MODULE CATALOG

International Master of Science Program in

SUSTAINABLE RESOURCE MANAGEMENT

Winter semester 2018/19

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Content

*The updates of the module catalog only concern editorial changes - with major structural and substantive changes a new version will be released. This module catalog is based on the '**Subject Examination and General Academic Regulations for the Master's Program Sustainable Resource Management (Nachhaltiges Ressourcenmanagement) at the Technische Universität München**' dated 20th of August, 2015 in its version of the First Change of Regulations as of July 22th 2016.

Introduction

The master's program in Sustainable Resource Management at the TU München fulfils the criteria of the Bologna Process detailed below, which were introduced to create uniformity (academic homologation) within the European Higher Education Area (EHEA).

Modularisation: The degree program is completely modularized, i.e. individual courses were developed whose interdisciplinary content is united around a central theme. An exam is taken during the course of study for each module at the end of the semester. This increases student mobility within the EHEA insofar as credits from modules completed at other universities during an exchange program can be recognized toward degree programs at the student's home university.

ECTS[1]: A certain amount of credits corresponding to the student workload is assigned to each course. Work load is determined by the number of hours spent in class (contact hours), the number of hours required for preparation and review in independent study, as well as the number of hours required to prepare for and take examinations. One credit point (CP) is equal to 30 "working hours". The number of total credits is based on the average employee workday of 1800 hours per year, or 900 hours per semester, which is equivalent to 30 credits. As a "unit of exchange", the credit system facilitates the recognition of courses and exams taken at other universities, including those outside the EHEA.

Transparency: The learning objectives and content of the modules in the master's program are described in detail in the brochure below.

Output Orientation: In addition to module content (input), learning objectives (output) are determined for each module.

Employability: Essential competencies to be acquired, learning objectives, and the thematic orientation of the modules were determined with regard to possible career objectives of future graduates of the program based on discussions with experts in the respective fields, through alumni questionnaires, as well as employment research studies (Future of Work, Megatrends). An 7-week internship allows students to apply knowledge acquired in their course of study, while the module itself fosters students' competencies in presentation. All students at the TUM have access to a wide range of further education opportunities, such as foreign languages and personal development courses.

Diploma Supplement: Every graduate of the program receives a "Diploma Supplement," an English-language annotation of the official master's degree diploma.

[1]ECTS= European Credits Transfer System

Program Objectives

Natural resources, such as earth, water, air and biological diversity, constitute the foundation of human life and industry. They serve as sources of nutrition, raw material or energy, as living and recreational space, even as sinks for pollutants. Global consumption of natural resources is rapidly increasing, made more severe by global population and economic growth, leading, in turn, to an increase of pressure on all natural resources, resulting in greater environmental concerns, such as the reduction of biodiversity, soil degradation, water shortages and air pollution. Conflicts of interest arise from the ever greater scarcity of resources and lead to ever more frequent international tensions, whose comprehensive and sustainable resolution represents one of humankind's greatest challenges to date.

In the face of these circumstances, the sustainable management of natural resources in the context of social, ecological and economic need becomes imperative. Along with solid specialist knowledge of various natural resources, this requires a thorough understanding of systems and wide-reaching competency in planning and methodology. The international master's degree program in Sustainable Resource Management offers the essential foundations of this kind of expertise. The program's objective is to give students the ability to sustainably manage natural resources on a scientific basis, with particular emphasis on the teaching of appropriate problem-solving management methods. Students' professional and personal development also forms a central feature of the program. For example, students have the opportunity to develop their individual career profile through the selection of a field of specialization. The master's program offers 9 fields of specialization covering the most significant natural resources and management concepts. Areas of specialization include:

- Environmental Economics and Policy
- Management and Protection of Forest Ecosystems
- Wildlife and Protected Area Management
- Landscape Management
- Renewable Resources
- Climate, Air and Water
- Material and Waste Management
- Agricultural Land-Use
- Soils and Soil Management

The international master's program in Sustainable Resource Management is an inter- and cross-disciplinary program in which students from all over the world and from all different disciplines are equipped with the expertise to face the manifold challenges of sustainable resource management. The program's curriculum includes an internship of seven weeks in the field of sustainable resource management to provide insight into potential career fields, such as managerial positions in large companies, national and international governmental and non-governmental organizations, environmental consultancy and information services, the protection and management of ecosystems, as well as research and education.

Acquired Qualifications

In addition to specialist competencies in managing natural resources, students of the international master's program in Sustainable Resource Management learn management methods to develop solutions for problems arising from conflicts concerning natural resources. Graduates are able to analyze and assess the impact of human activity on natural resources and, on that basis, to develop and implement viable concepts for the responsible management of natural resources. They understand the principles of sustainable human industry and activity, as well as the ecological, economic and socio-political significance of natural resources. Using methods of system analysis, students are able to identify the key interests of groups and influencing factors and take them into consideration in the development of alternative courses of action and to provide competent advice. Graduates have not only a solid knowledge of foreign languages but excellent social and intercultural skills, which serve as a basis for successful conflict management in an international context. They are also in a position to recognize and evaluate future socio-political and economic developments concerning the use of natural resources and take these into consideration in their work.

The expert knowledge and specialist competencies students acquire in the master's program in Sustainable Resource Management are organized in the framework of the 9 fields of specialization.

Program Structure

The program is designed for 4 semesters. Each semester comprises a workload of 30ECTS. The first semester covers a set of introductory and basic compulsory courses. The second and third semester comprise the fields of specialization (2 out of 9 are chosen), the elective modules and the general education subject. The master`s thesis is written during the fourth semester. A seven-week internship abroad is part of the program.

The language of instruction and examination is English for all modules.

International Master of Science Program (MSc) in

Sustainable Resource Management

1 Semester = 30 Credits (CP)

<table>
<tr><td>4 SS
30CP</td><td colspan="6">Master´s Thesis
30 CP</td></tr>
<tr><td>3 WS
30CP</td><td colspan="3">“Fields of Specialization”
[2 „Fields“ á 3 Modules]
Total number of credits: 15 CP</td><td>Elective Module
5 CP</td><td>Elective Module
5 CP</td><td rowspan="2">Internship
10 CP</td></tr>
<tr><td>2 SS
29CP</td><td colspan="3">“Fields of Specialization”
[2 „Fields“ á 3 Modules]
Total number of credits: 15 CP</td><td>Elective Module
5 CP</td><td>General Education Subject
4 CP</td></tr>
<tr><td>1 WS
31 CP</td><td>Natural Resources – Traits, Management, Theory of Sustainability
5 CP</td><td>Introduction to Economics and Business Ethics
5 CP</td><td>Inventory Methods, Statistics and GIS
6 CP</td><td>Project Management, Public Relations and CCC
5 CP</td><td>Methods of Scientific Communication
5 CP</td><td>System Analysis and Introduction to Ecology
5 CP</td></tr>
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Curriculum

1st Semester

Module ID	Module name	Type	CP
WZ1821	Natural Resources - Traits, Management, Theory of Sustainability	RM	5
WZ1822	Introduction to Economics and Business Ethics	RM	5
WZ1823	Inventory Methods, Statistics and GIS	RM	6
WZ2712	Project Management, Public Relations and CCC	RM	5
WZ2713	Methods of Scientific Communication	RM	5
WZ1824	System Analysis and Introduction to Ecology	RM	5

2nd and 3rd Semester

Module ID	Module name	Type	CP
	Elective Modules	EM	15
WZ2714	General Education Subject	RM	4
WZ4061	Internship	RM	10
WI000286	Environmental and Natural Resource Economics	Field of Specialization 1: Environmental Economics and Policy (EM)	5
WI000926	International Environmental Policy and Conflict Resolution	Field of Specialization 1: Environmental Economics and Policy (EM)	5
WZ1590	Climate Change Economics	Field of Specialization 1: Environmental Economics and Policy (EM)	5
WZ2936	Sustainable and Environmental Regulations	Field of Specialization 1: Environmental Economics and Policy (EM)	5
WZ2716	Forest Growth and Forest Operations	Field of Specialization 2: Management and Protection of Forest Ecosystems (EM)	5
WZ4161	Forest Management	Field of Specialization 2: Management and Protection of Forest Ecosystems (EM)	5
WZ2717	Genetic Resources Management and Forest Protection	Field of Specialization 2: Management and Protection of Forest Ecosystems (EM)	5
WZ4082	Plantation Forestry and Agroforestry	Field of Specialization 2: Management and Protection of Forest Ecosystems (EM)	5
WZ4197	Protected Areas Biodiversity and Management	Field of Specialization 3: Wildlife and Protected Area Management (EM)	5
WZ4198	Wildlife Management and Wildlife-Human Interactions	Field of Specialization 3: Wildlife and Protected Area Management (EM)	5
WZ4189	Fisheries and Aquatic Conservation	Field of Specialization 3: Wildlife and Protected Area Management (EM)	5
WZ6432	Wildlife and Conservation Biology	Field of Specialization 3: Wildlife and Protected Area Management (EM)	5

RM = Required Module (Compulsory Modules) EM = Elective Module

2nd and 3rd Semester

Module ID	Module name	Type	CP
WZ4201	Vegetation Ecology and Geographical Information Systems	Field of Specialization 4: Landscape Management (EM)	5
WZ2737	Remote Sensing and Image Processing	Field of Specialization 4: Landscape Management (EM)	5
WZ2719	Landscape Planning	Field of Specialization 4: Landscape Management (EM)	5
WZ4094	Landscape Management - Application Study	Field of Specialization 4: Landscape Management (EM)	5
WZ2720	Renewable Energy Technologies	Field of Specialization 5: Renewable Resources(EM)	5
WZ2721	Bioenergy Systems	Field of Specialization 5: Renewable Resources(EM)	5
WZ4098	Forestry Raw Materials and their Utilization	Field of Specialization 5: Renewable Resources(EM)	5
WZ4202	Political and Social Perspectives of Renewable Resources	Field of Specialization 5: Renewable Resources(EM)	5
WZ2731	Hydrometeorology and Management of Water Resources	Field of Specialization 6: Climate, Air and Water (EM)	5
WZ2722	Mountain Catchments under Changing Climate	Field of Specialization 6: Climate, Air and Water (EM)	5
WZ2732	Environmental Monitoring and Data Analysis	Field of Specialization 6: Climate, Air and Water (EM)	5
WZ2730	Climate Change – Science, Impacts and Adaptation, Mitigation	Field of Specialization 6: Climate, Air and Water (EM)	5
WZ4206	Material Flow Management and Applications	Field of Specialization 7: Material and Waste Management(EM)	5
WZ4207	Waste and Waste Water Treatment	Field of Specialization 7: Material and Waste Management(EM)	5
WZ2724	Emission Control in Land-Use and Animal Husbandry	Field of Specialization 7: Material and Waste Management(EM)	5
WZ2723	Utilization and Treatment of Special Materials and Waste	Field of Specialization 7: Material and Waste Management(EM)	5
WZ2725	Land-Use Systems from Local and Global Perspectives	Field of Specialization 8: Agricultural Land-Use (EM)	5
WZ2726	Assessment of Sustainability in Agriculture – Theory and Case Studies	Field of Specialization 8: Agricultural Land-Use (EM)	5
WZ2728	Sustainable Land-Use Management	Field of Specialization 8: Agricultural Land-Use (EM)	5
WZ2727	Sustainability of Food Chains	Field of Specialization 8: Agricultural Land-Use (EM)	5
WZ2733	Introduction to Soil Science	Field of Specialization 9: Soils and Soil Management (EM)	5
WZ2735	World Soil Resources	Field of Specialization 9: Soils and Soil Management (EM)	5
WZ2734	Soil Protection	Field of Specialization 9: Soils and Soil Management (EM)	5
WZ2736	Analytical Characterization of Soil Resources	Field of Specialization 9: Soils and Soil Management (EM)	5

4th Semester

Module ID	Module name	Type	CP
WZ2754	Master's Thesis	RM	30

MODULE DESCRIPTIONS

Compulsory Modules

Natural Resources – Traits, Management and Theory of Sustainability WZ1821

Dr. Peter Biber – Lehrstuhl für Waldwachstumskunde;
Hans-Carl-von-Carlowitz-Platz 2, 85354 Freising; 08161/ 71- 4708; Peter.Biber@lrz.tum.de

Module Level:	Master	**Credits:**	5 Credits		
Language:	English	**Occurrence:**	Winter semester	**Duration:**	one-semester
Total Hours:	150h	**Contact Hours:**	70h	**Self-study Hours:**	80h
Assessment Retake:	Next semester				

Description of Achievement and Assessment Methods

The intended learning outcomes as defined below require a differentiated way of examination. A written exam (duration 90min) at the end of the semester will test whether the students sufficiently understand sustainability concepts and their connection to specific resources. As a midterm course achievement, external lecturer Dr. Savage offers the students topics for writing short reports about current global resource management problems as a homework, where they should show their ability to research and structure information and to identify crucial information gaps. Successful performance will improve the exam grade by 0.3.

(Recommended) Prerequisites

None

Intended Learning Outcomes

At the end of the module the students understand the most important theories and perceptions of sustainable resource management as well as traits and challenges connected with essential natural resources. Moreover, they are able to apply this knowledge for critically questioning given real-world situations. This comprises the ability to assess strengths and weaknesses of given problem solution approaches (as presented in the media or specialist literature), and to outline possible approaches if confronted with a resource management problem.

Content

The module is intended to be a leitmotif during the first semester.

It consists of three basic units:
Unit 1 introduces the theory and the history of sustainability, supplemented by introducing interdisciplinary method knowledge.
Unit 2 introduces important natural resources, their specific traits in combination with sustainability challenges.
Unit 3 discusses case studies from interdisciplinary real-world-implementations.

Lecturers change during the semester. Each lecture is given by an expert in the specific field.

Teaching and Learning Methods

Depending on each lecture's specific contents and due to the modules' interdisciplinary character, teaching methods combine classic presentations, blended learning and group work.

Media:

presentations, worksheets, simulation models

Reading List:

Recommended up-to-date readings are supplied by the specific lecturers

Module Structure

Course	Natural Resources - Traits, Management, Theory of Sustainability
Lecturer	Peter Biber, Karl-Heinz Häberle, Max Kainz, Thomas Knoke, Michael Kohlpaintner, Annette Menzel, Hans Pretzsch, Michael Suda Guest lecturers: Hans-Dieter Kasperidus, Charles Savage
Form of Teaching	Lecture (5SWS)

Introduction to Economics and Business Ethics WZ1822

PD. Dr. Thilo Glebe – Lehrstuhl für Volkswirtschaftslehre - Umweltökonomie und Agrarpolitik
Alte Akademie 14; 85354 Freising; 08161-71-5965; glebe@wzw.tum.de

Module Level:	Master	**Credits:**	5 Credits		
Language:	English	**Occurrence:**	winter semester	**Duration:**	one-semester
Total Hours:	150h	**Contact Hours:**	60h	**Self-study Hours:**	90h
Assessment Retake:	**Next semester**				

Description of Achievement and Assessment Methods

The written examination (duration 90 min) assesses the students' understanding of the basic concepts of microeconomic theory (module part introduction to economics) and major business ethical concepts and issues. Furthermore, the examination tests students' ability to precisely describe solutions, achieve certain results and reproduce standard arguments within a limited amount of time.
A Mid-Term assignment (presentation) assesses the students' ability to present a new topic in a comprehensible manner. It will serve for grade improvement by 0.3 according to §6 (5) APSO.

(Recommended) Prerequisites

None

Intended Learning Outcomes

The major theoretical positions are reflected in public as well as private debates. Thus, understanding the structure of standard arguments contributes to the development of solution-oriented approach to ethical dilemmas and to the students' rhetorical skills.
We will take hands on approach to CSR, focusing on Un Global Compact and specific CSR policies. This approach will prepare the student for practical challenges of implementing CSR policies. We will approach Corporate Governance in a similar manner, looking at cases of bad corporate governance, at codes of corporate governance and at the practical challenges of implementing stricter procedures in the organizations.
The lectures on power will introduce the students to a significant aspect of organizational interaction. We look at different ways to obtain power in an organizational context and we will investigate the opportunity for ethical action in a professional environment characterized by a more or less intensive power struggles. The analysis of consumer ethics will clarify why our environmentally damaging consumer habits are so difficult to change.
Students will learn about ways in which the economy and the environment are independent. They will understand the microeconomic theory of consumer and producer behaviour and reasons for market failure. They will be able to apply welfare economics to evaluate governmental market interventions. Furthermore, they will understand the temporal dimension of economic decisions and their implications for sustainability.

Content

The module is an introduction to Business Ethics and Economics. Business ethics introduces the student to classical concepts of duty, consequentialism and virtues, in particular modern management virtues. The classical concepts are applied to corporate social responsibility and corporate governance. CSR and corporate governance will be discussed in the light of globalization, the financial crisis of 2008 and major corporate scandals.
The module part "Introduction to Economics" provides an introduction into microeconomic theory and the interaction between economics and the environment. Based on consumer and producer theory, we analyze the interactions of demand and supply on markets. We analyze economic reasons for market failure and use welfare economic concepts to evaluate market interventions. In the final part, we look at principles of intertemporal efficiency and an economic perspective of sustainability.

Teaching and Learning Methods

2/3 lectures, 1/3 group work and student presentations

Media:

Reading List:

The texts will be provided on moodle

Module Structure

Course 1	Business Ethics
Lecturer 1	Mariane Thejls Ziegler
Form of Teaching 1	Lecture and Seminar (2SWS)
Course 2	Introduction into Economics
Lecturer 2	Thilo Glebe
Form of Teaching 2	Lecture (2SWS)

Inventory Methods, Statistics and GIS WZ1823

Prof. Dr. Thomas Knoke – Professur für Waldinventur und nachhaltige Nutzung
Hans-Carl-von-Carlowitz Platz 2, 85354 Freising,; 08161/71-4701; knoke@forst.wzw.tum.de

Module Level:	Master	**Credits:**	6 Credits		
Language:	English	**Occurrence:**	Winter semester	**Duration:**	one-semester
Total Hours:	150h	**Contact Hours:**	70h	**Self-study Hours:**	110h
Assessment Retake:	**Next semester**				

Description of Achievement and Assessment Methods

The learning success will be assessed by a written examination (duration 120 min) covering the knowledge and competence achieved in the three main branches of the module, namely GIS, Terrestrial Inventory Methods, Remote Sensing (RS), and Statistics. In GIS, a basic understanding of various GIS concepts and problem solution strategies is referred to.

(Recommended) Prerequisites

None

Intended Learning Outcomes

At the end of the courses on Inventory methods, GIS and Statistics the students are able to:
- select an appropriate GIS/Image Analysis program with respect to its intended field of application;
- apply a GeoInformatics tool (GIS and RS) to solve individual problems dealing with spatial information.
- understand the principles of sampling and how to assure the quality of a sample.
- understand the basic principles of remote sensing
- identify a geospatial problem and to decide on the appropriate RS system as well as on the data analysis strategy for the task to be supported.
- understand data analysis as a support for their Master's Thesis, understanding the formulation of hypotheses, the connection of statistics to epistemology, their preconditions for proper application and interpretation of the results, applying important statistical techniques.

Content

Implementation of basic concepts for acquisition, management, visualization of spatial data, and data evaluation as well as their inter-connection with tabular data from different source.
1. GIS: the focus is on the use of vector based GIS; the potentials of raster based GIS are demonstrated.
2. Terrestrial Inventory Methods: Introduction to sampling theory and application.
3. Remote Sensing (RS): Introduction to RS Principles: basic understanding of the physical background, on sensor concepts, evaluation strategies and spatial information extraction are elucidated.
4. Statistics in Resource Management: Justification of statistics, descriptive statistics and exploration: Frequencies and their graphical representation, distributions and their moments, testing hypotheses, regression analysis, post hoc tests, a priori contrasts, analysis of variance.

Teaching and Learning Methods

The module includes lectures, exercises and accompanying examples.

Media:

Online material available at www.elearning.tum.de; Slides with lectures downloadable from a platform to be announced.

Reading List:

Environmental Systems Research Institute Inc.: Map Projections. Georeferencing spatial data, ESRI Press * Zeiler, M.: Modelling Our World. The ESRI Guide to Geodatabase Design, ESRI Press * Vienneau, A.: Using ArcCatalog, ESRI Press * Minami, M.;Sakala, M.;Wrightsell, J.: Using ArcMap, ESRI Press * Terrestrial Inventory Methods: Gregoire TG and Valentine HT (2008) Sampling strategies for natural resources and the environment. Boca Raton, Fla.; London, Chapman & Hall/CRC * Mandallaz D (2008) Sampling techniques for forest inventories. Applied Environmental Statistics. Chapman and Hall. 276 p * Introduction to Remote Sensing Principles: Richards, J.A., Jia, X.: Remote Sensing Digital Image Analysis - an introduction; Springer Press, Principles of Remote Sensing - an introductory textbook; Ed. L.L.F. Janssen, G.C. Huurneman, ITC educational textbook series; internet tutorials from ESA, DLR, NASA, CCRS, etc. * Statistics with Microsoft Excel (4th Edition) by Beverly Jean Dretzke (Paperback - June 20, 2008) *Discovering statistics using SPSS Field, Andy P. 2009

Module Structure

Course 1	Introduction to GIS
Lecturer 1	Martin Döllerer
Form of Teaching 1	Lecture and Exercise (2SWS)
Course 2	Inventory Methods
Lecturer 2	Thomas Knoke, Thomas Schneider
Form of Teaching 2	Lecture (2SWS)
Course 3	Statistics
Lecturer 3	Thomas Knoke
Form of Teaching 3	Lecture (1SWS)

Project Management, Public Relations and Cross Cultural Communication WZ2712

Martina Wayand – Lehrstuhl für Unternehmensführung
Arcisstr. 2, 850333 München; martina.wayand@tum.de

Module Level:	Master	**Credits:**	5 Credits		
Language:	English	**Occurrence:**	winter semester	**Duration:**	one-semester
Total Hours:	150h	**Contact Hours:**	75h	**Self-study Hours:**	75h
Assessment Retake:	**Next semester**				

Description of Achievement and Assessment Methods

The examination consists of a project work comprising a description of the relevant project planning tools required as well as a Public Relation Plan. Additionally, an oral group presentation of the results will be required. The project work shall validate the student´s ability to transform their project ideas into a project proposal including a corresponding work breakdown structure and a public relations strategy, while the presentation shall allow to assess the ability to present a project idea to an audience, and to conduct a discussion about the presented issues. The learning outcomes in cross cultural communication will be evaluated in a mid-term examination.

(Recommended) Prerequisites

None

Intended Learning Outcomes

At the end of the module students shall be able to plan a project in all its detail and to understand communication processes in Public Relations and apply current PR instruments to the requirements of their task. Furthermore the students are able to understand cross-cultural differences and to apply techniques to avoid miscommunication in project management based on cross-cultural differences.

Content

Objectives, dimensions and characteristics of project management; types of projects; project life cycle phases and work breakdown structures; project network diagrams; milestone plans; risk management in projects; critical path method; project resource planning and control; team building skills. Basic Public Relations know-how for future managers (why to communicate with stakeholders and other groups; how to plan a communication strategy; how to control PR service providers; PR and environmental organizations. Theory and practice of cross-cultural communication, exercises in dealing with different perceptions; rhetoric exercises individually and in team work.

Teaching and Learning Methods

Knowledge and skill are imparted by lectures, individual and group work, presentation of case studies and peer discussions; the learning methods are definition and solving of problems, collaborative work, group discussions, prepare and hold presentations, report writing.

Media:

PowerPoint presentations, case studies, Project Management software (MS-Project); presentation notes and online resources for further reference.

Reading List:

Meredith J.R., Mantel S.J. (2012): Project Management – A managerial approach. John Wiley & Sons, Inc.; Young, T.L. (2003): The handbook of project management (2nd edition). A practical guide to effective policies and procedures. Kogan Page, London and Sterling, VA; Chatfield, Carl S. (2010): Microsoft Project 2010 step by step Microsoft Press

Public Relations: Cutlip, Scott M. et al. (2005): Effective Public Relations. Heath, Robert L. (2004): Handbook of Public Relations. Saffir, Leohard (2007): PR on a Budget. Seitel, Fraser P. (2004): The Practice of Public Relations.

Module Structure

Course 1	Project Management
Lecturer 1	Martina Wayand
Form of Teaching 1	Lecture (3SWS)
Course 2	Public Relations
Lecturer 2	Katrin Röder-vomScheidt
Form of Teaching 2	Lecture (1SWS)
Course 3	Cross-cultural communication
Lecturer 3	Martina Wayand
Form of Teaching 3	Seminar (1SWS)

Methods of Scientific Communication WZ2713

Prof. Dr. Gabriele Weber-Blaschke – Lehrstuhl für Holzwissenschaft
Hans-Carl-von-Carlowitz-Platz 2, 85354 Freising; 08161/71- 5635; weber-blaschke@hfm.tum.de

Module Level:	Master	**Credits:**	5 Credits		
Language:	English	**Occurrence:**	winter-semester	**Duration:**	one-semester
Total Hours:	150h	**Contact Hours:**	60h	**Self-study Hours:**	90h
Assessment Retake:	**Next semester**				

Description of Achievement and Assessment Methods

The examination consists of a research paper which is the means to evaluate whether the students are able to apply the regulations of scientific writing in their own scientific paper. This assignment will be complemented by presentations of various lengths for the purpose of assessing the student's communication competency in presenting scholarly work to an audience.

(Recommended) Prerequisites

None

Intended Learning Outcomes

By the means of the module the students are able to:
- identify the elements of and barriers to communication; - understand the topic scientific writing;- apply the procedure of scientific writing;
- analyze other scientific papers;- apply literature sources; - create own scientific papers;- understand the importance of a good presentation;
- recognize the features of an excellent presentation;- apply the key elements of presentation ; - analyze a presentation's situation (purpose/audience/roles); - create an own presentation (effectively plan, research and structure their presentation).

Content

The students acquire detailed and differentiated knowledge about scientific communication including scientific writing, presentation and reflecting differentiated into the following topics:
- the communication process as two-way interaction; - group dynamics, dealing with difficult situations and facilitating conflict resolution in groups; - purpose of scientific writing; - procedure of scientific writing; - process of writing a scientific paper; - content details of the different chapters in a scientific paper; - looking for literature and data sources to write a scientific paper; - reflection of reviews; - English style of presentations; - how to express transition points; - how to describe tables, graphs and charts; - key characteristics of effective presentations; - the special features of scientific presentations; - the structural elements of a presentation; - vocal skills and body language, using and managing visual aids, persuasive language and delivery techniques;- dealing with nervousness, breaking the ice, handling questions and difficult situations; - different facilitation opportunities, challenges, and problems, verbal and nonverbal facilitation techniques, step-by-step facilitation processes and tools.

Teaching and Learning Methods

Concerning teaching methods lecture and presentation parts provide theoretical foundations in both scientific writing and presenting. Exercises are introduced to the students who are supposed to finish them individually as homework. In group work as in reality concerning the process of scientific writing the students have to study specialist literature and data files which are the basis for writing the scientific paper as homework under time constraint. On basis of critique (review) by the lecturer they have to revise the scientific paper. As complement every student has to prepare and hold oral presentations in the seminar.

Media:

Power point presentation, black board, flip chart, pin board, lecture sheets, PDFs of scientific papers, PDFs of Guidelines.

Reading List:

Summary guideline "How to write a scientific paper" within the seminar.
Day, R.A.; Gastel, B.; 2012: How to write & publish a scientific paper. 7th edition, 2012, Cambridge University Press, pp. 300
Huss, J.; 2014: Schreiben und Präsentieren in den angewandten Naturwissenschaften. Ein Leitfaden. 2. Auflage. 256 Seiten. Verlag Kessel, Remagen-Oberwinter 2014. ISBN 978-3-941300-94-1.

Module Structure

Course 1	Scientific Writing
Lecturer 1	Gabriele Weber-Blaschke
Form of Teaching 1	Seminar (2SWS)
Course 2	Presenting
Lecturer 2	Timothy Howe
Form of Teaching 2	Seminar (2SWS)

System Analysis and Introduction to Ecology WZ1824

Dr. Peter Biber – Lehrstuhl für Waldwachstumskunde
Hans-Carl-von-Carlowitz-Platz 2, 85354 Freising; 08161/ 71- 4708; Peter.Biber@lrz.tum.de

Module Level:	Master	**Credits:**	5 Credits		
Language:	English	**Occurrence:**	winter semester	**Duration:**	one-semester
Total Hours:	150h	**Contact Hours:**	60h	**Self-study Hours:**	90h
Assessment Retake:	**Next semester**				

Description of Achievement and Assessment Methods

In a written exam (duration 90min) , the students' understanding of important ecological concepts and ecosystem dynamics' patterns is assessed. Moreover, in the same exam, we test their understanding of system analysis methods and their ability to apply them in ecological and other contexts by correctly solving specific problems given in the questions.

(Recommended) Prerequisites

None

Intended Learning Outcomes

At the end of the module students understand essential elements of ecological theory and concepts. They remember important dynamic patterns and the ecological concepts behind. Moreover, they are able to apply key methods of system analysis to small and intermediate problems in ecology but also in other fields. The latter abilities include using causal loop diagrams and stock-and-flow diagrams for structuring information, understanding the basic mathematics behind dynamic models, being able to build small and intermediate simulation models, and to develop an understanding of the potential and limitations of computer simulations in general.

Content

This module combines an introduction to ecology with an introduction to analyzing and modelling dynamic systems. As ecosystems are intrinsically dynamic, i.e. governed by feedback structures, understanding dynamic systems is a key qualification for understanding ecological theory. By examples from ecology but also from other fields (in which cases, however, transfers to ecological applications are always highlighted) formal key methods in structuring system knowledge, building computer models, and learning from such models are taught. An important insight to convey is the interdisciplinarity of dynamic systems and the related methods: Feedback structures found in ecosystems can often as well be found in social science or engineering contexts and vice versa. Parallely, students get basic and advanced insights into fundamental elements of ecological concepts (e.g. modularity, unitarity, speciation, populations, metapopulations, competition, mutualism, ecosystems and their functions) and theory from the level of organisms to populations to species interactions up to the ecosystem level.

Teaching and Learning Methods

Lecture providing theoretical foundations in ecology. Interactive lecture in System Analysis,with an individual workstation being available for each student. In the beginning, the group is closely guided through simple problems in order to develop routine in the methodological and technical basics while understanding fundamental dynamic processes from exponential growth and decay up to nth order delays. Along with their increasing skills, students are given the opportunity to work more independently, with individual guidance upon request, about problems like different approaches to sustainable harvest or overshoot and collapse systems. This concept allows the lecturer to adjust the share of frontal teaching and independent work to the group's learning progress.

Media:

Reading material provided by lecturers, power point presentations, modelling software VENSIM PLE, example models

Reading List:

Begon, M., C. R. Townsend and J. L. Harper. 2006. Ecology: From Individuals to Ecosystems. Blackwell Publishing, Malden, MA.
Ford, A. Modeling the Environment. Island Press, 1999.
Sterman, J.D., Business Dynamics. McGraw-Hill Education, 2000.

Module Structure

Course 1	System Analysis
Lecturer 1	Peter Biber
Form of Teaching 1	Lecture (2SWS)
Course 2	Introduction to Ecology
Lecturer 2	Wolfang Weißer, Sebastian T. Meyer
Form of Teaching 2	Lecture (2SWS)

Internship WZ4061

Friederike Dörr – Praktikantenamt Weihenstephan – www.praktikantenamt-weihenstephan.de
Alte Akademie 1, 85354 Freising, 08161 / 71-3710, friederike.doerr@paw.bayern.de

Module Level:	Master	**Credits:**	5 Credits		
Language:	English	**Occurrence:**	winter semester	**Duration:**	seven weeks
Total Hours:	150h	**Contact Hours:**	0h	**Self-study Hours:**	300h
Assessment Retake:	**Next semester**				

Description of Achievement and Assessment Methods

After completion of the internship, the student has to hand in an internship report and a certification letter where the employer verifies the duration with eventual miss-outs and the kind of work which was performed from the trainee.

(Recommended) Prerequisites

None

Intended Learning Outcomes

On successful completion of the module, students are able to apply their theoretical knowledge in a practical environment. Furthermore, they are able to incorporate themselves into new companies and to analyze and assess business organizations.

Content

According to the study rules for the Master Program "Sustainable Resource Management", every student has to serve an internship with a minimum duration of 7 weeks (10 ECTS credits). The internship should act as a possibility for the trainee to get insight into the different areas of operation for sustainable resource managers. The student should be enabled to survey his individual career aspirations and to contact potential employers. The student has to search for an internship by his/her own and it has to be scheduled in a way that it does not conflict with the lecture periods. The internship can be split into two parts with a minimum duration of three weeks each. Further divisions are possible just due to significant reasons, but have to be approved in advance by the internship advisor. It is possible to serve the internship in different organizations; however the minimum duration of three weeks must be kept Recommended are organizations that are potential employers. Further information is available at: http://www.praktikantenamt-weihenstephan.de/praktikum/index.htm

Master´s Thesis WZ2754

General information: Renate van Beek (Program Coordinator)
Studienfakultät Forstwissenschaft und Ressourcenmanagement, Hans-Carl-von-Carlowitz-Platz 2, 85354 Freising, 08161/71-4464; beek@forst.wzw.tum.de;

Module Level:	Master	**Credits:**	30 Credits		
Language:	English	**Occurrence:**	Winter and summer semester	**Duration:**	one-semester
Total Hours:	900h	**Contact Hours:**	10h	**Self-study Hours:**	890h
Assessment Retake:	**Next semester**				

Description of Achievement and Assessment Methods

The assessment in this module is based on the successful completion of the Master's Thesis including the starting Master's Thesis Proposal. In order to promote the competences required for the Master´s thesis, the proposal should be submitted before the registration of the thesis.

(Recommended) Prerequisites

The Master's thesis should be started after successful completion of all module examinations.

Intended Learning Outcomes

After finishing the module the students have the availability to work independently and adapt to a problem in a limited period of time. Additionally, they are able to draw conclusions from the data they found and to present and discuss their results in an appropriate way.

Content

The Master Thesis is the closure project of the program on which students have the opportunity to show their availability to work independently and adapt to a problem in a limited period of time. The student selects a topic of his/her own choice on which he/she will work according to scientific methods. A combination of the master's thesis and an internship is possible if the rules for internships are kept. It would be ideal if student's master's thesis is based on the internship experience. Discussing the topic and the methods with a guiding professor or lecturer before starting the master's thesis is absolutely necessary. Therefore, for all students a starting seminar "Master's Thesis Proposal" is offered to guide them 1) theoretically in structuring their 6 months' work and 2) in practice in writing a proposal which outlines their thesis topic including the state of knowledge, the research gaps, the goal of the Master's Thesis, the planned methods and - which is really important - a working and a financial plan. It also includes training on literacy strategy.

The thesis must be written under supervision of a tutor who must be a lecturer of TUM and has the approval to conduct exams at TUM. It is recommended to select a lecturer of the "Sustainable Resource Management" Program. The tutor will in the end evaluate and mark the master's thesis. The thesis can be done at the faculty, outside the university, abroad or in the student's home-country, with previous consent of the tutor. Students can start writing their thesis in the fourth semester of the Master Program. To officially register the master's thesis, students have to hand in the application form for the master's thesis in the program coordination office The form has to be completed together with the tutor. After this registration the student has a timeframe of six months to finish the master's thesis.

Teaching and Learning Methods

Learning activities: literature search, scientific reading, to solve problems, to practice, to design an experiment, to create a scientific proposal and a scientific thesis, to constructive critique their own work and to revise it on basis of feedback, all parts under time constraints. Therefore, the learning methods are: an introduction lecture to support a structured procedure and peer instructions for their individual work.

Media:

Dependent on the topic of the thesis; e.g. specialized literature, software

Reading List:

Dependent on the topic of the thesis

Module Structure

Course 1	Master's Thesis Proposal
Lecturer 1	Gabriele Weber-Blaschke, Birgid Schlindwein
Form of Teaching 1	Seminar (1SWS)

Fields of Specialization

Environmental and Natural Resource Economics WI000286

PD. Dr. Thilo Glebe – Lehrstuhl für Volkswirtschaftslehre - Umweltökonomie und Agrarpolitik
Alte Akademie 14; 85354 Freising; 08161-71-5965; glebe@wzw.tum.de

Module Level:	Master	**Credits:**	5 Credits		
Language:	English	**Occurrence:**	summer semester	**Duration:**	one-semester
Total Hours:	150h	**Contact Hours:**	60h	**Self-study Hours:**	90h
Assessment Retake:	**Next semester**				

Description of Achievement and Assessment Methods

A written exam (duration 120 min) is considered to be most appropriate to test students' knowledge about environmental economic theory. The written exam tests if the students understand the economic view of environmental and resource problems. Furthermore, it proves the students ability to remember economic instruments, e.g. taxes, emission permits, payments for environmental services and how they work and their ability to compare them regarding their economic efficiency. Moreover, the ability is tested to apply specific valuation methods to attach a monetary value to environmental effects and conduct a Cost-Benefit Analysis.

(Recommended) Prerequisites

None

Intended Learning Outcomes

Upon successful completion of this module, students are able to
1) comprehend the interactions between economic growth and the environment;
2) understand the underlying economic reasons of environmental problems;
3) understand the role of the institutional setting for efficiently managing environmental resources;
4) gain the analytical skills for assessing the appropriateness of environmental policy instruments;
5) apply economic valuation techniques for environmental goods;
6) conduct and interpret economic cost-benefit analyses.

Content

a) Economic growth and the environment
b) Economic analysis of environmental problems
c) Role of institutions and liability rules
d) Analysis of environmental economic instruments
- Command and control measures
- Pollution taxes
- Emission trading
- Payments for environmental services

e) Valuation methods for environmental goods
f) Cost-benefit analysis.

Teaching and Learning Methods

The module includes lectures, exercises, group discussions and a classroom experiment.

Media:

PowerPoint, blackboard

Reading List:

A digital reader consisting of various textbook chapters and journal articles will be put on Moodle for each chapter of the course.

Module Structure

Course	Environmental and Natural Resource Economics
Lecturer	Thilo Glebe
Form of Teaching	Lecture & Exercises (4SWS)

International Environmental Policy and Conflict Resolution WI000926

Tim Kunkowski – Lehrstuhl für Wald- und Umweltpolitik
Hans-Carl-von-Carlowitz-Platz 2, 85354 Freising; 08161 / 71-4627; tim.kunkowski@tum.de

Module Level:	Master	**Credits:**	5 Credits		
Language:	English	**Occurrence:**	winter semester	**Duration:**	one-semester
Total Hours:	150h	**Contact Hours:**	60h	**Self-study Hours:**	90h
Assessment Retake:	**Next semester**				

Description of Achievement and Assessment Methods

The module grade is based on a project work with a written project report based on the elaboration of a case study (18-20 pages). The project work will be performed in teams of students. By working in teams, students show their ability to manage resources within the team and to solve separate project tasks within a specified time limit. The single student's contribution to the group work will be clearly identifiable and gradable.
With the project work students demonstrate that they are able to recall key issues of international environmental policy and relate those to pertinent conflicts about resource management. With this multi-level analysis students show their ability to carry out a distinct case study in groups, following a given methodology.
By preparing the case study, students demonstrate their ability to explore underlying causes and to generate and discuss possible solution strategies for a concrete example of the field of natural resource conflicts and their dynamics.
Within the process students demonstrate that they are able to consider different perspectives and to reflect these perspectives in order to attain a joint result. The case study is the outcome of joint project work.

(Recommended) Prerequisites

None

Intended Learning Outcomes

At the end of the module, students are able to: (a) to describe actors and discourses of international environmental policy as well as their development; (b) to differentiate between different types of international environmental policy instruments (regulatory, market- and information-based) with regard to their effect;(c) to analyze the impact of actors, discourses and/or instruments of international environmental policy on the local level, using an exemplary case; d) to apply a multi-level analysis to pertinent conflicts dealing with resource management; e) to propose and discuss appropriate resolution strategies of conflict management based on that analysis of an exemplary case.

Content

Conflicts of interest have become common in resource management. Moreover, actors, discourses and instruments from international environmental policy may play in the role in the emergence, escalation and/or management of these conflicts. The module embeds the local level of conflictive issues in resource management in the broader setting of international environmental policy. Therefore, the emergence and development of the international environmental regime from 1970-2015 is explored with reference to international conventions like, for example, the Montreal Protocol on ozone depleting substances, the UN's climate policies and initiatives to end the loss of biodiversity. Approaches ranging from traditional top-down instruments used by governments ("government") to less conventional instruments that presuppose active participation of non-state actors, including firms and NGOs ("governance") are analyzed. Conflict Resolution addresses conflicts that emerge from (over-)use of natural resources, like timber, water and mineral resources. The module's bottom line is that developments in international environmental policy affect management decisions over the use and/or protection of natural resources, yet solutions for conflictive issues have to be found at the local level and with involvement of multiple actors. So doing, an important trend in international environmental policy is addressed, namely that multi-stakeholder dialogues and arrangements are pertinent for successful conflict management.

Teaching and Learning Methods

The module is a lecture. Moreover, students are asked to actively participate and read the reading assignments. The lectures provide students with a basic grasp of International Environmental Policy and Conflict Resolution. Additionally policies, instruments and conflict cases will be analyzed. In the course of a project work students work in teams to develop a case study. The case study is the result of the project work, which is conducted by the student team and guided by the lecturer.

Media:

PowerPoint, chalc board, flip chart

Reading List:

Dauvergne, P. (2012) Handbook of Global Environmental Politics, Second Edition, Cheltenham (u.a.): Edward Elgar Publishing.
Dryzek, John S. (2013) The Politics of the Earth: Environmental Discourses, Third Edition: Oxford University Press
Falkner, R. (2013) Handbook of Global Climate and Environment Policy, Chichester: John Wiley & Sons Inc.

Module Structure

Course 1	International Environmental Policy
Lecturer 1	Tim Kunkowski
Form of Teaching 1	Lecture (2SWS)
Course 2	Conflict Resolution
Lecturer 2	Tim Kunkowski
Form of Teaching 2	Lecture (2SWS)

Sustainable and Environmental Regulations WZ2936

Dr. Isabel Augenstein; Lehrstuhl für Strategie und Management der Landschaftsentwicklung;
Emil-Ramann-Str. 6, 85354 Freising; 08161/71- 4783; isabel.augenstein@lrz.tum.de

Module Level:	Master	**Credits:**	5 Credits		
Language:	English	**Occurrence:**	winter semester	**Duration:**	one-semester
Total Hours:	150h	**Contact Hours:**	60h	**Self-study Hours:**	90h
Assessment Retake:	**Next semester**				

Description of Achievement and Assessment Methods

Successful completion of the course will be based on the quality of the presentation in the seminar and a term paper on the topic of the presentation. The presentation is a means to measure the students' ability to understand the context and complexity of sustainable development in different countries and formal impact assessment procedures by preparing and delivering a well-researched and instructive oral presentation on a certain facet. An accompanying executive summary of major findings and conclusions indicates the capacity of the students to summarise the presentation in a clear and concise manner. In addition, the students are expected to show their oral communication skills by responding competently to questions and comments by the audience as well as by contributing to class discussions. Depending on the number of seminar participants, the presentation may be given either individually or in groups.

(Recommended) Prerequisites

Class discussion is a core element of the seminars. Therefore, students are expected to take part and contribute to the discussions.

Intended Learning Outcomes

At the conclusion of the module, the students will have basic knowledge on sustainable development, its theoretical and empirical implications and its most important policy fields. The students understand the structure and the functioning of different political regimes and are able to evaluate their impact on the sustainable development of a country. Furthermore, the students are able to: appreciate the purpose of EIA and SEA and their role in the decision-making process; explain the major principles and procedural steps of EIA and SEA; know options for estimating environmental impacts; reflect critically on the strength and limitations of the instruments; communicate findings in class and comment on the work of fellow students.

Content

Course 1 "Sustainable Development and Regime Type" (SDRT): The seminar introduces both the theoretical debate on sustainable development and the discussion about the role political regime type (democracy, autocracy, hybrid regime) play for the sustainability performance of a country. What are the goals of "sustainable development"? Which policy areas have a strong relationship to sustainability? To what extent do countries differ in their "sustainability profile" in various policy areas? What influence does the regime type play in this regard?

The seminar investigates these theoretical and empirical issues in the context of pressing future challenges, such as rising government debt in many countries, growing global competition for innovation, and intensifying global environmental degradation and resource scarcity. The seminar will focus on discussing theoretical approaches to current "sustainability debates" and considering what defines generationally just behavior. In addition, empirically based comparisons of countries under different political leadership will be made looking at several sustainability areas (e.g. economic, financial, educational, research, family, pension, environmental and energy policy).

Course 2 "Methods of Environmental Assessment" (MEA): The seminar introduces the methodology of EIA and SEA as worldwide established instruments for assisting sound environmental management. Being integral parts of spatial planning and decision-making, the assessment procedures integrate biophysical and socioeconomic information to predict and evaluate the environmental consequences of proposed projects, plans and policies and to suggest means to avoid or mitigate significant impacts. The seminar gives an overview of the concepts, methods, procedural elements of EIA and SEA and stimulates discussion on key aspects of environmental assessment.

Teaching and Learning Methods

In the SDRT seminar lectures, presentations and discussions provide students with a basic knowledge on sustainable development and political regime type and allows them to evaluate the performance of different states with regard to their sustainability performance. In the MEA seminar, presentations by students and the lecturers provide the basis for exploring and discussing the concepts, methodology, current practice and potentials of environmental assessment. Class discussions engage students in critical thinking and analysing the scope and limitations of the presented material.

Media:

The module includes lectures, presentations, class discussions, (small group) exercises and assigned readings.

Reading List:

Wintrobe, R. (2000): The Political Economy of Dictatorship, Cambridge University Press, Cambridge; Tremmel, J. (2006): Handbook of intergenerational justice, Edward Elgar, Cheltenham; Morris, P. & R. Therivel (Eds., 2009): Methods of Environmental Impact Assessment. 3rd edition. Routledge, London and New York; Sadler, B., Aschemann, R., Dusik, J, Fischer, T.B., Partidário, M.R. & R. Verheem (2011): Handbook of Strategic Environmental Assessment. Earthscan, London, Washington, DC. Additional material will be provided.

Module Structure

Course 1	Sustainable Development and Regime Type
Lecturer 1	Stefan Wurster
Form of Teaching 1	Seminar (2SWS)
Course 2	Methods of Environmental Assessment
Lecturer 2	Isabel Augenstein
Form of Teaching 2	Seminar (2SWS)

Climate Change Economics WZ1590

Dr. Emmanuel Benjamin – Lehrstuhl für Produktions- und Ressourcenökonomie landwirtschaftlicher Betriebe (Prof. Sauer)
Alte Akademie 14 , 85354 Freising, Emmanuel.benjamin@tum.de

Module Level:	Master	**Credits:**	5 Credits		
Language:	English	**Occurrence:**	summer semester	**Duration:**	one-semester
Total Hours:	150h	**Contact Hours:**	70h	**Self-study Hours:**	80h
Assessment Retake:	**Next semester**				

Description of Achievement and Assessment Methods

There will be a written Exam (Klausur) of 90 minutes at the end of the semester. The students will be asked to demonstrate their knowledge of the relevant literature and their understanding of the issues relating to the economic modeling of climate change. A written exam is judged to be the appropriate form to evaluate the degree to which the students understand the theoretical and empirical framework of climate change implications as well as the ability of students to create their own research in the field.

(Recommended) Prerequisites

Basic knowledge of micro-, environmental- and resource-economics

Intended Learning Outcomes

After successfully completing the module, students will have a basic understanding of how to model the economics of climate change, which choices must be made and how these decisions affect the results. They will have a basic knowledge of how to deal with the complexity, uncertainty and limited possibilities to compensate the losers of political and economic choices from climate change related events. They will also understand why political climate negotiations are so difficult and which political instruments could help to mitigate climate change.

Content

This course covers the trends in current and future climate change and their effects on economic and social outcomes. The course consists of lectures and seminar activities. The lectures are divided in six blocks:

1. Climate trends and European crop yields
   - the students will learn how changes in precipitation and temperature affect crop yields.
2. Climate Data
   - the students will learn about choices of data selection in empirical research as well as their challenges.
3. State-of-the Art Climate Economics
   - the students will learn important empirical models, their assumptions, potential and limitations.
4. Non-Linear Effects of Temperature on Economic Production
   - the students will learn about the relationship between productivity and climate change.
5. The Social Costs of Carbon, IAMs, Discounting
   - the students will learn about the concept and models used to estimate the social cost of carbon.
6. Open Questions
   - finally, the course is also supposed to involve discussions and especially focus on ideas that come up during the course. The more students learn, the more they are expected to come up with questions that can be discussed at the end of the course.

In the seminar the students present specific theoretical and empirical articles on climate change modelling followed by discussions.

Teaching and Learning Methods

The course consists of lectures (3,2 SWS), presentations and discussions (0,8 SWS). The lecture will promote the basic upon which to build the presentations and discussions. This encourages the students to independently and self-reliantly study the literature guided by a structured framework.

Media:

PowerPoint Presentation, Hydrological model (e.g. WaSiM), Field work

Reading List:

Auffhammer, M., Hsiang, S.M, Schlenker, W. & Sobel, A. (2013). Using weather data and climate model output in economic analyses of climate change. Review of Environmental Economics and Policy, 7(2), 181-198.
Arrow, Kenneth, Maureen Cropper, Christian Gollier, Ben Groom, Geoffrey Heal, Richard Newell, William Nordhaus et al. “Determining benefits and costs for future generations.” Science 341, no. 6144 (2013): 349-350.
Baumgärtner, Stefan, Alexandra M. Klein, Denise Thiel, and Klara Winkler. “Ramsey discounting of ecosystem services.” Environmental and Resource Economics 61, no. 2 (2015): 273-296.
Burke, M., Hsiang, S. M., & Miguel, E. (2915). Global non-linear effect of temperature on economic production. Nature, 527 (7577), 235.
Dell, M., Jones, B. F., & Olken, B.A. (2014). What do we learn from the weather? The new climate-economy literature. Journal of Economic Literature, 52(3), 740-98.
Moore, F.C., & Lobell, D.B. (2015). The fingerprint of climate trends on European crop yields. Proceedings of the National Academy of sciences, 201409606.

Module Structure

Course 1	Climate Change Economics
Lecturer 1	Emmanuel Benjamin
Form of Teaching 1	Lecture (3,2 SWS)
Course 2	Climate Change Economics – Student Presentations
Lecturer 2	Emmanuel Benjamin
Form of Teaching 2	Seminar (0,8 SWS)

Forest Growth and Forest Operations WZ2716

Dr. Thomas Rötzer – Lehrstuhl für Waldwachstumskunde
Hans-Carl-von-Carlowitz Platz 2, 85354 Freising, thomas.roetzer@tum.de, Tel.: 08161/71-4667

Module Level:	Master	**Credits:**	5 Credits		
Language:	English	**Occurrence:**	summer semester	**Duration:**	one-semester
Total Hours:	150h	**Contact Hours:**	60h	**Self-study Hours:**	90h
Assessment Retake:	**Next semester**				

Description of Achievement and Assessment Methods

The learning success of the module Forest Growth and Forest Operations will be assessed by a written examination of 90 minutes. This is due to the fact that biometric topics, growth processes and analyses as well as the forest growth modelling part of the lecture can be presented best in a written form by drawings, figures, calculation schemes, etc. For example the description of biological processes and growth cycles in forest growth simulators can best be explained and depicted by graphical representations.

(Recommended) Prerequisites

Basic knowledge in biology and forest science.

Intended Learning Outcomes

On successful completion of the module, students are able to
- Understand the environmental factors influencing the forest stand production
- Describe the effects of silvicultural treatment on quantitatively measured growth and yield characteristics
- Understand the principles of growth models
- Analyze and evaluate the impact of environmental changes on tree and stand growth
- Create possible silvicultural measures to mitigate negative effects of environmental changes on forest stand growth
- Understand and evaluate the impact of biotic and abiotic factors on growth, vitality and stability of individual trees and forest stands
- Understand the fundamentals of sound resource road planning and construction
- Describe the links between mechanized harvesting and potential stand and soil damages
- Evaluate the productivity and carbon footprint of different harvesting systems.

Content

The part Forest Growth deals with objectives and methods of forest growth and yield science. First, as fundamental topic, principal factors of the organic production of forest stands based on the driving forces (climate, water, nutrients) are shown and explained. In a next step growth and yield is analyzed more closely as part of the total production of plant communities. This leads to principles of tree shape development, tree growth and carbon dynamics in general. From individual tree growth the course proceeds to structure and development of whole forest stands. Both previous subjects provide the basic knowledge for understanding the effect of silvicultural treatment on quantitatively measured growth and yield characteristics. Growth trends, productivity and carbon dynamics of the main tree species in Central Europe are presented. Analyses of stand structure, growth and yield in the view of climate change are discussed. Different types of forest growth models on tree, stand and forest enterprise levels are introduced. The part Forest Operations can be divided in 5 topics: (1) Overview of mechanized harvesting (methods and most common systems), (2) Environmentally sound resource road planning and construction, (3) Assessing the environmental impacts of forest operations on forest stands and soils, (4) Means of eco-efficient wood transportation from the forest to the mill and (5) Current developments in small-scale forest operations.

Teaching and Learning Methods

Lectures and presentations, field trip (optional).

Media:

Lectures and presentations (pdfs).

Reading List:

FOREST GROWTH: Pretzsch, H., (2009): Forest Dynamics, Growth and Yield. Springer Verlag, Berlin, 664 S. 2009 published as Hardcover(ISBN 978-3-540-88306-7) 2010 published as paperback (ISBN 978-3-642-14861-3) FOREST OPERATIONS: Bowers, S. 2012. Designing woodland roads. Oregon State University. EC 1137. 21 pp. Dykstra, D. P. and Heinrich, R. 1996. FAO Model code of forest harvesting practice. 85 pp. Enters, D., Applegate, G.B., Kho, P. C.S., and Man, G. (Eds.) 2002. Applying reduced impact logging to advance sustainable forest management. FAO. Heinrich, R. Recent developments on environmentally friendly forest road construction and wood transportation in mountainous forests. Rummer, B. 2009. New technology in forest operations. www.forestlandowners.com. 3 pp. Sutherland, B.J. 2003. Preventing soil compaction and rutting in the boreal forest of western Canada. FERIC. 53 pp.

Module Structure

Course 1	Forest Growth
Lecturer 1	Hans Pretzsch, Thomas Rötzer
Form of Teaching 1	Lecture (2SWS)
Course 2	Low impact forest operation technologies
Lecturer 2	Eric R. Labelle
Form of Teaching 2	Lecture and excursion (1,5 SWS + 0,5 SWS)

Forest Management WZ4161

Dr. Bernhard Felbermeier – Lehrstuhl für Waldbau
Hans-Carl-von-Carlowitz-Platz 2, 85354 Freising, 08161/71-4702, felbermeier@lrz.tum.de

Module Level:	Master	**Credits:**	5 Credits		
Language:	English	**Occurrence:**	summer semester	**Duration:**	one-semester
Total Hours:	150h	**Contact Hours:**	60h	**Self-study Hours:**	90h
Assessment Retake:	**Next semester**				

Description of Achievement and Assessment Methods

The module integrates different scientific and management methods with the objective to develop concepts for the sustainable management of forest. Forest managers must understand complex content and be able to explain it to a critical audience. The learning outcome will be assessed by an oral exam (30 minutes) covering the whole outcomes of the module.

(Recommended) Prerequisites

None

Intended Learning Outcomes

At the end of the module the students are able to:

- understand different concepts of forest management
- understand different demands in forest management
- apply means of linear programming to harmonize different measures
- apply decision support systems
- evaluate different forest management measures.

Content

1. Definition of forest and forest ecosystem
2. Overview of forestry on global, regional and local scales
3. Introduction into objectives and methods of forest ecosystem management and forest management planning
4. Demonstration of forest decision support systems and multiple-objective optimization
5. Overview of silvicultural techniques
6. Basic Knowledge of Forest economics
7. Demonstration of examples in lowland and mountain forest management.

Teaching and Learning Methods

The module is separated into lectures and exercises. Lectures providing the theoretical foundations and concepts in Forest Management. Exercises are done in supervised groups in the field.

Media:

PowerPoint presentations, additional reading material, software application.

Reading List:

FAO (2018): State of the World's Forests; FAO (2016): Global Forest Resources Assessment 2015.

Module Structure

Course 1	Forest Ecosystem Management
Lecturer 1	Bernhard Felbermeier
Form of Teaching 1	Practical (2SWS)
Course 2	Forest Management Planning
Lecturer 2	Thomas Knoke
Form of Teaching 2	Practical (2SWS)

Genetic Resources Management and Forest Protection WZ2717

Prof. Dr. Hanno Schäfer – Plant Biodiversity Research,
Emil-Ramann-Str. 2, 85354 Freising, 08161/71-5884, hanno.schaefer@tum.de

Module Level:	Master	**Credits:**	5 Credits		
Language:	English	**Occurrence:**	winter semester	**Duration:**	one-semester
Total Hours:	150h	**Contact Hours:**	50h	**Self-study Hours:**	100h
Assessment Retake:	**Next semester**				

Description of Achievement and Assessment Methods

The learning outcome will be assessed by a written exam (duration 60 min) where the student have to analyze the risk of given pest and abiotic hazard-scenarios and to develop adequate management strategies. Furthermore, they have to analyze a case study and interpret the genetic diversity situation presented there, including discussion of possible management strategies and problems. In this way, the students can demonstrate that they have obtained the ability to use their knowledge in real world management situations.

(Recommended) Prerequisites

None

Intended Learning Outcomes

On successful completion of the module, students are able to
- assess genetic diversity patterns in natural populations of different groups of organisms (mammals, birds, plants)
- understand the importance of maximizing genetic diversity
- understand the impact of biotic and abiotic factors on vitality and stability of individual trees and forests;
- assess the impact of fungal pathogens and insects on tree health;
- apply their ecological knowledge to minimize and forecast the risk of damages by fungal pathogens and insect pests;
- characterize the impact of forest management on insect populations and crop loss.

Content

Part I: Genetic Resource Management
1. introduction: DNA, genetic code, genes, alleles, genomes
2. speciation, hybridization, phylogenies
3. basics of population genetics
4. genetic variation in forest ecosystems
5. tree breeding, gene conservation & sampling strategies, certification of gene resources
6. genetics of plants and animals in the mountains
7. genetics of plants and animals in the Tropics
8. sustainable management strategies

Part II: Forest Protection- pathogens, insect pests, climatic and abiotic factors.
a) fungal pathogens in forest ecosystems
1. fungal pathogens-woody plant interactions worldwide (incl. Phytophthora pathogens)
2. techniques to identify fungal pathogens in forest ecosystems
3. techniques to inhibit pathogen spread
4. management strategies for nurseries and forest ecosystems

b) insect pests in forest ecosystems
1. insect morphology, anatomy and development
2. insect biology
3. herbivorous insects on trees
4. economically important herbivorous insects
5. pest control (monitoring and forecast)
7. insect pest management

c) Abiotic hazards
This part addresses risks of non-biotic damages (wind, water in different aggregation states, fire, pollutants, extreme climate conditions) and its interactions with pests and diseases as well as preventive management activities.

Teaching and Learning Methods

lectures and presentations, field trip (optional)

Media:

lectures and presentations (pdfs)

Reading List:

Agrios, G.N. 2005, Plant Pathology, 5th edition. Elsevier Academic Press, Oxford * Speight, M.R. & Wylie, F.R., 2001: Insect pests in tropical forestry. CABI publishing. * Ruppert, E.E. & Barnes, R.D., 1993: Invertebrate Zoology 6th edition (Chapter 16 insects; p 825-862)

Module Structure

Course 1	Genetic Resource Management
Lecturer 1	Hanno Schaefer
Form of Teaching 1	Lecture (1,4 SWS)
Course 2	Biotic and Abiotic Forest Protection
Lecturer 2	Axel Gruppe, Bernhard Felbermeier
Form of Teaching 2	Lecture (1,6 SWS)

Plantation Forestry and Agroforestry WZ4082

Dr. Bernhard Felbermeier – Lehrstuhl für Waldbau
Hans-Carl-von-Carlowitz-Platz 2, 85354 Freising; 08161/71- 4702; felbermeier@lrz.tum.de

Module Level:	Master	**Credits:**	5 Credits		
Language:	English	**Occurrence:**	winter semester	**Duration:**	one-semester
Total Hours:	150h	**Contact Hours:**	60h	**Self-study Hours:**	90h
Assessment Retake:	**Next semester**				

Description of Achievement and Assessment Methods

The learning outcomes are assessed by an oral examination of 30 minutes. Based on specific problem statements the students have to demonstrate their ability to analyze and assess the situation, to understand the origin of the problem and to propose solutions adapted from the methodologies and techniques procured in the course.

(Recommended) Prerequisites

None

Intended Learning Outcomes

Students will be able to
- understand and evaluate the major issues of plantations in the context of international forest policy,
- explain the fundamental purposes of Plantation Forestry,
- properly deploy the essential techniques of Plantation Silviculture, e.g. for establishment, tending and maintenance
- critically examine plantation projects (management, work volume, economic results).
- understand the fundamental principles and practices of agroforestry land use,
- analyze the interactions among different components of an AF system,
- assess the ecological and economic effects of AF-systems and develop adequate management options,
- address problems in the context of rural development and identify AF-based solutions
- understand the role of forests and forest management activities in the global C-cycle,
- assess forest management options for different purposes within the framework of the international climate policy,
- identify and develop concepts for mitigation projects.

Content

Plantation forestry: Background, Definitions, Plantations in the Context of International Forest Policy, Plantation Forestry Purposes, Plantation Silviculture, Management and Economics;
Agroforestry (AF): Introduction (global land-use problems, definitions, terminology), Traditional AF Systems, Environmental, economic and socio-cultural aspects of AF, Interactions in AF systems, Important tree groups in AF (NFT´s, MPT´s, Palms), Planning in AF, Legal aspects
Forest Management for Carbon Sequestration: Role of forests in the global carbon cycle, Possible impacts of climate change on forests, International climate policy, Forest in the Kyoto Protocol (KP), Flexible mechanisms of the KP, REDD and REDD+, Forest management options, Modelling forest sequestration with CO2FIX, Case studies.

Teaching and Learning Methods

Knowledge and skills are imparted by lectures, group discussions, presentation of case studies and small exercises; the learning methods are learning, reviewing scientific articles, and research reference articles. The lectures will provide theories and basic reference materials which will be deepened and proved by reviewing articles. The achieved skills will be used to develop and discuss solutions for specified problems.

Media:

PowerPoint presentations, case studies, additional reading material

Reading List:

ABARE - JaakoPöyry (1999): Global Outlook for Plantations. Australian Bureau of Agricultural and Resource Economics (ABARE) Research Report 99.9, www.abare.gov.au. Evans, J., Turnbull, J. W. (2004): Plantation forestry in the tropics. FAO, (1998): FRA 2000 - Terms and definitions. Forest Resources Assessment Programme, Working Paper 1. FAO (2001): Global Forest Resources Assessment 2000. FAO Forestry Paper 140. Pandey, D. and Ball, J. (1998): The role of industrial plantations in future global fibre supplies. Unasylva 193, Vol. 49, 37 - 43. Sawyer, J., (1993): Plantations in the Tropics. Smith, D.M., Larson, B.C.,Kelty, M.J. and Ashton, P.M.S. (1997): The Practice of Silviculture: Applied Forest Ecology. Smith, J. (2002): Afforestation and reforestation in the clean development mechanism of the Kyoto protocol: implications for forests and forest people. Int. J. Global Environmental Issues 2 (3/4): 322-343. Shepherd, K.R. (1986): Plantation Silviculture. West, P. W. (2006): Growing Plantation Forests. Ashton, M.S. and Montagnini, F. (2000): The silvicultural basis for agroforestry Systems. Agroforesty: Principles and Practice: Special issue of Forest Ecology and Management, 45 (1991). Nair, P.K.R. (2012): Agroforestry, the future of global land use. Atangana et al. (2014): Tropical Agroforestry. Springer Verlag

Module Structure

Course 1	Plantation Forestry
Lecturer 1	Bernd Stimm
Form of Teaching 1	Lecture (2 SWS)
Course 2	Agroforestry and Forest Management for Carbon sequestration
Lecturer 2	Bernhard Felbermeier
Form of Teaching 2	Lecture (2 SWS)

Protected Areas Biodiversity and Management WZ4197

Prof. Dr. Ralph Kühn – Lehrstuhl für Zoologie
Hans-Carl-von-Carlowitz-Platz 2, 85354 Freising; 08161/71-4608; kuehn@wzw.tum.de

Module Level:	Master	**Credits:**	5 Credits		
Language:	English	**Occurrence:**	summer semester	**Duration:**	one-semester
Total Hours:	150h	**Contact Hours:**	60h	**Self-study Hours:**	90
Assessment Retake:	**Next semester**				

Description of Achievement and Assessment Methods

Final written examination of 90 minutes in the field of protected areas biodiversity and its management to examine whether the students have understood the problematic of securing biodiversity in protected areas and are able to verify conservation measurements.

(Recommended) Prerequisites

None

Intended Learning Outcomes

On successful completion of the module students are able to:
- put ecosystems and its utilization options as well as its threats into a global perspective
- give clear options for further management, both regarding utilization and protection.

Content

Biodiversity and protected areas: A worldwide survey on ecozones and altitudinal belts of the word as carriers of natural biodiversity; protection of biological units; IUCN protected areas classification, the European FFH Directive as an example of a continent-wide tool for nature protection.

Habitat analysis and management: Habitat types, tools for protecting habitats, design of management plans, visitor management, best practice examples in sustainable biodiversity and habitat protection.

Teaching and Learning Methods

Lecture, case studies, practical experiments / demonstrations, discussions.

Media:

PowerPoint Presentation

Reading List:

Jürgen Schultz (2005): The Ecozones of the World: Ecological Divisions of the Geosphere. Springer, Berlin. 459p.

Module Structure

Course 1	Biodiversity in Protected Areas
Lecturer 1	Claus Bässler
Form of Teaching 1	Lecture (2 SWS)
Course 2	Protected Area Management
Lecturer 2	Roman Gula, Thomas Rödl
Form of Teaching 2	Lecture (2SWS)

Wildlife Management and Wildlife-Human Interactions WZ4198

Thomas Rödl Ph.D, Prof. Dr. Ralph Kühn - Lehrstuhl für Zoologie
Hans-Carl-von-Carlowitz-Platz 2, 85354 Freising;, 08161/71-4608; thomas.roedl@googlemail.com, kuehn@wzw.tum.de

Module Level:	Master	**Credits:**	5 Credits		
Language:	English	**Occurrence:**	summer semester	**Duration:**	one-semester
Total Hours:	150h	**Contact Hours:**	60h	**Self-study Hours:**	90h
Assessment Retake:	**Next semester**				

Description of Achievement and Assessment Methods

Written assignment (15 pages) requiring review of literature, synthesis and integration of key concepts and findings from the literature to develop a coherent research proposal that clearly demonstrates knowledge in the field of species management and conservation strategies and of human dimensions as a research and applied field of study. Expected to read in advance where possible assigned readings so to be prepared for course lectures.

(Recommended) Prerequisites

None

Intended Learning Outcomes

After the course students are able to: understand important ecological concepts in wildlife management; understand the importance of the human dimension in wildlife management; analyze a conservation strategy for a species; apply wildlife management plans; evaluate species and protected area management plans; understand the importance and nature of objectivity in conducting research and being a human dimension researcher; develop the ability to synthesize relevant literature pertinent to a research problem; organize ideas effectively and communicate these in a well-organized and developed written proposal.

Content

This lecture combines contents of Wildlife Management and Wildlife Human Interactions. The key aspects are: 1) Principles of Wildlife Management & Wildlife Science, 2) Planning tools, 3) Case study: Strategic planning, 4) Conflicting views in WMT with case studies, 5) Basic Concepts in Ecology, 6) Reintroductions studies, 7) Global threats to Conservation, 8) Nature of human dimensions (HD) from a research perspective through various examples 9) Nature of various wildlife-human interactions from different perspectives, 10) Nature of public involvement and HD as an applied approach 11) Types of conflict, levels of planning and how to work with people toward solutions, 12) Understanding decision-making processes.

Teaching and Learning Methods

lecture, video, group exercises, discussions

Media:

lecture notes, flip-chart/board, handouts, additional reading material.

Reading List:

Sinclair et al. 2006, Wildlife Ecology, Conservation, and Management, ISBN 1-4051-0737-5 ; Krausman 2002, Wildlife Management, ISBN 0-1328-0850-1; Pullin 2002, Conservation Biology, ISBN 0-521-64482-8

Module Structure

Course 1	Wildlife Management
Lecturer 1	Thomas Rödl
Form of Teaching 1	Lecture (2SWS)
Course 2	Wildlife-Human Interactions
Lecturer 2	Alistair James Bath
Form of Teaching 2	Seminar (2SWS)

Fisheries and Aquatic Conservation WZ4189

Prof. Dr. Jürgen Geist – Lehrstuhl für Aquatische Systembiologie
Mühlenweg 18-22, 85354 Freising; 08161/71-3947; geist@wzw.tum.de

Module Level:	Master	**Credits:**	5 Credits		
Language:	English	**Occurrence:**	winter semester	**Duration:**	one-semester
Total Hours:	150h	**Contact Hours:**	60h	**Self-study Hours:**	90h
Assessment Retake:	**Next semester**				

Description of Achievement and Assessment Methods

The examination consists of a 60 min. written exam (Klausur). The examination means to measure the student's ability to assess anthropogenic influence on aquatic ecosystem functioning, evaluate the socioeconomic importance of fisheries and aquaculture , explain factors affecting susceptibility to and recovery from overexpoitation, create and apply sustainable aquatic conservation tools and recall fisheries management tools for wild populations as well as of the underlying biological principles such as fish population dynamics. In the written examination students demonstrate by answering questions under time pressure and without helping material their theoretical and practical (e.g. application of methods) knowledge about fisheries management. For answering the questions, the students require their own wording. In the practical excercise the students prepare a broschure or poster to practice the knowledge transfer to specific target audiences in the context of fisheries and aquatic conservation.

(Recommended) Prerequisites

Interest in aquatic biology, social sciences, conservation biology and management; this course can be selected independently from other courses in the fields of Fish Biology and Limnology at TUM

Intended Learning Outcomes

At the end of the module students understand the importance of aquatic resources for mankind and the variables which influence ecosystem functions as well as the principles of aquatic biodiversity conservation. They are able to analyze the effects of natural and man-made disturbances in aquatic ecosystems (e.g. overexploitation) based upon an interdisciplinary understanding of methodological aquatic and fisheries biology, human dimensions, socioeconomic factors and management skills. In addition, students are able to objectively integrate knowledge from different disciplines (e.g. fish biology, conservation biology, commercial fishing techniques, aquatic habitat assessment and management) to evaluate sustainable resource management.

Content

The module combines the theoretical background and the practical implementation of fisheries management and aquatic conservation. The key aspects are:
1. Introduction to fish, shellfish and fisheries management,
2. The socioeconomic importance of fisheries and aquaculture,
3. The functioning of aquatic ecosystems and the impacts of fisheries on aquatic ecosystem health,
4.Factors affecting susceptibility to and recovery from overexploitation,
5. Fisheries Management Tools for wild populations,
6. Aquaculture,
7. Aquatic Biodiversity Conservation,
8. Case study and knowledge transfer/communication excercise

Teaching and Learning Methods

The module combines a lecture "Fisheries Management" with an accompanying practical excercise " Applied Aquatic Conservation". The lecture contents will be presented using lectures based on power-point presentation, group work and interactive role plays in order to combine activating teaching methods with classic presentation techniques. In the accompanying practical excercise to the lecture the students will apply the gained theoretical knowledge by conducting case studies or participating research experiments with various content in the field of freshwater ecology and aquatic conservation. The content of the practical work is incorporated into running research projects at the chair (e.g. habitat restoration, artificial breeding programmes, habitat assessment, conservation genetics). Additionally, the students learn to independently screen the respective literature in this field and learn methods in science communication.

Media:

Form of presentation: lecture, case study, movie segment and practical excercise
material: lecture notes, flip-chart/board, plus different materials for methodological/technical training

Reading List:

1. King (2007) Fisheries Biology, Assessment and Management
2. Helfman (2007) Fish Conservation: A guide to understanding and restoring global aquatic biodiversity and fishery resources
3. Moyle & Cech (2004) Fishes An introduction to Ichtyology
4. Primack (2008) A primer of conservation biology

Module Structure

Course 1	Fisheries Management
Lecturer 1	Jürgen Geist
Form of Teaching 1	Lecture (2SWS)
Course 2	Applied Aquatic Conservation
Lecturer 2	Joachim Pander
Form of Teaching 2	Excursion (2SWS)

Wildlife and Conservation Biology WZ6432

Prof. Dr. Ralph Kühn – Lehrstuhl für Zoologie
Hans-Carl-von-Carlowitz-Platz 2, 85354 Freising; 08161/71-4608; kuehn@wzw.tum.de

Module Level:	Master	**Credits:**	5 Credits		
Language:	English	**Occurrence:**	summer semester	**Duration:**	one-semester
Total Hours:	150h	**Contact Hours:**	75h	**Self-study Hours:**	75h
Assessment Retake:	**Next semester**				

Description of Achievement and Assessment Methods

The examination consists of a 60 min. written exam (Klausur). The examination means to measure the student's ability to assess anthropogenic influence on Biodiversty, to explain factors affecting Wildlife, to recall methods in Conservation Biology and applied Genetics and to evaluate Conservation Biology concepts. In the written examination students demonstrate by answering questions under time pressure and without helping material their theoretical and practical knowledge about Wildlife and Conservation Biology. For answering the questions, the students require their own wording. In the practical excercise the students present a case study and design a own research project proposal to practice their scientific communication skills and to transfer the theoretical knowledge to practical projects.

(Recommended) Prerequisites

Interest in Wildlife Conservation Biology and Nature Conservation. Basic background in Biology

Intended Learning Outcomes

At the end of the module students understand the importance of Biodiverstiy of terrestial resources and its interaction with human dimensions. They are able to apply and to evaluate Conservation Biology methods and strategies based upon an interdisciplinary understanding of species biology, conservation biology and applied genetics. In addition, students are able to integrate interdisciplinary knowledge into applied conservation management on a regional and international scale. They have an overview of applied interdisciplinary Nature Conservation management and are able to evaluate sustainable resource management strategies.

Content

The module combines the theoretical background and the practical implementation of Wildlife Conservation Biology, Conservation Genetics and Nature Conservation. The key aspects are:
1. Scope and tasks of Conservation Biology and applied Genetics
2. Biodiversity, Ecosystems, Ecosystem Services and Green Bankiing
3. Factors affecting terrestrial and aquatic Biodiversty
4. Methods in Wildlife Conservation Biology and applied Genetics
5. Conservation Biology concepts and strategies for natural population using international examples
6. Case studies and applied Nature Conservation, from theory to praxis

Teaching and Learning Methods

The module combines the lecture "Wildlife and Conservation Biology" with an accompanying practical excercise " Case Studies in Nature Conservation". The lecture contents will be presented using lectures based on power-point presentation and group work in order to combine activating teaching methods with classic presentation techniques. In the accompanying practical excercise, the students will apply the gained theoretical knowledge by conducting case studies (research programs), and presenting own concepts of research project in various content in the field of Wildlife Conservation Biology and Nature Conservation. Here the students learn to independently screen the respective literature in this field and learn methods in science communication.

Media:

Form of presentation: lecture, case study, movie segment and practical excercise
material: lecture notes, flip-chart/board, plus different materials for methodological/technical training

Reading List:

1. Primack (2014) Essentials of Conservation Biology
2. Frankham (2010) Introduction to Conservation Genetics
3. Sutherland (2009) Conservation Science and Action

Module Structure

Course 1	Conservation Biology and Applied Genetics
Lecturer 1	Ralph Kühn
Form of Teaching 1	Lecture (2SWS)
Course 2	Case studies in Nature Conservation
Lecturer 2	Ralph Kühn, Claus Bässler
Form of Teaching 2	Exercise (3SWS)

Vegetation Ecology and Geographical Information Systems WZ4201

Dr. Martin Döllerer – Professur für Waldinventur und nachhaltige Nutzung
Hans-Carl-von-Carlowitz-Platz 2, 85354 Freising, 08161/71-4656, doellerer@tum.de

Module Level:	Master	**Credits:**	5 Credits		
Language:	English	**Occurrence:**	summer semester	**Duration:**	one-semester
Total Hours:	150h	**Contact Hours:**	60h	**Self-study Hours:**	90h
Assessment Retake:	**Next semester**				

Description of Achievement and Assessment Methods

A written exam of 90 minutes assesses whether the students understand the basic concepts of spatial data analysis as well as vegetation ecology with respect to manage landscapes, the students' ability to apply these techniques to certain problems in landscape management as well as the students' ability to precisely describe solutions to achieve certain results within a limited amount of time.
A Mid-Term assignment (presentation) assesses the students' ability to communicate management plans based on vegetation and habitat data. It will serve for grade improvement by 0,3 according to §6 (5) APSO.

(Recommended) Prerequisites

Basic knowledge in GIS, remote sensing, for example learned by attending the module "Inventory Methods and GIS". Basic knowledge of plant species.

Intended Learning Outcomes

At the end of the module students are able to:
- manage, analyze and visualize spatial data to solve problems related to landscape management;
- break down general problems in landscape management to tasks which can be solved by using a GIS;
- develop and communicate management plans based on vegetation and habitat data;
- ascertain and classify habitats.

Content

1. Advanced analysis and visualization of spatial data;
2. GIS based raster analysis;
3. GIS and satellite navigation;
3. Application of GIS in selected projects;
4. Introduction to the vegetation ecology, theory of plant distribution and of plant communities;
5. Methods of habitat mapping;
6. Habitat mapping in the field;
7. Field data analysis;
8. Management measures for management plans.

Teaching and Learning Methods

Theoretical explanation of certain topics followed by practical exercises using GIS software supported by screen animations.
Transfer of theoretical knowledge in lectures (vegetation ecology, habitat mapping), practical field work and presentation of proposals for landscape management measures.

Media:

GIS software, PowerPoint Presentation.

Reading List:

Tba

Module Structure

Course 1	GIS (Landscape Management)
Lecturer 1	Martin Döllerer
Form of Teaching 1	Lecture + Exercise (2SWS)
Course 2	Vegetation Ecology
Lecturer 2	Leonardo Teixeira
Form of Teaching 2	Lecture + practical field work (2SWS)

Remote Sensing and Image Processing WZ2737

Dr. Thomas Schneider – Professur für Waldinventur und nachhaltige Nutzung
Hans-Carl-von-Carlowitz-Platz 2, 85354 Freising, 08161/ 71-4666; tomi.schneider@tum.de

Module Level:	Master	**Credits:**	5 Credits		
Language:	English	**Occurrence:**	winter semester	**Duration:**	one-semester
Total Hours:	150h	**Contact Hours:**	70h	**Self-study Hours:**	80h
Assessment Retake:	**Next semester**				

Description of Achievement and Assessment Methods

Achievements will be assessed by exercises, a presentation and a final report. On behalf of home exercises the students get a first insight into concepts of image analysis. “Hands on” exercises with state of the art software packages are employed to train the main image processing steps and to assess the understanding of the students in implementing the basic concepts of remote sensing from data take to data analysis. Regular discussions with the tutor measure the student’s ability to develop an idea from initial concepts to the complete picture within a given timeframe, delivering interim results at relevant milestones (35%). On behalf of a presentation of a topic related to remote sensing the student’s ability to understand a technical/scientific subject, to analyze and evaluate facts and factors of influence, to summarize the subject and present it to an audience, and to conduct a discussion about the presented subject is assessed. With the final report the students demonstrate that they have gained deeper knowledge of the specific image analysis software packages and its components, of differing analysis concepts and that they are prepared to evaluate an existing situation as imaged by the respective remote sensing data set. They demonstrate further that they are able to create new geodata layers appropriated to be analyzed in an integrating GIS environment (65%). The grade weights of module examination components correspond to the weighting factors given in brackets.

(Recommended) Prerequisites

Module "Inventory Methods and GIS" of the 1th semester of the Master Program "Sustainable Resource Management" passed, computer skills at least at working level .

Intended Learning Outcomes

At the end of the Remote Sensing and Image Processing module (RSIP) the students are able to:
- decide which data set is most appropriated to solve his thematic task, - access data bases, download and open a data set for image processing, - geocode/georeference digital data sets, - develop appropriated interpretation keys fitting the data set and the targeted thematic goal,- visualize and enhance the data set for interpretation, - extract spectral signatures, - calculate indices on behalf of the data,
- learn how to extract bio-geo-chemo-physical parameter from the data set, - perform unsupervised and supervised classifications, - proof the quality of the results by an accuracy assessment, - perform a change detection study, - export the results as GIS layer.

Content

The implementation of data interpretation and information extraction concepts and techniques is trained "hands on" with the help of advanced image processing and analysis programs. Topics: 1. Introduction to image processing concepts; 2. Implications of air- and space borne data takes; 3. Data types: Digital aerial photographs, high to very high resolution multispectral and hyperspectral scanner data, LIDAR data; 4. Development of interpretation keys; 5. Exercises on data pre-processing; 6. Unsupervised and supervised classification concepts, pixel-based, object based classification strategies; 7. Exercises on land use/land cover classification; 8. Basic verification concepts; 9. Exercises on the extraction of bio-geo-chemo-physical parameter from RS data; 10. Change detection concepts; 11. Interrelation of Remote Sensing with GIS; 12. Access and data download from geodata provider.

Teaching and Learning Methods

By using advanced image processing software packages the theoretical explained concepts are exercised “hands on” and discussed on basis of different data types applying the “just in time teaching (JiTT)” technique; the practical courses are prepared by homework (presentation of specific related topics, exercises); the short presentations will be given during the courses, contents, layout and style discussed and narrated; the home exercises explained in close relation to the computer exercises just done. The definition of the problem to be solved by image analysis techniques and the development of appropriated solutions needs research of reference materials. The final outcome of the courses, the classification result, will be used as basis for the Module “Application Study” of the concentration field “Landscape Management”.

Media:

Image processing software and tutorials, prepared exercises, different data types

Reading List:

The literature recommended within the Modules "Inventory Methods and GIS", "Remote Sensing and Image Processing", www.wiau.man.ac.uk/courses/cvmsc/Terminol.htm#SplitMerge;http://www.pfc.cfs.nrcan.gc.ca/landscape/inventory/wulder/large_area_rs/index.html; http://www.pfc.cfs.nrcan.gc.ca/landscape/inventory/wulder/hirespres.html; Uni Zürich, RSL: http://www.geo.unizh.ch/rsl2/; EARSeL: http://www-earsel.cma.fr/; http://www.ccrs.nrcan.gc.ca/ccrs/eduref/tutorial/indexe.html; http://observe.ivv.nasa.gov/nasa/education/reference/main.html; http://rst.gsfc.nasa.gov/starthere.html

Module Structure

Course	Remote Sensing and Image Processing
Lecturer	Thomas Schneider
Form of Teaching	Seminar with exercises (6SWS)

Landscape Planning WZ2719

Dr. Isabel Augenstein – Lehrstuhl für Strategie und Management der Landschaftsentwicklung
Emil-Ramann-Str. 6, 85354 Freising; 08161/71- 4783; isabel.augenstein@lrz.tum.de

Module Level:	Master	**Credits:**	5 Credits		
Language:	English	**Occurrence:**	summer semester	**Duration:**	one-semester
Total Hours:	150h	**Contact Hours:**	60h	**Self-study Hours:**	90h
Assessment Retake:	**Next semester**				

Description of Achievement and Assessment Methods

The attainment of learning outcomes for the module will be assessed in a piece of research paper in which students work independently on complex issues of contemporary landscape planning demonstrating their breadth of understanding in drawing out implications of their findings and putting them into a broader context. The written assignment is complemented by a presentation and/or a colloquium for the purpose of assessing the capacity of the students to communicate their findings orally to an audience. Depending on the number of participants, research paper and accompanying talk may be prepared either individually or in groups.

(Recommended) Prerequisites

Basis understanding of environmental systems. Course 2: Class discussion is a core element of the seminar. Therefore, students are expected to take part and contribute to the discussions.

Intended Learning Outcomes

Upon completion of the module, students are able to:
- recognize the purpose and objectives of Landscape Planning;
- explain instruments and procedural elements of contemporary Landscape Planning;
- select appropriate methods and tools to assess natural assets and landscape functions;
- be aware of the role of Landscape Planning in the decision-making upon the use of land;
- retrieve and interpret information from different sources;
- communicate key concepts relevant for environmental planning (both written and oral).

Content

Concerned with the stewardship and enhancement of environmental systems, Landscape Planning is the key planning instrument for nature conservation and landscape management in Germany. The module introduces Landscape Planning and reflects on its potential contribution to sustainable land use with a focus on non-urban areas.
Course 1: Lectures will address the guiding principles, formal instruments and procedural elements of Landscape Planning; present methodological approaches for the assessment of natural assets and landscape functions including methods and tools for data collection, analysis and evaluation; illustrate target formulation and implementation strategies with examples from the planning practice.
Course 2: The seminar gives students the opportunity to deepen their knowledge by reflecting on readings and planning documents as well as by discussing in class such topics as: contemporary and emerging scientific theories and methodological approaches relevant for environmental planning; rationale of stakeholder involvement; context-dependency of spatial planning; comparison of current jurisdictional and institutional arrangements on landscape-related planning in the home countries of the students and their implications.

Teaching and Learning Methods

Lectures provide subject specific knowledge; class discussions of selected readings engage students in critical thinking; in group work activities students experience the application of selected methods and tools.

Media:

Lectures, presentations, class discussions, small group exercises, assigned readings.

Reading List:

Haaren, Chr. v., Galler, C. & S. Ott (2008): Landscape planning. The basis of sustainable landscape development. Ed. by Federal Agency for Nature. Additional material will be provided.

Module Structure

Course 1	Landscape Planning
Lecturer 1	Isabel Augenstein
Form of Teaching 1	Lecture (2SWS)
Course 2	Landscape Planning
Lecturer 2	Isabel Augenstein
Form of Teaching 2	Seminar (2SWS)

Landscape Management – Application Study WZ4094

Dr. Thomas Schneider – Professur für Waldinventur und nachhaltige Nutzung
Hans-Carl-von-Carlowitz-Platz 2, 85354 Freising, 08161/ 71-4666; tomi.schneider@tum.de

Module Level:	Master	**Credits:**	5 Credits		
Language:	English	**Occurrence:**	winter semester	**Duration:**	one-semester
Total Hours:	150h	**Contact Hours:**	75h	**Self-study Hours:**	75h
Assessment Retake:	**Next semester**				

Description of Achievement and Assessment Methods

The assessment is based on: 1. the participation intensity on discussions and the quality of the contributions during the courses; 2. the demonstrated skills in creating new data layers by combining existing data from official sources (administrations, organizations, etc.) using GIS techniques, in exploring new data and information layers (RS, vegetation ecology), etc. 3. the contribution in developing the project (planning competences); 4. the presentation style, contents and layout; 5. the team work; 6. the project report.

(Recommended) Prerequisites

The successful completion of the modules "Inventory Methods and GIS", "Remote Sensing and Image Processing", "Geographical Information Systems and Vegetation Ecology" and "Landscape Planning" or equivalent skills are required, courses on scientific writing and reporting recommended.

Intended Learning Outcomes

At the end of the module the students are able to develop or at least to contribute to a landscape management project. More in detail the students are able to:
- work in a team;
- apply the theoretical and practical skills in vegetation ecology, landscape planning, remote sensing and GIS techniques;
- contribute to context-dependant landscape-related planning;
- deliver an oral presentation to communicate their findings;
- prepare a convincing project report using supporting data to back their statements in accordance with guidelines for scientific writing.

Content

1. Implementation of GIS and RS techniques.
2. Implementation of theoretical concepts of Vegetation Ecology;
3. Implementation of theoretical concepts of Landscape Planning;
4. Oral presentation of findings;
5. Elaboration of a final report.

Teaching and Learning Methods

Prime characteristic of the Application Study is the self-organized group work by the students to reach the defined objective of the project assignment. Progress of the team is supported by group discussions, theory input and coaching provided by lecturers on demand.

Media:

Scripts and reports of the above listed lectures and exercises offered within the elective field; basic data sets to develop the application study (GIS, RS, etc.); additional information on request and up on necessity (project driven).

Reading List:

The literature recommended within the Modules "Inventory Methods and GIS", "Remote Sensing and Image Processing", "Geographical Information Systems and Vegetation Ecology" and "Landscape Planning" should be used.

Module Structure

Course	Landscape Management - Application Study
Lecturer	Thomas Schneider, Martin Döllerer, Isabel Augenstein
Form of Teaching	Project work (5SWS)

Renewable Energy Technologies WZ2720

Dr.-Ing. Christoph Wieland – Lehrstuhl für Energiesysteme
Boltzmannstr.15, 85747 Garching, wieland@tum.de

Module Level:	Master	**Credits:**	5 Credits		
Language:	English	**Occurrence:**	summer semester	**Duration:**	one-semester
Total Hours:	150h	**Contact Hours:**	60h	**Self-study Hours:**	90h
Assessment Retake:	**Next semester**				

Description of Achievement and Assessment Methods

The examination consists of a written test (duration 60 min), where the students have to proof that they understand and remember the basic technical principles related to energy production and the working principles of the presented renewable energy technologies, as well as the related ecological and economical properties and frame conditions. The students have to answer questions, but may also be asked to do calculations, complete figures or prepare sketches.

(Recommended) Prerequisites

General understanding of natural science, mathematics and basics of technology.

Intended Learning Outcomes

At the end of the course, the students understand the technical principles of renewable energy conversion systems.
They are able to interpret energy scenarios and solve simple problems associated with a high renewable energy share and its implications on society. The students can estimate the importance of distinct technologies for a sustainable energy supply.

Content

The course provides an overview of the basics of thermodynamics and the principles of energy conversion. Energy conversion and its importance for the economy is discussed. Because of their transitional character due to the German “Energiewende”, the course focusses on the European and German energy systems. The international students in the course are expected to support the lecture with their experiences from abroad.
Basic technical principles of energy production, efficiencies, costs and environmental impacts will be understood. The focus lies on the following areas: solar, wind, water and geothermal energy conversion.
In order to complete the picture, also storage and fossil fuel technologies will be discussed. The students will understand their role and their contribution to balancing energy production and demand.

Teaching and Learning Methods

Lecture with integrated exercises and teamwork, as well as discussions to improve understanding.

Media:

Power point presentation, black board, Videoclips

Reading List:

Tba

Module Structure

Course	Renewable Energy Technologies
Lecturer	Christoph Wieland, Annelies Vandersickel
Form of Teaching	Lecture (4SWS)

Bioenergy Systems WZ2721

Dr. Omar Hijazi – Lehrstuhl für Agrarsystemtechnik
Am Staudengarten 2, 85354 Freising, ge34gaq@mytum.de

Module Level:	Master	**Credits:**	5 Credits		
Language:	English	**Occurrence:**	summer semester	**Duration:**	one-semester
Total Hours:	150h	**Contact Hours:**	60h	**Self-study Hours:**	90h
Assessment Retake:	**Next semester**				

Description of Achievement and Assessment Methods

The learning outcome will be assessed by a written exam of 60 minutes. The students show that they have understood the principles of biomass production for bioenergy use, biomass supply chains, and the different bioenergy systems, and are able to carry out related calculations, e.g. for estimation of energy efficiencies. The students have to answer questions, but may also be asked to do calculations, complete figures or prepare sketches.

(Recommended) Prerequisites

General understanding of natural science, mathematics and basics of technology.

Intended Learning Outcomes

At the end of the module students have acquired knowledge of the production and utilization of renewable resources from the agricultural and forestry sector.
They know how to analyze the performance and ecological impacts of different biomass supply and utilization chains. They can estimate the suitability of various crops for bioenergy use. The students have an insight in the physical and chemical basics of energy production from biomass and are able to apply related basic equations. They can compare different biomass combustion systems and attribute emissions. The students know the production pathways and properties of different biofuels for transportation and are able to estimate their future potentials. They understand the technological background of biogas production and can do basic designs of biomass supply and utilization chains using the example of biogas systems in agriculture.

Content

- Biomass production in agriculture;
- physiology of biomass crops such as perennials and their production systems ;
- biomass supply and utilization chains;
- bioenergy systems: biomass combustion,
- biofuels for transportation,
- biogas technology; selected aspects of ecology and economy;

Teaching and Learning Methods

Lecture with integrated exercises and discussions to improve understanding. Optional: field trip.

Media:

Power point presentations, black board.

Reading List:

Tba.

Module Structure

Course	Bioenergy Systems
Lecturer	Omar Hijazi
Form of Teaching	Lecture (4SWS)

Forestry Raw Materials and their Utilization WZ4098

Prof. Dr. Klaus Richter – Lehrstuhl für Holzwissenschaft
Winzererstr. 45, 80797 München, Tel.: 089/ 2180 - 6421, richter@hfm.tum.de

Module Level:	Master	**Credits:**	5 Credits		
Language:	English	**Occurrence:**	winter semester	**Duration:**	one-semester
Total Hours:	150h	**Contact Hours:**	60h	**Self-study Hours:**	90h
Assessment Retake:	**Next semester**				

Description of Achievement and Assessment Methods

The learning success will be assessed by a written examination (duration 60 min) where students are expected to demonstrate the level of knowledge and their ability to use and apply it in solution finding strategies. Additionally a midterm Assignment, the students have to prepare and give a structured oral presentation in a seminar organized at the end of the summer term. The topic of the presentation is defined in agreement with the lecturer. The presentation may be prepared either individually or in groups of two. The midterm presentation Assignment allows to improve the examination mark by 0.3.

(Recommended) Prerequisites

Basics of biology, chemistry, physics and sciences to deal with the biological production, and the processing and conversion processes of wood to final products, and the environmental assessment.

Intended Learning Outcomes

Upon successful completion of the module students are able to:
- illustrate the multidisciplinary of forests and their products;
- propose options to maximize the value chains of forest based products;
- exemplify production and process technologies and typical sector industries;
- demonstrate the role, potential and limitations of forestry raw materials in the framework of sustainable development;
- outline economical, environmental and social aspects of typical products and applications;
- develop strategies to strengthen the value and impact of typical forestry raw materials and non-timber forest products.

Content

1. Overview and global potential of forest resources;
2. Availability, characteristics and properties of forest based products (wood and non-timber forest products);
3. Technologies and processes from raw materials to final products: sawn timber, wood-based products, pulp and paper;
4. Criteria and rules of a resource efficient application;
5. Environmental assessment of forestry raw materials and products.

Teaching and Learning Methods

Lecture, exercises, seminar, Optional: visits to laboratories and industry.

Media:

Demonstration material: raw materials and products; PP presentations; videos.

Reading List:

Fengel, D.; Wegener, G. (2003): Wood - Chemistry, Ultrastructure, Reactions. Kessel Publishers
Dinwoodie, J.M. (2000): Timber: Its nature and behaviour. Van Nostrand Reinhold Publishers
Forest Products Laboratory (ed) (2010): Wood as an Engineering Material: http://www.fpl.fs.fed.us-documnts-FPLGTR-fplgtr.113-PL113.htm.
Rowell R. ed. (2012): Handbook of Wood Chemistry and Wood Composites. Sec. Edition, CRC Press Taylor & Francis Group, 703 pp.
Shmulsky, R., Jones P.D (2011): Forest Products & Wood Science, 6th ed. Wiley-Blackwell, Chichester UK

Module Structure

Course 1	Forestry Raw Materials and their Utilization
Lecturer 1	Klaus Richter, Jan-Willem van de Kuilen
Form of Teaching 1	Lecture (2SWS)
Course 2	Forestry Raw Materials and their Utilization
Lecturer 2	Klaus Richter, Jan-Willem van de Kuilen
Form of Teaching 2	Exercise (2SWS)

Political and Social Perspectives of Renewable Resources WZ4202

Prof. Dr. Jan-Willem G. van der Kuilen – Professur für Holztechnologie
Winzererstr. 45, 80797 München; +49 (89) 2180 - 6462; vandekuilen@hfm.tum.de

Module Level:	Master	**Credits:**	5 Credits		
Language:	English	**Occurrence:**	winter semester	**Duration:**	one-semester
Total Hours:	150h	**Contact Hours:**	45h	**Self-study Hours:**	105h
Assessment Retake:	**Next semester**				

Description of Achievement and Assessment Methods

Oral presentation of the group project work, review paper for a scientific journal. The learning outcomes are assessed by a group project work concerning a selected topic related to the political and social perspectives of renewable resources. Therefore students have to prepare a scientific paper for an international journal of their choice and give a short oral presentation about the work done for the paper, similar to what would be expected in a 15 minute conference presentation.

(Recommended) Prerequisites

Knowledge of sustainable resources (materials and energy). Scientific writing.

Intended Learning Outcomes

After this course, students should be able to:

1. Develop SR stimulation programs on country or regional level and priority analysis of renewable resource applications
2. Assess priorities for development and application of renewable resources in countries with different levels of development
3. Critically analyze existing SR programs taking into account social values of stakeholders,
4. Assess impacts of global developments such as urbanization and UN-policies on SR.

Content

In the lectures a number of examples of societal aspects of Sustainable Resource programs will be presented and discussed. Backgrounds are global developments such as urbanization, the rise of countries like China and India, resource availability and technological developments. Case studies deal with tropical forestry and pros and cons of tropical hardwood uses, urban planning, vernacular architecture and the use of renewable resources We take a tour around the world and look at social housing programs in Europe, Brazil and South-East Asia. Furthermore we look at successes and failures in the German/European energy policies in comparison to the United States.

Teaching and Learning Methods

Discussion and creativity sessions. Project work evolving in a scientific paper for a journal of choice. Oral presentation.

Media:

Lectures, UN-policy notes, Discussion and Creativity sessions.

Reading List:

Tba

Module Structure

Course	Political and Social Perspectives of Renewable Resources
Lecturer	Jan-Willem van de Kuilen
Form of Teaching	Lecture and exercise (3SWS)

Climate Change - Science, Adaptation, and Mitigation WZ2730

Prof. Dr. Anja Rammig – Professur für Land Surface-Atmosphere Interactions,
Hans-Carl-von-Carlowitz-Platz 2, 85354 Freising, 08161/ 71-4768

Module Level:	Master	**Credits:**	5 Credits		
Language:	English	**Occurrence:**	winter semester	**Duration:**	one-semester
Total Hours:	150h	**Contact Hours:**	60h	**Self-study Hours:**	90h
Assessment Retake:	**Next semester**				

Description of Achievement and Assessment Methods

Assessment consisting of oral examination on the lecture and the seminar (30 min). In this oral examination the student is expected to demonstrate that he/she has understood the physical basis of the climate system and that they can identify the drivers of climate change. The student shows that he/she is able to apply his/her knowledge to develop adaptation and mitigation measures and to argue in discussions on climate change issues. A voluntary mid-term assignment (presentation) in the seminar assesses the students' ability to summarize findings from scientific publications / case studies and to present them to an audience. The presentation is complemented by the preparation of a "PICO" that is presented on an interactive screen. The presentation will serve for grade improvement by 0.3 according to §6(5) APSO.

(Recommended) Prerequisites

Basic knowledge in meteorology, physics, biology.

Intended Learning Outcomes

After this module, the students can understand the physical basis of the climate system, identify all drivers of climate change and falsify common arguing of "climate sceptics". They can summarize observed changes in the climate system as well as impacts in divers systems and regions. They are able to assess cross-sectorial impacts of climate change in selected areas, to evaluate and develop adaptation and mitigation measures and strategies in biological, physical and chemical systems including an analysis of their effectiveness and cost-effectiveness.

Content

Based on the newest IPCC report (AR 5) the theoretical background on the physical science basis of climate change, theory and practical application of adaptation and mitigation measures in biological, physical and chemical systems will be presented. In a related seminar, selected topics will be intensified in case studies. TUM as a NGO in the UNFCCC process offers an optional possibility also for students to take part in COP and related negotiations.

Teaching and Learning Methods

Lecture on physical basis of the climate system, impacts of climate change and important mitigation strategies. In the seminar group presentations of various topics regarding adaptation and mitigation of climate change will be presented as case studies. Optional excursion to UNFCCC meeting if applicable.

Media:

Lecture with PowerPoint Presentation, reader and exercises. Group work in seminar including problem driven case studies and student presentations, excursion.

Reading List:

IPCC (2013) Fifth Assessment Report of WGI, II, III. Houghton (2015) Global warming, the complete briefing. Most recent scientific literature.

Module Structure

Course 1	Climate Change - The complete briefing
Lecturer 1	Anja Rammig
Form of Teaching 1	Lecture (2SWS)
Course 2	Ecological, social and economic aspects of climate change impacts on different scales
Lecturer 2	Annette Menzel, Nicole Estrella
Form of Teaching 2	Seminar (2SWS)

Mountain Catchments under Changing Climate WZ2722

Prof. Dr. Annette Menzel – Professur für Ökoklimatologie
Hans-Carl-von-Carlowitz-Platz 2, 85354 Freising, 08161/ 71-4740, amenzel@wzw.tum.de

Module Level:	Master	**Credits:**	5 Credits		
Language:	English	**Occurrence:**	summer semester	**Duration:**	one-semester
Total Hours:	150h	**Contact Hours:**	70h	**Self-study Hours:**	80h
Assessment Retake:	**Next semester**				

Description of Achievement and Assessment Methods

In a written exam, students demonstrate that they have gained an understanding of hydrological processes and that they are able to apply and run a hydrological model for a mountain catchment. By the presentation of a research paper the students' ability to understand a selected hydrology-related threats for mountain catchments and to scientifically analyze and evaluate important influencing facts and factors, to present it to an audience, to conduct a discussion about the presented subject, and to demonstrate the ability to write a paper with the major facts and conclusions from the presentation in a clear and concise scientific manner is assessed. The final grade is an averaged grade from the presented research paper (65%) and the written exam of 60 minutes (35%).

(Recommended) Prerequisites

Introduction in Hydrometeorology and management of water resources.

Intended Learning Outcomes

After completion of the module, the students understand the main processes in mountain catchments like runoff generation, runoff concentration and flood routing processes. Additionally, they are able to use a physically based hydrological model to simulate the rainfall runoff process in mountain catchments and its influencing parameters caused by the special circumstances of these regions in a widely realistic and transparent way. The students are able to generate event based scenarios as well as land use scenarios and understand recent hydrology-related threats for mountain catchments as well as the influence of climate change on hydrological processes and management in mountain areas. They remember suitable monitoring and risk prevention strategies and are able to analyze, evaluate and communicate (both oral and written) a specific case study or research questions related to the experimental sites visited to a general audience.

Content

In the Field Course Applied Hydrometeorology of Mountain Catchments we will visit selected research stations, field sites, hydrological infrastructure, restoration sites, and protected areas in the Munich PreAlpine and Alpine area and learn more about hydrology-related threats for mountain catchments ranging from Glacier melt to Munich's drinking water. Sites include e.g. Environmental Research Station Schneefernerhaus, KIT Alpine Campus Garmisch, Waldklimastation Kreuth, Sachenbach catchment, Versuchstation Obernach, Sylvensteinspeicher, Walchenseekraftwerk, Versuchsstation Wielenbach, Mangfall / Lech Wassereinzugsgebiet.
The Hydrological Modeling course includes:
1) Dominant hydrological processes in mountain catchments: Precipitation types, runoff generation, concentration and flood routing
2) Data in mountain catchments: Availability, quality, acquisition and analysis
3) Types of hydrological models
4) Generation, parameterization and calibration of the process based hydrological model WaSiM
5) Model sensitivity analyses with focus on meteorological input and land use scenarios.

Teaching and Learning Methods

Teaching methods include lecture as well as practical exercises at PC laboratory in respect to hydrological modelling, a week of field trip to Alpine and pre-alpine areas to the listed sites with guided tours by local scientists, administrators, TUM lectures as well as short presentations by the students.

Media:

PowerPoint Presentation, Hydrological model (e.g. WaSiM), Field work

Reading List:

IPCC (2013) Fifth Assessment Report; Shelton ML (2009): Hydroclimatology - Perspectives and Applications; IPCC (2008) Technical Paper VI on Climate Change and Water

Module Structure

Course 1	Field Course in Applied Hydrometeorology
Lecturer 1	Annette Menzel
Form of Teaching 1	Combined Lecture and Field Course (3SWS)
Course 2	Introduction in Hydrological Modeling
Lecturer 2	Gabriele Chiogna
Form of Teaching 2	Combined Lecture and PC exercise work (2SWS)

Environmental monitoring and data analysis WZ2732

Prof. Dr. Annette Menzel – Professur für Ökoklimatologie
Hans-Carl-von-Carlowitz-Platz 2, 85354 Freising, 08161/ 71-4740, amenzel@wzw.tum.de

Module Level:	Master	**Credits:**	5 Credits		
Language:	English	**Occurrence:**	winter semester	**Duration:**	one-semester
Total Hours:	150h	**Contact Hours:**	70h	**Self-study Hours:**	80h
Assessment Retake:	**Next semester**				

Description of Achievement and Assessment Methods

Upon completion of the module, the students have a profound understanding of key aspects of environmental monitoring and are able to choose appropriate as well as to efficiently run environmental measurements, to reproducibly analyze acquired data and to clearly communicate results of environmental measurements.
This ability should be demonstrated by writing a research paper following standards of reproducible research based on different aspects of environmental monitoring and data analysis with R. For the research paper, either available data or data measured during the module should be used and be analyzed in respect to defined hypotheses; developed R code has to be provided too.

(Recommended) Prerequisites

Basic knowledge in R is recommended.

Intended Learning Outcomes

After this module, the students can plan, implement and run environmental measurements. They are able to efficiently analyze environmental data sets, including download and import of data sets and visualization and modelling with R.

Content

1 Environmental monitoring including principles, techniques and management issues used in environmental monitoring and assessment; Observing, recording, communicating and archiving collected data and providing it to project stakeholders in order to identify sustainable and responsible environmental practices.
Optional: short course Aerobiology, GAW program, visit of companies

2 Environmental data analysis
Introduction to data analysis with R; Principles of reproducible research and implementation with R; Pipelines for environmental data analysis from obtaining data via cleaning and transforming to modelling and visualization with modern R; Coverage of data retrieval from different storage types for climate, proxy, phenology, and other data (text-based, netCDF, data bases); Modeling and visualization as complementary strategies for hypothesis-driven data analysis, based on published research from different fields of environmental sciences.

Teaching and Learning Methods

Course 1 consists of a practical course in the laboratory and in the field where students will work in small teams on applied case studies and exercises related to environmental / meteorological monitoring. Course 2 then offers combined lecture and exercise sessions at the PC lab on how to efficiently analyze those environmental data sets of course 1.

Media:

PowerPoint Presentation, Field work, Interactive documents for data analysis

Reading List:

Beginner level tutorials for Swirl (http://swirlstats.com/)

Module Structure

Course 1	Environmental monitoring
Lecturer 1	Marvin Lüpke, Annette Menzel
Form of Teaching 1	Combined Laboratory and Field Course (2SWS)
Course 2	Environmental data analysis
Lecturer 2	Christian Zang
Form of Teaching 2	Combined Lecture and PC exercise work (3SWS)

Hydrometeorology and management of water resources WZ2731

Prof. Dr. Annette Menzel – Professur für Ökoklimatologie
Hans-Carl-von-Carlowitz-Platz 2, 85354 Freising, 08161/ 71-4740, amenzel@wzw.tum.de

Module Level:	Master	**Credits:**	5 Credits		
Language:	English	**Occurrence:**	summer semester	**Duration:**	one-semester
Total Hours:	150h	**Contact Hours:**	60h	**Self-study Hours:**	90h
Assessment Retake:	**Next semester**				

Description of Achievement and Assessment Methods

The learning outcome will be assessed by an oral examination (30 min) in which students should demonstrate their profound understanding of water management and ability to analyze and evaluate key issues and challenges. They should exhibit the capability of identifying and solving problems in a concise way and show that they can express themselves in a clear and scientific manner. A voluntary mid-term assignment (presentation) in the seminar assesses the students' ability to communicate and present an integrated management study case in one selected topic in sustainable water management. It will serve for grade improvement by 0.3 according to §6(5) APSO.

(Recommended) Prerequisites

Basic knowledge in chemistry and physics.

Intended Learning Outcomes

Upon the successful completion of this module the students are able to understand the basics of hydrology, and the influence of climate change on hydrological processes and management. They are able to analyze and classify various problems in water resource management and to assess the suitability and applicability of different management practices in the field of water augmentation (e.g. rain water harvesting, fog nets, dams) and water saving strategies (e.g. in irrigation, sanitation) to integratively solve water-resource-problems.

Content

1. Hydrometeorology (including hydrological cycles, precipitation-, run off-, evapotranspiration - process of formation, measurement, global and regional spatial and temporal patterns, influences by land use land cover change, climate change scientific basis, climate change impacts, adaptation, vulnerability in water resources).
2. Problems in water management according to too little water, too much or too dirty. Different aspects of water augmentation (e.g. harvesting, desalination, translocation), water conservation (irrigation, pricing, household, …), water management processes (e.g. IWRM, virtual water) are discussed by practical examples;

Teaching and Learning Methods

The basics of hydrology and meteorology are presented and discussed in a lecture with thorough explanations. Some simple case studies are used to introduce into the theoretical background (e.g. meteorological instruments at the meteorological platform). Student presentations and discussions, group work in the seminar.

Media:

PowerPoint presentations; Presentation notes supporting the lecture. Case studies.

Reading List:

Ahrends (2000) Meteorology today, 7th edition. Jones JAA (2010) Water Sustainability - A Global Perspective, Hodder Education London. Clarke R & King J (2004) The atlas of water. Figueres C. et al. (2003) Rethinking water management. Wescoat JL et al. (2003) Water for life, water management and environmental policy. Grambow M (2008) Wassermanagement.

Module Structure

Course 1	Introduction to Hydrometeorology
Lecturer 1	Annette Menzel
Form of Teaching 1	Lecture (2SWS)
Course 2	Management of Water Resources
Lecturer 2	Annette Menzel, Nicole Estrella
Form of Teaching 2	Seminar (2SWS)

Material Flow Management and Applications WZ4206

Prof. Dr. Gabriele Weber-Blaschke – Lehrstuhl für Holzwissenschaft
Hans-Carl-von-Carlowitz-Platz 2, 85354 Freising; 08161/71- 5635; weber-blaschke@hfm.tum.de

Module Level:	Master	**Credits:**	5 Credits		
Language:	English	**Occurrence:**	summer semester	**Duration:**	one-semester
Total Hours:	150h	**Contact Hours:**	45h	**Self-study Hours:**	105h
Assessment Retake:	**Next semester**				

Description of Achievement and Assessment Methods

The examination consists of a research paper of around 12-15 pages which is the means to evaluate whether the students have understood and whether they are able to apply the methodology of material flow management on a case study in a scientifically manner and to create an own scientific paper about concepts for material flow management and treatment of materials based on the methodologies of material flow analysis and life cycle assessment.

(Recommended) Prerequisites

Knowledge in natural science (biology, chemistry, ecology, physics); understanding for engineering science and also for social/cultural aspects.

Intended Learning Outcomes

By the means of the module the students are able to:
- understand the necessity of material flow management
- understand the relationships between different processes, technological treatments of materials and organizational measures
- apply the procedure of material and substance flow analysis
- apply the assessment methods of indicator systems and life cycle assessment
- create concepts for material flow management and treatment of materials.

Content

The students acquire detailed and differentiated knowledge about the following topics:
- need of material flow management
- procedure of material flow management
- material and substance flow analysis
- material flow assessment by sustainability indicators
- life cycle assessment
- development of strategies and measures for material flow management
  (e.g. resource efficiency, urban mining, industrial ecology, bio-economy, circular economy).

Teaching and Learning Methods

Concerning teaching methods, lecture and presentation parts provide the theoretical foundation of materials flow management. Real case studies are introduced to the students and worked out in the class. Likewise within interdisciplinary projects in reality, the students have to define and to solve problems collaboratively in group work by studying specialist literature and data sources. At the end they have to create a research paper as homework about this topic. The students are supervised by tutorials by the lecturer.

Media:

Power point presentation, lecture sheets, case studies of material and substance flow analysis and life cycle assessment.

Reading List:

Brunner, P.H., Rechberger H. (2004): Practical Handbook in Material Flow Analysis. Advanced Methods in Resource and Waste Management. Lewis Publishers, Boca Raton, pp. 318.
Brunner, P.H.; Rechberger, H.; 2016: Handbook of Material Flow Analysis: For Environmental, Resource, and Waste Engineers. Taylor & Francis Inc; 2. Revised Edition, pp. 453
Weber-Blaschke, G.; 2009: Stoffstrommanagement als Instrument nachhaltiger Bewirtschaftung natürlicher und technischer Systeme. Ein kritischer Vergleich ausgewählter Beispiele. Schriftenreihe „Nachwachsende Rohstoffe in Forschung und Praxis“ des Wissenschaftszentrums Straubing, Bd. 1, Verlag Attenkofer, Straubing, 330 S.

Module Structure

Course	Material Flow Management and Application
Lecturer	Gabriele Weber-Blaschke
Form of Teaching	Lecture (3SWS)

Waste and Waste Water Treatment WZ4207

Dr.-Ing. Konrad Koch – Lehrstuhl für Siedlungswasserwirtschaft
Am Coulombwall 3, 85748 Garching b. München k.koch@tum.de

Module Level:	Master	**Credits:**	5 Credits		
Language:	English	**Occurrence:**	summer semester	**Duration:**	one-semester
Total Hours:	150h	**Contact Hours:**	60h	**Self-study Hours:**	90h
Assessment Retake:	**Next semester**				

Description of Achievement and Assessment Methods

The exam consists of general questions and calculations. In the written exam of 90 minutes duration students demonstrate by answering questions the theoretical knowledge of waste and wastewater treatment. The answers requires wording but also multiple choice tests are involved. Calculations also involved. The use of a calculator is allowed in the written exam.

(Recommended) Prerequisites

Interest and basic knowledge in process engineering.

Intended Learning Outcomes

At the end of the module, students are able to:
1. Understand the necessity and objectives of waste management.
2. Distinguish different types of waste.
3. Decide which treatment method is valid for which type of waste.
4. Know the requirements which the different treatment methods have to meet regarding legal aspects of waste treatment (emissions, waste water, deposition of waste).
5. Describe the technical composition of different types of landfills and to assign different types of wastes to the landfills.
6. Assess processes and risks arising from landfills. 8. Understand the process of composting, mechanical-biological as well as thermal treatment of waste.
7. Understand the necessity and the feasibility of waste water treatment especially in treating municipal wastewater.
8. Classify the single steps of eliminating wastewater compounds like coarse material, organic and inorganic compounds.

Content

Part waste: 1. Basics of waste management (What is waste, waste amounts, history and future of waste, waste legislation); 2. Avoidance and recovery of waste and waste management concepts; 3. Waste disposal (legal aspects of landfill, processes in above-ground landfill, above-ground landfill technologies, underground disposal sites); 4. Biological treatment (legal aspects, composting, fermentation, mechanical biological treatment, sewage sludge, substitute fuels); 5. Thermal treatment (legal aspect, thermal processes, equipment, power generation, alternative thermal processes, co-incineration, hazardous waste treatment).
Part wastewater: 1.Water treatment & management concepts; 2. Overview wastewater treatment steps; 3. Wastewater characteristics & discharge limits; 4. Mechanical wastewater treatment (technology and equipment), 5. Fundamentals in bioprocess technology; 6. Stoichiometry of biological reactions; 7. Kinetics of biological reactions; 8. Aeration (process, limits and technology); 9. Aerobic wastewater treatment (Activated sludge process; Sequencing batch reactor technology; Biofilm technology); 10. Sewage sludge treatment

Teaching and Learning Methods

The knowledge in the field of waste management is imparted during lectures and will be extended by 3 exercises, which have to be elaborated by the students at home. Practical insight into waste management is given during an excursion to a thermal as well as a biological waste treatment plant.

Media:

PowerPoint presentation, notices on black board, The files of the presentations during lectures are handed out to the students or are send to the students per email.

Reading List:

Bilitewski B., Härdtle G., Marek K. (1996): Waste Management, Transl. and ed. by Anette Weissbach and Hennig Boeddicker. Kiely, G. (1996): Environmental Engineering. Tchobanoglous, G., Theisen, H., Vigil, S. (1996): Integrated Solid Waste Management - Engineering Principles and Management Issues. Woodward, F. (2001): Industrial Waste Treatment Handbook. Wastewater Engineering. International Edition: Treatment and Reuse (Metcalf & Eddy). Mcgraw-Hill Series in Civil and Environmental Engineering von George Tchobanoglous, Franklin L. Burton und H. D. Stensel von Mcgraw-Hill Higher Education (2002) .

Module Structure

Course 1	Waste Management
Lecturer 1	Matthias Franke
Form of Teaching 1	Lecture (2SWS)
Course 2	Waste Water Treatment
Lecturer 2	Konrad Koch
Form of Teaching 2	Lecture (2SWS)

Emission Control in Land-Use and Animal Husbandry WZ2724

Dr. Stefan Neser – Bavarian State Research Center for Agriculture; Institute for Agricultural Engeneering and Animal Husbandry
Voettinger Strasse 36, 85354 Freising, 0049 8161 713566; stefan.neser@lfl.bayern.de

Module Level:	Master	**Credits:**	5 Credits		
Language:	English	**Occurrence:**	winter semester	**Duration:**	one-semester
Total Hours:	150h	**Contact Hours:**	45h	**Self-study Hours:**	105h
Assessment Retake:	**Next semester**				

Description of Achievement and Assessment Methods

The oral examination will be held either as an individual or as a group examination. If more than, 40 students sign in for the examination the oral examination can be done in a written form (90 minutes duration). The duration of the oral examination is 20 min per person. The Students are able to describe typical agricultural production, the environmental impact and the measurement procedures to quantify and to qualify these impacts. On that basis, they are able to weigh the advantages and disadvantages of possible measures of air pollution in agriculture.

(Recommended) Prerequisites

Interest in the field of agriculture; willingness to learn about the causal relation between agriculture and emission control.

Intended Learning Outcomes

At the end of the module students are able to:
- understand the interrelation between local causes and global impacts,
- apply the comprehension of basic physical, chemical, and biological principles to phenomena in practice,
- evaluate measurement techniques in a qualitative manner,
- evaluate measures and techniques of environment protection;
- understand the interrelation between animal husbandry and air pollution control,
- derive adequate measures of environmental protection.

Content

Upon completion of the module, students are able to understand and analyze:
- the principle of agriculture in plant and livestock production on a basic level
- the main emissions caused by agricultural processes on a deeper level
- interactions of agricultural processes with the emission
- the environmental effects of these emission
- the measurement procedures to qualify and quantify agricultural emissions
- possibilities of emission abatement in land-use and animal husbandry.

Teaching and Learning Methods

Lecture, practice course.

Media:

PowerPoint-slides, short clips.

Reading List:

Tba

Module Structure

Course	Emission control in Land-Use and Animal Husbandry
Lecturer	Stefan Neser
Form of Teaching	Lecture (3 SWS)

Utilization and Treatment of Special Materials and Waste WZ2723

Prof. Dr. Gabriele Weber-Blaschke - Lehrstuhl für Holzwissenschaft
Hans-Carl-von-Carlowitz-Platz 2, 85354 Freising; 08161/71- 5635; weber-blaschke@hfm.tum.de

Module Level:	Master	**Credits:**	5 Credits		
Language:	English	**Occurrence:**	winter semester	**Duration:**	one-semester
Total Hours:	150h	**Contact Hours:**	30h	**Self-study Hours:**	120h
Assessment Retake:	**Next semester**				

Description of Achievement and Assessment Methods

The learning outcome will be assessed by presentation. The presentation will be complemented by a brief written precis. This assessment method is a good means to evaluate both whether the students are able to work self-reliantly on a topic and to present their significant results to an auditorium and whether they have understood their respective selected topic.

(Recommended) Prerequisites

Basic knowledge in natural science (biology, chemistry, ecology, physics) and engineering.

Intended Learning Outcomes

By the means of the module the students are able:

- to describe the differences of special waste, e.g. municipal or industrial waste,
- to classify the amount and quality of special waste streams,
- to analyze problems concerning the special wastes,
- to develop treatment measures to handle the waste for avoiding or reducing impacts on the environment and human health,
- to transmit developed solutions to other waste and new products.

Content

The students acquire detailed and differentiated knowledge about the following topics:

- Selected materials, products and production processes concerning high waste generation and heavy environmental problems
- Origin and types of the specific wastes,
- Classical disposal,
- Waste as a source of raw material,
- Utilization for products,
- Energetic utilization,
- Legal specification.

The special topics addressed depend on relevance, e.g. sewage sludge, e-waste or the like

Teaching and Learning Methods

The module consists of a lecture, providing the theoretical foundations, in combination with a seminar including feedback by the lecturers to the students' work. The students have to define and to solve problems collaboratively in group work by studying specialist literature. At the end they have to prepare a presentation and a brief summary including problem statement and conclusions as homework under time constraint about this topic. The students are supervised by the lecturers.

Media:

PowerPoint Presentation

Reading List:

Literature depending on themes.

Module Structure

Course	Utilization and Treatment of Special Materials and Waste
Lecturer	Katharina Reh
Form of Teaching	Seminar (2 SWS)

Land-Use Systems from Local and Global Perspectives WZ2725

Dr. Hans-Jürgen Reents; Dipl. Ing. Max Kainz – Lehrstuhl für Ökologischen Landbau und Pflanzenbausysteme
Liesel Beckmann Str. 2, 85354 Freising, 08161/71 - 3778, reents@wzw.tum.de, kainz@wzw.tum.de

Module Level:	Master	**Credits:**	5 Credits		
Language:	English	**Occurrence:**	summer semester	**Duration:**	one-semester
Total Hours:	150h	**Contact Hours:**	60h	**Self-study Hours:**	90h
Assessment Retake:	**Next semester**				

Description of Achievement and Assessment Methods

The learning outcome will be assessed by an oral exam (duration: 30 minutes). In this form of exam the students can show how they are able to explain the farming systems and describe the elements and farming methods. Due to a deeper discussion the examiner is able to evaluate the students under-standing of farm practices, system concepts and interactions with site conditions.

(Recommended) Prerequisites

None

Intended Learning Outcomes

On successful completion of the module students are able to remember and identify different crops, farm animals, machines and implements. They will be able to describe farming systems esp. the difference of organic and conventional systems. They will understand farm management methods and interactions inside farming systems. The students can classify land-use systems worldwide and are able to explain the main elements and to evaluate the sustainability and resource impact.

Content

Basic information on farming: crops, crop rotations, permanent crops: hops and orchards; soil management, weed management; implements and machinery; organic and mineral fertilizers; pesticide use; livestock: animal husbandry, breeding criteria; consumer expectations; exemplified by Bavarian and German cases.
Introduction to farming systems worldwide: pastoral systems, permanent crops plantation systems, mixed systems, arable systems, intensive animal keeping; horticultural systems; students experience with agricultural land use in their countries.

Teaching and Learning Methods

Lectures providing theoretical foundations. Examples will be given during the lectures.
Short field trips to farms and university research station, demonstrating crops, animals, technical equipment.
Short discussion sessions.

Media:

Power Point.

Reading List:

Tba

Module Structure

Course	Land-Use Systems from a Global Perspective
Lecturer	Hans-Jürgen Reents, Max Kainz
Form of Teaching	Lecture (4SWS)

Assessment of Sustainability in Agriculture - Theory and Case Studies WZ2726

Dipl. Ing. Max Kainz; Dr. Hans-Jürgen Reents - Lehrstuhl für Ökologischen Landbau und Pflanzenbausysteme, Liesel Beckmann Str. 2, 85354 Freising, 08161/71 - 3778, kainz@wzw.tum.de, reents@wzw.tum.de

Module Level:	Master	**Credits:**	5 Credits		
Language:	English	**Occurrence:**	summer semester	**Duration:**	one-semester
Total Hours:	150h	**Contact Hours:**	60h	**Self-study Hours:**	90h
Assessment Retake:	**Next semester**				

Description of Achievement and Assessment Methods

The Assignment (Report+Assessment) is done as groupwork (2-3 students). As the report and assessment is based on a farm visit and to register presented details and understand the complexity of the system group working is necessary. The assignment shows the ability of the students to describe the farming system, to apply the developed criteria of sustainable agricultural practice, to assess the sustainability of farm as a system and to give recommendations for an improved development.

(Recommended) Prerequisites

None

Intended Learning Outcomes

On successful completion of the module students are able to understand the idea of sustainability in the context of farms. They will have the ability to create criteria and indicators to assess sustainability of farms and to built up benchmarking systems. The students can describe farming systems and are able to evaluate the sustainability using criteria and indicators and to document them in a report.

Content

Sustainability in farms context, principles of sustainability, criteria, inquiry strategies, indicator and indicator concepts, assessment and benchmarking.
Application to farming systems and farms at different level of intensification; case studies based on excursions: arable farming, organic vs. conventional farming, vegetable production in arable farms, grassland based farming system, dairy farming, suckling beef productio

Teaching and Learning Methods

Lectures with presentation of principles and systematics
Reading papers
Group work, mind mapping, meta plan technical to document discussion results.

Media:

Power Point, Flip Chart, Pin wall, Metaplan technic

Reading List:

Tba

Module Structure

Course	Assessment of Sustainability in Agriculture- Theory and Case Studies
Lecturer	Hans-Jürgen Reents, Max Kainz
Form of Teaching	Lecture (4SWS)

Sustainable Land-Use Management WZ2728

Dipl. Ing. Max Kainz; Dr. Hans-Jürgen Reents; Lehrstuhl für Ökologischen Landbau und Pflanzenbausysteme, Liesel Beckmann Str. 2, 85354 Freising, 08161/71 - 3778, kainz@wzw.tum.de, reents@wzw.tum.de

Module Level:	Master	**Credits:**	5 Credits		
Language:	English	**Occurrence:**	winter semester	**Duration:**	one-semester
Total Hours:	150h	**Contact Hours:**	60h	**Self-study Hours:**	90h
Assessment Retake:	**Next semester**				

Description of Achievement and Assessment Methods

In a Power Point (or comparable tool) supported oral presentation the students can show, how they identify a special issue of farm management related to terms of sustainability. In the further outline of the presentation, the students will show how to discuss the topic based on recorded results from published papers, to explain conclusions and to suggest solutions on improved sustainability.

(Recommended) Prerequisites

None

Intended Learning Outcomes

On successful completion of the module students are able to identify special problems of sustainability in farm management, economic and social conditions, to analyze the technical, social and economic impacts and to evaluate them on the background of criteria of sustainability. They will be able to create solutions for critical impacts.

Content

Agricultural systems and their relation to natural and human resources; site, economic and social conditions, regional and global,
adaptation of farm management techniques to principles of sustainability, research and scientific results, terms of politics and social debate, aims and scenarios for future development
Topics selected participative with the students.

Teaching and Learning Methods

Lectures provide facts, background and theoretical foundations.
Papers have to be read and used in group work.
Group work.

Media:

Power Point Presentations
Flip Chart
Pin wall, Metaplan technique

Reading List:

Tba

Module Structure

Course	Case Studies of Land-Use Management
Lecturer	Hans-Jürgen Reents, Max Kainz
Form of Teaching	Lecture (4SWS)

Sustainability of Food Chains WZ2727

Dipl. Ing. Max Kainz – Lehrstuhl für Ökologischen Landbau und Pflanzenbausysteme
Liesel Beckmann Str. 2, 85354 Freising, 08161/71 - 3034, kainz@wzw.tum.de

Module Level:	Master	**Credits:**	5 Credits		
Language:	English	**Occurrence:**	winter semester	**Duration:**	one-semester
Total Hours:	150h	**Contact Hours:**	60h	**Self-study Hours:**	90h
Assessment Retake:	**Next semester**				

Description of Achievement and Assessment Methods

Combination of Poster and oral presentation provides to assess the students ability to conduct a life cycle analysis of a special food product. The poster needs a very concentrated presentation, focus on the important information and factors and shows the students capability to understand the principles of the LCA and the special food production process.

(Recommended) Prerequisites

Attendance in Module 4209 and 4210 is recommended.

Intended Learning Outcomes

At the end of the module the students are able to understand food chains. They can describe and apply life cycle analysis to processed food products. They are able to assess energy and emission impact of different crop and animal production system and processing procedures. The will get basic skills of the software Umberto.

Content

Food chains of processed food, from agricultural production via processing to packed product unit in a food store, principles of life cycle analysis, assessment criteria, energy input output ratio, energy efficiency, CO2 emission, carbon footprint, virtual water
LCA calculation and calculation program (Umberto).

Teaching and Learning Methods

Teachers Presentations Life cycle analysis, food chain, energy, CO2 emission and water impacts,
students contributions, special aspects of processing paper reading for contributions to group discussions and outline of the final presentation.

Media:

Presentation notes, computer program.

Reading List:

Tba

Module Structure

Course	Sustainability of Food Chains
Lecturer	Max Kainz
Form of Teaching	Seminar (4SWS)

Introduction to Soil Science WZ2733

Dr. Peter Schad – Lehrstuhl für Bodenkunde
Emil-Ramann-Str. 2, 85354 Freising, 08161/71-4735, schad@wzw.tum.de

Module Level:	Master	**Credits:**	5 Credits		
Language:	English	**Occurrence:**	summer semester	**Duration:**	one-semester
Total Hours:	150h	**Contact Hours:**	70h	**Self-study Hours:**	80h
Assessment Retake:	**Next semester**				

Description of Achievement and Assessment Methods

In a written exam of 60 minutes duration, the students demonstrate by answering questions without helping material their understanding of the nature and properties of soils, and they remember the characteristics of the soils of the field course as well the field assessment methods. In a pass/fail exam (laboratory assignment) in the field of 10 minutes duration, they prove their ability to survey and interpret a soil profile.

(Recommended) Prerequisites

Basic knowledge in chemistry, physics, and biology.

Intended Learning Outcomes

The students understand the basics of soil science. They can use their knowledge from soil mineralogy, soil organic matter, soil chemistry, and soil physics to understand soil formation processes and important biochemical and physical properties. The students are able to survey a soil profile and to detect the genesis of the surveyed soil. They can evaluate the possibilities of soil use, the risks to the soil itself and the risks to its environment. They are able to evaluate the hydrology of the soil and to judge the erosion risk.

Content

- What is a soil?
- Mineral (inorganic) soil components
- Soil biology and soil organic matter
- Soil chemistry
- Soil physics
- Soil survey
- Soil interpretation
- Soil hydrology

Soil erosion assessment

Teaching and Learning Methods

The lecture discusses the essentials of soil science. The field assessment starts with peer instructions to analyse a soil profile. During the course, the students will do more and more group work to train the evaluation of a soil profile, its hydrology and its erosion risks.

Media:

Lecture: presentation notes. Field Assessment: spade, auger, knife, colour charts, TDR probes, suction cups, erosion assessment kits

Reading List:

Brady, Weil: The nature and properties of soils, 14th edition, 2007.
Blume et al.: Scheffer/Schachtschabel Soil science, 2016.
Eash, Sauer, O'Dell, Odoi, Bratz: Soil science simplified, 6th edition, 2016.
Blum, Schad, Nortcliff: Essentials of Soil Science, 2016.
FAO Guidelines for Soil Description. Prepared by Jahn, Blume, Asio, Spaargaren, Schad, 2006.

Module Structure

Course 1	Introduction to Soil Science: Lecture
Lecturer 1	Carsten Müller
Form of Teaching 1	Lecture (2SWS)
Course 2	Introduction to Soil Science: Field Course
Lecturer 2	Martin Wiesmeier and colleagues
Form of Teaching 2	Field Course (3SWS)

World Soil Resources WZ2735

Dr. Peter Schad – Lehrstuhl für Bodenkunde
Emil-Ramann-Str. 2, 85354 Freising, 08161/71-4735, schad@wzw.tum.de

Module Level:	Master	**Credits:**	5 Credits		
Language:	English	**Occurrence:**	summer semester	**Duration:**	one-semester
Total Hours:	150h	**Contact Hours:**	70h	**Self-study Hours:**	80h
Assessment Retake:	**Next semester**				

Description of Achievement and Assessment Methods

In an oral exam of 30 minutes duration, students demonstrate in a scientific discussion by answering questions without helping material their fundamental understanding of the soils of the world in relation to other ecological factors, and they remember the soils of the field course as well as the methods of surveying and classifying soils in the field. In a pass/fail exam (laboratory assignment) in the field of 10 minutes duration, they prove their ability to survey and classify soils of various landscapes and environmental settings. The understanding of soils, as achieved in the module "Introduction to soil science" is implicitly part of the oral exam.

(Recommended) Prerequisites

The successful participation at the module "Introduction to Soil Science" (which is given in the first half of the summer semester) is required.

Intended Learning Outcomes

The students are able to apply their knowledge of soils, as achieved in the module “Introduction to Soil Science”, to all soils of the world. The students understand the characteristics of the soils of the world, the pattern of their geographical distribution, their genesis, their ecological potential and the threats to their functions. The students are able to survey a soil profile, to detect the genesis of the surveyed soil and to classify it according to the international soil classification system. They are able to evaluate the possibilities and risks of soil management. They can assess the relationship between the soil and its environmental setting.

Content

- Soils of the world
- Chemical, biological and physical properties of soils
- Genesis of soils as the result of soil-forming processes
- Soil survey
- Soil classification according to the international system
- Soil interpretation.

Teaching and Learning Methods

The lecture gives an overview of all soils of the world. The field course (several days) presents soils in a landscape outside southern Bavaria. The students are trained in the methodological skills of soil survey, soil classification and soil interpretation.

Media:

Lecture: presentation notes. Field Assessment: spade, auger, knife, colour charts.

Reading List:

FAO Guidelines for Soil Description. Prepared by Jahn, Blume, Asio, Spaargaren, Schad, 2006.
IUSS Working Group WRB: World Reference Base for Soil Resources 2014. Update 2015. Prepared by Schad, van Huyssteen, Micheli. FAO World Soil Resources Reports 106.

Module Structure

Course 1	World Soil Resources
Lecturer 1	Peter Schad
Form of Teaching 1	Lecture (2 SWS)
Course 2	World Soil Resources: Field Course
Lecturer 2	Peter Schad
Form of Teaching 2	Field Course (3 SWS)

Soil Protection WZ2734

Dr. Christian Schurig – Lehrstuhl für Bodenkunde;
Emil-Ramann-Str. 2, 85354 Freising, 08161/71-3735, schurig@wzw.tum.de

Module Level:	Master	**Credits:**	5 Credits		
Language:	English	**Occurrence:**	winter semester	**Duration:**	one-semester
Total Hours:	150h	**Contact Hours:**	60h	**Self-study Hours:**	90h
Assessment Retake:	**Next semester**				

Description of Achievement and Assessment Methods

In an oral exam of 30 minutes duration, students demonstrate in a scientific discussion by answering questions without helping material their broad and deep understanding on how to protect soils. The understanding of soils, as achieved in the modules "Introduction to soil science" and "World soil resources", is implicitly part of the oral exam.

(Recommended) Prerequisites

The successful completion of the module "Introduction to Soil Science" or equivalent skills are required. The successful completion of the module "World Soil Resources" is recommended.

Intended Learning Outcomes

The students are able to apply their knowledge of soils, as achieved in the modules “Introduction to Soil Science” and “World Soil Resources”, to develop strategies of soil protection. They understand the major environmental factors that determine the food production in the world. They are able to address the specific problems of highly erodible soils, semi-arid land and kaolinitc soils and to design adequate land-use methods. The students understand the major factors that determine the fate of substances in soil. They are able to analyze and forecast the fate of heavy metals, organic pollutants and radionuclides in soil and are familiar with important techniques for managing and remediating brownfields.

Content

Principles of soil degradation, the world food problem, highly erodible soils, semi-arid environments (including irrigation and salinization problems), kaolinitic soils, shifting cultivation, organic and mineral fertilization, agroforestry, land use and greenhouse gases, soil functions, organic pollutants, inorganic pollutants (heavy metals), radionuclides, pesticides, pathways of pollutants, sorption, precipitation, co-precipitation, acidification, ways to assess the mobility of pollutants, remediation of brownfields.

Teaching and Learning Methods

Lecture, discussions

Media:

Presentation notes.

Reading List:

Blanco, H., Lal, R. (2008): Principles of soil conservation and management. Diamond, J. (1998): Guns, germs and steel. A short history of everybody for the last 13,000 years. Mirsal, I. (2008): Soil Pollution.

Module Structure

Course 1	Soil Protection and World Food Production
Lecturer 1	Peter Schad
Form of Teaching 1	Lecture (2 SWS)
Course 2	Soil Protection and Brownfield Management
Lecturer 2	Alix Vidal
Form of Teaching 2	Lecture (2 SWS)

Analytical Characterization of Soil Resources WZ2736

PD Dr. Carsten Müller – Lehrstuhl für Bodenkunde
Emil-Ramann-Str. 2, 85354 Freising, 08161/71-4423, carsten.mueller@wzw.tum.de

Module Level:	Master	**Credits:**	5 Credits		
Language:	English	**Occurrence:**	winter semester	**Duration:**	one-semester
Total Hours:	150h	**Contact Hours:**	60h	**Self-study Hours:**	90h
Assessment Retake:	**Next semester**				

Description of Achievement and Assessment Methods

The students collect their own soil samples, they prepare and analyze them, and they interpret the results. They present their results and their interpretation in a research paper of 10 pages. The research paper is accompanied by an oral presentation of 20 minutes to assess the scientific communication skills of the students.

(Recommended) Prerequisites

The successful completion of the module "Introduction to Soil Science" or equivalent skills are required.

Intended Learning Outcomes

The students are able to apply their knowledge of soils, as achieved in the module “Introduction to Soil Science”, to the most important physical, chemical and biological processes in soils. They are able to choose the adequate laboratory method to answer a certain question on soil management. They know how to do sampling, sample preparation and laboratory work. They can interpret laboratory data and know, which conclusions can be made and which conclusions cannot be made. The student ts are able to communicate their results in a written and an oral manner.

Content

- Sampling and sample preparation
- Lab analyses: texture, density, water conductivity, organic and inorganic carbon, nitrogen, soil organic matter decomposition, pH, cation exchange capacity, Fe oxides, phosphate retention;
- Data interpretation

Teaching and Learning Methods

For every step, the lecturers give the theoretical background. Afterwards, every step is done by the students themselves, guided by the lecturers and the laboratory staff: sampling, analyses, data interpretation.

Media:

Lecture: presentation notes; sampling: field equipment; laboratory course: laboratory instruments

Reading List:

Will be given in the course

Module Structure

Course	Analytical Characterization of Soil Resources
Lecturer	Carsten Müller and staff
Form of Teaching	Lecture (1 SWS), sample collection, laboratory analysis, data evaluation (3 SWS)

ELECTIVE MODULES

Human Resources and Social Aspects WZ2729

Tim Kunkowski – Lehrstuhl für Wald- und Umweltpolitik
Hans-Carl-von Carlowitz-Platz 2; 85354 Freising; 08161-71-4627; tim.kunkowski@tum.de

Module Level:	Master	**Credits:**	5 Credits		
Language:	English	**Occurrence:**	winter semester	**Duration:**	one-semester
Total Hours:	150h	**Contact Hours:**	75h	**Self-study Hours:**	75h
Assessment Retake:	**Next semester**				

Description of Achievement and Assessment Methods

The module will be assessed by a written examination (duration 60 min) at the end of the semester. The contribution of individual students is traceable as it is an individual exam. The exam will cover the content of both lectures (Human Resource Management, Corporate Social Responsibility). The exam will test, if the students are able to apply theoretical concepts and analyse management situations. After having diagnosed the situation, students should be able to give concrete recommendations. The exam will also allow students to demonstrate understanding of concepts, practical conditions and issues of social aspects in organisations. Further students have the opportunity to contribute with an oral presentation of a relevant topic. This mid-term assignment will serve for grade improvement by 0.3 according to §6 (5) APSO.

(Recommended) Prerequisites

None

Intended Learning Outcomes

At the end of the module students are able to critically understand issues of Corporate Social Responsibility (CSR) and Human Resource Management (HRM) and its changing role within business and society. They are able to analyze main evolutions and current issues of CSR and HRM from an international perspective and describe the principal functions, main tools and their use within organizations. Moreover, they learned how to participate in working processes concerned with HR and CSR.

Content

Social aspects in organizations are gaining interest of legal constraints and expectations of various stakeholders like employees, the Millennials generation, etc. The module will approach social aspects/CSR at two levels: A) The level of international trade; WTO and TRIPS agreement. We will look at the Novartis versus The Indian Government court case and compare to Novartis' CSR policy. B) Company level: Sustainability Reporting Standards, Responsible Supply Chain Management including digitisation of supply chain and its consequences for social responsibility. The module will be concluded with a special focus on Fair Trade and CSR issues of the oil industry. Human resources Management presents an accessible and lively introduction to the changing world human aspects in organizations, focusing on the frameworks of people management strategies, and covering the basic operational areas and practices. Throughout the module, we are going to discuss key topics and issues surrounding people management in business world. Clearly linking HR theory to the work environment, this module explores core areas such as HR strategy; CSR, Equality, Diversity and Inclusion; Recruitment, Selection & Onboarding techniques; Compensation & Benefits; Employee Appraisal and Training, Development and Career aspects.

Teaching and Learning Methods

The methodologies used in the course include lectures, class discussions of assigned readings with critical thinking questions, case presentation of students and case discussion sessions.
The sessions will consist of a case discussion with an in-depth review of the theory as it affects actual business practice. Readings (cases) can be found within the readers available on Moodle. Students participation in connection with their professional background is very important to obtain the maximum benefit of this module.

Media:,

PowerPoint, videos, reader, flip chart, chalk board

Reading List:

Dessler, Gary (2017). Human Resource Management, Global Edition. 15/E. Pearson Education
Cohen, E., Taylor, S., Muller-Camen, M. (2012). HRM's Role in Corporate and Environmental Sustainability. Publication of the SHRM Foundation's Effective Practice Guidelines Series, 48 pages.
Links to World Trade Organisation, "To patent or not to patent? The case of Novartis' cancer drug Glivec in India", Ravinder Gabble and Jillian Clare Kohler, Homepage of Global Reporting Initiative, UNGC Guide to Traceability.
New, Steve (2015) *Modern slavery and the supply chain: the limits of corporate social responsibility?* Supply Chain Management: An International Journal, 20 (6). pp. 697-707.

Module Structure

Course 1	Human Resource Management
Lecturer 1	Christine Naschberger
Form of Teaching 1	Lecture (2SWS)
Course 2	Corporate Social Responsibility
Lecturer 2	Marianne Thejls-Ziegler
Form of Teaching 2	Lecture (2SWS)

Modulnummer	Titel
POL62200	Energy Transformation
POL40100	Introductory Lecture Politics and Technology (Prof. Schreurs)
POL24302	The Political Economy of Standards and Certification
POL61300	Modul The Politics of Market Competition in a Global Economy (Governing Global Markets: The Law, Economics, and Politics of Market Competition)
WI001164	Modeling and Optimization in Energy Markets
000000 4328	Transportation Economics
IN2124	Basic Mathematical Tools for Imaging and Visualization
000000 2115	Integration of Renewable Energies
WZ1590	Climate Change Economics
821029504	Advanced Environmental and Natural Resource Economics

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Soils and Soil Management: Dr. Peter Schad, schad@wzw.tum.de