Eberswalde University for Sustainable Development

Module catalogue

Forest Information Technology (M.Sc.)

valid from WiSe 2021/2022

Inhalt

1. Semester FIT

M Introduction to Forest Information Technology I

Semester:	1
Module coordinator:	Prof. Dr. Jens Müller
Status:	Mandatory
Goal:	Students understand principles of forest data models and their spatial representation.
Examination form	Project report (100%)
ECTS-Credits:	6
SWH:	4

Module Component 1 Principles of forest data structures

Semester:	1
Coordinator:	Prof. Dr. Jens Müller
Lecturer:	Prof. Dr. Jens Müller
ECTS-Credits:	3
SWH:	2
Workload:	75 h / Semester
Teaching form	Lecture (15 h), Practical exercise (15 h), Self-study (45 h)
Max. study places	
Language:	English
Module type	blocked
Examination form	Project report (50%)
Entry requirements	-

Goal:	Students gain fundamental knowledge about forest data structures and their spatial and digital representation. They become familiar with IT based methods and techniques of relevance for forest science analysis and management.
Content:	The course makes a link between forest and environmental measurements and processes and the data structures most appropriate to represent them. Addressed are basic (e.g. arrays, lists, matrices) and complex (e.g. databases, georeferenced data, metadata) structures, as well as their digital representation in the computer. Concrete examples from forestry and environmental sciences are used, including imagery, categorical variables, images and video.
Recommended related elective modules :	
Competences :	Technical competence (40%) Media competence (20%) Methodological competence (40%)
Literature:	Bivand, Roger S., Edze Pebesma, and Virgilio Gomez-Rubio. 2013. *Applied Spatial Data Analysis with R, Second Edition*. Springer, NY. Deitel, P. J., & Deitel, H. (2020). Intro to Python for Computer Science and Data Science: Learning to Program with AI, Big Data and the Cloud. Pearson Education, Incorporated. West, P.W. 2004. *Tree and Forest Measurement*. Springer.

Module Component 2 — Principles of GIS and Remote Sensing 1

Semester:	1
Coordinator:	Prof. Dr. Jan-Peter Mund
Lecturer:	Prof. Dr. Jan-Peter Mund, Prof. Dr. Jens Müller
ECTS-Credits:	3
SWH:	2
Workload:	75 h / Semester
Teaching form	Lecture (15h), Practical exercise (15h), Self-study (45h)
Max. study places	
Language:	English
Module type	blocked
Examination form	Project report (50%)
Entry requirements	-

Goal:	Students get an applied introduction to the use of geospatial data and technology in ecological and sustainable forest management and applied forest technology and more broadly in environmental sciences. Students understand principal methods of geospatial spatial data. They deploy essential and state of the art geospatial technology and are able to analyze and interpret geospatial data collected primarily in forest ecosystems.
Content:	Students develop skills in collecting spatial data and using Geographical Information Systems (GIS), especially geospatial data management and analysing tools and software in order to survey, handle and analyse geospatial datasets and information. Students handle GIS software focussing on simple Open Source tools and on the ESRI ArcGIS product family. Several applied data surveying, handling analysing tasks considering about particular applications with special emphasis on forest management. In the second part students will get to know the physical bases of Remote Sensing (RS) (optical and microwaves). The role of RS as method of monitoring and inventory of forest and environment is introduced, discussed and demonstrated with the help of various practical applications. Different branches of RS such as photographs, aerial RS and satellite RS are handled. Another focus is on image processing and on image interpretation and classification. The use of RS as source of GIS data and information is demonstrated. The students learn to apply relevant software products. Examples for practical exercises come mainly from forest protection.
Recommended related elective modules :	
Competences :	Technical competence (50%) Media competence (20%) Methodological competence (30%)
Literature:	Campbell, J.B. (2007): Introduction to Remote Sensing. Guilford Press, New York. Lillesand, T.M., R.W. Kiefer (2008): Remote Sensing and Image Interpretation. John Wiley & Sons, Inc. Jones, H. G. & Vaughan, R. A. 2010: Remote Sensing of Vegetation: Principles, Techniques, and Applications. Pearson Education Ltd- Jensen, J. R. (2013): Remote Sensing of the Environment: Pearson New International Edition: An Earth Resource Perspective. Aronoff, M (2005): Remote Sensing for GIS Managers, ESRI Press additional relevant literature and current scientific resources will be provided by the lecturer

M Introduction to Forest Information Technology II

Semester:	1
Module coordinator:	Prof. Dr. Luis Miranda (luis.miranda@hnee.de)
Status:	Mandatory
Goal:	The students identify concepts and use techniques of information technology of relevance for forest science, particularly with data management and computer programming.
Examination form	Project report (single exam)
ECTS-Credits:	6
SWH:	4

Module Component 1 Programming I

Semester:	1
Coordinator:	Prof. Dr. Luis Miranda
Lecturer:	Prof. Dr. Luis Miranda
ECTS-Credits:	3
SWH:	2
Workload:	75 h / Semester
Teaching form	Lecture (12 h), Practical exercise (18 h), Self-study (45 h)
Max. study places	
Language:	English
Module type	
Examination form	Project report (50%)
Entry requirements	-

Goal:	The students identify and select data types and structures according to a given problem. The students deploy algorithms conceptually and implement them using a programming language.
Content:	The students are introduced to the computer programming from a basic level. The course comprises data types and basic structures, flow control and design of algorithms as well as simple data files and I/O-techniques. The course uses the python scripting language to introduce concepts from computer programming and introduces the use of pseudocode and flowcharts. Examples from environmental sciences and forestry are used to illustrate the design techniques and the selection of suitable data types and structures.
Recommended related elective modules :	
Competences :	Technical competence (50%) Media competence (10%) Methodological competence (40%)
Literature:	Lambert, K. A. (2011). Fundamentals of Python: First Programs. Cengage Learning. Lee, K. D. (2014). Python programming fundamentals. Shaw, Z. A. (2017). Learn python 3 the hard way: A very simple introduction to the terrifyingly beautiful world of computers and code. Addison-Wesley Professional.

Module Component 2 — Programming II

Semester:	1
Coordinator:	Prof. Dr. Luis Miranda
Lecturer:	Prof. Dr. Luis Miranda
ECTS-Credits:	3
SWH:	2
Workload:	75 h / Semester
Teaching form	Lecture (12 h), Practical exercise (18 h), Self-study (45 h)
Max. study places	-
Language:	English
Module type	blocked
Examination form	Project report (50%)
Entry requirements	-

Goal:	The students use computer programming techniques to analyze complex datasets from practical applications in environmental science and forestry. The students develop programs that handle with different data types and structures.
Content:	The course build upon the contents from Programming 1 further expanding the techniques with particular libraries for data analysis. The scripting language python is used in combination with jupyter notebooks to emphasize data preprocessing and curation, queries and plotting. The course introduces the use of data frames as data structure and uses them to calculate simple statistics and basic manipulation of time series. JSON, CSV and raw-text data files are presented and used as an interface with other specialized software. An integrating project is designed as application of the studied techniques.
Recommended related elective modules :	
Competences :	Technical competence (50%) Media competence (10%) Methodological competence (40%)
Literature:	Lee, K. D. (2014). Python programming fundamentals. McKinney, W. (2012). Python for data analysis: Data wrangling with Pandas, NumPy, and IPython. " O'Reilly Media, Inc.". Shaw, Z. A. (2017). Learn python 3 the hard way: A very simple introduction to the terrifyingly beautiful world of computers and code. Addison-Wesley Professional.

M Introduction to Forest Information Technology III

Semester:	1
Module coordinator:	Dr. Evelyn Wallor (evelyn.wallor@hnee.de)
Status:	Mandatory
Goal:	The students can organize and structure spatial environmental data in the form of a conceptual database and analyze and spatially visualize it with the help of suitable software applications. They are able to implement spatial data models using techniques from programming, cartography and statistics.
Examination form	Work report (50%), Written exam (50%)
ECTS-Credits:	6
SWH:	4

Module Component 1 Forestry data structures and spatial data models

Semester:	1
Coordinator:	Dr. Evelyn Wallor
Lecturer:	Dr. Evelyn Wallor, Prof. Dr. Luis Miranda
ECTS-Credits:	3
SWH:	2
Workload:	75 h / Semester
Teaching form	Lecture (12 h), Practical exercise (18 h), Self-study (45 h)
Max. study places	
Language:	English
Module type	blocked
Examination form	Work report (50%)
Entry requirements	-

Goal:	Students know the theoretical fundamentals of data concepts and are able to plan and to implement databases for spatial data processing. They define and describe the important data structures and data types involved in the creation of spatial data models and identify the processing techniques required by different types of data. They are able to perform conversions and information retrieval from complex data sources.
Content:	The module component conveys the principle characteristics of environmental data as well as their spatial and temporal dimensions. With respect to the reflection of a section of the real world data structures of environmental data are explored and transferred to a conceptual data model. Relevant elements of formal logic, information technological fundamentals and the steps to create databases, inclusive data modelling, are treated. Different database approaches are handled, although the focus is on relational databases. In the process, students learn and practice the definition and role of data scales and types, relationship types, and the concept of normalization and normal forms. They are trained to apply fundamental expressions and operations for data retrieval based on predefined research questions. SQL is introduced as language to communicate with databases and the differences between stand-alone and client-server applications are demonstrated. For the development of a complex example database containing data from various environmental observation campaigns, students use MS Access and PostrgeSQL. The connection to the database system for data visualisation and further exploration is demonstrated using the DBI package of R and RStudio.
Recommended related elective modules :	
Competences :	Technical competence (50%) Media competence (5%) Methodological competence (40%) Personal competence (5%)
Literature:	Heiberger, R. M., & Holland, B. (2015). Statistical analysis and data display: an intermediate course with examples in R. Revesz, P. (2009). Introduction to Databases: From Biological to Spatio-Temporal. Springer Science & Business Media. Robinson, A. P., & Hamann, J. D. (2010). Forest analytics with R: an introduction. Springer Science & Business Media. Wilks, D. S. (2011). Statistical methods in the atmospheric sciences (Vol. 100). Academic press.

Module Component 2 — Environmental spatial data analysis

Semester:	1
Coordinator:	Prof. Dr. Luis Miranda
Lecturer:	Prof. Dr. Luis Miranda, Dr. Evelyn Wallor
ECTS-Credits:	3

SWH:	2
Workload:	75 h / Semester
Teaching form	Lecture (12 h), Practical exercise (18 h), Self-study (45 h)
Max. study places	-
Language:	English
Module type	blocked
Examination form	Written exam (50%)
Entry requirements	-
Goal:	The students perform statistical analyses of environmental spatial data. They know the advantages and disadvantages of different sampling strategies and monitoring concepts. Students are able to select appropriate statistical procedures and tests to find structures and relations in the data and to justify statements.
Content:	The module component refreshes fundamentals of descriptive statistical analysis and, in connection with it, introduces the software R and RStudio, which will be used during the module component. Students achieve knowledge about different sampling strategies for environmental data collection (e.g. randomized sampling, non-probability sampling) and develop the associated expertise on inferential statistics and test theory (e.g. t-tests, regression analysis, ANOVA). In addition, the following approaches and methods are introduced and trained: Contingency table analysis, sample design for environmental objects as well as cluster and classification methods (e.g. cluster analysis). Data sources and databases from the module component "Forestry data structures and spatial data models" are used.
Recommended related elective modules :	
Competences :	Technical competence (50%) Media competence (5%) Methodological competence (40%) Personal competence (5%)
Literature:	Field, A., Miles, J., Field, Z. (Eds.) (2012). Discovering Statistics using R. SAGE Publications, UK, London. www.sagepub.co.uk/dsur Robinson, A. P., & Hamann, J. D. (2010). Forest analytics with R: an introduction. Springer Science & Business Media. Wilks, D. S. (2011). Statistical methods in the atmospheric sciences (Vol. 100). Academic press. additional relevant literature and current scientific resources will be provided by the lecturer

E Carbon Sequestration and accounting

Semester:	1
Module coordinator:	Prof. Dr. Martin Guericke (Martin.Guericke@hnee.de)
Status:	Elective
Goal:	Students detect and document patterns and processes of anthropogenic ecosystem changes as basis for conceptual modelling, planning and management. The analysis embraces the investigation both the study of ecological as well as socioeconomic phenomena and their cause-effect relationship.
Examination form	Work report (100%)
ECTS-Credits:	6
SWH:	4

Module Component 1 Carbon Sequestration and accounting

Semester:	1
Coordinator:	Prof. Dr. Martin Guericke
Lecturer:	Prof. Dr. Martin Guericke, Prof. Dr. Tobias Cremer, Prof. Dr. Winfried Riek
ECTS-Credits:	6
SWH:	4
Workload:	150 h / Semester
Teaching form	Lecture (30h), Project (30h), self-study (90h)
Max. study places	8 (+ 8 FST + 8 FIT)
Language:	English
Module type	blocked
Examination form	Work report
Entry requirements	-

Goal:

Students understand the carbon cycle with special reference to forests, soils and forest products. They are qualified to develop and critically reflect forest growth scenarios and have acquired basic knowledge of the purpose and the implementation of life cycle analysis (LCA), product carbon footprints (PCF) and corporate carbon footprints (CCF).

Content:

The interactions among vegetation, climate and soil properties as main factors influencing soil carbon storage will be explained. In terms of carbon sequestration the current EU-wide programs for observing and monitoring the element budget in forest ecosystems are presented. An overview of global threats to soils in particular by loss of humus and measures for soil protection will be given.

Finally forest yield and growth is modelled according to common, traditional approaches as well as to new tools like statistical computer growth models (BWinPro). In this context current trends and available tools in forest growth modelling are presented. Students carry out self-selected and self-defined case studies focused on carbon sequestration. Additionally the participants learn about the problems and challenges to include the dynamic change of management strategies, effects of climate change and the general change of site conditions in growth modelling and to evaluate the results of growth scenarios.

Secondly rules for the development of LCA (life cycle analysis), layout, structure and boundaries of LCA; PCF (product carbon footprints) and CCF (corporate carbon footprints) will be presented. Basic knowledge of the purpose and the implementation of life cycle analysis (LCA), product carbon footprints (PCF) and corporate carbon footprints (CCF) will be given. Moreover it will be discussed which data are needed to develop a LCA, how such data are collected and how the calculation is done. In this context important tools and software for the calculation of LCA will be explained.

Recommended related elective modules :

Competences :

Technical competence (50%), Methodological competence (20%), Social competence (10%), Personnel competence (20%)

Literature:

- V. Gadow, K., Pukkala, T. A., Tome, M., 2000. Sustainable Forest Management. Kluwer Academic Publishers.
- Jandl, R., Rodeghiero, M., Olsson, M. 2011. Soil carbon in Sensitive European Ecosystems: From Science to Land Management, John Wiley & Sons. Ltd. Olsthoorn et al. 1999. Management of mixed-species forest: silviculture and economics. IBN Scientific Contributions 15, Wageningen.
- Pommerening, A. a. Murphy, S.T., 2004. A review of the history, definitions and methods of continuous cover forestry with special attention to afforestation and restocking. Forestry, Vol. 77, No. 1, 27-44

E Forest inventory and tree monitoring

Semester:	1
Module coordinator:	Prof. Dr. Ute Sass-Klaassen
Status:	Elective
Goal:	Students are able to conceptualize and implement systematic collection of data and information for assessment or analysis of forest resource.
Examination form	Written Exam 90 min (50%); Project report (50%)
ECTS-Credits:	6
SWH:	4

Module Component 1 Principles of forest inventories

Semester:	1
Coordinator:	Prof. Dr. Ute Sass-Klaassen
Lecturer:	Prof. Dr. Ute Sass-Klaassen (HNEE), Prof. Dr. Barbara Wolff (HNEE) et al.
ECTS-Credits:	2
SWH:	1
Workload:	50 h / Semester
Teaching form	Lecture (7 h), Practical Exercise (8 h), Self-study (35 h)
Max. study places	25
Language:	English
Module type	blocked
Examination form	Written Exam 90 min (33 %); Project report (33 %)
Entry requirements	-

Goal:	Students know principal methods and concepts of inventories at different spatial scales and collect comprehensive information about the state and dynamics of forests for strategic and management planning.
Content:	General introduction to ground based inventories: (1) teaching of basic field measurements like tree height an dbh as well as crown size to calculate tree volume; (2) monitoring with a focus on the crown condition survey of ICP Forest and learning to estimate defoliation and principles of damage assessment to describe forest vitality and mortality; (3) understanding individual tree growth and practise to assess stem volume (cutting of trees assessing wood production (link to part 2)). General introduction to remotely sensed inventories: (4) assessment using remote sensing and UAVs “Change of perspective” and how does it link – introduction to Global Forest Watch (link to part 3) REDD+. Introduction to assignment on FAO Forest Resource assessment and Global Forest watch.
Recommended related elective modules:	
Competences :	Technical competence (40%) Media competence (10%) Methodological competence (40%) Personal competence (10%)
Literature:	FAO (2020): State of the world's forests. FAO, Rome. http://www.fao.org/state-of-forests/en/ FAO FRA (2020): Forest Resource Assessment 2020. http://www.fao.org/forest-resources-assessment/en/ Macdicken, K. (2015). Global Forest Resources Assessment 2015: What, why and how? Forest Ecology and Management. 352: 3–8. Senf, C., Pflugmacher, D., Zhiqiang, Y. et al. Canopy mortality has doubled in Europe’s temperate forests over the last three decades. Nat Commun 9, 4978 (2018). https://doi.org/10.1038/s41467-018-07539-6 Vanclay, J.K. (2005). Deforestation: correlations, possible causes and some implications. International Forestry Review 7:278-293.

Module Component 2 — Examples of forest monitoring at tree- and stand level

Semester:	1
Coordinator:	Prof. Dr. Ute Sass-Klaassen
Lecturer:	Prof. Dr. Ute Sass-Klaassen (HNEE) et al.
ECTS-Credits:	2
SWH:	2

Workload:	50 h / Semester
Teaching form	Lecture (15h), Practical Exercise (15h), Self-study (20h)
Max. study places	25
Language:	English
Module type	blocked
Examination form	Written Exam 90 min (33 %); Project report (33 %)
Entry requirements	-
Goal:	Students gain an understanding of basic principles of tree growth and physiology in relation to changing environmental conditions. Based on this, outcomes of state-of-the-art forest monitoring systems are used to assess forest productivity, carbon budgets, and forest resilience to changing environmental conditions.
Content:	Introduction to tree-individual dynamic field measurements and integration with stand related measurements. Potential of monitoring tools with high temporal resolution (automatic girth bands/dendrometers and sapflow meters, phenological phases) at intensive forest monitoring sites (ICP forest Level II & Britz). Understand relevance of tree-based monitoring data for assessment of tree responses to climatic extremes. Includes analyses of datasets (online data from the station Britz e.g. on phenology of 2021) and relation with climate records.
Recommended related elective modules :	
Competences :	Technical competence (40%) Media competence (10%) Methodological competence (40%) Personal competence (10%)
Literature:	Krause S., Sanders T.G.M., Mund J.-P., Greve K. (2019): UAV-Based Photogrammetric Tree Height Measurement for Intensive Forest Monitoring. Remote Sensing. 2019; 11(7):758. https://doi.org/10.3390/rs11070758 Sass-Klaassen, U.G.W.; Fonti, P.; Cherubini, P.; Gricar, J.; Robert, E. M.R.; Steppe, K.; Bräuning, A. (2016): A Tree-Centered Approach to Assess Impacts of Extreme Climatic Events on Forests. Frontiers in Plant Science 7. https://www.frontiersin.org/articles/10.3389/fpls.2016.01069/full Steppe. K, von der Crone, J., de Paauw, DJW. (2016): TreeWatch.net: a tree water and carbon monitoring network to assess instant tree hydraulic functioning and stem growth. Front Plant Sci 7: Article 993. Tobias Scharnweber, T., Smiljanic, M., Cruz-García, R. Manthey, M., & M. Wilmking (2020): Tree growth at the end of the 21st century - the extreme years 2018/19 as template for future growth conditions. Environ. Res. Lett. 15 07402; DOI: 10.1088/1748-9326/ab865d

Module Component 3	Relevance of FIT for forest conservation & management
Semester:	1
Coordinator:	Prof. Dr. Ute Sass-Klaassen
Lecturer:	Prof. Dr. Ute Sass-Klaassen (HNEE), Prof. Dr. Barbara Wolff (HNEE) et al.
ECTS-Credits:	2
SWH:	1
Workload:	50 h / Semester
Teaching form	Lecture (7 h), Practical Exercise (8 h), Self-study (35 h)
Max. study places	25
Language:	English
Module type	blocked
Examination form	Written Exam 90 min (33 %); Project report (33 %)
Entry requirements	-
Goal:	Students critically evaluate the relevance of long-term inventory and monitoring for decision making in forestry and environmental sciences.
Content:	Synthesis of results gained from practicals and excursions in module 1 & 2 to critically evaluate the outcome and comparability of ground based and remote sensing assessments. Based on presentations of the results of the assignment on FAO FRA data and information from Global Forest Watch discussion of the possibilities and limits of forest conservation, forest restoration and sustainable forest management to mitigate global climate change and protect global forests Exploring implications for decision making in different disciplines (forestry and environmental science) and on different scales (national, international).
Recommended related elective modules :	
Competences :	Technical competence (40%) Media competence (10%) Methodological competence (40%) Personal competence (10%)
Literature:	Jandl, R., Spathelf, P., Bolte, A. et al. (2019). Forest adaptation to climate change—is non-management an option? Annals of Forest Science 76, 48, https://doi.org/10.1007/s13595-019-0827-x Macdicken, K. (2015). Global Forest Resources Assessment 2015: What, why and how? Forest Ecology and Management. 352: 3–8.

Mansourian, S., Vallauri, D. & Dudley, N. (2005): Forest Restoration in Landscapes: Beyond Planting Trees. Springer. 437 p.
Nabuurs G.J., Delacote, P., Ellison, D., Hanewinkel, M., Hetemäki, L. & Lindner, M. (2017). By 2050 the mitigation effects of EU forests could nearly double
Vanclay, J.K. (2005). Deforestation: correlations, possible causes and some implications. International Forestry Review 7:278-293.

E Assessment tools and methods: Forest 4.0 / Parametrization and spatial assessment of biomass

Semester:	1
Module coordinator:	Prof. Dr. Jan-Peter Mund (jan-peter.mund@hnee.de)
Status:	Elective
Goal:	Students are aware of the principal methods and innovative technical tools for estimating, quantifying, calculating and mapping the baseline of different carbon pools and to monitor carbon stock changes related to various forest and land management measures. After the course, students have a solid foundation of principal concepts of biomass and carbon quantification and their specific cycles. Students know about the advantages applying remote sensing and modelling techniques for the spatial assessment and modelling of forest biomass at different scales. Students will learn about different carbon parametrization, quantification or simulation models for forest biomass on a landscape level and discuss methods to quantify forest biomass and estimate the forest carbon stock and their uncertainty.
Examination form	Project presentation (50%), Project report (50 %)
ECTS-Credits:	6
SWH:	4

Module Component 1 Assessment tools and methods: Forest 4.0 / Parametrization and spatial assessment of biomass

Semester:	1
Coordinator:	Prof. Dr. Jan-Peter Mund
Lecturer:	Prof. Dr. Jan-Peter Mund
ECTS-Credits:	6
SWH:	4
Workload:	150 h / Semester
Teaching form	Lecture (30h), Seminar (15 h), Practical exercise (15 h), Self-study (90h)

Max. study places	
Language:	English
Module type	blocked
Examination form	Project presentation (50%), Project report (50 %)
Entry requirements	-
Goal:	Students are aware of the principal methods and innovative technical tools for estimating, quantifying, calculating and mapping the baseline of different carbon pools and to monitor carbon stock changes related to various forest and land management measures. After the course, students have a solid foundation of principal concepts of biomass and carbon quantification and their specific cycles. Students know about the advantages applying remote sensing and modelling techniques for the spatial assessment and modelling of forest biomass at different scales. Students will learn about different carbon parametrization, quantification or simulation models for forest biomass on a landscape level and discuss methods to quantify forest biomass and estimate the forest carbon stock and their uncertainty.
Content:	In this module students will learn how to select the appropriate carbon accounting method or simulation model for specific requirements through a mix of informative e-learning presentations, online discussions and hands-on use of various models. Technical and conceptual guidance is provided during the course for components of carbon stocks and specific data analysis. The teaching material for this course includes e-learning lectures, online learning documents and reading assignments, instructor led discussions and student led discussions, practicals and a final student assignment in a group work. Each lecture will be presented with a corresponding reading assignment consisting of 2-4 extra readings or a lecture quiz that should be completed close to the lecture. An empirical carbon quantification exercise will be assigned as part of the course work and will focus on the development of a regional carbon monitoring system. Data analysis have to be finalised during the semester, concluding with the submission of a project report, analysing the respective carbon pools and their potential effect on landscape carbon dynamics in a group work. Classroom discussions on selected reading assignments and the development of the applied research project concept will occur periodically during the module.
Recommended related elective modules :	
Competences :	Technical competence (50%) Media competence (10%) Methodological competence (30%); Personal competence (10%)
Literature:	Campbell, A., Miles, L., Lysenko, I., Hughes, A., Gibbs, H. (2008): Carbon storage in protected areas: technical report. UNEP - World Conservation Monitoring Centre, Cambridge, UK. Henders, S.; Ostwald, M. (2012): Forest Carbon Leakage Quantification Methods and Their Suitability for Assessing Leakage in REDD. In: Forests 2012, 3, 33-58

Intergovernmental Panel on Climate Change [IPCC] (2006): IPCC guidelines for national greenhouse gas inventories. Japan: Institute for Global Environmental Strategies. Available at www.ipcc-nggip.iges.or.jp/public/2006gl/index.html (accessed October 6, 2015).
Miles, L., Kapos, V. (2008): Reducing Greenhouse Gas Emissions from Deforestation and Forest Degradation: Global Land-Use Implications. Science 320, 1454-1455.
United Nations Food and Agricultural Organization, Global Forest Resource Assessment [UN FAO FRA] (2015): Background on global forest resource assessment. Available at http://www. fao.org/forest-resources-assessment/en/ (accessed October 6, 2015).
Wisniewski, J.R.; Sampson; N. (1993): Terrestrial Biospheric Carbon Fluxes Quantification of Sinks and Sources of CO2.

E Project management

Semester:	1
Module coordinator:	Uli Gräbener (uli.graebener@hnee.de)
Status:	Elective
Goal:	Students acquire in-depth knowledge of projects, their planning and implementation, of different planning and implementation methods and instruments. Applying: Students are able to plan and implement projects using both classic and nature conservation-specific project planning tools. They can take different roles in project planning and execution. They define important tasks of their own lives as projects and to carry them out in an appropriately structured and organised manner. Analysing and evaluating: Students can assess and reflect on project success and ways for improvement.
Examination form	Oral exam (100%)
ECTS-Credits:	6
SWH:	4

Module Component 1 Project management

Semester:	1
Coordinator:	Uli Gräbener
Lecturer:	Uli Gräbener et al.
ECTS-Credits:	6
SWH:	4
Workload:	150 h / Semester
Teaching form	Lecture (30h), Seminar (30h), self-study (90h)
Max. study places	
Language:	English
Module type	blocked
Examination form	Oral exam (100%)

Entry requirements	-
Goal:	Students acquire in-depth knowledge of projects, their planning and implementation, of different planning and implementation methods and instruments. Applying: Students are able to plan and implement projects using both classic and nature conservation-specific project planning tools. They can take different roles in project planning and execution. They define important tasks of their own lives as projects and to carry them out in an appropriately structured and organised manner. Analysing and evaluating: Students can assess and reflect on project success and ways for improvement.
Content:	Basics & definitions of project management, problem analysis, problem tree / solution tree, planning methods, target planning, financial planning, time planning, DIN process descriptions, project phases, project team & roles, controlling, monitoring, adaptive management, agile planning, open standards for the practice of conservation, organizational development projects & change management, PM software, evaluation, donor landscape, application formats of various donors.
Recommended related elective modules :	
Competences :	Technical competence (35%) Social competence (15%) Methodological competence (35%), Personal competence (15%)
Literature:	

E Approaches and tools for research and monitoring with geodata and remote sensing

Semester:	1
Module coordinator:	Prof. Dr. Jens Müller
Status:	Elective
Goal:	The students are familiar with fundamental theoretical ideas and practical concepts for a long term monitoring framework in protected areas using geo-spatial data and remote sensing products
Examination form	Oral report (100%)
ECTS-Credits:	6
SWH:	4

Module Component 1 Geodata and remote sensing as tools for spatial monitoring

Semester:	1
Coordinator:	Prof. Dr. Jens Müller
Lecturer:	Prof. Dr. Jens Müller, Prof. Dr. Jan-Peter Mund
ECTS-Credits:	3
SWH:	2
Workload:	75 h / Semester
Teaching form	Seminar (15 h), Practical exercise (15h), self-study (90h)
Max. study places	
Language:	English
Module type	blocked
Examination form	Oral report
Entry requirements	-

Goal:	Familiarize the students with the fundamental theoretical ideas and practical concepts for a long term monitoring framework in protected areas using geo-spatial data and remote sensing products.
Content:	Innovative and coherent spatial data products are an essential prerequisite for ecological monitoring and political acceptance of nature conservation studies in protected areas. Students attending this practice-oriented seminar will apply innovative spatial survey and monitoring methods as well as professional geodata in protected areas. They discuss the suitability of operational remote sensing products, geospatial monitoring techniques and the use of professional services and products for a continuous spatial monitoring of landscape ecological structures and processes in Biosphere reserves. Students finishing this module master methodological significance and practical access to topical geodata at different levels of spatial and temporal scale. They are ready to implement spatial tools for monitoring habitat types and landscape ecological processes and structures and can communicate monitoring results and analytical geostatistics form Biosphere reserves using web-based cartography and other means of spatial communication and social media.
Recommended related elective modules :	
Competences :	Technical competence (50%) Media competence (10%) Methodological competence (30%); Personal competence (10%)
Literature:	

Module Component 2 — Basics in monitoring and research

Semester:	1
Coordinator:	Prof. Dr. Erik Aschenbrand
Lecturer:	Prof. Dr. Erik Aschenbrand
ECTS-Credits:	3
SWH:	2
Workload:	75 h / Semester
Teaching form	Lecture (30h), self-study (90h)
Max. study places	25
Language:	English
Module type	blocked
Examination form	Oral report

Entry requirements	-
Goal:	Presentation of the theoretical principles of quantitative research as well as spatial research and monitoring methods. Practical examples of application from research, monitoring and evaluation in the context of international protected areas. Inter- and transdisciplinary methods of knowledge management will be presented as well as innovative, digital methods of citizen science and communication via social media. Students learn the methods of empirical social research as well as scaled spatial analysis from the perspective of different actors in the context of protected areas.
Content:	Theories and concepts of social research: heuristics and biases in judgement and decision making, constructivism, discourse, symbolic interactionism, social categories and stereotyping, qualitative and quantitative research Methods: Surveys, analyzing existing resources, participant observation/ethnographic methods, experiments Research process: sampling, interviewing, questionaire design, processing/transcribing, coding, content analysis, data analysis
Recommended related elective modules :	
Competences :	Technical competence (35%) Social competence (15%) Methodological competence (35%), Personal competence (15%)
Literature:	

E Academic writing and presenting

Semester:	1
Module coordinator:	Language Centre (SPZ) NN (Sprachenzentrum@hnee.de)
Status:	Elective
Goal:	Students can understand and apply the principles of academic writing and presenting. They can communicate effectively in an academic context.
Examination form	Oral report (100%)
ECTS-Credits:	6
SWH:	4

Module Component 1 Academic writing and presenting

Semester:	1
Coordinator:	Language Centre
Lecturer:	Language Centre NN
ECTS-Credits:	6
SWH:	4
Workload:	150 h / Semester
Teaching form	Seminar (60h), self-study (90h)
Max. study places	25
Language:	English
Module type	blocked
Examination form	Oral report (100%)
Entry requirements	-
Goal:	Students can understand and apply the principles of academic writing and presenting. They can communicate effectively in an academic context.

Content:

This module imparts the principles of academic writing and presenting. Students analyse academic papers and presentations and work individually on short texts and presentations. Course objectives are:

- to differentiate between different kinds of writing tasks in an academic context
- to analyse writing tasks and structure texts accordingly
- to find appropriate text types for academic work
- to take notes effectively
- to develop a critical approach to reading
- to know how to use citation conventions
- to avoid plagiarism
- to understand the importance of proofreading and editing
- to understand the requirements of presenting in an academic context
- to present with confidence in an academic context

A particular emphasis is put on individual academic work and on individual needs and difficulties.
The examination form is a presentation held by students at the end of the course.

Recommended related elective modules :

Competences :

Methodological competence (50%), personal competence (50%)

Literature:

Bailey, S. (2017). Academic Writing. A Handbook for International Students (5th ed.). Routledge.

Burton, G. (2014). Presenting: Deliver Presentations with Confidence (2nd ed.). Collins.

E Fundamentals of Measurements and Modelling

Semester:	1
Module coordinator:	Prof. Dr. Luis Miranda (luis.miranda@hnee.de)
Status:	Elective
Goal:	The students get to know different automated measurement methods in the environmental sector. They are able to identify and discuss the data origins and to assess the data quality of a measurement. They process data in environmental modelling and apply the building methodology behind mathematical models in environmental science, forestry and ecology.
Examination form	Technical discussion (50%), Term paper (50%)
ECTS-Credits:	6
SWH:	4

Module Component 1 Sensors for automated measurements

Semester:	1
Coordinator:	Prof. Dr. Luis Miranda
Lecturer:	Prof. Dr. Luis Miranda
ECTS-Credits:	3
SWH:	2
Workload:	75 h / Semester
Teaching form	Lecture (12h), Practical exercise (18h), Self-study (45h)
Max. study places	
Language:	English
Module type	blocked
Examination form	Technical discussion (50%)
Entry requirements	-

Goal:	The students identify and describe the measuring principles behind sensor technologies used as data sources for environmental modelling. They know the principles of data quality assessment and further data processing procedures that guarantee a meaningful re-use of the measured data.
Content:	The course focuses on field data acquisition to support the construction and tuning of ecosystem and environmental models. The knowledge of different measuring principles is important for the processing, analysis and evaluation of sensory recorded environmental data and helps with the interpretation of ecosystem phenomena. The most important sensors for automatic field measurements are presented alongside their physical measuring principles and technical usage constrains. The parts of an automatic measuring system are presented and discussed, as well as the concepts of sensor resolution and accuracy. The concepts of analog to digital conversion, signal conditioning, interfaces and noise are reviewed. Practical exercises show the sensor construction and their installation and calibration, particularly sensors for temperature, relative humidity, solar radiation and soil water content. Practical troubleshooting and testing techniques are presented to assess the state of the sensors.
Recommended related elective modules :	
Competences :	Technical competence (50%) Methodological competence (40%) Personal competence (10%)
Literature:	Fritschen, L. J., & Gay, L. W. (2012). Environmental instrumentation. Springer Science & Business Media. Pearcy, R. W., Ehleringer, J. R., Mooney, H., & Rundel, P. W. (Eds.). (2012). Plant physiological ecology: field methods and instrumentation. Springer Science & Business Media.

Module Component 2 Process modelling methodology

Semester:	1
Coordinator:	Dr. Evelyn Wallor
Lecturer:	
ECTS-Credits:	3
SWH:	2
Workload:	75 h / Semester
Teaching form	Lecture (15 h), Practical exercise (15 h), Self-study (45 h)
Max. study places	
Language:	English
Module type	blocked

Examination form	Term paper (50%)
Entry requirements	-
Goal:	The students know about application areas of ecosystem models and are able to distinguish between different modelling concepts. They have a broad overview of different models and tools related to different focuses on environmental processes, e.g. carbon dynamics, water- and nutrient cycling, and biomass growth. Students learn the principles of modelling practice in terms of parameter estimation, model set-up, and model validation. They conceptualize and design mathematical models to be used in environmental science, forestry and ecology. The students define input and output variables as well as protocols for modelling exercises.
Content:	The course refreshes fundamental knowledge about ecosystems with respect to definitions, terms, and processes (e.g. element cycling, mass balance), and introduces the role and purpose of model applications in environmental science (e.g. large scale scenarios, retrospective evaluation). Based on relevant scientific findings from the field of modelling different models and modelling approaches are explored (e.g. quantitative vs. dynamic, point vs. terrain model). Building on this, students set up various ordinary differential equations to simulate exemplarily forest biomass growth (e.g. logistic growth, Gompertz growth). They extend the growth models with terms for carbon accounting depending on tree age and tree species. Furthermore, they conduct parameterisation and model curve fitting by applying the least squares method on selected process equations. Finally, measures for model validation to assess models' outcome are introduced and trained (e.g. RMSE, IA, MAE). All methods are trained and practiced in connection with the module component "Sensors for automated measurements" using the software R and RStudio.
Recommended related elective modules :	Information & mathematical models (2nd term) Principles of landscape ecology (2nd term)
Competences :	Technical competence (50%) Media competence (10%) Methodological competence (30%) Personal competence (10%)
Literature:	Ahuja, Laj R., Ma, L. (Eds.) (2011). Methods of Introducing System Models into Agricultural Research. ASA-CSSA-SSSA Book. DOI:10.2134/advagricsystmodel2 Teh, C. (2006). Introduction to mathematical modeling of crop growthhow the equations are derived and assembled into a computer model. Brown Walker Press. Wendroth, O., Lascano, R.J., Ma, L. (Eds.) (2019). Bridging Among Disciplines by Synthesizing Soil and Plant Processes. ASA-CSSA-SSSA Book. DOI:10.2134/advagricsystmodel8 additional relevant literature and current scientific resources will be provided by the lecturer

Specialisation module

Semester:	1,2,3,4
Module coordinator	Head of study programme
Status:	Elective
Goal:	Students deepen their professional knowledge and skills in a specific area, that is of special interest for them. Students can identify their personal interests in the field of global change management and expand their horizon to approaches in related study programmes.
Examination form:	
ECTS-Credits:	6
SWH:	4

Module component 1 — Specialisation module

Semester:	1,2,3,4
Coordinator	Head of study programme
Lecturer	NN
ECTS-Credits:	6
SWH:	4
Workload:	150 h / Semester
Max. study places:	
Teaching form:	
Language:	
Module type:	
Examination form:	
Entry requirements:	
Goal:	Students deepen their professional knowledge and skills in a specific area, that is of special interest for them. Students can identify their personal interests in the field of global change management and expand their horizon to approaches in related study programmes.

Content:

The contents of the module depend on the individual offer or selection. Courses can be chosen
- from other curricula of the Department of Forest and Environment, other study programs of the HNEE, other universities in Germany and abroad or scientific institutions; or
- which are newly developed and offered by lecturers without curricular commitment, e.g. in the context of research and development projects,
and
by are evaluated and approved by the head of the study program after application as qualifying in the sense of the program objectives.

Recommended related elective modules :

Competences:

Literature:

M Sustainable forestry

Semester:	2
Module coordinator	Dr. Arkadiusz Gruchala (arkadiusz_gruchala@sggw.edu.pl)
Status:	Mandatory
Goal:	Students are familiar with the basic concepts, terms, terminology and methods of close-to-nature silviculture. Students are able to manage the sustainable use of forest resources by using new technologies, optimization and planning techniques. Students can apply fundamentals of modern Forest policy in practice.
Examination form:	Project report, Written exam*
ECTS-Credits:	6
SWH:	6

Module component 1 Close to Nature Silviculture & Nature Conservation

Semester:	2
Coordinator	Prof. Dr. Bogdan Brzeziecki (bogdan_brzeziecki@sggw.edu.pl)
Lecturer	Prof. Dr Bogdan Brzeziecki, Dr. Kamil Bielak
ECTS-Credits:	2
SWH:	2
Workload:	50 h / Semester
Max. study places:	32
Teaching form:	Lecture (9 h), Project (9 h), Practical exercise (12 h), Self-study (20 h)
Language:	English
Module type:	partly-blocked

Examination form:	Project report / Written exam*
Entry requirements:	forest botany, dendrology, forest ecology, forest soil science, forest site science, forest biometrics
Goal:	To get the students acquainted with the basic concepts, terms, terminology and methods of close-to-nature silviculture (CNS) as a core component of modern, multifunctional forestry. After the course, the students should be able to plan different types of silvicultural actions (relating to forest reproduction and forest tending) in various categories of forest stands, with a special reference to Central European conditions.
Content:	**Lectures:** General introduction (characteristics of forest as a plant formation type, trees as major components of forest ecosystems; human needs and requirements on forests; forestry as an art and science of managing forests; legal foundations of forestry; the concept of Sustainable Forest Management (SFM) and its relation to Ecosystem Approach (EA); silviculture as a core segment of forestry, evolution of silviculture, major components of CNS, natural forests as a source of information for CNS). Forest reproduction 1 (natural and artificial regeneration as two basic modes of forest reproduction; choice of tree species (the concept of a target growing stock); composition of forest stand (species mixture); soil treatment; nursery stock (planting material) – parameters and requirements; choice of spacing; planting methods and techniques; direct seeding; natural reproduction as an alternative to artificial regeneration). Forest reproduction 2 (silvicultural regimes, silvicultural systems, the concept of regeneration cuttings and their classification: clear cuttings, shelterwood cuttings, combined cuttings, irregular shelterwood cuttings, planter cuttings; general characteristics, typical applications, advantages and disadvantages, major modifications and varieties, impact of different types of regeneration cuttings on tree stand structure and forest ecosystem functioning). Forest tending (the concept of forest growth cycle, characteristics of tending operations carried out in major stand developmental phases, classification of tending operations (intermediate cuttings and other tending operations); major tasks and principles of cleanings and thinnings, the role of tending operations in maintaining and enhancing the multifunctional character of forest stands. **Computer laboratory:** Individual project 1: Planning an establishment of a new forest stand by means of CNS methods (choice of tree species, species mixture, soil preparation, planting material, spacing, planting techniques) – ArcMap or QGIS software. Individual project 2: Computer simulation and visualization of different types of thinning operations (thinning from below, selection thinning, others) and their impact on forest stand structural characteristics and development in a mid-term time perspective (10 years) – BWINPro simulator.

	Laboratory exercises: Individual project 3: Selection and description (major parameters and graphical visualization of regeneration cuttings, timetable) of most appropriate silvicultural system (forest reproduction method) for given initial conditions (forest site type, tree species composition and quality of the existing forest stand, target growing stock). **Field classes:** Presentation and discussion (involving forest practitioners) of the representative study cases during the visit in two selected forest districts. During the field classes preparing the Project 4: Working on the marteloscope plot and selection of crop trees and marking trees for a removal in an exemplary stand. The aim of the project: comparing student's choices with decisions made by an experienced forester and with the results obtained by means of a computer programme.
Recommended related elective modules :	
Competences:	Technical competence (40 %) Media competence (10 %) Methodological competence (20 %), Social competence 10 %), Personal competence (10 %)
Literature:	

Module component 2 — Forest engineering and utilization

Semester:	2
Coordinator	Prof. Dr. Tadeusz Moskalik (tadeusz_moskalik@sggw.edu.pl)
Lecturer	Prof. Dr. Tadeusz Moskalik, Dr. Grzegorz Jednoralski
ECTS-Credits:	2
SWH:	2
Workload:	50 h / Semester
Max. study places:	32
Teaching form:	Lecture (10 h), Project (6 h), Practical exercise (14 h), Self-study (20 h)
Language:	English
Module type:	partly-blocked
Examination form:	Project report / Written exam*
Entry requirements:	
Goal:	Students are able to manage the sustainable use of forest resources by using new technologies, optimization and planning techniques. This course

	has the following contents: Organization of wood harvesting processes in premature and mature stands; methods of utilization of logging residuals; ecological aspects of timber harvesting; forest operation costs; forest road network optimization; ergonomics in harvesting operations.
Content:	Wood raw material base in Europe and in the world; possibilities of wood processing and development trends in forest sector. Organization of wood harvesting processes in premature and mature stands; methods of utilization of logging residuals; ecological aspects of timber harvesting; forest operation costs; forest road network optimization; ergonomics in harvesting operations.
Recommended related elective modules :	
Competences:	Technical competence (40%) Media competence (10%) Methodological competence (20%), Social competence 20%), Personal competence (10%)
Literature:	Provided on an ongoing basis by the teacher so that students can use the most up-to-date sources.

Module component 3 — Forest policy and economics

Semester:	2
Coordinator	Dr Lech Płotkowski Prof. WULS (lech_plotkowski@sggw.edu.pl)
Lecturer	Dr hab. Lech Płotkowski Prof. WULS, Dr Arkadiusz Gruchała
ECTS-Credits:	2
SWH:	2
Workload:	50 h / Semester
Max. study places:	32
Teaching form:	Lecture (11 h), Project (8 h), Practical exercise (11 h), Self-study (20 h)
Language:	English
Module type:	partly-blocked
Examination form:	Project report / Written exam*
Entry requirements:	

Goal:	Students can apply fundamentals of modern Forest policy in practice. The role of forestry in modern world forest biodiversity protection programmes, global environmental concerns, forest research and forestry institutions, global perspective on forest policy, forest certification systems.
Content:	The role of forestry in modern world forest biodiversity protection programmes, global environmental concerns, forest research and forestry institutions, global perspective on forest policy, forest certification systems.
Recommended related elective modules :	
Competences:	Technical competence (30%) Media competence (20%) Methodological competence (20%), Social competence 15%), Personal competence (15%)
Literature:	To be announced at start of semester

M Data processing and programming

Semester:	2
Module coordinator	Prof. Dr. Michal Zasada (michal_zasada@sggw.edu.pl)
Status:	Mandatory
Goal:	Students improve their practical skills in collecting, analyzing and presenting environmental data.
Examination form:	Project report, Project presentation*
ECTS-Credits:	6
SWH:	6

Module component 1 Programming 3

Semester:	2
Coordinator	Dr. Wiktor Tracz (wiktor_tracz@sggw.edu.pl)
Lecturer	Dr. Wiktor Tracz
ECTS-Credits:	2
SWH:	2
Workload:	50 h / Semester
Max. study places:	32
Teaching form:	Lecture (12 h), Project (6 h), Practical exercise (12 h), Self-study (20 h)
Language:	English
Module type:	partly-blocked
Examination form:	Project report / Project presentation*

Entry requirements:	Programming 1 and 2, Forestry data structures and spatial data models
Goal:	The students are able to develop programs of increased extent by means of different structures, database management and geodata analysis.
Content:	Working with some of the more advanced standard controls and common dialog controls. Manipulating files and directories. Exception handling. Enhancing user interface: menus and toolbars. Accessing data stored in database. Principles of user interface design.
Recommended related elective modules :	
Competences:	Technical competence (80 %), Methodological competence (20 %)
Literature:	Petroutsos E. 2006. Mastering Microsoft Visual Basic 2005. Wiley Publishing Inc. Liberty J. 2005. Programming Visual Basic 2005. O'Reilly. Felleisen M., Findler R., Flatt M., Krishnamurthi S. 2001. How to design programs. An Introduction to Computing and Programming. MIT. VB 2010 tutorial: http://vbtutor.net/vb2010/index.html VB.NET programming for beginners: www.homeandlearn.co.uk/NET/vbNet.html

Module component 2 — Environmental spatial data analysis 2

Semester:	2
Coordinator	Prof. Dr. Michał Zasada
Lecturer	Dr Karol Bronisz (karol_bronisz@sggw.edu.pl) Prof. Dr. Michał Zasada
ECTS-Credits:	2
SWH:	2
Workload:	50 h / Semester
Max. study places:	32
Teaching form:	Lecture (9h), Project (6h), Practical exercise (15h), Self-study (20h)
Language:	English
Module type:	continuous
Examination form:	Project report / Project presentation*

Entry requirements:	
Goal:	The main objective of the course is to introduce the use of the statistical programming environment for practical statistical problem solving.
Content:	The following chapters are handled: data preparation and processing, statistical software, sampling, sampling and sample site determination, estimation procedures, testing statistical hypotheses, multiple and multivariance methods (non-linear regression, analyze of variance and covariance), non-linear regression, analysis of variance.
Recommended related elective modules :	Introduction to Forest Information Technology 3
Competences:	Technical competence (40%), Methodological competence (50%), Personal competence (10%)
Literature:	Field, A. (2005): Discovering Statistics Using SPSS. Sage Publications. Dalgaard, P. (2008): Introductory Statistics with R. Springer, Berlin. Online and digital materials provided by the lecturer

Module component 3 — Forest information and technology, GIS and Remote Sensing 2

Semester:	2
Coordinator	Dr. Michał Brach (michal.brach@sggw.edu.pl)
Lecturer	Dr. Michał Brach
ECTS-Credits:	2
SWH:	2
Workload:	50 h / Semester
Max. study places:	32
Teaching form:	Lecture (12h), Project (6h), Practical exercise (12 h), Self-study (20 h)
Language:	English
Module type:	partly-blocked
Examination form:	Project report*
Entry requirements:	The base of GIS and remote sensing form the first semester.

Goal:	The concept of this module base on combining different data sources (LiDAR, filed measurements, GNSS and UAV) and different techniques (GIS, remote sensing, map algebra, tree segmentation) in order to get detailed forest metrics.
Content:	The data are collected in the WULS Rogów research station in the real forest. The canopy height model is generated from a digital surface model and the complete trees segmentation is performed. This is the base to calculate forests metrics. Students have the ability to compare the results of the data geoprocessing with the real metrics of the forest. The complete error analysis is performed including GNSS errors and UAV accuracy. One of the most important factors is the possibility to work with the real and present data what is the good background to understand the dynamic changes in the forest.
Recommended related elective modules :	Forest Photogrammetry, Map editing, Forest inventory and modelling, Spatial analysis
Competences:	Technical competence (40%), Methodological competence (30%), Social competence 15%), Personal competence (15%)
Literature:	Longley, P.A., M.F. Goodchild, D.J. Maguire & D.W. Rhind (2001): Geographic Information Systems and Science. John Wiley & Sons. Hofmann-Wellenhof, B., Lichtenegger, H., & Wasle, E. (2007): GNSS–global navigation satellite systems: GPS, GLONASS, Galileo, and more. Springer Science & Business Media. A.H. Robinson, J.L. Morrison, P.C. Muehrcke, A.J. Kimerling & S.C. Guptill (1995): Elements of Cartography. John Wiley & Sons. Maltamo, M., Næsset, E., & Vauhkonen, J. (2014). Forestry applications of airborne laser scanning. Concepts and case studies. Managing Forest Ecosystems, 27.

M Data collection and processing technology

Semester:	2
Module coordinator	Prof. Dr. Michal Zasada (michal_zasada@sggw.edu.pl)
Status:	Mandatory
Goal:	The students are able to solve various forestry-related problems by using image information, remote sensing and statistical fundamentals of forest inventory.
Examination form:	Project report, Project presentation, Written exam*
ECTS-Credits:	6
SWH:	6

Module component 1 Forest Photogrammetry

Semester:	2
Coordinator	Dr. Łukasz Kwaśny (lukasz_kwasny@sggw.edu.pl)
Lecturer	Dr. Łukasz Kwaśny
ECTS-Credits:	2
SWH:	2
Workload:	50 h / Semester
Max. study places:	32
Teaching form:	Lecture (6h), Project (18h), Practical exercise (6h), Self-study (20h)
Language:	English
Module type:	blocked
Examination form:	Project report*

Entry requirements:	The student has basic knowledge in the field of forest botany enabling the interpretation and recognition of forest communities and tree species.
Goal:	The aim of the course is to introduction students with the methods of acquiring, processing and interpreting image information (satellite images, aerial photos and low-altitude UAV-images) to assess the condition and changes in the environment of forest areas.
Content:	The subject explains the basics and methods of obtaining remote sensing data as well as their geometric and interpretative features in terms of the needs of forest management. Classes includes: interpretation of the forest environment with remote sensed RGB-images; Damage to trees and stands in remote sensing images; Identification of remote sensing imaging types; Assessment of the possibilities of their use in forest photogrammetry.
Recommended related elective modules :	Digital Processing of Remotely Sensed Data, Forest inventory and modelling
Competences:	Technical competence (40%) Media competence (10%) Methodological competence (30%), Social competence 10%), Personal competence (10%)
Literature:	Campbell, J.B. (2002): Introduction to Remote Sensing. Guilford Press, New York. Lillesand, T.M., R.W. Kiefer (1999): Remote Sensing and Image Interpretation. John Wiley & Sons, Inc.

Module component 2 — Digital Processing of Remotely Sensed Data

Semester:	2
Coordinator	Prof. Dr. Jarosław Chromański (Jaroslaw_chormanski@sggw.edu.pl)
Lecturer	Jarosław Chromański, Dr. Jonathan C-W Chan
ECTS-Credits:	2
SWH:	2
Workload:	50 h / Semester
Max. study places:	32
Teaching form:	Lecture (15 h), Practical exercise (15 h), Self-study (20 h)
Language:	English
Module type:	partly-blocked

Examination form:	Project report / Project presentation / Written exam*
Entry requirements:	
Goal:	The main objective of the course is to provide students with the ability of processing remotely sensed data for forestry and environmental purposes.
Content:	The content is developed with a focus on techniques in data/image processing and trends in remote sensing (a splash of advanced topics: texture analysis, hyperspectral data, machine learning algorithms). It is designed for students with related background but does not have the processing skills (concept and practical) to deal with the data. The course is formatted based on previous feedbacks and it is most complimentary to the ENVIRONMENTAL INFORMATICS.
Recommended related elective modules :	
Competences:	Technical competence (40%), Methodological competence (40%), Social competence 10%), Personal competence (10%)
Literature:	Manual of Remote Sensing. American Society of Photogrammetry. Lillesand T.M., Kiefer R.W. 2004: Remote Sensing and Image Interpretation. John Wiley & Sons, New York. Lasselin D., Remote Sensing: Physical and Technical Bases. Groupement pour le Développement de la Télédétection Aérospatiale. GDTA: Booklet M1. Digital Image Display. Booklet B3. Color Representation.Tutorials. Journals: ISPRS Journal of Photogrammetry and Remote Sensing. Geoinformatics. GIS-Geoinformationssysteme. http://www.geodetic.com/photogrammetry.htm

Module component 3 — Forest inventory and modelling

Semester:	2
Coordinator	Prof. Dr. Michał Zasada (michal_zasada@sggw.edu.pl)
Lecturer	Dr. Karol Bronisz, Prof. Dr. Michał Zasada
ECTS-Credits:	2
SWH:	2
Workload:	50 h / Semester

Max. study places:	32
Teaching form:	Lecture (6 h), Project (6 h), Practical exercise (18 h), Self-study (20 h)
Language:	English
Module type:	continuous
Examination form:	Project report / Written exam*
Entry requirements:	
Goal:	Students are able to apply deepened knowledge of the statistical fundamentals of forest inventory for planning and evaluating inventories.
Content:	Representative method; sampling frame construction; sample design; estimation methods; sampling error; examples of forest inventory using various designs.
Recommended related elective modules :	Forest monitoring and inventories, Fundamentals of Measurements and Modelling
Competences:	Technical competence (50%) Media competence (40%), Personal competence (10%)
Literature:	Shiver, B.D. & B.E. Borders (1996): Sampling Techniques for Forest Resource Inventory. John Wiley & Sons. Iles K. (2003): A sampler of Inventory Topics. Kim Iles & Associates. Materials provided by the lecturer

E Academic Scientific Principles: Presentation and planning skills

Semester:	2
Module coordinator	Luiza Czekała (luiza_czekala@sggw.edu.pl)
Status:	Elective
Goal:	Students are expected to gain closer understanding of how to get prepared mentally and physically to the speaking. Students will be presented with information on: application possibilities, partnerships, elements of a good application, benefits of project reporting and others.
Examination form:	Project presentation* (100%)
ECTS-Credits:	6
SWH:	4

Module component 1 Public speaking and scientific presentation

Semester:	2
Coordinator	Dr. Karol Chrobak (karol_chrobak@sggw.edu.pl)
Lecturer	Dr. Karol Chrobak
ECTS-Credits:	3
SWH:	2
Workload:	75 h / Semester
Max. study places:	32
Teaching form:	Lecture (30h), Self-study (45h)
Language:	English
Module type:	continuous

Examination form:	Project Presentation*
Entry requirements:	
Goal:	The course is going to cover all competencies being involved in public – both academic and non-academic – speaking.
Content:	There will be followed the whole process of preparing, delivering, and defending a public presentation. Students are expected to gain closer understanding of how to get prepared mentally and physically to the speaking, how to research and support their presentation, and how to incorporate media, data, and arguments into the whole presentation. What will be also commented are ethical aspects of public speaking, and the importance of listening as a competency complementary to speaking. List of subjects of individual classes is provided below: 1. Physical preparation for public speaking 2. Psychological preparation for public speaking 3. Analyzing the audience and adapting to it 4. Selecting a topic and a purpose of a speech 5. Researching and supporting a speech 6. Organizing the structure of a speech 7. Informative speaking 8. Persuasive speaking 9. Using media and data 10. Methods of engaging the audience 11. Speaking on special occasions (speaking in small groups) 12. Thinking and speaking critically 13. The art of listening 14. Ethical aspects of public speaking 1 5. Recapitulation (speech analysis)
Recommended related elective modules :	
Competences:	Media competence (40%), Social competence (20 %), Personal competence (40 %)
Literature:	S.R. Brydon, M.D. Scott, Between One and Many. The Art and Science of Public Speaking, McGraw-Hill Higher Education 2008. S.E. Lucas, The Art of Public Speaking, McGraw-Hill Higher Education 2009, 2012. Nowak, Power Speaking. The Art of the Exceptional Public Speaker, Allsworth Press, New York 2004. S.J. Coopman, J. Lull, Public Speaking. The Evolving Art, Wadsworth Cengage Learning, Boston 2012. J.R. Hale, The Art of Public Speaking. Lessons from the Greatest Speeches in History, The Great Courses, Chantilly 2010.

Module component 2	Presentation & planning skills: Writing and implementing research projects
Semester:	2
Coordinator	Luiza Czekała (International Research Projects Section) (luiza_czekala@sggw.edu.pl)
Lecturer	Luiza Czekała, Edyta Seliga-Kobylińska
ECTS-Credits:	3
SWH:	2
Workload:	75 h / Semester
Max. study places:	32
Teaching form:	Lecture (15h), Project (10 h), Practical exercise (5 h), Self-study (45 h)
Language:	English
Module type:	
Examination form:	Project Presentation *
Entry requirements:	
Goal:	The aim of the course is to provide students with knowledge in the field of applying and implementing international research projects, as well as to indicate the added values related to the implementation of MPB that affect the development of a scientific career. During the course, students will be presented with information on: application possibilities, partnerships, elements of a good application, benefits of project reporting and others.
Content:	This module will consist of a series of presentations on writing applications for research projects, including: measurable and non-measurable benefits of obtaining a project, presentation of application possibilities, how to prepare a good application and create a consortium. During the classes, students will also learn about the impact of research projects on the development of their scientific career. The classes will include theoretical part as well as practical exercises related to the application elements.
Recommended related elective modules :	
Competences:	Technical competence (5 %) Media competence (5 %) Methodological competence (70 %), Social competence (10 %), Personal competence (10 %)
Literature:	The Grant Writer's Handbook, Gerard M Crawley, Eoin O'Sullivan,

The Research Funding Toolkit Jacqueline Aldridge & Andrew M Derrington

How to Write Good Scientific Project Proposals: A Comprehensive Guide, Rui Pedro Paiva

E Academic, scientific principles: Language and social skills

Semester:	2
Module coordinator	Dr. Katarzyna Marciszewska (katarzyna_marciszewska@sggw.edu.pl)
Status:	Elective
Goal:	Students learn the Polish language and culture through the prism of forests and forestry. They become aware of the importance of forests as the material basis of various cultures and develop the skills to disseminate knowledge about their culture-forming role.
Examination form:	Project presentation, technical discussion*
ECTS-Credits:	6
SWH:	4

Module component 1 Polish language

Semester:	2
Coordinator	International Relations Office
Lecturer	International Relations Office
ECTS-Credits:	3
SWH:	2
Workload:	75 h / Semester
Max. study places:	32
Teaching form:	Lecture (15 h), Practical exercise (15 h), Self-study (45h)
Language:	English
Module type:	continuous
Examination form:	Project presentation, technical discussion*

Entry requirements:	
Goal:	Students know the fundamentals of the current Polish society and are able to apply Polish language in everyday situations.
Content:	The course is an offer exclusively for non-Polish foreign students. It introduces into Polish language and the fundamentals of the current Polish society. Everyday situations of Polish language are imparted and trained. It is given an insight into Polish social life, history and culture. Comprehension for the integration into Polish life and society is developed.
Recommended related elective modules :	
Competences:	Technical competence (20%) Media competence (20%) Methodological competence (20%), Social competence 20 %), Personal competence (20 %)
Literature:	to be announced at start of the semester

Module component 2 — Forests - human cultural heritage

Semester:	2
Coordinator	Dr. Katarzyna Marciszewska
Lecturer	Dr. Katarzyna Marciszewska
ECTS-Credits:	3
SWH:	2
Workload:	75 h / Semester
Max. study places:	32
Teaching form:	Lecture (10h), Project (10 h), Practical exercise (10 h), Self-study (45 h)
Language:	English
Module type:	continuous
Examination form:	Project presentation, technical discussion*
Entry requirements:	
Goal:	Students gain the knowlegde about forests as the material basis of European culture and source of inspiration in culture and art with special emphasis to Poland. They become familiar with various ways of defining the forest and the

basic concepts and definitions of civilization, culture and art, relations between these concepts and their development. On the basis of their own cultural identity, they make comparisons of the culture-creating role of the forests in different periods and regions of the world. Students understand the need and develop the skills to present forests as human cultural heritage.

Content:

Lectures
Introductory explanation of the genesis and purpose of the subject. Basic concepts: definitions of civilization, culture and art, relations between these concepts, types of arts, cult, myth, symbol, allegory, metaphor.

Natural roots of European culture: forests, and trees as a source of raw materials (building materials, food, healing agents) and a place of refuge and worship. Examples of historical messages about the natural conditions of Poland and cultural phenomena rooted in the forest environment. Presentation of different definitions of the concept of tree and forest.

Tree symbolism in various cultures from prehistoric times to modern times - sacred groves and main species of sacred trees, tree of life, cosmic tree, tree of knowledge, middle tree, etc. Greek, Roman and Slavic mythology.
Biblical tree symbolism - Tree of Life, Tree, Knowledge of Good and Evil, Tree of the Cross - olive, fig tree, vine, date palm, cypress and cedar. Meditations of Job, Jotham's fairy tale. The Tree of Remembrance, Trees of Martyrdom, Family Tree, Tree of Peace. Trees and their souls: metamorphoses, eg Daphne - laurel tree, Leuke - poplar, Phylira - linden, Pitys - pine, Carya - walnut, legends about trees.

Trees and forest in Polish: phraseology, onomastics. Comparisons and constant expressions: adages, proverbs, aphorisms motivated by observations of the forest environment. Proper names of people and places motivated by the forest environment.

Forest in European literature, painting and sculpture. Different ways of creating the image of the forest and its different meanings. Examples of works inspired by the forest theme and theme in European culture from the prehistoric period to the present day.
Forest in the newest art: photography, film, performance
Forest in music - examples of musical works inspired by the forest environment. Wooden musical instruments.
Architecture inspired by Nature, Tree and Forest.
Contemporary and historical forest-related professions as a source of cultural phenomena - e.g. hunting and dialect, hunting customs and signals.

Practical exercises: study tour to Forest Culture Center in Gołuchów an Institution focused on preservation of cultural heritage of Polish forestry and wide and continuous popularization of foresters' oeuvre.

Students projects presentations and discussions based on the reports and presentations

Recommended related elective modules :	Forest trees in Poland
Competences:	Technical competence (10%), Methodological competence (20%), Social competence 20%), Personal competence (20%)
Literature:	Cultural Heritage and Sustainable Forest Management: the role of traditional knowledge (Vol. 1 and 2). January 2006. Ministerial Conference on the Protection of Forests in Europe, Liaison Unit Warsaw. Editor: John A. Parrotta, Mauro Agnoletti, Elisabeth Johann ISBN: 13 978-83-922396-4-2. Project: IUFRO Task Force on Traditional Forest Knowledge. Frazer, Sir James (1993). The Golden Bough. London: Wordsworth Tabbush P. 2010. Cultural Value of Trees, Wood s and Forests. https://www.forestresearch.gov.uk/research/cultural-value-of-trees-woods-and-forests/ Zohar Amar, Flora of the Bible: A New Investigation Aimed at Identifying All of the Plants of the Bible in Light of Jewish Sources and Scientific Research, Jerusalem, 2012, p. 220 Zohary, Michael (1982) Plants of the Bible. New York: Cambridge University Press.

E Forest biometry, biomass and tree ring analysis

Semester:	2
Module coordinator	Prof. Dr. Michał Zasada (michal_zasada@sggw.edu.pl)
Status:	Elective
Goal:	Students will learn how to design, collect and process data in order monitoring forest growth and yield and to estimate amount of woody biomass in forest stands.
Examination form:	Project report, Project presentation*
ECTS-Credits:	6
SWH:	6

Module component 1 Forest mensuration

Semester:	2
Coordinator	Dr. Robert Tomusiak (robert_tomusiak@sggw.edu.pl)
Lecturer	Dr. Robert Tomusiak, Dr. Rafał Wojtan
ECTS-Credits:	2
SWH:	2
Workload:	50 h / Semester
Max. study places:	32
Teaching form:	Lecture (22h), Project (8 h), Self-study (20 h)
Language:	English
Module type:	continuous
Examination form:	Project report / Project presentation*
Entry requirements:	

Goal:	The main objective of the course is to introduce to theoretical foundations of forest measurements, use of principles and techniques for evaluating and monitoring forest growth and yield in various methods.
Content:	This module is composed of the following topics: growth of single trees and whole stands; tree crown development; stand social structure; impact of various biotic and abiotic factors on stand structure; growth and yield, impact of thinning on stand structure; growth and yield; yield tables; introduction to growth and yield models; stem analysis; measuring trees and stands, measurement techniques for various tree and stand attributes, volume, shape, taper, and product determination for single trees, concepts and techniques to determine product/tree volume and increment of stands.
Recommended related elective modules :	The environmental basis for management planning in forests
Competences:	Technical competence (40%), Methodological competence (40%), Personal competence (20%)
Literature:	Husch B., Beers T.W., Kershaw J.A. 2003. Forest Mensuration. Chichester: John Wiley and Sons.

Module component 2 — Biomass assessment and modelling

Semester:	2
Coordinator	Prof. Dr. Michał Zasada
Lecturer	Dr Karol Bronisz, Prof. Dr. Michał Zasada, Dr. Szymon Bijak
ECTS-Credits:	2
SWH:	2
Workload:	50 h / Semester
Max. study places:	32
Teaching form:	Lecture (6h), Project (9h), Practical exercise (15h), Self-study (20h)
Language:	English
Module type:	Partly-blocked
Examination form:	Project report / Project presentation*

Entry requirements:

Goal:

During the course students will learn how to design, collect and process data in order to estimate amount of woody biomass biomass in forest stands - as a tool for forest inventory related mainly to carbon sequestration.

Content:

Lectures cover, among others, bases of the carbon cycle and methodology of biomass inventory. Practical training in the field allows to learn methods of forest woody biomass measurements as well as laboratory procedures involved in the biomass assessment. Practical exercises is designed to show all the steps of data processing and modeling: data preparation and screening, basic calculations of volume and biomass on a single tree level, development of empirical biomass equations, calculation of biomass on the stand level using biomass equations an biomass expansion factors, and analysis of biomass allocation into different components (stem, branches, leaves and roots). Basic practical training in the field and in the lab is also provided.

The course assessment is based on the progress reports from the individual students' work and covers the following parts: i) determination of single tree volume, ii) determination of dry biomass of a single tree and its components, iii) development of biomass equations on a single tree level, iv) calculation of belowground biomass, v) calculation of biomass on the plot and per hectare level, vi) development of biomass conversion and expansion factors (BCEF) for total biomass and its components, vii) analysis of biomass shares and BCEFs in various tree components with respect to stand characteristics.

Recommended related elective modules :

Mathematical Models in Biology and Economics

Competences:

Technical competence (25%), Methodological competence (25%), Social competence 25%), Personal competence (25%)

Literature:

Ashton, M.S., Tyrrell, M.L., Spalding, D., Gentry, B. (Eds.), 2012. Managing Forest Carbon in a Changing Climate. Springer Netherlands, Dordrecht. https://doi.org/10.1007/978-94-007-2232-3

Bronisz, K., Strub, M., Cieszewski, C., Bijak, S., Bronisz, A., Tomusiak, R., Wojtan, R., Zasada, M., 2016. Empirical equations for estimating aboveground biomass of Betula pendula growing on former farmland in central Poland. Silva Fennica 50. https://doi.org/10.14214/sf.1559

Burkhart, H.E., Tomé, M., 2012. Modeling Forest Trees and Stands. Springer Netherlands, Dordrecht.

Fahey, T.J., Woodbury, P.B., Battles, J.J., Goodale, C.L., Hamburg, S.P., Ollinger, S.V., Woodall, C.W., 2009. Forest carbon storage: ecology, management, and policy. Frontiers in Ecology and the Environment 8, 245–252. https://doi.org/10.1890/080169

Jagodziński, A.M., Zasada, M., Bronisz, K., Bronisz, A., Bijak, S., 2017. Biomass conversion and expansion factors for a chronosequence of young naturally regenerated silver birch (Betula pendula Roth) stands growing on post-agricultural sites. Forest Ecology and Management 384, 208–220. https://doi.org/10.1016/j.foreco.2016.10.051
Zianis, D., Muukkonen, P., Mäkipää, R., Mencuccini, M., 2005. Biomass and stem volume equations for tree species in Europe, Silva Fennica Monographs. Finnish Society of Forest Science, Finnish Forest Research Institute, Tampere, Finland.

Module component 3 — Tree ring analysis

Semester:	2
Coordinator	Dr. Robert Tomusiak (Robert_Tomusiak@sggw.edu.pl)
Lecturer	Dr. Robert Tomusiak
ECTS-Credits:	2
SWH:	2
Workload:	50 h / Semester
Max. study places:	32
Teaching form:	Lecture (10h), Project (10h), Practical exercise (10h), self-study (20h)
Language:	English
Module type:	Partly-blocked
Examination form:	Project report / Project presentation*
Entry requirements:	
Goal:	Students are able to conduct research based on tree-ring data and have an extended understanding of past responses of tree growth to environmental variability and prediction of forest responses to change of environment in the future.
Content:	The following chapters are handled: process of forming of tree rings, factors effecting tree ring's width, software for control, creating and analysing tree ring chronologies, methods and applications of dendrochronology.
Recommended related elective modules :	

Competences: Technical competence (50%), Methodological competence (40%), Personal competence (10%)

Literature:

Bronisz, A., Bijak, S., Bronisz, K., Zasada, M., 2012. Climate influence on radial increment of oak (Quercus SP.) in central Poland. Geochronometria 39, 276–284. https://doi.org/10.2478/s13386-012-0011-7

Cook, E.R., Kairiukstis, L., 1990. Methods of Dendrochronology - Applications in the Environmental Sciences. IIASA, Kluwer Aca- demic Publishers, Boston.

Young, A.B., Cairns, D.M., Lafon, C.W., Moen, J., Martin, L.E., 2011. Dendroclimatic relationships and possible implications for mountain birch and Scots pine at treeline in northern Sweden through the 21st century. Canadian Journal of Forest Research 41, 450–459. https://doi.org/10.1139/X10-116.

E Principles of landscape ecology

Semester:	2
Module coordinator	Dr. Marek Slawski (marek_slaswki@sggw.edu.pl)
Status:	Elective
Goal:	Students will understand principles of landscape functioning and factors influencing it. Recognize ways and rates of matter flux within landscapes. Understand relations between landscape pattern and ecological processes.
Examination form:	Project report, Project presentation, Written exam*
ECTS-Credits:	6
SWH:	3

Module component 1 Principles of landscape ecology

Semester:	2
Coordinator	Dr. Marek Sławski
Lecturer	Dr .Marek Sławski, Dr. Taida Tarabula
ECTS-Credits:	6
SWH:	3
Workload:	150 h / Semester
Max. study places:	32
Teaching form:	Lecture (15h), Project (15h), Practical exercise (15h), Self-study (105 h)
Language:	English
Module type:	
Examination form:	Project report, Project presentation, Written exam*

Entry requirements:

Goal:

Students will understand principles of landscape functioning and factors influencing it. Recognize ways and rates of matter flux within landscapes. Understand relations between landscape pattern and ecological processes.

Content:

Lectures:

-Short history of “landscape” and landscape ecology.-Geosystem or ecosystem? Geocomponents. Scale and hierarchy. -Causes of landscape pattern. Abiotic, biotic and human impact on landscape pattern. Disturbance and stress. Landscape structure and compartments. Landscape ,measures. Patches, corridors and matrix. Land-water interactions. Water in landscape. Lakes and wetlands in the landscape. Model of river continuum. Role of riparian buffers.-Matter flux through the landscape.-Fragmentation of ecosystems. Biogeographical island theory. Recolonisation of defaunated mangrove isles. Island theory in terrestrial ecosystems and plants. Field crops as islands.-Introduction to metapopulation ecology. History of metapopulation ecology. Local population dynamics. Extinction and migration. Source-sink model. Effects of spatial pattern of landscape on organisms.-Components of disturbance regime. Influence of disturbance on landscape and landscape on disturbance. Disturbance and spatial patterns of succession in landscape. Human impact on landscapes (agriculture, forestry, water management, road network);Nature protection networks in Poland, EU and other countries

Classes:

-Modeling of nitrogen outflow from a field-forest-stream catchment area (computer modelling; Metapopulation in landscape; -Measuring landscape structure; Ecological corridors and road building – projecting animal crossings

Field exercise:

-Inventory and valorization of a landscape.-Students prepare landscape planning project. It includes collecting data in the field, analysis of landscape (with use of basic landscape metrics) and plan of habitat restoration, and enhancing ecological processes in landscape scale

Recommended related elective modules :

Competences:

Technical competence (40%) Media competence (10%) Methodological competence (30%), Social competence (10%), Personal competence (10%)

Literature:

Banaszak J., Cierzniak T., Kaczmarek S., Manole T., Piłacińska B., Ratyńska H., Szwed W., Wiśniewski H. 1996. Biodiversity of forest islands in an agricultural landscape. Bull. Pol. Acad. Sci. 44: 111-119.
BanaszakJ. (red.) Landscape and biodiversity. WSP Bydgoszcz Press

Forman R.T.T, Gordon M. 1986. Landscape ecology. Wiley & Sons, New York.
Environment Canada. 2004. How Much Habitat is Enough? A Framework for Guiding Habitat Rehabilitation in Great Lakes Areas of Concern
Hanski I. 1999. Metapopulation Ecology. Oxford Series in Ecology and Evolution. Oxford University Press, pp. 313.
MacArthur R.H., Wilson E.O. 1967. The theory of island biogeography. Princeton, pp. 2003.
Turner M.G., Gardner R.H., O'Neill R.V. – Landscape Ecology in Theory and Practice – Pattern and Process, Springer, 2001
Gergel S.E., Turner M.G. (red.) – Learning Landscape Ecology: A practical guide to concepts and techniques, Springer, 2002
Fahrig, L. (2001). How much habitat is enough? Biological Conservation 100:65-74.
1With, K.A.: Essentials of Landscape Ecology, Oxford University Press, Oxford, UK, 2019, 656 pp

E LiDAR data processing and geo-statistical methods in forestry

Semester:	2
Module coordinator	Dr. Michał Brach
Status:	Elective
Goal:	Acquisition of knowledge and skills for applications of process LiDAR data and geostatistical methods in forestry at local and regional scale
Examination form:	Project presentation, Project report*
ECTS-Credits:	6
SWH:	6

Module component 1 Spatial analysis

Semester:	2
Coordinator	Dr. Wiktor Tracz (wiktor.tracz@wl.sggw.pl)
Lecturer	Dr. Wiktor Tracz
ECTS-Credits:	2
SWH:	2
Workload:	50 h / Semester
Max. study places:	32
Teaching form:	Lecture (8 h), Project (4 h), Practical exercise (18 h), Self-study (20 h)
Language:	English
Module type:	continuous
Examination form:	Project report*
Entry requirements:	Principles of GIS and Remote Sensing

Goal:	The main objectives of the course are: to introduce students to wide range of spatial analyses; develop students' abilities to choose adequate analysis and successfully process spatial data and information about environmental objects and phenomenon.
Content:	Overview of spatial analyses. The process of analyzing of spatial data. Division of spatial analyses. Analysis of different spatial data type. Spatial and attribute queries. Overly, neighborhood and aggregation analyses. Interpolation and types of interpolation. Point pattern analyses. 3D analyses and result visualization. Network analyses.
Recommended related elective modules :	
Competences:	Technical competence (70%) Media competence (5%) Methodological competence (25%)
Literature:	O'Sullivan D., Unwin D. 2010. Geographic Information Analysis. Wiley, 2 edition. Longley P., Goodchild M., Maguire D., Rhind D. 2005. Geographic Information Systems and Science. Wiley. Haining Robert. 2003. Spatial Data Analysis: Theory and Practice. Cambridge University Press. Kraak Menno-Jan, Ormeling Ferjan. 1996. Cartography: Visualization of Spatial Data. Addison Wesley Longman Limited. ERDAS Field Guide. 1997. ERDAS, Inc. Mitchell Andy. 1999. The ESRI guide to GIS analysis. Geographic Patterns and Relationships. ESRI Press. Smith M., Goodchild M., Longley P. 2013. Geospatial Analysis - a comprehensive guide. http://www.spatialanalysisonline.com/HTML/index.html Zeiler M. 1999. Modeling our Word. ESRI Press Robinson A., Morrison J., others. 1995. Elements of cartography. JohnWiley and Son, New York. Using ArcGIS 9. 2006. ESRI Press. ArcGIS online help: http://help.arcgis.com/en/arcgisdesktop/10.0/help/

Module component 2 — Map editing

Semester:	2
Coordinator	Dr. Michał Brach
Lecturer	Dr. Michał Brach
ECTS-Credits:	2
SWH:	2

Workload:	50 h / Semester
Max. study places:	32
Teaching form:	Lecture (12 h), Project (9 h), Practical exercise (9 h), Self-study (20 h)
Language:	English
Module type:	partly-blocked
Examination form:	Project report*
Entry requirements:	The base of GIS and remote sensing form the first semester.
Goal:	Get knowledge about the principles of digital cartography, master the skills of precise digitalization, create a complete workflow of spatial analysis and process LiDAR data in order to solve three-dimensional spatial problems.
Content:	Students get practical skill on how to draw precisely in digital format. It includes usage of dimensions, coordinates, coordinate systems and raster and vector data calibration. The complete way of data organizing using cartographic rules is also performed. The base of LiDAR data geoprocessing is presented base on the real case and set of analysis. The full geoprocessing is organized by complete analysis automation. Students prepare various of projects which combined together create final Map Editing grade.
Recommended related elective modules :	Approaches and tools for research & monitoring with geodata and remote sensing
Competences:	Technical competence (40 %), Methodological competence (20 %), Social competence (10 %), Personal competence (20 %)
Literature:	Dong, P.; Chen, Q.; Chen, Q. LiDAR Remote Sensing and Applications; CRC Press, 2017; Misra, R.P.; Ramesh, A. Fundamentals of Cartography; Concept Publishing Company, 1989 Elangovan, K. GIS: Fundamentals, Applications and Implementations; New India Publishing, 2006 Tyner, J.A. Principles of Map Design; Guilford Press, 2010

Module component 3 — Spatial analysis

Semester:	2

Coordinator	Dr. Dariusz Gozdowski (dariusz_gozdowski@sggw.edu.pl)
Lecturer	Dr. Dariusz Gozdowski
ECTS-Credits:	2
SWH:	2
Workload:	50 h / Semester
Max. study places:	32
Teaching form:	Lecture (10 h), Project (5 h), Practical exercise (15 h), Self-study (20 h)
Language:	English
Module type:	continuous
Examination form:	Project presentation / Project report*
Entry requirements:	
Goal:	Acquisition of knowledge and skills for applications of geostatistical methods in forestry at local and regional scale.
Content:	Statistical measures of spatial dependence and spatial variability. Local and global spatial autocorrelation indices. Geostatistical methods of spatial interpolation and evaluation of uncertainty. Optimization of sampling methods based on geostatistical prediction.
Recommended related elective modules :	
Competences:	Technical competence (20%), Methodological competence (60%), Personal competence (20%)
Literature:	to be announced at start of the semester

E Sustainable Forest Management and forest products

Semester:	2
Module coordinator	Dr. Roman Wójcik (roman_wojcik@sggw.edu.pl)
Status:	Elective
Goal:	Forest species diversity - modern methods of assessing and shaping forest biodiversity. Adaptation of forests to the habitat/site. Specificity of forests in the city and its surroundings. Social and protective functions of forests. Methods of valorization of functions and shaping of forests to maximize social and protective functions. Non-wood forest products use in sustainable forest management; role of non-wood forest products in Poland and selected countries
Examination form:	Project presentation, Project report*
ECTS-Credits:	6
SWH:	5,5

Module component 1 The environmental basis for management planning in forests

Semester:	2
Coordinator	Dr. Michał Orzechowski (Michal_Orzechowski@sggw.edu.pl)
Lecturer	Dr. Michał Orzechowski, Dr. Roman Wójcik, Dr. Wojciech Kędziora, Dr. Dawid Sikora, Mgr. Joanna Mielczarczyk
ECTS-Credits:	2
SWH:	2
Workload:	50 h / Semester
Max. study places:	32
Teaching form:	Lecture (10 h), Project (10 h), Practical exercise (10 h), Self-study (20 h)
Language:	English
Module type:	partly-blocked

Examination form:	Project report / Project presentation*
Entry requirements:	
Goal:	Learning about the methods for determining the natural basis for management planning in forests
Content:	Forest species diversity - modern methods of assessing and shaping forest biodiversity (trees, plants, birds...). Adaptation of forests to the habitat/site. Methods of recognition of habitat/site conditions - site types, phytosociological types, natural habitats (Natura 2000). Assessment of naturalness of forests and forms of deformation/degradation. Consequences for management planning.
Recommended related elective modules :	
Competences:	Technical competence (40%) Media competence (5%) Methodological competence (45%), Social competence (5%), Personal competence (5 %)
Literature:	to be announced at start of the semester

Module component 2 — Urban forestry - planning of urban and suburban forests

Semester:	2
Coordinator	Dr. Roman Wójcik
Lecturer	Dr. Roman Wójcik, Dr. Michał Orzechowski, Dr. Wojciech Kędziora, Dr. Dawid Sikora, Mgr. Joanna Mielczarczyk
ECTS-Credits:	2
SWH:	2
Workload:	50 h / Semester
Max. study places:	32
Teaching form:	Lecture (10 h), Project (10 h), Practical exercise (10 h), Self-study (20 h)
Language:	English
Module type:	Partly-blocked
Examination form:	Project report / Project presentation*
Entry requirements:	

Goal:	Learning about the specificity of forestry in urban and suburban conditions.
Content:	Specificity of forests in the city and its surroundings. Social and protective functions of forests. Methods of valorisation of functions and shaping of forests to maximize social and protective functions. Environmental basis of forest management in cities - climate, water and soils. Forests in cities as green corridors and elements of nature and landscape protection system. Neighbourhood problems - forest and city. Urban forests in spatial planning.
Recommended related elective modules :	
Competences:	Technical competence (40%) Media competence (5%) Methodological competence (45%), Social competence (5 %), Personal competence (5 %)
Literature:	to be announced at start of the semester

Module component 3 — Non-Wood Forest Products

Semester:	2
Coordinator	Dr. Paweł Staniszewski (Pawel_Staniszewski@sggw.edu.pl)
Lecturer	Dr. Paweł Staniszewski
ECTS-Credits:	2
SWH:	2
Workload:	50 h / Semester
Max. study places:	32
Teaching form:	Lecture (6 h), Project (10 h), Practical exercise (14 h), Self-study (30 h)
Language:	English
Module type:	partly-blocked
Examination form:	Project report / Project presentation*
Entry requirements:	
Goal:	The main objective of the course is to present forest as a source of various non-wood forest raw material and products as well as problems of estimation of non-wood forest resources, its utilization, and market and law instruments.

Content:	Non-wood forest products (NWFPs) use in sustainable forest management; role of NWFPs in Poland and selected countries; resource assessment of NWFPs; characteristic, harvesting, processing and quality assessment of selected NWFPs, particularly forest floor resources (laboratory programme); policy and regulation of NWFPs utilisation.
Recommended related elective modules :	
Competences:	Technical competence (70 %) Media competence (10 %) Methodological competence (10 %), Social competence (10 %)
Literature:	

M Research project

Semester:	3
Module coordinator	Head of study programme
Status:	Mandatory
Goal:	The students accomplish a scientific or applied technical research project of medium size related to the study program's content. Based on the selected thematic orientation of the project, students can strengthen their particular orientation in the FIT program, in addition to two complementary elective modules.
Examination form:	Project report (75%), Term paper (25%)
ECTS-Credits:	12
SWH:	8

Module component 1 Scientific or technical research project

Semester:	3
Coordinator	Prof. Dr. Jan-Peter Mund
Lecturer	Prof. Dr. Jan-Peter Mund, Prof. Dr. Luis Miranda, Prof. Dr. Michal Zasada, Prof. Dr. Felipe Bravo
ECTS-Credits:	9
SWH:	6
Workload:	225 h / Semester
Max. study places:	
Teaching form:	Practical exercise (90 h), Self-study (135 h)
Language:	English
Module type:	

Examination form:	Project report (75 %)
Entry requirements:	
Goal:	Students are enabled to plan and accomplish a particular research project of moderate size and consolidated their senior level of graduate academic maturity concerning their thematic focus.
Content:	The main content of the course is to develop and to deepen abilities of analytical, methodical and reporting skills in an environment close to later professional practice. Students learn to plan and accomplish a research project of moderate size. Projects are related to the application of information technologies in order to describe and / or solve problems in forestry or environment. Students accomplish the research project in own responsibility, document the working steps, discuss conclusions and prepare a final project report.
Recommended related elective modules:	
Competences:	Technical competence (40%) Media competence (20%) Methodological competence (40%)
Literature:	to be published by supervisor of research project

Module component 2 — Scientific Internet Colloqium

Semester:	3
Coordinator	Prof. Dr. Luis Carlos Miranda Trujillo
Lecturer	Prof. Dr. Luis Carlos Miranda Trujillo, Prof. Dr. Michal Zasada, Prof. Dr. Felipe Bravo
ECTS-Credits:	3
SWH:	2
Workload:	75 h / Semester
Max. study places:	
Teaching form:	Practical exercise (30 h), Self-study (45 h)
Language:	English
Module type:	
Examination form:	Term Paper (25 %)

Entry requirements:

Goal:

Students are able to discover new areas of IT applications, extend and manifest their capacities for accomplishing scientific work including academic writing and reviewing scientific papers in an online virtual seminar.

Content:

The goal of the course is to enable students to open new areas of IT applications in forestry and environment. The course is organized as an interactive discussion of selected scientific papers which extend ideas and concepts conveyed in the previous semesters. The papers cover a typical spectrum of forest / environment related information technologies such as Geographical Information Systems, complex databases, ecosystem modelling and simulation incl. case studies, information systems, communication structures within complex projects and to the public.
The presented papers will be individually analyzed by the students according to inputs of the colloquium moderator. Students are requested to make additional literature search and to evaluate and to compare references. Students publish their evaluations in an online Discussion Forum. The individual contributions will then be commonly discussed and summarized. The mutual insemination and evaluation of knowledge and opinions is an integral part of the course.

Recommended related elective modules :

Competences:

Technical competence (20%) Media competence (40%) Methodological competence (40%)

Literature:

A topical selection of state of the art scientific papers of FIT applications in forest and environmental research will be announced at the beginning of the semester.

E Innovative economy, policy and social sciences in forestry

Semester:	3
Module coordinator	Dr. Arkadiusz Gruchala (arkadiusz_gruchala@sggw.edu.pl)
Status:	Elective
Goal:	Student is able to carry out a two-way communication process. Student knows methods and instruments of gaining data about functioning enterprises.
Examination form:	Project report, Project presentation*
ECTS-Credits:	6
SWH:	4

Module component 1 Negotations in forestry

Semester:	3
Coordinator	Dr. Arkadiusz Gruchala
Lecturer	Dr. Arkadiusz Gruchala
ECTS-Credits:	3
SWH:	2
Workload:	75 h / Semester
Max. study places:	32
Teaching form:	Lecture (2h), Project (5 h), Practical exercise (23 h), Self-study (45 h)
Language:	English
Module type:	Partly-blocked
Examination form:	Project report / Project presentation*

Entry requirements:

Goal: Student is able to prepare oral presentations. Student is able to carry out a two-way communication process, the aim of which is to reach an agreement when at least one party does not agree with a given opinion or with a given solution to the situation.

Content:

1. Types of negotiations
2. Negotiation strategies and criteria for selecting a strategy in the field of forestry
3. Principles in negotiations
4. Stages of negotiations
5. Criteria for evaluating negotiations taking into account forestry
6. Compromise - success or failure in negotiations?

Recommended related elective modules :

Competences: Technical competence (10%) Media competence (10%) Methodological competence (30%), Social competence (20 %), Personal competence (30 %)

Literature:

Bazerman M.H., Neal M.A., (1993) Negotiating Rationally. Free Press. USA

Casse P. (1992) The One Hour Negotiator. Architectural Press

Ury W, Fisher r. (2009) Getting to yes. Negotiating an agreement without giving in. Penguin Group. UK.

Cialdini R., (2008) Influence: Science and Practice (5th Edition). Allyn and Bacon. USA.

Mastenbroek W., (2002) Negotiating as Emotion Management. Holland Business Publications. Netherlands.

Module component 2 — Entrepreneurship (for Tourism)

Semester: 3

Coordinator Dr. Piotr Gabryjończyk (piotr_gabryjonczyk@sggw.edu.pl)

Lecturer Dr. Piotr Gabryjończyk

ECTS-Credits: 3

SWH: 2

Workload: 75 h / Semester

Max. study places: 32

Teaching form:	Lecture (15h), Practical exercise (15 h), Self-study (45 h)
Language:	English
Module type:	continuous
Examination form:	Project report / Project presentation*
Entry requirements:	
Goal:	Student knows methods and instruments of gaining data about functioning tourist enetrprises; knows basic rules of creation and development of individual entrepreneurship's forms; is planning and implementing own enterprising ideas; can prepare documents necessary to start and run business; can think and act in enterprising way; can work in a team.
Content:	Presentation of role of entrepreneurship in developing tourism industry; Showing ways of stimulating and developing entrepreneurship; Supporting independence in acting enterprisingly. **Lectures:** Definition and essence of entrepreneurship. Entrepreneur and enterprise in tourism. Types of enterprises. Innovative enterprise. Enterprising orientation. Risk and ways of handling with it. Local and global entrepreneurship. **Classes:** Conditions of developing entrepreneurship. Projects planning. Providing resources and conditions to implement enterprising project. Institutions and forms of supporting entrepreneurship.
Recommended related elective modules :	
Competences:	Technical competence (20%) Media competence (20%) Methodological competence (20%), Social competence (20%), Personal competence (20%)
Literature:	Scarborough N., 2011. Essentials of entrepreneurship and small business management, Pearson, Harlow; Scarborough N., 2012. Effective small business management: an entrepreneurial approach, Pearson, Upper Saddle River; Drucker P., 2007. Innovation and entrepreneurship: practice and principles, Butterworth-Heinemann, Oxford; Rekowski M., 2008. Entrepreneurial tissue and regional economy: case studies of selected Polish and Spanish regions, The Poznan University of Economics Publishing House, Poznań;

Bednarczyk M., 2011. Przedsiębiorczość w turystyce - zasady i praktyka, Wyd.
CeDeWu, Warszawa;
Piecuch T., 2010. Przedsiębiorczość - podstawy teoretyczne, Wyd. C.H. Beck,
Warszawa;
Bednarska M., Gołembski G., 2007. Przedsiębiorstwo turystyczne - ujęcie statyczne
i dynamiczne, Wyd. PWE, Warszawa;
Drucker P., 2004. Natchnienie i fart czyli innowacja i przedsiębiorczość, Wyd. Studio
Emka, Warszawa;
Staszewska J., 2009. Klaster perspektywą dla przedsiębiorców na polskim rynku
turystycznym, Wyd. Difin, Warszawa.

E Natural resources and conservation

Semester:	3
Module coordinator	Dr. Katarzyna Marciszewska
Status:	Elective
Goal:	Student knows basic characteristics of populations ecosystems and landscapes, basic method of assessment and evaluation.
Examination form:	Project report, Project presentation, Written exam*
ECTS-Credits:	6
SWH:	5,5

Module component 1 Assessment and Evaluation of Natural Resources

Semester:	3
Coordinator	Dr. Axel Schwerk (Axel_Schwerk@sggw.edu.pl)
Lecturer	Dr. Axel Schwerk, Dr. Izabela Dymitryszyn
ECTS-Credits:	2
SWH:	2
Workload:	50 h / Semester
Max. study places:	32
Teaching form:	Lecture (15h), Practical exercise (15 h), Self-study (20 h)
Language:	English
Module type:	continuous
Examination form:	Written exam*
Entry requirements:	

Goal:	The aim of the course is to teach possibilities to assess and evaluate natural resources by help of ecological methods.
Content:	**Lectures:** The lecture is divided int five parts which deal with different hierarchic levels in ecology (population, ecosystem, landscape) as well as the phenomenon of succession and cultural values. Population: To a high degree theoretical aspects (e.g. abundance and density, mortality, curves of survival); population dynamics and hunting models. Ecosystem: Definition of ecosystems; nutrient chains; basic organization of the most important types of terrestrial as well as aquatic ecosystems; evaluation of forest ecosystems based on carbon values. Succession: Definition of ecological succession; how to stimulate or to break successional processes; first aspects of assessment and evaluation will be involved, because different successional stages may be of different value. Cultural values: The importance and influence of cultural values will be discussed; assessment of esthetical values (scenic beauty estimation). Landscape: Assessment and evaluation of landscapes applying the knowledge provided by the first four parts; landscape species as indicators of landscape functioning and quality. **Exercises:** Selected methods to assess and evaluate natural resources will be trained. Indicator species, evaluation by help of carbon values, scenic beauty evaluation, contingent valuation methods.
Recommended related elective modules :	
Competences:	Technical competence (20%), Media competence (20%), Methodological competence (20%), Social competence (20%), Personal competence (20 %)
Literature:	Begon, M., Harper, J. L. & Townsend, C. R. (1996): Ecology: Individuals, Populations and Communities. 3rd ed. Blackwell Science. Begon, M. & Mortimer, M. (1986): Population ecology. A unified study of animals and plants, 2. ed. Blackwell Scientific Publications, Oxford, London, Edinburgh, Boston, Melbourne, Paris, Berlin, Vienna. Dymitryszyn, I., Szyszko, J. & Rylke, J. (eds.): Terenowe metody oceny i wyceny zasobów przyrodniczych / Field methods of evaluation and assessment of natural resources. WULS-SGGW Press, Warsaw. Odum, E. P. & Barrett, G. W. (2005): Fundamentals of ecology. 5th ed. Belmont, CA: Thomson Brooks/Cole. Schwerk, A. (2008): Model of the rate of succession of epigeic carabid beetles

(Coleoptera: Carabidae) on degraded areas. Instytut Badawczy Leśnictwa,
Sękocin Stary, 71 p.
Szyszko, J. (1990): Planning of prophylaxis of threatened pine forest biocenoses based on an analysis of the fauna of epigeic Carabidae. Warsaw
Agricultural University Press, Warsaw. • Szyszko, J., Schwerk, A. & Malczyk, J. (2011): Animals as an indicator of
carbon sequestration and valuable landscapes. In: Kotze, D. J., Assmann, T.,
Noordijk, J., Turin, H. & Vermeulen, R. (eds.): Carabid beetles as bioindicators:
biogeographical, ecological and environmental studies. ZooKeys 100, 565-573.

Module component 2 — Forest trees in Poland

Semester:	3
Coordinator	Dr. Katarzyna Marciszewska (katarzyna_marciszewska@sggw.edu.pl)
Lecturer	Dr. Katarzyna Marciszewska
ECTS-Credits:	2
SWH:	2
Workload:	50 h / Semester
Max. study places:	32
Teaching form:	Lecture (5h), Project (5 h), Practical exercise (10 h), Self-study (30 h)
Language:	English
Module type:	partly-blocked
Examination form:	Project presentation / Written exam*
Entry requirements:	
Goal:	The aim of the course is to familiarize students with the main species of conifers and deciduous trees found in the forests of Poland. The scope of the acquired knowledge includes the systematic affiliation of species, their morphological features, ecological requirements and forest-forming importance. Practical classes include recognizing the species according habit, characteristics of leaves, bark, flowers and fruits or

cones. Field classes consist in recognizing native trees and learning about species of foreign origin during a trip through the forest near Warsaw.

Content:

Lectures: characteristics of the organs of generative reproduction of woody plants. Structure and modifications of the above-ground vegetative organs of woody plants. Characteristics of selected families, genera and species of trees.
Practical exercise: practical identification of species on the basis of the characteristics of morphological features e.g. shoots, fruits etc. using identification keys. Characteristics of selected trees species.
Field classes consisting in collecting specimens and photo-documentation in aim to recognize native and foreign trees in the forest near Warsaw. Preparation of presentation based on the collected material.

Recommended related elective modules :

Competences:

Technical competence (30%), Methodological competence (30%), Social competence (20 %), Personal competence (20 %)

Literature:

Dendrology on-line. https://treesandshrubsonline.org/
Ciurzycki W., Marciszewska K. 2016. Flora of pine forests on former farmlands and in ancient forests in the Chojnów Forest District. Ann. WULS - SGGW, For. and Wood Technol. 93: 30-36.
Ciurzycki W., Marciszewska K. 2016. Vegetation of pine forests on former farmlands and in ancient forests in the Chojnów Forest District. Ann. WULS - SGGW, For. and Wood Technol. 93: 37-43.
Vegetation of pine forests on former farmlands and in ancient forests in the Chojnów Forest District
Ciurzycki W, Budna M., Marciszewska K. 2018. Protection and Threats to the Plant Cover of the Skarpa Ursynowska Nature Reserve in Warsaw. Ann. WULS -SGGW, For. and Wood Technol.104,481-491.
Ciurzycki W., Marciszewska K. 2018. Forest plant communities and their degeneration in the urban forests of Warsaw. Folia Forestalia Polonica, Series A 60(4):269-280. DOI: 10.2478/ffp-2018-0028
Forests in Poland. 2018. https://www.lasy.gov.pl/pl/informacje/publikacje/in-english/forests-in-poland/fortests-in-poland-2018-4.pdf/view
The State Forests in Figures 2018. http://www.lasy.gov.pl/pl/informacje/publikacje/in-english/the-state-forests-in-figures/the-state-forests-in-figures-2018.pdf

and recently issued Textbooks in Dendrology e. g. Harlow and Harrar's , M. Idžojtić etc.

Module component 3 — Active Nature Conservation

Semester: 3

Coordinator	Dr. Krzysztof Klimaszewski (Krzysztof_klimaszewski@sggw.edu.pl)
Lecturer	Dr. Krzysztof Klimaszewski
ECTS-Credits:	2
SWH:	2
Workload:	50 h / Semester
Max. study places:	32
Teaching form:	Lecture (10h), Practical exercise (20 h), Self-study (20 h)
Language:	English
Module type:	Partly-blocked
Examination form:	Project report / Project presentation*
Entry requirements:	
Goal:	The aim of the course is to present the measures of active nature conservation, with special focus on wild animals.
Content:	The aim of the course is to present the measures of active nature conservation, with special focus on wild animals. Special attention will be focused on few main topics: 1. Fauna of Poland – characteristics, status, population trends, threats. 2. Nature protection in Poland and Europe. Passive and active forms of protection 3. Conservation activities conducted in Poland – ongoing and finished projects. Organization, measures, aims and achievements – case studies. * Topic no. 3 will be also conducted during field trip
Recommended related elective modules :	
Competences:	Technical competence (20%) Media competence (20%) Methodological competence (20%), Social competence (20 %), Personal competence (20 %)
Literature:	The General Directorate for Environmental Protection in Poland http://www.gdos.gov.pl/eng biodiv.mos.gov.pl Majchrowska A., Papińska E., 2014. Natural value of the environment in Poland and its protection [in:] Marszał T., Kobojek E. (red.), Natural environment of Poland and it's protection. Wyd. Uniw. Łódzkiego, Łódź, s. 101-124.

E Information and mathematical models

Semester:	3
Module coordinator	Dr. Michał Brach (michal_brach@sggw.edu.pl)
Status:	Elective
Goal:	Students will know basic mathematical models in economics and biology. Students will know how to move the GIS projects from desktop to online form, create and field update the web-based maps and finally create the simple geoportal.
Examination form:	Project report, Project presentation*
ECTS-Credits:	6
SWH:	4

Module component 1 Mathematical Models in Biology and Economics

Semester:	3
Coordinator	Dr. Urszula Grzybowska (urszula_grzybowska@sggw.edu.pl)
Lecturer	Dr. Urszula Grzybowska
ECTS-Credits:	4
SWH:	2
Workload:	100 h / Semester
Max. study places:	32
Teaching form:	Lecture (15h), Project (5 h), Practical exercise (10 h), Self-study (70 h)
Language:	English
Module type:	blocked, partly-blocked
Examination form:	Project report / Project presentation*

Entry requirements:

Goal: Students will know basic mathematical models in economics and biology, be able to analyze the models, will be apply special software to analyze qualitative behavior of investigated models, will be able to make calculations concerning matrices, differential and difference equations in Mathematica or Matlab.

Content:

- Differential and difference equations. Stability of equilibrium solutions.
- Models for Single-Species Populations (Malthus Model, Logistic Growth).
- Predator-Prey Systems and the Lotka-Volterra Equations.
- Epidemic Models (SI, SIS, SIR).
- Markov chains and their application.
- Models of growth and equilibrium: Harrod–Domar Model, Solow–Swan Model.
- Samuelson-Hicks Model.
- Kalecki and Kaldor Models.
- Goodwin Model.

Recommended related elective modules :

Competences: Technical competence (30%), Methodological competence (30%), Social competence (15 %), Personal competence (15 %)

Literature:
Differential Equations with Mathematica, M. L. Abbel, J. Braselton, Academic Press, 1993.
Differential Equations and Their Applications, M. Braun, Springer Verlag, New York, 1992.
Mathematical Biology. An Introduction, J. D. Murray, Springer.
Essential Mathematical Biology N. F. Britton, Springer 2004.
Mathematical Models in Biology L. Edelstein-Keshet, SIAM, 2005.
Mathematical economics, A. Takayama, Cambridge University Press, 1985.

Module component 2 — Sharing data over the internet

Semester: 3

Coordinator Dr. Michal Brach

Lecturer Dr. Michal Brach

ECTS-Credits: 2

SWH: 2

Workload:	50 h / Semester
Max. study places:	32
Teaching form:	Lecture (10h), Project (10 h), Practical exercise (10 h), Self-study (20 h)
Language:	English
Module type:	Partly-blocked
Examination form:	Project report*
Entry requirements:	All GIS skills from the first and second semester
Goal:	Practical exercises how to move the GIS projects from desktop to online form, create and field update the web-based maps and finally create the simple geoportal.
Content:	The idea is to present complete workflow of how to switch GIS data from the desktop form to the on-line. Taking into account the students experience from first and the second semester this module allows to present different GIS projects in geoprotal. Students not only produce on-line content base on the previous works but also create the new concept of the spatial objects inventory. One of the points is using a mobile application in order to measure new objects and fill the database for them. This module combines the skills from GNSS usage, cartography presentation, map editing and programming. The result of the module is the geoportal which is shared globally.
Recommended related elective modules :	Spatial analysis, Map Editing, Spatial statistics
Competences:	Technical competence (30%) Media competence (10%) Methodological competence (20%), Social competence 20 %), Personal competence (20 %)
Literature:	Fu, P. Getting to Know Web GIS; Esri Press: Redlands, California, 2015; Laaribi, A.; Peters, L. GIS and the 2020 Census: Modernizing Official Statistics; Esri Press: Redlands, California, 2019 Dorman, M. Introduction to Web Mapping; CRC Press, 2020;

E Environmental Monitoring

Semester:	3
Module coordinator	Dr. Leszek Hejduk (Leszek_Hajduk@sggw.edu.pl)
Status:	Elective
Goal:	Legal basis of environmental monitoring, cross-border transfer of waste and pollution, international environmental monitoring programs. Sources of information about environment condition. Flow of environment information on the example of Polish State Environmental Monitoring System. Norms for air, water and soil quality.
Examination form:	Project report, Project presentation*
ECTS-Credits:	6
SWH:	2

Module component 1 Environmental Monitoring

Semester:	3
Coordinator	Dr. Leszek Hejduk
Lecturer	Dr. Leszek Hejduk, Dr. A. Hajduk, Dr. A. Bańkowska-Sobczak
ECTS-Credits:	6
SWH:	2
Workload:	150 h / Semester
Max. study places:	32
Teaching form:	Lecture (20h), Project (5 h), Practical exercise (20 h), Self-study (105 h)
Language:	English
Module type:	continuous
Examination form:	Project report / Project presentation*
Entry requirements:	

Goal:	Legal basis of environmental monitoring, cross-border transfer of waste and pollution, international environmental monitoring programs. Sources of information about environment condition. Flow of environment information on the example of Polish State Environmental Monitoring System. Norms for air, water and soil quality.
Content:	The aim of the teaching is to acquaint students with principles and organization of environmental monitoring, factors causing pollution of individual components of the environment and their condition in terms of quantity and quality. Legal basis of environmental monitoring, cross-border transfer of waste and pollution, international environmental monitoring programs (HELCOM, EIONET EEA and others). Sources of information about environment condition. Flow of environment information on the example of Polish State Environmental Monitoring System. Norms for air, water and soil quality. Methods of monitoring of: air quality, noise, water quantity and quality (inland waters, transitional waters, coastal waters groundwater), electromagnetic fields, ionizing radiation, soil, nature. Integrated monitoring. Review of devices for automatic measurement of environmental quantity and quality. The air quality monitoring exercises include methods of measurement of various elements of the natural environment, discussion of quantitative characteristics of selected pollutants. Students get acquainted with the construction, principles of operation and operation of selected measuring instruments. Classes: Students will become familiar with the construction, principles of operation and maintenance of selected instruments (hydro-meteorological and water quality) designed for monitoring purposes (filed trip) and/or students will prepare water quality monitoring plan for selected river i.e.: description of pollution sources and their characteristics, performance of hydro-chemical profile for selected pollutants, selecting of devices for the designated measuring points along with their technical description, positioning of measurement devices on maps, designing of working time for each device.
Recommended related elective modules :	
Competences:	Technical competence (xx%) Media competence (xx%) Methodological competence (xx%), Social competence xx %), Personal competence (xx %)
Literature:	Banasik k., Górski D., Ignar S., 2000. Modelowanie wezbrań opadowych i jakości odpływu z małych nieobserwowanych zlewni rolniczych. Wyd. SGGW Chełmicki W., 2001. Woda- Zasoby, degradacja, ochrona PWN Warszawa Dojlido J.R.1995.Chemia wód powierzchniowych. Wydawnictwo Ekonomia i Środowisko

Kajak Z. 1998. Hydrobiologia-Limnologia, Ekosystemy wód śródlądowych. PWN
Hejduk L., Igras J. 2011. Dobre praktyki ochrony zlewni rzecznych w świetle dyrektywy azotanowej i innych standardów Unii Europejskiej. Wyd. SGGW
Seria wydawnicza "Biblioteka Monitoringu Środowiska
Wanielista M., Kersten R., Eaglin R. Hydrology: water quantity and quality control. Wiley 1997
Banasik, K., Oygarden L., Hejduk L., Prediction and reduction of diffuse pollution solid emission and extreme flows from rural areas- case study of small agricultural catchments. SGGW, 2011
Guide to hydrological practices. World Meteorological Organization.WMO Nr.168
https://eur-lex.europa.eu/
Relevant scientific publications, including those of the module coordinator.

E Advanced remote sensing innovations (ARSI)

Semester:	3
Module coordinator	Prof. Dr. Jan-Peter Mund (jan-peter.mund@hnee.de)
Status:	Elective
Goal:	Students are enabled to apply up-to-date and innovative remote sensing methods in different forest protection and forest and environmental monitoring applications and advanced methodical experiences in analysing remote sensing imagery at large scale for environmental monitoring purposes.
Examination form:	Term paper (single exam)
ECTS-Credits:	6
SWH:	4

Module component 1 Photogrammetry and advanced image analytics 2

Semester:	3
Coordinator	Prof. Dr. Jan-Peter Mund
Lecturer	Prof. Dr. Jan-Peter Mund
ECTS-Credits:	3
SWH:	2
Workload:	75 h / Semester
Max. study places:	
Teaching form:	Lecture (12 h),Practical exercise (18 h), Self-study (45 h)
Language:	English
Module type:	
Examination form:	Term paper (50%) (part of exam)

Entry requirements:	Introduction to Forest Information Technology I-3
Goal:	Students know principles of photogrammetry algorithms and technological solutions for automated data collection using UAV applied in forestry and environment and have practical experiences with specific UAV devices.
Content:	Innovative 3d image analysis algorithms in combination with pattern recognition and machine learning and statistical modelling of photogrammetric point clouds with discussion of examples from various photogrammetric products such as digital elevation models DEN), crown height models (CHM) in raster versus tin representation; automatic DEM and CHM generation, normalized image generation and orthophoto generation with polynomial rectification or differential rectification and similar image resampling techniques.
Recommended related elective modules:	RS-III
Competences:	Technical competence (30%) Media competence (10%) Methodological competence (60%)
Literature:	Photogrammetric Computer Vision (W. Förstner, B. P. Wrobel, Springer 2016) online available (10/2016) Karl Kraus, 1993. Photogrammetry, Volume I: Fundamentals and Standard Processes. Dümmler, Bonn.– Karl Kraus, 1997. Photogrammetry, Volume II: Advanced Methods and Applications. Dümmler, Bonn. Toni Schenk, 1999. Digital Photogrammetry, Volume I. TerraScience. Elsheimy, N., Valeo, C., Habib, A., 2005. Digital Terrain Modeling: Generation, Manipulation, and Applications. Artech House.

Module component 2 — Remote Sensing change detection principles

Semester:	3
Coordinator	Prof. Dr. Jan-Peter Mund
Lecturer	Prof. Dr. Jan-Peter Mund, Prof. Dr. Luis Miranda
ECTS-Credits:	3
SWH:	2
Workload:	75 h / Semester
Max. study places:	

Teaching form:	Lecture (12 h),Practical exercise (18 h), Self-study (45 h)
Language:	English
Module type:	
Examination form:	Term paper (50%) (part of exam)
Entry requirements:	Introduction to Forest Information Technology I -3
Goal:	Students are enabled to use remote sensing and geographic information system in different applications related to forest protection and forest change detection.
Content:	Building on fundamental remote sensing concepts, techniques, and up-to-date remote sensing applications, this module aims at broadening your knowledge with advanced and current topics in processing and automated analysis of remote sensing images. The module Advanced Remote Sensing (ARS) focusses on the theory, methods and application of most recent semi-automated data and information extraction processes used by professional Earth and Environmental system science researchers to provide reliable and reproducible information about human and physical environments. The module introduces to the up-to-date research and recent innovations in remote sensing technology and image analysis techniques. The module is divided into four substantial and balanced theoretical parts and practical real-world application components in order to train students to process relevant, reliable, accurate and reproducible environmental information of the recent land cover. Specific topics of this module include atmospheric correction and radiometric normalization methods, statistics of accuracy assessment, multi-sensor data analysis and hyperspectral or LIDAR image data processing, This module consists of instructor-led seminar lectures, individual lab assignments and scientific article reviews as well as group discussions. The lectures focus on the core topics of digital image processing. Students will have the opportunity to deepen their hand-on experience in digital image processing using various image analysis packages. A series of laboratory works and tutorials is designed to lead students through the key steps in semi-automated image processing in order to detect, extract and evaluate quantitative information about different objects on the Earth. Each student needs to complete an individual applied research project with a scientific project work report.
Recommended related elective modules :	
Competences:	Technical competence (30%) Media competence (10%) Methodological competence (60%)

Literature:

Jensen, J. R. (2013): Remote Sensing of the Environment: Pearson New International Edition: An Earth Resource Perspective.
Jian Guo Liu & Mason (2009): Essential Image Processing and GIS for Remote Sensing
Jones, H. G. & Vaughan, R. A. (2010): Remote Sensing of Vegetation: Principles, Techniques, and Applications. Pearson Education Ltd-
Mather, P., & Tso, B. (2009). Classification methods for remotely sensed data. CRC press.
Schott, J.R. (1997): Remote sensing - the image chain approach
Timothy, D., Onisimo, M., Cletah, S., Adelabu, S., & Tsitsi, B. (2016). Remote sensing of aboveground forest biomass: A review. Tropical Ecology, 57(2).
E. Chuvievo, E. & Huete, A. (2010). Fundamentals of satellite remote sensing. CRC press.

E Advanced LIDAR data analytics for forest monitoring and modelling

Semester:	3
Module coordinator	Prof. Dr. Jan-Peter Mund (jan-peter.mund@hnee.de)
Status:	Elective
Goal:	Students are familiar with the technological principles of LiDAR approaches and are able to pre-process and analyse LiDAR data and to display and communicate related results.
Examination form:	Term paper (single exam)
ECTS-Credits:	6
SWH:	4

Module component 1 Advanced LIDAR data analytics for forest monitoring and modelling

Semester:	3
Coordinator	Prof. Dr. Jan-Peter Mund
Lecturer	Prof. Dr. Jan-Peter Mund
ECTS-Credits:	6
SWH:	4
Workload:	150 h / Semester
Max. study places:	
Teaching form:	Lecture (28 h), Practical exercise (32 h), Self-study (90 h)
Language:	English
Module type:	
Examination form:	Term paper (50%) (part of exam)

Entry requirements:

Goal: Students are familiar with the technological principles of LiDAR approaches and are able to pre-process and analyse LiDAR data and to display and communicate related results.

Content: The course covers principles of active LIDAR Remote Sensing and similar data sources like SAR and Radar, The course covers LIDAR data processing, interpretation and applications and popular data processing techniques, including LAS Tools and tree height/health estimation, DEM generation, and various environmental applications. Students will have experience on ordering, processing and interpreting LIDAR data, and an opportunity to discuss advantages and limitations of LIDAR remote sensing for their specific research, and to explore LIDAR and RADAR for its common applications in vegetation assessment and forest observations

Recommended related elective modules:

Competences: Technical competence (50%) Media competence (10%) Methodological competence (40%)

Literature:

Matthew J. McGill (Author), Nasa Technical Reports Server (Ntrs) (Creator) 2013: Lidar Remote Sensing
Sherman Karp (Author), Larry B. Stotts (Author) 2013: Fundamentals of Electro-Optic Systems Design: Communications, Lidar, and Imaging
Matti Maltamo (Editor), Erik Naesset (Editor), Jari Vauhkonen (Editor) 2014: Forestry Applications of Airborne Laser Scanning: Concepts and Case Studies (Managing Forest Ecosystems)
Further state-of-the-art scientific literature will be presented by the lecturer

E Big Data Analytics 1

Semester:	3
Module coordinator	Prof. Dr. Jens Müller
Status:	Elective
Goal:	The students are able to identify and define Big Data applications as well as the technical and strategic constrains related to them, including relevant data types, algorithms and hardware. The students can give a professional opinion on technical issues and are able to lay down a Big Data analysis project.
Examination form:	Technical discussion (100%)
ECTS-Credits:	6
SWH:	4

Module component 1 Big Data Analytics 1

Semester:	3
Coordinator	Prof. Dr. Jens Müller
Lecturer	Prof. Dr. Jens Müller
ECTS-Credits:	6
SWH:	4
Workload:	150 h / Semester
Max. study places:	
Teaching form:	Lecture (45 h), Practical exercise (15 h), Self-study (90 h)
Language:	English
Module type:	blocked
Examination form:	Technical discussion (100%)
Entry requirements:	

Goal:	The students are able to identify and define Big Data applications as well as the technical and strategic constrains related to them, including relevant data types, algorithms and hardware. The students can give a professional opinion on technical issues and are able to lay down a Big Data analysis project.
Content:	This module component introduces the current and much discussed topic of big data analytics. The course helps students to understand why data is the treasure of the 21st century and how big datasets can be explored and analysed. There is growing interest also in environmental science in extracting data from the rapidly growing data sources and streams. This data needs to be structured and analysed to look for interesting interrelationships and patterns (data exploration). Students learn how to proceed sensibly when evaluating huge amounts of data - starting with the most modern data mining techniques for exploration and pre-processing as well as uncovering previously hidden or unused information (e.g. frequent pattern mining, outlier mining). Current applications and memorable practical examples will familiarise students with the basic problems. The course discusses different algorithms that can be selected in particular situations.
Recommended related elective modules :	
Competences:	Technical competence (30%) Media competence (15%) Methodological competence (35%) Personal competence (20%)
Literature:	Grus, J. (2019). Data science from scratch: first principles with python. O'Reilly Media. Karimi, H. A. (Ed.). (2014). Big Data: techniques and technologies in geoinformatics. Crc Press. Thomas, R., & McSharry, P. (2015). Big Data Revolution: What farmers, doctors and insurance agents teach us about discovering big data patterns. John Wiley & Sons.

E Machine Learning and Data-Driven Modelling

Semester:	3
Module coordinator	Prof. Dr. Luis Miranda (luis.miranda@hnee.de)
Status:	Elective
Goal:	The students define concepts of machine learning and describe the characteristics and limitations of data-driven models. The students implement, evaluate and reflect on the results of machine learning techniques and their use in practical applications.
Examination form:	Technical discussion (100%)
ECTS-Credits:	6
SWH:	4

Module component 1 Machine Learning and Data-Driven Modelling

Semester:	3
Coordinator	Prof. Dr. Luis Miranda
Lecturer	Prof. Dr. Luis Miranda
ECTS-Credits:	6
SWH:	4
Workload:	150 h / Semester
Max. study places:	
Teaching form:	Lecture (20h), Practical exercise (40 h), Self-study (90 h)
Language:	English
Module type:	
Examination form:	Technical discussion (100%)

Entry requirements:

Goal:

The students define concepts of machine learning and describe the characteristics and limitations of data-driven models. The students implement, evaluate and reflect on the results of machine learning techniques and their use in practical applications.

Content:

The course focuses on machine learning techniques and their applications in forestry and environmental science. The concepts of supervised and unsupervised learning are presented and discussed along with techniques for clustering, regression and classification problems including k-means, random forest and artificial neural networks . The topic of data augmentation is presented together with the concepts of training, validation and testing datasets and cross-validation. The concept of hyperparameter is introduced together with the suitable optimization techniques. Practical examples with temporal and spatial data are presented, particularly with regard to time series forecasting and image classification. The practical exercises will be presented libraries from the python scripting language, particularly numpy, scikit-learn and keras. The importance of visualization and interpretation of the results is highlighted. Paticular care is taken to review the importance of the definition of datasets, the strenght of claims and the practical applications of the methods.

Recommended related elective modules :

Advanced Programming

Competences:

Technical competence (40%) Personal competence (25%) Methodological competence (35%)

Literature:

Géron, A. (2019). Hands-on machine learning with Scikit-Learn, Keras, and TensorFlow: Concepts, tools, and techniques to build intelligent systems. O'Reilly Media.

Goodfellow, I., Bengio, Y., Courville, A., & Bengio, Y. (2016). Deep learning (Vol. 1, No. 2). Cambridge: MIT press.

James, G., Witten, D., Hastie, T., & Tibshirani, R. (2013). An introduction to statistical learning (Vol. 112, p. 18). New York: springer.

Raschka, S., & Mirjalili, V. (2019). Python machine learning: Machine learning and deep learning with Python, scikit-learn, and TensorFlow 2. Packt Publishing Ltd.

VanderPlas, J. (2016). Python data science handbook: Essential tools for working with data. " O'Reilly Media, Inc.".

E Innovative Forest Management Methods

Semester:	3
Module coordinator	Prof. Dr. Tobias Cremer (tobias.cremer@hnee.de)
Status:	Elective
Goal:	Students get to know innovative methods in forest management. This includes new approaches in wood mensuration and wood logistics as well as the conceptual background, basic types and fields of application of forest growth and yield models. Students shall be enabled to apply these tools in theory and practice.
Examination form:	Term paper (50%), Project presentation (50%)
ECTS-Credits:	6
SWH:	4

Module component 1 Innovative concepts and technology trends in forest management

Semester:	3
Coordinator	Prof. Dr. Tobias Cremer
Lecturer	Prof. Dr. Tobias Cremer
ECTS-Credits:	3
SWH:	2
Workload:	75 h / Semester
Max. study places:	25
Teaching form:	Lecture (10 h), Seminar (10 h), Practical exercise (10 h), Self-study (45 h)
Language:	English
Module type:	blocked
Examination form:	Term paper (50%)

Entry requirements:

Goal: Students get to know innovative concepts and technologies related to forest management and wood logistics and learn how to apply them in practice.

Content: Challenges in wood logistics are presented and discussed. Based on that, students learn about approaches for optimization in wood logistics and how to apply them in practice. As well, latest developments in wood mensuration are analysed and tested in practice. Discussion with external experts will take place in the module as well.

Recommended related elective modules :

Competences: Technical competence (50%) Media competence (25%) Methodological competence (25%)

Literature:

Cremer, T. und Blasko, L. (2018): Analyse der fotooptischen Vermessung von Kiefernstamm- und -industrieholz im Vergleich zum Sektionsraummaß. Allgemeine Forst- und Jagdzeitung (AFJZ), 188. Jg., 7/8, S. 127-139. http://dx.doi.org/10.23765/afjz0002008

FORMEC (2017): Abstracts and Proceedings of the 50th Formec Symposium 2017. Innovating the competitive edge - From research to impact in the forest value chain. Symposium on Forest Mechanization, Braşov, Romania 2017

Heinzmann, B. (2017): Untersuchungen zur Volumenbestimmung von Industrieschichtholz der Holzart Fichte mithilfe elektronischer und einzelstammweiser Vermessung. Dissertation an der Fakultät für Technik, Holzwissenschaften und Kunst der Universität Sopron, 98 S.

Heinzmann, B. und M.-C. Barbu (2016): Genauigkeit der fotooptischen Poltervermessung von Industrieholz am Beispiel von FOVEA. Forstarchiv 87, Heft 6, S. 194-197.

Herborn, C. (2016): Photogrammetric Surveying of Wood Piles on Handheld Devices. Dissertation an der Fakultät für Informatik der Otto-von-Guericke-Universität Magdeburg, 195 S.

Herborn, C, K. Tönnies und B. Stock (2014): Detection and Segmentation of Clustered Objects by Using Iterative Classification, Segmentation, and Gaussian Mixture Models and Application to Wood Log Detection. In:X. JiANG et al. (Eds.): GCPR 2014, LNCS 8753, S. 354-364.

Module component 2 — Forest growth models and scenarios

Semester: 3

Coordinator	Prof. Dr. Martin Guericke
Lecturer	Prof. Dr. Martin Guericke, Prof. Dr. Jens Schröder
ECTS-Credits:	3
SWH:	2
Workload:	75 h / Semester
Max. study places:	25
Teaching form:	Lecture (12 h), Seminar (12 h), Practical exercise (16 h), Self-study (35 h)
Language:	English
Module type:	blocked
Examination form:	Project presentation (50%)
Entry requirements:	java programming, basics and handling of the statistical software R
Goal:	Participants know about the conceptual background, the basic types and fields of application of forest growth and yield models. They can apply the TreeGrOSS model in the BWINPro simulation program for their individual purposes by adapting model components and data levels to the specific needs.
Content:	Students will obtain detailed insights into theory and application of models for estimating forest growth and yield. Various examples for modelling approaches are presented that stress the importance of choosing the suitable model for the individual situation, particularly in data availability and output expectations. The differences between models and programs will be highlighted and the basic components of growth and yield "simulators" will be discussed. The participants will explore the opportunities and limitations of statistical models based on detailed insights into TreeGrOSS / BWINPro. The application of this model system will focus on: ▪ data input and use of the internal data bank with completion routines ▪ analyses of spatial structure and basic growth and yield information ▪ opportunities to adjust model components for individual needs ▪ realization of silvicultural scenarios and prognoses ▪ interpretation and comparison of results of model runs ▪ model constraints, strengths and weaknesses Exemplary data sets that can be used in the course will be collected on a field trip at the beginning of the course. In an additional lecture students will also learn about the batch application of the TreeGrOSS model in

	larger software environments that are used to derive cumulative information on the behaviour of forest enterprises / large forest estates under different growth and management scenarios.
Recommended related elective modules :	
Competences:	Technical competence (25%) Media competence (25%) Methodological competence (50%)
Literature:	Hansen, J.; Nagel, J. (2016): Waldwachstumskundliche Softwaresysteme auf Basis von TreeGrOSS - Anwendung und theoretische Grundlagen. Beiträge aus der Nordwestdeutschen Forstlichen Versuchsanstalt, Band 11 (online). Pretzsch, H. (2009): Forest Dynamics, Growth and Yield. Springer, New York/Heidelberg. Pretzsch, H.; Biber, P.; Dursky, J. (2002): The single tree-based stand simulator SILVA: construction, application and evaluation. Forest Ecology and Management (162): 3–21. Salas, C.; Gregoire, T.G.; Craven, D.J.; Gilabert, H. (2016): Forest growth modelling: the state of the art. Bosque (Valdivia), 37 (1): 03-12. https://dx.doi.org/10.4067/S0717-92002016000100001 Schröder, J.; Röhle, H.; Gerold, D.; Münder, K. (2007): Modeling individual-tree growth in stands under forest conversion in East Germany. European Journal of Forest Research 126: 459–472. Weiskittel, A.R.; Hann, D.W.; Kershaw, J. A.; Vanclay, J. K. (2011): Forest Growth and Yield Modeling. John Wiley & Sons, Ltd

E Advanced Programming

Semester:	3
Module coordinator	Prof. Dr. Luis Miranda (luis.miranda@hnee.de)
Status:	Elective
Goal:	The students carry out a programming project incorporating current coding techniques and standards relevant in the sector.
Examination form:	Project presentation (100%)
ECTS-Credits:	6
SWH:	4

Module component 1 Advanced Programming

Semester:	3
Coordinator	Prof. Dr. Luis Miranda
Lecturer	Prof. Dr. Luis Miranda, Prof. Dr. Jens Müller
ECTS-Credits:	6
SWH:	4
Workload:	150 h / Semester
Max. study places:	
Teaching form:	Seminar (60 h), Self-study (90h)
Language:	English
Module type:	
Examination form:	Project presentation (100%)
Entry requirements:	
Goal:	The students carry out a programming project incorporating current coding techniques and standards relevant in the sector.

Content:	The course is organised as a hands-on seminar to work in a programming project under practical conditions. Professional skills of practical importance in the IT sector like pair programming, version control (git), and benchmarking are encouraged and trained. The course does not contemplate a particular programming language, but focuses on the overall organisation and development process. The students work on an application project in a seminar environment that encourages information exchange and teamwork.
Recommended related elective modules :	
Competences:	Technical competence (50%) Personal competence (30%) Methodological competence (20%)
Literature:	Chacon, S., & Straub, B. (2014). Pro git (p. 456). Springer Nature. Williams, L., & Kessler, R. R. (2003). Pair programming illuminated. Addison-Wesley Professional.

E Learning by doing: Adaptive Management

Semester:	3
Module coordinator	Prof. Dr. Felipe Bravo (fbravo@pvs.uva.es)
Status:	Elective
Goal:	Students will be able to design, manage and apply techniques on (i) Adaptive Management, (ii) Forest Management under global change, (iii) silvicultural path design, (iv) quantitative silviculture and (v) monitoring, experimentation and data analysis.
Examination form:	Oral report ,Case study *
ECTS-Credits:	6
SWH:	4

Module component 1 Principles of adaptive management

Semester:	3
Coordinator	Prof. Dr. Felipe Bravo
Lecturer	Prof. Dr. Felipe Bravo
ECTS-Credits:	6
SWH:	4
Workload:	75 h / Semester
Max. study places:	
Teaching form:	Lecture (12 h), Practical exercise (18 h), Self-study (45 h
Language:	English
Module type:	

Examination form: Oral report ,Case study*

Entry requirements:

Goal: Students know about the principles of (i) Adaptive Management, (ii) Forest Management under global change, (iii) silvicultural path design, (iv)

Content:

PRINCIPLES (1 ECTS)
Adaptive Management (AM)Foundations
AM Types (Active vs Pasive)
Rooting on Forest Management traditional approach
Policy, legal and institutional framework
Social participation
Differences between Adaptive Management and Management for adaptation

TOOLS (2 ECTS)
Experimentation in forestry
Sampling and monitoring
Silvicultural path design and analysis
Modelling and simulation
Supervised and unsupervised classification (machine learning)

CASE STUDIES (3 ECTS)
Mixing effect (Nelder wheels, triplets,…)
Tree marking analysis (Marteloscope)
Thining response (Thining experiments)
Forest structure monitoring and assessment (Allometry, biomass equations, Coarse Woody
Debry sampling)
Site productivity (site index curves and site index classification)

Recommended related elective modules :

Competences: Technical competence (xx%) Media competence (xx%) Methodological competence (xx%) Personnel competence (xx%)

Literature:

Burkhart, H.E., Tomé, M. 2012. Modeling Forest Trees and Stands, Springer
Bocard, D., Gillet, F., Legendre, P. (2011). Numerical Ecology with R, Springer UseR! Series 306 p.
Robinson, A.P, Hamman J.D. 2011. Forest Analytics with R: An Introduction. Springer ISBN 978-1-4419-
7761-8
Hastie, T., Tibshirani, R. 2015 An introduction to statistical learning with applications in R. Springer 426
pag. http://statweb.stanford.edu/~tibs/ElemStatLearn/
James, G., Witten, D., Hastie, T., Tibshirani, R., Friedman, J. 2013 The elements of statistical learning.
Data mining, inference and prediction. Springer 745 pag. http://www-

bcf.usc.edu/~gareth/ISL/
Jones, O., Maillardet, R., Robinson, A. (2009). Introduction to scientific programming and simulation
using R. CRC Press, 453 p.
Kershaw, J.A, Ducey, M.J., Beers, T.W., Husch, B. 2016 Forest Mensuration, 5th Ed. Wiley
Messier, C., Puettmann, K.J., Coates, K. D. (2013). Managing forests as complex adaptive systems.
Building resilience to the challenge of global change. The Earthscan Forest Library from Routledge,
353 p.
Pretzsch, H. 2009 Forest dynamics, Growth and Yield Springer 664 pp
Schreuder HT, Ernst R, Ramirez-Maldonado H (2004) Statistical Techniques for Sampling and
Monitoring Natural Resources. Rocky Mt. Res. Stn. 111 p.
Weiskittel, A., Hann, D.W., Kershaw, J,A., Vanclay, J.K 2011 Forest Growth and Yield Modeling Wiley
Wood, S.N. (2006). Generalized additive models. An introduction with R. CRC Press, Texts in Statistical
Science series, 392 p

E Forest Pest and Diseases

Semester:	3
Module coordinator	Julio Javier Diez Casero (jdcasero@pvs.uva.es)
Status:	Elective
Goal:	Students know strategies, tactics and scientific and research advanced methods for the diagnostic and management of forest pests and diseases. Students remove, mine, manage, analyze and discuss the relevant information contained in national and international data bases. Students understand main concepts related to the diagnostic, defense and resistance mechanisms of conifers against insects vectors and their associated fungi.
Examination form:	Oral report , Case study *
ECTS-Credits:	6
SWH:	4

Module component 1 Forest Pest & Diseases

Semester:	3
Coordinator	Julio Javier Diez Casero
Lecturer	Julio Javier Diez Casero, Juan Alberto Pajares Alonso, Mercedes Fernández Fernández, Fernando Alves Santos
ECTS-Credits:	6
SWH:	4
Workload:	150 h / Semester
Max. study places:	
Teaching form:	Lecture (20h), Practical exercise (40 h), Self-study (90 h)
Language:	English
Module type:	
Examination form:	Oral report, Case study*

Entry requirements:

Goal:

Students know strategies, tactics and scientific and research advanced methods for the diagnostic and management of forest pests and diseases. Students remove, mine, manage, analyze and discuss the relevant information contained in national and international data bases. Students understand main concepts related to the diagnostic, defense and resistance mechanisms of conifers against insects vectors and their associated fungi.

Content:

1. Diagnosis of Forest Pest and Diseases: NCBI: GeneBank. Introduction to BLAST and their use to diagnostic of organisms. Bioinformatics analysis of sequencing data using MG-RAST, and Galaxy bioinformatics tools.
2. Forest pest dynamics and population patterns.
3. Forest pests management. Monitoring. Silvilcultural methods. Use of semiochemicals. Biological control strategies.
4. Main concepts related to conifer defense mechanisms against insects (borers and gall inducing insects).
5. Symbiotic associations of bark beetles and fungi: biodiversity and ecology.
6. Data bases for forest pest and diseases management. European network for forest damage.
7. International advisory organizations. Invasive forest pests and diseases. Quarantine organisms.

Recommended related elective modules :

Competences:

Technical competence (20%) Media competence (10%) Methodological competence (60%) Personnel competence (10%)

Literature:

E Genetic Resources Conservation and Molecular Markers

Semester:	3
Module coordinator	Dr. Rosario Sierra de Grado
Status:	Elective
Goal:	The students will acquire a global vision of the main problems facing by the forest genetic resources, and will learn how to: Evaluate the need of conservation and use of particular genetic resource; Decide on the more suitable strategy of conservation; Decide on the molecular tools suitable to identify genotypes and measure diversity in forest species; Understand the interplay between conservation and breeding in different contexts; Manage information on the main databases related with these topics.
Examination form:	Oral report (50%), Project presentation (50%)
ECTS-Credits:	6
SWH:	4

Module component 1 Genetic Resources Conservation and Molecular Markers

Semester:	3
Coordinator	Dr. Rosario Sierra de Grado
Lecturer	Dr. Rosario Sierra de Grado; Dr. Elena Hidalgo Rodríguez; Dr. José Climent Maldonado
ECTS-Credits:	6
SWH:	4
Workload:	150 h / Semester
Max. study places:	
Teaching form:	Lecture (30 h), Practical exercise (30 h), Self-study (90 h)
Language:	English

Module type:

Examination form: Oral report (50%), Case study (50%)

Entry requirements:

Goal: The students will acquire a global vision of the main problems facing by the forest genetic resources, and will learn how to:

1. Evaluate the need of conservation and use of particular genetic resource
2. Decide on the more suitable strategy of conservation
3. Decide on the molecular tools suitable to identify genotypes and measure diversity in forest species
4. Understand the interplay between conservation and breeding in different contexts
5. Manage information on the main databases related with these topics

Content: Block 1: Complex phenotypic traits and data associated

1. Concepts and drivers of evolutionary change
2. Morphological / functional traits and life history features
3. The problem of homogenizing protocols
4. Quantitative genetics
5. Phenotypic plasticity, g x e interaction and trait correlation (integration)
6. The adaptive phenotype in conservation and deployment of forest genetic resources

Block 2: Molecular tools to evaluate intraspecific diversity and support decisions

1. Molecular basis of biodiversity and potential consequences of mutations
2. Molecular markers & tools in detecting intraspecific biodiversity
3. Uses of genetic maps in breeding FGR
4. Basis for Molecular Genetic & Genomic Databases uses

Block 3:Main problems and strategies for conservation of the forest genetic resources

1.- FGR: concepts, state of the world's FGR, main threats.
2.- Insight of population genetics to support the conservation of FGR.
3.- Distribution of the genetic variability in forest populations. Management of the geographic variability.
4.- Strategies of conservation of FGR: in situ, ex situ, circa situm.
5.- Main databases related to conservation of FGR

Recommended related elective modules :

Competences:	Technical competence (40%) Media competence (10%) Methodological competence (40%) Personnel competence (10%)
Literature:	Falconer DS, Mackay FC (1996) Introduction to Quantitative Genetics (4th Edition). Pearson Education Limited. 480 pp. Garnier E, Lavorel S, Poorter H, et al. (2013) New handbook for standardised measurement of plant functional traits worldwide. Australian Journal of Botany 61: 167–234. Cornelissen JHC, Lavorel SB, Garnier EB, et al. (2003) A handbook of protocols for standardised and easy measurement of plant functional traits worldwide. Australian Journal of Botany 51: 335–380. Schlichting CD, Pigliucci M (1998) Phenotypic evolution - A reaction norm perspective. Sunderland, MA.: Sinauer Associates. 387 pp

M Master thesis colloquium

Semester:	4
Module coordinator	Head of study programme
Status:	Mandatory
Goal:	Students acquire further skills in interdisciplinary scientific work. They are able to evaluate research projects and to communicate results to expert and professional audience.
Examination form:	Project presentation (100%)
ECTS-Credits:	4
SWH:	2

Module component 1 Master thesis colloquium

Semester:	4
Coordinator	Head of study programme
Lecturer	Prof. Dr. Jan-Peter Mund, Prof. Dr. Luis Miranda, Dr. Evelyn Wallor, Lecturers SGGW, HNEE
ECTS-Credits:	4
SWH:	2
Workload:	100 h / Semester
Max. study places:	
Teaching form:	Seminar (30 h), self-study (70 h)
Language:	English
Module type:	
Examination form:	Project presentation (100%)
Entry requirements:	

Goal:	Students acquire further skills in interdisciplinary scientific work. They are able to evaluate research projects and to communicate results to expert and professional audience.
Content:	Students have to discuss and present their Master thesis topics, thesis design, conceptual orientation and expected results and challenges (in small groups and in plenum).
Recommended related elective modules :	
Competences:	Technical competence (30%) Media competence (20%) Methodological competence (30%) Personnel competence (20%)
Literature:	

M Master thesis colloquium

Semester:	4
Module coordinator	Head of study programme
Status:	Mandatory
Goal:	Students obtain own research results while solving and discussing a scientific problem. Students present the research results of their master thesis and are able to defend its underlying assumptions, methodologies, and robustness of the key findings.
Examination form:	Project report (70%), Project presentation (30%)
ECTS-Credits:	20
SWH:	12

Module component 1 Master thesis colloquium

Semester:	4
Coordinator	Head of study programme
Lecturer	Prof. Dr. Jan-Peter Mund, Prof. Dr. Luis Miranda, Dr. Evelyn Wallor, Lecturers SGGW, HNEE
ECTS-Credits:	20
SWH:	12
Workload:	500 h / Semester
Max. study places:	
Teaching form:	Project
Language:	English / Polish / German
Module type:	
Examination form:	Project report(70%), Project presentation (30%)
Entry requirements:	min 80 ECTS collected

Goal:	Students obtain own research results while solving and discussing a scientific problem. Students present the research results of their master thesis and are able to defend its underlying assumptions, methodologies, and robustness of the key findings.
Content:	Oral defence presentation and academic discussion of the individual FIT Master Thesis research and submitted thesis topics 20 Minutes oral presentation and 30 min discussion
Recommended related elective modules :	
Competences:	Technical competence (30%) Media competence (20%) Methodological competence (30%) Personnel competence (20%)
Literature:	

E Climate change impacts on plant growth and crop yield: non-invasive monitoring methods

Semester:	4
Module coordinator:	Prof. Dr.Hazem M. Kalaji (hazem@kalaji.pl)
Status:	Elective
Goal:	The aim of this course is to expose the students to the theory and tools that allow them understanding climate change impact on trees growth and quality by thoroughly emphasizing the theory and practice of using analytical tools to aid in taking proper action of pending and future changes in the complex global climate change situation.
Examination form:	Project presentation, Written exam*
ECTS-Credits:	6
SWH:	4

Module component 1 Climate change impacts on plant growth and crop yield: non-invasive monitoring methods

Semester:	4
Coordinator	Prof. Dr. Mohamed Hazem Kalaji
Lecturer	Prof. Dr. Mohamed Hazem Kalaji
ECTS-Credits:	6
SWH:	4
Workload:	150 h / Semester
Max. study places:	
Teaching form:	Lecture (30h), Practical exercise (30 h), Self-study (90 h)
Language:	English
Module type:	continuous

Examination form: Project presentation / Written exam*

Entry requirements:

Goal: The aim of this course is to expose the students to the theory and tools that allow them understanding climate change impact on trees growth and quality by thoroughly emphasizing the theory and practice of using analytical tools to aid in taking proper action of pending and future changes in the complex global climate change situation.

Content:

Lectures (30 hours):
The climate change – challenge and facts
The effects of changes in the world hydrological cycle on availability of water resources. The effects of global change on soil conditions in relation to plant growth and food production. The CO2 fertilization effect: higher carbohydrate production and retention as biomass and seed yield. The effects of elevated CO2 and temperature change on transpiration and crop water use. Effects of higher day and night temperatures on growth and yields of some crop plants. Adverse effects of elevated levels of ultraviolet (UV)-B radiation and ozone (O3) on crop growth and productivity.
Combined effects of changing CO2 temperature, UV-B radiation and O3 on crop growth. The potential effects of climate change on world food production and security
1Climate change, global agriculture and regional vulnerability. Integrating land-use change and evaluating feedbacks in global change models Global change impacts on agriculture, forestry and soils. Global climatic change and agricultural production: An assessment of current knowledge and critical gaps.

Laboratory and field (30 hours):
Providing students with knowledge related to the employment of advanced instrumentations to predict and detect the effects of climate change on plant growth. The aim of this part is to provide students with comprehensive knowledge related to the employment of most advanced instrumentations in the field of plant science including: forestry, agronomy, horticulture, biology, botany, crop sciences, forestry, ecology, soil science, meteorology and plant physiology.

Topics to be covered in lab:

- Light intensity and quality
- Morphological parameters of plant leaves
- Leaf Area Index
- Plant architecture analysis
- Water content and potential in plants and different plant organs
- Pigments content
- Photosynthesis, respiration, transpiration, stomatal conductance
- Photosynthetic efficiency of photosynthesizing organisms

- Temperature Measurement Comparison
- Normalized Difference Vegetation Index
- Remote Sensing
- Modelling and Artificial Neural Networks (ANN)
- Mobile applications for biology and agricultural researches

Recommended related elective modules:

Competences: Technical competence (20%) Media competence (20%) Methodological competence (20%), Social competence (20%), Personal competence (20%)

Literature:

PCC AR4 WG1 (2007). Solomon, S.; Qin, D.; Manning, M.; Chen, Z.; Marquis, M.; Averyt, K.B.; Tignor, M.; Miller, H.L., eds. Climate Change 2007: The Physical Science Basis.
Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press. ISBN 978-0-521-88009-1. (pb: 978-0-521-70596-7).
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Instruments:
http://www.hansatech-instruments.com/
http://ppsystems.com/
http://www.bbe-moldaenke.de/en/
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http://psi.cz/

E Advanced data mining techniques

Semester:	4
Module coordinator:	Dr. Urszula Grzybowska (urszula_grzybowska@sggw.edu.pl)
Status:	Elective
Goal:	Student should be able to define classification problems, choose appropriate method and solve problems. Students should be familiar with creation of parametric sketches. They should properly apple sketch relation.
Examination form:	Project report, Written exam*
ECTS-Credits:	6
SWH:	4

Module component 1 Modern Data Mining Techniques and Families of Classifiers. Examples of their application in forestry

Semester:	4
Coordinator	Urszula Grzybowska
Lecturer	Dr. Marek Karwański, Dr. Urszula Grzybowska
ECTS-Credits:	4
SWH:	2
Workload:	100 h / Semester
Max. study places:	32
Teaching form:	Lecture (15h), Practical exercise (15 h), Self-study (70 h)
Language:	English
Module type:	continuous

Examination form:	Project report / Written exam*
Entry requirements:	
Goal:	Student should be able to define classification problems, choose appropriate method and solve problems with help of available software (R, SAS). Student should be able to interpret obtained results and draw conclusions.
Content:	The aim of the course is to present modern data mining techniques including machine learning models for solving classification and regression problems. Supervised learning techniques based on the loss function will be discussed. These include regression models, decision trees, artificial neural networks, and families of classifiers (bagging, boosting). Each topic will be presented as a lecture. Theoretical content will be supplemented with exercises in the laboratory and will concern practical application of discussed techniques to analyse selected problems in natural sciences setting on real life data.
Recommended related elective modules:	
Competences:	Technical competence (20%) Media competence (20%) Methodological competence (20%), Social competence (20 %), Personal competence (20 %)
Literature:	Hastie T, Tibshirani R., Friedman J.,"The Elements of Statistical Learning, Data Mining, Inference, and Prediction", Springer, 2009. Barry deV., "Decision Trees for Business Intelligence and Data Mining: Using SAS ENterprise Miner", SAS Institute Inc., 2006 Williams G., "Data Mining with Rattle and R, The Art of Excavating Data for Knowledge Discovery", Springer, 2012 Berk R., "Criminal Justice Forecasts of Risk, a Machine Learning Approach", Springer, 2012 Berk R., "Statistical Learning from a Regression Perspective", Springer 2008 Berry M., Linoff G., „Data Mining Techniques For Marketing, Sales, and Customer Relationship Management", Wiley, 2004 Clarke B., Fokoue E., · Zhang H., "Principles and Theory for Data Mining and Machine Learning", Springer, 2009 Ed. Chun-houh Chen Ch., Hardle W., Unwin A., "Handbook of Data Visualization", Springer 2008 Tsiptsis K., Chorianopoulos A., „Data Mining Techniques in CRM", Wiley, 2009

Module component 2 — CAD in practice

Semester:	4
Coordinator	Dr. Marcin Zbieć (marcin_zbiec@sggw.edu.pl)
Lecturer	Dr. Marcin Zbieć
ECTS-Credits:	2
SWH:	2
Workload:	50 h / Semester
Max. study places:	
Teaching form:	Lecture (10h), Practical exercise (20 h), Self-study (20 h)
Language:	English
Module type:	continuous
Examination form:	Project report / Written exam*
Entry requirements:	
Goal:	Students should be familiar with creation of parametric sketches. They should properly apply sketch relation. Students should know basic methods of 3d modelling. They should also know how to create assemblies. Should know how to generate technical drafts of their models Optional (depending on the advance level). Students should know the basics of MES
Content:	Training on practical use of 3D CAD systems. (Solidworks, Topsolid etc): • History and introduction to 3D CAD. • Design philosophy in CAD, advantages and implications. • The functionality of CAD-creating sketches, parametric dimensioning. • Modelling operations, creating a part. Creation of assemblies. • Generate the resulting drawings in 2D. • Basic terms and concepts of visualization. Optional (depending on the advance level) • Simulation of mechanisms. • The basics of the MES, defining the material properties, loading and fastening.
Recommended related elective modules :	
Competences:	Technical competence (20%) Media competence (20%) Methodological competence (20%), Social competence (20 %), Personal competence (20 %)
Literature:	• materials prepared by teacher

- Solidworks tutorials (Dassault Systems, Jan Zuyderduyn)
- Topsolid tutorials (optional)

E Innovations and Applications of Forest IT

Semester:	4
Module coordinator	Prof. Dr. Luis Miranda
Status:	Elective
Goal:	Students are enabled to use up-to-date and innovative remote sensing systems in different applications and have methodical experiences analysing large image related to forest protection and forest and environmental monitoring.
Examination form:	Term paper (100%)
ECTS-Credits:	6
SWH:	4

Module component 1 Innovations in Remote Sensing

Semester:	4
Coordinator	Prof. Dr. Jan-Peter Mund
Lecturer	Prof. Dr. Jan-Peter Mund, Prof. Dr. Luis Miranda
ECTS-Credits:	3
SWH:	2
Workload:	75 h / Semester
Max. study places:	
Teaching form:	Lecture (14 h), Practical exercise (16 h), Self-study (45h)
Language:	English
Module type:	
Examination form:	Term paper (50%)

Entry requirements:	
Goal:	Students are enabled to use state-of-art and innovative remote sensing and geographic information system in different applications related to forest monitoring, management and forest change detection.
Content:	This module offers a changing spectrum of topics related to current developments in the area of remote sensing, image and point cloud analytics of forest and environment related applications. The offered topics preferably deepen and enhance knowledge imparted in the mandatory modules of the prior 3 semesters.
Recommended related elective modules :	Introduction to Forest Information Technology I-III; Programming 1-3
Competences:	Technical competence (40%) Media competence (10%) Methodological competence (50%)
Literature:	

Module component 2 — Innovations in Environmental Data Analysis

Semester:	4
Coordinator	Prof. Dr. Luis Miranda
Lecturer	Prof. Dr. Luis Miranda , Prof. Dr. Jan-Peter Mund
ECTS-Credits:	3
SWH:	2
Workload:	75 h / Semester
Max. study places:	
Teaching form:	Lecture (14h), Practical exercise (16h), Self-study (45 h)
Language:	English
Module type:	
Examination form:	Term paper (50%)
Entry requirements:	
Goal:	Students know the theoretical foundations and practical procedures for acquisition, exploration, transformation and analysis of environmental data. They are able to manage and process large structured and unstructured

	datasets from different environmental sources using suitable algorithms for analysis and visualisation.
Content:	The course focuses on a project-based approach to deepen the handling, transformation, visualisation and analysis techniques of interest for environmental datasets. Among the techniques introduced in the course are resampling of time series, data augmentation and machine learning techniques based on decision trees and forest structures (e.g. random forest and boosted regression trees). The course is primarily thought in python and R.
Recommended related elective modules :	Introduction to Forest Information Technology I-III; Programming 1-3
Competences:	Technical competence (45%) Media competence (10%) Methodological competence (45%)
Literature:	McKinney, W. (2012). Python for data analysis: Data wrangling with Pandas, NumPy, and IPython. " O'Reilly Media, Inc.". Pilz, J. (Ed.). (2009). Interfacing geostatistics and GIS. Springer Berlin Heidelberg. Wilks, D. S. (2011). Statistical methods in the atmospheric sciences (Vol. 100). Academic press. Zhang, Z. (2016). Environmental Data Analysis: Methods and Applications. Walter de Gruyter GmbH & Co KG.

E Big Data Analytics 2

Semester:	4
Module coordinator	Prof. Dr. Jens Müller
Status:	Elective
Goal:	The students define and implement a Big Data analysis project using relevant techniques of the field.
Examination form:	Project presentation (100%)
ECTS-Credits:	6
SWH:	4

Module component 1 Big Data Analytics 2

Semester:	4
Coordinator	Prof. Dr. Jens Müller
Lecturer	Prof. Dr. Jens Müller
ECTS-Credits:	6
SWH:	4
Workload:	150 h / Semester
Max. study places:	
Teaching form:	Seminar (25 h), Practical exercise (35 h), Self-study (90 h)
Language:	English
Module type:	blocked
Examination form:	Project presentation (100%)
Entry requirements:	
Goal:	The students define and implement a Big Data analysis project using relevant techniques of the field.

Content:	The students apply techniques from Big Data analytics in a practical project in environmental science, forestry or related disciplines. The students select the algorithms according to the dataset to be processed and search for the techniques most suitable to the data structure and size. Among the suitable techniques are cloud computing, processing of streams and parallel computing. The students are able to process datasets remotely and display the results using web interfaces.
Recommended related elective modules :	Big Data Analytics 1 Machine Learning and Data Driven Modelling
Competences:	Technical competence (40%) Media competence (5%) Methodological competence (50%) Personal competence (5%)
Literature:	Deitel, P. J., & Deitel, H. (2020). Intro to Python for Computer Science and Data Science: Learning to Program with AI, Big Data and the Cloud. Pearson Education, Incorporated. Lee, J., Wei, T., & Mukhiya, S. K. (2018). Hands-On Big Data Modeling: Effective database design techniques for data architects and business intelligence professionals. Packt Publishing Ltd. Madhavan, S. (2015). Mastering Python for Data Science. Packt Publishing Ltd.

* Assignment and proportion of examination form are determined by the partner university