

PROGRAMME-SPECIFIC PART OF THE EER 2023-2024 GRADUATE SCHOOL OF GEOSCIENCES: MASTER'S DEGREE PROGRAMMES IN ENVIRONMENTAL SCIENCES

The Master's degree programme *Environmental Sciences* offers the programmes *Sustainable Development* and *Water Science and Management*.

ART. 2.1 – ADMISSION REQUIREMENTS

1. The following conditions for admission apply:

Sustainable Development

Admission to the *Sustainable Development* programme is granted to students with a Dutch or a foreign diploma confirming that they have acquired the knowledge, insights and skills at university Bachelor's level. Furthermore, students need to prove that they have gained the following specific knowledge, insights and skills:

- a) knowledge in the field of *Environmental Sciences*, *Natural Sciences* or *Social Sciences* at the advanced level of a major in *Earth Sciences*, *Physics*, *Chemistry*, *Biology*, *Economics*, *Public Administration and Organisational Science* or *Social Sciences* at Utrecht University, or equivalent to this level
- b) knowledge in the field of sustainability issues
- c) basic knowledge of physical processes in the environment
- d) basic knowledge of mathematics at Bachelor's level
- e) insight into *Environmental Sciences*, *Natural Sciences* or *Social Sciences* at the advanced level of a major in *Earth Sciences*, *Physics*, *Chemistry*, *Biology*, *Economics*, *Public Administration and Organisational Science* or *Social Sciences* at Utrecht University, or equivalent to this level.
- f) academic and research skills of a major in *Earth Sciences*, *Physics*, *Chemistry*, *Biology*, *Economics*, *Public Administration and Organisational Science* or *Social Sciences* at Utrecht University, or equivalent to this level.

Water Science and Management

Admission to the *Water Science and Management* programme is granted to students with a Dutch or a foreign diploma confirming that they have acquired the knowledge, insights and skills at university Bachelor's level. Furthermore, students need to prove that they have gained the following specific knowledge, insights and skills:

- a) knowledge in the field of *Earth Sciences*, *Environmental Sciences* or *Natural Sciences*, at the advanced level of the major *Earth Sciences* or *Environmental Sciences* at Utrecht University, or equivalent to this level
- b) insight into *Earth Sciences*, *Environmental Sciences* or *Natural Sciences* at advanced level of the major *Earth Sciences* or *Environmental Sciences* at Utrecht University, or equivalent to this level
- c) academic and research skills of the major *Earth Sciences* or *Environmental Sciences* at Utrecht University, or equivalent to this level

2. Students will be selected based on objective standards regarding:
 - a) their previous academic performance in a relevant subject area or areas
 - b) relevant skills
 - c) their command of the language or languages used in the programme
 - d) the following additional selection criteria with proven relevance for the opinion on the suitability of the candidate:
 - motivation
 - average grade

This information is used to consider whether the student concerned will be able to complete the Master's Programme successfully within the set time period.

The admission requirements have been formulated clearly and transparently so that candidates know in advance which requirements must be met in order to qualify for selection.

ART. 3.1 – AIM OF THE DEGREE PROGRAMMES

1. The degree programme aims to:

- provide students with specialised knowledge, skills and understanding in the field of *Environmental Sciences* so that they can achieve the final qualifications as mentioned in Article 3.1.2
- prepare students for professional employment in one or more disciplines of *Environmental Sciences*
- prepare students for training as researchers in the field of *Environmental Sciences*

2. Graduates in *Environmental Science*

1. have advanced knowledge and understanding of the field of *Environmental Sciences* in its societal context
2. can conduct research in the field of *Environmental Sciences* in a creative and independent way
3. can apply knowledge and research methods as well as problem-solving abilities in broader contexts related to the dynamics and challenges of *Environmental Sciences*
4. have insight into the complex interactions between science, sustainability and society and are able to reflect critically upon the roles of science and sustainability in society.
5. have professional and academic skills, particularly in relation to the dynamics and challenges of *Environmental Sciences*
6. can apply knowledge and understanding in such a way that they demonstrate a professional approach to their work
7. can communicate their conclusions, as well as the knowledge, reasons and considerations underlying these conclusions, to an audience of specialists and non-specialists alike
8. are able to study and work independently and explore new areas of interest in the field of the programme or related fields and demonstrates a professional approach to their work.

More programme-specific qualifications are listed in the prospectuses of the different programmes.

ART. 3.6 – COMPOSITION OF THE PROGRAMMES

1. Appendices 1, 2 and 3 describe the required courses of the programmes including their course load.
2. Students may choose optional courses. The course load of the optional courses are listed in Appendices 1, 2 and 3. The rules for choosing optional courses are listed in Appendix 5.
3. The requirements for the Annotation Complex Systems (only for SUSU) can be found in Appendix 8.
4. The prospectus gives a detailed description of the content and type of courses in the different programmes, including prior knowledge that is required to participate successfully.

ART. 4.2 – ENTRY REQUIREMENTS OF COURSES

The Executive Board decides the order in which the required components of a Master's degree programme must be completed. This has been listed in Appendix 6.

ART. 4.7 – EVALUATION OF QUALITY OF THE EDUCATION

1. The Director of Education monitors the quality of education, and ensures that both the courses and the curriculum are evaluated. The Director takes into consideration the advice and suggestions given by the Education Committee regarding improving and ensuring the quality of the programme.
2. Students are informed of the outcomes of the course and curriculum evaluations.

APPENDICES

APPENDIX 1: EXAM PROGRAMME SUSTAINABLE DEVELOPMENT (COHORT 2023)

1. Compulsory components (75 EC)

- Perspectives on Sustainable Development	7.5 EC
- Systems thinking, Scenarios & Indicators for SD	7.5 EC
- Research Design SD	7.5 EC
- Consultancy Project SUSD and WSM	7.5 EC
- Master's thesis	45 EC

2. Obligatory optional components (30 EC)

Environmental Change & Ecosystems (30 EC)

- Global Environmental Change	7.5 EC
- Environmental Systems Analysis	7.5 EC
- Integrated Assessment of Climate Change	7.5 EC
- Quantifying Ecosystem Resilience to Global Environmental Change	7.5 EC

Energy & Materials (30 EC)

- Tools for Energy & Materials Analysis	7.5 EC
- Energy Supply Technologies	7.5 EC
- Policies for Energy and Materials Transitions	7.5 EC
- Squaring the Circular Economy	7.5 EC

Earth System Governance (30 EC)

- Foundations of ESG Research	7.5 EC
- Governance Theories	7.5 EC
- Research Strategies ESG	7.5 EC
- Analysing Governance Practices	7.5 EC

Politics, Ecology and Society (30 EC)

- Introduction to Political Ecology	7.5 EC
- Natural Resource Management and Society	7.5 EC
- Research Methods for Politics, Ecology and Society	7.5 EC
- Social Innovation and Alternatives to Development	7.5 EC

3. Other optional components (15 EC)

Students should select additional optional courses for 15 EC.

- Environmental Change & Ecosystems	15 EC
- Energy & Materials	15 EC
- Earth System Governance	15 EC
- Politics, Ecology and Society	15 EC

4. Conversion of former courses

<i>Old course</i>	<i>New course 2023-2024</i>
Transdisciplinary Case Study (GEO4-2302)	Consultancy Project SUSD and WSM (GEO4-2008)
Field Research Practical (GEO4-2342)	Individual arrangement; contact ID track coordinator

APPENDIX 2: EXAM PROGRAMME SUSTAINABLE DEVELOPMENT (COHORT 2022)

1. Compulsory components (60 EC)

- Perspectives on Sustainable Development	7.5 EC
- Systems thinking, Scenarios & Indicators for SD	7.5 EC
- Research Design SD	7.5 EC
- Consultancy Project SUSd and WSM	7.5 EC
- Master's thesis	30 EC

2. Obligatory optional components (30 EC)*Environmental Change & Ecosystems (30 EC)*

- Global Environmental Change	7.5 EC
- Environmental Systems Analysis	7.5 EC
- Integrated Assessment of Climate Change	7.5 EC
- Quantifying Ecosystem Resilience to Global Environmental Change	7.5 EC

Energy & Materials (30 EC)

- Tools for Energy & Materials Analysis	7.5 EC
- Energy Supply Technologies	7.5 EC
- Policies for Energy and Materials Transitions	7.5 EC
- Squaring the Circular Economy	7.5 EC

Earth System Governance (30 EC)

- Foundations of ESG Research	7.5 EC
- Governance Theories	7.5 EC
- Research Strategies ESG	7.5 EC
- Analysing Governance Practices	7.5 EC

International Development (30 EC)

- Development Themes	7.5 EC
- Natural Resource Management and Society	7.5 EC
- Advanced M&T for SUSd-ID	7.5 EC
- Field Research Practical	7.5 EC

3. Other optional components (30 EC)

Students should select additional optional courses for 30 EC.

- Environmental Change & Ecosystems	30 EC
- Energy & Materials	30 EC
- Earth System Governance	30 EC
- International Development	30 EC

4. Conversion of former courses

Not applicable in 2023-2024

APPENDIX 3: EXAM PROGRAMME WATER SCIENCE AND MANAGEMENT

1. Compulsory components (67.5 EC)

- Sustainable Water Resources Management	7.5 EC
- Principles of Groundwater Flow	7.5 EC
- Quantitative Water Management	7.5 EC
- Research in WSM	7.5 EC
- Water Quality Management	7.5 EC
- Water, Governance and Law	7.5 EC
- Drinking Water and Sanitation	7.5 EC
- Consultancy Project SUSL and WSM	7.5 EC
- Land Surface Hydrology	7.5 EC

2. Obligatory optional components (52.5 EC)

Choice 1 of 2:

- Systems thinking, Scenarios & Indicators for SD	7.5 EC
- Unsaturated Zone Hydrology	7.5 EC

Choice 1 of 2:

- Master's thesis (30 EC) + other optional courses (15 EC)	45 EC
- Extended Master's thesis	45 EC

3. Conversion of former courses

<i>Old course</i>	<i>New course 2023-2024</i>
Transdisciplinary Case Study (GEO4-2302)	Consultancy Project SUSL and WSM (GEO4-2008)

APPENDIX 4 : GRADE CONVERSION TABLES JOINT PROGRAMME

FROM GRAZ TO UTRECHT

Definition	GU	UU
Passed	≤4,0 Sehr gut Gut Befriedigend Genügend	Pass
Considerable further work is required, failed	> 4,0 Nicht genügend	Fail
Utrecht University transfers no specific grades but only pass/fail into their own system for credits acquired abroad.		

FROM LEIPZIG TO UTRECHT

Definition	LU	UU
Passed	≤4,0 Sehr gut Gut Befriedigend Ausreichend	Pass
Considerable further work is required, failed	> 4,0 Mangelhaft	Fail
Utrecht University transfers no specific grades but only pass/fail into their own system for credits acquired abroad.		

FROM CA' FOSCARI VENICE TO UTRECHT

Definition	CU	UU
Passed	18-30	Pass
Considerable further work is required, failed	< 18	Fail
Utrecht University transfers no specific grades but only pass/fail into their own system for credits acquired abroad.		

FROM BASEL TO UTRECHT

Definition	BU	UU
Passed	4,0-6,0	Pass
Considerable further work is required, failed	< 4,0	Fail
Utrecht University transfers no specific grades but only pass/fail into their own system for credits acquired abroad.		

FROM HIROSHIMA TO UTRECHT

Definition	HU	UU
Passed	S A B C	Pass
Considerable further work is required, failed	D	Fail
Utrecht University transfers no specific grades but only pass/fail into their own system for credits acquired abroad.		

FROM STELLENBOSCH TO UTRECHT

Definition	SU	UU
Passed	>=50%	Pass
Considerable further work is required, failed	<50%	Fail
Utrecht University transfers no specific grades but only pass/fail into their own system for credits acquired abroad.		

FROM TERI TO UTRECHT

Definition	TERI	UU
Passed	A+ A B+ B C+ C D	Pass
Considerable further work is required, failed	F	Fail
Utrecht University transfers no specific grades but only pass/fail into their own system for credits acquired abroad.		

APPENDIX 5: RULES FOR CHOOSING ELECTIVE COURSES

1. Students in the Master's programme choose elective courses from another or their own Master's programme. Courses that are obligatory in the exam programme cannot be used as elective courses.
2. Honours programmes for Master's students (e.g. Young Innovators, GHIS, Leadership Programme) do not count towards the electives in the programme.
3. Electives as mentioned in the student's academic progress review in OSIRIS are pre-approved by the track coordinator and by the Board of Examiners. Students can enrol for those courses via OSIRIS. It remains the student's responsibility to make sure that the points mentioned under 6 d-f are met. If the course is from another department than the Copernicus Institute, it may be that other students have priority and that they are therefore placed on a waiting list.
4. It is possible to choose other courses than the pre-approved courses mentioned in OSIRIS. Any non-pre-approved elective courses must be subjected in advance to the track coordinator and the Board of Examiners for approval. The track coordinator will advise the Board in this matter.
5. The application for a non-pre-approved elective is done by a written request (application form) to the track coordinator. Written information on the content, the level, and the study load of the course (preferably by means of a copy of the course's description from the course catalogue) must be attached. The 'Application Form Elective courses Copernicus' can be found in the Blackboard community Sustainable Development.
6. The track coordinator tests the proposed elective course(s) on the following criteria:
 - a. It must be thematically linked to the Master's programme;
 - b. It concerns a course at master level (M);
 - c. There is no overlap in content with courses still to be taken or already taken.The student is responsible for making sure that:
 - d. The course is available to students of the SUSD programme;
 - e. The student fulfills the entrance requirements of the course (if applicable). Actual participation is only possible if students satisfy the course's entrance conditions; in case of doubt they should contact the course coordinator first;
 - f. The course is not taught in the same period and timeslot as another course the student has selected.
7. If the track coordinator has declared that the elective course(s) meet the criteria under 6a-c (by signing the application form or approval via an email message), the student sends the application form (signed or with the approval email attached) and the course information to the Board of Examiners via OSIRIS Case. The Board of Examiners takes the final decision on whether or not the elective is approved.
8. In the programme's course schedule, room has been reserved for taking electives. However, the student is free to deviate from this planning, e.g. because they wish to take an interesting elective course in another period. If this causes delay in the study planning, it is the responsibility of the student! Students are therefore advised to take their electives in the reserved periods and timeslots, or use a part of the time planned for their Master's thesis.

APPENDIX 6: ENTRANCE REQUIREMENTS 2023-24

Sustainable Development:

Course	Entrance requirement
Sustainable Food Systems (GEO4-2005)	Letter of acceptance of a Master's programme
Consultancy Project SUSD and WSM (GEO4-2008)	Letter of acceptance MSc Sustainable Development or MSc Water Science & Management. - At least 22,5 EC gained in the master SUSD or WSM, including Perspectives on Sustainable Development (GEO4-2301) or Sustainable Water Resources Management (GEO4-6008).
Innovation and International Development (GEO4-2009)	Letter of acceptance MSc Sustainable Development or MSc Innovation Sciences or MSc Sustainable Business & Innovation or MSc Energy Science or MSc Water Science and Management.
Imagining the Future for Transformation (GEO4-2010)	Letter of acceptance of a Master's programme
Data Analytics for Sustainability (GEO4-2011)	Letter of acceptance MSc Sustainable Development or MSc Innovation Sciences or MSc Sustainable Business & Innovation or MSc Energy Science or MSc Water Science and Management.
Perspectives on Sustainable Development (GEO4-2301)	Letter of acceptance MSc Sustainable Development
Environmental Systems Analysis (GEO4-2303)	Recommended prerequisites: For students from other programmes: mathematics and modelling, level 1; e.g. Wiskunde & Systemanalyse (GEO1-2202), please contact the coordinator before enrolment in Osiris.
Research Strategies ESG (GEO4-2304)	Letter of acceptance MSc Sustainable Development. Actively participated in Foundations of ESG Research (GEO4-2306) and Governance Theories (GEO4-2332) Recommended prerequisites: Basic research methodology skills. Knowledge of the main literatures on environmental governance.
International Governance for SD (GEO4-2305)	Letter of acceptance of a Master's programme (social science background). Recommended prerequisites: Knowledge on policy analysis and governance theories.
Foundations of Earth System Governance Research (GEO4-2306)	Letter of acceptance MSc Sustainable Development or MSc Innovation Sciences or MSc Sustainable Business & Innovation or MSc Energy Science or MSc Water Science and Management.
Global Environmental Change (GEO4-2310)	Letter of acceptance of a Master's programme
Policies for Energy & Materials Transitions (GEO4-2311)	Letter of acceptance MSc Sustainable Development or MSc Innovation Sciences or MSc Energy Science or MSc Sustainable Business & Innovation or MSc Water Science and Management or MSc Earth Sciences. Recommended prerequisites: Tools for Energy & Materials Analysis(GEO4-2326)
Energy Supply Technologies (GEO4-2312)	Recommended prerequisites: Applied Thermodynamics (GEO2-2212), Energy Analysis (GEO3-2223) or Tools for Energy & Materials Analysis (GEO4-2326) or equivalent courses.

	<i>This course is not available to Energy Science students.</i>
Research Design SD (GEO4-2314)	Letter of acceptance MSc Sustainable Development
Tailor-made course SUSD (GEO4-2320)	- Letter of acceptance MSc Sustainable Development, and - At least 45 EC passed within the programme Students in the SUSD-Joint Programme will need to have passed 45 EC, including one of the mobility tracks.
Master's Thesis SD (GEO4-2321)	- Only for cohort 2021 and earlier Letter of acceptance MSc Sustainable Development, and - At least 60 EC passed within the program, including: <ul style="list-style-type: none"> • Perspectives on SD (GEO4-2301) • Systems Thinking, Scenarios & Indicators (GEO4-2331) • Research Design SD (GEO4-2314) <p><i>And:</i></p> <p>- at least two track-specific courses of which 1 methods course (at least 15 EC in total). These are specified per track:</p> <p><u>For track E&M:</u></p> <ul style="list-style-type: none"> - Tools for E&M Analysis (GEO4-2326) <p>And 1 out of 2:</p> <ul style="list-style-type: none"> - Energy Supply Technologies (GEO4-2312) - Policies for E&M Transitions (GEO4-2311) <p><u>For track ECE:</u></p> <ul style="list-style-type: none"> - Environmental Systems Analysis (GEO4-2303), and - Global Environmental Change (GEO4-2310) <p><u>For track ESG:</u></p> <ul style="list-style-type: none"> - Research Strategies ESG (GEO4-2304) <p>And 1 out of 2:</p> <ul style="list-style-type: none"> - Foundations of ESG Research (GEO4-2306) - Governance theories (GEO4-2332) <p><u>For track ID:</u></p> <ul style="list-style-type: none"> - Advanced M&T Development Studies (GEO4-3518), or Research Methods for PES (GEO4-2345) <p>And 1 out of 2:</p> <ul style="list-style-type: none"> - Development Themes (GEO4-3510) - Development Theories (GEO4-3505) <p>Students in the SUSD-Joint Programme will need to have passed 60 EC, including one of the mobility tracks.</p>
Environmental Ethics & Sustainable Development (GEO4-2323)	Letter of acceptance of a Master's programme
Tools for Energy & Materials Analysis (GEO4-2326)	Recommended prerequisites: Energy Analysis (GEO3-2223) or similar course.

	<i>This course is not available to Energy Science students.</i>
Analysing Governance Practices (GEO4-2328)	Letter of acceptance MSc Sustainable Development. Actively participated in Foundations of ESG Research (GEO4-2306) and Governance Theories (GEO4-2332)
Systems thinking, Scenarios & Indicators for SD (GEO4-2331)	Letter of acceptance MSc Sustainable Development or MSc Water Science and Management or profile Complex Systems. Recommended prerequisites: Perspectives on Sustainable Development (GEO4-2301), or Sustainable Water Resources Management (GEO4-6008)
Governance Theories (GEO4-2332)	Letter of acceptance MSc Sustainable Development or MSc Innovation Sciences or MSc Sustainable Business & Innovation.
Squaring the Circular Economy (GEO4-2338)	Letter of acceptance MSc Sustainable Development or MSc Innovation Sciences or MSc Sustainable Business & Innovation or MSc Energy Science or MSc Water Science and Management. Recommended prerequisites: Basic background in natural sciences.
Natural Resource Management and Society (GEO4-2339)	Letter of acceptance MSc Sustainable Development or MSc Innovation Sciences or MSc Sustainable Business & Innovation or MSc Energy Science or MSc Water Science and Management or MSc Environmental Biology.
Integrated Assessment of Climate Change (GEO4-2340)	Letter of acceptance of a Master's programme
Quantifying Ecosystem Resilience to Global Environmental Change (GEO4-2341)	Letter of acceptance MSc Sustainable Development Recommended prerequisite: Passed Global Environmental Change (GEO4-2310)
Master's thesis (GEO4-2343)	<p>- Only for cohort 2022</p> <p>- Letter of acceptance MSc Sustainable Development, and</p> <p>- At least 60 EC passed within the program, including:</p> <ul style="list-style-type: none"> • Perspectives on SD (GEO4-2301) • Systems Thinking, Scenarios & Indicators (GEO4-2331) • Research Design SD (GEO4-2314) <p><i>And:</i></p> <p>- at least two track-specific courses of which 1 methods course (at least 15 EC in total). These are specified per track:</p> <p><u>For track E&M:</u></p> <ul style="list-style-type: none"> - Tools for E&M Analysis (GEO4-2326) <p>And 1 out of 2:</p> <ul style="list-style-type: none"> - Energy Supply Technologies (GEO4-2312) - Policies for E&M Transitions (GEO4-2311) <p><u>For track ECE:</u></p> <ul style="list-style-type: none"> - Environmental Systems Analysis (GEO4-2303), and - Global Environmental Change (GEO4-2310)

	<p><u>For track ESG:</u></p> <ul style="list-style-type: none"> - Research Strategies ESG (GEO4-2304) <p>And 1 out of 2:</p> <ul style="list-style-type: none"> - Foundations of ESG Research (GEO4-2306) - Governance theories (GEO4-2332) <p><u>For track ID:</u></p> <ul style="list-style-type: none"> - Advanced M&T Development Studies (GEO4-3518), or Research Methods for PES (GEO4-2345) and - Development Themes (GEO4-3510)
Introduction to Political Ecology, GEO4-2344	Letter of acceptance MSc Sustainable Development
Research Methods for Politics, Ecology and Society, GEO4-2345	Letter of acceptance MSc Sustainable Development Actively participated in Introduction to Political Ecology (GEO4-2344) and Natural Resource Management and Society (GEO4-2339)
Social Innovation and Alternatives to Development, GEO4-2346	Letter of acceptance MSc Sustainable Development Actively participated in Introduction to Political Ecology (GEO4-2344)
Techniques of Futuring (GEO4-5501)	Letter of acceptance of a Master's programme

Water Science and Management:

Course	Entrance requirement
Principles of Ground Water Flow (GEO4-1434)	<ul style="list-style-type: none"> - Letter of acceptance MSc Earth Sciences or MSc Water Science and Management. - BSc or equivalent in Earth Sciences, Applied Sciences, or related fields. - basic knowledge of physics, calculus, ordinary and partial differential equations. <p>Recommended prerequisites:</p> <ul style="list-style-type: none"> - basic knowledge of hydrology, introductory geology and/or environmental sciences.
Sustainable Food Systems (GEO4-2005)	Letter of acceptance of a Master's programme
Consultancy Project SUSDM and WSM (GEO4-2008)	Letter of acceptance MSc Sustainable Development or MSc Water Science & Management. - At least 22,5 EC gained in the master SUSDM or WSM, including Perspectives on Sustainable Development (GEO4-2301) or Sustainable Water Resources Management (GEO4-6008).
Innovation and International Development (GEO4-2009)	Letter of acceptance MSc Sustainable Development or MSc Innovation Sciences or MSc Sustainable Business & Innovation or MSc Energy Science or MSc Water Science and Management.
Imagining the Future for Transformation (GEO4-2010)	Letter of acceptance of a Master's programme
Data Analytics for Sustainability (GEO4-2011)	Letter of acceptance MSc Sustainable Development or MSc Innovation Sciences or MSc Sustainable Business & Innovation or MSc Energy Science or MSc Water Science and Management.
Systems thinking, Scenarios & Indicators for SD (GEO4-2331)	Letter of acceptance MSc Sustainable Development or MSc Water Science and Management. Recommended prerequisite:

	Perspectives on Sustainable Development (GEO4-2301), or Sustainable Water Resources Management (GEO4-6008)
Land Surface Hydrology (GEO4-4404)	Letter of acceptance MSc Earth Sciences or MSc Water Science and Management. Recommended prerequisites: Basic knowledge of quantitative analysis, including statistics, mathematics (differentiation, integration) and physics (mechanics).
Unsaturated Zone Hydrology (GEO4-4417)	Letter of acceptance MSc Earth Sciences or MSc Water Science and Management. Recommended prerequisites: <ul style="list-style-type: none"> - Knowledge of groundwater hydrology: GEO2-4203 Physical hydrology or GEO4-1434 Principles of groundwater flow (or equivalent); - basic physics/mathematics skills.
Quantitative Water Management (GEO4-6001)	Letter of acceptance of a Master's programme. Recommended prerequisites: <ul style="list-style-type: none"> - A bachelor level natural sciences background. - One or more of the following courses: GEO2-4203 Physical Hydrology; GEO3-4307: Fluid mechanics 1; GEO4-1434 Principles of groundwater flow. Students without a natural science Bachelor's degree should contact the course coordinator <i>before</i> registering for the course.
Water, Governance and Law (GEO4-6002)	Letter of acceptance of a Master's programme.
Drinking Water and Sanitation (GEO4-6003)	Letter of acceptance MSc Water Science and Management.
Master's thesis (Internship) (GEO4-6004; GEO4-6006)	Letter of acceptance MSc Water Science and Management. At least 60 EC passed within the programme.
Tailor made course WSM (GEO4-6005)	Letter of acceptance MSc Water Science and Management. At least 45 EC passed within the WSM programme.
Water Quality Management (GEO4-6007)	Letter of acceptance of a Master's programme. Recommended prerequisite: Basic knowledge of chemistry at 1 st year bachelor level
Sustainable Water Resources Management (GEO4-6008)	Letter of acceptance MSc Water Science and Management or MSc Sustainable Business and Innovation or MSc Innovation Sciences or MSc Energy Science or MSc Sustainable Development or MSc Earth Sciences or MSc Physical Geography.
Research in WSM (GEO4-6009)	Letter of acceptance MSc Water Science and Management.
Techniques of Futuring (GEO4-5501)	Letter of acceptance of a Master's programme

APPENDIX 7: ANNOTATION COMPLEX SYSTEMS (SUSD ONLY)

Description

The Master's profile Complex Systems is an interdisciplinary profile for students who are interested to broaden their knowledge and expertise within the field of Complex Systems. In this research field societal issues, such as a financial crisis, a sudden epidemic or climate change are studied from a quantitative modelling perspective. Students will get an understanding of the various models used in the complexity field and the behaviour (i.e. transitions, predictability) of these models.

The aim of the Complex Systems Profile is for students to develop or improve their

- affinity for quantitative approaches in order to address societal issues,
- ability to build models that are amenable to quantitative approaches,
- familiarity with standard (quantitative) methods in the toolbox for analysing complex systems, and
- ability to work in interdisciplinary teams.

Learning outcomes

Upon completion of the Master's profile the student

- is able to recognise the complex systems aspects when confronted with a societal problem,
- is able to develop models of complex systems and/o has a good overview of model-building for complex systems,
- has a good overview of the methods in the complex systems toolbox, can apply them to models and extract quantitative results, and
- communicate/explain complex-systems models and methods to (interdisciplinary) teammates.

Programme

The Master's profile comprises 30 EC and consists of the following parts:

- Two electives (7.5 EC each) from the following courses (**one of these electives need to be from 1-3 below**, which are termed as **core courses** for Complex Systems):
 1. Introduction to Complex Systems (WISM484)
 2. Advanced Topics in Climate Physics16 (NS-MO411)
 3. Computational Aspects of Machine Learning17 (NS-EX426M)
 4. Mathematical Biology18 (WISL411)
 5. A Complex Systems labelled course listed under a master programme that is **different** from the one to which the student is admitted (see list below). **Note on this list:** some programmes may require one of their own primary elective courses, labelled as Complex Systems course to be taken; the student **cannot** count them as primary electives **as well as** Complex Systems master profile courses. More information can be found in the specific programme description section of the Education and Examination Regulations.
- A Research Project on a Complex Systems topic (15 EC, Osiris code GSNS- CSRP), for which focus should be on interdisciplinary aspects and at least two supervisors from two different departments/faculties must be involved.

The topic should not correspond to the topic of the master thesis, however if the master research project deals with a complex system subject – currently available only for Theoretical Physics, Experimental Physics and Climate Physics Master programmes at Utrecht University – it is permitted to combine the research project of

the master's profile Complex Systems (15 EC) with the master thesis project. In case the master research project deals with a complex system subject, the complex systems aspects must be separately assessed and a supervisor from a different department or faculty other than the department related to the student's master programme needs to be involved in assessing the complex system aspects of the research project.

The topic must be approved by the coordinator of the profile as well as by the coordinator of the master programme to which the student is admitted.

The total number of EC of each master's programme will NOT be increased by completing the master profile Complex Systems. Students receive a certificate by completing the Master's profile Complex Systems.

List of courses labelled as a complex systems course:

Master's programme	Course	Osiris code
Artificial Intelligence	Evolutionary Computing	INFOEA
Climate Physics	Waves in Geophysical Fluids	NS-MO447M
Computing Science	Network Science	INFOMNWSC
Data Science	Data Mining	INFOMDM
	Pattern Recognition and Deep Learning	INFOMPRDL
Energy Science	Energy Systems Modelling	GEO4-2515
Experimental Physics	Modelling and Simulation	NS-TP432M
	Fundamentals of Biophysics AND	NS-TP464M AND
	Advanced Methods in Biophysics†	NS-EX433M
Game and Media Technology	Pattern Recognition and Deep Learning	INFOMPR
	Crowd Simulation	INFOMCRWS
Mathematical Sciences	Inverse Problems in Imaging*	WISL435
	Introduction to Numerical Bifurcation Analysis of ODEs and Maps*	WISL606
Nanomaterials Science	Toy Models	SK-MTOYM
	Modelling and Simulation	NS-TP432M
Sustainable Development	Systems Thinking, Scenarios and Indicators	GEO4-2331
	Environmental Systems Analysis	GEO4-2303
	Integrated Assessment of Climate Change	GEO4-2340
Theoretical Physics	Modelling and Simulation	NS-TP432M
	Fundamentals of Biophysics AND	NS-TP464M AND
	Stochastic Processes in Biophysics†	NS-TP465M
Multidisciplinary Economics	Algorithms in Finance	ECMAF
	The Triumph of the City	ECRMTCE

† These two courses can only be taken in combination with each other since individually they are 3.75 EC courses

* Registration via elo.mastermath.nl

Entry Requirements

- The student belongs to one of the participating master programmes
- Upon consultation with the coordinator for the profile, it is also possible for students from outside Utrecht University to participate in the profile, when their master programme has an affinity to complex systems

Participating Master's programmes

- Climate Physics
- Computing Science
- Energy Science
- Artificial Intelligence
- Experimental Physics
- Game and Media Technology
- Mathematical Sciences
- Nanomaterials Science
- Sociology and Social Research
- Sustainable Development
- Theoretical Physics
- Multidisciplinary Economics

Legacy issues

The following courses were labelled as Complex Systems courses in the past academic years (noted in parenthesis).

Master's programme	Course	Osiris code
Artificial Intelligence	Seminar Social Simulation (2018-19)	INFOMSOCs
Core courses	Algorithms in Finance (2018-19, 2019-20) Complex Networks (2020-21) Seminar Applications of Mathematics in Radiation Research (2018-19, 2019-20) Understanding Complexity: Economy and the Planet (2018-19, 2019-20) Mathematical Neuroscience	WISM410 WISL115 WISM409 NS-MO450M WISL413
Computing Science	Evolutionary Algorithms (2018-19, 2019-20), Evolutionary Computing Data Mining (2020-21, 2021-22, 2022-23) Pattern Recognition (2020-21, 2021-22, 2022-23)	INFOEA INFOMDM INFOMPR
Experimental Physics	Biophysics	NS-EX430M
Game and Media Technology	Games and Agents (2017-18)	INFOMGMAG

Mathematical Sciences	<p>Interacting particle systems: Theory and applications (2018-19)</p> <p>Introduction to Numerical Bifurcation Analysis of ODEs and Maps (2019-20, 2021-22)</p> <p>Inverse Problems in Imaging (2020-21)</p> <p>Laboratory class for scientific computing (2018- 19)</p> <p>Mathematical Biology (2017-18, 2019-20, 2021-22)</p> <p>Mathematical Neuroscience (2020-21)</p> <p>Nonlinear Waves (2017-18)</p> <p>Numerical bifurcation analysis of large-scale systems (2018-19, 2020-21, 2021-22)</p>	<p>WISL431</p> <p>WISL606</p> <p>WISL430</p> <p>WISM454</p> <p>WISL411</p> <p>WISL413</p> <p>WISL409</p> <p>WISL425</p>
Multidisciplinary Economics	Advanced behavioural and experimental finance (2018-19)	ECRMABEF
Sustainable Development	Sustainability Modelling and Indicators (2018-19, 2019-20)	GEO4-2331