# Curriculum for the Master's Degree Programme Environmental Systems Sciences / Climate Change and Transformation Science

The legal basis for the Master's degree programme in Environmental Systems Sciences / Climate Change and Transformation Science consists of the Universities Act (in German: Universitätsgesetz, UG) and the Statutes of the University of Graz. Only the German version of this curriculum is legally binding.

On 20 May 2026, the Senate adopted the following curriculum for the Master's degree programme in Environmental Systems Sciences / Climate Change and Transformation Science in accordance with § 25 para. 1 item 10a UG.



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## § 1 Subject, qualification profile and relevance of the degree programme

### (1) Subject of the degree programme

The Master's degree programme in "Environmental Systems Sciences / Climate Change and Transformation Science" (ESS/CCTS) provides research-oriented training in addressing both the natural-scientific and social-scientific dimensions of climate change and the transformation towards a sustainable, climate-neutral, and climate-resilient society.
Students may choose to specialise either in the physical climate sciences or in transformation sciences. This disciplinary focus is complemented by interdisciplinary and systems science competencies, with particular emphasis on the application of research-oriented methods.
The programme is rounded off by an independently designed environment-related module, which enables students to set individual thematic priorities.

### (2) Qualification profile and competences

Graduates of the Master's degree programme "Environmental Systems Sciences / Climate Change and Transformation Science" (ESS/CCTS) are able to:

- apply the acquired subject-specific knowledge in the fields of climate science as well as social and economic sciences, together with advanced methodological competencies, in relevant research projects and in practice, and to generate new knowledge;
- apply systems science methods for the abstraction and parameterisation of problem contexts and the evaluation of results, and to derive corresponding options for action and intervention in relevant subject areas;
- communicate at a high level in interdisciplinary teams with representatives of other disciplines, work on projects related to climate, climate impact, and transformation, and jointly develop solutions to complex problems;
- integrate knowledge from different disciplines and, on this basis, make well-founded decisions in complex and uncertain problem situations;
- competently communicate sustainability-related topics to affected target groups as well as to employees and upstream decision-making levels;
- apply the acquired skills in the public sector, in NGOs, and in companies alike, and to establish or further develop future-oriented functional areas and strategies addressing current challenges;
- act in responsible leadership positions, independently addressing complex and unpredictable situations with appropriate sustainability-oriented strategies and measures, as well as to lead the implementation of strategic decisions.

### (3) Demand for and relevance of the programme for science and the labour market

Climate change is one of the most significant societal challenges of our time, with potentially dramatic impacts on future generations. The necessity of a transformation towards a climate-neutral and climate-resilient society is becoming increasingly evident. Addressing the associated challenges requires, on the one hand, an understanding of the climate system and, on the other hand, knowledge of economic and social structures, processes, and dynamics. Interdisciplinary cooperation between the relevant disciplines is therefore indispensable.
Graduates of the Master's degree programme "Environmental Systems Sciences / Climate Change and Transformation Science" (ESS/CCTS) are exceptionally well qualified to contribute to addressing these challenges in a wide range of professional fields, through the combination of their in-depth expertise in climate and transformation sciences, their systems science and formal methodological repertoire, and their ability to work in interdisciplinary teams.
Typical fields of employment for graduates of the Master's degree programme "Environmental Systems Sciences / Climate Change and Transformation Science" (ESS/CCTS) can be found in academic, public, semi-public, and private-sector/industrial contexts:

- teaching and research at university level;
- development of climate services in the public sector at municipal, regional, national, and international level, as well as in international organisations, NGOs, and the private sector;
- development of strategies and measures for climate change mitigation, climate change adaptation, and loss and damage in response to climate change and its impacts;

- development and implementation of sustainability-related strategies and policy packages in the public sector;
- strategy development and implementation in the public sector and in companies on the transition towards a near-zero greenhouse gas emission economy and society;
- environmental consultancy as well as management and support of environmental protection institutions;
- completion of the Master's degree programme "Environmental Systems Sciences / Climate Change and Transformation Science" entitles graduates, subject to the respective admission requirements, to pursue further doctoral or PhD studies.

## § 2 General provisions

### (1) Admission requirements

1 For admission to the Master's degree programme "Environmental Systems Sciences / Climate Change and Transformation Science" (ESS/CCTS), the following prior studies are considered relevant in terms of subject content:
- Bachelor's Degree in Environmental Systems Sciences / Natural Sciences–Technology (USW / NAWI-Tech) within NAWI Graz
- Bachelor's Degree in Environmental Systems Sciences / Economics at the University of Graz
- Bachelor's Degree in Environmental Systems Sciences with a specialisation in Management at the University of Graz
- Bachelor's Degree in Environmental Systems Sciences / Geography at the University of Graz

2 For degree programmes in which at least 90 ECTS credits have been completed in one of the following fields, there are no substantial academic differences compared to the programmes listed in item 1:
- Natural sciences with a focus on dynamical systems and physical climate science or meteorology
- Economics
- Business administration
- Sociology
- Political Science
- Psychology
- Geography

of which
- 6 ECTS credits must be in systems science
- 5 ECTS credits must be in mathematics.

3 For degree programmes in which at least 60 ECTS credits have been completed in one of the fields listed in item 2, there are substantial academic differences compared to the programmes listed in items 1 and 2. To compensate for these substantial differences, additional examinations totalling a maximum of 30 ECTS credits may be required and completed.

4 For degree programmes in which fewer than 60 ECTS credits have been completed in one of the fields listed in item 2, or where compensatory examinations exceeding 30 ECTS credits would be required, the substantial academic differences to a relevant degree programme under items 1 and 2 cannot be compensated, and admission is not possible.

5 As a prerequisite for admission to the programme, proof of sufficient knowledge of the English language required for successful academic progress must be provided. The form of this proof is specified in a regulation issued by the Rectorate.

### (2) Duration and structure of the degree programme

The Master's degree programme comprises a total workload of 120 ECTS credits, has a duration of four semesters, and is structured into modules.

| Module Designation and Title | ECTS |
|---|---|
| Module A: Interdisciplinary Practice | 10 |
| Module B: Systems Sciences | 10 |
| Module C: Onboarding | 6 |

| | |
|---|---|
| Module D: Climate Science<br>*or*<br>Module E: Transformation Science | 33 |
| Module F: Interdisciplinary Climate Science | 9 |
| Module G: Environment-related Elective Module | 15 |
| Master Thesis | 30 |
| Master Exam | 1 |
| Free Electives | 6 |
| **Total** | **120** |

**(3) Academic degree**

Graduates of the Master's degree programme are awarded the academic degree "Master of Science", abbreviated as "MSc".

**(4) Number of participants in courses and ranking criteria**

1 For pedagogical-didactical and spatial reasons, due to the number of available devices/equipment, or for safety reasons, the number of participants in individual types of courses may be limited:

| Course Type | Number of Participants |
|---|---|
| Lecture (in German: Vorlesung, VO) | no restriction |
| Course (in German Kurs: KS) | 40 |
| Working group (in German: Arbeitsgemeinschaft, AG) | 20 |
| Seminar (in German: Seminar, SE) *(only Module B)* | 15 |
| Seminar (in German: Seminar, SE) *(except Module B)* | 20 |
| Lecture with exercises (in German: Vorlesung mit Übung, VU) | 60 |
| Project (In German: Projekt, PT) | 30 |
| Field Trip (in German: Exkursion, EX) | 20 |

2 If the maximum number of participants is exceeded, students shall be admitted to courses according to the ranking procedure criteria for the allocation of places in courses with a limited number of participants, as defined in the current version of the Senate's guideline on the allocation of course places in courses with restricted participant numbers (URBI).

## § 3 Structure and outline of the degree programme

**(1) Modules and examinations**

The modules and examinations are listed below with module title, course title, course type (CT), ECTS credits, contact hours (CH), and recommended semester allocation (rec. sem.). The module descriptions are provided in Annex I.

| | Modules and Examinations | Course Type | ECTS | CH | Rec. Sem. |
|---|---|---|---|---|---|
| **Module A** | **Interdisciplinary Practice** | | **10** | **6** | |
| A.1 | IP – Interdisciplinary Practical Training | AG | 10 | 6 | 3 |
| **Module B** | **Systems Sciences** | | **10** | **6** | |
| B.1 | Data in Systems Sciences | VO | 3 | 2 | 1 |
| B.2 | Systems-Modelling and Systems-Analysis | VO | 3 | 2 | 2 |
| | *One of the following courses (B.3–B.5) must be selected:* | | | | |
| B.3 | Data in Systems Sciences | SE | (4) | (2) | (3) |
| B.4 | Systems-Modelling and Systems-Analysis | SE | (4) | (2) | (3) |
| B.5 | AI Methods for Modelling Complex Systems | KS | (4) | (2) | (3) |
| **Module C** | **Onboarding** | | **6** | **4** | |
| | *Two of the following three courses must be selected. If Module D is chosen, the selected courses must be C.2 and C.3. If Module E is chosen, C.1 must be included*[1]*.* | | | | |
| C.1 | Introduction to the Climate System | VO | (3) | (2) | (1) |
| C.2 | Introduction to Social Sciences | VO | (3) | (2) | (1) |
| C.3 | Introduction to Economics | VO | (3) | (2) | (1) |
| | | | | | |
| | *The specialisation comprises 33 ECTS credits and may be chosen either in Module D (Climate Science) (D.1–D.3) or in Module E (Transformation Science) (E.1–E.3).* | | | | |
| **Module D** | **Climate Science** | | **33** | | |
| **Module D.1** | **Theoretical Climate Science** | | **9-12** | **6-8** | |
| D.1.1 | Climate Dynamics | VO | 3 | 2 | 1 |
| D.1.2 | Atmospheric Dynamics | VO | 3 | 2 | 2 |
| | *One or two of the courses D.1.3 to D.1.5 must be selected.* | | | | |
| D.1.3 | Physical Oceanography, Hydrology and Climate | VO | (3) | (2) | (2) |
| D.1.4 | Paleoclimatology | VO | (3) | (2) | (1) |
| D.1.5 | Radiation and Energy Balance | VO | (3) | (2) | (3) |
| **Module D.2** | **Atmosphere and Climate Observations** | | **6** | **4** | |
| D.2.1 | Atmosphere and Climate Measurement Methods: In situ | VO | 3 | 2 | 1 |
| D.2.2 | Atmosphere and Climate Measurement Methods: Remote Sensing | VO | 3 | 2 | 2 |
| **Module D.3** | **Methods for Climate Science** | | **15-18** | 10-12 | |
| D.3.1 | Mathematics for Climate Science | KS | 2 | 1 | 1 |
| D.3.2 | Time Series Analysis | VO | 3 | 2 | 1 |
| D.3.3 | Special Topics in Climate Science Methods: Data Handling and Programming | KS | 3 | 2 | 1 |
| D.3.4 | Analysis Methods in Climate Science | KS | 4 | 3 | 2 |
| D.3.5 | Climate Modelling | VO | 3 | 2 | 2 |



[1] Students who have already acquired relevant prior knowledge in their previous studies may, with the approval of the chairperson of the Curricula Commission, combine the courses of Module C in a different form.

| | | | | | |
|---|---|---|---|---|---|
| | *Course D.3.6 may be selected. If D.3.6 is not selected, two courses must be chosen from D.1.3 to D.1.5.* | | | | |
| D.3.6 | Special Topics: Regional Climate Modeling in Practice | KS | (3) | (2) | (3) |
| **Module E** | **Transformation Science** | | **33** | | |
| **Module E.1** | **Concepts in Transformation Science** | | **12** | **8** | |
| | *Four courses must be chosen from E.1.1 to E.1.5.* | | | | |
| E.1.1 | Human Behaviour and Human-Nature Interactions | KS | (3) | (2) | (1) |
| E.1.2 | Social-Ecological Systems Analysis | KS | (3) | (2) | (1) |
| E.1.3 | Environmental Economics | VU | (3) | (2) | (2) |
| E.1.4 | Climate Change Economics | KS | (3) | (2) | (3) |
| E.1.5 | Advanced Environmental and Climate Policy | KS | (3) | (2) | (3) |
| **Module E.2** | **Methods in Transformation Science** | | **12** | **6** | |
| | *Two courses must be selected from E.2.1 to E.2.5.* | | | | |
| E.2.1 | Mathematics for Social-Ecological Systems Science | KS | (6) | (3) | (1) |
| E.2.2 | Qualitative Research Methods and Transdisciplinarity | KS | (6) | (3) | (2) |
| E.2.3 | Quantitative Research Methods: Computable General Equilibrium Modelling | KS | (6) | (3) | (1) |
| E.2.4 | Quantitative Research Methods: Spatial Analysis | KS | (6) | (3) | (2) |
| E.2.5 | Quantitative Research Methods: Complex Systems Modelling | KS | (6) | (3) | (2) |
| **Module E.3** | **Applications in Transformation Science** | | **9** | **5** | |
| E.3.1 | Research Project in Climate Resilience & Transformation Management | PT | 6 | 3 | 3 |
| E.3.2 | Special Topics in Transformation Science: Climate and Energy Management | KS | 3 | 2 | 2 |
| **Module F** | **Interdisciplinary Climate Science** | | **9** | **6** | |
| F.1 | Climate Risks | VU | 4 | 2 | 2 |
| | *One of the following courses (F.2 and F.3) must be selected:* | | | | |
| F.2 | Special Topics in Interdisciplinary Climate Science | KS | (3) | (2) | 3 |
| F.3 | Special Topics: Practical Studies in Interdisciplinary Climate Science | EX | (3) | (2) | 3 |
| F.4 | Master Seminar | SE | 2 | 2 | 4 |
| **Module G** | **Environment-oriented Elective Module** | | **15** | | |
| | Module G – see § 3 para. 2 | | | | 1-3 |
| | **Master Thesis** | | **30** | | **3-4** |
| | | | | | |
| | **Master Exam** | | **1** | | **4** |
| | | | | | |
| | **Free Electives** | | **6** | | |
| | | | | | |
| **Total** | | | **120** | | |

**(2) Environment-related elective module**
For Module G, courses amounting to 15 ECTS credits must be compiled and completed in accordance with the following criteria:

1. The module comprises a thematically coherent, environment-related set of subjects. It may be used to deepen the student's own specialisation (Module D or E), to gain deeper insight into the alternative specialisation, or to pursue a broader orientation beyond the two specialisations.
2. This environment-related set of subjects is covered by one or more courses that provide an in-depth treatment of the respective topics. These courses may also originate from more distant disciplines such as ecology, law, psychology, philosophy, or political science.
3. These courses may be completed at any recognised national or international university.
4. The Environment-related Elective Module must be assigned a specific title, which will be included in the Master's certificate.
5. The admissibility (title and course selection) of the Environment-related Elective Module is subject to prior approval by the chairperson of the Curricula Commission for Environmental Systems Sciences upon the student's application.

**(3) Cross faculty master module**

In place of Module G and 6 ECTS credits from free elective courses, a Cross Faculty Master Module may be completed.

**(4) Master thesis**

1. The topic of the Master thesis must be taken from one of Modules B, D, E, F, or G, or must be meaningfully related to one of these subject areas. Exceptions shall be decided by the chairperson of the Curricula Commission for Environmental Systems Sciences.

2. The Master thesis must be registered prior to commencement, including the specification of the topic, the module from which the topic is derived, and the supervisor, at the URBI Dean's Office for Studies.

3. The topic of the Master thesis cannot be taken from a cross faculty master module.

4. The public presentation of the Master thesis forms part of the Master exam (see § 5).

**(5) Free electives**

1. It is recommended that free elective courses be selected from the following areas: courses in women's and gender studies, foreign languages, the "Timegate" programme, courses offered by the Centre for Social Competence and the Centre for Digital Teaching and Learning, as well as courses in leadership skills and philosophy of science.

2. Students are encouraged to gain practical employment experience as part of the free electives, where one week of full-time employment corresponds to 1.5 ECTS credits.

**(6) Student mobility**

Students are encouraged to complete a study period abroad during the Master's degree programme. The individually designed focus within Module G, "Environment-related Elective Module", is particularly well suited for this purpose.

## § 4 Teaching and learning formats

### (1) Teaching and learning formats

The Master's degree programme "Environmental Systems Sciences / Climate Change and Transformation Science" is designed to be accessible to a broad range of international students and to allow for a flexible organisation of study schedules. For this reason, a high proportion of virtual or blended learning is aimed for. Various forms of work with electronic learning platforms are used, such as assignments, reading tasks with opportunities for feedback, short videos, recorded lectures, and block courses. The choice of the specific didactic concept lies with the respective instructor.

### (2) Language

All courses and examinations of the Master's degree programme "Environmental Systems Sciences / Climate Change and Transformation Science" are conducted in English, and all required examination components as well as the Master's thesis must be completed or written in English. Parts of the Environment-related Elective Module as well as free electives may also be completed in languages other than English.

## § 5 Master exam

The Master exam is an oral examination by committee, worth one ECTS credit.

The examination committee consists of three members, two of whom act as examiners, while one serves as chair.

The Master exam comprises the public presentation of the Master's thesis (max. 20 minutes), the defence of the Master's thesis (max. 20 minutes), and topics from one of the following modules (max. 20 minutes):

- Module B: Systems Sciences
- Module D.1: Theoretical Climate Science
- Module D.2: Atmosphere and Climate Observations
- Module D.3: Methods for Climate Science
- Module E.1: Concepts in Transformation Science
- Module E.2: Methods in Transformation Science
- Module E.3: Applications in Transformation Science
- Module F: Interdisciplinary Climate Science
- Module G: Environment-related Elective Module

A single overall grade shall be awarded for the Master exam, which also takes the overall impression of the examination into account.

## § 6 Entry into force of the curriculum and transitional provisions

(1) This curriculum shall enter into force on 1 October 2026 (Curriculum 2026).

(2) Students of the Master's degree programme Environmental Systems Sciences / Climate Change and Transformation Science who, at the time this curriculum enters into force on 1 October 2026, are subject to the 2022 curriculum shall be transferred to the 2026 curriculum as of 1 October 2026. Examinations completed under the provisions of the 2022 curriculum shall be recognised for the 2026 curriculum in accordance with the equivalence list.

## Annex I: Module descriptions

| Module A | Interdisciplinary Practice |
|---|---|
| **ECTS Credits** | **10 ECTS** |
| **Content** | • Advanced concepts for the analysis, modelling, and assessment of human–environment systems<br>• Inter- and transdisciplinary methods<br>• Practical training based on an inter- or transdisciplinary problem in the field of applied environmental research<br>• Collaboration of students from different disciplines across disciplinary boundaries on a concrete problem |
| **Intended learning outcomes and competences** | Upon successful completion of this module, students are able to:<br>• analyse inter- and transdisciplinary environmental problems and address them using appropriate methods,<br>• present developed solutions and results, and understand and contextualise alternative disciplinary approaches and perspectives,<br>• conduct literature research and prepare academic content, critically reflect on and evaluate ideas and models, and develop new ones,<br>• independently structure their further learning process, communicate and work in interdisciplinary teams, and analyse problems from a holistic perspective. |
| **Teaching and learning activities / methods** | Theoretical input by lecturers as well as guest lectures, group work, active participation, preparation and discussion of selected literature, computer-based demonstrations, explanation of concepts using concrete examples, and individual as well as collaborative preparation of a scientific report or research papers |
| **Frequency of offering** | Every semester |

| Module B | Systems Sciences |
|---|---|
| **ECTS Credits** | **10 ECTS** |
| **Content** | • Conceptual, mathematical, and computer-based systems modelling<br>• Modelling using modern AI-based approaches<br>• Data extraction, integration, and analysis<br>• Model and systems evaluation<br>• Conceptual and computational systems analysis<br>• System resilience and sustainability |
| **Intended learning outcomes and competences** | Upon completion of the module, students are able to:<br>• model complex systems,<br>• understand and apply scenarios and concepts integrating natural and social sciences to case studies,<br>• evaluate systems from a sustainability perspective,<br>• conduct academic literature research and prepare scholarly work,<br>• communicate findings clearly in oral and written form,<br>• work in interdisciplinary teams,<br>• critically reflect on, evaluate, and further develop ideas and models,<br>• independently structure their further learning process. |
| **Teaching and learning activities / methods** | Lectures, continuous homework assignments, active participation, preparation and discussion of selected literature, computer-based demonstrations, writing of papers, and explanation of concepts using concrete examples |

| | |
|---|---|
| **Frequency of offering** | Courses B.1 and B.2 are offered every academic year. At least two of the three courses from B.3 to B.5 are offered every academic year. |

| **Module C** | **Onboarding** |
|---|---|
| **ECTS Credits** | **6 ECTS** |
| **Content** | • Introduction to the disciplinary foundations of the respective non-selected specialisation within the programme<br>• Introduction to meteorology and climatology<br>• Introduction to the social sciences<br>• Introduction to economics |
| **Intended learning outcomes and competences** | Upon completion of the module, students are able to:<br>• explain the content, research questions, and basic methodological approaches of the non-selected specialisation and contextualise alternative disciplinary perspectives,<br>• describe basic meteorological and climatological phenomena, relationships, and changes, and provide qualitative explanations of these,<br>• describe key concepts, qualitative and quantitative methods in the social sciences, and the relationships between established social science fields and systems science,<br>• describe fundamental economic and socio-economic concepts, relationships, and metrics,<br>• conduct academic literature research and prepare scholarly work. |
| **Teaching and learning activities / methods** | Lectures and discussion |
| **Frequency of offering** | Every academic year |

| **Module D.1** | **Theoretical Climate Science** |
|---|---|
| **ECTS Credits** | **9-12 ECTS** |
| **Content** | • Introduction to dynamical processes in the atmosphere and their physical–mathematical description<br>• Introduction to the components and processes of the climate system and their interactions, including their physical–mathematical description<br>• Introduction to climate variability on timescales from months to millions of years and its drivers |
| **Intended learning outcomes and competences** | Upon completion of this module, students are able to:<br>• explain the theoretical physical and mathematical foundations of atmospheric and climate dynamics,<br>• identify, explain, and mathematically describe key dynamical processes in the atmosphere,<br>• explain interactions and feedback mechanisms in the climate system and describe their foundations mathematically,<br>• explain the carbon cycle, radiative processes, and the energy balance of the climate system in physical terms and describe their underlying mathematical principles,<br>• interpret climate variability across different timescales and attribute it to internal or external drivers,<br>• conduct academic literature research and critically evaluate scientific sources. |
| **Teaching and learning activities / methods** | Lectures and discussion |

| | |
|---|---|
| **Frequency of offering** | Courses D.1.1 and D.1.2 are offered every academic year. At least two of the three courses D.1.3 to D.1.5 are offered every academic year. |

| **Module D.2** | **Atmosphere and Climate Observations** |
|---|---|
| **ECTS Credits** | **6 ECTS** |
| **Content** | • Introduction to the theoretical and physical foundations of measurement and instrumentation<br>• Treatment of measurement uncertainties and calibration theory<br>• Overview of in-situ and remote sensing methods and their applications in atmospheric and climate research<br>• Overview of sensor and instrument types, measurement principles, and measurement geometries<br>• Overview of global and regional observation networks |
| **Intended learning outcomes and competences** | Upon completion of this module, students are able to:<br>• identify, classify, explain, and distinguish key atmospheric measurement methods,<br>• relate measurement principles to fundamental physical and chemical processes,<br>• discuss advantages and limitations of different observational methods,<br>• select appropriate observation systems for practical applications,<br>• estimate and interpret measurement uncertainties. |
| **Teaching and learning activities / methods** | Lectures and discussion |
| **Frequency of offering** | Every academic year |

| **Module D.3** | **Methods for Climate Science** |
|---|---|
| **ECTS Credits** | **15-18 ECTS** |
| **Content** | • Applied vector calculus and partial differential equations<br>• Fundamentals of probability theory, inferential statistics, stochastic processes, and statistical time series analysis<br>• Practical applications of analytical methods in climate research, including handling of large datasets<br>• Practical exercises in programming<br>• Principles of climate modelling<br>• Overview of different climate models, their performance, and areas of application<br>• Practical applications of regional climate modelling |
| **Intended learning outcomes and competences** | Upon completion of this module, students are able to:<br>• mathematically describe spatio-temporal dynamical problems,<br>• formulate, evaluate, and formally address statistical problems,<br>• analyse and interpret large climate datasets using advanced statistical methods,<br>• assess the quality and uncertainty of climate simulations,<br>• perform regional climate simulations independently. |
| **Teaching and learning activities / methods** | Lectures, independent study, group work, discussions, literature research, computational exercises, and computer-based training. |
| **Frequency of offering** | Every academic year. Course D.3.6 is offered at least every second academic year. |

| Module E.1 | Concepts in Transformation Science |
|---|---|
| **ECTS Credits** | **12 ECTS** |
| **Content** | • Current theories of human behaviour with relevance to sustainability<br>• Social-ecological systems as complex adaptive systems<br>• Issues of inequality, distribution, and justice, including gender perspectives<br>• Theory of resilience and critical transitions in social-ecological systems<br>• Introduction to social metabolism: energetic and material foundations of society<br>• Relationships between social metabolism, human development, and environmental change<br>• Core concepts of environmental and climate economics: externalities, public goods, social cost of carbon, evaluation of instruments and policy measures<br>• Empirical challenges in environmental governance and environmental policy<br>• Core models of climate economics: integrated assessment models, structural models, empirical models<br>• Aspects of inequality, distribution, and justice, including gender dimensions |
| **Intended learning outcomes and competences** | Upon completion of this module, students are able to:<br>• distinguish between systems thinking and reductionism and analyse social-ecological systems using systems-based approaches,<br>• describe the relationships between sustainability requirements and issues of inequality, distribution, and justice,<br>• assess system resilience and apply principles of resilience,<br>• explain core concepts of socio-metabolic analysis,<br>• explain fundamental concepts of climate economics, including the value of an economy-wide perspective,<br>• discuss the advantages and limitations of different climate-economic models,<br>• identify the limits of available concepts and theories,<br>• explain implications of the acquired concepts and theories for effective policy implementation. |
| **Teaching and learning activities / methods** | Lectures, independent study, presentations, group work, discussions, and exercises |
| **Frequency of offering** | Every academic year. At least one course is offered each academic year. |

| Module E.2 | Methods in Transformation Science |
|---|---|
| **ECTS Credits** | **12 ECTS** |
| **Content** | • Methods of optimisation<br>• Differential equations and dynamical systems<br>• Applied general equilibrium modelling<br>• Spatial statistics and analysis<br>• Qualitative research methods<br>• Complex network modelling<br>• Computational modelling methods<br>• Transdisciplinary methods |

| | |
|---|---|
| **Intended learning outcomes and competences** | Upon completion of this module, students are able to:<br>• apply specific quantitative and/or qualitative research methods,<br>• describe problems using quantitative equations,<br>• select the most appropriate methods for addressing a given research question,<br>• acquire relevant data,<br>• identify the limitations and constraints of the learned methods,<br>• communicate research results in an accessible manner. |
| **Teaching and learning activities / methods** | Lectures, independent study, presentations, group work, discussions, computational exercises, practical exercises, and programming |
| **Frequency of offering** | Every academic year. At least two courses are offered each academic year. |

| **Module E.3** | **Applications in Transformation Science** |
|---|---|
| **ECTS Credits** | **9 ECTS** |
| **Content** | • Case studies of socio-technical transitions<br>• Application of concepts and research methods to empirical problems in natural resource management<br>• Linking theory and empirical analysis<br>• Empirical data analysis<br>• Organisation and management of the research process<br>• Academic writing<br>• Inter- and transdisciplinarity |
| **Intended learning outcomes and competences** | Upon completion of this module, students are able to:<br>• explain selected concepts and methods,<br>• link theory and empirical evidence and select appropriate research methods,<br>• design empirical research,<br>• organise and manage the research process,<br>• write and present empirical research results,<br>• work with different stakeholder groups. |
| **Teaching and learning activities / methods** | Lectures, independent study, presentations, group work, and discussions |
| **Frequency of offering** | Every academic year |

| **Module F** | Interdisciplinary Climate Science |
|---|---|
| **ECTS Credits** | **9 ECTS** |
| **Content** | • Climate change risks<br>• Climate change adaptation<br>• Climate change mitigation<br>• Current topics in interdisciplinary climate research<br>• Aspects of inequality, distribution, and justice, including gender perspectives<br>• Practical work on case studies, including field and study excursions |
| **Intended learning outcomes and competences** | Upon completion of this module, students are able to:<br>• assess climate-related risks,<br>• formulate and evaluate climate change adaptation measures,<br>• discuss interdisciplinary research questions in climate science, |

| | |
|---|---|
| | • work in interdisciplinary teams consisting of climate scientists and social scientists. |
| **Teaching and learning activities / methods** | Lectures, workshops, independent study, presentations, group work, discussions, literature research, exercises, and preparation of a written assignment |
| **Frequency of offering** | Courses F.1 and F.4 are offered every academic year. At least one of the courses F.2 or F.3 is offered each academic year. |

## Annex II: Sample study plan structured by semester

Possible study plan with specialisation in Module D:

| Semester | Course Title / Examinations | ECTS |
|---|---|---|
| **1** | | **30** |
| B.1 | Data in Systems Sciences | 3 |
| C.2 | Introduction to Social Sciences | 3 |
| C.3 | Introduction to Economics | 3 |
| D.1.1 | Climate Dynamics | 3 |
| D.2.1 | Atmosphere and Climate Measurement Methods: in situ | 3 |
| D.3.1 | Mathematics for Climate Science | 2 |
| D.3.2 | Time Series Analysis | 3 |
| D.3.3 | Special Topics in Climate Science Methods: Data Handling and Programming | 3 |
| G | Environmentally-oriented Elective Subject | 4 |
| H | Free Electives | 3 |
| **2** | | **30** |
| B.2 | Systems-Modelling and Systems-Analysis | 3 |
| D.1.2 | Atmospheric Dynamics | 3 |
| D.1.3 | Physical Oceanography, Hydrology and Climate | 3 |
| D.2.2 | Atmosphere and Climate Measurement Methods: Remote Sensing | 3 |
| D.3.4 | Analysis Methods in Climate Science | 4 |
| D.3.5 | Climate Modelling | 3 |
| F.1 | Climate Risks | 4 |
| G | Environmentally-oriented Elective Subject | 7 |
| **3** | | **30** |
| A.1 | IP - Interdisciplinary Practical Training | 10 |
| B.5 | AI Methods for Modelling Complex Systems | 4 |
| D.3.6 | Special Topics: Regional Climate Modeling in Practice | 3 |
| F.2 | Special Topics in Interdisciplinary Climate Science | 3 |
| G | Environmentally-oriented elective subject | 4 |
| H | Free Electives | 3 |
| | Master Thesis | 3 |
| **4** | | **30** |
| F.4 | Master Seminar | 2 |
| | Master Thesis | 27 |
| | Master Exam | 1 |

Possible study plan with specialisation in Module E:

| Semester | Course Title / Examinations | ECTS |
|---|---|---|
| **1** | | **30** |
| B.1 | Data in Systems Sciences | 3 |
| C.1 | Introduction to the Climate System | 3 |
| C.2 | Introduction to Social Sciences | 3 |
| E.1.1 | Human Behaviour and Human-Nature Interactions | 3 |
| E.1.2 | Social-Ecological Systems Analysis | 3 |
| E.2.3 | Quantitative Research Methods: Computable General Equilibrium Modelling | 6 |
| G | Environmentally-oriented Elective Subject | 6 |

| | | |
|---|---|---|
| H | Free Electives | 3 |
| **2** | | **30** |
| B.2 | Systems Modelling and Systems-Analysis | 3 |
| E.1.3 | Environmental Economics | 3 |
| E.2.2 | Qualitative Research Methods and Transdisciplinarity | 6 |
| E.3.2 | Special Topics in Transformation Science: Climate and Energy Management | 3 |
| F.1 | Climate Risks | 4 |
| G | Environmentally-oriented Elective Subject | 8 |
| H | Free Electives | 3 |
| **3** | | **30** |
| A.1 | IP - Interdisciplinary Practical Training | 10 |
| B.5 | AI Methods for Modelling Complex Systems | 4 |
| E.1.5 | Advanced Environmental and Climate Policy | 3 |
| E.3.1 | Research Project in Climate Resilience & Transformation Management | 6 |
| F.2 | Special Topics in Interdisciplinary Climate Science | 3 |
| G | Environmentally-oriented Elective Subject | 1 |
| | Master Thesis | 3 |
| **4** | | **30** |
| F.4 | Master Seminar | 2 |
| | Master Thesis | 27 |
| | Master Exam | 1 |

## Annex III: Equivalence lists

**Equivalence list for transition into the current curriculum of the Master's degree programme Environmental Systems Sciences / Climate Change and Transformation Science (2026 version) from the curriculum of the Master's degree programme Environmental Systems Sciences / Climate Change and Transformation Science (2022W version).**

The left-hand side of the table lists the examinations of the current curriculum. The right-hand side lists the corresponding equivalent examinations of the phasing-out curriculum of the Master's degree programme Environmental Systems Sciences / Climate Change and Transformation Science, which are recognised for examinations of the current curriculum when transferring to it. Examinations from the outgoing curriculum that are not listed may be used as free electives.

| Current curriculum (2026 version) | | | | | Phasing-out curriculum (2022W version) | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **Course title / examination** | **Course Type** | **ECTS** | **Contact hours** | | **Course title / examination** | **Course type** | **ECTS** | **Contact hours** |
| B.5 | AI Methods for Modelling Complex Systems | KS | 4 | 2 | | Individual recognition | | | |
| D.1.5 | Radiation and Energy Balance | VO | 3 | 2 | | Individual recognition | | | |
| D.3.2 | Time Series Analysis | VO | 3 | 2 | D.3.2 | Statistics and Time Series Analysis | VO | 3 | 2 |
| D.3.6 | Special Topics: Regional Climate Modeling in Practice | KS | 3 | 2 | | Individual recognition | | | |
| E.1.3 | Environmental Economics | VU | 3 | 2 | | Individual recognition | | | |
| E.1.5 | Advanced Environmental and Climate Policy | KS | 3 | 2 | E.3.2 | Advanced Environmental and Climate Policy | KS | 3 | 2 |
| E.2.1 | Mathematics for Social-Ecological Systems Science | KS | 6 | 3 | | Individual recognition | | | |
| E.2.2 | Qualitative Research Methods and Transdisciplinarity | KS | 6 | 3 | E.2.2 | Qualitative Research Methods and Transdisciplinarity | KS | 6 | 2 |
| E.3.2 | Special Topics in Transformation Science: Climate and Energy Management | KS | 3 | 2 | E.1.3 | Special Topics in Transformation Science: Climate and Energy Management | KS | 3 | 2 |
| F.2 | Special Topics in Interdisciplinary Climate Science | KS | 3 | 2 | F.2 | Special Topics in Interdisciplinary Climate Science | SE | 3 | 2 |
| F.3 | Special Topics: Practical Studies in Interdisciplinary Climate Science | EX | 3 | 2 | | Individual recognition | | | |
| F.4 | Master Seminar | SE | 2 | 2 | F.3 | Master Seminar | SE | 2 | 2 |