JACOBS UNIVERSITY

Integrated Environmental Studies

Bachelor‘s Degree Program (BSc)

Contents

1 Integrated Environmental Studies - ERDE

1.1 Concept

An ever-burgeoning world population increases demand for food, water, energy, health care, and education. These demands place unprecedented pressure on the "Earth System" (natural resources and the environment) as well as on the institutions organizing the distribution of resources and education. Sustainable management of these global challenges requires an integrated approach, combining elements from engineering and natural sciences with those from the social sciences, such as political science and economics. The study program Integrated Environmental Studies provides a broad and interdisciplinary education in these diverse fields within the multicultural environment of Jacobs University Bremen, whose students hail from over 100 different countries. In addition to lectures and seminars, students gain practical experience and skills during laboratory courses, internships and field excursions (e.g., five-day field trip with focus on Land Use, Climate Change and Renewable Energies in East Frisia; and the one-week Field Camp on Environment, Resources and Energy in Iceland). The Integrated Environmental Studies program offers two specializations: "Environment and Resources" and "Energy Policy and Technology."

1.2 Career Options

Companies and organizations have responded very favorably to the Integrated Environmental Studies program. By attaining a broad focus on cutting-edge issues, combined with the multi-cultural experience gained by studying at Jacobs University, graduates will be ideally suited to enter companies, government institutions and non-government organizations that operate worldwide in the fields of Environment, Resources, Development and Energy. They are also well-qualified to continue their academic education within M.A., M.Sc. or MBA programs.

1.3 Research

Research is essential at Jacobs University. There are excellent opportunities for undergraduates to participate in research projects. The research activities of our faculty reflect the wide field and transdisciplinary nature of the Integrated Environmental Studies program, including:

- Trace components and their fates in freshwater systems
- Consequences of fertilization on soil and groundwater quality
- Manganese nodules as potential metal resource
- Marine and freshwater mussels as proxies for environmental conditions
- Impact of climate change on ecosystems
- High-technology metals: resources and environmental impact
- Influence of economical development on biodiversity
- Socio-political aspects of development
- Sustainable energy use, including renewable energies
- Energy Transitions
- Geopolitics of energy supply
- Energy supply in remote areas

2 Requirements for a B.Sc. in Integrated Environmental Studies

2.1 General Requirements

To obtain a B.Sc. degree at Jacobs University a minimum of 180 ECTS credit points must be earned over a period of 6 semesters.

- 15 ECTS credits must be earned through transdisciplinary courses, comprised of University Study Courses (**USC**) or their equivalents.
- 15 ECTS credits must be earned through language courses. In case a 5th or 6th semester language course is not offered, the equivalent number of ECTS credits may be replaced by other SES or SHSS courses.

To obtain the remaining credits (180 credits minus sum of mandatories, USCs and language courses) courses may be chosen as electives.

2.2 Mandatory Courses for the Major

1st Year

- 50 ECTS credits must be earned from the block "Integrated Environmental Studies":
  - Academic and Professional Skills (990100, 2,5 ECTS credits)
  - Statistical Concepts and Data Analysis (990121, 5 ECTS credits)
  - Mathematics: ESM 1C (120121, 5 ECTS credits)
  - General Environmental Science I (040101, 5 ECTS credits)
  - General Environmental Science II (040102, 5 ECTS credits)
  - General Earth and Space Sciences I (210101, 5 ECTS credits)
  - General Earth and Space Sciences II (210102, 5 ECTS credits)
  - Natural Science Lab Unit Earth and Space Sciences I: Harz Excursion (210111, 2.5 ECTS credits)
  - Introduction to Economics (930201, 5 ECTS credits)
  - Environmental and Resource Economics (040122, 5 ECTS credits)
  - Resolving Wicked Environmental Problems (042101, 5 ECTS credits)
- 5 ECTS credits must be earned from language courses
- 5 ECTS credits must be earned from USCs

At the end of the first year of studies students choose one of the specialization areas "**Environment and Resources**" or "**Energy Policy and Technology**". Courses from the specialization area not chosen may still be taken as electives.

2nd Year

- 22,5 ECTS must be earned from the block Integrated Environmental Studies:
  - Geospatial Environmental and Resource Data Analysis (041201, 2.5 ECTS credits)
  - IES Seminar I (040261, 2.5 ECTS credits)
  - Field Lab/Excursion I: Energy and Construction Materials: Coal and Limestone Mining (040251, 2.5 ECTS credits)
  - Field trip to East Frisia: Consequences for changed land use, climate change, and developments in renewable energies (041202, 5 ECTS credits)
  - Fundamental Processes in Ecology (040231, 5 ECTS credits)
  - Histories of Development (042231, 5 ECTS credits)

- Students specializing in "**Environment and Resources**" earn 20.0 ECTS credits from
  - Environmental Geosciences (210302, 5 ECTS credits)
  - Fundamentals of Hydrogeology (040221, 2.5 ECTS credits)
  - Introduction to Soil Sciences (040241, 2.5 ECTS credits)
  - Geology I: Volcanism & Metamorphism (210271, 2.5 ECTS)
  - Geology II: Sedimentology & Structural Geology (210281, 2.5 ECTS)
  - General Inorganic Chemistry (400101, 5 ECTS credits)
- Students specializing in "**Energy Policy and Technology**" earn 20.0 ECTS credits from
  - Sustainable Energy Policy (040201, 5 ECTS credits)
  - Energy Economics (040202, 5 ECTS credits)
  - International Energy and Environmental Politics (040211, 5 ECTS credits)
  - Public Management and Public Policy (970202, 5 ECTS credits)

3rd Year

- 22,5 ECTS must be earned from the Block Integrated Environmental Studies in the 3rd year:
  - IES Seminar II (040361, 2.5 ECTS)
  - IES Seminar III (040362, 2.5 ECTS)
  - Waste Management & Technology (041301, 2.5 ECTS credits)
  - Environmental Biotechnology (560341, 5 ECTS credits)
  - IES Field Camp Iceland: Environment, Resources and Energy (040351, 5 ECTS credits)
  - Guided Research/BSc Thesis (040322, 7.5 ECTS credits)
    or
  - Bachelor Thesis Seminar (990301, 7.5 ECTS credits)
- Students specializing in "**Environment and Resources**" earn 5 ECTS credits from
  - Resource Geology I: Oil, Natural Gas & Coal (210381,2.5 ECTS)
  - Resource Geology II: Mineral Resources (210391, 2.5 ECTS)
- Students specializing in "**Energy Policy and Technology**" earn 5 ECTS credits from
  - Renewable Energy Technology (201231, 5 ECTS credits)

2.3 Recommendations

Students specializing in Environment and Resources are recommended to take the course "400121 Analytical and Environmental Chemistry". Students planning to take the course "Renewable Energy" should consider taking a general physics course first.

3 Recommended Course Plan

Although this course plan is not binding, it is highly recommended since it ensures an even workload, optimum efficiency and maximum congruence with the objectives of the curriculum.

Year 1 Courses	**Fall**	**C**	**T**	**Spring**	**C**	**T**
Academic and Professional Skills	990100	*2.5*	m			
Statistical Concepts and Data Analysis				990121	*5*	m
ESM1C	120121	*5*	m			
General Environmental Science I	040101	*5*	m			
General Environmental Science II				040102	*5*	m
General Earth and Space Sciences I	210101	*5*	m			
General Earth and Space Sciences II				210102	*5*	m
NatSciLab ESS I[1],[4]	210111	*2.5*	m			
Introduction to Economics	930201	*5*	m			
Resolving Wicked Environmental Problems	042101	*5*	m			
Environmental and Resource Economics				040122	*5*	m
Language Courses		*2.5*	e		*2.5*	e
University Studies Courses					*5*	e
Running Total / *Semester Total*	30	*32.5*		60	*27.5*	

C = ECTS credit points, T=type (m=mandatory, e=elective)

Recommendations

- Students choose one of the specializations "**Resources and Environment**" or "**Energy Policy and Technology**" at the end of the first year of studies.
- The course "**General Information and Communication Technologies**" is recommended for students with no IT knowledge.
- Students with more interest in Energy, in particular renewable Energy, might consider Esc subjects like "**General Physics I/II**".
- Students with more interest in Ecology, might consider Esc subjects like "**General Biology I /II**".

[1] weekend course

[4] will be offered in spring 14

Year 2 Courses	**Fall**	**C**	**T**	**Spring**	**C**	**T**
Geospatial Enviromental and Resource Data Analysis	041201	*2.5*	m			
IES Seminar I	040261	*2.5*	m			
Field Lab I -Fossil Fuels: Energy and Construction Materials:[1]						
Coal and Limestone Mining	040251	*2.5*	m			
Field trip to East Frisia				041202	*5*	m
Fundamental Processes in Ecology	040231	*5*	m			
Histories of Development				042231	*5*	m
plus						
Specialization in Environment and Resources						
Environmental Geosciences				210302	*5*	m
Fundamentals of Hydrogeology[2]	040221	*2.5*	m			
Introduction to Soil Sciences[2]	040241	*2.5*	m			
General Inorganic Chemistry	400101	*5*	m			
Geology I	210271	*2.5*	m			
Geology II	210281	*2.5*	m			
Language Courses		*2.5*	e		*2.5*	e
Electives in SHSS and SES					*7.5*	e
University Studies Courses					*5*	e
Running Total / *Semester Total*	90	*30*		120	*30*	
or						
Specialization in Energy Policy and Technology						
Sustainable Energy Policy	040201	*5*	m			
International Energy and Environmental Politics				040211	*5*	m
Energy Economics	040202	*5*	m			
Public Management and Public Policy				970202	*5*	m
Language Courses		*2.5*	e		*2.5*	e
Electives in SHSS and SES		*5*	e		*2.5*	e
University Studies Courses					*5*	e
Running Total / *Semester Total*	90	*30*		120	*30*	

C = ECTS credit points, T=type (m=mandatory, e=elective)

[1] weekend course
[2] intersession course

Year 3 Courses	**Fall**	**C**	**T**	**Spring**	**C**	**T**
IES Seminar II	041361	*2.5*	m			
IES Seminar III				040362	*2.5*	m
Waste Management and Technology[2]	041301	*2.5*	m			
Environmental Biotechnology	560341	*5*	m			
IES Field Camp Iceland:						
Environment, Resources and Energy[3]	040351	*5*	m			
Guided Research/Thesis (SES Supervisor)				040322	*7.5*	m
or						
Bachelor Thesis Seminar (SHSS Supervisor)				990301	*7.5*	m
plus						
Specialization in Environment and Resources						
Resource Geology I	210381	*2.5*	m			
Resource Geology II	210391	*2.5*	m			
Language Courses		*2.5*	e		*2.5*	e
Electives in SHSS and SES		*7.5*	e		*12.5*	e
University Studies Courses					*5*	e
Running Total / *Semester Total*	150	*30*		180.0	*30*	
or						
Specialization in Energy Policy and Technology						
Renewable Energy				201231	*5*	m
Language Courses		*2.5*	e		*2.5*	e
Electives in SHSS and SES		*12.5*	e		*7.5*	e
University Studies Courses					*5*	e
Running Total / *Semester Total*	150	*30*		180.0	*30*	

C = ECTS credit points, T=type (m=mandatory, e=elective)

Comments

This is a recommended course plan. Students should make sure that they take sufficient courses each semester to attain an average of 30 credits.

All undergraduate students are required to complete an internship, normally to be accomplished between the second and third year of study. Each student must file a report shortly after completion of the internship. Information about the internship will be listed on the transcript. The internship must last at least two consecutive months. No credits are connected to the internship requirement. For more detailed information on internship procedures see http://www.jacobs-university.de/career-services/internship. Field trips may not be graded (tbc), just pass or fail.

Third-year students must provide the IES coordinators with a preliminary sketch of their Thesis (title and short description of the thesis as well as the name of the Thesis supervisor) on the first Friday of February. Students who select an SES faculty member as their thesis supervisor must register for the Guided Research/Thesis course (040322). Students who opt for an SHSS faculty member as supervisor must register for the Bachelor Thesis Seminar (990301). Please note, in addition to their thesis supervisor, students in 990301 will also be assigned a seminar course instructor.

[2] intersession course

[3] summer break course (either 1st or last week or the summer break)

4 Courses: Integrated Environmental Studies

4.1 First Year of Study

4.1.1 Methods

990100 – Academic and Professional Skills

Short Name: APS
Type: Modules
Semester: 1
Credit Points: 2,5 ECTS
Prerequisites: None
Corequisites: None
Tutorial: No

Course contents The Academic and Professional Skills (APS) module aims at broadening students' key qualifications to increase academic success, foster career planning, and enhance employability. APS consists of one obligatory course "Academic skills in a nutshell: an introduction to writing an academic paper" (1.6 credits), which must be completed in the first year of studies, and a series of elective workshops (0.9 credits), which can be completed during the three years at Jacobs University. Students pass the APS module when they successfully obtain a total of 2.5 credits, including the obligatory course. "Academic skills in a nutshell: an introduction to writing an academic paper" introduces students to the basic principles and procedures of scientific inquiry. Students will learn the essentials of writing an academic paper, which will prepare them for academic life at the university level and enable them to be more successful throughout their studies. On successful completion of the course students will be awarded 1.6 credits toward the overall APS module credit. The elective credits in the APS module cover a wide range of professional, academic, coping, and interpersonal skills. Workshops are offered by SHSS, Career Services, the Information Resource Center, the Counseling Center, Financial Services, and more. SHSS publishes a schedule and description of upcoming elective credits at the start of every semester. Students are able to choose workshops tailored to their needs and wishes (to a total of at least 0.9 credits).

990121 – Statistical Concepts and Data Analysis

Short Name: StatConcepts
Type: Lab/Lecture
Semester: 2
Credit Points: 5 ECTS
Prerequisites: None
Corequisites: None
Tutorial: No

Course contents This course extends the discussion of quantitative methods beyond the introductory level. It reviews some exemplary pieces of quantitative research in management, economics, and the social sciences in order to explain fundamental statistical concepts and examine their potential and limitations in practical data analysis. The topics covered include descriptive statistics, hypothesis testing, and statistical modeling with a focus on regression type models, such as ordinary least squares regression, logistic regression and analysis of variance. The course is equally divided between lecture and lab sessions. During the lab sessions, the tools and concepts discussed in the lectures beforehand are applied to real life data sets. The course also serves as a basic training in the statistics software SPSS.

Lab classes are run with small student numbers to ensure optimum supervision and learning outcome. In regular homework tasks, students will work in teams to apply their acquired knowledge to typical data analysis situations.
Students who successfully complete this course will not receive credits towards the 180 ECTS-credits required for their BA degree from the courses "Statistical Methods I (course-no.: 990 102)" and "Statistical Methods II (course-no.: 990 201)". These courses are mutually exclusive due to comparable content.

120121 – ESM1C - Calculus and Matrix Algebra

Short Name: ESM1A
Type: Lecture
Semester: 1
Credit Points: 5 ECTS
Prerequisites: None
Corequisites: None
Tutorial: No

Course contents The Course ESM1C Calculus and Matrix Algebra covers the standard topics of pre-calculus (numbers, units, transformations, inequalities, elementary functions and their properties and graphs), single variable calculus (sequences and series, limits and continuity, derivates and differential calculus, anti-derivates and Riemann integral, with selected applications) and a brief introduction to matrix-vector calculus. Sufficient time is spent on the acquisition of solid problem solving skills.
ESM1C is an entrance Mathematics course for students in the School of Engineering and Science from Life Sciences and Chemistry Majors, students from School of Humanities and Social Sciences, as well as for students with a less rigorous high school preparation in Mathematics (approval by advisor/program coordinator necessary). It serves as a prerequisite for later ESM and more advanced Mathematics courses. It can be complemented by the lab units 110111 NatSciLab Math Symbolic Software or 110112 NatSciLab Math Numerical Software.

4.1.2 IES Basics

040101 – General Environmental Science I

Short Name: GenEnvSciI
Type: Lecture
Semester: 1
Credit Points: 5 ECTS
Prerequisites: None
Corequisites: None
Tutorial: No

Course contents The earth is under unprecedented environmental stress and this course provides students with a basic foundation for understanding the earth system and how it is affected by human behavior, particularly by resource extraction and energy use. The course content is transdisciplinary and is divided into three modules.
(1) Earth Surface System: The "Critical Zone" is the complex near-surface environment in which interactions between rock, soil, water, air and living organisms define the natural habitat and control the availability of life-sustaining resources. In this module, participants will be introduced in a qualitative way to the basic components of and fundamental processes operating in the critical zone. (2) Human

Interaction with the Environment: It will be demonstrated how physical, chemical and biological processes interact in the geological environment and drive the functions of the ecosystem, and how human activities interfere with these natural processes. Anthropogenic changes in the ecosystem at local and global scales will be discussed, with emphasis on the degradation of the atmosphere, freshwater systems, soils, forests, grassland and cropland and the changes of polar and coastal regions. Strategies are proposed for controlling environmental degradation from extraction and consumption of Earth resources and for maintaining a healthful and sustainable earth. (3) Earth, Energy and Sustainability: "Energy" is a multi-dimensional topic that provides several vantage points for understanding sustainability issues. Conventional energy is sourced from the earth, which causes environmental degradation, and energy use is the primary cause of greenhouse gases and climate change. Nonetheless, energy is crucial for development. The challenge is sourcing and using it in a sustainable manner. In this module, students will learn about the sustainability movement, climate change and basic energy facts.

040102 – General Environmental Science II

Short Name: GenEnvSciII
Type: Lecture
Semester: 1
Credit Points: 5 ECTS
Prerequisites: 040101
Corequisites: None
Tutorial: No

Course contents The course General Environmental Science II is the basic science core course for IES majors, which prepares them for more specialized IES-related courses in the 2nd and 3rd year. The General Environmental Science II courses introduces the students to the basics of physics, chemistry and biology/ecology.

4.1.3 SES Basics

210101 – General Earth and Space Sciences I

Short Name: GenESSI
Type: Lecture
Semester: 1
Credit Points: 5 ECTS
Prerequisites: None
Corequisites: None
Tutorial: No

Course contents Introduction to geology, oceanography, planetary and space sciences. The geology unit introduces fundamental principles and concepts in the geosciences, and puts special emphasis on the Earth's internal structure and plate tectonics. The oceanography unit introduces the relations of biology, chemistry, geology and physics in marine environments and gives basic information on techniques and methods. The planetary sciences unit discusses the inventory of the solar system from small bodies to the giant planets, with particular emphasis on terrestrial planets and their geology. The space sciences unit deals with planet Earth in the cosmos, discusses implications of the motion of Earth and Moon, and explains fundamentals of radiation physics in the planetary context.

210111 – Natural Science Lab Unit Earth and Space Sciences I: Harz Excursion

Short Name: NatSciLab
Type: Lab
Semester: 1
Credit Points: 2.5 ECTS
Prerequisites: None
Corequisites: 210101
Tutorial: Non

Course contents Introduction to the fundamentals of field geology and environmental problems in the Harz Mountains. The conflict of economic benefit and environmental consequences of the long tradition of ore mining in the area will be demonstrated, and the concept of the National Park/Geopark will be introduced. The students have to participate in a two-day weekend excursion during the fall semester that includes introductory seminar lectures, the excursion itself, and follow-up work, such as the preparation of an excursion report.

210102 – General Earth and Space Sciences II

Short Name: GenESSII
Type: Lecture
Semester: 2
Credit Points: 5.0 ECTS
Prerequisites: 210101
Corequisites: None
Tutorial: No

Course contents This course is a continuation of the first-semester lecture General Earth and Space Sciences I. The concepts are developed further and in a more quantitative way. The geology unit introduces the Earth's geological history, the rock cycle, principles of crystallography, as well as different sedimentological processes and features. Topics of the oceanography unit include the ocean as a biogeochemical system and the marine carbon cycle including the marine carbonate system. Also the role of the ocean as a resource of minerals, the use and misuse of the ocean, and environmental issues will be presented. The extraterrestrial component of the course deals with the Earth's neutral atmosphere, the near-Earth space environment, the Sun and the heliosphere, solar activity and space weather.

4.1.4 SHSS Basics

930201 – Introduction to Economics

Short Name: IntroEconomics
Type: Lecture
Semester: 1
Credit Points: 5 ECTS
Prerequisites: None
Corequisites: None
Tutorial: No

Course contents This lecture introduces students to the institution of the market. It reconstructs the micro-logic of market exchanges at the level of individual market participants (microeconomics), ana-

lyzes the resulting macro-patterns at the level of market aggregates (macroeconomics), and looks into the role that governments play in defining, shaping, and destroying market relations.
Economics is the study of how society allocates scarce resources; time, oil, and since two decades, the environment provide good examples. Note firstly that economics studies scarce resources only. If it scarce, it has a price and can be traded. Note furthermore that economics studies how to make optimal use of scarce resources. Note lastly that economics is a social science as it studies individual and collective human behaviour. The objective of the course is to teach and shape economic thinking: how does a rational economic agent behave and what does this mean for the allocation of scarce resources?
There are many different branches in economics. We will focus on two main branches: micro-economics, which takes the individual consumer and the firms as decision making units, and macro-economics, which studies the economy as a whole. Even if economics is a social science, academic economic analysis can be (but need not be) highly mathematical. In contrast, this course will be non-mathematical. Instead, the course relies more strongly on graphical analysis.

040122 – Environmental and Resource Economics

Short Name: ResEnviroEcon
Type: Seminar
Semester: 2
Credit Points: 5 ECTS
Prerequisites: None
Corequisites: None
Tutorial: No

Course contents This course will cover the application of theoretical and empirical economics to the analysis of environmental and resource management issues. Specific topics will include global climate change, the relation between international trade and the environment, energy use, and the extraction of exhaustible and non-exhaustible resources. Cross-cutting these topics will be an emphasis on how economic analysis can contribute to contemporary policy debates.

042101 – Resolving Wicked Environmental Problems

Short Name: ResWickEnvirProbl
Type: Lecture
Semester: 1
Credit Points: 5 ECTS
Prerequisites: None
Corequisites: None
Tutorial: No

Course contents In the early 1970s, planning experts Horst Rittel and Melvin Webber coined the term 'wicked' as a label for the most difficult type of problems facing decision-makers. They argued that much harm has come from continuous attempts to resolve the wicked problems that abound in today's complex societies with methods that are only appropriate for simple (or 'tame') issues. In this course, you learn to distinguish wicked from tame environmental problems, and gain insight into the policies and institutions with which wicked environmental issues can be successfully resolved. In the process, you come to understand the alternative views of time, space, risk, nature, human nature, technology and democracy that stakeholders in debates about wicked environmental problems believe in. You are also introduced to a leading social theory with which to better understand these issues. Examples of

wicked environmental problems that we look at include climate change, loss of biodiversity, Himalayan deforestation as well as the pollution of the Rhine river and the Great Lakes.

4.2 Second Year of Study

4.2.1 IES

041201 – Geospatial Environmental and Resource Data Analysis

Short Name: GERDA
Type: Lecture
Semester: 3
Credit Points: 2.5 ECTS
Prerequisites: 210101
Corequisites: None
Tutorial: No

Course contents This introductory course on geospatial data analysis and Geographic Information Systems (GIS) will focus on the use of spatial information systems and technologies such as ArcGIS for modellling and analysis of environmental data and resource management. The main purpose is to train students in environmental problem-solving skills using data analysis and GIS techniques.
GIS provides the tools to combine, manage, visualize, and map large volumes of complex multidimensional geographical data and use it for spatial correlation, analysis, and modeling. This course will introduce you to the principles, methods, techniques and applications of GIS through a variety of lectures and hands-on computer exercises. Aspects of computer sciences, cartography, geodesy, remote sensing and advanced topics such as spatial interpolation, surface analysis, terrain modeling, raster / vector data models, landscape pattern analysis, land cover modeling and resource management will be touched upon during this course.

040261 – IES Seminar I

Short Name: IESSemI
Type: Seminar
Semester: 3
Credit Points: 2.5 ECTS
Prerequisites: 040101, 040102, 210101, 210102, 210111, 930201
Corequisites: None
Tutorial: No

Course contents The IES seminar series provides a forum for the presentation of talks on the complete range of topics encountered in the program Integrated Environmental Studies. It serves as an integrated platform for interdisciplinary discussion and exchange of information on ongoing research within the community at Jacobs University Bremen related to the program. Apart from contributions by faculty and students from Jacobs University, external guest speakers will be invited. Moreover, the seminar promotes the development and improvement of oral presentations and discussion skills. The topics of the presentations will be defined in one of the first seminar sessions.

040251 – FieldLab/Excursion I: Fossil Fuels: Energy and Construction Materials: Coal and Limestone Mining

Short Name: IESFieldLabI
Type: Field Lab/Excursion
Semester: 3
Credit Points: 2.5 ECTS
Prerequisites: 040101/040102 or 210101 and 210102
Corequisites: None
Tutorial: No

Course contents The course is comprised of a two-day excursion/visit to operating open-pit coal and limestone mining operations and also addresses the related impact on ground water quality and management. This course will be taught as a one-weekend-module.

041202 – Field trip to East Frisia: Consequences of changed land use, climate change, and developments in renewable energies

Short Name: IESFieldTrip
Type: Field Lab/Excursion
Semester: 4
Credit Points: 5.0 ECTS
Prerequisites: 040261
Corequisites: None
Tutorial: No

Course contents The excursion is comprised of several days with visits to an East Frisian Island, the UNESCO world heritage region Wadden Sea, the marsh polder land, the moraine "Geest" and the peat bogs located in East Frisia. During the excursion to the 5 macrochores, the differences in the geology, pedology and ecology will be studied to understand the historic and present development of this dynamic landscape and the consequences of climate change for these unique ecosystems and the society. Additionally the chances and consequences of developments in renewable energy and the effects of political decisions on the land use and landscape will be discussed, while visiting an off-shore windpark, biofuel plantations and a biogas plant.

040231 – Fundamental Processes in Ecology

Short Name: FundProcEcol
Type: Lecture
Semester: 3
Credit Points: 5 ECTS
Prerequisites: 120101, 040101, 040102
Corequisites: None
Tutorial: No

Course contents This course will present an overview of major ecological concepts from a rather new and unusual perspective: a process-based perspective. The fundamental processes analysed and discussed in this course are chosen according to their relevance to a planet with carbon-based life that persists over geological timescales. Such processes are: energy flow, multiple guilds, ecological trade-offs and biodiversity, ecological hypercycles, merging of organismal and ecological physiology, carbon

sequestration and photosynthesis. Nutrient cycling will be described as an emergent property of these fundamental processes. Fascinating aspects such as the reasons why a biosphere based on a single species with no nutrient cycling is very unlikely to exist or the possibility that feedbacks between organisms and their environment have helped to maintain habitable conditions on Earth will be explored. By studying the fundamental processes governing the ecology of our planet one can gain a deep understanding of its functioning from an Earth system perspective. The ideas and concepts discussed during the course will be formulated in the context of biology, ecosystem services and conservation biology. A module (8 academic hours) on computational ecology will be part of this course.
Module on Computational Ecology The module on computational ecology will consist of brief theoretical lectures and specific laboratory exercises to introduce the students to exponential, logistic, and nutrient-limited growth models. Moreover, a simple Nutrient-Phytoplankton-Zooplankton (NPZ) model will be presented and a number of exercises will be analysed with the students to explore the diverse dynamic behaviour of consumer-resource systems. To illustrate the importance of life on a planet, a "Daisyworld" model will be introduced. With computer simulations, students will investigate the conditions under which biology regulates fundamental processes on a planet. Recommended is also a computer lab-course on basic programming although a crash-course in the programming language python will be provided with this module.

042231 – Histories of Development

Short Name: HistoriesDevelop
Type: Lecture
Semester: 1
Credit Points: 5 ECTS
Prerequisites: None
Corequisites: None
Tutorial: No

Course contents History provides us with the tools to conceive of alternatives and to weigh current problems in light of past experiences. If 'development' is defined as being more of the same, then 'development' has been a characteristic feature of recorded human history. If we mean by 'development' a planned, coordinated effort to promote higher standards of living and conditions of economic and social progress, then development policies have a history which date back to the early twentieth century. 'Development' has multiple meanings and a fractured history, and the principle aim of this course is to provide students with an in-depth overview into the leading theories of development, actors and institutions, and practices as they evolved over time.
The course familiarizes students with the evolution of development thinking from Adam Smith to contemporary scholars such as Amartya Sen. Changing concepts of development ranging from an emphasis on industrialization to individual empowerment will be discussed. In a second broad trajectory, the course traces the evolution of a set of actors and institutions and their role in development policies. National governments, international organizations and a variety of civil society actors have been active in the field of development. Thirdly, the course probes the challenge of devising and implementing strategies of development in light of the historical experience. Here, the course draws on examples taken from a variety of regions over a longer period of time.

4.2.2 Specialization in Environment and Resources

210302 – Environmental Geosciences

Short Name: EnvirGeoSc
Type: Lecture
Semester: 4
Credit Points: 5.0 ECTS
Prerequisites: 210101, 210102, 210111, 040101, 040102
Corequisites: None
Tutorial: No

Course contents This course covers the development of the atmosphere, the hydrosphere and the geosphere throughout Earth's history from the beginning of the geological record to modern times and focuses on geological, cosmogenic and anthropogenic changes. Several major events in the evolution of the Earth will be discussed, such as the evolution of an oxic atmosphere and ocean, onset of early life, snowball Earth, mass-extinctions in Earth history, and modern glaciation cycles. In the second (more extensive) part of the course, human interactions with natural systems will be discussed. Besides climate change and global warming, the focus is placed upon anthropogenic contamination of the environment and local as well as global consequences for the atmosphere and hydrosphere. The principles of contaminant transports and uptake by organisms are introduced. Heavy metal cycling in terrestrial and marine environments, behavior and transport of organic pollutants, and radioactive compounds are some of the topics. The concept of risk assessment studies is introduced.

040221 – Fundamentals of Hydrogeology

Short Name: Hydrogeology
Type: Lecture
Semester: 3
Credit Points: 2.5 ECTS
Prerequisites: 040101, 040102, 210101, 210102
Corequisites: None
Tutorial: No

Course contents The course will provide a basic introduction to hydrogeology, touching upon issues such as the study of groundwater and groundwater chemistry, groundwater flow, well hydraulics, groundwater quality and pollution and resource exploration, evaluation, and management. This course will be taught as a one-week-module during intersession in January.

040241 – Introduction to Soil Sciences

Short Name: SoilSciences
Type: Lecture
Semester: 3
Credit Points: 2.5 ECTS
Prerequisites: 040101,040102, 210101, 210102
Corequisites: None
Tutorial: No

Course contents Overall aim of the course is to understand soils as a complex and multi-functional part of ecosystems, which is non-renewable and has to be protected. Soil development determines the

functioning of soils as ecosystem compartments. Following this conceptual model, the course will start with the processes of soil development and the effect of different soil forming factors on soil formation. The distribution of soil units on a global scale will be shown. Then we will educe soil properties and ecological functioning of soils from soil development. Interactions between soils and other ecosystem compartments (hydrosphere, biosphere) will be clarified. Finally the use of soils and human impact on soils will be addressed.

400101 – General Inorganic Chemistry

Short Name: GenChem I
Type: Lecture
Semester: 3
Credit Points: 5 ECTS
Prerequisites: None
Corequisites: None
Tutorial: Yes

Course contents An introduction to chemistry that comprises the following parts: Introduction and definitions of history, elements, compounds, units; Chemical reactions: Chemical equations, energy, reaction rates, equilibrium, acids and bases, thermodynamics. Atoms and Atomic structure, Spectroscopy, the hydrogen atom, many electron atoms, the periodic properties of the elements, the chemical bond, ionic bonds, lattice enthalpy, covalent bonds, hydrogen bonds, the shape of molecules (VSEPR). The elements and their properties: A walk through the periodic table - characteristic properties, natural abundance and chemistry of main group elements and transition metals

210201 – Geology I: Volcanism and Metamorphism

Short Name: Geology1
Type: Lecture
Semester: 3
Credit Points: 2.5 ECTS
Prerequisites: 210101, 210102
Corequisites: None
Tutorial: No

Course contents Course contents Introduction to the fundamentals of (physical) geology. Part I starts with a discussion on how magma forms in the Earth's mantle and what igneous rocks crystallize from it. Plutonic, volcanic and pyroclastic rocks, volcanoes and their different eruption styles will be introduced. We will also discuss the reaction of rocks to increasing pressure and temperature, touch upon metamorphism and introduce the concept of metamorphic facies and the mineral assemblages typical of them. In addition to lectures, the course comprises practicals in rock description and recognition.

210281 – Geology II: Sedimentology and Structural Geology

Short Name: Geology2
Type: Lecture
Semester: 3
Credit Points: 2.5 ECTS
Prerequisites: 210101, 210102
Corequisites: None
Tutorial: No

Course contents This course provides an introduction to the fundamentals of (physical) geology. In part II, students will be made familiar with the basics concepts of structural geology, sedimentary geology and stratigraphy. Topics such as folding and faulting will be covered and a basic introduction to geological field mapping will be provided. The sedimentology part will focus on the identification and recognition of sedimentary features and an understanding of modern and ancient processes and environments.

4.2.3 Specialization in Energy Policy and Technology

040201 – Sustainable Energy Policy

Short Name: SusEnergy
Type: Seminar
Semester: 3
Credit Points: 5 ECTS
Prerequisites: None
Corequisites: None
Tutorial: No

Course contents How can wide-scale social, economic and political change be achieved? In this course, we explore this question in the context of encouraging "sustainability". To address global warming and environmental degradation, humans must adopt more sustainable lifestyles and switch from fossil fuel to low-carbon energy sources. Almost all countries, regions, companies and individuals must alter how they source and use energy. The main challenge to achieving this "energy transition" stems from human behavior and not from a lack of technology or scientific know-how. This course thus examines the transition from the perspective of the social sciences, including political science, sociology, psychology, economics and management. Some of the key questions the course addresses are: What is meant by sustainability? Are renewable energies "sustainable"? How can a change to sustainable energies be encouraged? What are the challenges? The aim of the course is to prepare students to critically assess sustainable energy policies from multiple perspectives.

040202 – Energy Economics

Short Name: EnergyEcono
Type: Seminar
Semester: 4
Credit Points: 5 ECTS
Prerequisites: 930201
Corequisites: None
Tutorial: No

Course contents Energy is indispensable to the functioning of a modern economy. Securing access to low-cost and reliable sources of energy while at the same time maintaining environmental stewardship are among the most pressing challenges of our age. The aim of this course is to introduce students to economic theories and analytical frameworks for analyzing these issues. The course will begin by covering the economics of energy supply, focusing on both renewable and non-renewable energy sources. On the demand side, the course will distinguish between energy use in the residential, industrial and transportation sectors. Finally, the course will address the functioning of energy markets and market design. This will include discussions on the international oil market, the markets for natural gas, developments in the coal market, and the economics of energy-environment interactions. The course will regularly draw on case studies to illustrate the theoretical concepts.

040211 – International Energy and Environmental Politics

Short Name: Geopolitics
Type: Lecture
Semester: 3
Credit Points: 5 ECTS
Prerequisites: None
Corequisites: None
Tutorial: No

Course contents Because of the critical importance of energy to a state's stability and prosperity, energy-related strategies and foreign policy have historically been driven by a mixture of economic and geopolitical factors. In recent years, environmental policy - particularly pertaining to global warming - has begun to follow suit. In this course students will gain an understanding of the political dimension of energy and environmental matters through an examination of historical and contemporary examples of geopolitical jostling over energy supply (for example, Central Asia, Asia, Russia, the US, South America, and Europe) and by exploring topics such as energy security, nationalization, resource wars, climate change, and the resource curse. We will also assess the political implications of the shift to renewable energy: are political and energy security concerns likely to remain the same, increase or lessen?

970202 – Public Management and Public Policy

Short Name: PublicManagement
Type: Seminar
Semester: 4
Credit Points: 5 ECTS
Prerequisites: None
Corequisites: None
Tutorial: No

Course contents This course introduces the student to the theory and practice of public management and public policy analysis. On the one hand, the course will provide the student with an overview of what public management is today, how it has changed in the past 30 or so years and where it is going. Not only will the course expose students to contemporary thinking in public management, by looking at the way public managers over the world deal with today's policy challenges, the course will also allow students to apply this knowledge to real cases. On the other hand, the course exposes students to the conceptual and methodological tool-box of contemporary policy analysis and, by drawing on real-life examples from a variety of policy domains, shows students how academic and professional policy analysts bring this tool-box to bear on issues of public management and public policy. Additionally, the course will show how different socio-cultural, political or disciplinary frames of references shape policy analysis and how policy analysts can use these frames to sharpen their understanding of the way public institutions are managed.

4.3 Third year of study

4.3.1 IES

040361 – IES Seminar II

Short Name: IESSemII
Type: Seminar
Semester: 5
Credit Points: 2.5 ECTS
Prerequisites: 040101, 040102, 210101, 210102, 210111, 930201, 040261
Corequisites: None
Tutorial: No

Course contents The IES Seminar II is a continuation of IES seminar I and is mandatory for third-year students of Integrated Environmental Studies. It will include presentations by registered students, guest speakers, Jacobs University faculty and graduate students on research topics or literature reviews related to all fields of IES.

040362 – IES Seminar III

Short Name: IESSemIII
Type: Seminar
Semester: 6
Credit Points: 2.5 ECTS
Prerequisites: 040101, 040102, 210101, 210102, 210111, 930201, 040261, 040361
Corequisites: None
Tutorial: No

Course contents The IES Seminar III is a continuation of IES seminar II and is mandatory for third-year students of Integrated Environmental Studies. It will include presentations by registered students, guest speakers, Jacobs University faculty and graduate students on research topics or literature reviews related to all fields of IES.

041301 – Waste Management & Technology

Short Name: WasteManageTech
Type: Lecture
Semester: 5
Credit Points: 2.5 ECTS
Prerequisites: 040101, 040102
Corequisites: None
Tutorial: No

Course contents The course is designed to give students an overview of all waste handling, management and disposal technologies. The lecture course will cover waste disposal, waste transport, landfill design, waste management and recycling technologies. The series will start with discussion on waste composition and an outline of chemical fate and environmental fate analysis and the dangers of heavy metals. Landfill design, leachate collection systems, compact clay liners, covers and the barrier materials will be included. A description of contaminant transport processes will be given, and contaminant transport modeling will be briefly introduced. Waste management including plastic and paper recycling will be discussed with the relevant environmental impacts. The waste incineration technologies and

disposal will also be included. This course will be taught as a one-week-module during intersession in January.

560341 – Environmental Biotechnology

Short Name: EnvironBiotech
Type: Lecture
Semester: 5
Credit Points: 5 ECTS
Prerequisites: None
Corequisites: None
Tutorial: None

Course contents Environmental Biotechnology is also known as Grey Biotechnology. It is the fundamental basis of applied biotechnology when it is applied to and used to study processes in the natural environment. Environmental Biotechnology could also imply that one try to harness biological process for commercial uses and exploitation. The growing concern over the quality of our environment demands prevention of polluting releases in the ecosystem and treatment of pollutants already there. The lecture course will deal with aerobic and anaerobic treatment of waste water. The most important part of a waste-water cleaning plant is the biological part. During several hours of stay a considerable part of the pollution is removed by bacteria and the BOD5 (biological oxygen demand) is reduced by 85 to 95% during the waste-water treatment. Modern waste-water treatment plants do a good job for the removal of the organic matter. The problem nowadays is the removal of nitrogen (ammonia and nitrate) and phosphate from waste-water. The essential processes are nitrification (i.e. oxidation of ammonia to nitrate) and denitrification (i.e. the reduction of nitrate to nitrogen). These processes cannot proceed at the same time or in the same place because nitrification needs high oxygen concentration (oxygen concentration above 2 mg/l) whereas denitrification needs anaerobic condition (oxygen concentration lower than 0.1 mg/l). All the different aerobic and anaerobic biological processes that are involved in the elimination of organic pollution from waste water and soil will be discussed in the course.

040351 – IES Field Camp Iceland: Environment, Resources and Energy

Short Name: IESFieldCamp
Type: Field Trip
Semester: 5
Credit Points: 5 ECTS
Prerequisites: all first, second, third, fourth semester courses mandatory of the respective specialization area
Corequisites: None
Tutorial: No

Course contents The course is an at least one week long field camp in Iceland where the participants will visit hydroelectric and geothermal power plants and geothermally active volcanic areas. The impact of global warming will be addressed during visits to glaciers in southern Iceland and the topic of geohazards will be discussed using explosive volcanic eruptions and their impact on agriculture, industry and tourism as examples. This course will be taught as a one-week-module in June after the fourth semester.

4.3.2 IES Bachelor Thesis

All IES students must write a bachelor's thesis in their sixth semester. Students from either specialization may write their thesis under the supervision of either an SES or SHSS faculty member. Students who

select an SES faculty member as their thesis supervisor must register for the IES Guided Research/Thesis course (040322, details below). Students who opt for an SHSS faculty member as supervisor must register for the Bachelor Thesis Seminar (990301, details below). Please note, in addition to their thesis supervisor, students in 990301 will also be assigned a seminar course instructor. All IES students must provide the IES coordinators with a preliminary sketch of their Thesis (title and short description of the thesis as well as the name of the Thesis supervisor) on the first Friday of February.

040322 – Guided Research/Thesis

Short Name: GRBScIES
Type: Lecture
Semester: 6
Credit Points: 7.5 ECTS
Prerequisites: all 1st to 5th semester courses mandatory of the respective specialization area
Corequisites: None
Tutorial: No

Course contents Majors in IES must work on small research projects called Guided Research Projects (GRPs) in their sixth semester of study. This work is formally organized in the framework of Guided Research Courses (GRCs). A GRP may focus on experimental work, a field campaign, data analysis, computer simulations, theory, modeling, or a literature review. Students who are interested in a broader project may be given the opportunity to combine this course with a fifth semester course and already start their B.Sc. thesis project in the fifth semester. However, this has to be discussed with and approved by the IES coordinator(s) before(!) Sept. 20th of the respective fall semester. In any case, students are most strongly recommended to contact supervisors/instructors of their GRP before the end of the fifth semester. In any case, it is mandatory to formally submit the tentative title of the GRP/B.Sc. thesis and the name and written consent of the GRP supervisor to the IES coordinator(s) on February 20th of the respective spring semester at the latest. Although students may chose to prepare their GRP with external supervision/collaboration (at a company or research institute), they always need a Jacobs faculty as a responsible co-supervisor. Each GRP/B.Sc. thesis must be concluded with a written report which will be graded.

990301 – Bachelor Thesis Seminar

Short Name: GRBScIES
Type: Seminar
Semester: 6
Credit Points: 7.5 ECTS
Prerequisites: all 1st to 5th semester courses mandatory of the respective specialization area
Corequisites: None
Tutorial: No

Course contents The purpose of this course is to guide students through the process of writing their baccalaureate thesis. The seminar serves as a source of technical advice and as a forum for the discussion of problems encountered in the writing process. It also trains students to review, critically assess and discuss research projects. Classes are kept small and are organized around related topics for the baccalaureate thesis. Each group is instructed by a regular faculty member and will meet in a at least four workshops organized around the following topics:

- 1. Brief review of research design issues
- 2. Developing a research question and writing a research proposal

- 3. Discussing and improving the research proposal
- 4. Presentation of progress report
- 5. Presentation and discussion of main scientific contribution of thesis

The baccalaureate thesis is intended to demonstrate mastery of the contents. Topics for the baccalaureate these will be developed by the students in close cooperation with their thesis supervisors. The thesis must be at least 6,000 words and not longer than 7,000 words, including footnotes. This does not include the title page, student declaration, abstract, table of contents, bibliography, and appendices.

4.3.3 Specialization in Environment and Resources

210381 – Resource Geology I: Oil, Natural Gas and Coal

Short Name: ResGeology1
Type: Lecture
Semester: 5
Credit Points: 2.5 ECTS
Prerequisites: 210101, 210102, 210111, 210162, 210271, 210281, 210252
Corequisites: None
Tutorial: No

Course contents This course is an introduction to the genesis, occurrence, characteristics, economic and geopolitical importance of hydrocarbon reservoirs. Based on the "seven petroleum geological magics" the development of petroleum systems consisting of source rocks and their maturation, migration of hydrocarbons, deposition of reservoir and seal rocks, the formation of geological traps, and the favorable timing of all these processes will be presented, followed by volumetric reservoir calculations. An overview on the chemistry and physics of oil and gas including the occurrences of conventional and unconventional oil and gas (e.g. gas hydrates and tar sands) and their geopolitical importance will be introduced. The course will be concluded with an overview on different exploration and exploitation methods (e.g. enhanced oil recovery). The lectures will be supplemented by practical exercises.

210391 – Resource Geology II: Mineral Resources

Short Name: ResGeology2
Type: Lecture
Semester: 5
Credit Points: 2.5 ECTS
Prerequisites: 210101, 210102, 210111, 210162, 210271, 210281, 210252
Corequisites: None
Tutorial: No

Course contents This course is an introduction to the genesis, occurrence, characteristics, economic significance, and resource assessment of metallic and non-metallic ore deposits. After an introduction to the principles of ore formation, magmatic, sedimentary and metamorphic ore-forming environments are presented. Different metal ore deposits, including base metal, precious metal, iron and alloy ore deposits will be addressed. Also rare metals of interest for new high-tech industries will be a topic of the course. Deposits of industrial minerals and uranium as an energy resource will finalize the course curriculum. The lectures will be supplemented by practical exercises and student presentations on selected topics.

4.3.4 Specialization in Energy Policy and Technology

201231 – Renewable Energy

Short Name: RenewEnergy
Type: Seminar
Semester: 6
Credit Points: 5 ECTS
Prerequisites: None
Corequisites: None
Tutorial: No

Course contents Renewable energy resources promise to provide clean, decentralized solutions to the world energy crisis, as energy resources which directly depend on the power of the sun's radiation. The course gives an overview of the potential and limitations of energy resources. We start with an overview of energy scenarios based on current energy needs and available energy resources. After an introduction to the basic physics of solar energy we cover physics and engineering aspects of solar cells, solar thermal collectors, wind power, geothermal power, thermophotovoltaics, the potential of biomass energy resources, hydro, tidal and wave energy.