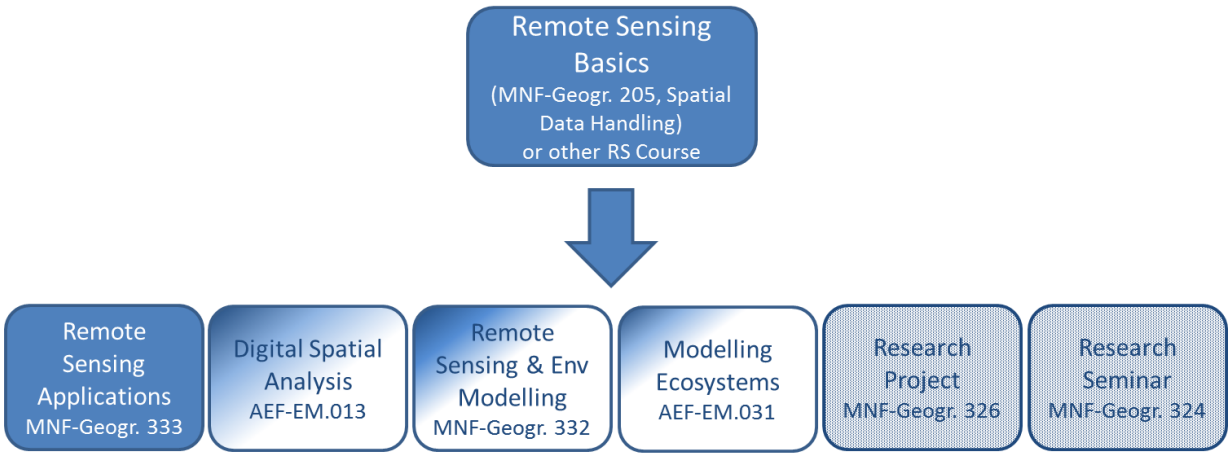
Remote Sensing and Environmental Modelling as major field of study in the Master programs of the School of Sustainability at CAU

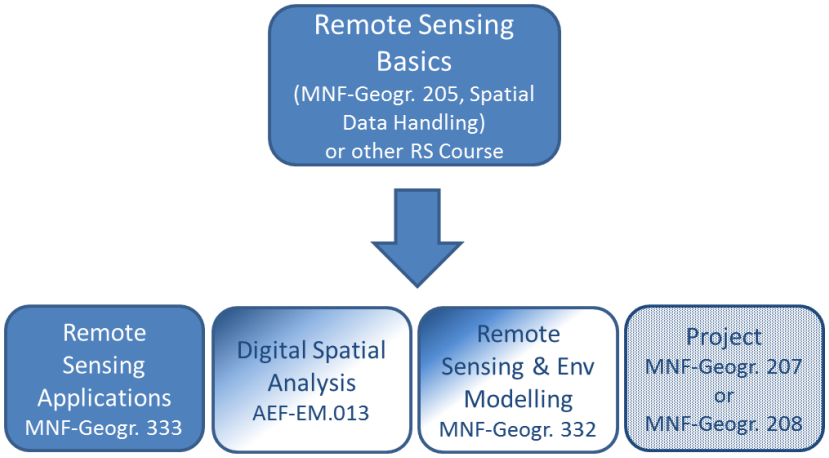
The Remote sensing and Environmental Modelling stream aims to deepen the understanding of environmental processes via the use of remote sensing data and ecosystem models. Remote sensing and modelling techniques are increasingly providing important components of technologies available for the study of ecosystems and their functioning. With our classes we intend to give insights into state-of-art remote sensing and modelling approaches for analysing ecosystems, the interaction of processes and the response of ecosystems to a changing environment. However, the courses have a strong emphasis on the physical environment.

For students which aim to attend the Remote Sensing and Environmental Modelling stream but do not have any previous knowledge on remote sensing we strongly recommend attending the Spatial Data Analysis (S 21) module.



Overview of modules in the Remote Sensing and Environmental Modelling Stream for **UGM** students (colours indicate remote sensing (blue) and modelling (white) shares); depending on the topic research project and research seminar may have varying shares.

To pass the stream UGM students need to attend (and pass) at least 3 modules out of 6 (S 119, 116, 117 and 026, Project (MNF-Geogr. 326), Research Seminar (MNF-Geogr. 324)).



Overview of modules in the Remote Sensing and Environmental Modelling Stream for **SSE and EM** students (colours indicate remote sensing (blue) and modelling (white) shares); depending on research topic research project and research seminar may have varying shares

To focus on remote sensing we recommend SSE and EM students to attend 3 of the above mentioned modules out of the B3 module complex and one project.

Remote Sensing Basics (part of MNF-Geogr.205; Complimentary Methods)

Lecture + practical exercises (N. Oppelt, F. Uhl)
Preconditions: Excel, Windows
RS/Modelling share: 100 % pure remote sensing

Remote Sensing Basics (part of the Spatial Data Analysis (S 21) module). This interactive, computer based module is intended as an overview on remote sensing principles and touches on physics, environmental sciences, computer sciences and geography. The course provides an introduction to Earth observation on the terrestrial environment using freely available software tools. No prior knowledge of the subject is assumed. The module is structured to take students from the underpinning physical principles of the subject, through the properties of the most prominent sensors, the basic principles of image interpretation to examples of the applications of remote sensing data.
The students will gain a basic understanding of physical, radiometric and geometric principles of Earth observation (EO) data and their analysis. They will learn basics of visual image interpretation (real and false colour composites; thermal data), image enhancement (e.g. calculation of indices) and digital image analysis using remote sensing freeware (Beam, EnMAP or Sentinel-Toolbox).

Recommended literature:

- Campbell, J.B. & Whynne, R.H. 2011. Introduction into Remote Sensing. Guilford Press.
- Tutorial "Fundamentals of Remote Sensing" of Natural Resources Canada
  http://www.nrcan.gc.ca/earth-sciences/geomatics/satellite-imagery-air-photos/satellite-imagery-products/educational-resources/9363

Remote Sensing Applications (MNF-Geogr.333, TB 3 Environmental Management)

Practical exercises (N. Oppelt, G. Riegler (Novlum))
Precondition: Remote Sensing Basics course or other RS courses, Excel, Windows
RS/Modelling share: 100 % pure remote sensing

Remote sensing is a popular method for monitoring the Earth's surface, its state as well as direct and indirect indicators for environmental, ecological and socio-cultural change. Institutions and organizations such as the UN, EU, ESA and NGOs use remote sensing data to analyse changing conditions themselves or to hand over pre-processed data to experts of other disciplines. A systematic spatial assessment of ongoing changes is essential to achieve a better understanding of the dynamics of the process and to help support decision-makers and stakeholders. The course "Remote Sensing Applications" covers remote sensing methods for processing and interpreting data in more advanced fields of remote sensing (e.g. precision agriculture, monitoring of environmental hazards, forest degradation, RADAR, digital elevation models). The potential and limitations of remote sensing data are addressed with special emphasis on qualitative (i.e. visual) and quantitative interpretation methods. A part of the course also addresses the marketing and value of remote sensing data for industry, governmental and non-governmental organisations.

Recommended literature:

- Campbell, J.B. & Whynne, R.H. 2011. Introduction into Remote Sensing. Guilford Press.
- Tutorial "Fundamentals of Remote Sensing" of Natural Resources Canada
  http://www.nrcan.gc.ca/earth-sciences/geomatics/satellite-imagery-air-photos/satellite-imagery-products/educational-resources/9363

Digital Spatial Analysis – Practical Exercises (AEF-EM.013, TB 3 Environmental Management)

Practical exercises (N. Oppelt, G. Hörmann)
Preconditions: Remote Sensing Basics course or other RS courses, GIS, Excel, Windows
RS/Modelling share: 40 % / 60 %

Work with data of research stations, monitoring projects, satellite and orto-photo data depending on tasks. In the remote sensing part the students learn to visually analyse remote sensing data of the respective research area (e.g. India, China) to get an insight into the landscape setting and practice analysis of satellite images using remote sensing freeware (e.g. BEAM, Sentinel or EnMAP toolbox). Working in small groups the students learn to process remote sensing data to serve as input or validation data for model approaches they deal with in the modelling part where they learn different techniques for collecting spatial data in different geographic regions. And get an introduction into theory of the soft- and hardware of spatial analysis, modelling of spatial systems with PC grid. They learn to create a data-and map basis of a certain area, which can be used as basis for planning and modelling. They further build a simple, raster based spatial model with PC Raster.

Recommended literature:

- Richards, J.A. and Xiuping, J. 2006. Remote sensing digital image analysis. An introduction. Springer.
- PC Raster Manual of the PC-Raster Development Group http://pcraster.geo.uu.nl/documentation /index.html

Remote Sensing and Environmental Modelling (MNF-Geogr.332, TB 3 Environmental Management)

Lecture + practical exercises (N. Oppelt, M. König)
Preconditions: Remote Sensing Basics course or other RS courses, basics in oceanography and GIS (we recommend GIS and modelling basics (EM Hörmann), Excel, Windows
RS/Modelling share: 50 % / 50 %

The understanding of environmental processes and the analysis of interactions between environment, ecosystems and humans is increasingly important in environmental stewardship and the development of sustainable means of human dependency on environmental systems. Environmental modelling is an essential tool that allows scientists, managers and decision makers both to understand reality and to enable future scenarios. Since simulation of spatially distributed phenomena and processes becomes increasingly important, spatial information are needed as input data as well as for calibration and validation purposes – a gap which can be filled by using remote sensing data. The course “Remote Sensing and Environmental Modelling” covers the possibilities and problems of the use of RS in order to model environmental systems. The lecture will give an introduction to model theory of bio-optical models (e.g. WASI-2D) as well as accuracy assessment and interpretation of model results.

Main subjects of the pratical part of the module are the set up of hydrological/ecological models, analysis and interpretation of model results, integration of remote sensing data into ecological models as a calibration and validation basis.

Recommended literature:

Dörnhöfer, K.; Oppelt, N. 2016. Remote sensing for lake research and monitoring - recent advances. Ecological Indicators 64, pp. 105-122. (Paper addresses inland water; most of it, however, also applies to coastal waters)

Gege, P. 2014. WASI-2D – a software tool for regionally optimized analysis of imaging spectrometer data from deep and shallow waters. Computers & Geosciences 62, pp. 208-215.

Modelling Ecosystems (AEF-EM.031, TB 5 Systems Theory and Ecosystem Services)

Practical exercises and 3 day pre-course (K. Wirtz (Helmholtz Centre Geesthacht))
Preconditions: Remote Sensing Basics course or other RS courses, math (5th grade)
RS/Modelling share: 10 % / 90%

This module is a perfect add-on, but not a must-have for the remote Sensing and Environmental Modelling course. The module introduces underlying concepts, major techniques, and relevant working stages of environmental modelling of aquatic resources. The course is built on a preparatory rehearsal module on basic mathematical methods and script programming. In the main module, the motivation for environmental modelling and an overview on model types will be provided. Along a focal problem such as eutrophication or biodiversity loss, own model approaches will then be developed and discussed. Within this practical part, students will learn to solve recurrent problems and will experience limitations and potentials of environmental modelling.

Exercises will be addressed using scripts and models implemented in R or, on demand, in another computer framework such as R or MATLAB. The module should enable the participants to better evaluate modelling as an increasingly important approach in environmental science and management, and to devise own models during their curriculum.

Recommended literature:

- Haefner, J.W. 2005. Modelling biological systems: principles and applications.
- Sortaert, K. and Hermann P.M.J. 2009. A practical guide to ecological modelling.

Project or Projektstudie (MNF-Geogr.207, 208, TB A Core Modules)

Research project (N. Oppelt)
Preconditions: depend on topic
RS/Modelling share: depends on topic

Students will carry out research or applied projects, generally individually or in small teams (depending on extent and difficulty of research topic). The students introduce themselves into the topic, draw up a time schedule, carry out the project work and present results in a seminar/workshop.

Schedule of courses

Remote Sensing Basics: = Spatial Data Handling, winter term 2018/19

Remote Sensing and Environmental Modelling: summer term 2019

Ecosystem Modelling: Probably summer term 2019

Digital Spatial Analysis: Summer term 2019

Remote Sensing Applications: last course was in September 2018, next course most probably in spring 2020