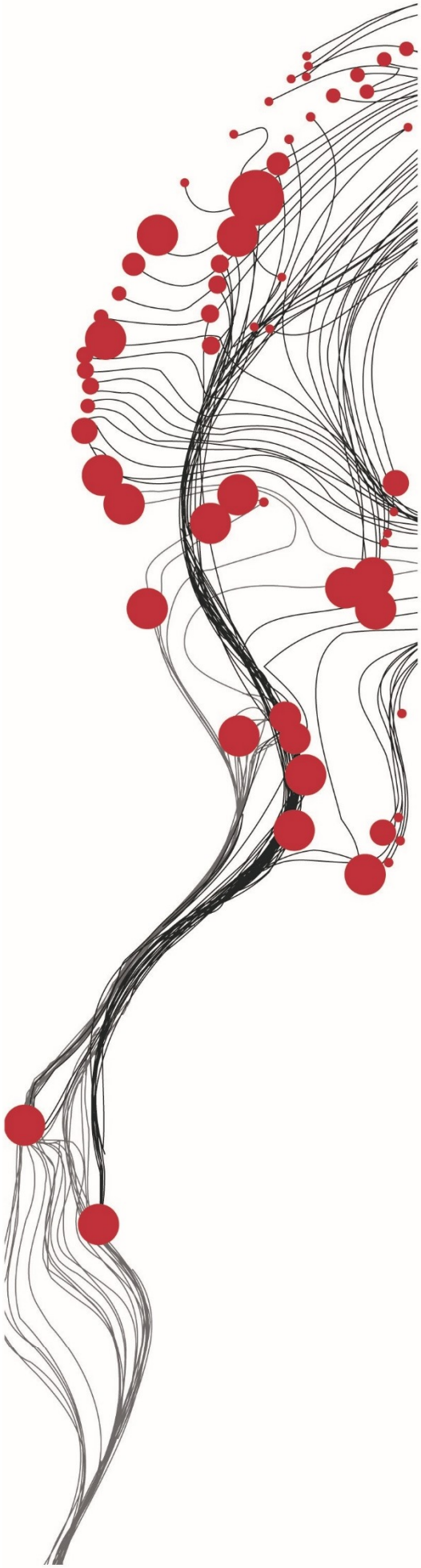

STUDY GUIDE

Master of Science Degree Programme in Spatial Engineering

Academic year 2022-2023

University of Twente, Faculty ITC
Bureau Education and Research Support

UNIVERSITY OF TWENTE.

ITC

COLOFON

UNIVERSITY OF TWENTE
FACULTY OF GEO-INFORMATION SCIENCE AND EARTH OBSERVATION
Bureau Education and Research Support

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PREFACE

This study guide provides an overview of the Master's programme Spatial Engineering and the study units of the programme for academic year 2019. In this study guide you find an overview of the learning outcomes and the structure of the programme as well as an overview of the various roles within the programme.

Each study unit of the study programme is described in terms of its study load, learning outcomes, contents, teaching and learning approach, test plan and entry requirements.

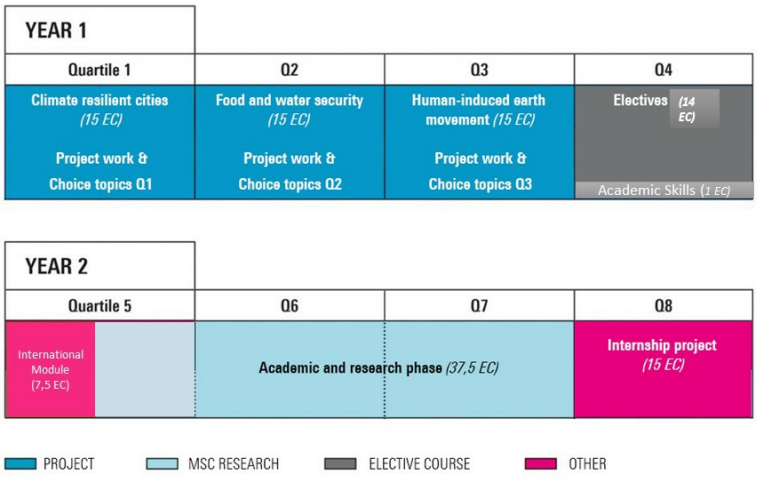
Through this study guide we hope to provide you insight in what you can expect from the education we offer. The programme manager can be contacted for further general information about the programme. For further information about a specific study unit, the coordinator of that study unit can be contacted.

Success with your studies!

CONTENTS

INTRODUCTION

PROGRAMME STRUCTURE



First year - case study projects and electives
In the first year of the Master's programme Spatial Engineering students will work on three case study projects to develop (in a scientific way) sustainable interventions to help solve certain problems. During the case study projects students will encounter the need for more knowledge. This can be obtained during the case study projects - in specialized lectures on choice topics, skill learning line workshops and of course self study – as well as after using the 4th quartile for electives courses related to their own research topic.

Second year - fieldtrip, MSc research and internship
The second year of Spatial Engineering allows students to further pursue a more personally oriented curriculum. The main part is the individual MSc research, on a topic of choice. At ITC, the MSc research topics are integrated with the main research themes at ITC, which are the responsibility of the professors and associate professors. There are six main research themes at ITC, each of which has multiple sub-themes that are very well suited for Spatial Engineering: urban development, climate change, disasters, resource extraction, agriculture etc.

Moreover, in view of the capacity development mission of ITC, a large number of projects is available for students to participate in. These can be NWO and EU research projects, but also capacity development projects that are more consultancy type activities and offer training and advice. Examples are water management projects in Kenya and Ethiopia, urban development research in Rwanda, disaster management research in the Caribbean, Thailand, Indonesia and Nepal, but also agricultural research in Spain or dike strength research in the Netherlands. In these type of large projects, there is a close cooperation with local counterparts from governments and academic institutes, and they are often funded by UN level organizations (with their own policy and coordination requirements). It is relatively common for MSc students to participate in these projects, keeping in mind that the MSc research work should be of a high scientific standard. An overview of current project services can be found at the ITC website.

- Case studies
- Electives
- Academic Skills
- Academic and research phase
- International module
- Internship project

Q1	Q2	Q3	Q4
Climate Resilient Cities	Food and Water Security	Human-induced Earth Movement	Electives
Project Work Climate Resilient Cities	International and Intercultural Competences	Academic and Research Skills	Academic Skills
Academic and Research Skills	Academic and Research Skills	International and Intercultural Competences	
International and Intercultural Competences	Project Management and Teamwork Skills	Project Management and Teamwork Skills	
Project Management and Teamwork Skills			

60 EC / 60

Q5	Q6	Q7	Q8
Academic and Research Phase	Academic and Research Phase	Academic and Research Phase	Internship Project
International Module			

60 EC / 60

TEACHING PERIOD

Period	Time
1st period	08:45 - 10:30
	Coffee/tea break
2nd period	10:45 - 12:30
	Lunch break
3rd period	13:45 - 15:30
	Coffee/tea break
4th period	15:45 - 17:30

EVENTS, HOLIDAYS AND BREAKS

Opening Academic Year	Monday, 05 September 2022
Quartile 1	05 September 2022 - 11 November 2022
Quartile 2	14 November 2022 - 03 February 2023
Dies Natalis UT	
Winter break	26 December 2022 - 06 January 2023
Quartile 3	06 February 2022 - 21 April 2023
Topic Fair	
Spring break	27 February 2023 - 03 March 2023
Career Event	
Good Friday	Friday, 07 April 2023
Easter Monday	Monday, 10 April 2023
Quartile 4	24 April 2023 - 07 July 2023
Kings's Day	Thursday, 27 April 2023
Liberation Day	Friday, 05 May 2023
Ascension Day + Bridging day	Thursday, 18 May 2023 and Friday 19 May 2023
Whit Monday	Monday, 29 May 2023
Graduation	
Resit exams Q4	24 July 2023 - 28 July 2023
Summer Break	10 July 2023 - 1 September 2023

ROLES WITHIN THE CURRICULUM

Confidential Advisor
The Faculty ITC is a strong, vibrant community that consists of people from all over the world. We expect all members of our community to respect the diversity of all students and staff. The Confidential Advisor plays an essential role in the faculty's response to harassment concerns. If you are affected by undesirable behaviour, such as bullying, aggression and unwanted sexual advances, you can turn to the confidential advisor for help, support and advice. The advisor is authorized to receive complaints and will treat information discreetly and privately. You can find the Confidential Advisor, Ms. Annemarie Arets-Meulman, in room 1-164 from Monday - Friday 09:00-14:00 and/or you can send an e-mail to confidentialadvisor- itc@utwente.nl

Education Support Office
The Education Support Office provides administrative and logistic support during the execution of the programme and courses and assists the Programme Management and Study Unit Coordinators. The Education Support Office is the first point of contact for students requiring information regarding the course.

Examination Board
The Examination Board is the body which determines autonomously and objectively whether a student satisfies the conditions that the Education and Examination Regulations set on the knowledge, understanding and skills needed to obtain an MSc degree or Certificate.

Examiner
The individual who has been appointed by the Examination Board in accordance with Article 7.12c of the WHW to hold exams and tests and determine their results.

Mentor
The faculty member who offers academic guidance to a student.

Personal Development Plan and Portfolio
The digital environment in which the student keeps his/her personal plans, progress and reflections during the study in the M-SE (abbreviated as PDP).

Programme Committee
As referred to in Article 9.18 of the WHW; the Programme Committee is composed of both teacher and student members and approves the EER on specific topics and offers advice on other academic matters (Article 9.18, WHW, and article 12, Faculty Regulations).

Programme Director
Person appointed by the Dean to be the governing head of a Master's programme as defined in Article 9.17 of the WHW. The Programme Director is responsible for the development and quality of the programme (in Dutch this person is called Opleidingsdirecteur or OLD).

Programme Manager
The person who is responsible for the planning and organization of the development and implementation of the Master's programme and derived courses and who assumes the role of study adviser.

Proposal Assessment Board
The Proposal Assessment Board is responsible for the assessment of the MSc Research Proposal.

Student Affairs Officers
ITC Student Affairs Officers provide ITC students with information, advice, and assistance on social, cultural, and medical issues. Occasionally, a student may have a serious problem. Student Affairs officers can help by listening and can advise and guide you on where best to seek assistance. Everything you tell them is treated with strict confidentiality.

Study Adviser
Faculty member appointed by the Dean of the Faculty to act as contact between the student and the programme, and in this role represents the interests of the students, as well as fulfilling an advisory role. The role of Study Adviser is put with the Programme Manager.

Study Unit Coordinator
Each study unit is coordinated by a staff member of the Scientific Department. He is responsible for the organization and execution of the entire study unit, and is first point of contact for staff and students when questions arise.

Supervisor
All Master's programme students will be assigned to a Supervisor for the development of their MSc Research proposal and the execution of their MSc Research.

Tutor
A staff member who coaches a student group during the case study project.

Thesis Assessment Board
The Thesis Assessment Board is responsible for the assessment of the MSc Research exam at the end of the Master's programme.

PROGRAMME LEARNING OUTCOMES (FINAL QUALIFICATIONS)

The worldwide challenges that are the work field of the Spatial Engineer are often called ‘wicked’ problems because at face value, they seem unsolvable. The programme wants to enable the graduate addressing ‘wicked’ problems by, using the core knowledge areas of Technical Engineering, Spatial Information Sciences and Spatial Planning and Governance, applying scientifically sound spatio-temporal analysis and the development of models, taking into account socio-environmental drivers of system Earth and conducting research projects in an international and multidisciplinary team. At successful completion of the Master’s programme Spatial Engineering, the student has reached the following final qualifications:

Is an expert in integrated knowledge development of technical engineering, spatial information science and spatial planning for governance.

1. The graduate has a sufficient knowledge of the theory and principles of technical engineering and environmental processes, spatial information science and spatial planning and governance related to policy goals of resilience, sustainability and legitimacy. The graduate is capable of creating added value by combining the disciplines in analysis. The graduate can independently identify his/her knowledge gaps and can revise and extend his/her own knowledge through study.

Does research in a purposeful and methodological way.

2. The graduate can independently develop new knowledge in a purposeful and methodical way while dealing with ‘wicked’ societal problems and take into account the system boundaries. He/she can contribute to scientific knowledge in the Spatial Engineering knowledge base by collecting, processing, analysing and visualising data to produce and validate information in a logical way. The graduate can assess research on its scientific value taking into account scientific quality issues

Can design context specific and appropriate interventions for sustainable development

3. The graduate can design interventions and scenarios that balance possible solutions between technical possibilities and genuine interests of the parties involved. He/she can adapt and steer the design process taking into account changing external requirements and new information, involving stakeholders in various stages in this process. The graduate can evaluate and justify design decisions, in a systematic and reproducible manner.

Has an academic approach to the development, justified use and validation of theories and models.

4. The graduate can compare, justify choices and identify possible improvements in state-of-the-art knowledge, theories and methods. He/she can use, develop and validate models; consciously choosing between different modelling techniques for spatiotemporal processes, while accounting for socio-environmental drivers. The graduate can evaluate the impact of scientific and quality issues on the suitability of interventions. He/she can document, reproduce and publish the results of research and design according to scientific standards

Is competent in reasoning, reflection, and judgment.

5. The graduate can reflect on his/her own arguments and decisions and adjust these on the basis of this reflection. The graduate can operationalise theoretical concepts and develop research questions. The graduate can analyse the completeness, uncertainty and lineage of data

Is competent in cooperation and communication.

6. The graduate can function in different disciplinary contexts; communicate on different levels and has awareness of different perspectives from different scientific backgrounds. He/she can engage effectively in productive teamwork in a variety of roles in diverse teams, applying project management methods. The graduate can convey information and ideas effectively using written, oral, visual and graphical tools. The graduate can present the results of scientific work, including the underlying knowledge, choices and considerations, to peers and to different audiences.

Can work internationally as a global citizen and as an empathic engineer.

7. The graduate can evaluate the impact and sustainability of an intervention and/or design in various governance contexts. The graduate has professional skills and awareness of ethical values needed to work in international and multicultural teams and environments and as an empathic engineer who aspires to social justice

TEACHING AND LEARNING APPROACH

Spatial Engineering is special in various ways. Throughout the programme students will notice the student-centeredness; the road towards achieving the MSc degree will be designed by the student. There is a large group of dedicated and highly motivated teachers to support the student during their journey. Any student will have lots of opportunities to develop not only the multidisciplinary knowledge for designing a sustainable future but also to acquire the skills to be able to work in international projects with team members from different backgrounds and nationalities.

A multidisciplinary approach is required, because worldwide challenges require an acute awareness of the way technological and engineering solutions function within diverse and increasingly complex societal, political, economic and cultural contexts. Rapid developments in the world demand a sustainable approach in how we plan and change our living environment. Good engineers need to be able to design multiple solutions together with stakeholder groups, while at the same time they must be flexible and creative in searching and obtaining data, information, and resources to ensure the success of their project. Drawing from multiple disciplines enables the Spatial Engineer to structure and redefine problems beyond the obvious frames and reach solutions based on a new understanding of complex situations and 'wicked' problems. Moreover, engineers today cannot wait for problems to be formulated for them to solve. They need the skills to engage with various stakeholders to help them frame and define the problems in a way that allows successful solution design. Not only that, many organizations that drive developments, such as the World Bank, UN organizations and national governments, promote and foster capacity development with a focus on analytical, reflective and interactional skills in diverse environments.

Therefore, a curriculum is designed where four elements are brought together:
Integrated approach
- Integration of knowledge, tools and methods of different sciences
- Multidisciplinary group composition

Student-centred learning
- Self-direct learning, learning by doing, learning by questioning

Lifelong learning
- Work-related learning skills
- Flipped classroom, e-learning, virtual learning environment

Internationalization
- International learning environment, diversity in student and teachers

In the first year of the Master's Programme Spatial Engineering, students will work on three case study projects to develop (in a scientific way) sustainable interventions to help solve a certain problem.

The core teaching concept is project-led education (PLE); all four vision elements mentioned above are applied in case study projects. This is achieved by a deliberate design of the projects and scaling between completely student-centred learning and project-driven teaching. The final qualifications guide this process. We see a project as an activity in which a group of students collaborate to develop and apply new knowledge, skills and attitudes by solving a (design) problem within a set of boundaries and conditions. In project-led education the project is central and leading in the study units. Project-led education will be partly assessed as a group effort and partly based on individual performance. Both concepts, project-led education as well as group learning, require from the student the ability to pose questions and learn by questioning, to go beyond the obvious and find out what is causing the problem and how scientific knowledge can help to solve the problem.

The Personal Development Portfolio shows how the student integrates the student-centred and lifelong learning in the international environment towards achieving their vision for being a Master in Spatial Engineering. Students provide insight into their study choices, participation and progress. The Personal Development Portfolio contains the personal development plan for the different study units, the choices they made on courses to follow, specific knowledge gained in courses and project execution, development on skills learning lines, and reflection on project and learning process. The mentor and tutor will guide the student in developing the Personal Development Portfolio and keep track of progress and completeness. Students become eligible to take the oral test when the Personal Development Portfolio is assessed complete and forwarded to the assessors. After the oral test, the students receive feedback on the Personal Development Portfolio and the case study project assessment.

SOURCES OF INFORMATION

STUDY GUIDE IN DIGITAL FORMAT
www.itc.nl/studyguide

EDUCATION AND EXAMINATION REGULATIONS AND RULES AND REGULATIONS OF THE EXAMINATION BOARD
www.itc.nl/regulations

FACULTY ITC
www.itc.nl

UNIVERSITY OF TWENTE
www.utwente.nl/en

CASE STUDIES

CLIMATE RESILIENT CITIES

Course	**201800208**
Period	05 September 2022 - 11 November 2022
EC	15

Course coordinator

INTRODUCTION

Worldwide, cities are challenged by water excess that can cause widespread floods. Fast growing cities, of which many are in low lying deltas, are under pressure to accommodate changing societies and to protect its inhabitants, especially those in the global South. Moreover, urban drainage infrastructures increasingly have difficulties to cope with the imminent higher rain intensities caused by climate change. Cities need to become resilient for such changes in the hydrologic behaviour of urban catchments to provide stakeholders a secure environment to build up their livelihoods and sustain socio-economic growth.

In the first case study project, students focus on urban flood management and analyse the water system of a city. Students build up skills in analysing an urban flood problem taking into consideration the perspectives of stakeholders and the government arrangements in place, and learn to design effective measures (engineering interventions) that make the urban environment more resilient to extreme rainfall.

CONTENT

Climate Resilient Cities is the central theme of the first case study project of the Spatial Engineering programme. Students work in teams, of at least three individuals, on the project. Individuals follow choice topics, keynote lectures, tutorials and activities linked to the three skills learning lines that set the scientific context and support the skills and knowledge development that is needed to complete the project.

The urban flood problem studied in the case study project is constrained to a multi-disciplinary problem, for which aspects of the three core knowledge areas (Technical Engineering, Spatial Planning and Governance, Spatial Information Sciences) need to be considered in developing the final case study project results. The focus of education activities for the Technical Engineering domain lies on modelling of floods in the urban environment as a result of extreme rainfall. For the Spatial Planning for Governance domain, this is the perspectives of stakeholders at the city level and for the Spatial Information Sciences domain, image processing and spatial data visualization.

Students keep track of and motivate the choices they make during the case study project in the Personal Development Portfolio (PDP), which is an integral part of Spatial Engineering curriculum.

TEACHING AND LEARNING APPROACH

A student-centred teaching approach framed within a project-driven education concept is adopted. Content for thematic knowledge and skills development is provided during the choice topics, keynote lectures, tutorials and skills learning lines, which are delivered in a variety of 'blended' educational formats, such as mini-lectures, exercises, workshops, panel discussions and question and answer sessions. Students are expected to apply this in their project, and learn by doing, sharing, explaining and discussing the gained knowledge and skills to their team and peers.

In the first quartile it is mandatory for students to select three choice topics, one from each of the three core knowledge areas. Each choice topic has an estimated study load of 28 hours.

The following five choice topics are offered:

Technical Engineering (TE)
TE1.A: Flood Modelling
TE1.B: Hydrological Monitoring and Statistics

Spatial Information Sciences (SIS)
SIS1.A: Spatial Data Visualization
SIS1.B: Digital Elevation Models Creation

Spatial Planning and Governance (SPG)
SPG1.A: Stakeholder Analysis for Climate Resilient Cities

TESTS

The study unit is the entire quartile for which students are awarded 15 EC. The 15 ECs are awarded to students who have i) completed all assessments, ii) earned a pass mark for the individual assessments and iii) earned a total weighed mark higher than the defined threshold. The total mark is composed of four independent assessments of which two are group-based and two are individual. The total weight of the group-based assessments is 40% and the total weight of the individual assessments is 60%.

The four summative assessments are the:

1. **Inception report** (weight: 10% of the final mark, group) on the case study project is submitted by student teams in week 3.
2. **Written test** (weight: 20% of the final mark, individual) on the theory provided during the three selected choice topics in week 6.
3. **Final report** (weight: 30% of the final mark, group) submitted by student teams at the end of week 9.
4. **Oral test** (weight: 40% of the final mark, individual) on the entire learning process during the quartile in week 10.

Detailed instructions for the inception and final case study project report are provided to the students via the assignment document. The criteria for these group-based assessments are formalized through rubrics that made available to the students at the start of the quartile. The group-based assessments (inception report and final case study project report) can be repaired. The maximum mark for a repaired group-based assessment is 6.

A second test opportunity is available for the individual tests. The second test opportunity for the written test will be scheduled within the first quartile. Students have to contact the examiner to request a second test opportunity for the oral test. It is the student's responsibility to make the appointment for a second oral test.

Students are only eligible to take the oral test once they have submitted a completed Personal Development Portfolio (PDP) to the assessors via the study advisor. The programme management assesses the completeness of the PDP based on a checklist. The PDP contains the plan, a reflection on the plan after completion of the case study project and a 500 words essay as part of the 'International and Intercultural Competences' skills learning line.

A complete test plan is made available before the start of the quartile (study unit) with both summative and formative assessments. The formative assessments are meant to help students prepare for the summative assessments.

ENTRY REQUIREMENTS

M-SE entry requirements

LEARNING OUTCOMES

Upon completion of this course, the student is able to:

LO 1 Find and use scientific literature to conceptualise climate resilience of the urban environment

LO 2 Translate a multidisciplinary problem in urban climate resilience into a plan for a research project

LO 3 Apply a model to simulate a relevant physical process, making use of two-dimensional spatial data

LO 4 Use appropriate methods for identifying stakeholders; analysing their perspectives on the problem and involving these in the design of interventions

LO 5 Design an engineering intervention that contributes to the resilience of the urban environment and takes into consideration the perspectives of stakeholders

LO 6 Evaluate the potential impact of the engineering intervention and its feasibility

LO 7 Communicate the results of the research project using visual, written and oral means

LO 8 Define a Personal Development Portfolio aimed at building up knowledge and skills during the case study project

LO 9 Identify the relationship between culture (underlying values and assumptions of a society) and the specific behaviours that derive from these

ALLOCATED TIME PER TEACHING AND LEARNING METHOD

Teaching / learning method	Hours
Lecture	70
Supervised practical	70
Individual assignment	34
Group assignment	162
Self-study	80
Written/oral test	4

TESTPLAN

		Learning Outcomes that are addressed in the test			
	Learning outcomes (LO) of the course: The student will be able to...	**Inception report (SA1)**	**Final report (SA2)**	**Written test (SA3)**	**Oral test (SA4)**
LO 1	Find and use scientific literature to conceptualise climate resilience of the urban environment	●	●		
LO 2	Translate a multidisciplinary problem in urban climate resilience into a plan for a research project	●			
LO 3	Apply a model to simulate a relevant physical process, making use of two-dimensional spatial data		●	●	●
LO 4	Use appropriate methods for identifying stakeholders; analysing their perspectives on the problem and involving these in the design of interventions		●	●	●
LO 5	Design an engineering intervention that contributes to the resilience of the urban environment and takes into consideration the perspectives of stakeholders		●		●
LO 6	Evaluate the potential impact of the engineering intervention and its feasibility		●		●
LO 7	Communicate the results of the research project using visual, written and oral means				●
LO 8	Define a Personal Development Portfolio aimed at building up knowledge and skills during the case study project				●
LO 9	Identify the relationship between culture (underlying values and assumptions of a society) and the specific behaviours that derive from these				●
	Test type	Report	Report	Written test	Oral test
	Weight of the test	15	25	20	40
	Individual or group test	Group	Group	Individual	Individual
	Type of marking	1-10	1-10	1-10	1-10
	Required minimum mark per test			55	55
	Number of test opportunities per academic year	2	2	2	2

RELATION OF LEARNING OUTCOMES (LO) OF THE COURSE WITH THE PROGRAMME LEARNING OUTCOMES

	Learning outcomes (LO) of the course: The student will be able to...	1	2	3	4	5	6	7
LO 1	Find and use scientific literature to conceptualise climate resilience of the urban environment	●			●			
LO 2	Translate a multidisciplinary problem in urban climate resilience into a plan for a research project		●					
LO 3	Apply a model to simulate a relevant physical process, making use of two-dimensional spatial data	●			●			
LO 4	Use appropriate methods for identifying stakeholders; analysing their perspectives on the problem and involving these in the design of interventions	●			●			
LO 5	Design an engineering intervention that contributes to the resilience of the urban environment and takes into consideration the perspectives of stakeholders			●				
LO 6	Evaluate the potential impact of the engineering intervention and its feasibility			●		●		
LO 7	Communicate the results of the research project using visual, written and oral means						●	
LO 8	Define a Personal Development Portfolio aimed at building up knowledge and skills during the case study project					●		

	Learning outcomes (LO) of the course: The student will be able to...	1	2	3	4	5	6	7
LO 9	Identify the relationship between culture (underlying values and assumptions of a society) and the specific behaviours that derive from these						●	●

PROJECT WORK CLIMATE RESILIENT CITIES

Course	**201800261**
Period	05 September 2022 - 11 November 2022
Course coordinator	

INTRODUCTION

The case study project of the first quartile focuses on urban flood problems, and is inspired by the 2012-2013 Integrated Flood Management project that was supported through the Cities and Climate Change Initiative (CCCI) of UN-Habitat. Integrated Flood Management is a term adopted for the approach of tackling the multi-dimensional and multi-sectorial nature of urban flood problems. Floods can have a variety of causes ranging from the absence of appropriate and effective urban drainage infrastructure to governance structures that oversee proper planning. Solutions that address only a part of this spectrum will not be effective in adequately reducing urban flood risks in a sustainable manner. Cities in western societies, where a large portion of the urban environment is privately owned, face similar challenges. Developments of urban drainage infrastructure often take decades, which makes it difficult to adapt to socio-economic trends and changing climate. Scholars have acknowledged the complexity of the urban flood problem, and described how this affects the urban poor in the Global South. They call for adapting the urban environment to climate change through an approach that fosters a wide range of stakeholder involvement and creates institutional readiness to enhance the resilience towards extreme weather.

CONTENT

Students perform, as a team, an analysis of the urban flood problem of a city and identify physical and non-physical engineering interventions that contribute to the long-term flood resilience. A design will be made for one of the identified interventions, including quantifications of the impact on the flood resilience and an analysis of feasibility.

Choice topics, keynote lectures, tutorials and skills learning lines set the academic context of the case study project. The student teams use the knowledge and skills mastered during these educational activities in their project work. Three choice topics and the three skills learning lines are mandatory and described in separate sections of the study guide.

The provided keynote lectures are on the three Spatial Engineering core knowledge areas: i) Climate Change, ii) Spatial Information Sciences, iii) Technical Engineering, and iv) Spatial Planning and Governance.

The provided tutorials are: i) QGIS: getting started, ii) Engineering design, and iii) Urban drainage infrastructure w

TEACHING AND LEARNING APPROACH

A flipped classroom approach is adopted for the development of the project and tutors are available to advise the student teams in feedback sessions, panel discussions and presentations of project results.

Keynote lectures and tutorials provide the context for the project. Keynotes are lectures that are meant to deepen the student’s academic capacity in a specific scientific discipline and tutorials are typically workshops of a half day duration where students learn applications of tools and conceptual frameworks useful for the project.

TESTS

The project work is assessed through the i) inception report, ii) final project report and iii) oral test. Details are available in the case study project section of the study guide.

ENTRY REQUIREMENTS

M-SE entry requirements

RELATION OF LEARNING OUTCOMES (LO) OF THE COURSE WITH THE PROGRAMME LEARNING OUTCOMES

Learning outcomes (LO) of the course: The student will be able to...	1	2	3	4	5	6	7

ACADEMIC AND RESEARCH SKILLS

Course	**201800211**
Period	05 September 2022 - 11 November 2022
Course coordinator	

INTRODUCTION

The skills learning lines have an important place in the curriculum and are an integral part of the final qualifications. Of particular relevance it supports

FQ 2:Does research in a purposeful and methodological way

FQ 4:Has an academic approach to the development, justified use and validation of theories and models

FQ 5:Is competent in reasoning, reflection, and judgment

FQ 6:Is competent in cooperation and communication

In the academic skills learning line we focus on developing the skills that students will need to succeed in this master program as well as their future careers. These include skills related to the structuring, organising, and communication of their academic work and ideas.

For the academic skills learning line an expert teacher is responsible for ensuring a coherent incremental education programme over the course of the Spatial Engineering curriculum. In each case study project students will draw on these skills learning lines.

The study load for the academic skills learning lines is estimated at 14 hours per quartile for the first 3 quartiles.

CONTENT

In this case study project the student will be learning about:

- Basic information skills:
  - Formulating a search strategy to find relevant academic literature;
  - Using a defined format (e.g. APA 6th) for handling citations and references;
  - Creating a personal information structure for literature;
- Scanning and deep reading scientific literature;
- Formulating and justifying some key questions related to a given research problem;
- Tips for structured writing

TEACHING AND LEARNING APPROACH

Formative feedback during the inception phase (weeks 1 and 2), tutorial on critical reading and writing.

TESTS

Skills learning lines form an integral part of the case study project, and will be assessed throughout the regular case study project assessments. The skills learning line Academic and Research Skills is not directly assessed, however it is indirectly assessed through the assignments for the case study projects. Formative feedback is given related to the topics covered in the sessions for academic skills in the quartile.

ENTRY REQUIREMENTS

Personal Plan for Development needs to be completed during the first weeks and the goals for Academic skills need to be included. This will help the student navigate the material delivered in this skill learning line.

LEARNING OUTCOMES

Upon completion of this course, the student is able to:

LO 1 Apply basic information skills to find and manage scientific literature relevant for the case study

LO 2 Apply rapid and deep reading skills to select and extract information from literature for the case study.

LO 3 Define research objectives and related questions suitable for the case study topic

LO 4 Create a logical structure for the case study report which shows the most important elements of the research.

ALLOCATED TIME PER TEACHING AND LEARNING METHOD

Teaching / learning method	Hours
Lecture	6
Self-study	8

RELATION OF LEARNING OUTCOMES (LO) OF THE COURSE WITH THE PROGRAMME LEARNING OUTCOMES

	Learning outcomes (LO) of the course: The student will be able to...	1	2	3	4	5	6	7
LO 1	Apply basic information skills to find and manage scientific literature relevant for the case study		●					
LO 2	Apply rapid and deep reading skills to select and extract information from literature for the case study.		●					
LO 3	Define research objectives and related questions suitable for the case study topic				●	●		
LO 4	Create a logical structure for the case study report which shows the most important elements of the research.		●		●		●	

INTERNATIONAL AND INTERCULTURAL COMPETENCES

Course	**201800210**
Period	05 September 2022 - 11 November 2022
Course coordinator	

INTRODUCTION

The skills learning lines have an important place in the curriculum and are an integral part of the final qualifications (especially the 1st , 6th and 7th). There are three skills learning lines:
1. International and Intercultural Competences
2. Academic and Research Skills
3. Project Management and Teamwork Skills

For each of the skills learning lines an expert teacher is responsible for ensuring a coherent incremental education programme over the course of the Spatial Engineering curriculum. In each case study project students will need to draw on these skills learning lines.

The study load for the three skills learning lines is estimated at a total of 42 hours, 14 hours per quartile.

International and Intercultural Competences are indispensable for spatial engineers tackling wicked problems around the world, in international groups consisting of professionals from various political and social cultures and with various disciplinary backgrounds, rooted in technical and social sciences.

CONTENT

In this case study project, the student will be learning about:

- Story telling and reading between the lines;
- Distinguishing observable from hidden aspects of culture; linking values to behavior; distinguishing between universal, cultural and personal behaviors
- The social production of facts
- Contests around and trade-offs regarding values
- The inseparability of facts and values

TEACHING AND LEARNING APPROACH

Lectures, supervised practical and self-study.

TESTS

As part of the Personal Development Plan (PDP), you will submit a 500 words Essay Assignment about your own (worst) experience in a foreign country (or in a different cultural setting). The essay assignment takes the following aspects into account: (1) beliefs (and facts) (2) desires (and values) and (3) relation between facts and values.

Skills learning lines form an integral part of the case study project, and will be assessed throughout the regular case study project assessments.

ENTRY REQUIREMENTS

Personal Plan for Development (PDP) in International and Intercultural Competences Skills Learning Line.

LEARNING OUTCOMES

Upon completion of this course, the student is able to:

LO 1 Describe the variety of meanings for ‘culture’ using story telling

LO 2 Explain how facts are produced

LO 3 Describe how values (equity, efficiency, accountability) are produced and sustained.

ALLOCATED TIME PER TEACHING AND LEARNING METHOD

Teaching / learning method	Hours
Lecture	4
Self-study	10

RELATION OF LEARNING OUTCOMES (LO) OF THE COURSE WITH THE PROGRAMME LEARNING OUTCOMES

	Learning outcomes (LO) of the course: The student will be able to...	1	2	3	4	5	6	7
LO 1	Describe the variety of meanings for ‘culture’ using story telling							●
LO 2	Explain how facts are produced							●
LO 3	Describe how values (equity, efficiency, accountability) are produced and sustained.							●

PROJECT MANAGEMENT AND TEAMWORK SKILLS

Course	201800212
Period	05 September 2022 - 11 November 2022
Course coordinator	

INTRODUCTION

The skills learning lines have an important place in the curriculum and are an integral part of the final qualifications (especially the 1st , 6th and 7th). There are three skills learning lines:

1. **International and Intercultural Competences**
2. **Academic and Research Skills**
3. **Project Management and Teamwork Skills**

For each of the skills learning lines an expert teacher is responsible for ensuring a coherent incremental education programme over the course of the Spatial Engineering curriculum. In each case study project students will need to draw on these skills learning lines.

The study load for the three skills learning lines is estimated at a total of 42 hours, 14 hours each.

CONTENT

In this case study project, the student will be learning about:

- Analysing the problem as stated in the project-outline and to formulate a project activities and time plan;
- Implementing the project plan to achieve the proposed results in time;
- Functioning effectively as a team;
- Identifying personal strengths and points of attention while working in a team;
- Monitoring and evaluating the group’s performance during the project.

TEACHING AND LEARNING APPROACH

Formative feedback during the inception phase (weeks 1 and 2), bi-weekly evaluation meetings (weeks, 4, 6 and 8) and self-study.

TESTS

Skills learning lines form an integral part of the case study project, and will be assessed throughout the regular case study project assessments. The most important aspects of the skills learning line assessments are described below.

The skills learning line Project Management and Teamwork Skills is assessed via the inception report, final project report and the PDP as input for the oral test.

ENTRY REQUIREMENTS

Personal Plan for Development

ALLOCATED TIME PER TEACHING AND LEARNING METHOD

Teaching / learning method	Hours
Supervised practical	10
Self-study	4

RELATION OF LEARNING OUTCOMES (LO) OF THE COURSE WITH THE PROGRAMME LEARNING OUTCOMES

Learning outcomes (LO) of the course: The student will be able to...	1	2	3	4	5	6	7

SPATIAL DATA VISUALIZATION (SIS1.A)

Course	**201800217**
Period	05 September 2022 - 11 November 2022
Course coordinator	

INTRODUCTION

Five choice topics are offered as part of the first case study project. Each choice topic has an estimated study load of 28 hours. Students choose three choice topics, one from each of the three core knowledge areas (Technical Engineering, Spatial Planning for Governance, Spatial Information Sciences).

The five choice topics are:

Spatial Planning for Governance (SPG, scheduled in week 3, 19 Sept – 23 Sept)

SPG1.A: Stakeholder Analysis for Climate Resilient Cities

Technical Engineering (TE, scheduled in week 4, 26 Sept– 30 Sept)

TE1.A: Flood Modelling

TE1.B: Hydrological Monitoring and Statistics

Spatial Information Sciences (SIS, scheduled in week 5, 3 - 7 Oct)

SIS1.A: Spatial Data Visualization

SIS1.B: Digital Elevation Models Creation

The text below is applicable to **SIS1.A: Spatial Data Visualization**

CONTENT

Maps come into action as soon as a location is involved. Maps reveal patterns and can show trends, and as such give answers to questions about the student population distributions in the city, or how the ice cover at the North Pole is evolving over time. Maps offer insight in how phenomena relate to each other, such as settlement structures and hydrographic patterns. Today, maps of human movement patterns can be created on the fly based on our mobile phone locations. However, we can only explore these patterns efficiently and comprehend the mapped processes effectively if the maps are attractive and well designed. In other words: “maps that matter should raise interest, be engaging, instantly understandable, and relevant to society”. It is the objective of the discipline of Cartography to realize and facilitate this.

Topics addressed:

- Generic (maps, cartography, needs and context)
- Design (design constraints, organising qualitative and quantitative data, guidelines, reading the map, design at work, animation, perception of change)
- Thematic maps (chorochromatic maps, isoline maps, choropleth maps, proportional symbol map, other maps (dot map, cartogram, flowmap))
- Base maps (topographic and base maps; geographic names, (administrative) boundaries)

TEACHING AND LEARNING APPROACH

Lectures, and exercises

TESTS

The theory provided during the selected choice topic is assessed in a written test. Detailed information on assessment of the case study project is provided in the Climate Resilient Cities section of the study guide.

ENTRY REQUIREMENTS

M-SE entry requirements

LEARNING OUTCOMES

Upon completion of this course, the student is able to:

LO 1 Apply cartographic design principles to different kinds of geodata, taking data characteristics and use issues into account

LO 2 Judge the appropriateness of the application of design principles to maps

ALLOCATED TIME PER TEACHING AND LEARNING METHOD

Teaching / learning method	Hours
Lecture	6
Individual assignment	7
Self-study	14
Written/oral test	1

RELATION OF LEARNING OUTCOMES (LO) OF THE COURSE WITH THE PROGRAMME LEARNING OUTCOMES

	Learning outcomes (LO) of the course: The student will be able to...	**1**	**2**	**3**	**4**	**5**	**6**	**7**
LO 1	Apply cartographic design principles to different kinds of geodata, taking data characteristics and use issues into account	●	●			●		
LO 2	Judge the appropriateness of the application of design principles to maps	●			●	●		

DIGITAL ELEVATION MODELS CREATION (SIS1.B)

Course	**201800218**
Period	05 September 2022 - 11 November 2022
Course coordinator	

INTRODUCTION

Five choice topics are offered as part of the first case study project. Each choice topic has an estimated study load of 28 hours. Students choose three choice topics, one from each of the three core knowledge areas (Technical Engineering, Spatial Planning for Governance, Spatial Information Sciences).

The five choice topics are:

Spatial Planning for Governance (SPG, scheduled in week 3, 19 Sept – 23 Sept)

SPG1.A: Stakeholder Analysis for Climate Resilient Cities

Technical Engineering (TE, scheduled in week 4, 26 Sept– 30 Sept)

TE1.A: Flood Modelling

TE1.B: Hydrological Monitoring and Statistics

Spatial Information Sciences (SIS, scheduled in week 5, 3 - 7 Oct)

SIS1.A: Spatial Data Visualization

SIS1.B: Digital Elevation Models Creation

The text below is applicable to **SIS1.B: Digital Elevation Models Creation**

CONTENT

In this choice topic, the students learn how to represent the topography by creating Digital Elevation Models; which sensors are available and what is the optimal procedure to process this sensor data. The Motivation to study this topic in relation to the Q1 study case project is that DEMs are one of the major spatial datasets needed for dealing with the management of water and floods simulation. In such a simulation, with a given rainfall, the quantity of water to be accumulated can be calculated. Then, DEMs are used to estimate the area to be flooded and in case of abundance of water, the DEM is used to predict where the water will go.

TEACHING AND LEARNING APPROACH

The teaching will be conducted by theoretical and practical lectures. Significant time is also allocated for a self-study where a few textbooks and scientific papers are advised for further studying. The supervised practical lessons are designed to strengthen the students understanding and ability to process the data collected from different sensors for the DEM creation.

TESTS

The theory provided during the selected choice topic is assessed in a written test.
Detailed information on assessment of the case study project is provided in the Climate Resilient Cities section of the study guide.

ENTRY REQUIREMENTS

M-SE entry requirements

LEARNING OUTCOMES

Upon completion of this course, the student is able to:

LO 1 Describe the standard processes of generating height data, for the production of DEM

LO 2 Apply image orientation and point cloud processing procedures and generate DEMs

LO 3 Make informed decisions on the best way of data acquisition (type of imagery, overlap, resolution) and the (combination of) processing method(s) suitable for a given problem within the group project

ALLOCATED TIME PER TEACHING AND LEARNING METHOD

Teaching / learning method	Hours
Lecture	8
Supervised practical	10
Self-study	18
Written/oral test	1

RELATION OF LEARNING OUTCOMES (LO) OF THE COURSE WITH THE PROGRAMME LEARNING OUTCOMES

	Learning outcomes (LO) of the course: The student will be able to...	**1**	**2**	**3**	**4**	**5**	**6**	**7**
LO 1	Describe the standard processes of generating height data, for the production of DEM		●	●	●			
LO 2	Apply image orientation and point cloud processing procedures and generate DEMs		●	●	●			
LO 3	Make informed decisions on the best way of data acquisition (type of imagery, overlap, resolution) and the (combination of) processing method(s) suitable for a given problem within the group project		●	●	●			●

CLIMATE-RESILIENCE AND VULNERABILITY ASSESSMENT (SPG1.A)

Course	**201800213**
Period	05 September 2022 - 11 November 2022
Course coordinator	

INTRODUCTION

Five choice topics are offered as part of the first case study project. Each choice topic has an estimated study load of 28 hours. Students choose three choice topics, one from each of the three core knowledge areas (Technical Engineering, Spatial Planning for Governance, Spatial Information Sciences).

The five choice topics are:

Spatial Planning for Governance (SPG, scheduled in week 3, 19 Sept – 23 Sept)

SPG1.A: Stakeholder Analysis for Climate Resilient Cities

Technical Engineering (TE, scheduled in week 4, 26 Sept– 30 Sept)

TE1.A: Flood Modelling

TE1.B: Hydrological Monitoring and Statistics

Spatial Information Sciences (SIS, scheduled in week 5, 3 - 7 Oct)

SIS1.A: Spatial Data Visualization

SIS1.B: Digital Elevation Models Creation

The text below is applicable to **SPG1.A: Stakeholder Analysis for Climate Resilient Cities**

CONTENT

The increased occurrence of extreme weather as a result of climate change has strengthened the need for cities to improve their climate resilience. For cities to become resilient for the effects natural hazards have on society requires measures that have drastic impact on the way in which we make use of space in the urban environment and affects many stakeholders.

This choice topic provides students with the opportunity to learn the principles underlying resilience frameworks and learn how to carry out a stakeholder analysis for their intended Climate Resilient Cities Project. The purpose of the stakeholder analysis is to ensure the identification and involvement of the relevant stakeholders in the problem analysis and the design of effective measures that contribute to the resilience of the urban environment.

TEACHING AND LEARNING APPROACH

Lectures, and readings introduce the key concepts of resilience and stakeholder analysis. Stakeholder analysis in the context of measures that improve the climate resilience will be practiced in class.

TESTS

The theory provided during the selected choice topic is assessed in a written test. Detailed information on assessment of the case study project is provided in the Climate Resilient Cities section of the study guide.

ENTRY REQUIREMENTS

M-SE entry requirements

LEARNING OUTCOMES

Upon completion of this course, the student is able to:

LO 1 Discuss and differentiate frameworks to assess climate resilience

LO 2 Discuss and classify the importance of stakeholder's analysis for climate resilience assessment

LO 3 Apply resilience frameworks to assess measures in the urban environment that involves stakeholders

ALLOCATED TIME PER TEACHING AND LEARNING METHOD

Teaching / learning method	Hours
Lecture	12
Supervised practical	4
Individual assignment	0
Self-study	11
Written/oral test	1

RELATION OF LEARNING OUTCOMES (LO) OF THE COURSE WITH THE PROGRAMME LEARNING OUTCOMES

	Learning outcomes (LO) of the course: The student will be able to...	**1**	**2**	**3**	**4**	**5**	**6**	**7**
LO 1	Discuss and differentiate frameworks to assess climate resilience	●			●			
LO 2	Discuss and classify the importance of stakeholder's analysis for climate resilience assessment	●		●	●			
LO 3	Apply resilience frameworks to assess measures in the urban environment that involves stakeholders	●	●		●			

FLOOD MODELLING (TE1.A)

Course	201800216
Period	05 September 2022 - 11 November 2022
Course coordinator	

INTRODUCTION

The five choice topics are:

Spatial Planning for Governance (SPG, scheduled in week 3, 19 Sept – 23 Sept)

SPG1.A: Stakeholder Analysis for Climate Resilient Cities

Technical Engineering (TE, scheduled in week 4, 26 Sept– 30 Sept)

TE1.A: Flood Modelling

TE1.B: Hydrological Monitoring and Statistics

Spatial Information Sciences (SIS, scheduled in week 5, 3 - 7 Oct)

SIS1.A: Spatial Data Visualization

SIS1.B: Digital Elevation Models Creation

The text below is applicable to **TE1.A: Flood Modelling**

CONTENT

The development of a flood is a complex process that generally depends on the atmospheric drivers such as excessive rainfall and/or snowmelt and catchment boundary conditions. Environmental conditions such as antecedent soil moisture, topography, land use, soil physical properties and drainage infrastructure form crucial components that determine the hydrological response. For a flood model, these factors are incorporated in the spatial input database.

In this choice topic students will learn the importance of catchment hydrology and the effect of urbanization on flood response. As a framework we use the openLISEM model, with which you can simulate in detail the effect of changing hydrological and environmental conditions on the dynamics of floods. The emphasis is on flash floods that are a result of excessive rainfall having an immediate response in the same area. You will learn about the physical concepts (conservation and momentum laws, routing principles) upon which flood models are based. Furthermore, we will discuss how to translate simulated flood characteristics to a flood hazard and various ways in which we can reduce the flood hazard. Note that while a flood model is based on physical laws, the user actually determines how a model behaves by creating a spatial input dataset that represents a given scenario: a large part of flood modelling consists of learning how to apply GIS operations. OpenLISEM uses the PCRaster GIS modelling language.

TEACHING AND LEARNING APPROACH

The teaching will be conducted by theoretical and practical lectures.

TESTS

The theory provided during the selected choice topic is assessed in a written test. Detailed information on assessment of the case study project is provided in the Climate Resilient Cities section of the study guide.

ENTRY REQUIREMENTS

M-SE entry requirements

LEARNING OUTCOMES

Upon completion of this course, the student is able to:

LO 1 Explain the hydraulic principles of floods and how these affect model results

LO 2 Learn how to create a spatial flood model database and apply a flood model, and analyse its results

LO 3 Analyse which hydrological parameters affect flooding due to urbanization.

ALLOCATED TIME PER TEACHING AND LEARNING METHOD

Teaching / learning method	Hours
Lecture	6
Supervised practical	10
Self-study	11
Written/oral test	1

RELATION OF LEARNING OUTCOMES (LO) OF THE COURSE WITH THE PROGRAMME LEARNING OUTCOMES

	Learning outcomes (LO) of the course: The student will be able to...	1	2	3	4	5	6	7
LO 1	Explain the hydraulic principles of floods and how these affect model results	●			●			
LO 2	Learn how to create a spatial flood model database and apply a flood model, and analyse its results	●						
LO 3	Analyse which hydrological parameters affect flooding due to urbanization.			●				

HYDROLOGICAL MONITORING AND STATISTICS (TE1.B)

Course	**201800215**
Period	05 September 2022 - 11 November 2022
Course coordinator	

INTRODUCTION

The five choice topics are:

Spatial Planning for Governance (SPG, scheduled in week 3, 19 Sept – 23 Sept)

SPG1.A: Stakeholder Analysis for Climate Resilient Cities

Technical Engineering (TE, scheduled in week 4, 26 Sept– 30 Sept)

TE1.A: Flood Modelling

TE1.B: Hydrological Monitoring and Statistics

Spatial Information Sciences (SIS, scheduled in week 5, 3 - 7 Oct)

SIS1.A: Spatial Data Visualization

SIS1.B: Digital Elevation Models Creation

The text below is applicable to **TE1.B: Hydrological Monitoring and Statistics**

CONTENT

Reliable and near-real-time hydrological measurements form the basis upon which water managers make decisions. Rainfall is the key input to the hydrological cycle that is partitioned at the land surface into either groundwater recharge to deep reservoirs or surface runoff, contributing to streamflow with very short time lags. The lack of near-real-time data on rainfall constrains the understanding of hydrological processes and their interaction with natural and anthropogenic forcings. For example, the city of Kampala (in Uganda) suffers from recurring flood events. However, measurements of rainfall are very scarce and highly uncertain.

In this course, we will treat state-of-the-art techniques for near-real-time monitoring of rainfall and learn how to assign a probability of future occurrence of a heavy rain event based on available measurements.

TEACHING AND LEARNING APPROACH

On the first day, we will introduce the physical processes and measurement concepts of precipitation. On the second day, the concept of frequency analysis in hydrology will be introduce with hands-on exercises. The third day will be reserved to realize a practical exercise on estimating the risk of heavy rain using rainfall measurements.

TESTS

The theory provided during the selected choice topic is assessed in a written test. Detailed information on assessment of the case study project is provided in the Climate Resilient Cities section of the study guide.

ENTRY REQUIREMENTS

M-SE entry requirements

LEARNING OUTCOMES

Upon completion of this course, the student is able to:

LO 1 Describe the types of precipitation and their measurement principles

LO 2 Apply statistical methods for designing the return period of extreme rain events

ALLOCATED TIME PER TEACHING AND LEARNING METHOD

Teaching / learning method	Hours
Lecture	6
Supervised practical	9
Self-study	12
Written/oral test	1

RELATION OF LEARNING OUTCOMES (LO) OF THE COURSE WITH THE PROGRAMME LEARNING OUTCOMES

	Learning outcomes (LO) of the course: The student will be able to...	**1**	**2**	**3**	**4**	**5**	**6**	**7**
LO 1	Describe the types of precipitation and their measurement principles	●		●				
LO 2	Apply statistical methods for designing the return period of extreme rain events	●		●				

FOOD AND WATER SECURITY

Course	**201800237**
Period	14 November 2022 - 03 February 2023
EC	15

Course coordinator

INTRODUCTION

The terms “food and water security” refer to the sustainable access to sufficient food and water in order to meet the needs and personal/cultural preferences for sustaining livelihoods. For part of the population, this access can be ascertained by buying food, which is sometimes transported over large distances. For example, in the Netherlands we can buy fruits year-round that are sourced from places as far as New Zealand and Chile, and even our livestock enjoys South-American soy. However, the demands of a growing global population are increasingly hard to meet by the finite natural resources. Unsustainable use of resources may result in land degradation or groundwater depletion while global challenges like climate change puts food and water security for the global population in jeopardy. Particularly in regions with limited water availability, and where people rely largely on locally-produced food, competing claims and conflicts may arise between stakeholders on how to share resource access and use. Weather impacts may intensify such conflicts, as for example water availability and food production will be lower in years of drought.

During this quartile you will explore food and water security issues in detail in a case study. Your group can choose between various study areas. It will be the group’s task to first understand the challenges related to food and water security in the chosen area. This comprises an analysis of the various stakeholders and how these are affected by the identified challenges. Based on this overview, and using a Theory of Change framework, the group then chooses to focus on a specific challenge/problem and develops an intervention. A good rationale is required of how the envisaged intervention contributes to a positive impact pathway (*that is: how will the intervention help solve the problem*). While the intervention should focus on a specific stakeholder, the group will also need to analyse possible impacts on other stakeholders in the area, in order to identify if the intervention is acceptable. Lastly, the analysis needs to comprise an assessment of how various (future) scenarios may impact the success of the intervention.

CONTENT

The content that will be offered in this project consists of group work, keynote lectures, choice topics, and tutorials. Regarding the choice topics, three out of eight available choice topics need be selected. The students need to identify if and how the acquired knowledge can be used for the project. It is encouraged that different members of a group follow different choice topics, although not each topic needs to be covered by the group. Furthermore we note that the choice topics may be considered as a starting point (introduction), but as part of the group project and self-study, students are encouraged to apply and deepen their knowledge/skills. This can be reflected in the Personal Development Plan, and will be an element of the oral test.

The tutorials on offer in case study project 2 emphasize techniques and/or methodologies that can be applied to the case studies. Mini-lectures and self-explanatory exercises are typical educational formats of the tutorials. Student groups are themselves largely responsible for the application to their case. The following tutorials have been selected:
TU1: Regression Analysis
TU2-4: Cloud-based access to gridded weather and satellite data
TU5: Data visualisation

It is not obligatory for an individual student to attend each tutorial, but it is encouraged.

TEACHING AND LEARNING APPROACH

The teaching and learning approach will follow the general approach as described for the case study projects in the Spatial Engineering programme. However, compared to Q1, the Q2 case studies are less prescribed, and student groups are expected to become more independent and put a stronger effort themselves to search for literature and spatial data. In addition, the wickedness of the challenges is expected to increase with respect to Q1. For each case study there will be a short description, and ITC staff can help to identify and contact resource persons. Given that the analysis requires a spatial component, students may need to partially rely on freely-available global data layers. In that sense, we specifically encourage the use of multi-temporal satellite data in the projects.

Group work vs personal development

The project is a team effort, leading eventually to a common output in the form of a final report. However, based on their PDP individual students should define and follow their own learning trajectories also within the quartile and within the group work. For example, students are encouraged to go beyond applying what was taught during choice topics, but deepen their knowledge and skills for effective application to the case study. The larger weight for the oral test reflects the importance of these personal learning lines. Although questions in the oral test draw partially upon the group report, the grading will draw predominantly on good individual reflection on a) the designed intervention, b) the research performed, and c) the choices made by the group. Moreover, you will be asked to highlight your role in the team effort, and demonstrate which skills you developed/deepened.

TESTS

Case study project 2 contains four summative assessments, out of which two tests are individual and two are group-based contributing for respectively 60% and 40% to the final mark.

The two group-based assessments are:

1. **Mid-term poster presentation** (weight: 15% of the final mark) submitted and executed by student teams at the end of week 6;
2. **Final report** (weight: 25% of the final mark) submitted by student teams at the end of week 9.

Detailed instructions for the mid-term poster presentation and final project report can be found in the assignment document. Both the mid-term poster presentation and the final project report can be repaired. The maximum mark for repaired mid-term presentation and final project report is 6.

The two individual assessments are:

1. **Written test** (weight: 20% of the final mark) on the theory taught during the selected choice topics early in week 5. Per choice topic, a resit can be requested, which takes place in week 10.
2. **Oral test** (weight: 40% of the final mark) on the entire learning process during the case study project.

Ad group 1) Mid-term poster

The mid-term poster presentation displays the initial analysis of the challenges related to food and water security in the case study area, as well as the relevant stakeholders related to these challenges. The group should present a Theory of Change framework, identify a possible intervention, and indicate how and for whom this intervention may have a positive impact.

Ad group 2) Final report

The final report is the output of the completed case study project. The final report should not exceed 45 pages. The report should clearly describe how the research was set up to analyse this problem. The conclusions drawn from the analysis should be justified in a scientific manner and feed into the proposed intervention.

Ad individual 1) Written test

The written test focuses on assessment of the theory taught during the three selected choice topics. The test for these choice topics will be held during the same three-hour session. The duration of an individual choice topic test is expected to be 45 minutes.

Ad individual 2) Oral test
The oral test includes a short presentation of 7 minutes (pitch) followed by approximately 35 minutes of questions posed by the assessors. Questions will focus on the following components and address the case study project learning objectives: the content of the 7-minute pitch, general questions on all components of the project, the implementation of choice topics followed in the project, the student's contribution to the project, and the general skill learning lines. The Personal Development Portfolio (see below) is an important input for this oral test.

The student can request a second test opportunity, which must take place before the start of the second study year. If desired, the student is responsible to contact the course coordinator to organize an opportunity for the second test.

Personal Development Portfolio
Students provide insight into their study choices, participation and progress through a Personal Development Portfolio (PDP). This PDP contains the choices the student has made on choice topics to follow, specific knowledge gained in choice topics and during project execution, development on skills learning lines, and reflection on project and learning process. The mentor can guide the student in developing the PDP by helping him/her in setting the personal learning goals. The MSE program manager, in coordination with the mentors, keep track of progress and completeness. Students become eligible to take the oral test when the Personal Development Portfolio is complete and forwarded to the assessors. In fact, the PDP is an important input for the assessment, allowing assessors to understand the choices that the students made and the focus of their efforts. After the oral test the students receive feedback on the PDP and the case study project assessment.

ENTRY REQUIREMENTS
Having participated successfully the Q1 case study project on climate resilient cities.

LEARNING OUTCOMES

Upon completion of this course, the student is able to:

LO 1 Identify and describe in the case study area the processes (ecological, social, economic) that influence food and water security

LO 2 Identify the stakeholders and reflect on their differences in equity, empowerment and equality, and how the affect the process

LO 3 Set system boundaries to plan a research project and formulate relevant research questions or hypothesis that are manageable within the given time

LO 4 Analyze (provided) data sources for their suitability (e.g. completeness, quality and lineage) to analyze and model the problem at hand

LO 5 Reflect on the scientific value of the case study research; explain and interpret sources of uncertainty and probabilities of events happening, given the methods used

LO 6 Design in a systematic manner interventions to improve food and water security for specific stakeholders

LO 7 Find, evaluate and assess existing scientific knowledge in the Spatial Engineering Knowledge base on food and water security adhering to proper crediting and referencing

LO 8 Choose (or develop) and apply a model for the availability of water and food over time for a stakeholder, based on spatio-temporal processes in the case study area

LO 9 Report on the analysis, results, discussion and conclusions of the research project

LO 10 Demonstrate clear scientific reasoning and making justified choices on the proposed intervention(s) and modelling food and water availability

LO 11 Participate effectively and share knowledge within the project team

LO 12 Reflect on own role as a team member and professional

LO 13 Reflect on how cultural differences between stakeholders may affect the acceptance of the proposed intervention

ALLOCATED TIME PER TEACHING AND LEARNING METHOD

Teaching / learning method	Hours
Lecture	50
Supervised practical	80
Individual assignment	30
Group assignment	176
Self-study	80
Written/oral test	4

TESTPLAN

		Learning Outcomes that are addressed in the test			
	Learning outcomes (LO) of the course: The student will be able to...	**Mid-term poster**	**Final project report**	**Written test**	**Oral test**
LO 1	Identify and describe in the case study area the processes (ecological, social, economic) that influence food and water security		●	●	●
LO 2	Identify the stakeholders and reflect on their differences in equity, empowerment and equality, and how the affect the process	●	●		
LO 3	Set system boundaries to plan a research project and formulate relevant research questions or hypothesis that are manageable within the given time	●	●		
LO 4	Analyze (provided) data sources for their suitability (e.g. completeness, quality and lineage) to analyze and model the problem at hand		●		●
LO 5	Reflect on the scientific value of the case study research; explain and interpret sources of uncertainty and probabilities of events happening, given the methods used		●		●
LO 6	Design in a systematic manner interventions to improve food and water security for specific stakeholders		●		●
LO 7	Find, evaluate and assess existing scientific knowledge in the Spatial Engineering Knowledge base on food and water security adhering to proper crediting and referencing		●		
LO 8	Choose (or develop) and apply a model for the availability of water and food over time for a stakeholder, based on spatio-temporal processes in the case study area		●		●
LO 9	Report on the analysis, results, discussion and conclusions of the research project		●		
LO 10	Demonstrate clear scientific reasoning and making justified choices on the proposed intervention(s) and modelling food and water availability		●		●
LO 11	Participate effectively and share knowledge within the project team				●
LO 12	Reflect on own role as a team member and professional				●

		Learning Outcomes that are addressed in the test			
	Learning outcomes (LO) of the course: The student will be able to...	**Mid-term poster**	**Final project report**	**Written test**	**Oral test**
LO 13	Reflect on how cultural differences between stakeholders may affect the acceptance of the proposed intervention				●
	Test type	Presentation	Report	Written test	Oral test
	Weight of the test	15	25	20	40
	Individual or group test	Group	Group	Individual	Individual
	Type of marking	1-10	1-10	1-10	1-10
	Required minimum mark per test				
	Number of test opportunities per academic year	1	1	2	2

RELATION OF LEARNING OUTCOMES (LO) OF THE COURSE WITH THE PROGRAMME LEARNING OUTCOMES

	Learning outcomes (LO) of the course: The student will be able to...	**1**	**2**	**3**	**4**	**5**	**6**	**7**
LO 1	Identify and describe in the case study area the processes (ecological, social, economic) that influence food and water security	●						
LO 2	Identify the stakeholders and reflect on their differences in equity, empowerment and equality, and how the affect the process	●						
LO 3	Set system boundaries to plan a research project and formulate relevant research questions or hypothesis that are manageable within the given time		●					
LO 4	Analyze (provided) data sources for their suitability (e.g. completeness, quality and lineage) to analyze and model the problem at hand		●					
LO 5	Reflect on the scientific value of the case study research; explain and interpret sources of uncertainty and probabilities of events happening, given the methods used		●					
LO 6	Design in a systematic manner interventions to improve food and water security for specific stakeholders			●				

	Learning outcomes (LO) of the course: The student will be able to...	1	2	3	4	5	6	7
LO 7	Find, evaluate and assess existing scientific knowledge in the Spatial Engineering Knowledge base on food and water security adhering to proper crediting and referencing				●			
LO 8	Choose (or develop) and apply a model for the availability of water and food over time for a stakeholder, based on spatio-temporal processes in the case study area				●			
LO 9	Report on the analysis, results, discussion and conclusions of the research project					●		
LO 10	Demonstrate clear scientific reasoning and making justified choices on the proposed intervention(s) and modelling food and water availability					●		
LO 11	Participate effectively and share knowledge within the project team						●	
LO 12	Reflect on own role as a team member and professional						●	
LO 13	Reflect on how cultural differences between stakeholders may affect the acceptance of the proposed intervention							●

ACADEMIC AND RESEARCH SKILLS

Course	**201800240**
Period	14 November 2022 - 03 February 2023
Course coordinator	

INTRODUCTION

The skills learning lines have an important place in the curriculum and are an integral part of the final qualifications. Of particular relevance it supports

LO 2:Does research in a purposeful and methodological way

LO 4:Has an academic approach to the development, justified use and validation of theories and models

LO 5:Is competent in reasoning, reflection, and judgment

LO 6:Is competent in cooperation and communication

In the academic skills learning line we focus on developing the skills that students will need to succeed in this master program as well as their future careers. These include skills related to the structuring, organising, and communication of their academic work and ideas.

For the academic skills learning line an expert teacher is responsible for ensuring a coherent incremental education programme over the course of the Spatial Engineering curriculum. In each case study project students will draw on these skills learning lines.

The study load for the academic skills learning lines is estimated at 14 hours per quartile for the first 3 quartiles.

CONTENT

Academic skills will mainly be achieved by applying a scientific approach in the project group work as outlined by several learning outcomes as detailed below. Academic skills will be assessed via the group report, the PDP and the oral test. Various skills are also part of some of the choice topics, which can thus help in strengthening academic skills. In particular skills on conceptualizing a system (TE2.A: Systems Analysis), logical structuring of arguments and text (SPG2.B: Evidence-based Policy Analysis), orally presenting ideas (SPG2.A: Markets and Value Chain Analysis) and data management (SIS2.A: remote sensing in general).

In this quartilet, the student will be learning about:

- Developing, modifying and using conceptual frameworks;
- Scientific writing
  - use of tenses in scientific writing
  - Advanced argumentation - use of a rebuttal; identifying how values affect the proposed intervention in relation to ethical issues in societal context: harm, social justice, corruption;
  - Plagiarism and how to avoid it

TEACHING AND LEARNING APPROACH

Short lectures and tutorials in which skills can be practiced.

TESTS

Project report and oral test.

ENTRY REQUIREMENTS

- Personal plan for development and portfolio from case study project 1
- Participation in case study project 1

LEARNING OUTCOMES

Upon completion of this course, the student is able to:

LO 1 Apply a scientific approach to the development of a group project

ALLOCATED TIME PER TEACHING AND LEARNING METHOD

Teaching / learning method	Hours
Tutorial	8
Self-study	6

RELATION OF LEARNING OUTCOMES (LO) OF THE COURSE WITH THE PROGRAMME LEARNING OUTCOMES

	Learning outcomes (LO) of the course: The student will be able to...	1	2	3	4	5	6	7
LO 1	Apply a scientific approach to the development of a group project		●		●	●		

INTERNATIONAL AND INTERCULTURAL COMPETENCES

Course	**201800239**
Period	14 November 2022 - 03 February 2023
Course coordinator	

INTRODUCTION

The skills learning lines have an important place in the curriculum and are an integral part of the final qualifications (especially the 1st , 6th and 7th). There are three skills learning lines:
1. **International and Intercultural Competences**
2. **Academic and Research Skills**
3. **Project Management and Teamwork Skills**

For each of the skills learning lines an expert teacher is responsible for ensuring a coherent incremental education programme over the course of the Spatial Engineering curriculum. In each case study project students will need to draw on these skills learning lines.

The study load for the three skills learning lines is estimated at a total of 42 hours, 14 hours each.

CONTENT

In this quartile the student will be learning how to suggest a solution to a policy problem making use of cultural theory.

TEACHING AND LEARNING APPROACH

Lectures and self-study

TESTS

In case study project 2, the focus will be for the student to suggest a solution to a policy problem. A 2-page Essay Assignment, as part of the PDP, has to revisit the experience of case study project 2 (Mara) and describes:

1. How the problem was structured;
2. Which were the dominant cultural bias(es).

ENTRY REQUIREMENTS

- Personal plan for development and portfolio from case study project 1
- Participation in case study project 1

LEARNING OUTCOMES

Upon completion of this course, the student is able to:

LO 1 Explain how policy problems are structured

LO 2 Identify dominant cultural biases

ALLOCATED TIME PER TEACHING AND LEARNING METHOD

Teaching / learning method	**Hours**
Lecture	4
Self-study	10

TESTPLAN

		Learning Outcomes that are addressed in the test
	Learning outcomes (LO) of the course: The student will be able to...	**Test 1**
LO 1	Explain how policy problems are structured	●
LO 2	Identify dominant cultural biases	●
	Test type	Essay
	Weight of the test	0
	Individual or group test	Individual
	Type of marking	Pass/Fail
	Required minimum mark per test	0
	Number of test opportunities per academic year	1

RELATION OF LEARNING OUTCOMES (LO) OF THE COURSE WITH THE PROGRAMME LEARNING OUTCOMES

	Learning outcomes (LO) of the course: The student will be able to...	**1**	**2**	**3**	**4**	**5**	**6**	**7**
LO 1	Explain how policy problems are structured							●
LO 2	Identify dominant cultural biases							●

PROJECT MANAGEMENT AND TEAMWORK SKILLS

Course	**201800241**
Period	15 November 2021 - 03 February 2023
Course coordinator	

INTRODUCTION

The skills learning lines have an important place in the curriculum and are an integral part of the final qualifications (especially the 1st , 6th and 7th). There are three skills learning lines:

1. **International and Intercultural Competences**
2. **Academic and Research Skills**
3. **Project Management and Teamwork Skills**

For each of the skills learning lines an expert teacher is responsible for ensuring a coherent incremental education programme over the course of the Spatial Engineering curriculum. In each case study project students will need to draw on these skills learning lines.

The study load for the three skills learning lines is estimated at a total of 42 hours, 14 hours each.

CONTENT

In this quartile, the student will be learning about:

- Analyse a complex problem in a structured manner, e.g. identifying the relevant stakeholders, objectives and defining the key outcomes;
- Use support tools (such as logical framework, problem trees, Gantt-chart…) during the problem analysis;
- Develop a project time-planning with intermediate milestones, activities and deadlines.

TEACHING AND LEARNING APPROACH

Lectures (wk 1-2), formative feedback at planning stage (wk 3-4), bi-weekly evaluation meetings (wk 6 and 8); self-study.

TESTS

Project plan, project report, self-assessment (PDP) and oral test

ENTRY REQUIREMENTS

- Personal plan for development and portfolio from case study project 1
- Successful completion of case study project 1

RELATION OF LEARNING OUTCOMES (LO) OF THE COURSE WITH THE PROGRAMME LEARNING OUTCOMES

Learning outcomes (LO) of the course: The student will be able to...	1	2	3	4	5	6	7

REMOTE SENSING IN GENERAL (SIS2.A)

Course	**201800243**
Period	14 November 2022 - 03 February 2023
Course coordinator	

INTRODUCTION

Eight choice topics are offered in the second quartile to provide the student with the theoretical background on scientific disciplines addressed in case study project 2 on Food and Water Security. Each choice topic has a study load of 28 hours and focuses on one of the three core knowledge domains of the Spatial Engineering Master's programme, namely Spatial Planning and Governance, Technical Engineering and Spatial Information Sciences. The choice topics contribute to the first learning outcome formulated at case study project level.

Detailed descriptions, viz. content and learning outcomes, of the individual choice topics are given on the following pages. Students choose a total of three choice topics.

Spatial Planning and Governance (SPG)
SPG2.A: Markets and Value Chain Analysis
SPG2.B: Evidence-based Policy Analysis
SPG2.C: Spatial Multi-criteria Analysis

Technical Engineering (TE)
TE2.A: Systems Analysis
TE2.B: Dynamic Modelling

Spatial Information Sciences (SIS)
SIS2.A: Remote Sensing in General
SIS2.B: Image Classification
SIS2.C: Spatial Statistics

The text below is applicable to **SIS2.A: Remote Sensing in General**

CONTENT

In this topic, the students will gain knowledge about the principles of Electro-Magnetic (EM) Radiation, and the interaction of EM radiation with the atmosphere and the earth objects. Besides, they will learn about the main types and the four characteristics of the different sensors, which determine to a significant extent the characteristics of the acquired images.

Furthermore, the students will learn the display and visual inspection of image contents, which require band selection for colour composites and efficient and effective contrast enhancement methods. Finally, the image ratios and indices with a focus on vegetation related indices will be applied.

The topics which will be covered in the course are

- Physics of Remote Sensing
- Sensors and Image characteristic
- Visualization and radiometric operations
- Image ratios and indices: NDVI

TEACHING AND LEARNING APPROACH

In this course, a different teaching and learning methods will be used, including lectures, practical, a demonstration on a spectrometer, among others. Lectures will provide information about the main concepts of the various topics, and the practical exercises will deepen the students' understanding of the theories and give them the chance to apply the learned concepts using appropriate functions and tools.

Besides, students are encouraged to participate in group discussions and use the different provided materials to acquire the essential theoretical knowledge based on their preferences and backgrounds.

TESTS

Written test

ENTRY REQUIREMENTS

Participation in case study project 1

LEARNING OUTCOMES

Upon completion of this course, the student is able to:

LO 1 Interpret the EM radiation process and the types of interaction that occur in the atmosphere and at the Earth surface which are relevant for Earth Observation.

LO 2 Interpret the characteristics of the main types of EO sensor especially based on the four sensor characteristics

LO 3 Apply the fundamental visualization principals, image enhancement techniques, and understand radiometric corrections.

LO 4 Explain the mathematical and spectral concepts behind spectral indices and ratio, and apply the NDVI

ALLOCATED TIME PER TEACHING AND LEARNING METHOD

Teaching / learning method	Hours
Lecture	7
Supervised practical	7
Self-study	13
Written/oral test	1

TESTPLAN

		Learning Outcomes that are addressed in the test
	Learning outcomes (LO) of the course: The student will be able to...	**Written test**
LO 1	Interpret the EM radiation process and the types of interaction that occur in the atmosphere and at the Earth surface which are relevant for Earth Observation.	●
LO 2	Interpret the characteristics of the main types of EO sensor especially based on the four sensor characteristics	●
LO 3	Apply the fundamental visualization principals, image enhancement techniques, and understand radiometric corrections.	●
LO 4	Explain the mathematical and spectral concepts behind spectral indices and ratio, and apply the NDVI	●
	Test type	Written test
	Weight of the test	100
	Individual or group test	Individual
	Type of marking	1-10
	Required minimum mark per test	
	Number of test opportunities per academic year	2

RELATION OF LEARNING OUTCOMES (LO) OF THE COURSE WITH THE PROGRAMME LEARNING OUTCOMES

	Learning outcomes (LO) of the course: The student will be able to...	1	2	3	4	5	6	7
LO 1	Interpret the EM radiation process and the types of interaction that occur in the atmosphere and at the Earth surface which are relevant for Earth Observation.		●					
LO 2	Interpret the characteristics of the main types of EO sensor especially based on the four sensor characteristics		●					
LO 3	Apply the fundamental visualization principals, image enhancement techniques, and understand radiometric corrections.		●					
LO 4	Explain the mathematical and spectral concepts behind spectral indices and ratio, and apply the NDVI		●		●	●		

IMAGE CLASSIFICATION (SIS2.B)

Course	**201800245**
Period	14 November 2022 - 03 February 2023
Course coordinator	

INTRODUCTION

Eight choice topics are offered in the second quartile to provide the student with the theoretical background on scientific disciplines addressed in case study project 2 on Food and Water Security. Each choice topic has a study load of 28 hours and focuses on one of the three core knowledge domains of the Spatial Engineering Master's programme, namely Spatial Planning and Governance, Technical Engineering and Spatial Information Sciences. The choice topics contribute to the first learning outcome formulated at case study project level.

Detailed descriptions, viz. content and learning outcomes, of the individual choice topics are given on the following pages. Students choose a total of three choice topics.

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SPG2.A: Markets and Value Chain Analysis
SPG2.B: Evidence-based Policy Analysis
SPG2.C: Spatial Multi-criteria Analysis

Technical Engineering (TE)
TE2.A: Systems Analysis
TE2.B: Dynamic Modelling

Spatial Information Sciences (SIS)
SIS2.A: Remote Sensing in General
SIS2.B: Image Classification
SIS2.C: Spatial Statistics

The text below is applicable to **SIS2.B: Image Classification**

CONTENT

A wealth of information can be obtained from analysing and processing RS data by visual interpretation, which sounds straightforward but is not, or by digital image classification. The latter tries to make full use of the multi spectral characteristics of the RS data. As a first level of computer-assisted image analysis we will introduce the widely used pixel-based digital image classification. Understanding the concepts and limitations of this method should trigger the student's interest in more advanced methods for image analysis which will also be briefly introduced.

- Concepts of image classification
- Pixel-based image classification
- Advanced image classification methods

TEACHING AND LEARNING APPROACH

Through some short lectures the concepts of digital image classification are transferred. However, experimenting with sampling, algorithms, feature spaces and assessing the accuracy of resulting image classifications in practical sessions with and without supervision increases understanding of the possibilities and limitations of pixel based image classification. Whether real fieldwork is feasible and necessary is up to the participants since fieldwork data is also provided for. A final lecture in which more advanced methods are introduced will trigger curiosity and stimulate to self study these methods for application in the project.

TESTS

Written test

ENTRY REQUIREMENTS

Participation in case study project 1

LEARNING OUTCOMES

Upon completion of this course, the student is able to:

LO 1 Describe and explain the differences between the two main image analysis procedures (visual image interpretation and image classification) needed for applications in EO science including quality assessment.

LO 2 Apply a maximum likelihood pixel-based digital image classification on EO data.

LO 3 Compute and describe the three types of accuracies (overall, user and producer) needed to identify the quality of a supervised image classification.

LO 4 Relate ‘advanced’ digital image classification methods to pixel-based digital image classification.

ALLOCATED TIME PER TEACHING AND LEARNING METHOD

Teaching / learning method	Hours
Lecture	7
Supervised practical	7
Self-study	13
Written/oral test	1

TESTPLAN

		Learning Outcomes that are addressed in the test
	Learning outcomes (LO) of the course: The student will be able to...	**Written test**
LO 1	Describe and explain the differences between the two main image analysis procedures (visual image interpretation and image classification) needed for applications in EO science including quality assessment.	●
LO 2	Apply a maximum likelihood pixel-based digital image classification on EO data.	●
LO 3	Compute and describe the three types of accuracies (overall, user and producer) needed to identify the quality of a supervised image classification.	●
LO 4	Relate ‘advanced’ digital image classification methods to pixel-based digital image classification.	●
	Test type	Written test
	Weight of the test	100
	Individual or group test	Individual
	Type of marking	1-10
	Required minimum mark per test	
	Number of test opportunities per academic year	2

RELATION OF LEARNING OUTCOMES (LO) OF THE COURSE WITH THE PROGRAMME LEARNING OUTCOMES

	Learning outcomes (LO) of the course: The student will be able to...	1	2	3	4	5	6	7
LO 1	Describe and explain the differences between the two main image analysis procedures (visual image interpretation and image classification) needed for applications in EO science including quality assessment.		●			●		
LO 2	Apply a maximum likelihood pixel-based digital image classification on EO data.		●					
LO 3	Compute and describe the three types of accuracies (overall, user and producer) needed to identify the quality of a supervised image classification.		●		●			
LO 4	Relate ‘advanced’ digital image classification methods to pixel-based digital image classification.		●					

SPATIAL STATISTICS (SIS2.C)

Course	**201800248**
Period	14 November 2022 - 03 February 2023
Course coordinator	

INTRODUCTION

Eight choice topics are offered in the second quartile to provide the student with the theoretical background on scientific disciplines addressed in case study project 2 on Food and Water Security. Each choice topic has a study load of 28 hours and focuses on one of the three core knowledge domains of the Spatial Engineering Master's programme, namely Spatial Planning and Governance, Technical Engineering and Spatial Information Sciences. The choice topics contribute to the first learning outcome formulated at case study project level.

Detailed descriptions, viz. content and learning outcomes, of the individual choice topics are given on the following pages. Students choose a total of three choice topics.

Spatial Planning and Governance (SPG)
SPG2.A: Markets and Value Chain Analysis
SPG2.B: Evidence-based Policy Analysis
SPG2.C: Spatial Multi-criteria Analysis

Technical Engineering (TE)
TE2.A: Systems Analysis
TE2.B: Dynamic Modelling

Spatial Information Sciences (SIS)
SIS2.A: Remote Sensing in General
SIS2.B: Image Classification
SIS2.C: Spatial Statistics

The text below is applicable to **SIS2.C: Spatial Statistics**

CONTENT

This study unit part will give an introduction to essential aspects of dealing with spatial data in a quantitative way. Traditionally, three ways of doing so are distinguished: geostatistics (use of variogram and kriging), point pattern analysis (use of K-, F-, G- and J- functions on top of intensities) and lattice analysis (using spatial autocorrelation and CAR modelling). The aim of the three-days block is to give a very basic introduction to these methods, and to provide hands-on exercises with suited datasets from previous research.

TEACHING AND LEARNING APPROACH

Lectures and supervised practical

TESTS

Written test

ENTRY REQUIREMENTS

Participation in case study project 1

LEARNING OUTCOMES

Upon completion of this course, the student is able to:

LO 1 Explain the basic aspects of geostatistics

LO 2 Explain the basics of point patterns analysis;

LO 3 Decide whether assumptions underlying the methods are met;

LO 4 Perform analysis on geostatistical data and point pattern data with an open source software package

ALLOCATED TIME PER TEACHING AND LEARNING METHOD

Teaching / learning method	Hours
Lecture	7
Supervised practical	7
Self-study	13
Written/oral test	1

RELATION OF LEARNING OUTCOMES (LO) OF THE COURSE WITH THE PROGRAMME LEARNING OUTCOMES

	Learning outcomes (LO) of the course: The student will be able to...	**1**	**2**	**3**	**4**	**5**	**6**	**7**
LO 1	Explain the basic aspects of geostatistics	●						
LO 2	Explain the basics of point patterns analysis;	●						
LO 3	Decide whether assumptions underlying the methods are met;				●			
LO 4	Perform analysis on geostatistical data and point pattern data with an open source software package		●					

CHANGING VALUE CHAINS (SPG2.A)

Course	**201800244**
Period	14 November 2022 - 03 February 2023
Course coordinator	

INTRODUCTION

Eight choice topics are offered in the second quartile to provide the student with the theoretical background on scientific disciplines addressed in case study project 2 on Food and Water Security. Each choice topic has a study load of 28 hours and focuses on one of the three core knowledge domains of the Spatial Engineering Master's programme, namely Spatial Planning and Governance, Technical Engineering and Spatial Information Sciences. The choice topics contribute to the first learning outcome formulated at case study project level.

Detailed descriptions, viz. content and learning outcomes, of the individual choice topics are given on the following pages. Students choose a total of three choice topics.

Spatial Planning and Governance (SPG)
SPG2.A: Markets and Value Chain Analysis
SPG2.B: Evidence-based Policy Analysis
SPG2.C: Spatial Multi-criteria Analysis

Technical Engineering (TE)
TE2.A: Systems Analysis
TE2.B: Dynamic Modelling

Spatial Information Sciences (SIS)
SIS2.A: Remote Sensing in General
SIS2.B: Image Classification
SIS2.C: Spatial Statistics

The text below is applicable to **SPG2.A: Markets and Value Chain Analysis**

CONTENT

Concepts:

- Sustainable rural livelihoods
- Trade, value and the effect of (spatial) information
- Domestic vs. international value chains illustrated in in agro-industrial sector
- Fair trade, organic trade, certified trade
- Market failures
- Role of (spatial) information in value chains

Dilemmas:

- Positive and negative externalities of change
- Risk of change

TEACHING AND LEARNING APPROACH

Lectures, excursion, poster presentation, discussion

TESTS

Written test

ENTRY REQUIREMENTS

Participation in case study project 1

LEARNING OUTCOMES

Upon completion of this course, the student is able to:

LO 1 Apply the concepts of market and value chain theory in a rudimentary value chain description to be elaborated during your project

LO 2 Recognize and understand dilemma's in changing value chains using a wicked lens

LO 3 Conceive the potential of (Geo)-ICT use for changing value chains

ALLOCATED TIME PER TEACHING AND LEARNING METHOD

Teaching / learning method	Hours
Lecture	7
Supervised practical	7
Self-study	13
Written/oral test	1

RELATION OF LEARNING OUTCOMES (LO) OF THE COURSE WITH THE PROGRAMME LEARNING OUTCOMES

	Learning outcomes (LO) of the course: The student will be able to...	**1**	**2**	**3**	**4**	**5**	**6**	**7**
LO 1	Apply the concepts of market and value chain theory in a rudimentary value chain description to be elaborated during your project							
LO 2	Recognize and understand dilemma's in changing value chains using a wicked lens							
LO 3	Conceive the potential of (Geo)-ICT use for changing value chains							

EVIDENCE-BASED POLICY ANALYSIS (SPG2.B)

Course	201800246
Period	14 November 2022 - 03 February 2023
Course coordinator	

INTRODUCTION

Eight choice topics are offered in the second quartile to provide the student with the theoretical background on scientific disciplines addressed in case study project 2 on Food and Water Security. Each choice topic has a study load of 28 hours and focuses on one of the three core knowledge domains of the Spatial Engineering Master's programme, namely Spatial Planning and Governance, Technical Engineering and Spatial Information Sciences. The choice topics contribute to the first learning outcome formulated at case study project level.

Detailed descriptions, viz. content and learning outcomes, of the individual choice topics are given on the following pages. Students choose a total of three choice topics.

Spatial Planning and Governance (SPG)
SPG2.A: Markets and Value Chain Analysis
SPG2.B: Evidence-based Policy Analysis
SPG2.C: Spatial Multi-criteria Analysis

Technical Engineering (TE)
TE2.A: Systems Analysis
TE2.B: Dynamic Modelling

Spatial Information Sciences (SIS)
SIS2.A: Remote Sensing in General
SIS2.B: Image Classification
SIS2.C: Spatial Statistics

The text below is applicable to **SPG2.B: Evidence-based Policy Analysis**

CONTENT

Policy analysis and auditing

- Introduction to concepts: governance as interplay of the political, the public administrative and the society spheres and their scientific disciplines. Governance and ‘wicked’ problems
- Models of the policy process: institutional rational choice, Advocacy Coalition
- Framework, Policy Arrangement Approach. (Sabatier 2007, Arts 2004)
- ‘Wicked’ problems, policy analysis, use of analytical tools and information. (de Boer 2010)
- Auditing ‘wicked’ policy problems (Westbrook2007)
- Differentiating analysis of policy, politics, and public administration

Spatial planning and role of evidence

- Defining spatial planning as a policy and policy analysis process
- Theories and conceptual models of planning and public participation (Lane, 2005)
- Evidence discourse and frames, the case of housing policy (Murphy, L. 2016; Jacobs K. and Manzi, T., 2013)

Evidence and argumentation

- Use of evidence in politics and society, the case of Department for Environment, Food & Rural Affairs. (Eppel et al. 2013; DEFRA2014)
- Differentiating argumentation in politics, policy analysis, and research
- The argumentative turn in policy analysis and planning: reasoning about uncertainty. (Fischer 1993 and Hanson et al. 2016)
- Argumentation, starting with Toulmin's practical argumentation from claim to justification, evidence in argumentation (Betz 2016) and web-based argumentation mapping (Krauthoff et al 2016)

TEACHING AND LEARNING APPROACH

Lectures, discussions, exercise, role game

TESTS

Written test

ENTRY REQUIREMENTS

Participation in case study project 1

LEARNING OUTCOMES

Upon completion of this course, the student is able to:

LO 1 Recognize different models of policy change in policy practice

LO 2 Understand the role policy analysis and evidence can, ought and is playing, in policy practice, considering the ethics and framing in policy analysis

LO 3 Structure and frame policy problems

LO 4 Audit policy outcomes

LO 5 Analyse and develop policy arguments

LO 6 Apply your argumentation skill to an energy transition game in ITC's Spatial Group Decision Room

LO 7 Appreciate the value of spatial information and a spatial group decision room in a policy activity in terms of possibilities and limitations

ALLOCATED TIME PER TEACHING AND LEARNING METHOD

Teaching / learning method	Hours
Lecture	7
Supervised practical	7
Self-study	13
Written/oral test	1

RELATION OF LEARNING OUTCOMES (LO) OF THE COURSE WITH THE PROGRAMME LEARNING OUTCOMES

	Learning outcomes (LO) of the course: The student will be able to...	**1**	**2**	**3**	**4**	**5**	**6**	**7**
LO 1	Recognize different models of policy change in policy practice							
LO 2	Understand the role policy analysis and evidence can, ought and is playing, in policy practice, considering the ethics and framing in policy analysis							
LO 3	Structure and frame policy problems							
LO 4	Audit policy outcomes							
LO 5	Analyse and develop policy arguments							
LO 6	Apply your argumentation skill to an energy transition game in ITC's Spatial Group Decision Room							
LO 7	Appreciate the value of spatial information and a spatial group decision room in a policy activity in terms of possibilities and limitations							

SPATIAL MULTI-CRITERIA ANALYSIS (SPG2.C)

Course	**201900079**
Period	14 November 2022 - 03 February 2023
Course coordinator	

INTRODUCTION
Eight choice topics are offered in the second quartile to provide the student with the theoretical background on scientific disciplines addressed in case study project 2 on Food and Water Security. Each choice topic has a study load of 28 hours and focuses on one of the three core knowledge domains of the Spatial Engineering Master's programme, namely Spatial Planning and Governance, Technical Engineering and Spatial Information Sciences. The choice topics contribute to the first learning outcome formulated at case study project level.

Detailed descriptions, viz. content and learning outcomes, of the individual choice topics are given on the following pages. Students choose a total of three choice topics.

Spatial Planning and Governance (SPG)
SPG2.A: Markets and Value Chain Analysis
SPG2.B: Evidence-based Policy Analysis
SPG2.C: Spatial Multi-criteria Analysis

Technical Engineering (TE)
TE2.A: Systems Analysis
TE2.B: Dynamic Modelling

Spatial Information Sciences (SIS)
SIS2.A: Remote Sensing in General
SIS2.B: Image Classification
SIS2.C: Spatial Statistics

The text below is applicable to **SPG2.C: Spatial Multi-criteria Analysis**

The decision-making process in land use planning and environmental assessment and management is rather complex. Spatial decision support (SDS) tools, like spatial multi-criteria evaluation (SMCE), can help to identify and structure the problem(s), to find possible solutions, to evaluate the proposed solutions, and to monitor and evaluate the development. In this course section the student will learn the basic concepts and principles of SMCE.
The tool will be demonstrated using a case study on the selection of optimal locations for a waste disposal site.

CONTENT

The SMCE process exists of four stages, which students will go through step-by-step using a set of interactive presentations and related exercises:

1. Introduction on SMCE and development of a criterion tree.
   In this section students will acquire a basic knowledge on the concept of Spatial Multi Criteria evaluation (SMCE), how to define objectives, criteria and indicators, explain the difference between constraints and factors and how to construct a criterion tree using ILWIS-SMCE.
2. Standardization
   After developing the criterion tree, students will continue with the Multi Criteria Analysis (MCA) phases in ILWIS-SMCE. This section of the course will deal with standardization. Students will learn why standardization is needed, what type of standardization methods can be used and to apply different standardization methods.
3. Assignment of weights
   How important are the different criteria? After standardization, students will now continue with the assignment of weights as part of the Multi Criteria Analysis (MCA) in ILWIS-SMCE. The student will explore and apply different types of weighting methods, incorporate divers stakeholder preferences and create different policy visions.
4. Composite index or suitability maps
   What are optimal locations for a waste disposal site? After standardization and the assignment of weights, students will learn how to create optimal locations for a waste disposal site according to the five different policy visions they created in the previous section. Students will compare the different visions maps. As part of consensus building among all stakeholders, students will also observe how to create a map showing optimal locations for a waste disposal site common to all five visions.

TEACHING AND LEARNING APPROACH

The course will be 'problem-driven', based on learning by doing. Teaching will be based on (interactive) presentations, supervised and un-supervised practicals and plenary discussions

TESTS

Written test

ENTRY REQUIREMENTS

Basic knowledge in GIS, Participation in case study project 1

LEARNING OUTCOMES

Upon completion of this course, the student is able to:

LO 1 Explain the concept of Spatial Multi Criteria Evaluation (SMCE)

LO 2 Construct a criterion tree using ILWIS-SMCE

LO 3 Apply standardization

LO 4 Assign weights to criteria and formulate policy visions

LO 5 Show optimal locations for a waste disposal site for different policy visions

ALLOCATED TIME PER TEACHING AND LEARNING METHOD

Teaching / learning method	Hours
Lecture	6
Supervised practical	4
Self-study	13
Tutorial	4
Written/oral test	1

RELATION OF LEARNING OUTCOMES (LO) OF THE COURSE WITH THE PROGRAMME LEARNING OUTCOMES

	Learning outcomes (LO) of the course: The student will be able to...	**1**	**2**	**3**	**4**	**5**	**6**	**7**
LO 1	Explain the concept of Spatial Multi Criteria Evaluation (SMCE)							
LO 2	Construct a criterion tree using ILWIS-SMCE							
LO 3	Apply standardization							
LO 4	Assign weights to criteria and formulate policy visions							
LO 5	Show optimal locations for a waste disposal site for different policy visions							

SYSTEMS ANALYSIS (TE2.A)

Course	**201800242**
Period	14 November 2022 - 03 February 2023
Course coordinator	

INTRODUCTION

Eight choice topics are offered in the second quartile to provide the student with the theoretical background on scientific disciplines addressed in case study project 2 on Food and Water Security. Each choice topic has a study load of 28 hours and focuses on one of the three core knowledge domains of the Spatial Engineering Master's programme, namely Spatial Planning and Governance, Technical Engineering and Spatial Information Sciences. The choice topics contribute to the first learning outcome formulated at case study project level.

Detailed descriptions, viz. content and learning outcomes, of the individual choice topics are given on the following pages. Students choose a total of three choice topics.

Spatial Planning and Governance (SPG)
SPG2.A: Markets and Value Chain Analysis
SPG2.B: Evidence-based Policy Analysis
SPG2.C: Spatial Multi-criteria Analysis

Technical Engineering (TE)
TE2.A: Systems Analysis
TE2.B: Dynamic Modelling

Spatial Information Sciences (SIS)
SIS2.A: Remote Sensing in General
SIS2.B: Image Classification
SIS2.C: Spatial Statistics

The text below is applicable to **TE2.A: Systems Analysis**

CONTENT

In this choice topic, students will learn to analyse systems in a systematic way. This will help to structure complex problems in a way that gives insight and can help in identifying the most urgent bottleneck in a system that need to be addressed. The choice topic connects to the choice topic on dynamical modelling where the concepts learned in this topic will be converted into computational models.

Topics that will be covered are:

- General systems theory;
- Systems analysis concepts,
- Conceptual modelling;
- Momenclature conventions;
- Soft systems methodology (7 stages, rich pictures, root definition, catwoe) for ‘wicked’ problems.

Within Conceptual modelling the following issues will be discussed:

- (Discover) subsystems;
- System properties;
- Hierarchy;
- Emergence.

TEACHING AND LEARNING APPROACH

In this course, students will learn the difference between various types of diagrams that are often used to analyses systems. Then, based on a provided case study, students are challenged in groups to create a conceptual Diagram, as one of the types of diagrams that are considered important. The final products of every group will be discussed in plenary sessions, using both feedback from fellow students (do they understand the message from the presented conceptual diagrams) and Staff (is the conceptual diagram logically built up, give the intricacies of the provided case study, and where is room for improvement).

The course will be assessed on the basis of a written test.

TESTS

Written test

ENTRY REQUIREMENTS

Participation in case study project 1.

LEARNING OUTCOMES

Upon completion of this course, the student is able to:

LO 1 Design conceptual diagrams illustrating how natural systems work and how humans influence them

ALLOCATED TIME PER TEACHING AND LEARNING METHOD

Teaching / learning method	Hours
Lecture	7
Supervised practical	7
Self-study	13
Written/oral test	1

TESTPLAN

		Learning Outcomes that are addressed in the test
	Learning outcomes (LO) of the course: The student will be able to...	**Written test**
LO 1	Design conceptual diagrams illustrating how natural systems work and how humans influence them	●
	Test type	Written test
	Weight of the test	100
	Individual or group test	Individual
	Type of marking	1-10
	Required minimum mark per test	
	Number of test opportunities per academic year	2

RELATION OF LEARNING OUTCOMES (LO) OF THE COURSE WITH THE PROGRAMME LEARNING OUTCOMES

	Learning outcomes (LO) of the course: The student will be able to...	**1**	**2**	**3**	**4**	**5**	**6**	**7**
LO 1	Design conceptual diagrams illustrating how natural systems work and how humans influence them		●		●			

DYNAMIC MODELLING (TE2.B)

Course	**201800247**
Period	14 November 2022 - 03 February 2023
Course coordinator	

INTRODUCTION

Eight choice topics are offered in the second quartile to provide the student with the theoretical background on scientific disciplines addressed in case study project 2 on Food and Water Security. Each choice topic has a study load of 28 hours and focuses on one of the three core knowledge domains of the Spatial Engineering Master's programme, namely Spatial Planning and Governance, Technical Engineering and Spatial Information Sciences. The choice topics contribute to the first learning outcome formulated at case study project level.

Detailed descriptions, viz. content and learning outcomes, of the individual choice topics are given on the following pages. Students choose a total of three choice topics.

Spatial Planning and Governance (SPG)
SPG2.A: Markets and Value Chain Analysis
SPG2.B: Evidence-based Policy Analysis
SPG2.C: Spatial Multi-criteria Analysis

Technical Engineering (TE)
TE2.A: Systems Analysis
TE2.B: Dynamic Modelling

Spatial Information Sciences (SIS)
SIS2.A: Remote Sensing in General
SIS2.B: Image Classification
SIS2.C: Spatial Statistics

The text below is applicable to **TE2.B: Dynamic Modelling**

CONTENT

The course will teach how to simulate dynamical systems. The focus will be on dynamics in ecological systems. For example grassland ecosystems, where grazers consume a large portion of the vegetation. But modelling other types of systems will also be discussed. Ordinary differential equations and their discrete implementations will be simulated using InsightMaker as a platform. We will also shortly discuss Cellular Automata and the use of remote sensing to create or check these models.

TEACHING AND LEARNING APPROACH

Lectures, exercises, discussion, literature

TESTS

Written test

ENTRY REQUIREMENTS

Participation in case study project 1

LEARNING OUTCOMES

Upon completion of this course, the student is able to:

LO 1 Describe what dynamical systems are

LO 2 Simulate dynamical systems by means of discrete simulation

LO 3 Formulate different types of equations to simulate ecosystem dynamics in a discrete way

LO 4 Interpret results of dynamical simulation models

ALLOCATED TIME PER TEACHING AND LEARNING METHOD

Teaching / learning method	Hours
Lecture	7
Supervised practical	7
Self-study	13
Written/oral test	1

TESTPLAN

		Learning Outcomes that are addressed in the test
	Learning outcomes (LO) of the course: The student will be able to...	**Written test**
LO 1	Describe what dynamical systems are	●
LO 2	Simulate dynamical systems by means of discrete simulation	●
LO 3	Formulate different types of equations to simulate ecosystem dynamics in a discrete way	●
LO 4	Interpret results of dynamical simulation models	●
	Test type	Written test
	Weight of the test	100
	Individual or group test	Individual
	Type of marking	1-10
	Required minimum mark per test	
	Number of test opportunities per academic year	2

RELATION OF LEARNING OUTCOMES (LO) OF THE COURSE WITH THE PROGRAMME LEARNING OUTCOMES

	Learning outcomes (LO) of the course: The student will be able to...	1	2	3	4	5	6	7
LO 1	Describe what dynamical systems are	●						
LO 2	Simulate dynamical systems by means of discrete simulation	●						
LO 3	Formulate different types of equations to simulate ecosystem dynamics in a discrete way		●					
LO 4	Interpret results of dynamical simulation models				●	●		

HUMAN-INDUCED EARTH MOVEMENT

Course	**201800250**
Period	06 February 2023 - 21 April 2023
EC	15

Course coordinator

INTRODUCTION

This study unit focuses on the wicked problem of human-induced earth movements: Extraction of groundwater, salt, natural gas and other resources, or cracking of shale, often may result in subsidence of the Earth’s surface or earthquakes. It is an increasing problem in the Netherlands (Groningen) and in many areas around the world: 29 earthquakes per year in the central USA (USGS, 2016), massive subsidence in several mega-cities in the world (Jakarta, Bangkok, Beijing). Solutions are not readily available, but studying these phenomena and quantifying their effects on our living environment requires the complex 3D analysis of large datasets. For instance, earthquake wave propagation can be modelled using seismic data and knowledge of the 3D composition of the material through which the waves travel. The societal dimension requires consideration of participative approaches to governance and planning, including the use of new data sources and information channels such as volunteered geographic information, social media, and citizen science, in addition to authoritative databases such as the Dutch DINO.

CONTENT

An important element of the study unit is project work in groups. Each group will take the role of a stakeholder, and develop an intervention that addresses the wicked problem from that stakeholder's perspective (although the interests of all relevant stakeholders need to be considered). All project groups will work on wicked problems caused by human-induced earth movements. However, the exact type of problem and the geographic scope of the case study will be determined during the first week of the study unit. One example for a case study are the human-induced earthquakes in the Dutch province of Groningen:

The northeast of the Netherlands has extensive subsurface gas fields. The largest and most actively exploited gas field is situated beneath the territory of the province of Groningen. Besides economic benefits for the region and the Netherlands as a whole, the gas exploitation also results in induced subsidence and earthquakes. The earthquakes have caused considerable damage at several locations in the region. This has fueled a public and political debate about the future of the gas exploitation in the area and the compensation of house owners for damaged property. Several distinct stakeholder groups in this debate argue for continuation, reduction, or complete stop of gas exploitation.

TEACHING AND LEARNING APPROACH

The study unit has a similar structure and similar components as the previous study units: Initial keynotes and introductory lectures, six choice topics, and supporting materials (e.g. data sets, tutorials). However, as part of the increased difficulty and wickedness level, there will be fewer supporting materials than in previous study units. Students are expected to be able to find the necessary material.

During the first week, the students form project groups that are going to represent one stakeholder (e.g., municipality, citizens, …), and will then during the following weeks continue to develop intervention(s) that support their particular stakeholder's interests. However, for successfully addressing the wickedness of the problem, they will also have to take the arguments from other stakeholders into account, and consider a wide range of factors, e.g. subsurface conditions, technical aspects, and social, planning, and economic issues. During the penultimate week, the project groups will present and defend their proposed interventions in a simulated public debate. As final deliverables, they will prepare a technical/scientific report, a short reflection on project work, and a document for the general public. The latter can take different forms (brochure, video, website), as appropriate for the type of the proposed intervention.

Indicative schedule of activities (a detailed schedule will be available at the beginning of the study unit):

Project Inception Phase (weeks 1-4): students join a project group and choose a concrete stakeholder to represent during the project (exact modalities of this depending on number of students, to be communicated at the beginning of the study unit), followed by teacher-assisted group work (self-study materials, flipped class-room lectures, supervised workshops, tutorials, resulting in mid-term poster) and individual work (choice topics including written test).

Project Implementation Phase (weeks 5-8): project work in groups (teacher assistance through discussion forums, question and answer hours) with some individual activities (tutorials, skill learning lines).

Project Presentation and Assessment Phase (weeks 9-10): presentation of project work in (e.g., in simulated public debate) and individual and group assessment (PDP, oral tests, final project reports).

TESTS

The study unit is the whole project (15 EC). The summative assessment has two group-based and two individual components, with a combined weight of 40% and 60% respectively. In addition, there will be formative assessments in the form of short presentations of each project group on their progress and a specific aspect of their stakeholder group's perspective. These formative assessments will help to ensure and steer a project group's progress.

The four summative components are:

1. Written test (20%, individual) on core knowledge acquired in choice topics: Students choose three of the offered topics (study load 1 ECTS each), and the knowledge acquired during these choice topics will be tested by means of a written test.
2. Mid-term poster (15%, group) on the case study project: The assessment of the mid-term poster focuses on the framing of the problem, i.e. translation of the wicked problem to a manageable research project through formulation of a research problem and research questions. The poster will be presented in a poster session, but only the poster itself will be graded. For the corresponding presentation, the project group will receive formative feedback.
3. Final report (25% of final mark, group) on the case study project results: The group submits a final report that includes three parts: a scientific report (the main part), a short communication aimed at the general public, and a short reflection on the project's process.
4. Oral test (40% of final mark, individual) on all elements of this academic quarter: The oral test is composed of a short pitch by the student emphasizing the main parts of the project, his or her own contribution, and the implementation of acquired knowledge within the project. Every individual student can decide freely on the format of this pitch. After the pitch, the questions by the examiners will address and focus on the student's individual learning during the case study, taking into account the pitch's content, all project components, the implementation of choice topic knowledge in the project, the student's contribution to the project, and the skills learning lines.

Students receive a more detailed test plan including a rubric with the start of the study unit. The individual assessments can be repeated during a second test opportunity.

Students will continue to provide insight into their study choices, participation and progress through a Personal Development Portfolio (PDP). More information on the PDP is available at course level. Students become eligible to take the oral test only when the required PDP information is complete and submitted on Canvas.

ENTRY REQUIREMENTS

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LEARNING OUTCOMES

Upon completion of this course, the student is able to:

LO 1 Explain processes in the case study area that make it susceptible to human-induced earth movements

LO 2 Differentiate multiple governance perspectives on human-induced earth movement

LO 3 Collect and process spatio-temporal data and information required for the analysis and planned intervention, considering multiple sources

LO 4 Develop a Personal Development Portfolio that identifies and describes gaps in own knowledge

LO 5 Apply the 'wicked problem' framework to the analysis of human-induced earth movement problem in the case study area, using all three knowledge domains

LO 6 Plan a project, formulating SMART objectives and demonstrating project and time management skills

LO 7 Reflect on and justify the choice of methods and data, taking into account reproducibility, uncertainty, error propagation, sensitivity, and model robustness (among others) where appropriate

LO 8 Compare systematically multiple possible interventions for the case study area and analyse strengths, weaknesses, costs, and benefits

LO 9 Systematically analyze common and opposing interests of relevant stakeholder groups and their policy and financial constraints

LO 10 Evaluate and reflect on professional and team roles of project group members, including his/her own

LO 11 Convey information and results effectively using written, visual, and oral tools to peers, professionals and a broader public, in particular taking into account the wickedness of the problem.

LO 12 Evaluate and account for own cultural sensitivity and ethical values in project process and outcomes

ALLOCATED TIME PER TEACHING AND LEARNING METHOD

Teaching / learning method	Hours
Lecture	50
Supervised practical	80
Individual assignment	30
Group assignment	160
Self-study	96
Written/oral test	4

TESTPLAN

		Learning Outcomes that are addressed in the test			
	Learning outcomes (LO) of the course: The student will be able to...	**Mid-term poster**	**Core knowledge test**	**Final report**	**Final oral test**
LO 1	Explain processes in the case study area that make it susceptible to human-induced earth movements		●	●	
LO 2	Differentiate multiple governance perspectives on human-induced earth movement		●	●	
LO 3	Collect and process spatio-temporal data and information required for the analysis and planned intervention, considering multiple sources		●	●	
LO 4	Develop a Personal Development Portfolio that identifies and describes gaps in own knowledge				●
LO 5	Apply the 'wicked problem' framework to the analysis of human-induced earth movement problem in the case study area, using all three knowledge domains	●		●	●
LO 6	Plan a project, formulating SMART objectives and demonstrating project and time management skills	●		●	●
LO 7	Reflect on and justify the choice of methods and data, taking into account reproducibility, uncertainty, error propagation, sensitivity, and model robustness (among others) where appropriate			●	●
LO 8	Compare systematically multiple possible interventions for the case study area and analyse strengths, weaknesses, costs, and benefits			●	●
LO 9	Systematically analyze common and opposing interests of relevant stakeholder groups and their policy and financial constraints	●		●	●
LO 10	Evaluate and reflect on professional and team roles of project group members, including his/her own			●	●
LO 11	Convey information and results effectively using written, visual, and oral tools to peers, professionals and a broader public, in particular taking into account the wickedness of the problem.	●		●	●
LO 12	Evaluate and account for own cultural sensitivity and ethical values in project process and outcomes				●

		Learning Outcomes that are addressed in the test			
	Learning outcomes (LO) of the course: The student will be able to...	**Mid-term poster**	**Core knowledge test**	**Final report**	**Final oral test**
	Test type	Presentation	Written test	Report	Oral test
	Weight of the test	15	20	25	40
	Individual or group test	Group	Individual	Group	Individual
	Type of marking	1-10	1-10	1-10	1-10
	Required minimum mark per test				
	Number of test opportunities per academic year	1	2	1	2

RELATION OF LEARNING OUTCOMES (LO) OF THE COURSE WITH THE PROGRAMME LEARNING OUTCOMES

	Learning outcomes (LO) of the course: The student will be able to...	1	2	3	4	5	6	7
LO 1	Explain processes in the case study area that make it susceptible to human-induced earth movements							
LO 2	Differentiate multiple governance perspectives on human-induced earth movement							
LO 3	Collect and process spatio-temporal data and information required for the analysis and planned intervention, considering multiple sources							
LO 4	Develop a Personal Development Portfolio that identifies and describes gaps in own knowledge							
LO 5	Apply the ‘wicked problem’ framework to the analysis of human-induced earth movement problem in the case study area, using all three knowledge domains							
LO 6	Plan a project, formulating SMART objectives and demonstrating project and time management skills							
LO 7	Reflect on and justify the choice of methods and data, taking into account reproducibility, uncertainty, error propagation, sensitivity, and model robustness (among others) where appropriate							

	Learning outcomes (LO) of the course: The student will be able to...	1	2	3	4	5	6	7
LO 8	Compare systematically multiple possible interventions for the case study area and analyse strengths, weaknesses, costs, and benefits							
LO 9	Systematically analyze common and opposing interests of relevant stakeholder groups and their policy and financial constraints							
LO 10	Evaluate and reflect on professional and team roles of project group members, including his/her own							
LO 11	Convey information and results effectively using written, visual, and oral tools to peers, professionals and a broader public, in particular taking into account the wickedness of the problem.							
LO 12	Evaluate and account for own cultural sensitivity and ethical values in project process and outcomes							

ACADEMIC AND RESEARCH SKILLS

Course	**201800253**
Period	07 February 2022 - 21 April 2023
Course coordinator	

INTRODUCTION

The skills learning lines have an important place in the curriculum and are an integral part of the final qualifications. Of particular relevance it supports

LO 2:Does research in a purposeful and methodological way

LO 4:Has an academic approach to the development, justified use and validation of theories and models

LO 5:Is competent in reasoning, reflection, and judgment

LO 6:Is competent in cooperation and communication

In the academic skills learning line we focus on developing the skills that students will need to succeed in this master program as well as their future careers. These include skills related to the structuring, organising, and communication of their academic work and ideas.

For the academic skills learning line an expert teacher is responsible for ensuring a coherent incremental education programme over the course of the Spatial Engineering curriculum. In each case study project students will draw on these skills learning lines.

The study load for the academic skills learning lines is estimated at 14 hours per quartile for the first 3 quartiles.

CONTENT

In this quartile the student will learn to:

- Collect and analyse information from stakeholders through interviews and questionnaires;
- Recognise the important aspects for delivering effective on-line/face-to-face presentations
- Understand how to give and accept peer feedback for improvement

TEACHING AND LEARNING APPROACH

Tutorials, face-to-face lectures and feedback on skills

TESTS

Project report and oral test

ENTRY REQUIREMENTS

- Personal plan for development and portfolio from case study projects 1 and 2
- Participation in case study projects 1 and 2

LEARNING OUTCOMES

Upon completion of this course, the student is able to:

LO 1 • Collect and analyse information from stakeholders through interviews and questionnaires;

LO 2 • Recognise the important aspects for delivering effective on-line/face-to-face presentations

LO 3 • Understand how to give and accept peer feedback for improvement

ALLOCATED TIME PER TEACHING AND LEARNING METHOD

Teaching / learning method	Hours
Lecture	2
Tutorial	8
Self-study	4

RELATION OF LEARNING OUTCOMES (LO) OF THE COURSE WITH THE PROGRAMME LEARNING OUTCOMES

	Learning outcomes (LO) of the course: The student will be able to...	**1**	**2**	**3**	**4**	**5**	**6**	**7**
LO 1	• Collect and analyse information from stakeholders through interviews and questionnaires;	●						
LO 2	• Recognise the important aspects for delivering effective on-line/face-to-face presentations						●	
LO 3	• Understand how to give and accept peer feedback for improvement						●	

INTERNATIONAL AND INTERCULTURAL COMPETENCES

Course	201800252
Period	06 February 2023 - 21 April 2023
Course coordinator	

INTRODUCTION

The skills learning lines have an important place in the curriculum and are an integral part of the final qualifications (especially the 1st , 6th and 7th). There are three skills learning lines:
1. **International and Intercultural Competences**
2. **Academic and Research Skills**
3. **Project Management and Teamwork Skills**

For each of the skills learning lines an expert teacher is responsible for ensuring a coherent incremental education programme over the course of the Spatial Engineering curriculum. In each case study project students will need to draw on these skills learning lines.

The study load for the three skills learning lines is estimated at a total of 42 hours, 14 hours each.

CONTENT

In this quartile the student will learn about preparing for social primary data collection and how cultural patterns influence risk perception and framing.

TEACHING AND LEARNING APPROACH

Lecture, supervised practical and self-study

TESTS

Skills learning lines form an integral part of the case study project. For this quartile, a one page Essay Assignment has to be submitted. The Essay Assignment takes the notions of risk perception and framing, and strategies used to tackle policy problems into account.

ENTRY REQUIREMENTS

- Personal plan for development and portfolio from case study projects 1 and 2
- Participation in case study projects 1 and 2

LEARNING OUTCOMES

Upon completion of this course, the student is able to:

LO 1 Describe framing (problem, cause, solution) and give examples of risk framing;

LO 2 Describe cultural patterns in the perception of risks

LO 3 Discuss strategies for collecting social primary data when tackling policy problems

ALLOCATED TIME PER TEACHING AND LEARNING METHOD

Teaching / learning method	Hours
Lecture	8
Self-study	6

TESTPLAN

		Learning Outcomes that are addressed in the test
	Learning outcomes (LO) of the course: The student will be able to...	**Test**
LO 1	Describe framing (problem, cause, solution) and give examples of risk framing;	●
LO 2	Describe cultural patterns in the perception of risks	●
LO 3	Discuss strategies for collecting social primary data when tackling policy problems	●
	Test type	Essay
	Weight of the test	0
	Individual or group test	Individual
	Type of marking	Pass/Fail
	Required minimum mark per test	0
	Number of test opportunities per academic year	1

RELATION OF LEARNING OUTCOMES (LO) OF THE COURSE WITH THE PROGRAMME LEARNING OUTCOMES

	Learning outcomes (LO) of the course: The student will be able to...	**1**	**2**	**3**	**4**	**5**	**6**	**7**
LO 1	Describe framing (problem, cause, solution) and give examples of risk framing;							●
LO 2	Describe cultural patterns in the perception of risks							●
LO 3	Discuss strategies for collecting social primary data when tackling policy problems							●

PROJECT MANAGEMENT AND TEAMWORK SKILLS

Course	**201800254**
Period	07 February 2022 - 21 April 2023
Course coordinator	

INTRODUCTION

The skills learning lines have an important place in the curriculum and are an integral part of the final qualifications (especially the 1st , 6th and 7th). There are three skills learning lines:

1. **International and Intercultural Competences**
2. **Academic and Research Skills**
3. **Project Management and Teamwork Skills**

For each of the skills learning lines an expert teacher is responsible for ensuring a coherent incremental education programme over the course of the Spatial Engineering curriculum. In each case study project students will need to draw on these skills learning lines.

The study load for the three skills learning lines is estimated at a total of 42 hours, 14 hours each.

CONTENT

In this quartile the student will learn to:

- To independently develop a project plan using project management support tools;
- To evaluate the group's progress with reference to the project plan, identify deviations and look mitigation options (if needed);
- The basics of project budgeting.

TEACHING AND LEARNING APPROACH

Lectures, formative feedback at planning stage, self-study

TESTS

Project plan (proposal), self-assessment (PDP) and oral test

ENTRY REQUIREMENTS

- Personal plan for development and portfolio from case study projects 1 and 2
- Successful completion of case study projects 1 and 2

RELATION OF LEARNING OUTCOMES (LO) OF THE COURSE WITH THE PROGRAMME LEARNING OUTCOMES

Learning outcomes (LO) of the course: The student will be able to...	1	2	3	4	5	6	7

3D/TEMPORAL VISUALIZATIONS IN COLLABORATIVE ENVIRONMENT (SIS3.A)

Course	201800257
Period	06 February 2023 - 21 April 2023
Course coordinator	

INTRODUCTION

Six choice topics are offered in the third quartile to provide students with the theoretical background on scientific disciplines addressed in case study project 3 on Human-induced Earth Movement. Each choice topic has a study load of 28 hours and focuses on one of the three core knowledge domains of the Spatial Engineering Master's programme, namely Spatial Planning and Governance, Technical Engineering and Spatial Information Sciences.

Detailed descriptions, viz. content and learning outcomes, of the individual choice topics are given on the following pages. Students choose a total of three choice topics.

Spatial Planning and Governance (SPG)
SPG3.A: Spatial Knowledge Management
SPG3.B: Rights and Restrictions in the Built Environment

Technical Engineering (TE)
TE3.A: Structural Vulnerability of the Built Environment
TE3.B: Seismic Hazard above Gas Reservoirs (Regional Scale)

Spatial Information Science (SIS)
SIS3.A: 3D/Temporal Visualizations in Collaborative Environments
SIS3.B: Crowdsourcing, Volunteered Geographic Information, and Citizen Science

The text below is applicable to **SIS3.A: 3D/Temporal Visualizations in Collaborative Environments**

CONTENT

Maps come into action as soon as location is involved. However, to visualize changes and the dynamics in our multi-dimensional society sometimes requires solutions beyond the standalone 'traditional' 2D map. Not only interaction is required to view multi-dimensional objects from different angles or to move along the timeline to see change in action, but also options to see alternatives and to reason.

Mapping the third dimension requires knowledge on the when and how to apply depth cues in the visualization and / or which viewing environment to use. Mapping time requires one to go beyond the snapshot-based approach to incorporate processes. This can be combined in an interactive geovisualization environment.

Topics related to subsurface and dynamic (temporal) phenomena:

- 3D (examples, map types, and perception/depth cues);
- Time (what is time/change, representation environments, data analysis and design, map types);
- Geovisualization (context scientific/info/data visualization, (geo)visual analytics;

TEACHING AND LEARNING APPROACH

Project work supported by mini-lectures

TESTS

Written test

ENTRY REQUIREMENTS

Participation in case study projects 1 and 2

LEARNING OUTCOMES

Upon completion of this course, the student is able to:

LO 1 Understand the requirements of the 3d viewing environment and in relation to this be able to explain the application of depth cues and their different perceptions properties

LO 2 Be able to select appropriate graphic representation to map changes based on the different notions of time

LO 3 Understand what geovisualization can do in a collaborative working environment

ALLOCATED TIME PER TEACHING AND LEARNING METHOD

Teaching / learning method	Hours
Lecture	6
Supervised practical	6
Self-study	15
Written/oral test	1

RELATION OF LEARNING OUTCOMES (LO) OF THE COURSE WITH THE PROGRAMME LEARNING OUTCOMES

	Learning outcomes (LO) of the course: The student will be able to...	**1**	**2**	**3**	**4**	**5**	**6**	**7**
LO 1	Understand the requirements of the 3d viewing environment and in relation to this be able to explain the application of depth cues and their different perceptions properties							
LO 2	Be able to select appropriate graphic representation to map changes based on the different notions of time							
LO 3	Understand what geovisualization can do in a collaborative working environment							

CROWDSOURCING, VOLUNTEERED GEOGRAPHIC INFORMATION, AND CITIZEN SCIENCE (SIS3.B)

Course	**201800258**
Period	06 February 2023 - 21 April 2023
Course coordinator	

INTRODUCTION

Six choice topics are offered in Q3 to provide students with the theoretical background on scientific disciplines addressed in case study project 3 on Human-induced Earth Movement. Each choice topic has a study load of 28 hours and focuses on one of the three core knowledge domains of the Spatial Engineering Master's programme, namely Spatial Planning and Governance, Technical Engineering and Spatial Information Sciences.

Detailed descriptions, viz. content and learning outcomes, of the individual choice topics are given on the following pages. Students choose a total of three choice topics.

Spatial Planning and Governance (SPG)
SPG3.A: Spatial Knowledge Management
SPG3.B: Rights and Restrictions in the Built Environment

Technical Engineering (TE)
TE3.A: Structural Vulnerability of the Built Environment
TE3.B: Seismic Hazard above Gas Reservoirs (Regional Scale)

Spatial Information Science (SIS)
SIS3.A: 3D/Temporal Visualizations in Collaborative Environments
SIS3.B: Crowdsourcing, Volunteered Geographic Information, and Citizen Science

The text below is applicable to **SIS3.B: Crowdsourcing, Volunteered Geographic Information, and Citizen Science**

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 choice topic gives an overview of its history and new developments, focusing on examples of successful and unsuccessful projects to identify criteria for sustainable crowdsourcing or volunteering, including issues of privacy and ethical research. For the case study project, it is particularly relevant for eliciting and arguing the needs, interests, and positions of any stakeholder that incorporates or directly works with the public.

TEACHING AND LEARNING APPROACH

The topic is taught in thematically grouped study units. Each study unit usually consists of reading a key paper and discussing its content, a short lecture on key concepts, followed by practical lab work to experiment with software tools and data, an opportunity for self-regulated learning (i.e. students decide individually whether to deepen knowledge through reading or continuing with practical work), and concluded with a brief recap at the beginning of the next study unit.

TESTS

Written test

ENTRY REQUIREMENTS

Participation in case study projects 1 and 2

LEARNING OUTCOMES

Upon completion of this course, the student is able to:

LO 1 distinguish different types of participation and describe their (dis)advantages

LO 2 discuss important concepts related community-building and research ethics

LO 3 distinguish different participatory data sources and describe their (dis)advantages

LO 4 find, choose, and customize appropriate data collection tools

LO 5 [optional, depending on student interest and skills]

implement simple and typical data handling (pre-processing) tasks

LO 6 argue and demonstrate representativeness and quality of a crowdsourced or volunteered data set

LO 7 discuss and ensure basic reproducibility and sustainability of crowdsourced or participatory research

ALLOCATED TIME PER TEACHING AND LEARNING METHOD

Teaching / learning method	Hours
Lecture	6
Supervised practical	6
Self-study	15
Written/oral test	1

RELATION OF LEARNING OUTCOMES (LO) OF THE COURSE WITH THE PROGRAMME LEARNING OUTCOMES

	Learning outcomes (LO) of the course: The student will be able to...	1	2	3	4	5	6	7
LO 1	distinguish different types of participation and describe their (dis)advantages	●	●		●	●		
LO 2	discuss important concepts related community-building and research ethics		●	●		●	●	●
LO 3	distinguish different participatory data sources and describe their (dis)advantages	●	●		●			
LO 4	find, choose, and customize appropriate data collection tools		●		●			
LO 5	[optional, depending on student interest and skills] implement simple and typical data handling (pre-processing) tasks	●			●			
LO 6	argue and demonstrate representativeness and quality of a crowdsourced or volunteered data set	●	●	●	●	●		●
LO 7	discuss and ensure basic reproducibility and sustainability of crowdsourced or participatory research		●	●		●	●	●

SPATIAL KNOWLEDGE MANAGEMENT (SPG3.A)

Course	**201800259**
Period	06 February 2023 - 21 April 2023
Course coordinator	

INTRODUCTION

Six choice topics are offered in the third quartile to provide students with the theoretical background on scientific disciplines addressed in case study project 3 on Human-induced Earth Movement. Each choice topic has a study load of 28 hours and focuses on one of the three core knowledge domains of the Spatial Engineering Master's programme, namely Spatial Planning and Governance, Technical Engineering and Spatial Information Sciences.

Detailed descriptions, viz. content and learning outcomes, of the individual choice topics are given on the following pages. Students choose a total of three choice topics.

Spatial Planning and Governance (SPG)
SPG3.A: Spatial Knowledge Management
SPG3.B: Rights and Restrictions in the Built Environment

Technical Engineering (TE)
TE3.A: Structural Vulnerability of the Built Environment
TE3.B: Seismic Hazard above Gas Reservoirs (Regional Scale)

Spatial Information Science (SIS)
SIS3.A: 3D/Temporal Visualizations in Collaborative Environments
SIS3.B: Crowdsourcing, Volunteered Geographic Information, and Citizen Science

The text below is applicable to **SPG3.A: Spatial Knowledge Management**

CONTENT

This choice topic introduces students to the politics of spatial knowledge management in relation to the spatial development and governance of an area. It discusses different types of spatial knowledge and how knowledge is produced, used, shared or contested by different actors or a network of actors, with or without the help of geo-spatial data, methods and tools. It puts particular emphasis on the critical reading of spatial knowledge processes and products in area development. It includes critical GIS theoretical perspectives as well concrete illustrative cases emerged from practice.

Learning outcomes
Upon completion of this choice topic, the student will be able to:

- Describe and identify different (spatial) knowledge types, ranging from tacit knowledge to scientific knowledge;
- Analyse the actors and actor networks who produce, use, share or contest spatial knowledge;
- Analyse knowledge building processes and underlying framings;
- Analyse spatial knowledge products (e.g. zoning maps) with respect to choices made with regard to data, classifications, generalizations, boundaries, and cartographic representations;
- Sketch the spatial knowledge landscape with respect to the Groningen case study.

TEACHING AND LEARNING APPROACH

na

TESTS

Written test

ENTRY REQUIREMENTS

Participation in case study projects 1 and 2

ALLOCATED TIME PER TEACHING AND LEARNING METHOD

Teaching / learning method	Hours
Lecture	6
Supervised practical	6
Self-study	15
Written/oral test	1

RELATION OF LEARNING OUTCOMES (LO) OF THE COURSE WITH THE PROGRAMME LEARNING OUTCOMES

Learning outcomes (LO) of the course: The student will be able to...	1	2	3	4	5	6	7

RIGHTS AND RESTRICTIONS IN THE BUILT ENVIRONMENT (SPG3.B)

Course	**201800260**
Period	06 February 2023 - 21 April 2023
Course coordinator	

INTRODUCTION

Six choice topics are offered in the third quartile to provide students with the theoretical background on scientific disciplines addressed in case study project 3 on Human-induced Earth Movement. Each choice topic has a study load of 28 hours and focuses on one of the three core knowledge domains of the Spatial Engineering Master's programme, namely Spatial Planning and Governance, Technical Engineering and Spatial Information Sciences.

Detailed descriptions, viz. content and learning outcomes, of the individual choice topics are given on the following pages. Students choose a total of three choice topics.

Spatial Planning and Governance (SPG)
SPG3.A: Spatial Knowledge Management
SPG3.B: Rights and Restrictions in the Built Environment

Technical Engineering (TE)
TE3.A: Structural Vulnerability of the Built Environment
TE3.B: Seismic Hazard above Gas Reservoirs (Regional Scale)

Spatial Information Science (SIS)
SIS3.A: 3D/Temporal Visualizations in Collaborative Environments
SIS3.B: Crowdsourcing, Volunteered Geographic Information, and Citizen Science

The text below is applicable to **SPG3.B: Rights and Restrictions in the Built Environment**

CONTENT

An introduction to the legal frameworks around the built environment. Generic principles and some Dutch examples are given. Focus is on the difference and connections between private and public law, between property rights (work against all) and obligations (work between parties), between policy intentions and legal instruments, and between general and individual interests. Especially in the context of changes in (allowed) land use, access to land and other natural resources, and the consequences of those for property rights holders, other affected parties, and/or the general interest.

Learning outcomes
Upon completion of this choice topic, the student will be able to:

- Distinguish between private and public law, as well as between general and individual interests;
- Distinguish between property rights, obligations and policy statements;
- Analyse a document whether it is 'just' policy, or includes instruments with legal effects;
- Compare the position of property rights holder and other stakeholders in policy preparation as well as during implementation;
- Analyse whether those that are affected negatively by an activity, a plan or a policy's implementation have a legal recourse;
- Sketch the legal dilemmas of the gas production-induced earthquakes in Groningen.

TEACHING AND LEARNING APPROACH

na

TESTS

Written test

ENTRY REQUIREMENTS

Participation in case study projects 1 and 2

ALLOCATED TIME PER TEACHING AND LEARNING METHOD

Teaching / learning method	Hours
Lecture	6
Supervised practical	6
Self-study	15
Written/oral test	1

RELATION OF LEARNING OUTCOMES (LO) OF THE COURSE WITH THE PROGRAMME LEARNING OUTCOMES

Learning outcomes (LO) of the course: The student will be able to...	1	2	3	4	5	6	7

STRUCTURAL VULNERABILITY OF THE BUILT ENVIRONMENT (TE3.A)

Course	**201800255**
Period	07 February 2022 - 21 April 2023
Course coordinator	

INTRODUCTION

Six choice topics are offered in the third quartile to provide students with the theoretical background on scientific disciplines addressed in case study project 3 on Human-induced Earth Movement. Each choice topic has a study load of 28 hours and focuses on one of the three core knowledge domains of the Spatial Engineering Master's programme, namely Spatial Planning and Governance, Technical Engineering and Spatial Information Sciences.

Detailed descriptions, viz. content and learning outcomes, of the individual choice topics are given on the following pages. Students choose a total of three choice topics.

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Technical Engineering (TE)
TE3.A: Structural Vulnerability of the Built Environment
TE3.B: Seismic Hazard above Gas Reservoirs (Regional Scale)

Spatial Information Science (SIS)
SIS3.A: 3D/Temporal Visualizations in Collaborative Environments
SIS3.B: Crowdsourcing, Volunteered Geographic Information, and Citizen Science

The text below is applicable to **TE3.A: Structural Vulnerability of the Built Environment**

CONTENT

In this choice topic, the soil site effects caused by human-induced subsidence will be presented. A very brief introduction to geomechanics, foundations, and structural engineering is given and the interactions between soil, foundation, and structure. This will allow the understanding of structural and non-structural damage of buildings. Students will be able to understand damage due to ground movements as a consequence of subsidence. The different causes for damage will be described, in order to determine the factors affecting the structural vulnerability. The use of UAVs (Unmanned Aerial Vehicles) to characterize the damage occurred to buildings and man-made objects will be presented briefly as well. Students will be shown how to capture images using UAV and how to extract useful information from the acquired images and the generated point clouds. Both manual and automated methods for damage detection will be presented and discussed.

TEACHING AND LEARNING APPROACH

Classes, self-study, literature study, practicals

TESTS

Written test

ENTRY REQUIREMENTS

Participation in case study projects 1 and 2

LEARNING OUTCOMES

Upon completion of this course, the student is able to:

LO 1 Explain the principal soil site effects related to gas extraction and human-induced earthquakes.

LO 2 Identify the causes of structural damage and the expected damage patterns.

LO 3 Determine the factors affecting the vulnerability of structures.

LO 4 Collect data using UAV and process UAV images in order to extract 2D and 3D information useful to estimate building damages.

ALLOCATED TIME PER TEACHING AND LEARNING METHOD

Teaching / learning method	Hours
Lecture	6
Supervised practical	6
Self-study	15
Written/oral test	1

RELATION OF LEARNING OUTCOMES (LO) OF THE COURSE WITH THE PROGRAMME LEARNING OUTCOMES

	Learning outcomes (LO) of the course: The student will be able to...	1	2	3	4	5	6	7
LO 1	Explain the principal soil site effects related to gas extraction and human-induced earthquakes.							
LO 2	Identify the causes of structural damage and the expected damage patterns.							
LO 3	Determine the factors affecting the vulnerability of structures.							
LO 4	Collect data using UAV and process UAV images in order to extract 2D and 3D information useful to estimate building damages.							

SEISMIC HAZARD ABOVE GAS RESERVOIRS (REGIONAL SCALE) (TE3.B)

Course	**201800256**
Period	06 February 2023 - 21 April 2023
Course coordinator	

INTRODUCTION

Six choice topics are offered in the third quartile to provide students with the theoretical background on scientific disciplines addressed in case study project 3 on Human-induced Earth Movement. Each choice topic has a study load of 28 hours and focuses on one of the three core knowledge domains of the Spatial Engineering Master's programme, namely Spatial Planning and Governance, Technical Engineering and Spatial Information Sciences.

Detailed descriptions, viz. content and learning outcomes, of the individual choice topics are given on the following pages. Students choose a total of three choice topics.

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Technical Engineering (TE)
TE3.A: Structural Vulnerability of the Built Environment
TE3.B: Seismic Hazard (Regional Scale)

Spatial Information Science (SIS)
SIS3.A: 3D/Temporal Visualizations in Collaborative Environments
SIS3.B: Crowdsourcing, Volunteered Geographic Information, and Citizen Science

The text below is applicable to **TE3.B: Seismic Hazard above Gas Reservoirs (Regional Scale)**

CONTENT

In this lecture series, students will learn the basics of seismic hazard analysis. Crustal motions slowly build up stress and strain in rock masses and when stress reaches a critical threshold due to the natural or human-induced factors, failure occurs along fault planes. Seismic waves are generated by this sudden release of energy associated with the rupturing event. In this lecture series, the different kinds of waves that originate from rupturing planes and their specific characteristics, in terms of motion and propagation, will be discussed. Knowledge of where earthquakes might occur combined with their propagation characteristics will be used in seismic hazard analysis. Students explore which elements are needed for seismic hazard analysis and how that might have an impact on assessing the vulnerability of society. Regional deformation due to earthquakes will be analyzed using InSAR analysis.

Learning outcomes
Upon completion of this choice topic, the student will be able to:

- Describe about the different kind of seismic waves with their specific physical characteristics;
- Estimate seismic hazard for a region;
- Use InSAR to derive information on vertical displacement in a region.

TEACHING AND LEARNING APPROACH

Classes, self-study, literature study, practicals

TESTS

Written test

ENTRY REQUIREMENTS

Participation in case study projects 1 and 2

ALLOCATED TIME PER TEACHING AND LEARNING METHOD

Teaching / learning method	Hours
Lecture	6
Supervised practical	6
Self-study	15
Written/oral test	1

RELATION OF LEARNING OUTCOMES (LO) OF THE COURSE WITH THE PROGRAMME LEARNING OUTCOMES

Learning outcomes (LO) of the course: The student will be able to...	1	2	3	4	5	6	7

ACADEMIC SKILLS

ACADEMIC SKILLS

Course	201800271
Period	24 April 2023 - 07 July 2023
EC	1
Course coordinator	

INTRODUCTION

This course provides students with an opportunity to improve their scientific argumentation and writing skills. It builds upon the knowledge and skills they gained during quartiles 1 through 3. They will write a short justification for their intended research proposal. In doing so, they will demonstrate that they are able to find and critically read a number of relevant research publications and use these to help identify a suitable research problem that they may later use as a basis for their research proposal development in year 2. A critical, scientific attitude and the ability to reflect upon their own work and that of others will be developed through peer review sessions.

CONTENT

1. Scientific communication:
    - Write a well-structured and logically-argued justification for their research topic according to scientific writing principles
    - Design and produce graphic illustrations (maps, charts, diagrams, etc.) and tables to communicate scientific concepts, data and information
2. Critical reflection
    - Evaluate the work of peers in order to stimulate their learning and skill levels
    - Identify their strengths and weaknesses to determine requirements for further academic skill development.

TEACHING AND LEARNING APPROACH

Teaching and learning involves a mix of different types of activities: short lectures, peer-review sessions and self study. Active participation and critical reflection are stimulated.

TESTS

Students will be evaluated on the basis of a written assignment submitted at the end of quartile 4.

ENTRY REQUIREMENTS

Participation in case study projects 1, 2 and 3

LEARNING OUTCOMES

Upon completion of this course, the student is able to:

LO 1 Effectively communicate research process and outcomes

LO 2 Critically reflect on their performance in the design and execution of research tasks

ALLOCATED TIME PER TEACHING AND LEARNING METHOD

Teaching / learning method	Hours
Lecture	2
Tutorial	4
Individual assignment	22

TESTPLAN

		Learning Outcomes that are addressed in the test
	Learning outcomes (LO) of the course: The student will be able to...	**Assignment**
LO 1	Effectively communicate research process and outcomes	●
LO 2	Critically reflect on their performance in the design and execution of research tasks	●
	Test type	Written test
	Weight of the test	100
	Individual or group test	Individual
	Type of marking	1-10
	Required minimum mark per test	
	Number of test opportunities per academic year	2

RELATION OF LEARNING OUTCOMES (LO) OF THE COURSE WITH THE PROGRAMME LEARNING OUTCOMES

	Learning outcomes (LO) of the course: The student will be able to...	1	2	3	4	5	6	7
LO 1	Effectively communicate research process and outcomes						●	
LO 2	Critically reflect on their performance in the design and execution of research tasks					●		

ELECTIVES

ELECTIVES

Course	201800547
Period	25 April 2022 - 07 July 2023
EC	14

Course coordinator

INTRODUCTION

In this quartile, we offer the student a chance to make the most of their interests and ambitions, and shape their own "expert view", before the thesis phase starts. With that thesis (and possibly their plans for internship and for after graduation) in view, students should investigate in what direction(s) they want to further develop themselves.

The chosen set of courses should be discussed with the mentor and addressed in the Personal Development Portfolio. In line with the quartile goals, students have to think about how they will integrate the (to be) acquired knowledge to position themselves as experts within multidisciplinary teams, and how this will be beneficial for their research (thesis) phase and beyond.

CONTENT

The student is free to select from the electives and specialisation courses offered at ITC and other faculties of the University of Twente, and/or any other courses at other universities he/she is eligible for, as long as they are acknowledged to be at Master's programme level.

The electives (excluding the mandatory academic skills) should together consist of a **minimum** of 14 EC of content. Note that the constituent programme parts are possibly of rather different sizes (e.g. 7 EC for most ITC M-GEO courses, 3 up to 15 EC for various courses at other faculties), therefore achieving exactly 14 EC might not always be possible.

TEACHING AND LEARNING APPROACH

Teaching and learning approaches will be *inherited* from the electives the student chooses.

TESTS

The evidence of having achieved the goals of the various electives themselves will depend on the set-up and learning goals of each elective individually: evidence for each of these will thus be based on the specific assessment rules and criteria of these electives; this might consist of a test (for which the student must get a passing mark), an assignment, report or an essay (which must have been assessed with a passing mark), etcetera...

ENTRY REQUIREMENTS

Participation in case study projects 1, 2 and 3. Note that it is the student's responsibility to make sure he/she is fulfilling any *entry* requirements set by the elective he/she chooses.

LEARNING OUTCOMES

Upon completion of this course, the student is able to:

LO 1 Identify and describe gaps in his/her knowledge, with a view towards his/her thesis phase

LO 2 Specialise in topics of her/his choice

LO 3 Reason how the expert he/she has become is positioned within, and will be a benefit to, multidisciplinary project teams

LO 4 Further learning outcomes will be *inherited* from the electives the student chooses to follow.

TESTPLAN

	Learning Outcomes that are addressed in the test Learning outcomes (LO) of the course: The student will be able to...	Not Applicable
LO 1	Identify and describe gaps in his/her knowledge, with a view towards his/her thesis phase	
LO 2	Specialise in topics of her/his choice	
LO 3	Reason how the expert he/she has become is positioned within, and will be a benefit to, multidisciplinary project teams	
LO 4	Further learning outcomes will be *inherited* from the electives the student chooses to follow.	●
	Test type	Personal Development Plan
	Weight of the test	100
	Individual or group test	Individual
	Type of marking	Completed/fail
	Required minimum mark per test	0
	Number of test opportunities per academic year	2

RELATION OF LEARNING OUTCOMES (LO) OF THE COURSE WITH THE PROGRAMME LEARNING OUTCOMES

	Learning outcomes (LO) of the course: The student will be able to...	**1**	**2**	**3**	**4**	**5**	**6**	**7**
LO 1	Identify and describe gaps in his/her knowledge, with a view towards his/her thesis phase	●	●					
LO 2	Specialise in topics of her/his choice	●						
LO 3	Reason how the expert he/she has become is positioned within, and will be a benefit to, multidisciplinary project teams	●					●	
LO 4	Further learning outcomes will be *inherited* from the electives the student chooses to follow.							

INTERNATIONAL MODULE

INTERNATIONAL MODULE

Course	**201900006**
Period	05 September 2022 - 11 November 2022
EC	7.5

Course coordinator

INTRODUCTION

The international module aims to provide different views on the knowledge fields and provide students with ideas for the types of organisations for their internship or later job. Therefore, the module contains an international excursion to several (European) institutes and companies, and/or videoconferences with organisations in- and outside Europe, relevant to the knowledge fields of Spatial Engineering. Care will be taken to have a good mix of research organisations, governmental organisations and private companies, to provide different views on the knowledge fields and different possible working environments. Before and after the excursion the last workshops of the skills learning line International and Intercultural Competences will be organised, to reflect on the ethical aspects of spatial engineering and on working in international and multicultural teams.

CONTENT

The second and third week of the module contain an excursion and/or a series of videoconferences, during which we will visit several European institutes and companies in the knowledge fields of Spatial Engineering and/or have videoconferences with organisations in- and outside Europe. Staff will organise the logistics and ask the host organizations to show at least one concrete project in the field of Spatial Engineering, while students are in charge of preparing content.

The preparation of the content will be done in the first week of the module. The organisations which will be visited during the excursion or via videoconference will be distributed over the students. Each student will prepare for the visit to one host organisation. Preparation includes obtaining and going through information on the host organisation and the project or topic which will be presented and formulating a number of questions to start the discussion after the presentations. Students should prepare for a discussion with elements of the technical aspects, stakeholder- and governance related questions and ethical dilemmas. The latter can be related to the workshops on international skills. At the end of the first week, each student gives a briefing to prepare the others for the context of the visit. Students with inadequate preparation are not allowed to join the excursion and/or videoconferences.

After the excursion and/or videoconferences, each student will summarise the findings and reflect on the content of the visit where he or she prepared for. This should be done in a written report, relating the content of the visit to Spatial Engineering and especially the case study projects. In the last week of the module, students will synthesise their findings in a final group report, in which they compare the organisations visited, and reflect on similarities and differences. Depending on the number of students, there can be multiple groups.

The internationalisation skill learning line finishes in this module with workshops and an essay on geo-ethics.

The International module is also the last module formally requiring a plan and a reflection as part of the PDP.

TEACHING AND LEARNING APPROACH

The module contains a mix of individual and group assignments, with ample incentives for reflection. The student will formulate individual learning goals as part of the PDP. During the individual assignment, each student will prepare for and report on the visit to or videoconference with one host organisation, relating the practise in the projects presented to Spatial Engineering and especially the case study projects. In the final report, a group of students will compare and synthesise their findings and reflect together on the similarities and differences between the organisations, to obtain a broader view on the field of Spatial Engineering. In the group reflection, also organisations' approach to ethical aspects and to international, multicultural teams should be included, based on the workshops in the international skills learning line. Individual reflection on personal lessons learnt is part of the PDP. An individual essay on geo-ethics forms the final assessment in the international skills learning line.

TESTS

- Preparation plan and report of the visit to or videoconference with one host organisation (40%, individual, the preparation part has to be approved (pass/fail) by the teachers to gain access to the actual excursion)
- Personal plan for development as part of PDP (individual, pass/fail access to the actual excursion)
- Final report (30%, group)
- Essay on geo-ethics (30%, individual)
- Reflection on lessons learnt as part of PDP (individual, pass/fail)

ENTRY REQUIREMENTS

Completion of the case study projects in the first year of Master's programme Spatial Engineering.

LEARNING OUTCOMES

Upon completion of this course, the student is able to:

LO 1 Identify and describe gaps in own knowledge in a Personal Development Plan and resulting learning objectives for the module.

LO 2 Apply the 'wicked' problem framework to the analysis of a problem presented by a host organisation, formulate research questions and find and evaluate scientific knowledge on the project presented by the host organisation, identifying data-, information- and knowledge gaps.

LO 3 Define clear operationalized fact-finding questions on stakes and interests for the host organisation and interact effectively and respectfully with host organisations to obtain information for analyses.

LO 4 Present the results, underlying knowledge, choices and considerations, learnt during the excursion and videoconferences and adhere to giving proper credit and referencing.

LO 5 Reflect on own professional behaviour in the interaction with the host organisation.

LO 6 Participate effectively and share knowledge within the project team, describe role as a team member, reflect on own strengths and weaknesses in working in a team.

LO 7 Reflect on the differences experienced during the excursion, comparing organisations and projects presented during the excursion and videoconferences.

LO 8 Describe own professional skills and awareness of ethical values needed for working in international and multicultural teams and environments and as an empathic engineer who aspires to social justice.

ALLOCATED TIME PER TEACHING AND LEARNING METHOD

Teaching / learning method	Hours
Study trip	84
Lecture	8
Group assignment	30
Individual assignment	60
Self-study	22

TESTPLAN

		Learning Outcomes that are addressed in the test				
	Learning outcomes (LO) of the course: The student will be able to...	**Preparation plan and report of the visit or videoconference**	**Final group report**	**Essay on geo-ethics**	**PDP Plan**	**PDP Reflection**
LO 1	Identify and describe gaps in own knowledge in a Personal Development Plan and resulting learning objectives for the module.				●	●
LO 2	Apply the 'wicked' problem framework to the analysis of a problem presented by a host organisation, formulate research questions and find and evaluate scientific knowledge on the project presented by the host organisation, identifying data-, information- and knowledge gaps.	●	●			
LO 3	Define clear operationalized fact-finding questions on stakes and interests for the host organisation and interact effectively and respectfully with host organisations to obtain information for analyses.	●				
LO 4	Present the results, underlying knowledge, choices and considerations, learnt during the excursion and videoconferences and adhere to giving proper credit and referencing.	●	●			
LO 5	Reflect on own professional behaviour in the interaction with the host organisation.	●				●

		Learning Outcomes that are addressed in the test				
	Learning outcomes (LO) of the course: The student will be able to...	**Preparation plan and report of the visit or videoconference**	**Final group report**	**Essay on geo-ethics**	**PDP Plan**	**PDP Reflection**
LO 6	Participate effectively and share knowledge within the project team, describe role as a team member, reflect on own strengths and weaknesses in working in a team.		●			●
LO 7	Reflect on the differences experienced during the excursion, comparing organisations and projects presented during the excursion and videoconferences.		●			
LO 8	Describe own professional skills and awareness of ethical values needed for working in international and multicultural teams and environments and as an empathic engineer who aspires to social justice.			●	●	●
	Test type	Report	Report	Report	Personal Development Portfolio	Personal Development Portfolio
	Weight of the test	40	30	30		
	Individual or group test	Individual	Group	Individual	Individual	Individual
	Type of marking	1-10	1-10	1-10	Pass/Fail	Pass/Fail
	Required minimum mark per test	5.5		5.5		
	Number of test opportunities per academic year	1	1	2	2	2

RELATION OF LEARNING OUTCOMES (LO) OF THE COURSE WITH THE PROGRAMME LEARNING OUTCOMES

	Learning outcomes (LO) of the course: The student will be able to...	**1**	**2**	**3**	**4**	**5**	**6**	**7**
LO 1	Identify and describe gaps in own knowledge in a Personal Development Plan and resulting learning objectives for the module.	●						
LO 2	Apply the 'wicked' problem framework to the analysis of a problem presented by a host organisation, formulate research questions and find and evaluate scientific knowledge on the project presented by the host organisation, identifying data-, information- and knowledge gaps.		●					
LO 3	Define clear operationalized fact-finding questions on stakes and interests for the host organisation and interact effectively and respectfully with host organisations to obtain information for analyses.			●			●	
LO 4	Present the results, underlying knowledge, choices and considerations, learnt during the excursion and videoconferences and adhere to giving proper credit and referencing.				●	●		
LO 5	Reflect on own professional behaviour in the interaction with the host organisation.						●	

	Learning outcomes (LO) of the course: The student will be able to...	1	2	3	4	5	6	7
LO 6	Participate effectively and share knowledge within the project team, describe role as a team member, reflect on own strengths and weaknesses in working in a team.						●	●
LO 7	Reflect on the differences experienced during the excursion, comparing organisations and projects presented during the excursion and videoconferences.							●
LO 8	Describe own professional skills and awareness of ethical values needed for working in international and multicultural teams and environments and as an empathic engineer who aspires to social justice.							●

ACADEMIC AND RESEARCH PHASE

ACADEMIC AND RESEARCH PHASE

Course	**201900005**
Period	05 September 2022 - 22 April 2023
EC	37.5

Course coordinator

INTRODUCTION

The MSc research is the main part of the second year. It is an individual effort where the student will learn to use scientific principles to do reasearch. From a societal or scientific overall problem, the student will investigate the state-of-the-art using peer reviewed literature and formulate what needs to be investigated in order to improve our understanding. From this, research objectives are defined, corresponding questions are formulated and a detailed and transparent methodology is created to provide answers. Conclusions and recommendations and a synthesis are formulated in a critical way. Spatial Engineering is a multidisciplinary study. Although this is a specialisation phase where the student can analyse a problem in depth, they are required to use at least 2 out of 3 of the core knowledge areas, and reflect on how the results in potentially related to the third core knowledge area. If the research is for instance more technical in nature, the results should include a reflection on the potential effects on stakeholders. If the emphasis is on planning/governance, a reflection on the feasibility of the technical engineering context should be included. The MSc research is in total 37.5 EC, split in a proposal writing phase and a research phase that results in a thesis. The proposal itself is a written document that is defended in an oral test before a Proposal Assessment Board (PAB), and must be successful in order to be allowed into the research phase itself.

Details on the assessment of the Academic and Research phase can also be found on the ITC intranesite: https://www.itc.nl/intranet/education/rules-and-procedures/assessment/assessment-instructions/.

CONTENT

Proposal

Developing the MSc research proposal requires a sufficient understanding and integration of research aspects from all different scientific technical and non-technical disciplines involved in the proposed research. So, in addition to the academic and research skills already gained during the first-year students will receive guidance on these skills during this part of the Academic Research phase.

The proposal is developed in steps that follow the logic of a written proposal.

General lectures are provided on

1. Development of research questions

2. Methodological choices

3. Ethical concerns

In addition each research theme provides supervised peer review sessions.

The proposal has to contain a detailed methodology that in principle should be able to answer each of the questions. Analysis methods and models have to be specified in sufficient detail, and based on an expected outcome and potential problems encountered. If you do not master parts of the methodology yet, make sure you understand these sufficiently to estimate their outcome, based on your literature review. Plan sufficient time to learn new methodologies.

The student will have two supervisors with whom the content of the proposal is discussed. The supervisors will ascertain that the proposal is feasible, and will help with identifying counterparts that the student may contact. One of the supervisors should be from ITC faculty representing one of the three core knowledge areas of Spatial Engineering. The other can be from another research institute.

Practical constraints apply: the topic must be possible in terms of availability of data, logistics, and supervision, and be financially possible. If a field investigation is envisaged, supervision in the field is required and the investigation must be possible within the time frame and financial constraints.

Thesis

The research phase has a normal duration of 2 quartiles and usually starts with acquisition of data and information. In case this involves fieldwork, a staff member or a counterpart will be present for a part of the time. Regular meetings are scheduled at the student's initiative. The student comes to the meetings prepared, and gives a concise summary with action points afterwards. It is expected that the student gradually takes control of his/her own research and becomes an expert in the topic. The role of the supervisor is to guide the independent research of a student. Sometimes, depending on the data vailability or application of a focus along the way, research objectives may be adjusted. This is done in discussion with the supervisors. The set of objectives, analysis and conclusions in the thesis should be an integrated work, but it can differ from the original proposal. During this phase new analysis techniques may be learned, but plan sufficient time for this.

TEACHING AND LEARNING APPROACH

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TESTS

There are four assessment moments:

The proposal has to be defended before a committee of staff members and peers. A written feedback is given by both staff and students with points of attention that should be addressed in the course of the research. The proposal presentation is chaired by the research chair or replacement. The presentation should be attended by all staff available and fellow students. Acceptance of the proposal is required to be allowed to continue into the research phase.

At an appropriate moment, decided by the student and the supervisors, the student gives an oral presentation summarizing the research and (preliminary) results so far. This “mid-term review” is done for the other students, staff and supervisors, and chaired by the research theme leader (or replacement). Often this is done after the data acquisition phase, when there has been a first “reality check” of how feasible the research is. The purpose of the mid-term review is to get advice on parts of the research, which may possibly lead to a redefinition of research objectives, alternative methods, and to get advice potential problems the student has encountered. In case the student has a risk of delay, a warning letter is issued, and the student cannot yet start the internship project.

Upon the approval of the completed MSc research by the research theme leader (or delegate) and the first supervisor the student submits the Thesis for the MSc research exam.

The oral defence will be scheduled after submission of the thesis for the MSc research exam. The written thesis, the research process and the oral defense are together judged by a Thesis Assessment Board, consisting of the chair, an independent researcher and the two supervisors.

ENTRY REQUIREMENTS

At least 46 EC's of the first academic year.

LEARNING OUTCOMES

Upon completion of this course, the student is able to:

LO 1 Translate a multidisciplinary (societal) problem to a set of research objectives and questions, based on state-of-the-art peer-reviewed literature, of sufficient scope and depth related to the three core knowledge areas of Spatial Engineering.

LO 2 Define a clear structured methodology with conscious and justifiable choices between different modelling techniques for spatio-temporal processes.

LO 3 Collect and analyse relevant data and information, and use, develop and validate models, working in a transparent and fully reproducible way.

LO 4 Draw viable conclusions and generate a good synthesis, and where possible, give recommendations that recognize the needs and wishes of stakeholder groups involved.

LO 5 Work in a structured and independent way, while making adequate use of the guidance of the supervisor

LO 6 Convey written information effectively using a professionally written and structured research proposal and thesis

LO 7 Convey information effectively using professional visual and oral means in presenting the research

ALLOCATED TIME PER TEACHING AND LEARNING METHOD

Teaching / learning method	Hours
Individual assignment	1036

TESTPLAN

		Learning Outcomes that are addressed in the test		
	Learning outcomes (LO) of the course: The student will be able to...	**Proposal**	**Thesis**	**Process and Defense**
LO 1	Translate a multidisciplinary (societal) problem to a set of research objectives and questions, based on state-of-the-art peer-reviewed literature, of sufficient scope and depth related to the three core knowledge areas of Spatial Engineering.	●	●	
LO 2	Define a clear structured methodology with conscious and justifiable choices between different modelling techniques for spatio-temporal processes.	●	●	
LO 3	Collect and analyse relevant data and information, and use, develop and validate models, working in a transparent and fully reproducible way.		●	●
LO 4	Draw viable conclusions and generate a good synthesis, and where possible, give recommendations that recognize the needs and wishes of stakeholder groups involved.		●	●
LO 5	Work in a structured and independent way, while making adequate use of the guidance of the supervisor			●
LO 6	Convey written information effectively using a professionally written and structured research proposal and thesis	●	●	
LO 7	Convey information effectively using professional visual and oral means in presenting the research		●	●
	Test type	Report	Report	Presentation
	Weight of the test	0	70	30
	Individual or group test	Individual	Individual	Individual
	Type of marking	Pass/Fail	1-10	1-10
	Required minimum mark per test			
	Number of test opportunities per academic year	2	2	2

RELATION OF LEARNING OUTCOMES (LO) OF THE COURSE WITH THE PROGRAMME LEARNING OUTCOMES

	Learning outcomes (LO) of the course: The student will be able to...	1	2	3	4	5	6	7
LO 1	Translate a multidisciplinary (societal) problem to a set of research objectives and questions, based on state-of-the-art peer-reviewed literature, of sufficient scope and depth related to the three core knowledge areas of Spatial Engineering.	●						
LO 2	Define a clear structured methodology with conscious and justifiable choices between different modelling techniques for spatio-temporal processes.		●					
LO 3	Collect and analyse relevant data and information, and use, develop and validate models, working in a transparent and fully reproducible way.		●		●			
LO 4	Draw viable conclusions and generate a good synthesis, and where possible, give recommendations that recognize the needs and wishes of stakeholder groups involved.			●		●		
LO 5	Work in a structured and independent way, while making adequate use of the guidance of the supervisor				●		●	

	Learning outcomes (LO) of the course: The student will be able to...	1	2	3	4	5	6	7
LO 6	Convey written information effectively using a professionally written and structured research proposal and thesis						●	
LO 7	Convey information effectively using professional visual and oral means in presenting the research						●	

INTERNSHIP PROJECT

INTERNSHIP PROJECT

Course	**201900001**
Period	25 April 2022 - 07 July 2023
EC	15

Course coordinator

INTRODUCTION

In the internship, the student demonstrates the ability to work at an academic level in a professional project context. As such, doing the internship is indispensable for acquiring the competences of an academic and professional Spatial Engineering graduate. Whether this internship is his/her first introduction to the world of work, or whether he/she has already gained a lot of professional experience, the student will get the chance to further develop his/her knowledge and skills. The student is expected to apply the tools and concepts of the project management skill learning line.

The internship may be carried out within consultant companies, government agencies, research institutes, NGOs or intergovernmental organizations in the Netherlands or abroad. ITC has a working relation and has made agreements on the possible placement of interns with these organizations. 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, he/she will receive guidance from a daily supervisor in the organization concerned. At the end of the internship, the student will make an internship report (IR) and an Internship Reflection Report (IRR) report in which he/she discusses results, experiences and highlights the learning that has been achieved during the internship. The supervisor of the host organization will provide him/her with feedback on his/her professional skills using the Host Evaluation Form (HEF).

CONTENT

During the internship period, the student will be part of a professional project organization. They will be working on a societal problem in a professional context and will typically contribute to an ongoing project and operate in a project context. The project needs to be closely related to the content of the Spatial Engineering programme such that at least two of the three core knowledge areas are covered. ITC is providing a database in CANVAS with host organizations and project outlines from which the student can choose his/her internship project. The student can also develop his/her own internship project. For support, they can contact the internship coordinator.

After choosing the project outline, the student will make a project proposal for the internship (IPP) and apply for internship placement within the organization. The IPP will be evaluated by the ITC supervisor and the supervisor in the host organization. Only after approval of the IPP by the ITC supervisor, can the actual internship commence. Orientation and planning an internship should preferably start at least six months prior to the desired date for an internship in the Netherlands and preferably nine months in advance for an international internship. This extra time is required for arrangements that need to be made such as applying for accommodation, visa and other formalities. The UT online tool “mobility online” and the internship coordinator help in planning and organizing the internship. During the internship, the student will be supervised by an ITC staff member as well as by a representative of the host organization where the internship takes place.

At the end of the internship the student will hand in an Internship Report (IR) in which the project is described. This IR provides a content description of the process and results of the internship and includes a discussion of the problem and context, objectives of the assignment, the questions addressed, the methods used, analyses performed, results and discussion. He/she also makes an Internship Reflection Report (IRR) that highlights his/her learning on professional skills during the internship project.

The mark of the internship will be based on the discussion of an assessment committee, which consists of both supervisors and an ITC staff member who has not been involved in the internship. The representative of the host organization advises the internship examiner in the assessment of the internship (specifically on professional attitude and skills), whereas the ITC supervisor focuses on the academic level of the internship.

TEACHING AND LEARNING APPROACH

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TESTS

Internship Project Plan (IPP)

The project plan contains the following elements:

1. Introduction (with the title of the project, name of the author, UT and company supervisors, date, planned period of the training)
2. Project definition and aims
3. Project plan
4. Expected results

Internship Report (IR)

A report contains the following elements:

1. Introduction
2. Project definition and aims
3. Scientific level
4. Discussion, conclusions and recommendations

Host organization Evaluation Form (HEF)

1. Initiative and creativity
2. Insight in functioning of the organization
3. Adaptation capacity
4. Commitment and perseverance
5. Independence
6. Handling supervisor's comments and development skills
7. Time management
8. Dealing with uncertainty and risks in project
9. Dealing with limited resources
10. Responsibility
11. Flexibility; compromise in complex situations
12. International multicultural teamwork
13. Contribution to the scientific knowledge of the internship organization
14. Presentation of the results of the internship project

Reflection report

The reflection report describes the non-technical aspects of the internship period.

Its size should be two to four pages.

The reflection report should reflect on:

- The learning **process:** which professional skills did the student gain in the workplace, with focus on application of theoretical knowledge, problem solving, time management and teamwork
- The **realization** process: how were the tasks and deliverables realized and
- The **communication** process; how were the internship results communicated to professionals, ITC and the host?
- Self-assessment **reflection** on student's strengths (best skills), values (what matters most to him/her) and interests (what he/she likes to do) in professional work
- **Recommendation** for improved experience on internship

ENTRY REQUIREMENTS

Academic Research positive feedback on mid term review

IMPORTANT:
Whether an internship is possible in a certain country could depend on scholarship conditions. As these are different for each scholarship provider, the internship coordinator should be consulted to provide clarity on this issue.

LEARNING OUTCOMES

Upon completion of this course, the student is able to:

LO 1 apply project management tools and concepts such as the management of time, costs, quality, communication, risks, stakeholders, be pragmatic and have a sense of responsibility; deal with limited sources; deal with risks; deal with compromise in complex projects

LO 2 demonstrate professional skills: Initiative and creativity, Insight in functioning of the organization and the team, Adaptation capacity, Commitment and perseverance, Independence, Handling supervisor's comments and development skills.

LO 3 to document, reproduce and report adequately the results of the internship project with a view to contributing to the development of knowledge within the host organization

LO 4 to reflect on their professional skills, own role in the team, ethical values needed for working in international and multicultural teams and environments.

ALLOCATED TIME PER TEACHING AND LEARNING METHOD

Teaching / learning method	Hours
Supervised practical	420

TESTPLAN

		Learning Outcomes that are addressed in the test			
	Learning outcomes (LO) of the course: The student will be able to...	**Project Proposal**	**Report**	**Reflection Report**	**Host organization evaluation**
LO 1	apply project management tools and concepts such as the management of time, costs, quality, communication, risks, stakeholders, be pragmatic and have a sense of responsibility; deal with limited sources; deal with risks; deal with compromise in complex projects	●	●	●	●
LO 2	demonstrate professional skills: Initiative and creativity, Insight in functioning of the organization and the team, Adaptation capacity, Commitment and perseverance, Independence, Handling supervisor's comments and development skills.		●		●
LO 3	to document, reproduce and report adequately the results of the internship project with a view to contributing to the development of knowledge within the host organization	●		●	
LO 4	to reflect on their professional skills, own role in the team, ethical values needed for working in international and multicultural teams and environments.		●		●
	Test type	Report	Report	Report	Evaluation form
	Weight of the test	10	40	0	50
	Individual or group test	Individual	Individual	Individual	Individual
	Type of marking	1-10	1-10	Pass/Fail	1-10
	Required minimum mark per test				
	Number of test opportunities per academic year	2	2	2	1

RELATION OF LEARNING OUTCOMES (LO) OF THE COURSE WITH THE PROGRAMME LEARNING OUTCOMES

	Learning outcomes (LO) of the course: The student will be able to...	1	2	3	4	5	6	7
LO 1	apply project management tools and concepts such as the management of time, costs, quality, communication, risks, stakeholders, be pragmatic and have a sense of responsibility; deal with limited sources; deal with risks; deal with compromise in complex projects		●				●	●
LO 2	demonstrate professional skills: Initiative and creativity, Insight in functioning of the organization and the team, Adaptation capacity, Commitment and perseverance, Independence, Handling supervisor's comments and development skills.						●	●
LO 3	to document, reproduce and report adequately the results of the internship project with a view to contributing to the development of knowledge within the host organization	●				●	●	
LO 4	to reflect on their professional skills, own role in the team, ethical values needed for working in international and multicultural teams and environments.						●	●

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