Universität für Bodenkultur Wien

University of Natural Resources and Life Sciences, Vienna

Curriculum

for the Master's Programme in

Climate Change and Societal Transformation

Programme classification no. 066 …

Effective date: October 1st 2023

CONTENTS

§ 1 QUALIFICATION PROFILE

The master's programme in Climate Change and Societal Transformation is a degree programme which serves to deepen and extend students' pre-vocational academic education, building on the basis provided by a bachelor degree programme (§ 51 [2] item 5 of the Universities Act UG 2002, Federal Law Gazette BGBl I no. 81/2009).

The inter- and transdisciplinary Master's program Climate Change and Societal Transformation conveys a systems perspective on the global climate crisis and integrates (1) a physical understanding of the climate system, its processes and drivers, and climate change and associated impacts, (2) a socio-ecological analysis of the drivers, agents and impacts of climate change, and (3) transformative approaches for a sustainable and just society explicitly taking North-South dynamics into account. Thereby, the program provides fundamental knowledge about the climate system and climate change as a physical phenomenon, environmental threat, and a social and political crisis and associated strategies and solutions.

1a) Knowledge, skills, professional and personal competencies

Knowledge: Graduates have acquired a research-based qualification to understand climate change as a result of society-nature interactions and to develop and critically assess response strategies. Based on this, they can contribute to a social-ecological transformation towards a sustainable society with low resource use and low GHG emissions. The program combines system knowledge, target knowledge and transformation knowledge, thereby preparing students for a critical assessment of climate change impacts, mitigation and adaptation strategies and policies, as well as trade-offs and synergies with other sustainable development goals.

- Graduates are able to apply quantitative and qualitative methods, tools and models to analyse the climate system and climate change and its drivers and impacts at different spatial and temporal scales.
- Graduates are able to assess the effects of mitigation and adaptation strategies as well as the potentials, risks, limitations and ethical issues associated with potential geoengineering strategies.
- Graduates have developed a critical understanding of strategies to reduce resource use and GHG emissions (e.g., circular economy, bioeconomy, natural climate solutions, decoupling, degrowth) and the related challenges (including North-South relations).
- Graduates are able to assess the potentials and limitations of these strategies and understand trade-offs and synergies including issues of environmental conflict and justice.

Graduates have deepened this knowledge by choosing one of three specialisations:

a) *Climate dynamics and climate impacts* provides an in-depth understanding of the physico-chemical processes of the climate system and changes through anthropogenic activity and beyond, thereby providing the theoretical, technical, and empirical basis to understand, observe and model the spatial and temporal dynamics of the climate

system, the natural and human-induced changes and the impacts of these changes on nature and society.

b) *Social ecology of climate change* places climate change in the larger context of society-nature interactions, introduces social metabolism and land use as physical drivers of climate change and methods to investigate these interactions, and provides a critical and interdisciplinary perspective on strategies of social-ecological transformation ranging from decoupling to degrowth.

c) *Climate crisis and transformative development* offers in-depth insights and training in participatory and transdisciplinary approaches, processes, and methods, working both with local communities in concrete places in the Global North and the Global South as well as at national and international level, towards a climate-friendly and just transformation.

Skills: Graduates acquire a broad range of disciplinary as well as inter- and transdisciplinary quantitative and qualitative skills enabling them to assess climate impacts, mitigation and adaptation strategies, as well as trade-offs and synergies in pathways for transformative development.

- Graduates are equipped with the competencies to work and communicate in interdisciplinary teams bridging social- and natural science perspectives. They can communicate complex problems related to climate change and socio-ecological transformation to policy makers and the wider public.
- Graduates have the competencies to make evidence-based decisions as innovative, critical, and intellectually open actors in society, business, politics and science.
- Graduates have acquired transformative competencies which empower them to become actors of change.
- Graduates also develop a series of specific competencies and skills through tailored training in one of the three specialisations:

a) Climate dynamics and climate impacts: climate processes and climate dynamics, physico-chemical analyses, numerical methods including the application of climate and impact models, scenario analysis and design, attribution techniques and statistics of extremes, identification of climate impacts on local/regional/global scales, water, carbon and nutrient cycles, biosphere-climate interactions, alpine hazards, adaptation and mitigation techniques and potentials, transformative approaches

b) Social ecology of climate change: biophysical socio-ecological methods and indicators (e.g., material and energy flow analysis, carbon accounting); qualitative and quantitative methods (e.g., policy and discourse analysis, qualitative interviews) and theories and concepts of social sciences and economics; critical analysis of transformation processes and the actors involved, policies and policy instruments; assessment of climate solutions based on biophysical, social and economic criteria; identification of barriers for behaviour change and climate solutions as well as trade-offs and synergies with other sustainable development goals

c) Climate crisis and transformative development: critical analysis and reflection of past and present development approaches, design and critical analysis of applied

development research, transformative development approaches, political ecology, structural and intersecting inequalities, theory-guided analyses, qualitative methods of social sciences, quantitative analysis of socio-ecosystems, analysis of effectiveness of governance approaches, transdisciplinary facilitation skills supporting effective collaboration between different actors

Professional/vocational competencies: Through disciplinary, inter-, and transdisciplinary training students will gain in-depth process understanding and tailored professional and vocational competencies that enable them to solve complex problems in climate and transformation science. Students will acquire the competencies to develop, communicate, implement, and assess strategies and policies for climate change mitigation and adaptation, sustainable development, and societal transformation.

Personal competencies: Students will strengthen personal, analytical, and methodological skills as well as their presentation techniques and skills in scientific writing. Through joint project work students will learn how to work in diverse inter- and transdisciplinary teams and contexts, to present and critically reflect ideas, problems, and solutions to both professional and non-specialist audiences. BOKU is the university of sustainability and diversity and offers a unique environment for the further development of the graduates beyond the main focus of their studies.

1b) Professional qualifications

The Master's program qualifies graduates to pursue the following professional activities:

- Teaching and research in inter- and transdisciplinary climate and sustainability science at university level, in public and private research and educational institutions, both at national and international level.
- Development, implementation and assessment of strategies and policies for climate change mitigation and adaptation in the public sector (regional or national administration, international organizations), in non-governmental organizations, (e.g., development, environmental and nature conservation organizations), consulting and advisory firms, statistical offices, sustainability departments, etc.
- Contributing to the development and implementation of solutions for sustainable development in the public and private sector, e.g., business, public administration, non-profit organizations, social and health care, etc.
- Knowledge "translation", communication, and dissemination: adult education, investigation and media coverage, journalism, (non-)governmental organizations and boundary organizations concerned with environment and climate, etc.

§ 2 ADMISSION REQUIREMENTS

The proof of English knowledge at level B2 (Common European Framework of Reference for Languages) must be provided.

Graduates of the bachelor's programme in Environment and Bioresources Management (Umwelt- und Bioressourcenmanagement), Environmental Sciences and Civil Engineering (Umweltingenieurwissenschaften), Landscape Architecture and Landscape Planning (Landschaftsplanung und Landschaftsarchitektur), Agricultural Sciences

(Agrarwissenschaften), and Forestry (Forstwirtschaft) offered by BOKU – University of Natural Resources and Life Sciences, Vienna, as well as Environmental System Sciences (Umweltsystemwissenschaften) offered by University of Graz, and Geography (Geographie) offered by University of Vienna, University of Innsbruck, University of Salzburg and University of Klagenfurt are eligible for admission with no further requirements.

Graduates of other relevant bachelor's programmes in environmental and sustainability sciences, natural sciences or social sciences can be admitted with no further requirements if they can prove 9 ECTS credit points each in social and natural sciences as well as 3 ECTS credit points in technical sciences.

Admission of those holding other relevant degrees will be determined on a case-by-case basis and may be made contingent upon successful completion of additional subjects.

To compensate for substantial subject-related differences, supplementary examinations may be specified, which must be taken by the end of the second semester of the master's programme. The notice of admission may specify which of these supplementary examinations are a prerequisite for taking the examinations provided in the curriculum of the master's programme.

If the substantial differences exceed the extent of 30 ECTS credit points, the corresponding bachelor programme may not be considered as a relevant study programme.

§ 3 PROGRAMME STRUCTURE

3a) Duration, scope (ECTS credit points) and structure

The programme consists of courses and other requirements worth a total of 120 ECTS credit points. This is equivalent to a duration of four semesters (a total of 3000 60-minute credit hours).

The study program has a modular structure. A module is a unit that is stringently structured in terms of content, time and didactics, and for which learning outcomes are defined.

The scope of each module is 6 ECTS credit points or a multiple thereof (e.g., 12, 18, ... ECTS credit points). Depending on the didactic requirements, a module is divided into up to two, in exceptional cases three module courses.

For a module course, immanence in exams or non-immanence in exams can be provided.
A module extends over one semester, in justified exceptional cases over two consecutive semesters.

The Master's curriculum includes compulsory modules (there are no options for compulsory modules) totalling 66 ECTS credit points and elective modules totalling 42 ECTS credit points. Furthermore, 12 ECTS credit points are freely selectable for the students, whereby these can be completed as module courses at BOKU or as courses at other universities.

Compulsory:	66 ECTS, of which:
Master's thesis including defensio:	30 ECTS credit points

Elective:	42 ECTS credit points, of which:
Specialisation:	30 ECTS credit points (of which 18 ECTS credit points compulsory, 12 ECTS credit points elective)
Free electives:	12 ECTS credit points

The official language of the study programme is English.

3b) Framework of mobility

Student mobility and/or the opportunity to acquire international experience, intercultural skills and global perspectives is expressly recommended as part of a study program offered at BOKU. There are various options for this:

- Achievement of learning outcomes at foreign universities, in particular within the free electives, the master's thesis. (Compulsory and elective module courses not completed at BOKU require recognition for the course of study, the master's thesis requires the appointment of an external supervisor.)

- Achievement of international competences at BOKU by dealing with international, intercultural, or global aspects, attending module courses by guest lecturers, excursions abroad, etc.

3c) Three-pillar principle

The three-pillar principle serves to solve interdisciplinary issues and is the central identification feature of the bachelor's and master's programs at BOKU – University of Natural Resources and Life Sciences, Vienna.

In the master's programmes, the content of the compulsory and elective modules, based on the entire curriculum (except for the master's thesis and compulsory internship), are assigned to the following areas with a minimum share of 15% each:

15% Technology and engineering
15% Natural sciences
15% Economics, social sciences, and law

A detailed description of the modules can be found in Annex A.

§ 4 COMPULSORY MODULES

Compulsory modules worth a total of 66 ECTS credit points are required to complete the master's programme. This includes the completion of the master's thesis with 30 ECTS credit points (see §7 Master's thesis).

Compulsory modules	ECTS credit points
Climate change and social ecology	**6**
Grand challenges in the Anthropocene	**6**
Scenarios and models as tools to understand complex systems	**6**
Transformation pathways	**6**
Inter- and transdisciplinary approaches and processes	**6**
Field of thesis research	**6**

A detailed description of the modules can be found in annex A.

§ 5 ELECTIVE MODULES

Elective modules worth a total of 42 ECTS credit points are required to complete the master's programme. Within these, one of three specialisations comprising 30 ECTS credit points must be chosen, the remaining 12 ECTS credit points must be chosen from the list of general elective modules.

Elective modules – Specialisation 1 Climate dynamics and climate impacts	**ECTS credit points**
Compulsory specialisation modules	
Climate dynamics	**6**
Atmospheric composition and climate	**6**
Numerical methods for climate science	**6**
Elective specialisation modules	
Grand challenges in climate and biodiversity	**6**
Extreme events and Alpine hazards	**6**
Urban climate and environmental meteorology	**6**
Land-atmosphere interactions and land-climate dynamics	**6**
Impact of climate change on water resources	**6**
Carbon, nutrient, and water cycling in a changing climate	**6**

Elective modules – Specialisation 2 Social ecology of climate change	**ECTS credit points**
Compulsory specialisation modules	
Biophysical concepts and methods of social ecology	**6**
Social-ecological transformation	**6**
Climate change mitigation – a socio-ecological perspective	**6**
Elective specialisation modules	
Land system science and climate change	**6**
Social metabolism and climate change	**6**
Climate politics, justice, and conflict	**6**
Environmental history	**6**
Climate solution sciences	**6**
Sustainable spatial development and energy transition	**6**

Elective modules – Specialisation 3 Climate crisis and transformative development	**ECTS credit points**
Compulsory specialisation modules	
Gender, food systems, and natural resources	**6**
Facilitating change for sustainable development	**6**
Political ecology of the climate crisis	**6**
Elective specialisation modules	
Climate justice and security	**6**
Applied development research and sustainable development goals	**6**
System science in development	**6**
Negotiating change for sustainable development	**6**

Farming systems in a changing climate	**6**
Climate scholar activism	**6**

Elective modules – General elective modules	ECTS credit points
Food systems transformation in the context of global change	**6**
Climate change and global aspects in planning and spatial development	**6**
Sustainable cities, urban metabolism, and climate change	**6**
Projects in climate science and transformation	**6**
Actor-centred perspectives and pathways towards transformation	**6**
One module selected from specialisations not chosen	**6**

A detailed description of the modules can be found in annex A.

§ 6 FREE ELECTIVES

Free electives worth a total of 12 ECTS credit points are required to complete the master's programme. Free electives may be selected from all courses offered by all recognized universities in Austria and abroad.

§ 7 MASTER'S THESIS

A master's thesis is a thesis on a scientific topic, to be written as part of a master's degree programme.

The study regulations for the master's thesis can be found in the statutes of the University of Natural Resources and Life Sciences.

The thesis is worth a total of 30 ECTS credit points including defensio.

The topic of the master's thesis is taken from a subject of the programme. The master's thesis is supervised by a person who is authorized to teach this subject (exception: § 86 paragraph 7 of the statutes of the University of Natural Resources and Life Sciences, Vienna).

The topic of a master's thesis shall be chosen in such a way that it is reasonable to expect a student to be able to complete it within six months (§ 81 [2] UG 2002).

Multiple students may jointly address a topic, provided that the performance of individual students can be assessed (§ 81 [3] UG 2002).

The master's thesis shall be written in English. The thesis defensio must be held in English.

§ 8 COMPLETION OF THE MASTER'S PROGRAMME

The master's programme has been completed when the student has passed all required modules and courses successfully and received a positive grade on the master's thesis and defensio. The confirmation of the degree will be by notification.

§ 9 ACADEMIC DEGREE

Graduates of the master's programme in Climate Change and Societal Transformation are awarded the academic degree Master of Science, abbreviated as M.Sc. The academic degree M.Sc., if used, shall be placed after the bearer's name (§ 88 [2] UG 2002 BGBl. I no. 81/2009).

§ 10 EXAMINATION REGULATIONS

(1) Any didactically required admission requirements for examinations in the form of successfully completed module courses are to be listed in § 4 and § 5.

(2) The master's programme in Climate Change and Societal Transformation has been completed successfully when the following requirements have been met:

- positive completion of the compulsory modules worth a total of 36 ECTS credit points (§ 4)
- positive completion of elective modules worth a total of 42 ECTS credit points (§ 5)
- positive completion of free electives worth a total 12 ECTS credit points (§ 6)
- a positive grade on the master's thesis and the defensio worth a total of 30 ECTS credit points (§ 7)

(3) The performance record for the modules is provided by the performance record for the module courses belonging to the modules.

(4) After the successful completion of all the courses and examinations required in the master's programme, the completed master's thesis, after it has been given a positive evaluation by the thesis supervisor, shall be publicly presented by the student and defended in the form of an academic discussion (defensio). The committee shall consist of a committee chair and two additional university teachers with a venia docendi or equivalent qualification. The student's total performance (thesis and defensio) will be assigned a comprehensive grade. Both thesis and defensio must receive a passing grade for the student to complete the programme. The written evaluations stating the rationale for the thesis grade and the defensio grade are included in calculating the comprehensive grade and are documented separately.

The comprehensive grade is calculated as follows:

- Master's thesis: 70%
- Defensio (incl. presentation): 30%

(5) Student evaluation in modules: Module evaluation is based on the grades given the students in the individual courses that make up the module. The total evaluation for the module is calculated as the average of the grades of all module courses, weighted by ECTS credit points. Average values of .5 or lower are rounded to the better (numerically lower) grade; values of over .5 are rounded to the worse (numerically higher) grade. If deemed necessary, the Dean of Studies may require a module examination at his/her discretion.

§ 11 EFFECTIVE DATE

This curriculum shall take effect on October 1st 2023.

ANNEX A MODULE DESCRIPTIONS

COMPULSORY MODULES

Title of the module	**Climate change and social ecology**	
Module type (*Compulsory- or elective)*	***Compulsory***	
Workload of the module in ECTS credit points	**ECTS Credit points** total	**Total hours (à 60 min.)**
	6	**150**
Learning Outcomes of the module *Knowledge:*	*After completion of this module students have gained a detailed understanding of the physico-chemical and socio-ecological processes and drivers of the climate system and concepts to analyse them. On the one hand students become familiar with the evolution of the atmosphere and climate over Earth's history and have obtained a broad overview about the core physico-chemical processes in the atmosphere, hydrosphere, and pedosphere. Students will comprehend among others the Earth's radiation and energy balance, and fundamentals of energy and mass transport and conservation, water cycle and water resources management, soil respiration and (de)nitrification in the climate system. On the other hand, students gain knowledge about key socio-ecological theories and concepts (social metabolism, colonization of nature) to describe and analyse interactions between societies and their natural environment underlying environmental and climate change. They have gained an overview of the evolution of socio-ecological regimes and their energy systems in human history and know about major driving forces of changes in society-nature interactions as well as transformative approaches from a socio-ecological perspective.*	
Skills:	*Students are able to understand important physico-chemical processes in climate science and astronomical and geological drivers of past climate change and variability. Students are able to identify connections between drivers and feedback among individual components of the climate system across the pedo-, hydro-, bio- and atmosphere and to comprehend and quantify effects of changes in Earth's radiation and energy balance and global carbon stocks. Students are able to apply socio-ecological principles and concepts to systematically analyse human pressures on the climate system and to critically assess climate solutions. They are able to identify and address inter- and transdisciplinary challenges in the context of climate change from a systemic, socio-ecological perspective.*	
Professional/vocational competencies:	*Students will have gained a fundamental understanding of the physico-chemical and socio-ecological drivers of the climate system. Students will be able to quantify changes in the Earth's radiative and energy budget through in-class exercises and thereby develop their analytical skills and critically assess changes in climate system components and their contribution to climate variability and change.*	
Personal competencies:	*In break-out groups and plenary discussion students improve their skills to develop and argue scientific positions. Through work on problem sets students will learn how to work in teams, train their analytical skills, and to incorporate feedback from both their peers and the lecturers into their work.*	
Module structure – types of module course(s) with ECTS credit points	VU Fundamentals of the climate system - 3 ECTS-Credits VO Social ecology and sustainable development - 3 ECTS- Credits	
(If applicable) **Participation requirements for the module**		

Title of the module	**Grand challenges in the Anthropocene**	
Module type (*Compulsory- or elective)*	***Compulsory***	
Workload of the module in ECTS credit points	**ECTS Credit points** total	**Total hours (à 60 min.)**
	6	**150**
Learning Outcomes of the module *Knowledge:* *Skills:* *Professional/vocational competencies:* *Personal competencies:*	*After completion of this module students have gained an overview and a systemic socio-ecological understanding of the Grand Challenges in the Anthropocene and developed a particular understanding of challenges related to the climate crisis and its linkages to biodiversity loss. Regarding the human contribution to climate change students have developed an in-depth understanding of the contribution of changes in atmospheric composition from land-use change, burning of fossil fuels and other anthropogenic activities from the preindustrial to present and the overlaying natural drivers of interdecadal to inter-annual climate variability. Students will understand positive and negative contributions to radiative forcing and how these forcings, and feedbacks, are projected to change the climate system over coming decades. Based on a socio-ecological understanding of the long-term evolution of the current sustainability challenges, students have gained an understanding of the transformative change needed to achieve the sustainable development goals. Students are able to understand important aspects of the embedding of climate change mitigation strategies in concepts of sustainable development.* *Students will be able to understand different anthropogenic alterations of the climate system since the preindustrial and their complex interactions. They will be able to understand contributions to positive and negative radiative forcing, assess and allocate emission baskets, and discuss and understand scenario dependent climate projections and associated impacts in the coming decades. Students will be able to describe measures of biodiversity, understand drivers of biodiversity and its loss. They can discuss the potential responses of organisms and ecosystems to human-driven stressors, such as increased atmospheric CO2, warming, increased precipitation variability or intensification of land use and their effects on ecosystem processes and ecosystem services, including biodiversity changes and biogeochemical cycling. Students are able to elaborate on the interrelations between climate change, land use and management, biodiversity and ecosystem responses.* *Students are able to understand the dominant role of humans for the Grand Challenges including climate change and biodiversity loss and that future projections of climate warming and sustainable development depend on future socio-economic development. This includes specific topics like the sectoral contributions to greenhouse gas emissions and radiative forcing since preindustrial times. Through numerical exercises and practical examples students are improving their analytical skills. In lecture, break out groups and plenary discussion students improve their skills of interdisciplinary and system-oriented thinking and to argue scientific positions.* *Students will have the opportunity to build communication skills and build their understanding of different scientific approaches to sustainable development. Through numerical exercises, practical examples, discussions in break out groups and plenary discussions students are improving their analytical competences as well as interdisciplinary and system-oriented knowledge and thinking*	
Module structure – types of module course(s) with ECTS credit points	VO The climate crisis as a grand challenge in the Anthropocene - 3 ECTS-Credits VO Biodiversity, ecosystems, and climate crisis - 3 ECTS-Credits	
(If applicable) **Participation requirements for the module**		

Title of the module	**Scenarios and models as tools to understand complex systems**	
Module type (*Compulsory- or elective)*	***Compulsory***	
Workload of the module in ECTS credit points	**ECTS Credit points** total	**Total hours (à 60 min.)**
	6	**150**
Learning Outcomes of the module *Knowledge:* *Skills:* *Professional/vocational competencies:* *Personal competencies:*	*Models are key tools in sustainability and climate science to analyse complex systems and their development over time. Students gain insights into different scenarios and modelling strategies and how they can be used to explore dynamics of historic and potential future developments. This will include in-depth knowledge on Integrated Assessment Models and major scenarios used, for example, in IPCC assessments (SSPs). The module will provide an introduction to socio-ecological, socioeconomic and earth system models and simulation techniques and a basic understanding of the development, structure and application of simulation models. The critical reflection of the strengths and weaknesses of different model approaches will be emphasized throughout the module. Through exploring different Foresight approaches and techniques, students will become what is also known as future literate and get a basic introduction to systems thinking, enabling them to make sense of current global trends and grand challenges. They know about the main concepts and methods with respect to foresight and scenarios, their advantages and limits.* *After successful completion of the module, students have gained a critical understanding of strengths and weaknesses of different modelling strategies and their application in climate and socio-ecological and socio-economic research and are familiar with scenario techniques. In particular they get a basic understanding of which modelling methods (top-down, bottom-up) are used to analyse dynamics of society-nature interaction (e.g., system-dynamics, agent-based, earth-system models, integrated assessment models).* *After completion of the module, students are able to apply scenario techniques and can reflect on future scenarios and their underlying assumptions and are able to identify and define consistent and plausible scenarios about the future. This will equip students to assess social, economic, and environmental developments from a systemic perspective.* *Students will prepare inputs on relevant topics in small groups and also participate in joint discussions throughout the module. Through collaboration on exercises and scenario building tasks, they will reflect and benefit from peer learning.*	
Module structure – types of module course(s) with ECTS credit points	Based on two existing courses which will be adopted to the specific focus of this master's program VS Integrated socio-ecological and climate modelling - 3 ECTS-Credits VU Foresights - what future to expect? (Late lessons from early warnings) - 3 ECTS-Credits	
(If applicable) **Participation requirements for the module**		

Title of the module	**Transformation pathways**	
Module type (*Compulsory- or elective)*	***Compulsory***	
Workload of the module in ECTS credit points	**ECTS Credit points** total	**Total hours (à 60 min.)**
	6	**150**

Learning Outcomes of the module *Knowledge:* *Skills:* *Professional/vocational competencies:* *Personal competencies:*	*The integrative module introduces and critically debates concepts and practical applications in societal transformation and transformative development - using perspectives from development, transformation, economics, sociology, and political sciences. After completing this module, participants will understand how different disciplines frame social, economic and ecological challenges at local, regional and international level and which leverage points for change they propose and analyse. Specifically, they will know how (i)development thinking has evolved from modernization to transformation; (ii) transformation studies seek to understand fundamental shifts in the way societies, economies, and ecosystems function, (iii) economics and sociology of climate solutions propose mitigation and adaptation measures as drivers of transformation and (iv) political sciences analyse governance and social movements.* *Students will be able to use different lenses to critically analyse proposals for societal transformation and transformative development. Students will strengthen their analytical reading skills, their systemic thinking skills, and their abilities to participate in the transformation and transformative development discourses.* *Participants will increase a range of transversal competencies, including abilities to identify and critically process information and to formulate concise lines of argument based on relevant sources. They will strengthen their interdisciplinary skills by integrating perspectives from various fields such as economics, politics, sociology, development and transformation studies.* *The module is based on principles of team-based, inverted classroom learning and focuses on collaboration and debate. The participants can develop their collaboration and communication skills. They will experience that different perspectives, also among the teaching team, require tolerance for uncertainty and ambiguity - which will expand their understanding of science and its role in transformation and transformative development processes.*
Module structure – types of module course(s) with ECTS credit points	VS Transformative development - 3 ECTS-Credits SE Economics and sociology of climate solutions - 3 ECTS-Credits
(If applicable) **Participation requirements for the module**	

Title of the module	**Inter- and transdisciplinary approaches and processes**	
Module type (*Compulsory- or elective)*	***Compulsory***	
Workload of the module in ECTS credit points	**ECTS Credit points** total	**Total hours (à 60 min.)**
	6	**150**
Learning Outcomes of the module *Knowledge:*	*Students learn about the significance of inter-and transdisciplinary approaches in climate and sustainability science and gain knowledge about different inter- and transdisciplinary approaches, including collaborative and transformative, co-conceptualizing and co-creating research and methods. The interdisciplinary team of lecturers will offer insights into an array of methods and introduce different examples of transdisciplinary case studies. The lecturers will guide student groups in problem-based learning while pursuing a small project including participative elements with practice and stakeholders. Students will learn about their own discipline and the diversity of disciplinary approaches regarding climate change and socio-ecological transformation present in the group of students and lecturers. Understanding and reflecting communalities and differences in disciplinary cultures concerning theories, methods, "doing" research and quality criteria is key to be able to identify the opportunities and limitations of different disciplinary approaches. This is an important prerequisite for inter- and transdisciplinary research. Students will further understand different expectations in science-society interaction concerning the problem definition (societal and scientific problems) and the relevant outcomes (solutions and new knowledge).*	

Skills: *Professional/vocational competencies:* *Personal competencies:*	*Students will have developed skills to apply different interdisciplinary and transdisciplinary methods to integrate different types of knowledge adequately and to reflect on the limitations of these methods.* *Students will acquire competencies which enable them to design cooperative research elements and set-up, implement and reflect on a transformation process. They will have gained experience in dealing with uncertainty, unknown situations, heterogeneous groups and conflicting interests and expectations of different actors involved. They will have acquired the basics of communication and conflict management. Additionally, they have learned to reflect on power and intersecting inequalities in transformative processes.* *Social and personal competences result from reflecting on experiences in transformative learning on different levels (self, group, organization, society) and on their own role in transformative processes.*
Module structure – types of module course(s) with ECTS credit points	VU Inter- and transdisciplinary approaches and processes - 6 ECTS-Credits
(If applicable) **Participation requirements for the module**	

Title of the module	**Field of thesis research**	
Module type (*Compulsory- or elective)*	***Compulsory***	
Workload of the module in ECTS credit points	**ECTS Credit points** total	**Total hours (à 60 min.)**
	6	150
Learning Outcomes of the module *Knowledge:* *Skills:* *Professional/vocational competencies:* *Personal competencies:*	*After successful completion of the module students have advanced their knowledge of theories, concepts, and methods relevant for their master thesis and of current research in the field of climate change and societal transformation.* *After completion of the module students will have acquired advanced quantitative and/or qualitative skills in the field of their thesis research and advanced their presentation skills and be able to critically reflect and comment on methods and findings of transdisciplinary research focused on changes in climate and societal transformation.* *Students will be able to present their own research (research questions/hypothesis, methods, findings) to a professional audience in a concise and comprehensible way. They will be able to argue the choice of research questions, concepts and methods and the interpretation of their findings and put them in the larger context of climate change and societal transformation. Students will be prepared to discuss and defend their research with a professional audience, and they are able to critically comment on the thesis research of their peers and critically discuss their findings.* *Students have acquired competencies in presenting scientific research in a given time frame and for an interdisciplinary audience. They have skills in providing constructive feedback concerning research design, methodological issues, and the interpretation of research findings to their peers and discuss research at a scientific level.*	
Module structure – types of module course(s) with ECTS credit points	SE Master seminar - 3 ECTS-Credits VS Theories and methods in the field of the thesis research - 3 ECTS-Credits	
(If applicable) **Participation requirements for the module**		

SPECIALISATION 1: CLIMATE DYNAMICS AND CLIMATE IMPACTS

Title of the module	**Climate dynamics**	
Module type (*Compulsory- or elective)*	***Compulsory***	
Workload of the module in ECTS credit points	**ECTS Credit points** total	**Total hours (à 60 min.)**
	6	**150**
Learning Outcomes of the module *Knowledge:* *Skills:* *Professional/vocational competencies:* *Personal competencies:*	*After completing the module students will have gained an in depth understanding of atmospheric and climate dynamics. Students will understand the typical laws governing large-scale atmospheric motions and be able to apply them for the characterization of atmospheric and climate phenomena across temporal and spatial scales. Students will understand the main modes of climate variability and the dynamics behind them as well as their surface impacts.* *After completion of this module students will be able to solve equations of state and mass and energy conservation, be able to characterize atmospheric motions and quantify energy transfer in the climate system numerically. Students will be able to diagnose the influence of climate modes on surface variables and understand teleconnection patterns. Students will be able to perform reduced complexity experiments in idealized models for causal analysis.* *In this module students will develop fundamental skills in numerics and atmospheric and climate physics that build the foundation for the application of climate and climate impact models. Students will gain experience in applying multivariate calculus and solving differential equations as well as the application of idealized atmospheric and climate models.* *Students will strengthen their quantitative and analytical skills as well as their presentation techniques. Through joint project work students will learn how to work in teams, how to present their ideas to an audience and how to incorporate feedback from both their peers and the lecturers into their work.*	
Module structure – types of module course(s) with ECTS credit points	VU Climate dynamics - 3 ECTS-Credits VU Climate lab - 3 ECTS-Credits	
(If applicable) **Participation requirements for the module**	Basic physical knowledge	

Title of the module	**Atmospheric composition and climate**	
Module type (*Compulsory- or elective)*	***Compulsory***	
Workload of the module in ECTS credit points	**ECTS Credit points** total	**Workload** of the module in ECTS credit points
	6	**150**

Learning Outcomes of the module *Knowledge:* *Skills:* *Professional/vocational competencies:* *Personal competencies:*	*After completing the module students will have gained an in-depth understanding of the chemical processes driving Earth's atmospheric composition, how atmospheric chemical composition drives and responds to climate and the importance of aerosols. Students will understand photochemistry, kinetics, and thermodynamics important to the chemistry of the atmosphere, e.g., stratospheric ozone depletion, the oxidation chemistry of the troposphere, photochemical smog, aerosol chemistry and aerosol-radiation-cloud interactions as well as sources and sinks of greenhouse gases and their global warming potentials. Students will understand chemical approaches to carbon dioxide removal and be able to comprehend the physico-chemical aspects of geoengineering strategies to combat climate warming as well as the risks associated with them.* *After completion of this module students will be able to understand and solve key processes of atmospheric gas phase chemistry, apply box models, and understand the physico-chemical process formulation in state-of-the art climate models of different scales (global to local), understand fundamentals of aerosol physics and chemistry, and processes involved in aerosol formation, evolution, and removal. Students will be able to understand the role of gases and aerosols in the context of climate, cloud formation, and air pollution.* *In this module students will develop fundamental skills in atmospheric chemistry and physics as well as the interaction of chemistry and climate. This will enable them to apply models to assess quantitatively the impact of climate and air pollution and feedbacks, synergies, and trade-offs.* *Students will strengthen their quantitative and analytical skills as well as their presentation techniques. Through joint project work students will learn how to work in teams, how to present their ideas to an audience and how to incorporate feedback from both their peers and the lecturers into their work. Students will further develop an ability to quantitatively assess the interaction of atmospheric chemistry and climate from local to global scale. They will also be able to reduce the complexity of the chemistry climate interaction to the crucial processes across temporal and spatial scales.*
Module structure – types of module course(s) with ECTS credit points	VU Atmospheric chemistry and climate - 3 ECTS-Credits VU Aerosols, radiation, clouds, and climate - 3 ECTS-Credits
(If applicable) **Participation requirements for the module**	Basic chemical knowledge

Title of the module	**Numerical methods for climate science**	
Module type (*Compulsory- or elective)*	***Compulsory***	
Workload of the module in ECTS credit points	**ECTS Credit points** total	**Total hours (à 60 min.)**
	6	**150**
Learning Outcomes of the module *Knowledge:* *Skills:*	*After successfully completing the module students will be familiar with the fundamentals of climate modelling, numerical recipes for efficient analyses of model outputs and observational records and state-of-the-art visualization techniques in climate science. Students will be able to write shell scripts, utilize high-performance computing (HPC) systems, and perform simple to medium-complexity experiments with atmospheric and climate models. Students will have a general understanding of the structure of atmospheric transport and climate models and the role of parameterizations in the model architecture. Students will be able to analyse data effectively, to create automatized analytical scripts in open-source languages such as Python and R and to produce clear and well-layouted graphical artwork to illustrate research outcomes.* *After successfully completing the module, the students will be able to perform atmospheric and climate model experiments and to analyse and visualize model outputs. Furthermore, students will be able to select appropriate models*	

Professional/vocational competencies: *Personal competencies:*	*or model outputs to answer their research questions and use open-source programming environments and HPC resources.* *Within the module the students will develop modelling and numerical analysis skills through hands-on experience. They will be able to perform experiments with state-of-the-art numerical models, get familiar with a broad range of data sets and data formats and obtain training in open-source software and the use of computational clusters and high-performance computing infrastructure.* *Through joint project work students will learn how to work in teams, how to present their ideas to an audience and how to incorporate feedback from both their peers and the lecturers into their work. Students have competences to select, analyse and visualize project relevant climate data. Students will further strengthen their presentation techniques through training in state-of-the art visualization techniques.*
Module structure – types of module course(s) with ECTS credit points	UE Atmospheric and climate modelling - 3 ECTS-Credits VU Meteorological data analysis and visualization - 3 ECTS-Credits
(If applicable) **Participation requirements for the module**	Basic knowledge of programming

Title of the module	**Grand challenges in climate and biodiversity**	
Module type (*Compulsory- or elective)*	***Elective***	
Workload of the module in ECTS credit points	**ECTS Credit points** total	**Total hours (à 60 min.)**
	6	**150**
Learning Outcomes of the module *Knowledge:* *Skills:* *Professional/vocational competencies:* *Personal competencies:*	*After participation students will have obtained an overview about the most recent literature in physical climate science and climate change biology and will be enabled to lead an informed discussion about trade-offs, feedbacks, and knowledge gaps in these fields. Students will thereby also become able to understand the manifold connections between these two contemporary crises and the importance of climate action and conservation for society.* *After successful completion of this module students will have gained an overview about the most recent literature addressing individual grand challenges and be able to identify remaining knowledge gaps and fields of progress. Students will be able to discuss key challenges of known-knowns and known-unknowns in climate science, the impacts and risks of future changes in climate for terrestrial, freshwater and marine biodiversity and nature's contributions to people as well as the impact of biodiversity conservation on greenhouse gas emissions.* *Students acquire competences in literature review and the assessment of topical relevance and selection of seminal studies in the broad body of scientific literature.* *Through joint project and seminar work students will learn how to work in teams, how to present their ideas to an audience and how to incorporate feedback from both their peers and the lecturers into their work.*	
Module structure – types of module course(s) with ECTS credit points	SE Grand challenges in climate research - 3 ECTS-Credits SE Interrelations between biodiversity and climate change - 3 ECTS-Credits	
(If applicable) **Participation requirements for the module**		

Title of the module	**Extreme events and Alpine hazards**	
Module type (*Compulsory- or elective)*	***Elective***	
Workload of the module in ECTS credit points	**ECTS Credit points** total	**Total hours (à 60 min.)**
	6	**150**
Learning Outcomes of the module *Knowledge:*	*After successfully completing the module students will have developed an understanding for the tremendous economic and societal impact of severe weather events and associated geomorphological processes during recent decades and that there is broad scientific consensus that climate change will increase - and has in parts already increased - the frequency and severity of meteorological hazards and other alpine hazards. Students will comprehend the driving mechanisms and trends in occurrence of individual meteorological phenomena on different spatial and temporal scales and different methodological frameworks to characterize and define extremes. Students will have acquired knowledge regarding the impacts of extreme meteorological events and climate change on alpine hazards of different types, such as snow avalanches, landslides, and torrential processes, and on disturbance regimes in alpine forests (forest fire, insect outbreaks and storm damages) which interrelate with gravitational hazards. Students will also understand the underlying processes of these natural hazards, the relationship to climate change, and the associated changes in the future, as well as multi-hazards and cascading processes and aspects of natural hazard management and vulnerability.*	
Skills:	*After participation students will have gained a deep understanding of individual meteorological hazards and their underlying drivers. Students will be able to apply state-of-the-art statistical methods to quantify the severity of individual weather events and derive probabilistic recurrence estimates. Participants will have gained knowledge about past and future changes in extreme events and the (un)certainty associated with future projections of changes in the frequency, duration, and severity of extreme events. Students will be able to explain recent extreme events from a climate perspective. Concerning natural hazards i.e., snow avalanches, landslides and torrential processes as well as forest disturbance regimes, students will have gained a basic understanding about classification systems, fundamental processes, and the impact of climate change on these hazards. Students will understand the role of predisposing factors and triggers for alpine hazards, and they will know mechanisms related to multi-hazards and cascading events. Furthermore, students will understand modern concepts of mountain hazard risk management and different dimensions of vulnerability and know how to apply them.*	
Professional/vocational competencies:	*Students consolidate their competence to comprehend complex scientific topics and to present and discuss them in front of an audience. They have the competence to understand basic meteorological, climatological, forest, snow, landslide, and torrential processes in the framework of climate change and are familiar with tools related to risk assessment and management.*	
Personal competencies:	*Through joint project work students will learn how to work in teams, how to present their ideas to an audience and how to incorporate feedback from both their peers and the lecturers into their work. Students will strengthen their analytical and presentation techniques through training in state-of-the art open-source software environments.*	
Module structure – types of module course(s) with ECTS credit points	VU Meteorological hazards and climate extremes - 3 ECTS-Credits VO Climate change impacts on hazards in mountain regions - 3 ECTS-Credits	
(If applicable) **Participation requirements for the module**		

Title of the module	**Urban climate and environmental meteorology**	
Module type (*Compulsory- or elective)*	***Elective***	
Workload of the module in ECTS credit points	**ECTS Credit points** total	**Total hours (à 60 min.)**
	6	**150**
Learning Outcomes of the module *Knowledge:* *Skills:* *Professional/vocational competencies:* *Personal competencies:*	*After module completion students will have gained an understanding about the dominant physical and chemical processes (and their connections) in the urban boundary layer and how they affect thermal comfort and ambient air quality. Students will have gained knowledge on the possibilities of transferring the information obtained into various policy fields such as climate sensitive urban development (based on selected examples) including adaptation measures to improve thermal comfort in outdoor urban environments.* *In this module students will become familiar with micro- and biometeorological measurement techniques to obtain information on urban thermal environments and ambient air quality, as well as modelling techniques to assess changes in thermal environments and/or ambient air quality following anthropogenic activities but also methods to develop adaptation measures.* *Students will develop competencies in the selection of suitable field sites, observational techniques and model and observational data sets for informed decision making in climate friendly urban development.* *Through joint project work students will learn how to work in teams, how to present their ideas to an audience and how to incorporate feedback from both their peers and the lecturers into their work.*	
Module structure – types of module course(s) with ECTS credit points	VS Urban climate and environmental meteorology - 3 ECTS-Credits UE Urban climate and environmental meteorology - 3 ECTS-Credits	
(If applicable) **Participation requirements for the module**		

Title of the module	**Land-atmosphere interactions and land-climate dynamics**	
Module type (*Compulsory- or elective)*	***Elective***	
Workload of the module in ECTS credit points	**ECTS Credit points** total	**Total hours (à 60 min.)**
	6	**150**
Learning Outcomes of the module *Knowledge:* *Skills:* *Professional/vocational competencies:* *Personal competencies:*	*After successfully completing the module students will be familiar with the management impacts on forest- and agroecosystems and the resulting interactions with the atmosphere. They will understand the differences (e.g., spatial and temporal challenges) between long- and short-term oriented production systems as well as between close-to-nature and intensive land-use practices.* *Based on their knowledge the students will be able to recognize the overall consequences of land-use and management decisions in the context of climate change. Identifying positive and negative feedback loops is a prerequisite for related modelling approaches.* *The students can support decision-making processes in the field of primary production and ecosystem services as well as contribute to advisory services and policy making.* *Students will learn how to work in teams, how to present their ideas and arguments to an audience. Students have competences to select, analyse and visualize research-based results. Students will further strengthen their*	

	presentation techniques through training in state-of-the art visualization techniques.
Module structure – types of module course(s) with ECTS credit points	VO Agrometeorology - 3 ECTS-Credits VO Climate-forest interactions - 3 ECTS-Credits
(If applicable) **Participation requirements for the module**	

Title of the module	**Impact of climate change on water resources**	
Module type (*Compulsory- or elective)*	***Elective***	
Workload of the module in ECTS credit points	**ECTS Credit points** total	**Total hours (à 60 min.)**
	6	**150**
Learning Outcomes of the module *Knowledge:*	*This module introduces the functioning of the earth system with a particular focus on the atmospheric and hydrological system. It integrates knowledge from the field of meteorology, hydrology, forestry, and alpine hazard research. Further, we elaborate on specific examples in different fields of water research and how water resources are impacted by climate change. Examples and potential mitigation and adaptation strategies will be discussed. After successfully completing this module students will be able to explain the coupled atmospheric-hydrological system. They will be able to describe the impact of climatic factors on water resources and specific processes, such as evapotranspiration, infiltration, runoff and cryosphere processes. They will be able to categorize the boundary conditions of climate scenarios including RCPs and SSPs. They will be able to explain the impacts of climate change on relevant sectors that depend on hydrology (e.g., agriculture, hydropower, tourism, timber production, water consumption, river management) and on aquatic ecosystems. They will identify the impacts of agricultural and forestry practices on the hydrological and carbon cycles. They will be able to assess the impact of climate aspects of river water management as well as sanitary and environmental engineering. They will be able to discuss evidence-based explanations for climate change and develop mitigation and adaptation strategies.*	
Skills:	*Students will be able to explain the relationships and interdependencies between the climate system and water resources. They will be able to explain the energy transfers between the systems. They can interpret the hard and soft facts of climate change.*	
Professional/vocational competencies:	*Students will be able to identify the connections between the climate drivers, the hydrological cycle and water resources. They will be able to discuss and bring in the various impacts that climate change can have on the water sector. They will gain competencies in sustainable management of water resources under non-stationary conditions.*	
Personal competencies:	*Students will be exposed to different impacts of climate change on the water cycle in different sectors. They will have more awareness of the latest scientific fact-based information and reports on climate change at the international and national levels.*	
Module structure – types of module course(s) with ECTS credit points	VO Possible impact of climate change on water resources - 3 ECTS-Credits SE Selected topics of climate change on water resources - 3 ECTS-Credits	
(If applicable) **Participation requirements for the module**	Basic knowledge in hydrology and water management	

Title of the module	**Carbon, nutrient, and water cycling in a changing climate**	
Module type (*Compulsory- or elective)*	***Elective***	
Workload of the module in ECTS credit points	**ECTS Credit points** total	**Total hours (à 60 min.)**
	6	**150**
Learning Outcomes of the module *Knowledge:*	*After successfully completing the module students will be familiar with the fundamentals of biogeochemical cycling of carbon and nutrients. Students understand how these systems work and how different environmental conditions alter element cycles. Students appreciate linkages between carbon and other nutrients. Students make out the physiological process of carbon storage and distribution within biomass. How is carbon storage calculated? There are different ways in assessing the carbon storage of plants and especially for forests. These different procedures are rationalized and how they are used for carbon modelling and its interactions with water, energy, and nutrients (BGC modelling). After the course students perceive water cycles in selected agro-ecosystems and agricultural management implications; the basic concept of soil health and related soil hydrologic functions; land degradation processes and soil and water conservation strategies.*	
Skills:	*When are forests turning from a carbon sink into a carbon source? To solve this question students can design data collection studies and calculation schemes as well as modelling the carbon sequestration of forests. Understanding the challenges of carbon sequestration is supported by the ability to distinguish well-managed forests and soils. Students can design field experiments, and desktop meta-analyses They can measure biogeochemical carbon and nutrient turnover. Students know how to assess surface water and erosion processes through empiric concepts that are applied in runoff and erosion models as well as the selection of soil and water conservation approaches in agriculture.*	
Professional/vocational competencies:	*Students are able to plan and implement measures that lead to the successful protection of existing organic carbon pools and to biological carbon sequestration. Students can assess climate-smart carbon and nutrient and water management in agriculture and forestry under regional pedoclimatic constraints. Students know the difficulty in designing, collecting, and calculating carbon relevant measures for forests. Which systems are currently in use, why do we have different assessment methods? The role of deadwood. The interaction of above-ground with below-ground carbon processes. The effect of degradation and what methods currently exist for large scale carbon assessment (e.g., from a forest stand to the whole continent). Students are able to evaluate surface water and soil erosion amounts, and to design well-targeted soil and water conservation measures for actual and projected climate conditions.*	
Personal competencies:	*Students develop their analytic skills to assess climate-smart carbon and nutrient and water management in agriculture and forestry under regional pedoclimatic constraints. Through practical applications students learn to plan, collect, and calculate carbon relevant measures for forests. Students develop theoretical and practical skills to evaluate surface water and soil erosion amounts. Through teamwork they learn how to cooperate in order to design well-targeted soil and water conservation measures for actual and projected climate conditions.*	
Module structure – types of module course(s) with ECTS credit points	VU Carbon sequestration and nutrient turnover - 3 ECTS-Credits VU Soil conservation - 3 ECTS-Credits	
(If applicable) **Participation requirements for the module**		

SPECIALISATION 2: SOCIAL ECOLOGY OF CLIMATE CHANGE

Title of the module	**Biophysical concepts and methods of social ecology**	
Module type (*Compulsory- or elective)*	***Compulsory***	
Workload of the module in ECTS credit points	**ECTS Credit points** total	**Total hours (à 60 min.)**
	6	**150**
Learning Outcomes of the module *Knowledge:*	*After successful completion of the module students have deepened their understanding of systemic biophysical concepts to analyse society-nature interactions and human impacts on the climate system by learning and applying principles of biophysical accounting for climate change research. They have gained a basic understanding of main methods and approaches (i.e., material flow analysis (MFA), human appropriation of net primary production (HANPP), full carbon accounting, life cycle assessment (LCA) and footprint accounts) and learned to identify strengths and limitations of different indicators and accounting frameworks in order to quantitatively analyse society-nature interactions and pressures on the environment. Students have gained expertise in critically discussing and reflecting different socio-ecological methods and indicator frameworks.*	
Skills:	*Students will have attained skills in conceptually applying different biophysical socio-ecological methods and critically assessing insights gained by studies using these methods and indicators. They are able to identify strengths and limitations of selected methods and indicator frameworks of social ecology and how they vary in different contexts.*	
Professional/vocational competencies:	*In the lecture-seminar part, students have gained skills in critically reading current academic literature, excerpting main messages as well as options and limitations of methods presented therein, and have developed competences in discussing those in plenary discussions with peers and experts. In the practical part, students will have gained abilities to interpret selected socio-ecological methods in practical research and will have trained their skills in presenting and discussing scientific results.*	
Personal competencies:	*Due to the disciplinary mix of students and lecturers and different settings of group discussions and interactive group work, participants will have developed skills in interdisciplinary communication with colleagues from other scientific backgrounds. In plenary and group discussions students will learn how to present their ideas and how to defend and argue scientific positions.*	
Module structure – types of module course(s) with ECTS credit points	VS Biophysical concepts and methods of social ecology: Introduction - 3 ECTS-Credits US Biophysical concepts and methods of social ecology: Practical Application - 3 ECTS-Credits	
(If applicable) **Participation requirements for the module**		

Title of the module	**Social-ecological transformations**	
Module type (*Compulsory- or elective)*	***Compulsory***	
Workload of the module in ECTS credit points	**ECTS Credit points** total	**Total hours (à 60 min.)**
	6	**150**

Learning Outcomes of the module *Knowledge:* *Skills:* *Professional/vocational competencies* *Personal competencies:*	*After completion of the module, the students have gained an overview on the societal challenges of the climate crisis and the reduction of resource use and greenhouse gas emissions – and how to analyse these.* *Students have basic knowledge on historical perspectives on transformations, the industrial revolution and its legacies for dealing with the climate crisis. They have a basic knowledge of contemporary theories and perspectives on social-ecological change (e.g., green growth/ecological modernization, degrowth/sufficiency) and understand different strategies and instruments to deal with the climate crisis, including the role of technology, the state/legal aspects, the market and civil society in transformative change (e.g., phase-out policies, tax reform and emission trading, contemporary sectoral climate policies, activism/bottom-up civil society initiatives). Furthermore, they have an overview of methods to analyse potentials and barriers for social-ecological transformation processes, with a focus on qualitative methods (e.g., policy analysis, discourse analysis, qualitative interviews, historical source analysis, legal analysis).* *After the successful completion of the module, students will be able to a) understand the societal challenges of historical, contemporary, and future transformations, b) understand the potential of different qualitative methods for the analysis of transformation processes, and c) differentiate contested societal strategies and instruments to deal with the climate crisis.* *Students are able to read, discuss and compare different perspectives on societal change and their characteristics as well as to read, discuss and compare scientific literature on strategies and instruments for social-ecological transformations. Students are able to critically evaluate different societal strategies and instruments to deal with the climate crisis in oral and written form and have basic knowledge on how to conduct qualitative social research on social-ecological transformations.*
Module structure – types of module course(s) with ECTS credit points	SE Conceptualizing social-ecological transformations - 3 ECTS-Credits VU Qualitative methods in transformation research - 3 ECTS-Credits
(If applicable) **Participation requirements for the module**	

Title of the module	**Climate change mitigation: A socio-ecological perspective**	
Module type (*Compulsory- or elective)*	***Compulsory***	
Workload of the module in ECTS credit points	**ECTS Credit points** total	**Total hours (à 60 min.)**
	6	**150**
Learning Outcomes of the module *Knowledge:* *Skills:*	*After successful completion of the course students have gained a systematic overview of different strategies and measures to mitigate climate change aiming at a reduction of resource use, waste and emissions and natural and technical solutions for carbon sequestration. They have gained insights into potentials and limitations of different strategies as well as possible trade-offs and synergies with other sustainable development goals and are able to distinguish between aspects of ecological modernization and transformative change. They are able to critically discuss climate solutions from a socio-ecological perspective taking bio-physical, economic and socio-political issues into account.* *Students are able to apply socio-ecological principles and criteria to critically assess climate solutions. They are able to identify trade-offs and synergies with other sustainable development goals. They can discuss climate solutions from an interdisciplinary perspective taking bio-physical, economic, and social criteria into account.*	

Professional/vocational competencies: *Personal competencies:*	*Students learn how to critically read and analyse scientific texts and to develop and defend scientific arguments. They improve their skills in writing scientific texts and to give critical and constructive feedback to peers. They learn about the relevance of system boundaries for assessing strategies, how to develop criteria and how to use mixed methods of qualitative and quantitative approaches.* *In plenary and group discussion students learn how to present their ideas, how to defend and argue scientific positions and gain skills in interdisciplinary communication in the climate change debate; by reading their peers' manuscript drafts, students will learn how to critically and constructively give feedback on scientific texts and also to incorporate feedback from their peers and teachers.*
Module structure – types of module course(s) with ECTS credit points	VS Climate change mitigation: A socio-ecological perspective - 6 ECTS
(If applicable) **Participation requirements for the module**	

Title of the module	**Land system science and climate change**	
Module type (*Compulsory- or elective)*	***Elective***	
Workload of the module in ECTS credit points	**ECTS Credit points** total	**Total hours (à 60 min.)**
	6	**150**
Learning Outcomes of the module *Knowledge:*	*The module provides an overview of the research field land system science and students learn how to apply techniques of empirical research in this field. After completion of the course, the students have gained knowledge in following topics in the field of land systems and the climate system: Approaches and data sources to quantify extent and intensity of land-use (change), drivers of land use change, (historic) linkages of energy use and land systems, global land use trends, land-use and the carbon state of ecosystems, teleconnections in the land system, trade-offs and synergies in the land system: nexus energy, food, biodiversity, ecosystem services and climate change, natural climate solutions, IPCC AFOLU and LULUCF accounting, opportunity carbon costs of land use, full carbon accounting, solutions/option spaces (e.g., land sharing vs. land sparing), demand-side solutions vs. production side solutions (e.g., diets, organic farming, intensification).*	
Skills:	*After completion of the course, students will be able to plan and conduct a micro-research project, correctly apply statistical data for land-based / carbon accounting; they will be able to choose and apply appropriate empirical methods of land-use research as well as to discuss aspects of nexus between land-use, climate, and their change over time and biodiversity. Key skills further include the ability to analyse land-use processes and to discuss and present scientific results.*	
Professional/vocational competencies:	*Professional competencies include systemic thinking related to the interlinkages between land use and climate dynamics in order to understand potentials and implications of natural climate solutions; the ability to correctly use important international databases for land-use analyses and AFOLU / LULUCF accounting and competencies to understand and evaluate trade-offs in the land systems and of land-based mitigation, in the light of the interwoven nature of the land use, climate and biodiversity crises. Students have acquired the ability to apply selected socio-ecological methods in practical research.*	
Personal competencies:	*Students develop skills in interdisciplinary communication and in cooperative research with colleagues from other scientific backgrounds. They have trained their skills in presenting and discussing scientific results.*	

Module structure – types of module course(s) with ECTS credit points	VS Land use, climate change and biodiversity - 3 ECTS-Credits VU Socio-ecological methods: Land use accounting - 3 ECTS-Credits
(If applicable) **Participation requirements for the module**	

Title of the module	**Social metabolism and climate change**	
Module type (*Compulsory- or elective)*	***Elective***	
Workload of the module in ECTS credit points	**ECTS Credit points** total	**Total hours (à 60 min.)**
	6	**150**
Learning Outcomes of the module *Knowledge:*	*After completion of the module, the students will have gained an understanding of the interrelations and feedbacks between socioeconomic use of resources (materials, energy, land) and drivers of climate change, such as GHG emissions. Participants will be familiar with nexus concepts dealing with systemic interrelations between different resources, material stocks, and the outflows of wastes and emissions (materials-energy-land-GHG), between economic growth and resource use ('decoupling, ecological modernization and green growth, degrowth') as well as between resource use and provision of key services (the 'stock-flow-service' nexus). Moreover, they are able to appreciate the role of dominant practices of everyday life (e.g., practices related with being mobile, with food/nutrition, work or housing) for social metabolism. The students will have developed an understanding of several methods that can be used to empirically analyse social metabolism and its relationships with services and practices, as well as emissions and their societal drivers.*	
Skills:	*Students will be able to apply relevant methods of material, energy and carbon accounting and approaches to model stock-flow dynamics, supply chains and footprints in a mini-research-project. In the empirical work students develop skills in data extraction from international databases, data compilation according to standardized conventions, the application of a model (e.g., Environmentally Extended Input Output Models, Life Cycle Assessment or Dynamic Material Stock Analysis), and in the presentation and discussion of results.*	
Professional/vocational competencies:	*After successful completion of the course, students will be able to use concepts of sociometabolic research to discuss and analyse the link between resource use, GHG emissions, production and consumption, as well as their wellbeing contributions and linkages with practices of everyday living. They will have become acquainted with selected methods from sociometabolic research to investigate resource use in sustainability science and climate change research, including hands-on work with the analysis and interpretation of data from international databases, statistical data, and model results. In the lecture-seminar part, students will have gained competencies in critically reading current academic literature, excerpting main scientific messages, analysing their methodological and conceptual foundations, and discussing those in plenary discussions with peers and experts. In the practical part, students will have gained ability to apply selected socio-metabolic methods in practical research and will have trained their skills in presenting and discussing scientific results.*	
Personal competencies:	*Due to the disciplinary mix of students and lecturers, participants develop skills in interdisciplinary communication in empirical work with colleagues from other scientific backgrounds.*	
Module structure – types of module course(s) with ECTS credit points	VU Social metabolism and climate change - 6 ECTS	

(If applicable) **Participation requirements for the module**	

Title of the module	**Climate politics, justice, and conflict**	
Module type (*Compulsory- or elective)*	***Elective***	
Workload of the module in ECTS credit points	**ECTS Credit points** total	**Total hours (à 60 min.)**
	6	**150**
Learning Outcomes of the module *Knowledge:*	*After completion of the module, the students will have gained an overview on the political and societal challenges of adequately addressing the climate crisis, ranging from justice implications to effective policymaking. Furthermore, they are familiar with different forms of political participation and societal empowerment. Students gain knowledge on effective forms of climate policy-making and actual forms of political action as well as the role of different actors that aim to influence (i.e., advance or hinder) effective climate policy (e.g., government representatives, climate movements, corporate actors) and resulting conflicts. They know about the justice implications of the climate crisis at different scales as well as about different forms of political participation and their potential impacts on climate policies and the wider social-ecological transformation.*	
Skills:	*After the successful completion of the module, students will be able to a) understand barriers for effective climate policies and how to potentially overcome these barriers, b) critically assess the discrepancies between scientific claims for effective climate policy and actual government responses, as well as c) understand the links between the climate crisis and social inequalities/considerations of justice.*	
Professional/vocational competencies:	*Students will be able to read, discuss and compare scientific and activist literature on politics, conflicts, and justice implications of the climate crisis. Furthermore, they will be able to reflect on effective policymaking, its barriers, and conflicts as well as the justice implications of the climate crisis in oral and written form.*	
Personal competencies:	*Regarding personal competencies, students will be able to realize different forms of individual empowerment and political participation in the light of the climate crisis.*	
Module structure – types of module course(s) with ECTS credit points	SE Governments and society in climate emergency - 3 ECTS-Credits VU Environmental and climate justice - 3 ECTS-Credits	
(If applicable) **Participation requirements for the module**		

Title of the module	**Environmental and climate history**	
Module type (*Compulsory- or elective)*	***Elective***	
Workload of the module in ECTS credit points	**ECTS Credit points** total	**Total hours (à 60 min.)**
	6	**150**

Learning Outcomes of the module *Knowledge:*	*Students will know major approaches to environmental and climate history (e.g., material, cultural and political environmental history, long-term socio-ecological research, historical ecology). They will have an overview over important methods (e.g., source critique, oral history, content analysis, historical environmental accounting, historical GIS…) and source types (e.g., image databases, historical statistics, maps, digital newspaper archives etc.).*
Skills:	*Students will gain competence in positioning academic texts in different fields of environmental history, in developing small research projects in environmental and climate history and in relevant methods, including source critique, as well as qualitative, quantitative, or spatial analysis of historical sources (including handwritten or printed texts, data, images, maps).*
Professional/vocational competencies:	*Students will have skills in critical reading, presenting, and discussing; in media and information literacy; in developing small projects that use suitable material and methods to address particular questions.*
Personal competencies:	*Students will advance their engagement with diverse perspectives, critical thinking, respectful social interaction across disciplinary boundaries, finding of creative solutions.*
Module structure – types of module course(s) with ECTS credit points	VS Long-term socio-ecological research in the Anthropocene - 3 ECTS-Credits VS Society, culture, and politics in historical transformations - 3 ECTS-Credits
(If applicable) **Participation requirements for the module**	

Title of the module	**Climate solution sciences**	
Module type (*Compulsory- or elective)*	***Elective***	
Workload of the module in ECTS credit points	**ECTS Credit points** total	**Total hours (à 60 min.)**
	6	**150**
Learning Outcomes of the module *Knowledge:*	*Upon successful completion of the module, the students are able to (i) describe and explain the economic and societal merits and mechanisms of policy instruments implemented in the EU and member states (i.e. CO2 emission tax, European Emission Trading System (ETS), Carbon Border Adjustment Mechanism (CBAM)) and internationally; (ii) apply social welfare theory and mechanism theory in order to analyse the instrument performances, public investments in mitigation and adaptation technologies and measures, and social compensation paradigms between winners and losers of societal processes; (iii) analyse existing and develop new social, organizational and institutional interventions that foster climate change mitigation and adaptation of individuals and groups of actors, while considering cognitive biases and addressing agents of change; and (iv) apply selected theories and concepts of sociology of climate change (e.g., behavioural and behavioural change theories, agentic theories) at different spatial and temporal scales and in different institutional, organizational and inter-relational contexts, and evaluate their advantages and limitations.*	
Skills:	*Upon successful completion of the module, the students are able to (i) analyse and evaluate the advantages and limitations of policy instruments including their distributional effects, and (ii) explain recent social movements as forces for climate change mitigation and adaptation.*	
Professional/vocational competencies:	*Upon successful completion of the module, the students are able to (i) evaluate policy instruments fostering societal transition to a low-carbon economy, and (ii) design communication and intervention strategies fostering climate change mitigation and adaptation.*	
	Upon successful completion of the module, the students are able to (i) recognize benefits and challenges related to economic and sociological	

Personal competencies:	*aspects of climate change, and (ii) communicate their perceptions clearly and non-judgmentally.*
Module structure – types of module course(s) with ECTS credit points	SE Economics of climate change - 3 ECTS-Credits SE Sociology of climate change - 3 ECTS-Credits
(If applicable) **Participation requirements for the module**	

Title of the module	**Sustainable spatial development and energy transition**	
Module type (*Compulsory- or elective)*	***Elective***	
Workload of the module in ECTS credit points	**ECTS Credit points** total	**Total hours (à 60 min.)**
	6	**150**
Learning Outcomes of the module *Knowledge:*	*After successful completion of the module students have gained a systematic overview on values and objectives of sustainable spatial development, they know the spatial requirements of energy transition and climate change mitigation as well as strategies and instruments of spatial planning and land policy to support land thrift, energy transition and climate change mitigation. The course consists of a lecture part with topic-relevant inputs as well as a seminar part.*	
Skills:	*In the lecture part, students gain knowledge on sustainability challenges in spatial development, spatial development strategies regarding energy transition and climate change mitigation as well as basic concepts, challenges, and instruments of land policy. They are able to reflect the contributions of spatial planning and land policy instruments to land thrift, energy transition and climate change mitigation. In the seminar part students write and present a seminar paper on challenges, strategies and instruments of spatial planning and land policy regarding energy transition and climate change mitigation guided by the lecturers. The seminar papers are based on evaluation and analysis of relevant international scientific literature.*	
Professional/vocational competencies:	*Students gain skills in assessing potentials and restrictions of spatial planning and land policy with regard to land thrift, climate change mitigation and energy transition.*	
Personal competencies:	*Students are able to critically read and reflect scientific papers and planning documents and to analyse strategies and instruments of spatial planning and land policy. They improve their skills in writing papers and in providing feedback and arguments on the above-mentioned strategies and instruments. Furthermore, students consolidate their ability to independently study scientific literature and expand their skills in the evaluation of scientific readings.*	
Module structure – types of module course(s) with ECTS credit points	VS Sustainable spatial development and energy transition - 6 ECTS	
(If applicable) **Participation requirements for the module**		

SPECIALISATION 3: CLIMATE CRISIS AND TRANSFORMATIVE DEVELOPMENT

Title of the module	**Gender, food systems and natural resources**	
Module type (*Compulsory- or elective)*	***Compulsory***	
Workload of the module in ECTS credit points	**ECTS Credit points** total	**Total hours (à 60 min.)**
	6	**150**
Learning Outcomes of the module *Knowledge:* *Skills:* *Professional/vocational competencies:* *Personal competencies:*	*After successful completion of this module students will have gained an understanding of the meanings and interpretations of gender in theory, policy, and practice, and how these impact on the development and governance of food systems and natural resources. They will have gained insights into alternative rights-based approaches to food systems and natural resources, such as food sovereignty, food justice and the right to food, from the perspective of social movements and civil society. They will further be able to uncover the challenges and barriers, but also opportunities for different actors in these food systems. Students will have an understanding of underlying structural power dynamics and intersecting inequalities, and of the need for a societal transformation in order to achieve sustainable food systems. Students will be familiar with conceptual frameworks, analytical insights and methodological tools stemming from different approaches to addressing gender and intersectionality, based on thematic case studies in different geographic, socio-economic and socio-cultural contexts.* *Students gain skills and key competencies in (i) scientific reading and writing, working with academic literature through guided reading, presenting and discussing readings in class, writing an annotated bibliography (as part of the assessment, 50%), (ii) media-supported presentation skills, (iii) team work capacity, (iv) facilitation skills, through active participation in and facilitation of different interactive formats (e.g., World Café, Fishbowl discussion) and online facilitation, (v) discussions and plenary debate and (vi) peer review: receiving and providing guided feedback.* *Engaging in group work and working on specific case studies across disciplines and topics, students will be able to assess and analyse complex underlying structural issues within food systems from different perspectives. Through invited guest lectures from civil society organizations and with practitioners, students will be exposed to real world projects and problems and gain rich insights into the respective experiences and challenges in development research and related fields.* *The emphasis is on student participation and fostering dialogue and debate. Students will feel able to explore and develop their understanding of key concepts introduced in the sessions through discussions in a supportive environment, and they will be able to critically reflect on these concepts. Through in-class discussions and guided learning activities, such as peer-review, students will be able to receive and give structured feedback, enabling learning from each other.*	
Module structure – types of module course(s) with ECTS credit points	VS Gender, food systems and natural resources - 6 ECTS-Credits	
(If applicable) **Participation requirements for the module**		

Title of the module	**Facilitating change for sustainable development**	
Module type (*Compulsory- or elective)*	***Compulsory***	
Workload of the module in ECTS credit points	**ECTS Credit points** total	**Total hours (à 60 min.)**
	6	**150**
Learning Outcomes of the module *Knowledge:* *Skills:* *Professional/vocational competencies:* *Personal competencies:*	*Students will understand the challenges and opportunities for facilitating change in complex, multi-actor processes and food systems. They will also learn to facilitate and support effective collaboration between different actors to promote convergence in support of climate action. Students will be able to differentiate between different change models.* *Students will develop the essential skills for facilitating and supporting effective collaboration between different actors to promote sustainability and resilience.* *Students will be trained to analyse and evaluate facilitation strategies supporting food system transition challenges; they will also identify improvement opportunities in managing change. They will improve their analytical competencies, as well as process design skills.* *Students will be competent in analysing key concepts and practices of change facilitation and their application to climate change mitigation and adaptation. Students will know how to work in teams, resolve conflicts, engage in team learning. Finally, students can work effectively with diverse groups and actors, including government agencies, NGOs, communities, and agricultural industries, to promote collective action and drive change in food systems.*	
Module structure – types of module course(s) with ECTS credit points	VS Facilitating Change for Sustainable Development - 6 ECTS-Credits	
(If applicable) **Participation requirements for the module**		

Title of the module	**Political ecology of the climate crisis**	
Module type (*Compulsory- or elective)*	***Compulsory***	
Workload of the module in ECTS credit points	**ECTS Credit points** total	**Total hours (à 60 min.)**
	6	**150**
Learning Outcomes of the module *Knowledge:* *Skills:*	*Students will be familiar with different theories of political ecology analysing causes and consequences of the climate crisis. Students will be able to differentiate between different theoretical strands, i.e., structuralist, post-structuralist, feminist and decolonial approaches. They will be familiar with structural causes of the climate crisis in different world regions. They will have a general understanding of social inequalities contributing to the climate crisis and agency-based processing of the climate crises. Students will be able to apply qualitative methods (e.g., expert interviews, participatory observation, focus group discussion, etc.) in combination with a theoretical political ecology perspective.* *Students will be able to create and implement a research design targeting a conflict within the climate crisis. Students will be able to apply qualitative methods in combination with a theoretical perspective. Students will be able to write a seminar paper. In addition, they will get trained in academic writing, e.g., writing an abstract, commenting on a paper, etc.*	

Professional/vocational competencies: *Personal competencies:*	*Students get trained in structured analytical thinking and taking different perspectives from a theoretical point of view. They deepen their reading and writing skills. Students learn how to prepare and conduct group work, taking different roles as lead and team member. They practice moderation and leading a discussion. They get background knowledge in North-South relations.* *Students have competences in giving and receiving feedback. They are experienced in teamwork. They train clear communication, working independently, conflict management, time management, presenting their outcomes and self-organizing in general.*
Module structure – types of module course(s) with ECTS credit points	VS Political ecology of the climate crisis - 6 ECTS-Credits
(If applicable) **Participation requirements for the module**	

Title of the module	**Climate justice and security**	
Module type (*Compulsory- or elective)*	***Elective***	
Workload of the module in ECTS credit points	**ECTS Credit points** total	**Total hours (à 60 min.)**
	6	**150**
Learning Outcomes of the module *Knowledge:*	*Students will learn about the effectiveness of different policy and governance approaches to achieving sustainable development and climate justice. Students will gain an understanding of how climate change disproportionately impacts marginalized communities and how this intersects with issues of economic inequality, gender disparities and skewed political power. They will also learn about the security implications of climate change, including how extreme weather events contribute to resource scarcity and displacement, and access to resources and land. Finally, students will learn about the role of social capital and capacity building in addressing environmental, resilience and climate injustice.*	
Skills:	*Students will develop the basic skills to analyse the effectiveness of different policy and governance approaches to achieving sustainable development and climate justice. They will also practice ways to support effective collaboration between actors to promote convergence.*	
Professional/vocational competencies:	*Students will be trained on complex linkages between climate, the environment and security, and how linkages can lead to resource scarcity and displacement. Students will be able to examine the role of various actors, including governments, international organizations, and civil society, in addressing climate change. Students will develop the ability to connect theory and practical case studies and develop conclusions and solutions for practical action.*	
Personal competencies:	*Students will have the competence to debate the political economy of inaction and how it has hindered progress in addressing climate change. They learn how to organize seminars, and how to convene international fora. They will be able to critically evaluate the political and economic systems that shape the response to climate change and security and advocate for solutions promoting sustainability, equity and peace. Students will be able to analyse socio-ecological systems (SES) and examine the role of various actors, including governments, international organizations, and civil society, in addressing climate change.*	
Module structure – types of module course(s) with ECTS credit points	VS Resilience and environmental justice - 3 ECTS-Credits VS Environmental change and climate security - 3 ECTS-Credits	

(If applicable) **Participation requirements for the module**	

Title of the module	**Applied development research and sustainable development goals**	
Module type (*Compulsory- or elective)*	***Elective***	
Workload of the module in ECTS credit points	**ECTS Credit points** total	**Total hours (à 60 min.)**
	6	**150**
Learning Outcomes of the module *Knowledge:*	*After completing this module, students will learn to understand applied development research together with the Agenda 2030 and their UN Sustainable Development Goals (SDGs). Students will be familiar with the SDGs' theory, policy and practice in natural resources management and climate mitigation. Further, they can analyse our global responsibility in the context of development research. Students will understand the SDGs' universal, integrated, and indivisible principles and why trans- and interdisciplinary project approaches are needed for a societal transformation to implement the SDGs till 2030. Students will be familiar with project cause-effect analyses, design, and budgeting on different spatial and temporal scales. They will be able to create different trans- and interdisciplinary approaches to translate theoretical development research ideas into practical research proposals and to relate their scientific discipline and research interest to the SDGs.*	
Skills:	*After this module, students will be able to strengthen their skills. The will (i) understand the meanings of current principles and practices of applied development research with the potential to implement the SDGs, (ii) they will be able to draft research for a development project from project idea to research question to a basic implementation plan. (iii) Students will have gained skills in evaluating and assessing different styles of research proposals for applied development. (iv) They are able to present their research ideas to a broader audience and (v) to bridge disciplinary boundaries on several temporal and spatial (transboundary) scales.*	
Professional/vocational competencies:	*Participants will increase their professional competencies in applied development research and the implementation of the SDGs (e.g., project design, critical reflection of tailormade solutions, scientific presentation) and develop competencies directly relevant to work for international partnership and cooperation (e.g., international classroom, international case studies). Students can explore future career pathways through close interaction with several experienced BOKU CDR partners (Cluster for development partner Team Teaching) and stakeholders (e.g., ADA, OEAD, Caritas). Students learn to organize a small stakeholder event and to evaluate the ability to conceptualize, organize and moderate trans- and interdisciplinary scientific communication*	
Personal competencies:	*This module's personal competencies are rooted in team-based learning and team-teaching principles (e.g., from CDR partners, NGO´s or ADA). Through various learning phases, every participant has several chances to assume responsibility and accountability for the collaborative learning process. In addition, the module aims to cultivate key personal competencies like communication, critical thinking, collaboration, and assertiveness in public.*	
Module structure – types of module course(s) with ECTS credit points	VS Project design and sustainable development goals - 3 ECTS-Credits VS Scientific communication and impacts - 3 ECTS-Credits	
(If applicable) **Participation requirements for the module**		

Title of the module	**System science in development**	
Module type (*Compulsory- or elective)*	***Elective***	
Workload of the module in ECTS credit points	**ECTS Credit points** total	**Total hours (à 60 min.)**
	6	**150**
Learning Outcomes of the module *Knowledge:* *Skills:* *Professional/vocational competencies:* *Personal competencies:*	*This module is for students interested in understanding and managing socio-ecosystems and livelihood systems whose development path is influenced by interactions within and between Nature and Society. Livelihood circumstances affect disadvantaged people in managing change to improve their well-being. This involves building on an understanding of the structure and dynamics of aquatic and terrestrial ecosystems and then expanding inquiry to address how ecosystems interact with anthropogenic processes (social, political, economic) and climate crises. Bringing together insights from system theory, biology, social sciences, and practical experiences in rural development. It offers students an in-depth perspective on how populations in the Global South manage livelihoods based on agriculture and natural resources. Further, the module introduces concepts that enable students to understand transformation processes in agriculture and food systems.* *Students will develop skills to examine theory (Systems, Hierarchy, Resilience, Cultural) that deals with the structure and dynamics of socio-ecosystems, establishing the need for flexible and adaptive management to address surprising and irreversible dynamics. The course also examines students' practice (modelling, serious gaming) that supports developing and applying science and policy in adaptive management. It enhances the learning of the skills needed to design and lead the participatory process by replacing lectures with a 'learning-by-doing' laboratory in the classroom literature search & review concerning systems science theory and participatory science applications; experience in learning the skills and concepts needed to design and carry out participatory science in support of ecosystem and food systems management.* *This module is a comprehensive approach to increasing participants' professional competencies in managing complex systems that involve collaboration, modelling, and adaptive management strategies and methods. By bringing together stakeholders and experts, this approach helps students to build more resilient and sustainable systems that can better withstand the challenges of a rapidly changing world.* *Students gain personal competencies for managing in a participatory partnership between public and private actors by describing barriers and bridges to establishing a recursive, iterative learning process.*	
Module structure – types of module course(s) with ECTS credit points	VS Systems science for participatory management of dynamic socio-ecosystems - 3 ECTS-Credits VS Livelihood system dynamics in rural development - 3 ECTS-Credits	
(If applicable) **Participation requirements for the module**		

Title of the module	**Negotiating change for sustainable development**	
Module type (*Compulsory- or elective)*	***Elective***	
Workload of the module in ECTS credit points	**ECTS Credit points** total	**Total hours (à 60 min.)**
	6	**150**
Learning Outcomes of the module *Knowledge:* *Skills:* *Professional/vocational competencies:* *Personal competencies:*	*After completing this module, participants will have gained in-depth understanding of a specific sustainability challenge (e.g., climate migration, energy justice) from a global and regional perspective. They will have profound knowledge of the mechanisms and structures of multilateral collaboration and negotiation, particularly in the context of climate change conferences (COPs/UNFCCC) and the wider UN system.* *Students will be able to identify primary and scholarly information on ecological, social and economic realities of a region, critically assess these sources and conclude on the interests a specific region will have facing particular sustainability challenges. Students will be able to translate large volumes of information into narratives to support a specific negotiation position. Students will strengthen their scientific writing skills, develop skills in reading and writing multilateral legal texts and practice public speaking in a formal diplomatic setting.* *Participants will increase their professional competencies in the research domain (e.g., identification of information, critically processing information, scientific writing) and develop competencies directly relevant for work in the policy arena (e.g., multilateralism and its language, science-policy interfaces). Through close interaction with stakeholders beyond academia (e.g., diplomats, activists), students can explore future career pathways.* *The module is entirely based on principles of team-based, transformative learning. The different learning phases thus provide multiple opportunities for each participant to take initiative, responsibility, and accountability for the joint learning process. Communication, critical thinking, collaboration and being assertive in public are among the key personal competencies the module fosters.*	
Module structure – types of module course(s) with ECTS credit points	VS Negotiating change: Simulating an international conference for sustainable development - 6 ECTS-Credits	
(If applicable) **Participation requirements for the module**		

Title of the module	**Farming systems in a changing climate**	
Module type (*Compulsory- or elective)*	***Elective***	
Workload of the module in ECTS credit points	**ECTS Credit points** total	**Total hours (à 60 min.)**
	6	**150**

Learning Outcomes of the module *Knowledge:* *Skills:* *Professional/vocational competencies:* *Personal competencies:*	*After attending this module, students will be able to describe and elaborate on different agricultural production systems in tropical and subtropical areas including aspects on e.g., low-input agriculture and smallholder systems (subsistence agriculture, livestock-cropland mixed production systems), relevant tropical crops (e.g., rice, soybean, oil palm), livestock husbandry and grazed rangelands.* *Students will be able to discuss the interlinkages between soil and land management with crop productivity and food security, along with the environmental effects of agricultural practices and soil degradation. In addition, students will be able to analyse and discuss the role of agricultural activities to adaptation and mitigation to climate change in the frame of sustainable soil use and the sustainable development goals (SDG)* *Students will be able to analyse, discuss and evaluate agricultural management strategies in the frame of specific climatic, social, and economic environments in the tropics. Students can evaluate from different perspectives the options for increasing sustainability of tropical agricultural production systems (e.g., sustainable intensification, conservation agriculture, agroforestry) and will be able to identify key challenges.* *Students will increase their skills in solving situations involving problems of different nature and stakeholders. Furthermore, they will be able to relate theoretical knowledge into practical case studies and develop conclusions for practical solutions towards sustainable development of tropical and subtropical agricultural production systems.*
Module structure – types of module course(s) with ECTS credit points	VO Animal husbandry in tropical and subtropical regions - 3 ECTS-Credits VO Soil management in tropical and subtropical developing regions - 3 ECTS-Credits
(If applicable) **Participation requirements for the module**	

Title of the module	**Climate scholar activism**	
Module type (*Compulsory- or elective)*	***Elective***	
Workload of the module in ECTS credit points	**ECTS Credit points** total	**Total hours (à 60 min.)**
	6	**150**
Learning Outcomes of the module *Knowledge:* *Skills:* *Professional/vocational competencies:*	*Students will reflect on the self-conception and self-understanding of researchers. They will be familiar with different strategies of science and the role of scientists in the climate crisis. Students will acquire knowledge in different scientific theoretical anchoring. They will engage in "doing political ecologies", in the fields of climate-social politics; together with non-academic actors such as NGOs and social movements. They will be familiar with innovative transdisciplinary methods, e.g., critical participatory action research, creative methods (e.g., storytelling, social cartography) and arts-based approaches.* *Students will apply different innovative transdisciplinary methods. As such, students will be able to design and conduct workshops, do videos, mapping etc. Students will be trained in out of the box thinking, flexible process-led co-researching and translating findings (e.g., via blogs for public dissemination).* *Students get trained in participatory and creative methods. Students learn how to prepare and conduct group work, taking different roles as lead and team member and co-researcher among academic and non-academic actors. They*	

Personal competencies:	*practice different methods of moderation and co-researching. They get background knowledge in North-South relations.* *Students have competences in giving and receiving feedback. They are experienced in teamwork. They train clear communication, working independently, conflict management, time management, presenting their outcomes and self-organizing in general.*
Module structure – types of module course(s) with ECTS credit points	VS Climate scholar activism - 6 ECTS-Credits
(If applicable) **Participation requirements for the module**	

GENERAL ELECTIVE MODULES

Title of the module	**Food systems transformation in the context of global change**	
Module type (*Compulsory- or elective)*	***Elective***	
Workload of the module in ECTS credit points	**ECTS Credit points** total	**Total hours (à 60 min.)**
	6	**150**
Learning Outcomes of the module *Knowledge:*	*After successfully completing this module students will understand how local climatic conditions impact the availability of natural resources and how changes in the human population necessitate transitions in food production systems. Specifically, students will be able to describe the effect of water availability, temperature, CO2 levels, air pollutants radiation and nitrogen deposition on the physiology of the different crop species and be able to discuss the potential impact of these factors on food supply. Students will be familiar not only with the different approaches aiming to maintain or even improve crop yields under present and future climate conditions, but also with diverse academic and civil society initiatives that aim to realize a more sustainable agriculture. Students will know how agriculture can help mitigate but also exacerbate changes in the environment. In the seminar part of this module, specific research questions in the field of climate change impacts on agriculture and the transitions towards sustainable agricultural systems in different regions of the world will be discussed. Students will have gained insights into different approaches and scientific perspectives towards current challenges in agriculture and food systems. They will have gained interdisciplinary and systemic understanding of the interrelations between agriculture, climate change and sustainability.* *Skills:* *Students will be attentive to different perspectives and worldviews. They will be able to critically reflect on and assess controversies in scientific discourse and learn to work in teams on complex problems. The seminar part of this module consists of a mix of keynote lectures, literature reviews, discussions, other interactive formats, and presentations by the students. Students will work in groups and will be able to develop their teamwork and interpersonal skills.* *Professional/vocational competencies:* *Students are able to suggest viable crop production systems depending on the environmental conditions. Students are able to critically evaluate promises of higher crop yields in the scientific literature. Students are able to discuss the environmental and socio-economic impact of using high-yielding genotypes that often require significant investments in fertilizer and chemicals. They are*	

Personal competencies:	*able to explain the impact of different land-use practices on long-term food security and on the emission of greenhouse gasses.* *In the seminar part of this module, students will apply interdisciplinary thinking to the challenges posed to agriculture and world nutrition by climate change, and demographic and social challenges. They understand that sustainable solutions for these problems need to integrate the ecological, economic and societal dimensions surrounding food systems. They are able to identify the scale at which a challenge originates and manifests (local, regional, global) and can address the suitable scale in their proposed approach*.
Module structure – types of module course(s) with ECTS credit points	VO Global change aspects in crop production - 3 ECTS-Credits SE Agriculture, climate change and transition - 3 ECTS-Credits
(If applicable) **Participation requirements for the module**	

Title of the module	**Climate change and global aspects in planning and spatial development**	
Module type (*Compulsory- or elective)*	***Elective***	
Workload of the module in ECTS credit points	**ECTS Credit points** total	**Total hours (à 60 min.)**
	6	**150**
Learning Outcomes of the module *Knowledge:* *Skills:* *Professional/vocational competencies:* *Personal competencies:*	*The integrative module introduces and critically debates concept and practical application of global aspects of climate change and climate change adaptation in the context of grand challenges like demographic change, political changes, urbanization, or gender equality at different scales (global to local) and analyses their impact on spatial development (policies). After completing this module, participants will understand different significant impacts of global aspects on the spatial development and socio-economy at different scales.* *After completing the course Students are able to understand climate change adaptation policies and their impact on spatial development policies and critically assess them. Using practical examples, they learn about the significant impact of global challenges e.g., demographic change, political changes, urbanisation, or gender equality in the context of climate change and their impact on spatial development and socio-economy at different scales.* *Students are able to understand and critically discuss the implications, complexities and importance as well as controversy of climate change and climate change adaptation related issues in planning and spatial development as well as related climate change adaptation policies.* *Students will prepare inputs on relevant topics in small groups and participate in joint discussions throughout the lecture. Through collaboration on preparing a contribution to the excursion by choosing a case study they will reflect the research topic on the scientific debates and the practical examples and thereby acquire competences in the field of spatial and policy analysis, the reflection of scientific debates and the transfer of these findings to practical examples.*	
Module structure – types of module course(s) with ECTS credit points	VX Climate change and global aspects in planning and spatial development - 6 ECTS	
(If applicable) **Participation requirements for the module**		

Title of the module	**Sustainable cities, urban metabolism, and climate change**	
Module type (*Compulsory- or elective)*	***Elective***	
Workload of the module in ECTS credit points	**ECTS Credit points** total	**Total hours (à 60 min.)**
	6	**150**
Learning Outcomes of the module *Knowledge:*	*After completion of the course students have gained interdisciplinary knowledge of the metabolism of cities and of urban sustainability challenges and solutions. They have deepened their knowledge on how urban environments are affected by climate change and the role of urban agglomerations as leverage points for reducing resource use and emissions in different geographic, socio-cultural and socio-economic contexts. They are familiar with the concept of urban metabolism and how it can be applied in analysing urban sustainability issues as well as city-hinterland relations. Based on micro-research projects in interdisciplinary teams investigating a specific urban case students improve their knowledge on selected topics of urban sustainability, and they gain a critical understanding of climate change adaptation and mitigation strategies. Topics to be investigated can include, for example, the urban energy system, the urban food system, infrastructures and the built environment; urban resource flows and urban mining, city-hinterland relations and urban environmental footprints, circular and bioeconomy challenges at the urban scale; urban heat islands; urban policies at different scales (e.g., smart city strategies; C40 cities initiative); land use conflicts, urban actors and power dynamics; inequality.*	
Skills:	*Students develop skills in analysing urban systems from different disciplinary perspectives; they improve their skills in applying concepts and methods from their specialisation to questions of climate change and sustainability in an urban context.*	
Professional/vocational competencies:	*In a micro-project they get familiar with data and sources for investigating urban systems, they gain skills and competences in collecting, processing, and integrating data and information from different sources; they improve their competencies in applying quantitative and qualitative methods and models from their specialisation in an urban context, in analysing policy documents and in transdisciplinary methods and dialogue with urban stakeholders.*	
Personal competencies:	*Through working in interdisciplinary teams in micro research projects, students develop competencies in inter- and transdisciplinary science and communication, they are able to develop research questions, and gain competences in the presentation of findings including fact-based argumentation in group discussions. They acquire problem-solving skills (e.g., data gap closure, design skills, innovative information gathering across a wide array of information types).*	
Module structure – types of module course(s) with ECTS credit points	VU Sustainable cities, urban metabolism, and climate change - 6 ECTS-Credits	
(If applicable) **Participation requirements for the module**		

Title of the module	**Projects in climate science and transformation**	
Module type (*Compulsory- or elective)*	***Elective***	
	ECTS Credit points total	**Total hours (à 60 min.)**

Workload of the module in ECTS credit points	**6**	**150**
Learning Outcomes of the module *Knowledge:*	*Students will gain experience in interdisciplinary work through collaboration on small research projects in a case study region. After successful completion of this module students will have gained an understanding of the local/regional manifestation and impacts of climate change and potential futures depending on progressing warming. Students will have gained an understanding of adaptation and mitigation potentials of communities and corporations, learned to assess consequences of inaction and/or maladaptation and gained experience in exchange formats with policy makers and stakeholders on the local/regional level. Students will have further gained knowledge on local perspectives on transformation, potential key agents of change and potentials and barriers of transformative development. Potential topics include communal heat burdens and associated impacts, changes in soil water content, water availability or water demand, exposure and vulnerability to alpine hazards, changes in local biodiversity and species composition, local climate impacts on agriculture and forestry and their effects on communities, energy demand and energy production potentials, climate impacts on built infrastructure and infrastructure to mitigate climate impacts.*	
Skills:	*Depending on project and case studies students will acquire and train various skills. E.g., students will have gained experience in interdisciplinary project work including the collection and analysis of observational data sets, selection of scenarios and models process and impact research, model application and model output analysis, stakeholder dialogue, network analyses and qualitative interviews.*	
Professional/vocational competencies:	*Students will have acquired a series of professional and vocational competencies ranging from quantitative skills such as data collection and data analysis or model applications and model output analyses to qualitative skills such as preparation and leading of dialogue formats and structured interviews.*	
Personal competencies:	*Students will have gained experience in collaboration in diverse and interdisciplinary research teams, to prepare inputs in a timely and structured manner, translate methods, data and findings to non-topical experts, advanced their communication, presentation and administrative skills, and gained experience in science-to-policy, science-to-practice and science-to-public formats.*	
Module structure – types of module course(s) with ECTS credit points	PJ Projects in climate science and transformation - 6 ECTS-Credits	
(If applicable) **Participation requirements for the module**		

Title of the module	**Actor-centred perspectives and pathways towards transformation**	
Module type (*Compulsory- or elective)*	***Elective***	
Workload of the module in ECTS credit points	**ECTS Credit points** total	**Total hours (à 60 min.)**
	6	**150**
Learning Outcomes of the module *Knowledge:*	*Within this module, students work in interdisciplinary teams on challenges in the context of sustainable development and transformation. Following an entrepreneurial approach, they collaborate with a practice partner (intrapreneurship) or focus on their individual topic (entrepreneurship). They develop a solution to a specific problem from an idea into a viable project or business plan. Participating students have the opportunity to exchange with practice partners (e.g., NGOs, public administration and politics, companies, consultants) on practical issues of societal and economic transformation. Ideally, students and practice partners can mutually learn from each other and*	

Skills: *Professional/vocational competencies:* *Personal competencies:*	*thus foster transdisciplinary exchange. After completing this module, students will be able to identify and seize opportunities based on their understanding of sustainability-driven entrepreneurship and its relation to transformation. They will be able to define methods to develop circular design solutions as well as methods to measure societal impact and classify their relevance related to ecological, social and economic criteria. As for a suitable framework for the solution approach, students can name and describe the elements of the chosen structure, e.g., building blocks of an impact/project/business canvas and plan. They will be able to estimate the relevance of intellectual property and name and qualify possible sources for financing sustainable ventures.* *Students will be able to apply their disciplinary knowledge and skills in a practice-oriented setting through developing solutions for sustainability challenges. They will be able to set up a viable impact/project/business model, elaborate a project or business plan – equally considering economic, ecological, and social aspects – and to define the measures to implement their particular sustainability-driven project or business model. Students will delve deeper into the complexities and challenges of running a sustainability-driven activity. They will be able to create (positive) societal impact by building upon the fundamentals of sustainability-driven intra-/entrepreneurship and expanding upon them.* *Within this module, students learn to start their own project or business – in collaboration with an existing organization or by founding a new one. They will learn to contribute to societal and economic transformation in line with the SDGs by breaking down complex problems to a specific solution approach. They will learn how to deal with uncertainties and to implement solutions to tackle impacts and causes of global grand challenges such as climate change or biodiversity loss.* *Students will learn to collaborate in interdisciplinary teams – i.e., develop a mutual understanding and join their knowledge, skills, and strengths – and experience group dynamics and leadership. They will learn to pitch (present) their project or business idea to specific target audiences and develop an entrepreneurial attitude.*
Module structure – types of module course(s) with ECTS credit points	VS Sustainability-driven entrepreneurship and transformation - 6 ECTS-Credits
(If applicable) **Participation requirements for the module**	