STUDY GUIDE

Master of Science Degree Programme in Spatial Engineering

Academic year 2020-2021

University of Twente, Faculty ITC
Bureau Education and Research Support
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!
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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.
<table>
<thead>
<tr>
<th>Q1</th>
<th>Q2</th>
<th>Q3</th>
<th>Q4</th>
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<td>Food and Water Security</td>
<td>Human-induced Earth Movement</td>
<td>Electives</td>
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<td>International and Intercultural Competences</td>
<td>Academic Skills</td>
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<td>Project Management and Teamwork Skills</td>
<td>Project Management and Teamwork Skills</td>
<td>Project Management and Teamwork Skills</td>
<td>Internship Project</td>
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| 15 EC                  | 15 EC                  | 15 EC                  |

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<th>Q5</th>
<th>Q6</th>
<th>Q7</th>
<th>Q8</th>
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<td>Academic and research phase</td>
<td>Academic and research phase</td>
<td>Internship Project</td>
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<td>60 EC / 60</td>
</tr>
</tbody>
</table>

| 60 EC / 60              | 60 EC / 60              | 60 EC / 60              | 60 EC / 60              |

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

<table>
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<td>2nd period</td>
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<tr>
<td>4th period</td>
<td>15:45 - 17:30</td>
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# EVENTS, HOLIDAYS AND BREAKS

## Events
- **Introduction week**: 23 August 2020 through 30 August 2020
- **Opening Academic Year UT**: Monday, 31 August 2020
- **Dies Natalis UT**: Friday, 27 November 2019
- **Research Themes Introduction**: Wednesday, 16 December 2020
- **Christmas drinks**: Thursday 17 December 2020
- **New Year’s coffee**: Monday, 4 January 2021
- **MSc topic market**: Friday, 29 January 2021
- **Career Event**: Wednesday, 17 March 2021
- **International Food Festival**: June 2021

## Holidays and Breaks
- **Winter break**: 21 December 2020 through 01 January 2021
- **Spring break**: 22 February 2021 through 26 February 2021
- **Good Friday**: Friday, 2 April 2021
- **Easter Monday**: Monday, 5 April 2021
- **King’s Day**: Tuesday, 27 April 2021
- **Liberation Day**: Wednesday, 05 May 2021
- **Ascension break**: Thursday, 13 May 2021 and Friday, 14 May 2021
- **Whit Monday**: Monday, 24 May 2021
- **Summer break**: 26 July 2021 through 27 August 2021
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 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:

1. Is an expert in integrated knowledge development.
   
   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.

2. Does research in a purposeful and methodological way.
   
   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.

3. Can design interventions for sustainable development.
   
   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.

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

5. Is competent in reasoning, reflection, and judgment.
   
   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.

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.

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: 31 August 2020 - 06 November 2020
EC: 15
Course coordinator: Velde, R. van der (Rogier, dr.ir.)

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 in 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 by analysing 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 for water excess situations.

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 water excess in the urban environment. For the Spatial Planning for Governance domain, this is the perspectives of stakeholders at the city level and for the Spatial Information Sciences domain, two-dimensional spatial data processing and visualization.

Students keep track of and motivate the choices they make during the first 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 42 hours.

The following six 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: Climate-Resilience and Vulnerability Assessment
SPG1.B: Stakeholder Analysis
CASE STUDIES

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 6. The inception report contains the plan for the research project that addresses the urban flood problem of a city, Kampala or Enschede. In case study project 1, the inception report replaces the mid-term assessment described in the EER of the Spatial Engineering programme.
2. **Core knowledge written test** (weight: 30% of the final mark, individual) on the theory provided during the selected choice topics.
3. **Final case study project report** (weight: 30% of the final mark, group) submitted by student teams at the end of week 9. The final report includes an analysis of urban flood problem, an elaboration of the physical and non-physical engineering interventions that contribute to the flood resilience, and a functional design for a selected engineering intervention with justification of its feasibility.
4. **Oral test** (weight: 30% of the final mark, individual) on the entire learning process during the quartile. The oral test starts with a short presentation (pitch, max. 7 minutes) by the student, after which a question/answer session (max. 35 minutes) follows. The questions address the case study project’s learning outcomes and focus on the entire case study project.

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. Student 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. 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 to students 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.

COMPULSORY TEXTBOOK(S)
Students are encouraged to find their own literature as part of the case study project. A list of non-compulsory reference materials for the core knowledge areas is provided in the common section of the case study project.

Compulsory specialized reading materials are available under the sections of the selected choice topics.

OTHER STUDY MATERIAL
See the compulsory textbook(s) section.
LEARNING OUTCOMES

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

LO 1  Apply a given model for the simulation of physical processes that make the urban environment susceptible to disasters that have an event-based character.

LO 2  Use appropriate methods for identifying stakeholders, analysing their perspectives on the urban flood problem, and involving them in the design of measures contributing to the resilience of the urban environment.

LO 3  Make use of two-dimensional spatial data required to model or analyse an event in the urban environment.

LO 4  Define a Personal Development Portfolio aimed at building up knowledge during the case study project.

LO 5  Translate a multidisciplinary problem in the urban environment into a plan for a research project that can be completed within the time and resources available.

LO 6  Analyse the current situation of the urban environment, and choose physical and non-physical engineering interventions that contribute to its resilience.

LO 7  Design an engineering intervention that contributes to the resilience of urban environment and takes into consideration the perspectives of stakeholders at the level of a city.

LO 8  Examine the impact of engineering interventions on the resilience of the urban environment through application of scientific methods.

LO 9  Find and use scientific literature in the Spatial Engineering knowledge domains on climate resilience of the urban environment.

LO 10  Critically review the feasibility of engineering interventions from the perspectives of stakeholders at the level of a city.

LO 11  Combine the results of research project into information and communicate this using visual, written and oral means.

LO 12  Recognize personal strengths and weaknesses when working in a team.

LO 13  Identify the relationship between culture (underlying values and assumptions of a society) and the specific behaviours that derive from these and the pitfalls of communication.

ALLOCATED TIME PER TEACHING AND LEARNING METHOD

<table>
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<tr>
<th>Teaching / learning method</th>
<th>Hours</th>
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<td>Supervised practical</td>
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<td>Individual assignment</td>
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<td>Group assignment</td>
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<tr>
<td>Self-study</td>
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<td>Written/oral test</td>
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<td>Inception report (SA1)</td>
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<tr>
<td>LO 1</td>
<td>Apply a given model for the simulation of physical processes that make the urban environment susceptible to disasters that have an event-based character</td>
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<td>Define a Personal Development Portfolio aimed at building up knowledge during the case study project</td>
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<td>LO 5</td>
<td>Translate a multidisciplinary problem in the urban environment into a plan for a research project that can be completed within the time and resources available</td>
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<td>LO 6</td>
<td>Analyse the current situation of the urban environment, and choose physical and non-physical engineering interventions that contribute to its resilience</td>
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<tr>
<td>LO 7</td>
<td>Design an engineering intervention that contributes to the resilience of urban environment and takes into consideration the perspectives of stakeholders at the level of a city</td>
</tr>
<tr>
<td>LO 8</td>
<td>Examine the impact of engineering interventions on the resilience of the urban environment through application of scientific methods</td>
</tr>
<tr>
<td>LO 9</td>
<td>Find and use scientific literature in the Spatial Engineering knowledge domains on climate resilience of the urban environment</td>
</tr>
<tr>
<td>LO 10</td>
<td>Critically review the feasibility of engineering interventions from the perspectives of stakeholders at the level of a city</td>
</tr>
<tr>
<td>LO 11</td>
<td>Combine the results of research project into information and communicate this using visual, written and oral means</td>
</tr>
<tr>
<td>LO 12</td>
<td>Recognize personal strengths and weaknesses when working in a team</td>
</tr>
<tr>
<td>Learning outcomes (LO) of the course: The student will be able to...</td>
<td>Inception report (SA1)</td>
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<tr>
<td>LO 13</td>
<td>Identify the relationship between culture (underlying values and assumptions of a society) and the specific behaviours that derive from these and the pitfalls of communication.</td>
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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 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 may 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 weather patterns. 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 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) Spatial Information Sciences, ii) Technical Engineering, and iii) Spatial Planning and Governance.

The provided tutorials are: i) QGIS: getting started, ii) Engineering design, and iii) Urban drainage infrastructure when permitted by the COVID-19 regulations.

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 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.

COMPULSORY TEXTBOOK(S)
Students are encouraged to find their own literature as part of the case study project. A list of non-compulsory reference materials for the core knowledge areas is provided in the common section of the case study project.

Compulsory specialized reading materials are available under the sections of the selected choice topics.
OTHER STUDY MATERIAL

ACADEMIC AND RESEARCH SKILLS

Course
201800211

Period
31 August 2020 - 06 November 2020

Course coordinator
Boer, C.L. de (Cheryl, dr.)

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 Academic and Research Skills in Quartile 1 is 14 hours.

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
- Basic (carto)graphic communication and design principles (maps and flow charts).

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 most important aspects of the skills learning line assessments are described below.

The skills learning line Academic and Research Skills is not directly assessed. However, they are indirectly assessed via the project report and oral test for this quartile.

COMPULSORY TEXTBOOK(S)
The main materials for academic skills consist of two volumes. These are available both as a hardcopy and as a softcopy. Volume 1 contains material related to research principles and concepts, Volume 2 contains materials related to specific skills needed when doing research. These volumes can be used as reference material through the programme. Some additional materials will also be made available when required.

OTHER STUDY MATERIAL
You also may use the SAGE Research Methods website which has a lot of specific materials on all aspects of research, though it is somewhat biased toward social science research.

http://methods.sagepub.com/methods-map
ENTRY REQUIREMENTS
Personal Plan for Development

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

<table>
<thead>
<tr>
<th>Teaching / learning method</th>
<th>Hours</th>
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<tr>
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<td>Self-study</td>
<td>8</td>
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</table>
CASE STUDIES

INTERNATIONAL AND INTERCULTURAL COMPETENCES

Course 201800210
Period 31 August 2020 - 06 November 2020
Course coordinator Georgiadou, P.Y. (Yola, prof.dr.)

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
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 this quartile for this learning line are described below.

A 500 words essay, to be submitted together with the PDP, about your own (worst) experience in a foreign country, but now taking into account the aspects: (1) beliefs (and facts) (2) desires (and values) and (3) relation between facts and values.

How the essay will be marked:

Excellent= reference is made to aspects 1+2+3,
Good= reference is made to aspects 1 and 2 only,
Weak = no reference to any of the three aspects.

COMPULSORY TEXTBOOK(S)
- Stone, D. (2011) Quantitative analysis as narrative (proofs)
OTHER STUDY MATERIAL
See compulsory textbook(s).

ENTRY REQUIREMENTS
Personal Plan for Development

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

LO 1 Become aware of the variety of meanings for ‘culture’.
- Appreciate story telling as a method of representing reality and as a window into culture
- Appreciate links between culture (beliefs & values) and behaviour

LO 2 Understand how facts are produced:
- Become aware that the production of numerical facts—i.e. “counting” or “quantifying”—serves as evidence in specific contexts and for specific purposes.
- Understand the mental and social processes of creating numerical facts in Stone’s theory; appreciate how creating numerical facts depends on deliberate decisions about “categorizing” people and things

LO 3 Understand how values (equity, efficiency, accountability) are produced and sustained.
PROJECT MANAGEMENT AND TEAMWORK SKILLS

Course 201800212
Period 31 August 2020 - 06 November 2020
Course coordinator Alkema, D. (Dinand, dr.)

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.

COMPULSORY TEXTBOOK(S)
Project Management Institute (2000) Project Management Body of Knowledge Readers and teaching material will be provided by teaching staff.

OTHER STUDY MATERIAL
See compulsory textbook(s).

ENTRY REQUIREMENTS
Personal Plan for Development
SPATIAL DATA VISUALIZATION (SIS1.A)

Course 201800217
Period 31 August 2020 - 06 November 2020
Course coordinator Kraak, M.J. (Menno-Jan, prof.dr.)

INTRODUCTION
Six choice topics are offered as part of the first case study project. Each choice topic has an estimated study load of 42 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 six choice topics are:

Technical Engineering (TE, scheduled in week 2, 7–11 Sept)
- TE1.A: Flood Modelling
- TE1.B: Hydrological Monitoring and Statistics

Spatial Information Sciences (SIS, scheduled in week 3, 14–18 Sept)
- SIS1.A: Spatial Data Visualization
- SIS1.B: Digital Elevation Models Creation

Spatial Planning for Governance (SPG, scheduled in week 4, 21 Sept – 25 Sept)
- SPG1.A: Climate-Resilience and Vulnerability Assessment
- SPG1.B: Stakeholder Analysis

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)

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.

COMPULSORY TEXTBOOK(S)
- Some paper to be selected
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

<table>
<thead>
<tr>
<th>Teaching / learning method</th>
<th>Hours</th>
</tr>
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<tbody>
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<td>1</td>
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</tbody>
</table>
INTRODUCTION
Six choice topics are offered as part of the first case study project. Each choice topic has an estimated study load of 42 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 six choice topics are:

**Technical Engineering (TE, scheduled in week 2, 7–11 Sept)**
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- SIS1.A: Spatial Data Visualization
- SIS1.B: Digital Elevation Models Creation

**Spatial Planning for Governance (SPG, scheduled in week 4, 21 Sept – 25 Sept)**
- SPG1.A: Climate-Resilience and Vulnerability Assessment
- SPG1.B: Stakeholder Analysis

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

CONTENT
In this choice topic, the students learn how to create Digital Elevation Models; which sensors are available and what is the optimal procedure to process this sensor data. The relation to the project is that DEMs are one of the major spatial datasets needed for dealing with the management of water. In case of abundancy of water, the DEM is used to predict where the water will go.

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.

COMPULSORY TEXTBOOK(S)

ENTRY REQUIREMENTS
Admission criteria
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

<table>
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CLIMATE-RESILIENCE AND VULNERABILITY ASSESSMENT
(SPG1.A)

INTRODUCTION
Six choice topics are offered as part of the first case study project. Each choice topic has an estimated study load of 42 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 six choice topics are:

Technical Engineering (TE, scheduled in week 2, 7–11 Sept)
- TE1.A: Flood Modelling
- TE1.B: Hydrological Monitoring and Statistics

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- SIS1.A: Spatial Data Visualization
- SIS1.B: Digital Elevation Models Creation

Spatial Planning for Governance (SPG, scheduled in week 4, 21 Sept – 25 Sept)
- SPG1.A: Climate-Resilience and Vulnerability Assessment
- SPG1.B: Stakeholder Analysis

The text below is applicable to SPG1.A: Climate-Resilience and Vulnerability Assessment

CONTENT
Considering the impacts of climate change and other technological and societal developments, there is an urgent need for urbanized cities and regions to become more resilient. A resilient system is able to sustain key functions when disruptions, e.g. due to natural hazards or extreme weather events, occur. In this choice topic you will be introduced to different aspects of climate resilience with focus on: what (urban) resilience is about and why it has become such a relevant concept, how the resilience of systems and the vulnerability of people can be assessed as well as how resilience can be strengthened, for example, through the implementation of different types of infrastructure and emergency management.

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

COMPULSORY TEXTBOOK(S)
- Links to a selection of journal articles (available online) will be provided on Canvas.

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

LO 1 Explain, select and apply concepts, methods and frameworks to assess (urban) climate resilience and the vulnerability of societal groups.

LO 2 Propose policies and measures to improve (urban) climate resilience.
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STAKEHOLDER ANALYSIS (SPG1.B)

INTRODUCTION
Six choice topics are offered as part of the first case study project. Each choice topic has an estimated study load of 42 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 six choice topics are:

Technical Engineering (TE, scheduled in week 2, 7– 11 Sept)
- TE1.A: Flood Modelling
- TE1.B: Hydrological Monitoring and Statistics

Spatial Information Sciences (SIS, scheduled in week 3, 14 – 18 Sept)
- SIS1.A: Spatial Data Visualization
- SIS1.B: Digital Elevation Models Creation

Spatial Planning for Governance (SPG, scheduled in week 4, 21 Sept – 25 Sept)
- SPG1.A: Climate-Resilience and Vulnerability Assessment
- SPG1.B: Stakeholder Analysis

The text below is applicable to SPG1.B: Stakeholder Analysis

CONTENT
This choice topic provides students with the opportunity to 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 an appropriate intervention.

Students will be encouraged to broaden their perspective on the role of different stakeholders in water-related projects and look at the value of incorporating expertise and knowledge from different parts of society.

Games, lectures, readings, and videos will introduce the theory of stakeholder involvement and analysis. In support of students’ selected Climate Resilient Cities Project, various tools commonly used in Stakeholder Analysis will be practiced.

TEACHING AND LEARNING APPROACH
Games, lectures, readings, and videos will introduce the theory of Stakeholder Involvement and Analysis. In support of students’ selected Climate Resilient Cities Project, various tools commonly used in Stakeholder Analysis will be practiced in class. Approaches and tools to achieve Stakeholder Involvement are highlighted by guest lectures and/or excursion.

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

OTHER STUDY MATERIAL
- Various online videos.
- Online interactive tools for stakeholder analysis.

ORGANIZATION AND PLANNING
Admission criteria

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

LO 1 identify, list and prioritize stakeholders for a given problem situation
LO 2 identify stakeholders’ perceptions and needs related to the problem situation
LO 3 involve stakeholders in designing an intervention to contribute to solving the problem

ALLOCATED TIME PER TEACHING AND LEARNING METHOD

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<th>Teaching / learning method</th>
<th>Hours</th>
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FLOOD MODELLING (TE1.A)

Course 201800216
Period 31 August 2020 - 06 November 2020
Course coordinator Jetten, V.G. (Victor, prof.dr.)

INTRODUCTION
Six choice topics are offered as part of the first case study project. Each choice topic has an estimated study load of 42 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 six choice topics are:

Technical Engineering (TE, scheduled in week 2, 7– 11 Sept)
- TE1.A: Flood Modelling
- TE1.B: Hydrological Monitoring and Statistics

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- SIS1.A: Spatial Data Visualization
- SIS1.B: Digital Elevation Models Creation

Spatial Planning for Governance (SPG, scheduled in week 4, 21 Sept – 25 Sept)
- SPG1.A: Climate-Resilience and Vulnerability Assessment
- SPG1.B: Stakeholder Analysis

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.

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.

COMPULSORY TEXTBOOK(S)
ENTRY REQUIREMENTS
Admission criteria

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

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<th>Teaching / learning method</th>
<th>Hours</th>
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<tbody>
<tr>
<td>Lecture</td>
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CASE STUDIES

HYDROLOGICAL MONITORING AND STATISTICS (TE1.B)

Course 201800215
Period 31 August 2020 - 06 November 2020
Course coordinator Salama, S. (Suhyb, dr.ir.)

INTRODUCTION
Six choice topics are offered as part of the first case study project. Each choice topic has an estimated study load of 42 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 six choice topics are:

Technical Engineering (TE, scheduled in week 2, 7–11 Sept)
- TE1.A: Flood Modelling
- TE1.B: Hydrological Monitoring and Statistics

Spatial Information Sciences (SIS, scheduled in week 3, 14–18 Sept)
- SIS1.A: Spatial Data Visualization
- SIS1.B: Digital Elevation Models Creation

Spatial Planning for Governance (SPG, scheduled in week 4, 21 Sept – 25 Sept)
- SPG1.A: Climate-Resilience and Vulnerability Assessment
- SPG1.B: Stakeholder Analysis

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.

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.

COMPULSORY TEXTBOOK(S)
ENTRY REQUIREMENTS
- admission requirements

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

LO 1 Understand 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

<table>
<thead>
<tr>
<th>Teaching / learning method</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lecture</td>
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<td>17</td>
</tr>
<tr>
<td>Written/oral test</td>
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</tbody>
</table>
CASE STUDIES

FOOD AND WATER SECURITY

Course 201800237
Period 09 November 2020 - 29 January 2021
EC 15
Course coordinator Groen, T.A. (Thomas, dr.ir.)

INTRODUCTION
Natural resources in the Mara River Basin (Kenya), such as water and primary productivity of ecosystems, are important for different stakeholders. Stakeholders all suffer from the effects non-sustainable use of these natural resources. They also suffer periodically from drought spells. However, the way in which they are affected and the solutions to mitigate the effects of this are not necessarily the same. Therefore, what is considered as a solution for one stakeholder can cause problems for other stakeholders. In this project you have to analyze the situation in the Mara River Basin and develop a research report for professionals assisting the local government (Narok County Executive) in which you make an initial analysis of problems related to food and water insecurity as a result of non-sustainable use of natural resources. Subsequently, the group identifies a problem the group find most interesting to tackle and identifies the different stakeholders for this problem. The report should propose at least 1 effective and robust intervention to address the identified problem from the view point of one stakeholder.

CONTENT
The content that will be offered in this project will consists of group work, key note lectures, choice topics and tutorials. The tutorials on offer in case study project 2 emphasize techniques and/or methodologies that can be directly applied to the case. 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: Data Acquisition
TU3: Scenario Development
TU4: Data Visualisation
TU5: Vegetation Mapping and Monitoring
TU6: Rangeland Assessment with MARIS Workflow
Tutorials are not obligatory.

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.
**CASE STUDIES**

**TESTS**

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

The two group-based assessments are:

1. **Mid-term poster presentation** (SA1, weight: 15% of the final mark) submitted by student teams at the end of week 6
2. **Final report** (SA2, 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:

3. **Written test** (SA3, weight: 20% of the final mark) on the theory taught during the selected choice topics in the middle of week 5 and the resit takes place in week 10.
4. **Oral test** (SA4, weight: 40% of the final mark) on the entire learning process during the case study project.

Ad 1) **Mid-term poster**

The mid-term poster presentation is the output of the initial analysis of the case and delineates the possible interventions that will be analysed in the remainder of the project.

Ad 2) **Final report**

The final report is the output of the complete case study project and should include materials from all phases of the project, project analysis, intervention and design, and advice and presentation. The final report should describe the following: how stakeholders were identified, how the research was set up, how the impact on stakeholders was quantified, explanation and interpretation of sources of uncertainty (including decision maker uncertainty in scenario analysis) the probabilities of events happening, how scenarios were developed and on which principles the intervention was designed. It should consider at least 2 of the concepts equity, empowerment and equality in the comparison of the impact of the intervention on other stakeholders, based on the state-of-the-art of the scientific discipline of that field.

Ad 3) **Written test**

The written test focuses on assessment of the theory taught during the choice topics. In case study project 2, students choose four out of eight choice topics and will only take the written test for three of selected 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 4) **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 skills learning lines.

The student can request for a second test opportunity, which must take place before the start of the second study year. It is the student's responsibility to contact the examiner and make the appointment for the 2nd test opportunity.

**Personal Development Portfolio**

Students provide insight into their study choices, participation and progress through a Personal Development Portfolio. This Personal Development Portfolio contains the choices the student has 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 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.
ENTRY REQUIREMENTS
Joining the previous case study unit 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
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 Analyse (provided) databases of information for their suitability (e.g. completeness, quality and lineage) to analyse and model the problem at hand
LO 5 Reflect on the scientific value of 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

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</thead>
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<td>Group assignment</td>
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<tr>
<td>Learning outcomes (LO) of the course: The student will be able to...</td>
<td>Mid-term poster</td>
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<tr>
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<tr>
<td>LO 1 Identify and describe in the case study area the processes (ecological, social, economic) that influence food and water security</td>
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<td>LO 12 Reflect on own role as a team member and professional</td>
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### Learning Outcomes that are addressed in the test

<table>
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<tr>
<th>LO 13</th>
<th>Reflect on how cultural differences between stakeholders may affect the acceptance of the proposed intervention</th>
<th>Mid-term poster</th>
<th>Final project report</th>
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<td></td>
<td></td>
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<tr>
<td>Number of test opportunities per academic year</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
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</table>
INTRODUCTION
The project
In this project the students will prepare a research report and a presentation for professionals assisting the local government (Narok County Council) in which the students:

- Make an initial analysis of the problem of food and water insecurity as a result of non-sustainable use of natural resources;
- Identify the different stakeholders;
- Describe the processes involved and develop at least three scenarios for the future of the area;
- Propose at least one effective and robust intervention to address the problem of food and water insecurity in the area from the viewpoint of one stakeholder;
- Analyse how this intervention mitigates the impact of food and water insecurity for the selected stakeholder, and at least two other identified stakeholders. Consider at least two concepts out of equity, empowerment and equality in this comparison.

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.

Requirements
Students will argue from the viewpoint of one stakeholder what an effective and robust intervention would be. Students will start by assessing the impact of non-sustainable use of natural resources for different stakeholders and how these impacts can be mitigated by possible interventions. Students will develop at least three scenarios for the next five years and will assess the impact of at least one intervention under these scenarios to improve food and water security for the selected stakeholder in the area. The choice of used model(s) and data are to be justified and the effects of uncertainty in data and models are to be described. This includes an assessment of how effective and robust the intervention possibly is.

Output
The final report should describe the following: how stakeholders were identified, how the research was set up, how the impact on stakeholders was quantified, explanation and interpretation of sources of uncertainty (including decision maker uncertainty in scenario analysis) the probabilities of events happening, how scenarios were developed and on which principles the intervention was designed. It should consider at least two of the concepts sustainability, equity, empowerment, equality and fairness in the comparison of the impact of the intervention on other stakeholders, based on the state-of-the-art of the scientific discipline of that field.

The presentation conveys the information on the possible scenarios and intervention(s) and their impact on food and water security effectively using written and oral tools to professionals advising the local government (Narok County Council).

Key knowledge fields
The study unit consists, next to project work, of tutorials and eight choice topics (study load 28 hours each) of which three have to be elected. Three choice topics have to be followed before the mid-term presentation, which come from the key knowledge fields of Technical Engineering, Spatial Information Sciences, and Spatial Planning and Governance.
CONTENT
Tutorials
Tutorials on offer in case study project 2 emphasize techniques and/or methodologies that can be directly applied to the case. 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: Data Acquisition
TU3: Scenario Development
TU4: Data Visualisation
TU5: Vegetation Mapping and Monitoring
TU6: Rangeland Assessment with MARIS Workflow
Tutorials are not obligatory.
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
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 quartile 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
- Identifying how preconceptions have affected his/her research design and suggesting ways to overcome those.

TEACHING AND LEARNING APPROACH
Short lectures and tutorials in which skills can be practiced

TESTS
Project report and oral test.

COMPULSORY TEXTBOOK(S)
The main materials for academic skills consist of two volumes. These are available both as a hardcopy and as a softcopy. Volume 1 contains material related to research principles and concepts, Volume 2 contains materials related to specific skills needed when doing research. These volumes can be used as reference material through the programme. Some additional materials will also be made available when required.

OTHER STUDY MATERIAL
You also may use the SAGE Research Methods website which has a lot of specific materials on all aspects of research, though it is somewhat biased toward social science research.
http://methods.sagepub.com/methods-map
ENTRY REQUIREMENTS
- Personal plan for development and portfolio from case study project 1
- Participation in case study project 1

ALLOCATED TIME PER TEACHING AND LEARNING METHOD

<table>
<thead>
<tr>
<th>Teaching / learning method</th>
<th>Hours</th>
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</thead>
<tbody>
<tr>
<td>Tutorial</td>
<td>8</td>
</tr>
<tr>
<td>Self-study</td>
<td>6</td>
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</table>
CASE STUDIES

INTERNATIONAL AND INTERCULTURAL COMPETENCES

Course 201800239
Period 09 November 2020 - 29 January 2021
Course coordinator Georgiadou, P.Y. (Yola, prof.dr.)

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, 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).

COMPULSORY TEXTBOOK(S)

Readers and teaching material will be provided by teaching staff.

ENTRY REQUIREMENTS
- Personal plan for development and portfolio from case study project 1
- Participation in case study project 1
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;
- Identify any significant risks or threats to the fulfilment of the objectives and develop strategies to mitigate them;
- Use support tools (such as logical framework, stakeholder matrix, SWOT analysis, problem trees, …) during the problem analysis;
- Develop a project time-planning with intermediate milestones, activities and deadlines (e.g. Gantt-chart).

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
- Participation in case study project 1
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. The reflected part of the EM is measured by sensors and stored in large datasets. 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, basic radiometric operations are explained and applied.

The topics which will be covered in the course are

- Physics of Remote Sensing
- Sensors and Image characteristic
- Visualization and radiometric operations
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

COMPULSORY TEXTBOOK(S)

Chapter 2 Physics,

- Paragraph 4.1 Platforms and passive electro-optical sensors,
- Paragraph 5.1 visualization and radiometric operations and Paragraph 5.2 correction of atmospheric disturbance

Other readers and teaching material will be provided by teaching staff

ENTRY REQUIREMENTS
Participation in case study project 1

ORGANIZATION AND PLANNING
Access to dark room for spectrometer demonstration

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

LO 1 Interprete 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 radiometric corrections.

ALLOCATED TIME PER TEACHING AND LEARNING METHOD

<table>
<thead>
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<th>Hours</th>
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</tr>
<tr>
<td>Written/oral test</td>
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</table>
IMAGE CLASSIFICATION (SIS2.B)

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.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
CASE STUDIES

COMPULSORY TEXTBOOK(S)

OTHER STUDY MATERIAL
Lecture material including lecture slides will be provided through the online system.

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

<table>
<thead>
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<tbody>
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<td>Self-study</td>
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</tr>
<tr>
<td>Written/oral test</td>
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</table>
SPATIAL STATISTICS (SIS2.C)

Course 201800248
Period 09 November 2020 - 29 January 2021
Course coordinator Osei, F.B. (Frank, dr.)

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

COMPULSORY TEXTBOOK(S)

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

<table>
<thead>
<tr>
<th>Teaching / learning method</th>
<th>Hours</th>
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<tbody>
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<tr>
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</table>
MARKETS AND VALUE CHAIN ANALYSIS (SPG2.A)

Course 201800244
Period 09 November 2020 - 29 January 2021
Course coordinator Boerboom, L.G.J. (Luc, dr.ir.)

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
COMPULSORY TEXTBOOK(S)

ENTRY REQUIREMENTS
Participation in case study project 1

ORGANIZATION AND PLANNING
1-day excursion following an agricultural value chain around Enschede

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

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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
- ‘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

COMPULSORY TEXTBOOK(S)
- DEFRA, 2014. Making the Most of Our Evidence - a Strategy for DEFRA and its network

ENTRY REQUIREMENTS
Participation in case study project 1

ORGANIZATION AND PLANNING
ITC decision room

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

<table>
<thead>
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<tbody>
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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 unsupervised practicals and plenary discussions

TESTS
Written test

COMPULSORY TEXTBOOK(S)
Selected articles related to the topic.

OTHER STUDY MATERIAL
Interactive presentations

ENTRY REQUIREMENTS
Basic knowledge in GIS, Participation in case study project 1

ORGANIZATION AND PLANNING
Room type: suitable to give presentations and do also practical exercises (1 room).

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
<table>
<thead>
<tr>
<th>Teaching / learning method</th>
<th>Hours</th>
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<tbody>
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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.

**TESTS**
Written test
COMPULSORY TEXTBOOK(S)
Materials will be handed out during the lecture, but in case additional reading is requested by the students, the below references are suggested.


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

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</tr>
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</tbody>
</table>
DYNAMIC MODELLING (TE2.B)

**Course** 201800247

**Period** 09 November 2020 - 29 January 2021

**Course coordinator** Groen, T.A. (Thomas, dr.ir.)

**INTRODUCTION**

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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 **TE2.B: Dynamic Modelling**

**CONTENT**

The course will teach how to simulate dynamical systems, with a focus on the dynamics in ecological systems, such as grassland ecosystems, where grazers consume a large portion of the vegetation. Ordinary differential equations and their discrete implementations will be simulated using InsightMaker as a platform.

**TEACHING AND LEARNING APPROACH**

Lectures, exercises, discussion, literature

**TESTS**

Written test

**COMPULSORY TEXTBOOK(S)**

Readers and teaching material will be provided by teaching staff

**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

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</tbody>
</table>
HUMAN-INDUCED EARTH MOVEMENT

Course 201800250
Period 01 February 2021 - 16 April 2021
EC 15
Course coordinator Ostermann, F.O. (Frank, dr.)

INTRODUCTION
This 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.

CONTENT
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 both 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. In the Netherlands, we have such knowledge compiled in databases such as DINO. 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.

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

Project Inception Phase (weeks 1-4): teacher-assisted group work (self-study materials, flipped classroom lectures, supervised workshops, tutorials, resulting in mid-term poster) and individual work (choice topics including written test).

Project Implementation Phase (weeks 5-8): independent group project work (teacher assistance through discussion forums, question and answer hours).

Project Presentation and Assessment Phase (weeks 9-10): continued independent group project work (teacher assistance through discussion forums, question and answer hours), and assessment (simulated public debate, project report deliverable, oral tests).
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.

For all summative assessments, the learning outcomes are available in this document. Students receive this complete test plan before the start of the study unit. The rubric will be available at the beginning of the course in the learning management system. 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.
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 intense, sudden onset events such as 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 LO 1 and LO 2, considering multiple (authoritative and participatory) 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 Analyze interests of relevant stakeholder groups and their policy and financial constraints, by systematically investigating common and opposing elements
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

<table>
<thead>
<tr>
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<td>Group assignment</td>
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**TESTPLAN**

<table>
<thead>
<tr>
<th>Learning outcomes (LO) of the course: The student will be able to...</th>
<th>Mid-term poster</th>
<th>Core knowledge test</th>
<th>Final report</th>
<th>Final oral test</th>
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<tbody>
<tr>
<td>LO 1 Explain processes in the case study area that make it susceptible to intense, sudden onset events such as human-induced earth movements</td>
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<tr>
<td>LO 2 Differentiate multiple governance perspectives on human-induced earth movement</td>
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<td>LO 3 Collect and process spatio-temporal data and information required for LO 1 and LO 2, considering multiple (authoritative and participatory) sources</td>
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<td>LO 4 Develop a Personal Development Portfolio that identifies and describes gaps in own knowledge</td>
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<td>LO 6 Plan a project, formulating SMART objectives and demonstrating project and time management skills</td>
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<td>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</td>
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<td>LO 8 Compare systematically multiple possible interventions for the case study area and analyse strengths, weaknesses, costs, and benefits</td>
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<td>LO 9 Analyze interests of relevant stakeholder groups and their policy and financial constraints, by systematically investigating common and opposing elements</td>
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<td>LO 10 Evaluate and reflect on professional and team roles of project group members, including his/her own</td>
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<td>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.</td>
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<td>Learning Outcomes that are addressed in the test</td>
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<tr>
<td>LO 12 Evaluate and account for own cultural sensitivity and ethical values in project process and outcomes</td>
<td><img src="https://via.placeholder.com/150" alt="Test type" /> <img src="https://via.placeholder.com/150" alt="Mid-term poster" /> <img src="https://via.placeholder.com/150" alt="Core knowledge test" /> <img src="https://via.placeholder.com/150" alt="Final report" /> <img src="https://via.placeholder.com/150" alt="Final oral test" /></td>
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<td>1</td>
<td>2</td>
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</table>
## INTRODUCTION
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 fuelled a public and political debate about the future of the gas exploitation in the area. Several distinct stakeholder groups in this debate argue for continuation, reduction, or complete stop of gas exploitation.

## TEACHING AND LEARNING APPROACH
During the first week, the students form project groups that are going to represent one stakeholder group (e.g. municipality, citizens, …), and will then continue to develop intervention(s) that support their particular stakeholder group’s interests. However, for successfully addressing the wickedness of the problem, they will also have to take the arguments from other stakeholder groups 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 then present and defend their proposed interventions in a simulated public debate. As final deliverables, they will prepare a technical report, a short reflection on project work, and a document for the general public.

### Table: Project Work Human-Induced Earth Movement

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<thead>
<tr>
<th>Course</th>
<th>201800263</th>
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<tbody>
<tr>
<td>Period</td>
<td>01 February 2021 - 16 April 2021</td>
</tr>
<tr>
<td>Course coordinator</td>
<td>Ostermann, F.O. (Frank, dr.)</td>
</tr>
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</table>
ACADEMIC AND RESEARCH SKILLS

**Course** 201800253

**Period** 01 February 2021 - 16 April 2021

**Course coordinator** Boer, C.L. de (Cheryl, dr.)

**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:

- Collect and analyse information from stakeholders through interviews and questionnaires;
- Prepare a data management plan
- Reflect on 'wicked' problems.

**TEACHING AND LEARNING APPROACH**
Tutorials, video-supported interview training

**TESTS**
Project report and oral test

**COMPULSORY TEXTBOOK(S)**
The main materials for academic skills consist of two volumes. These are available both as a hardcopy and as a softcopy. Volume 1 contains material related to research principles and concepts, Volume 2 contains materials related to specific skills needed when doing research. These volumes can be used as reference material through the programme. Some additional materials will also be made available when required.

**OTHER STUDY MATERIAL**
You also may use the SAGE Research Methods website which has a lot of specific materials on all aspects of research, though it is somewhat biased toward social science research.

http://methods.sagepub.com/methods-map

**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  Be able to prepare a data management plan
LO 2  Be able to prepare an interview or questionnaire to acquire information from stakeholders.
<table>
<thead>
<tr>
<th>Teaching / learning method</th>
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<tbody>
<tr>
<td>Lecture</td>
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<td>Tutorial</td>
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<tr>
<td>Self-study</td>
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</tbody>
</table>
INTERNATIONAL AND INTERCULTURAL COMPETENCES

Course: 201800252
Period: 01 February 2021 - 16 April 2021
Course coordinator: Georgiadou, P.Y. (Yola, prof.dr.)

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:

- Prepare for social primary data collection;
- Describe framing (problem, cause, solution) and give examples of risk framing;
- Describe cultural patterns in the perception of risks.

TEACHING AND LEARNING APPROACH
Lecture, supervised practical and self-study

TESTS
Assessment is integral part of group report and titled "Analysis and synthesis of media reports and stakeholders' risk perceptions in Groningen." It includes transcripts of group interviews in appendix.

COMPULSORY TEXTBOOK(S)

ENTRY REQUIREMENTS
- Personal plan for development and portfolio from case study projects 1 and 2
- Participation in case study projects 1 and 2
**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:

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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:

- Draft a project budget based on the project plan, staff input and planned activities;
- Evaluate the group’s progress with reference to the project plan, identify changes and mitigation measures;
- Evaluate proposals, including budget, according to a set of criteria.

**TEACHING AND LEARNING APPROACH**

Lectures, formative feedback at planning stage, peer-review discussion session, self-study

**TESTS**

Project plan (proposal) and budget, peer-review report, self-assessment (PDP) and oral test

**COMPULSORY TEXTBOOK(S)**

- Readers and teaching material will be provided by teaching staff.

**ENTRY REQUIREMENTS**

- Personal plan for development and portfolio from case study projects 1 and 2
- Participation in case study projects 1 and 2
3D/TEMPORAL VISUALIZATIONS IN COLLABORATIVE ENVIRONMENT (SIS3.A)

Course 201800257
Period 01 February 2021 - 16 April 2021
Course coordinator Raposo, P. (Paulo, dr.)

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
COMPULSORY TEXTBOOK(S)
Selected Chapters from:

ENTRY REQUIREMENTS
Participation in case study projects 1 and 2

ORGANIZATION AND PLANNING
Geovisual Analytics Laboratory

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

<table>
<thead>
<tr>
<th>Teaching / learning method</th>
<th>Hours</th>
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<tbody>
<tr>
<td>Lecture</td>
<td>6</td>
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<tr>
<td>Supervised practical</td>
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</tr>
<tr>
<td>Self-study</td>
<td>15</td>
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<tr>
<td>Written/oral test</td>
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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 adoption of Web 2.0 technologies facilitates the convenient generation and sharing of digital content and the collaboration on other projects. However, the concept of participation is not new, and participatory GIS a research domain with a long tradition. 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 relevant for eliciting and arguing the needs, interests, and positions of any stakeholder group 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
COMPULSORY TEXTBOOK(S)

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 public participation and their impact on research design
LO 2 Select appropriate participatory data sources and tools
LO 3 Integrate different crowdsourced, volunteered, or authoritative information sources
LO 4 Discuss issues of new data sources with respect to research design

ALLOCATED TIME PER TEACHING AND LEARNING METHOD

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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.

TESTS
Written test
**COMPULSORY TEXTBOOK(S)**

Readers and teaching material will be provided by teaching staff; examples are given below:


**ENTRY REQUIREMENTS**

Participation in case study projects 1 and 2

**ALLOCATED TIME PER TEACHING AND LEARNING METHOD**

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<thead>
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**CASE STUDIES**

**INTRODUCTION**
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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.

**TESTS**
Written test
COMPULSORY TEXTBOOK(S)


ENTRY REQUIREMENTS
Participation in case study projects 1 and 2

ALLOCATED TIME PER TEACHING AND LEARNING METHOD

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<td>Written/oral test</td>
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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 earthquakes as a result of gas extraction 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 and earthquakes. 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

COMPULSORY TEXTBOOK(S)

Readers and teaching material will be provided by teaching staff.

OTHER STUDY MATERIAL

Lecture notes
ENTRY REQUIREMENTS
Participation in case study projects 1 and 2

ORGANIZATION AND PLANNING
Personal laptops and software (Matlab, UT licenses) and Pix4D (free license) downloading are required

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

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<td>Written/oral test</td>
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</tbody>
</table>
CASE STUDIES

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

Course 201800256
Period 01 February 2021 - 16 April 2021
Course coordinator Mavrouli, O.C. (Olga, dr.)

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.

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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.B: Seismic Hazard above Gas Reservoirs (Regional Scale)

CONTENT
In this lecture series students will learn the basics on gas exploration and the resulting compaction and stresses on and in the reservoir. Due to release of stress in earthquakes, seismic waves will propagate from the reservoir to the surface. The different kind of waves that originate from reservoirs and their specific characteristics, in terms of motion and propagation, will be discussed. Knowledge on 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 for assessing the vulnerability of a society. Regional deformation due to earthquakes will be analysed using InSAR analysis.

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

- Describe the basics about gas exploration and resulting reservoir dynamics;
- 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

COMPULSORY TEXTBOOK(S)
Readers and teaching material will be provided by teaching staff.
ENTRY REQUIREMENTS
Participation in case study projects 1 and 2

ORGANIZATION AND PLANNING
Computer, SARScape or alternative

ALLOCATED TIME PER TEACHING AND LEARNING METHOD

<table>
<thead>
<tr>
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</tr>
</tbody>
</table>
ACADEMIC SKILLS

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.

COMPULSORY TEXTBOOK(S)
Lecture notes and provided articles.

OTHER STUDY MATERIAL
Supplementary publications and other materials that students will identify for their own topic through a literature search.

ENTRY REQUIREMENTS
Participation in case study projects 1, 2 and 3

ORGANIZATION AND PLANNING
Students are expected to attend lectures, participate in peer review sessions and work individually on the assignment. Most sessions will be followed together with students of the M-GEO programme.
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

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<tbody>
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<td>Tutorial</td>
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<tr>
<td>Individual assignment</td>
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</table>
## Learning Outcomes that are addressed in the test

<table>
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<th>Learning outcomes (LO) of the course: The student will be able to...</th>
<th>Assignment</th>
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<tbody>
<tr>
<td>LO 1 Effectively communicate research process and outcomes</td>
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</tr>
<tr>
<td>LO 2 Critically reflect on their performance in the design and execution of research tasks</td>
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<td>Weight of the test</td>
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<tr>
<td>Individual or group test</td>
<td>Individual</td>
</tr>
<tr>
<td>Type of marking</td>
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</table>
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 including 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.

Learning outcomes
At the end of this course the student is able to...

1. Identify and describe gaps in his/her knowledge, with a view towards his/her thesis phase
2. Specialise in topics of the student's choice
3. Reason how the expert he/she has become is positioned within, and will be a benefit to, multidisciplinary project teams

Further learning outcomes will be inherited from the electives the student chooses.

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.
INTRODUCTION
The international module aims to provide different views on the knowledge fields as well as provide students with contacts for their internship or later job. By means of an international excursion to several (European) institutes and companies relevant to the knowledge fields of Spatial Engineering. During the preparation of the excursion the last workshop of the skills learning line International and Intercultural Competences will be planned.

CONTENT
Preparation for the visits, collect and read literature on host organisations, projects and topics in the excursion, prepare questions for the hosts and a presentation of M-SE.

Excursion to several (European) institutes and companies relevant to the knowledge field of Spatial Engineering.

Preparation of a joint report on the results of the excursion.

Workshop in internationalisation skill learning line followed by an essay.

TEACHING AND LEARNING APPROACH
During the excursion, we will visit several European institutes and companies in the knowledge fields of Spatial Engineering. These will vary from year to year. Care will be taken to have a good mix of research organizations, governmental organizations and private companies, to provide different views on the knowledge fields and also to provide the students with contacts for their internship or later job. Staff will organise the logistics, while students are in charge of preparing content. Staff will ask the host organizations to show at least one concrete project in the field of Spatial Engineering.

Students will be divided in teams, each team responsible for the content of one or two days. Preparation consists of going through relevant information about the host organization and the project(s) to be discussed and preparing questions for discussion after the presentations of the host institute. Students prepare a discussion with elements of the technical aspects, but also include stakeholder- and governance related questions and ethical dilemmas. The latter can be related to the workshops on international skills, principles in codes of engineering ethics, dystopia and utopia in the big data era, ethics in digital interventions and elements of empathic engineering.

Each student steam gives a briefing beforehand to prepare the others for the context of the visit. Afterwards, they will reflect on the content of that day related to Spatial Engineering and especially the case study projects in a written report. The daily reports will be input to one final common report for the excursion. If the group is large, the coordinator may decide to form two groups, each writing a final report.

An approved preparation plan is mandatory for access to the actual excursion.

The internationalisation skill learning line finishes in this module with a workshop and an essay on geo-ethics.
TESTS
- Preparation plan (20%, team, at least a pass to have access to the actual excursion)
- Personal plan for development and Portfolio (individual, pass/fail access to the actual excursion)
- Final report and presentation (50%, group)
- Essay on geo-ethics (30%, individual)

COMPULSORY TEXTBOOK(S)
To be determined by staff and students, based on which organizations are visited.

International skills

ENTRY REQUIREMENTS
Participation in the first year of Master's programme Spatial Engineering

ORGANIZATION AND PLANNING
Transport, hotel accommodation for which students will not have additional costs. Rooms will be shared. Th
All breakfasts will be included, as well as lunches on working days. The lunches in the weekend are at the choice and expense of the student. Depending on budget and logistics, staff may choose to provide a number of dinners to facilitate (mandatory) group discussion.
LINK BETWEEN THE LEARNING OUTCOMES OF THE COURSE AND OF THE PROGRAMME
The International module relates to the Learning Outcomes 1, 2, 4, 5, 6 and 7 of the M-SE in the following way:

LO 1: Is an expert in integrated knowledge development
- Identifies and describes gaps in own knowledge in a Personal Development Plan: describes learning objectives for the excursion.

LO2: Does research in a purposeful and methodological way
- Applies the ‘wicked’ problem framework to analysis of a problem in the excursion area;
- Formulates research questions;
- Finds and evaluates scientific knowledge of the excursion area, identifying data/information/knowledge gaps.

LO4: Has an academic approach to the development, justified use and validation of theories and models
- Applies scientific reasoning;
- Adheres to giving proper credit and referencing.

LO5: Is competent in reasoning, reflection and judgement
- Defines clear operationalized fact-finding questions on stakes and interests for the excursion;
- Interacts with host organizations in the excursion area to obtain information for analyses;
- Presents the results, underlying knowledge, choices and considerations, learnt in the during the excursion.

LO6: Is competent in co-operation and communication
- Participates effectively and shares knowledge within the project team/group;
- Describes role as a team member, reflects on own strengths and weaknesses in working in a team, evaluates own professional behaviour;
- Demonstrates time management skills;
- Conveys information effectively using written and oral tools.

LO7: Can work internationally as a global citizen and as an empathic engineer
- Reflects on the international differences experienced during the excursion (comparing country of origin with destinations);
- Evaluates own professional and ethical values and evaluate own performance being part of an international, multidisciplinary and multicultural team;
- Describes their 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.
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: describe learning objectives for the excursion
LO 2 Apply the ‘wicked’ problem framework to analysis of a problem in the excursion area
LO 3 Formulate research questions
LO 4 Find and evaluate scientific knowledge of the excursion area, identifying data/ information/ knowledge gaps
LO 5 Apply scientific reasoning
LO 6 Adhere to giving proper credit and referencing
LO 7 Define clear operationalized fact-finding questions on stakes and interests for the excursion
LO 8 Interact with host organizations in the excursion area to obtain information for analyses
LO 9 Present the results, underlying knowledge, choices and considerations, learnt during the excursion
LO 10 Participate effectively and share knowledge within the project team
LO 11 Describe role as a team member, reflect on own strengths and weaknesses in working in a team, evaluate own professional behavior
LO 12 Demonstrate time management skills
LO 13 Convey information effectively using written and oral tools
LO 14 Reflect on the international differences experienced during the excursion (comparing country of origin with destinations)
LO 15 Evaluate own professional and ethical values and evaluate own performance being part of an international, multidisciplinary and multicultural team
LO 16 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

<table>
<thead>
<tr>
<th>Teaching / learning method</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Study trip</td>
<td>80</td>
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<tr>
<td>Lecture</td>
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<tr>
<td>Group assignment</td>
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<tr>
<td>Individual assignment</td>
<td>26</td>
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<tr>
<td>Self-study</td>
<td>24</td>
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## Learning Outcomes that are addressed in the test

<table>
<thead>
<tr>
<th>Learning outcomes (LO) of the course: The student will be able to...</th>
<th>Preparation plan</th>
<th>Excursion report</th>
<th>PDP</th>
<th>Essay on geo-ethics</th>
</tr>
</thead>
<tbody>
<tr>
<td>LO 1 Identify and describe gaps in own knowledge in a Personal Development Plan: describe learning objectives for the excursion</td>
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<tr>
<td>LO 2 Apply the ‘wicked’ problem framework to analysis of a problem in the excursion area</td>
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<tr>
<td>LO 3 Formulate research questions</td>
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<td>LO 4 Find and evaluate scientific knowledge of the excursion area, identifying data/ information/ knowledge gaps</td>
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<tr>
<td>LO 5 Apply scientific reasoning</td>
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<tr>
<td>LO 6 Adhere to giving proper credit and referencing</td>
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<tr>
<td>LO 7 Define clear operationalized fact-finding questions on stakes and interests for the excursion</td>
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<tr>
<td>LO 8 Interact with host organizations in the excursion area to obtain information for analyses</td>
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<td>LO 9 Present the results, underlying knowledge, choices and considerations, learnt during the excursion</td>
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<td>LO 10 Participate effectively and share knowledge within the project team</td>
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<td>LO 11 Describe role as a team member, reflect on own strengths and weaknesses in working in a team, evaluate own professional behavior</td>
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<tr>
<td>LO 12 Demonstrate time management skills</td>
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<tr>
<td>LO 13 Convey information effectively using written and oral tools</td>
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</tr>
<tr>
<td>LO 14 Reflect on the international differences experienced during the excursion (comparing country of origin with destinations)</td>
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<tr>
<td>LO 15 Evaluate own professional and ethical values and evaluate own performance being part of an international, multidisciplinary and multicultural team</td>
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</table>
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<th>Essay on geo-ethics</th>
</tr>
</thead>
<tbody>
<tr>
<td>LO 16 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</td>
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<table>
<thead>
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<th>Test type</th>
<th>Report</th>
<th>Report</th>
<th>Personal Development Portfolio</th>
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<tr>
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<td>50</td>
<td>30</td>
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<tr>
<td>Individual or group test</td>
<td>Group</td>
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<td>Individual</td>
<td>Individual</td>
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<tr>
<td>Type of marking</td>
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<td>1-10</td>
<td>Completed/fail</td>
<td>1-10</td>
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<tr>
<td>Required minimum mark per test</td>
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<td>Number of test opportunities per academic year</td>
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<td>1</td>
<td>2</td>
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</tbody>
</table>
ACADEMIC AND RESEARCH PHASE

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 research. 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 you can analyse a problem in depth, you 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 your research is for instance more technical in nature, you should reflect 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 in the EER.
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:

Supervised peer review sessions:

1. Introduction and problem setting, translate an overall (societal) problem to a research problem, based on the state of the art in knowledge as defined in peer-reviewed literature
2. Define research objectives and questions, focussing on the part that you will study. Formulate what you expect will be the outcome, as specific as possible.

There will be an introductions with examples and discussion. Your proposals will be reviewed by your peers in a guided session, with the aim to create a set of objectives and questions that are as clear as possible. The research should lead to improved understanding, so apart from questions that quantify the problem (where/when/how much), there should be questions that ask "why/how" to highlight for instance cause-effect relations. It helps if you create a conceptual diagram in which the different parts are logically related, and if you define a hypothesis that can be tested.

Sessions with your supervisors:

1. Methodology (analysis tools and methods), and inventory of necessary data (including acquisition of field data and possible lab analyses)
2. Time schedule and planning of activities
3. Contingency planning: is all data available, what is your plan b?

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 is 30 EC 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 changes from more instructive to peer-level discussion. 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.
TESTS
There are three test 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.

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.

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

<table>
<thead>
<tr>
<th>Teaching / learning method</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual assignment</td>
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## Learning Outcomes that are addressed in the test

<table>
<thead>
<tr>
<th>Learning outcomes (LO) of the course: The student will be able to...</th>
<th>Proposal</th>
<th>Thesis</th>
<th>Process and Defense</th>
</tr>
</thead>
<tbody>
<tr>
<td>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.</td>
<td>●</td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>LO 2 Define a clear structured methodology with conscious and justifiable choices between different modelling techniques for spatio-temporal processes.</td>
<td>●</td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>LO 3 Collect and analyse relevant data and information, and use, develop and validate models, working in a transparent and fully reproducible way.</td>
<td></td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>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.</td>
<td></td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>LO 5 Work in a structured and independent way, while making adequate use of the guidance of the supervisor</td>
<td></td>
<td></td>
<td>●</td>
</tr>
<tr>
<td>LO 6 Convey written information effectively using a professionally written and structured research proposal and thesis</td>
<td>●</td>
<td>●</td>
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</tr>
<tr>
<td>LO 7 Convey information effectively using professional visual and oral means in presenting the research</td>
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<table>
<thead>
<tr>
<th>Test type</th>
<th>Report</th>
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<th>Presentation</th>
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<tbody>
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<td>30</td>
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<td>Individual or group test</td>
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<tr>
<td>Type of marking</td>
<td>Completed/fail</td>
<td>1-10</td>
<td>1-10</td>
</tr>
<tr>
<td>Required minimum mark per test</td>
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<tr>
<td>Number of test opportunities per academic year</td>
<td>2</td>
<td>2</td>
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</tr>
</tbody>
</table>
INTRODUCTION

The MSc research is the main part of the second year. Following principles of scientific research a student, having chosen a research topic, derives a number of research questions, designs and executes a methodology to answer these and finally draws conclusions. The research is multidisciplinary, using at least two out of the three core knowledge areas of Spatial Engineering, with a strong reflection on the implications for the third area. In some cases, the research may lead to the design of one or more interventions, that adhere to principles of sustainability and that is based on the wishes/expectations of all stakeholder groups involved.

The MSc research is in total 37.5 EC, split in a proposal writing phase and a MSc thesis phase. The proposal itself is a written document that is defended in an oral test before a Proposal Assessment Board (PAB), and must be successfully completed by the PAB before the student is allowed into the research phase itself.

Details on the assessment of the Academic and Research phase can also be found in the EER.

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.

Proposal writing is organised as a peer-reviewed exercise. The proposal is developed in steps that also are the chapters in the written proposal:

1. Introduction and problem setting
2. Literature review, leading to a research hypothesis and research questions
3. Methodology (analysis tools and methods), and inventory of necessary data (including acquisition of field data and possible lab analyses)
4. Time schedule and planning of activities

These phases are discussed on a weekly basis with peers who are expected to comment on fellow proposals. The discussions are done in presence of a staff member. The different parts are supported by lectures and exercises, that help students to achieve the best result. Examples will be given showing how to derive research questions from broader societal problems, of good and bad hypotheses, and how to define helpful research questions based on gaps in knowledge in general, or relevant to the specific topic (or research area). The methodology must be detailed and specific, and leading to answers. Analysis methods and models have to be specified in detail, and based on an expected outcome and potential problems encountered. Help will be given to judge feasibility of the different parts of the research, and the methods to acquire data.

The research topic is chosen by the student in discussion with staff members during Elective's study unit. A final topic description has to be submitted to the programme manager within two weeks of starting the study unit. The topic does not have to honour equally the three core knowledge areas of Spatial Engineering, but should always contain elements of all three areas. There is freedom to specialize, but the student must be able to reflect and elaborate upon the link between the research topic and all three core knowledge areas. In the first two weeks after starting the study unit the topic must be placed within an ITC research theme.
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, university or faculty.

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.

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(s) or replacement(s). 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.

Thesis
Assuming that the objectives and methods are clear the research starts with acquisition of data. 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 students initiative. The student comes to the meetings prepared, and gives a concise summary with action points afterwards.

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.

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.
TESTS
The research work and Thesis will be officially reviewed and/or assessed on four occasions:

1. The MSc Research proposal defence. A successful defence is necessary for continuing with the research work and Thesis.
2. The mid-term presentation. No mark is given. The student receives feedback from the research theme leader (or delegate) and at least one of the supervisors. In the case of weak performance, the student will receive a written warning from the Programme Manager.
3. Academic and Research phase exam request: upon the approval of the completed MSc Research by the first supervisor the student requests the Academic and Research phase exam and submits his/her Thesis.

In addition to these formal assessments, the student will receive feedback on the student’s performance from the supervisors throughout the Academic and Research phase.

A proposal assessment board (PAB) and a Thesis Assessment Board (TAB) will assess the individual MSc research based on the written proposal, thesis and a presentation plus oral defence. The assessed aspects are:

General
1. Overall quality of writing
2. Autonomy in applying methodology
3. Adhering to timeline

Components of the thesis
1. Abstract
2. Background: theory, context. Regional setting, previous work
3. Problem definition, reflection on ‘wickedness’ and research questions
4. Method
5. Results
6. Discussion
7. Conclusion

Defence
1. Content
2. Presentation skills
3. Supporting media
4. Handling of questions

ENTRY REQUIREMENTS
Have obtained at least 50 EC of the M-SE programme
LEARNING OUTCOMES
Upon completion of this course, the student is able to:

LO 1 Derive an overall research objective from a multidisciplinary societal problem
LO 2 Find, critically assess and summarize literature from all relevant disciplines
LO 3 Identify gaps in knowledge that lead to research questions
LO 4 Link the research objectives clearly to the three knowledge domains and aim at solutions/interventions in a multidisciplinary context
LO 5 Can design a detailed, justified and well-balanced methodology that potentially answers the research questions
LO 6 Formulate expected outcomes and potential results, and identify potential for new results that guide the research methodology
LO 7 Collect and analyse relevant data and information, correctly quantifying and interpreting uncertainty, as well as scaling and resolution issues in space and time
LO 8 Make a feasible and detailed time schedule and execute this in a timely and efficient manner
LO 9 Strike a balance in recommending interventions, between workable solutions of complex requirements, technical possibilities and genuine interests of the parties involved
LO 10 Evaluate, adapt and justify decisions in the (design) process based on changing external requirements and new information
LO 11 Evaluate and justify design decisions, in a systematic and reproducible manner
LO 12 Design multidisciplinary, sustainable interventions
LO 13 Use scientific principles rigorously throughout the research
LO 14 Use, develop and validate models, and consciously and justifiably choses between different modelling techniques for spatio-temporal processes
LO 15 Draw viable conclusions and generate a good synthesis, and give recommendations that recognize the needs and wishes of stakeholder groups (potentially) involved
LO 16 Work independently and professionally
LO 17 Discuss effectively the research with peers
LO 18 Convey written information effectively using a professionally written and structured research proposal and Thesis
LO 19 Convey information effectively using professional visual and oral means in presenting the research
LO 20 Show data correctly and objectively, and makes effective choices in visualization
LO 21 Integrate ethical and normative aspects in his/her work: is aware of his/her position as scientist and of his/her cultural background

ALLOCATED TIME PER TEACHING AND LEARNING METHOD

<table>
<thead>
<tr>
<th>Teaching / learning method</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual assignment</td>
<td>1036</td>
</tr>
</tbody>
</table>
# TESTPLAN

<table>
<thead>
<tr>
<th>Learning outcomes (LO) of the course: The student will be able to...</th>
<th>Proposal</th>
<th>Thesis</th>
<th>Defence</th>
</tr>
</thead>
<tbody>
<tr>
<td>LO 1 Derive an overall research objective from a multidisciplinary societal problem</td>
<td>●</td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>LO 2 Find, critically assess and summarize literature from all relevant disciplines</td>
<td>●</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LO 3 Identify gaps in knowledge that lead to research questions</td>
<td>●</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LO 4 Link the research objectives clearly to the three knowledge domains and aim at solutions/interventions in a multidisciplinary context</td>
<td>●</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LO 5 Can design a detailed, justified and well-balanced methodology that potentially answers the research questions</td>
<td>●</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LO 6 Formulate expected outcomes and potential results, and identify potential for new results that guide the research methodology</td>
<td>●</td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>LO 7 Collect and analyse relevant data and information, correctly quantifying and interpreting uncertainty, as well as scaling and resolution issues in space and time</td>
<td></td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>LO 8 Make a feasible and detailed time schedule and execute this in a timely and efficient manner</td>
<td></td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>LO 9 Strike a balance in recommending interventions, between workable solutions of complex requirements, technical possibilities and genuine interests of the parties involved</td>
<td></td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>LO 10 Evaluate, adapt and justify decisions in the (design) process based on changing external requirements and new information</td>
<td></td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>LO 11 Evaluate and justify design decisions, in a systematic and reproducible manner</td>
<td></td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>LO 12 Design multidisciplinary, sustainable interventions</td>
<td></td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>LO 13 Use scientific principles rigorously throughout the research</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>LO 14 Use, develop and validate models, and consciously and justifiably choses between different modelling techniques for spatio-temporal processes</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>LO 15 Draw viable conclusions and generate a good synthesis, and give recommendations that recognize the needs and wishes of stakeholder groups (potentially) involved</td>
<td></td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>LO 16 Work independently and professionally</td>
<td></td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>LO 17 Discuss effectively the research with peers</td>
<td>●</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Learning Outcomes that are addressed in the test

**Learning outcomes (LO) of the course: The student will be able to...**

<table>
<thead>
<tr>
<th>LO</th>
<th>Description</th>
<th>Proposal</th>
<th>Thesis</th>
<th>Defence</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>Convey written information effectively using a professionally written and structured research proposal and Thesis</td>
<td>●</td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>Convey information effectively using professional visual and oral means in presenting the research</td>
<td>●</td>
<td></td>
<td>●</td>
</tr>
<tr>
<td>20</td>
<td>Show data correctly and objectively, and makes effective choices in visualization</td>
<td></td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>Integrate ethical and normative aspects in his/her work; is aware of his/her position as scientist and of his/her cultural background</td>
<td>●</td>
<td>●</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Test type</th>
<th>Report</th>
<th>Report</th>
<th>Oral test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight of the test</td>
<td>80</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Individual or group test</td>
<td>Individual</td>
<td>Individual</td>
<td>Individual</td>
</tr>
<tr>
<td>Type of marking</td>
<td>Completed/fail</td>
<td>1-10</td>
<td>1-10</td>
</tr>
<tr>
<td>Required minimum mark per test</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of test opportunities per academic year</td>
<td>2</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>
INTERNSHIP PROJECT

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).
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.
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

OTHER STUDY MATERIAL

- CANVAS: Internship ITC: https://canvas.utwente.nl/courses/2865 - Internship ITC
ENTRY REQUIREMENTS
Academic Research declared ready for defence by first supervisor

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.

ORGANIZATION AND PLANNING
IMPORTANT:
The faculty does not provide financial support for internships. Any financial or expense reimbursements to be received from an internship have to be negotiated on an individual basis between the student and the internship provider. Whether or how much the student can be financially reimbursed for an internship, depends on individual tax and (if applicable) scholarship conditions. 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

<table>
<thead>
<tr>
<th>Teaching / learning method</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supervised practical</td>
<td>420</td>
</tr>
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</table>
### Learning Outcomes (LO) of the course: The student will be able to...

<table>
<thead>
<tr>
<th>LO 1</th>
<th>Project Proposal</th>
<th>Report</th>
<th>Reflection Report</th>
<th>Host organization evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>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</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LO 2</th>
<th>Project Proposal</th>
<th>Report</th>
<th>Reflection Report</th>
<th>Host organization evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>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.</td>
<td></td>
<td></td>
<td>●</td>
<td>●</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LO 3</th>
<th>Project Proposal</th>
<th>Report</th>
<th>Reflection Report</th>
<th>Host organization evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>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</td>
<td>●</td>
<td></td>
<td>●</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LO 4</th>
<th>Project Proposal</th>
<th>Report</th>
<th>Reflection Report</th>
<th>Host organization evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>to reflect on their professional skills, own role in the team, ethical values needed for working in international and multicultural teams and environments.</td>
<td></td>
<td>●</td>
<td></td>
<td>●</td>
</tr>
</tbody>
</table>

### Test type
- Project Proposal: Individual
- Report: Individual
- Reflection Report: Individual

### Weight of the test
- Project Proposal: 10
- Report: 40
- Reflection Report: 0
- Host organization evaluation: 50

### Individual or group test
- Project Proposal: Individual
- Report: Individual
- Reflection Report: Individual
- Host organization evaluation: Individual

### Type of marking
- Project Proposal: 1-10
- Report: 1-10
- Reflection Report: Completed/fail
- Host organization evaluation: Completed/fail

### Required minimum mark per test
- Project Proposal: 1-10
- Report: Completed/fail
- Reflection Report: Completed/fail
- Host organization evaluation: Completed/fail

### Number of test opportunities per academic year
- Project Proposal: 2
- Report: 2
- Reflection Report: 1
- Host organization evaluation: 1