Module	**Rethinking Environmental Economics I**
Components	**1) Introduction to environmental, resource and ecological economics**
	2) Human wellbeing, Ecosystem Functions, Services and Valuation Approaches
Study program	Forestry System Transformation (FST)
Semester term	1. Sem.
Module coordinator	Prof. Dr. Carsten Mann carsten.mann@hnee.de
Status	Mandatory
Responsible	Prof. Dr. Carsten Mann
Lecturer	Prof. Dr. Carsten Mann
ECTS - Credits	6
SWS	4
Max. participants	25
Learning/ Teaching method	Lecture (30h), exercises (20h), group debates /discussion (40h), self-study (90h)
Language	English
Examination form	Oral Exam
Prerequisite for participation	-
Learning objectives	**Introduction to environmental, resource and ecological economics**: Students have a solid understanding of concepts and methods of environmental, ecological and natural resource economics. They are familiar with the dynamics of economic systems, functioning of markets, reasons for market failures and potential solutions. They are able to discuss the relevancy of these concepts for sustainable forest management and to optimize the use of forest resources, being aware of their respective chances and limitations. **Human wellbeing, Ecosystem Functions, Services and Valuation Approaches**: Students are enabled to understanding the ecosystem services concept, its rationales, as well as the current state of scientific research and policy. They are familiar with definitions, typologies, and frameworks that link ES to wellbeing, and recent socio-political and scientific debates for mapping, indicators & valuation. Based on case study examples, they can analyse chances and challenges of the ES concept and distinct valuation approaches for political and economic decision-making, know about the challenges to communicate to the science-policy/practice interface, and develop strategies for overcoming them.
Module content	<u>Central themes/topics of the module components are:</u> 1) **Introduction to environmental, resource and ecological economics** - Introduction to environmental and natural resource economics, analytical methodologies, and their fields of application, including economic systems, two-sector model, optimal allocation of resources, the concept of perfect markets, production functions, dynamics of economic systems, growths; - Elaboration of environmental economic solutions to market failures (state interventions, private markets/Pigou taxes, Coase theorem;

	property rights); - Critically assessing the validity and limitations of economic theories, models and methodologies when dealing with different environmental problems; - Deeping concepts of public goods, externalities, collective action and the tragedy of the commons; - Major environmental problems and bioeconomy trends, and discussions of suitable solutions from local to global level based on case study examples with a focus on sustainable forest resource management and governance; - Introduction to the foundation of ecological economics; its underlying rationales and principles (Spaceship Earth); - Debate of alternative economic theories and recommendations regarding environmental and natural resource issues, i.e. welfare economics; - Role games for negotiating tradeoffs and solutions. **2) Human wellbeing, Ecosystem Functions, Services and Valuation Approaches** - Understanding of the range of ecosystem functions, services, benefits, and the need for trade-offs; - Knowledge of the ecosystem service concept, its history, drivers and surrounding discourses; - Distinguishing different kinds of costs and values (total, direct/indirect, optional, intrinsic…) - Introduction to different kinds of valuation methods and their scope of application (conventional cost-benefit analysis and market estimates, implicit markets, constructed markets); - Deepening debate on valuation as complex and normative processes, introduction to alternative approaches (multi-criteria/stakeholder); - Discussion of Chances and challenges of the ES concept and the potential of nature-based solutions for mainstreaming; - Introduction to governance of ES: status-quo and future implications; - Examples of new market approaches and inventive-based policy instruments (carbon, PES, REDD+); - Practice examples and exercises for ES assessment and valuation (e.g., cost-benefit analysis, multi-criteria impact assessment, economic modelling (e.g., ABM, behavioral economics).
Pursuing elective modules	-
Skills and competences	Thematic competences (50%), Methodological competences (50%)
Literature	*Literature part 1:* Bromley, D. W. (1991). Environment and Economy, Property Rights and Public Policy; Blackwell: Cambridge, MA, USA; Oxford, UK.

	Daly, H.E., Farley, J., 2011. Ecological Economics: Principles and Applications, 2nd ed. Island Press, Washington, DC. Chapter 10: Market Failures (pp. 165-191). Ehrlich, P.R., Ehrlich, A.H., Holdren, J.P., 1993 [1977]. Availability, Entropy, and the Laws of Thermodynamics, Chapter 2 in H. E. Daly and K. N. Townsend (Eds.) Valuing the earth : economics, ecology, ethics. MIT Press, Cambridge, Massachusetts, pp. 69-73. Gowdy, J.M., 2000. Terms and concepts in ecological economics. Wildlife Society Bulletin. 28 (1), 26-33. Jollands, N., 2006. Concepts of efficiency in ecological economics: Sisyphus and the decision maker. Ecological economics. 56 (3), 359-372. Røpke, I., 2004. The early history of modern ecological economics. Ecological Economics. 50 (3–4), 293-314. Spash, C.L., 2011. Social ecological economics: Understanding the past to see the future. The American Journal of Economics and Sociology. 70 (2), 340-375. Vatn, A., 2014. Markets in environmental governance — From theory to practice. Ecological Economics 105: 97–105. Wunder, S. 2015. Revisiting the concept of payments for environmental services. Ecological Economics doi:10.1016/j.ecolecon.2014.08.016. *Literature part 2:* Ban, N.C., Mills, M., Tam, J., Hicks, C.C., Klain, S., Stoeckl, N., Bottrill, M.C., Levine, J., Pressey, R.L., Satterfield, T., Chan, K.M.A. 2013. A Social-Ecological Approach to Conservation Planning: Embedding Social Considerations. Frontiers in Ecology and the Environment 11(4): 194–202. Brockhaus, M. and Angelsen, A. 2012. Seeing REDD+ through 4Is: A political economy framework In: Analysing REDD+: Challenges and choices, edited by A. Angelsen, M. Brockhaus, W. D. Sunderlin and L. V. Verchot. Bogor, Indonesia: CIFOR, pp. 15-30. Costanza, R., d'Arge, R., de Groot, R., Farber, S., Grasso, M., Hannon, B., Limburg, K., Naeem, S., O'Neill, R.V., Paruelo, J., Raskin, R.G., Sutton, P., van den Belt, M. 1997. The value of the world's ecosystem services and natural capital. Nature 387: 253–260. Daily, G.C., 1997. Nature's Services: Societal Dependence on Natural Ecosystems. Island Press, Washington, DC. de Groot, R.S., Alkemade, R., Braat, L., Hein, L., Willemen, L. 2010. Challenges in integrating the concept of ecosystem services and values in landscape planning, management and decision making. Ecological Complexity 7, 260-272. Elmquist, T., Maltby, E., Barker, T., Mortimer, M., Perrings, C., Aronson, J., De Groot, R., Fitter, A., Mace, G., Norberg, J., Pinto, I.S., Ring, I. 2010. Biodiversity, Ecosystems and Ecosystem Services. In: TEEB – The Economics of Ecosystem Services, Ecological and Economic Foundations, Edited by P. Kumar. Washington, D.C.: Island Press: 42-111. Engel, S., Pagiola, S., Wunder, S. 2008. Designing payments for environmental services in theory and practice: an overview of the issues. Ecological Economics 65(4):663–674.

	Farley, J. and Costanza, R. 2010. Payments for ecosystem services: from local to global. Ecological Economics 69(11): 2060–2068. Gómez-Baggethun, E., De Groot, R., Lomas, P.L., Montes, C. 2010. The history of ecosystem services in economic theory and practice: From early notions to markets and payment schemes. Ecological Economics 69(6): 1209–1218. Gómez-Baggethun, E. and Muradian, R. 2015. In markets we trust? Setting the boundaries of Market-Based Instruments in ecosystem services governance, Ecol. Econ. http://dx.doi.org/10.1016/j.ecolecon.2015.03.016 Haines-Young, R. and Potschin, M. 2010. The links between biodiversity, ecosystem services and human well-being. In: Raffaelli D, Frid C, editors. Ecosystem ecology. A new synthesis. Cambridge (UK): University Press. p. 110–140. Jax, K., Barton, D.N., Chan, K.M.A., de Groot, R.S., Doyle, U., Eser, U., Görg, C., Gómez-Baggethun, E., Griewald, Y., Haber, W., et al. (2013). Ecosystem services and ethics. Ecological Economics 93: 260-268. Millennium Ecosystem Assessment (MA). 2003. Ecosystems and Human Well-Being: A Framework for Assessment. Washington (DC): Island Press. Rival, L. and Muradian, R. 2013. Introduction: Governing the Provision of Ecosystem Services. Heidelberg, New York, London: Springer, pp. 1–17. Schomers, S. and Matzdorf, B. 2013. Payments for ecosystem services: A review and comparison of developing and industrialized countries. Ecosystem Services 6: 16–30.

Module	**Future Management Systems I**
Components	**1) Forest Management Systems for Ecosystem Services**
	2) Silvicultural management based on growth modelling for decision support
Study program	Forestry System Transformation (FST)
Semester term	1. Sem.
Module coordinator	Prof. Dr. Martin Guericke martin.guericke@hnee.de
Status	Mandatory
Responsible	Prof. Dr. Martin Guericke
Lecturer	Prof. Dr. Martin Guericke, Prof. Dr. Peter Spathelf, Prof. Dr. Tobias Cremer, external lecturers
ECTS - Credits	6
SWS	4
Max. participants	25
Learning/ Teaching method	Lecture, practical exercises, group debates, self-study
Language	English
Examination form	Project Report (PR)
Prerequisite for participation	FST reader recommended for silviculture, forest growth and management.
Learning objectives	**Forest Management Systems for Ecosystem Services**: Students gain knowledge about a wide spectrum of forest management systems for ecosystem service provision. They are familiar with existing and potential future societal demands concerning forestry systems and understand how these change over time. They have a good understanding of forest management approaches and their influences on different kinds of ecosystem services. They are enabled to suggest and debate organisational, procedural, and institutional adjustment needs and potentials, to provide a holistic view on forestry system transformation demands and options. Students are enabled to guide structured goal-setting processes and to define operational realizable and measurable goals. By means of selected case studies (forestry enterprises of different types of ownership) and self-defined target hierarchies the influence of different silvicultural strategies and management decisions can be quantified on the basis of forest growth model calculations. **Silvicultural management based on growth modelling for decision support:** The students are able to apply growth models and software with integrated GIS components and to evaluate and map the results of different mid-term scenario simulations. Students are enabled to weight the results of different target and management strategies by applying decision support systems. They are able to identify potentials and processes for the optimization of target hierarchies and to implement silvicultural control processes in the sense of adaptive management.

Module content	<u>Central themes/topics of the module components are:</u> **1) Forest Management Systems for Ecosystem Services** **2) Silvicultural management based on growth modelling for decision support**
Pursuing elective modules	-
Skills and competences	Thematic competences (50%), Methodological competences (50%)
Literature	v. Gadow, K. u. Hui, G.Y. (1999): Modelling Forest Development. Kluwer Academic Publishers, Dordrecht: 212 p. Bravo, F. et al. (2017): Managing Forest Ecosystems: The Challenge of Climate Change, Managing Forest Ecosystems 34, Springer International Publishing Switzerland. Pretzsch, H. (2009): Forest Dynamics, Growth and Yield - From Measurement to Model. Springer-Verlag Berlin Heidelberg. Jan Hansen, J.; Nagel, J. (2014): Waldwachstumskundliche Softwaresysteme auf Basis von TreeGrOSS - Anwendung und theoretische Grundlagen. Beiträge aus der Nordwestdeutschen Forstlichen Versuchsanstalt Band 11, Universitäts-drucke Göttingen. v. Gadow. K. (2005): Forsteinrichtung – Analyse und Entwurf der Waldent-wicklung, Universitätsdrucke im Universitätsverlag Göttingen. v. Gadow, K. (2006): Forsteinrichtung – Adaptive Steuerung und Mehrpfad-prinzip, Universitätsdrucke im Universitätsverlag Göttingen.

Module	**Forest governance and Policy I**
Components	**1. Concepts, Institutions and Actors**
	2. Environmental Policy and Nature Conservation
Study program	Forestry System Transformation (FST)
Semester term	1. Sem.
Module coordinator	Prof. Dr. Carsten Mann carsten.mann@hnee.de
Status	Mandatory
Responsible	Prof. Dr. Carsten Mann
Lecturer	Prof. Dr. Carsten Mann, Prof. Dr. Heike Walk, Prof. Dr. Pierre Ibisch, Prof. Dr. Martin Welp
ECTS - Credits	6
SWS	4
Max. participants	25
Learning / Teaching method	Lecture (20h), exercises (30h), group work (40h), self-studies (90h)
Language	English
Examination form	PP (50%), PR (50%)
Prerequisite for participation	-
Learning objectives	**Concepts, Institutions and Actors**: Students understand, can explain and analyse environmental governance systems. Rooted in a new institutional economics and political sciences understanding, students can distinguish between governance structures, institutions, actors and organisations. In particular they are familiar with key policy and governance concepts relevant for sustainable natural resources management and use. Besides the deepening of dedicated governance systems, students are able to explain and handle multiple realities for collaboration, integrated and adaptive approaches, and conflict management. **Environmental Policy and Nature Conservation**: Students are familiar with the general objectives, tools and current debates of environmental-, nature- and biodiversity conservation policy on different levels. They know the basic environmental governance structures, and the different policy instruments at stake to manage environmental problems. They are able to discuss the chances and limitations of these policy approaches in a nuonced way. For dedicated environmental policy arenas, students can analyse central actors, inherent problem perceptions and ideas for policy solutions. They are able to analyze participatory governance in different policy fields.
Module content	<u>Central themes/topics of the module components are:</u> **1) Concepts, Institutions and Actors** - Introduction to the conceptual foundation of (environmental) governance and different schools of thought: structures, institutions, actors; - Exploration of a paradigm shift from central government steering to collaborative approaches in natural resource management; - Deepening of key policy concepts such as policy cycle, rational choice and advocacy coalitions, and governance approaches such

	as integrated, multi-level/sector/actor governance - Exploration of community-based governance approaches; - Deepening of dedicated governance systems: Forest and environmental governance; biodiversity conservation governance, and governance of protected areas; - Besides conceptual-thematic orientations, scientific requirements for handling multiple realities are deepened and exercised: inter-disciplinary and transdisciplinary research approaches; **2) Environmental Policy and Nature Conservation** - Students gain fundamental knowledge of environmental policy instruments, strategies and mixes to manage environmental problems and the utilization/extraction of natural resources; - Introduction to central environmental policy fields and actors, analysis of their beliefs and positions (such as for forestry, nature/ biodiversity conservation, climate protection, bioeconomy, energy…); - Insights and application of key policy concepts such as policy cycle, rational choice and belief systems; - The science-policy interface and decision-supporting processes; - Challenges for environmental policy: technocracy, problem export, impacts and power struggles; - Examples of local to global environmental problems and solutions
Pursuing elective modules	-
Skills and competences	Conceptual competences (35%), Technical competences (10%), Methodical competences (35%), Personal competences (10%), Media competences (10%)
Literature	Cox, M., Arnold, G., and Villamayor Tomás, S. 2010. A Review of Design Principles for Community-Based Natural Resource Management. Ecology and Society 15(4):38. Heinelt, H. 2018. Handbook on Participatory Governance. Handbooks of Research on Public Policy series. Cheltenham: Edward Elgar Publishing Hodge, I. 2007. The Governance of Rural Land in a Liberalised World. Journal of Agricultural Economics 58(3):409–32. Jordan, A. J. and Turnpenny, J. R. 2015. The Tools of Policy Formulation: Actors, Capacities, Venues and Effects. Northampton, MA: Edward Elgar Publishing Ltd. Kemp, R., Parto, S., and Gibson, R. B. 2005. Governance for Sustainable Development: Moving from Theory to Practice. International Journal of Sustainable Development 8(1):12–30. Loft, L.; Mann, C.; and Hansjürgens, B. (2015): Challenges in Ecosystem Services Governance: Multi-levels, multi-actors, multi-rationalities. In: L. Loft; C. Mann & B. Hansjürgens “Governance of Ecosystem Services – Challenges for sustainable development”, Journal of Ecosystem Services, Special Issue 16, pp. 150 – 157, DOI: 10.1016/j.ecoser.2015.11.002. Mann, C.; Plieninger, T.; Raymond, C. M.; Garcia Martin, M.; and Shaw, B. (in preparation). Integrated landscape management as an operational bridge for implementing the Sustainable Development Goals (SDGs) in Europe. *Landscape and Urban Planning*.

	Ostrom, E. and Basurto, X. 2011. Crafting Analytical Tools to Stu-dy Institutional Change. Journal of Institutional Economics 7(3):317–43. Paavola, J., Gouldson, A., and Kluvánková-Oravská, T. 2009. Interplay of Actors, Scales, Frameworks and Regimes in the Governance of Biodiversity. Environmental Policy and Governance 19(3):148–58. Persha, L., Agrawal, A., and Chhatre, A. 2011. Social and Ecological Synergy: Local Rulemaking, Forest Livelihoods, and Biodiversity Conservation. Science 331(6024):1606–8. Rival, L. and Muradian, R. 2013. Introduction: Governing the Provision of Ecosystem Services. Pp. 1–17 in Governing the Provision of Ecosystem Services. Springer. Scott, W. R. 2008. Institutions and Organizations: Ideas and Interests. Thousand Oaks, Calif.: Sage. Stone, D. 2012. Policy Paradox: The Art of Political Decision Making. Auflage: 3. Auflage. New York: Norton & Company. Walk, H. and Müller, M. 2014. Democratizing the climate negotiations system through improved opportunities for participation. In: Dietz, M. und Garrelts, H. (Eds.): Handbook of the climate change movement. Routledge International Handbooks, S. 31-43 Windhoff-Héritier, A. 2002. Common Goods: Reinventing European and International Governance. Rowman & Littlefield. Young, O. R. 2002. The Institutional Dimensions of Environmental Change: Fit, Interplay, and Scale. MIT Press.

Module	**Resource Competition**
Components	**1) Spatial dimension, Assessment and Solutions**
	2) Ecosystem modelling
Study program	Forestry System Transformation (FST)
Semester term	1. Sem.
Module coordinator	Prof. Dr. Jan-Peter Mund jan-peter.mund@hnee.de
Status	Mandatory
Responsible	Prof. Dr. Jan.Peter Mund,
Lecturer	Prof. Dr. Jan.Peter Mund, Prof. Dr. Alfred Schultz
ECTS - Credits	6
SWS	4
Max. participants	25
Learning / Teaching method	Lecture (20h), Seminar/Tutorials (40h), Exercises (30h), self-study (90h). The learning and teaching strategies are student centered and based on practical lab tutorials and exercises framed by lectures and a literature review about resource competitions and their spatial dimension. A creative and self-critical learning approach by using seminar group work sessions and discussions of recent literature shall encourage students additionally to learn about global or regional competitions on forest resource competitions and particular counter measures. In a research project students will apply spatial assessment methods for forest resources and will discuss regional to global resource competitions and potential solutions. The learning material for this course includes academic lectures and online learning documents as well as reading assignments, practical tutorials and technical exercises and a student led discussion.
Language	English
Examination form	WR (50%), TD (50%) Technical exercise assignments, a research project report and a workshop presentation with discussion. In this seminar, students have to perform 3 online assignments similar to the supervised lab-exercises. Additionally students carry out an academic research project about particular spatial dimension and assessment methods for forest resources and present and discuss particular competitions and potential solutions in a workshop presentation. The project work will be evaluated and awarded regarding conceptual, technical and methodological quality of the project report as well as the presentation of the results.
Prerequisite for participation	-
Learning objectives	**Spatial dimension, Assessment and Solutions:** Students have knowledge about recent spatial competitions on forest resources based on conceptual and methodical approaches. They are aware about potential political solution and feasible counter management strategies such as land management measures and forest policy decisions. They are able to apply monitoring tools and develop monitoring strategies integrating spatial data products and global monitoring services. A primary objective is that the students are eventually in the position to carry out their own monitoring projects, and that they have the criteria to judge the quality of monitoring projects in general.

	Ecosystem modelling: Students gain knowledge and acquire the methodological skills for the development of simulation models of ecological and technical systems. They are enabled to describe, analyse and evaluate dependencies and interrelations between observations and processes in the field of the environment and economics on the basis of empirical data.
Module content	Land is a scarce resource increasingly affected by the competition of mutually exclusive uses. On the remaining land, local, national and international users with different socioeconomic status and power compete to achieve food security, economic growth, energy supply, nature conservation and other objectives. This module introduces to the discussion on forest resources and their competition in a global or regional land-use management. It offers interactive training using most recent spatial management tools and methods to assess and analyse spatial dimensions of recent land use and potential land use completions. The module offers conceptual insights into different land-use planning and management strategies aiming at preserving forest resources or reducing land conflicts by introducing sustainable forest resource management strategies. The technical implementation of spatial methods and tools such as GIS and Remote Sensing complete the interdisciplinary learning approach in this module.
Pursuing elective modules	Transformation and innovation I
Skills and competences	Conceptual competences (15%), Technical competence (35%), Methodical competence (35%), Personal competence (10%), Media competence (5%)
Literature	AGRAWAL, A.; CHHATRE; A.; HARDIN, R. (2008): Changing Governance of the World's Forests. in Science 13 Jun 2008, Vol. 320, Issue 5882, pp. 1460-1462. DOI: 10.1126/science.1155369 BONNER MTL, SCHMIDT S, SHOO LP. (2013): A meta-analytical global comparison of aboveground biomass accumulation between tropical secondary forests and monoculture plantations. For Ecol. Management. 2013; 291:73–86. FRITSCHE, U.R.; SIMS, R. E. H.; MONTI, A. (2010): Direct and indirect land-use competition issues for energy crops and their sustainable production – an overview. DOI: 10.1002/bbb.258 MELI, P.; HOLL,K.D.; BENAYAS, J.M.R.; JONES, H.P.; JONES, P.C.; MONTOYA, D.; MATEOS, D.M. (2017): A global review of past land use, climate, and active vs. passive restoration effects on forest recovery. Open access: http://dx.doi.org/10.1371/journal.pone.0171368 SANDS, R. D.; MALCOLM, S. A.; SUTTLES, S. A.; MARSHALL, E. (2017): Dedicated Energy Crops and Competition for Agricultural Land. In: United States Department of Agriculture, Economic Research Report Number 223, accessed: http://ageconsearch.umn.edu/bitstream/252445/2/ERR223.pdf SCHWENK WS, DONOVAN TM, KEETON WS, NUNERY JS.(2012): Carbon storage, timber production, and biodiversity: comparing ecosystem services with multi-criteria decision analysis. In: Ecol. Appl. 2012; 22(5):1612–27. pmid:22908717

	SMITH, P.; GREGORY, P.J.; VAN VUUREN, D.; OBERSTEINER, M.; HAVLI, P.; ROUNSEVELL, M. WOODS, J.; STEHFEST, E.; BELLARBY, J. (2010): Competition for land – a review. In: Philosophical Transactions B of the Royal British Society – Biological Sciences. DOI: 10.1098/rstb.2010.0127 *Further and more recent literature will be presented during the lectures and in the literature review of the seminar.*

Module	**Forest Management Strategies for ecosystem service provision I**
Components	**Carbon sequestration and accounting**
Study program	Forestry System Transformation (FST)
Semester term	1. Sem.
Module coordinator	Prof. Dr. Martin Guericke Martin.Guericke@hnee.de
Status	Elective
Responsible	Prof. Dr. Martin Guericke
Lecturer	Prof. Dr. Martin Guericke, Prof. Dr. Winfried Riek, Prof. Dr. Tobias Cremer
ECTS - Credits	6
SWS	4
Max. participants	25
Learning / Teaching method	Lecture (30h), Practical Exercise (30h), self-study (120h)
Language	English
Examination form	Working Report (WR)
Prerequisite for participation	Future Management Systems I
Learning objectives	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).
Module content	The interactions among vegetation, climate, soil organisms 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. 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. 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 modeling and to evaluate the results of growth scenarios.

Pursuing elective modules	Forest Management Strategies for ecosystem service provision II
Skills and competences	Technical competence (50%), Methodological competence (20%), Social competence (10%), Personal competence (20%)
Literature	JANDL, R., RODEGHIERO, M., OLSSON, M. 2011: Soil carbon in Sensitive European Ecosystems: From Science to Land Management, John Wiley & Sons. Ltd. VANCLAY, J.K., 1994: Modelling Forest Growth and Yield. Applications to Mixed Tropical Forests. Cab International. ISBN: 0 85198 913 6. V. GADOW, K., PUKKALA, T. A., TOME, M., 2000: Sustainable Forest Management. Kluwer Academic Publishers. 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. OLSTHOORN ET AL., 1999: Management of mixed-species forest: silviculture and economics. IBN Scientific Contributions 15, Wageningen.

Module	**Transformation and Innovation I**
Components	**Assessment tools and methods: Forest 4.0 / Parametrization and spatial assessment of biomass**
Study program	Forestry System Transformation (FST)
Semester term	1. Sem.
Module coordinator	Prof. Dr. Jan-Peter Mund jan-peter.mund@hnee.de
Status	Elective
Responsible	Prof. Dr. Jan.Peter Mund, N.N
Lecturer	Prof. Dr. Jan.Peter Mund, N. N.
ECTS - Credits	6
SWS	4
Max. participants	25
Learning / Teaching method	Lecture (12h), seminar (18h), practical exercise (30h), self-study (60h). The learning and teaching strategies are student centered and based on practical lab tutorials framed by lectures and seminar work about methods and concepts of global monitoring. A creative and self-critical learning approach by using seminar group work sessions and discussions of recent literature shall be encouraged students additionally. During this module students will get an overview about most recent remote sensing tools and methods for global monitoring and will apply remote sensing products and services in their research project. Technical and conceptual guidance is provided during the course on most recent global monitoring schemes and their limitations. The teaching material for this course includes lectures and online learning documents and reading assignments, instructor led discussions and student led discussions and a technical IT-lab work.
Language	English
Examination form	PP (50%), PR (50%) Global monitoring research project report and workshop presentation. In the framework of a seminar, students will choose an individual example of a global monitoring scheme and will present results of their research work in a workshop presentation. The project work will be evaluated and awarded regarding conceptual, technical and methodological quality of the project report as well as the presentation of the results.
Prerequisite for participation	Resource Competition
Learning objectives	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.
Module content	This module offers an introduction to selected monitoring methods of global phenomena and recent trends in earth observation of the environment. The module focuses on standardized remote sensing products and sensor networks for earth observation. Global monitoring and standardized earth observation products will be discussed and students will critically evaluate existing NASA and ESA–Copernicus and Sentinel products and discuss recent trends and challenges in multi-temporal earth observation especially land cover land-use topics. In addition students will learn about typical earth observation services like Marine services, Soil and Water services; Crop monitoring, Atmosphere services or Emergency response and Security services.
Pursuing elective modules	Transformation and Innovation II
Skills and competences	Conceptual competences (35%), Technical competence (15%), Methodical competence (35%), Personal competence (5%), Media competence (10%)
Literature	ASCHBACHER; J & PILAR MILAGRO-PÉREZ; M. (2012): The European Earth monitoring (GMES) programme: Status and perspectives. In: Remote Sensing of Environment 120 (2012) 3–8. DE MEY, STEFAAN (2015): The Future of Satellite Applications: The End-User Perspective. In: Yearbook on Space Policy 2015, pp 175-191. DONLON, C. ET AL (2012): The Global Monitoring for Environment and Security (GMES) Sentinel-3 mission. In: Remote Sensing of Environment 120 (2012) 37– 57. ELSHARKAWY, A., ET AL. (2012). Improvement in the Detection of Land Cover Classes Using the Worldview-2 Imagery ASPRS Sacramento, CA. HOUGHTON, R.A.; NASSIKAS, A.A.(2017): Global and regional fluxes of carbon from land use and land cover change 1850–2015, DOI: 10.1002/2016GB005546 JENSEN(2006): Remote Sensing of the Environment: An Earth Resource Perspective (2nd Edition) JONES & VAUGHAN (2010): Remote Sensing of Vegetation: Principles, Techniques, and Applications VUOLO, F., WAI-TIM, NG, ATZBERGER, C. (2016): Smoothing and gap-filling of high resolution multi-spectral time series: Example of Landsat data. In: International Journal of Applied Earth Observation and Geoinformation, Volume 57, May 2017, Pages 202–213 WULDER, M.A., S.E. FRANKLIN (2003): Remote Sensing of Forest Environments. Kluwer Academic Publishers. *Further and more recent literature will be presented during the lectures and in the literature review of the seminar.*

Module	**Rethinking Environmental Economics II**
Components	**1) Economy – Ecology System Interactions**
	2) Bioeconomy strategies
Study program	Forestry System Transformation (FST)
Semester term	2. Sem.
Module coordinator	Prof. Dr. Carsten Mann carsten.mann@hnee.de
Status	Mandatory
Responsible	Prof. Dr. Carsten Mann
Lecturer	Prof. Dr. Carsten Mann, Prof. Dr. Tobias Cremer
ECTS - Credits	6
SWS	4
Max. participants	25
Learning/ Teaching method	Lecture (20h), exercises (20h), group project (80h), self-study (60h)
Language	English
Examination form	Project presentation (group work)
Prerequisite for participation	-
Learning objective	**Economy – Ecology System Interactions**: Students acquire knowledge on economy - ecology system interactions conceptualized as 'social-ecological systems' (SES). They gain a system-based understanding of system dynamics, stability and change, and economy as an integral part of the environment that needs to be understood in its uncertainties and limitations. Students are introduced to SES analysis frameworks, and will be able to apply them. The crucial role of institutions that mediate system interactions is highlighted. Alternative concepts for economic growth and human well-being are introduced and related critical issues such as ethics, fairness and equity debated. **Bioeconomy strategies**: Students have a good understanding of the Bioeconomy concept in general. They understand the aims of different concepts and strategies related to Bioeconomy and how an efficient and resource-friendly use of natural resources such as plants, animals, and microorganisms shall be achieved. They can identify bioeconomy potentials of a range of various institutional, economic and biophysical settings with a special focus on forestry and analyze in how far these play a crucial role for shaping the countries bioeconomy strategies. Further, students are able to derive implications for a sustainable forest resource management.
Content	<u>1) Central components of the module are</u>: • Understanding of socio-ecological systems and interdependencies; • Identification and constructive debate of socio-economic and political trends that influence natural resource uses, overuse and degradation; • Getting to know the idea of system dynamics, and phases of stability and change; • Elaborating on the crucial role of institutions for natural resource uses and introduction to related analysis frameworks;

	• Carrying out system analysis – and implications for desired solution; • Introduction to the concepts of robustness, resilience and adaptive capacity; • Introduction and debate of the `limits of growth´ and alternative concepts and indicators for welfare and human wellbeing (e.g. the post growths debate and new quality of life indicators); • Elaboration of crucial issues of ethics, fairness and equity; • Role games on political decision making and negotiating tradeoffs; • Self organisation of stakeholder discussions and/or workshops and/or conferences on related module topics. <u>2) Central components of the module are:</u> Bioeconomy aims to achieve an efficient and resource-friendly use of natural resources. It concerns a wide variety of sectors, including especially forestry, agriculture and plant breeding. In forestry, this new global trend has the potential to significantly change demand for wood and other resources. By that, traditional markets and market participants will be influenced, and forest management strategies might have to be adapted, according to new stakeholders in the market. It is therefore crucial to understand this new megatrend, to be able to derive first assumptions of how to react and how to handle the upcoming challenges and changes. In this module, students are therefore introduced to a range of country perspectives on bioeconomy. Based on cross-country comparisons, socio-economic insights into this emerging policy and business field are presented: strategies, actors, risks and promises. Differences in institutional, economic and biophysical settings are identified and analyzed in how far these play a crucial role for shaping the countries' bioeconomy strategies and how forestry is affected. Potentials for a European way are debated, and implications for resource management are thematised.
Perusing elective modules	-
Skills and competences	Thematic competence (50%), Methodological competence (50%)
Literature	*<u>Literature part 1</u>:* Berkes, Fikret, Carl Folke, and Johan Colding. 2000. Linking Social and Ecological Systems: Management Practices and Social Mechanisms for Building Resilience. Cambridge, New York: Cambridge University Press. Bromley, Daniel W. et al. 1992. Making the Commons Work: Theory, Practice, and Policy. San Francisco: ICS Press. Costanza, R., Daly, L., Fioramonti, L., Giovannini, E., Kubiszewski, I., Mortensen, L.F., Pickett, K.E., Ragnarsdottir, K.V., De Vogli, R., Wilkinson, R., 2016. Modelling and measuring sustainable wellbeing in connection with the UN Sustainable Development Goals. Ecological Economics. 130, 350-355. Cox, Michael, Gwen Arnold, and S.Villamayor Tomás. 2010. A Review of Design Principles for Community-Based Natural Resource Management." Ecology and Society 15(4):38.

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Module	**Future Management Systems II**
Components	**Strategic silvicultural planning**
Study program	Forestry System Transformation (FST)
Semester term	2. Sem.
Module coordinator	Prof. Dr. Peter Spathelf peter.spathelf@hnee.de
Status	Mandatory
Responsible	Prof. Dr. Peter Spathelf
Lecturer	Prof. Dr. Peter Spathelf, N.N.
ECTS - Credits	6
SWS	4
Max. participants	25
Learning / Teaching method	Lecture (20h), exercises (30h), group debates (40h), self-study (90h)
Language	English
Examination form	WE120
Prerequisite for participation	Future Management Systems I
Learning objectives	Students are familiar with basics of sustainable biomass production in forests (forest ecosystems, dendrochronology, forest growth science).
Content	Focus of the module is silvicultural strategies for the sustainable provision of wooden biomass and ecosystem services under variable economic and social framework conditions, encompassing, among others: • Strategies to produce energywood and pulpwood, as well as high- value timber • Concepts of plantation forestry • Strategies to transform even-aged pure into uneven-aged mixed forests • Development of continuous-cover forestry approaches and agroforests • Development of concepts for and provision of specific ecosystem services (such as soil protection, water, carbon storage, and biodiversity) • Inclusion of silvicultural strategies into land use decisions (e.g. development of restoration concepts)
Pursuing elective modules	Forest management strategies for ecosystem service provision II
Skills and competences	Thematic competences (50%), Methodological competences (50%)
Literature	*Textbeispiele:* Barreto, P., Amaral, P., Vidal, E. & Uhl, C. (1998): Costs and benefits of forest mnagement for timber production in eastern Amazonia. Forest Ecology and Management 108. S. 9-26. FAO (2016): State of the world's forests. FAO, Rome. http://www.fao.org/docrep/016/i3010e/i3010e00.htm Fritz, P. (Hrsg.) 2006. Ökologischer Waldumbau in Deutschland. Fragen, Antworten, Perspektiven. Oekom-Verlag. 351 S. Günter, S., Weber, M., Stimm, B., Mosandl, R. (Eds) (2012): Silviculture in

	the tropics. Series Tropical Forestry, Vol. 8. Springer, Dordrecht. 560 p. Kammesheidt, L., Glauner, R., Schröder, J.M. & Heuveldop, J. (2004): Haben Kiefernplantagen in den Tropen eine Zukunft? Holzzentralblatt 130. S. 476-478. Lamprecht, H. (1986): Waldbau in den Tropen. Parey, Hamburg und Berlin. 318 S. Mansourian, S., Vallauri, D. & Dudley, N. (2005): Forest Restoration in Landscapes: Beyond Planting Trees. Springer. 437 p. Nambiar, E.K.S. 1999. Pursuit of Sustainable Plantation Forestry. Southern African Forestry Journal, No 184. p. 45-62. Nutto, L., Spathelf, P. & Seling, I. (2002): Plantagenwälder – eine Option für Brasilien. Holz-Zentralblatt 109. S. 1287. Pearce, D., Putz, F.E. & Vanclay, J.K. (2003): Sustainable forestry in the tropics: panacea or folly? Forest Ecology and Management 172 / 2-3. S. 229-247. Röhrig, E., Bartsch, N. & Von Lüpke, B. 2006. Waldbau auf ökologischer Grundlage. 7. Auflage. Verlag Eugen Ulmer Stuttgart. 479. S. Smith, D.M. 1962. The practice of silviculture. John Wiley & Sons, New York. 578 p. Spathelf, P., Schneider, P.R., Finger, C.A., 2001. Zur nachhaltigen Bewirtschaftung von Araukarien-Mischwäldern in Südbrasilien. Forstarchiv 72, 92-100.

Module	**Forest Governance and Policy II**
Components	**Conflicts, Cases and Conflict Management**
	Social Science Analysis of Conflict Cases
Study program	Forestry System Transformation (FST)
Semester term	2. Sem.
Module coordinator	Prof. Dr. Carsten Mann carsten.mann@hnee.de
Status	Mandatory
Responsible	Prof. Dr. Carsten Mann
Lecturer	Prof. Dr. Carsten Mann, Prof. Dr. Heike Walk, Prof. Dr. Pierre Ibisch, Prof. Dr. Martin Welp
ECTS - Credits	6
SWS	4
Max. participants	25
Learning / Teaching method	Lecture (20h), exercises (40h), group debates (30h), self-study (90h)
Language	English
Examination form	Project Presentation (PP)
Prerequisite for participation	-
Learning objectives	**Conflicts, Cases and Conflict Management**: Students gain a basic theoretical and practice-oriented understanding of conflicts in the realm of natural resource use and forest management. They are familiar with different types of (land-use) conflicts, conflict theory, distinct sets of conflict resolution strategies and underlying principles. They can analyse and derive conflict management strategies for sustainable land-uses and forest management that seem suitable for a range of distinct situations. **Social Science Analysis of Conflict Cases:** Students know about main empirical social science methods, types of data, and techniques for collecting social science data. They can decide for and apply different methods for different kinds of research questions (policy analysis, constellation analysis, network analysis). In addition, they can develop and discuss a variety of governance concepts.
Content	<u>Central themes/topics of the module components are:</u> 1) **Cases, Conflicts and Conflict Management** This module contains following thematic blocks, each one consisting of theoretical insights, practice examples and exercises: - Land-use transitions: Dynamic socio-ecological systems in relation to changing policy agendas and societal demands; - Conceptual orientation: Conflict types, patterns and conflict reasons; - Mapping of conflict potentials and spatial arrangements; - Conflict management: regulation, negotiation, mediation strategies; - Exploration and debate of challenges and implications for sustainable natural resource use and management; - Group work, role games and hands-on exploration of conflict potentials and suitable solutions over a range of contexts in natural

	resource management. **2) Social science analysis** Students gain a comprehensive knowledge about different social science research methods: - Selection of methods, types of data, and techniques for collecting social science data; - Learning about differences between research using qualitative and quantitative methods - Analyzing data sets, and correctly interpreting questionnaires, in-depth semi-structured interviews, focus groups, case studies - Formulating relevant and precise research questions and hypotheses - Selecting appropriate research strategies and methods fitting the research questions - Active Learning Exercises for Research Methods in Social Sciences
Pursuing elective modules	-
Skills and competences	Thematic competences (50%), Methodological competences (50%)
Literature	Babbie, E. (2010). The Practice of Social Research. Wadsworth Cengage Learning. International Edition. Buckles, D. & Rusnak, G. (1999). Cultivating Peace: Conflict and Collaboration in Natural Resource Management. Washington: World Bank Institute. Food and Agriculture Organisation of the United Nations (FAO) 2005. Negotiation and mediation techniques for natural resource management. ROME: FAO/UN [URL document] ftp://ftp.fao.org/docrep/fao/008/a0032e/a0032e00.pdf. Foley, J.A., et al. (2005). Global consequences of land use. Science 309(5734): 570-574. Griggs, S., et al. (2014). Practices of freedom. Decentred governance, conflict and democratic participation. Cambridge: Cambridge University Press. Henle, K., et al. (2008). Identifying and managing the conflicts between agriculture and biodiversity conservation in Europe – A review. Agriculture, Ecosystems and Environment 124: 60-71. Hesselink, F. (2004). How to manage change? How to manage people? Skills and knowledge for effectiveness in communicating protected areas and biodiversity values. In: D. Hamú et al. (eds.), Communicating Protected Areas, IUCN, pp. 9-12. Kvale, S. (2007). Doing interviews. Los Angeles: SAGE Publications. Krueger, R. A. (1994). Focus groups: a practical guide for applied research. Thousand Oaks, Cal.: Sage Lockwood, M., et al. (2009). Managing protected areas - A global guide. London: Earthscan. Torre, A., et al. (2014). Identifying and measuring land-use and proximity conflicts: methods and identification. SpringerPlus 3: 85. USDA Forest Service (2001). Defining, Managing, and Monitoring Wilderness Visitor Experiences. General Technical Report RMRS-GTR-

	79. Rocky Mountain Research Station, Fort Collins, CO. Von der Dunk, A., et al. (2011). Defining a typology of peri-urban land-use conflicts – A case study from Switzerland. Landscape and Urban Planning 101: 149-156.

Module	**Socio-technical system transformation**
Components	**1) Transformation governance**
	2) Innovation types, patterns and processes
Study program	Forestry System Transformation (FST)
Semester term	2. Sem.
Module coordinator	Prof. Dr. Heike Walk heike.walk@hnee.de
Status	Mandatory
Responsible	Prof. Dr. Heike Walk
Lecturer	Prof. Dr. Benjamin Nölting; Prof. Dr. Carsten Mann
ECTS - Credits	6
SWS	4
Max. participants	25
Learning / Teaching method	Lecture (30h), exercises (20h), group debates (50h), self-study (80h)
Language	English
Examination form	Oral Report (OR)
Prerequisite for participation	-
Learning objectives	**Transformation governance**: Students become acquainted with theories and concepts of transformation. They learn about actors, strategies and governance of transformation processes. Of special interest are civil society organizations and social movements. Students learn what a social movement is and about their part in transforming societies and stimulating rapid periods of cultural evolution. Students are enabled to reflect upon the role of civic, private and public sector institutions in transformation processes towards sustainable development. **Innovation types, patterns and processes**: Students gain a comprehensive understanding of-, and insights into, different innovation types as part of broader transformation strategies. Guided by a socio-ecological-technical system-based innovation understanding, they are able to differentiate between technology innovations, social innovations, governance and policy innovations as well as innovative forms of organisations related to natural resources provision and use. As such students gain a wide spectrum of conceptual and practice knowledge ranging from technical-production processes such as for bioenergy up to cooperative forms of organisation.
Content	Students learn about different concepts and models of transformation and apply them to case studies of UNESCO Biosphere Reserves: • A social contract for sustainability • Transformation theories and approaches • Multi level perspective • Transition management • Coping with dilemmas of resource-oriented management Students learn about the role of social movements and about their part in transforming societies and stimulating rapid periods of cultural evolution.

	• Reflection about civic, private and public sector institutions • Examples of social movements • Main characteristics • Cooperatives and civil society organizations Students gain a comprehensive understanding of-, and insights into, different innovation types, patterns and strategies as part of broader transformation processes. Central themes/topics are among others: • Introduction to concepts and criteria of innovation systems and patterns of change (success factors, barriers to innovation); • Different innovation types (e.g., technological, social, business and policy) • Innovation patterns/journeys (linear vs. non-linear, evolutionary) • innovation • Approaches for innovation testing, assessment, management, and transfer • "Real laboratories" • Ideas of responsible innovation • Examples e.g. Strategies for sustainable policy design: Constructive Assessment of biodiversity impact mitigation • International approaches for innovation transfer. The example of the United Nations Public Service Innovation Approach
Pursuing elective modules	Transformation and Innovation I + II
Skills and competences	You will become an Innovation pioneer
Literature	*Textbeispiele*: Beck, G. and Kropp, C. 2012. Die Gesellschaft wird innovativ – und die Wissenschaft von ihr? Zur Einleitung. In Gesellschaft innovativ. Wer sind die Akteure?, eds. G. Beck and C. Kropp, pp. 11-28, Wiesbaden, VS Verlag. Borrás, S. and J. Edler. 2012. "The Governance of Change in Sociotechnical and Innovation Systems: Some Pillars for Theory-Building." Pp. 1–2 in Governance of Innovation and Socio-Technical Systems in Europe: New Trends, New Challenges conference. Brand, Ulrich (2016). "Transformation" as a New Critical Orthodoxy. The Strategic Use of the Term "Transformation" Does Not Prevent Multiple Crises. In: GAIA 25/1(2016): 23–27 Braun-Thürmann, H. 2005. Innovation, Bielefeld: transcript. Della Porta, Donatella (ed.). 2014. Methodological practices in social movement research. Oxford: Oxford University Press Edquist, C. (ed.) 1997. Systems of Innovation - Technologies, Institutions and Organizations. London, Washington: Pinter Publishers/Cassell Academic. Fagerberg, J. and Verspagen, B. 2009. Innovation studies - the emerging structure of a new scientific field. Research Policy 38, pp. 218-233 Geels, F.W. 2002. Technological transitions as evolutionary reconfiguration processes - A multi-level perspective and a case-study. Research Policy 31, pp. 1257-1274. Geels, F.W. 2004. From sectoral systems of innovation to socio-technical systems. Insights about dynamics and change from sociology and

institutional theory . Research Policy 33 (6-7), pp. 897-920.
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Grin, John; Rotmans, Jan; Schot, Johan (2010). Transitions to Sustainable Development. New Direction in the Study of Long Term Transformative Change. New York, London: Routledge.
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Loorbach, Derk (2007). Transition Management. New mode of governance for sustainable development. Utrecht: International Books.
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Müller-Christ, Georg (2011). Sustainable Management. Coping with the dilemmas of resource-oriented management. Heidelberg etc.: Springer.
Partzsch, Lena (2015). Kein Wandel ohne Macht – Nachhaltigkeitsforschung braucht ein mehrdimensionales Machtverständnis. In: GAIA 24/1(2015): 48 – 56
Rammert, W. (2007). Technik – Handeln – Wissen. Zu einer pragmatischen Technik- und Sozialtheorie. Wiesbaden: Verlag für Sozialwissenschaften, pp. 47-64.
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Schneidewind, Uwe; Augenstein, Karoline (2016). Three Schools of Transformation Thinking. In: GAIA 25 (2/2016), S. 88-93.
Van de Ven, A.H., Polley, D.E., Garud, R., Venkataraman, S. (1999). The innovation journey. Oxford: Oxford University Press.
Voß, Jan Peter; Newig, Jens; Kastens, Britta; Monstadt, Jochen; Nölting, Benjamin (2007): Steering For Sustainable Development: A Typology Of Problems And Strategies With Respect To Ambivalence, Uncertainty And Distributed Power. Journal Of Environmental Policy & Planning, 2007 (Volume 9, Issue 3 & 4), S. 193–212.
WBGU (German Advisory Council on Global Change) (2011). World in Transition – A social contract for sustainability. Flagship Report. Berlin: WBGU Secretariat.

Module	**Forest Management Strategies for ecosystem service provision II**
Components	**1) Water management**
	2) Nutrient Management
Study program	Forestry System Transformation (FST)
Semester term	2. Sem.
Module coordinator	Prof. Dr. Jens Schröder jens.schroeder@hnee.de
Status	Elective
Responsible	Prof. Dr. Jens Schröder
Lecturer	N.N.
ECTS - Credits	6
SWS	4
Max. participants	25
Learning / Teaching method	Lecture, exercises, group debates, self-study, project work
Language	English
Examination form	Project Presentation (PP)
Prerequisite for participation	Forest Management Strategies for ecosystem service provision I
Learning objectives	**Water management**: Students are able to explore the close interrelations between forests and water. They can build on insights from forest site classification systems as well as forestry-related hydrological-meteorological findings, and understand the relevancy of forest management for water regulation in the light of global change problems. They can examine and debate the particular role of forests and its water regulation and adaptation abilities, its influence on water and heat systems, buffer functions and risks. The fundamental importance of water availability for ecosystem services will be highlighted together with management options for forests supporting their adaptive capacity. Students can recognise various context conditions, institutional frameworks and social demands for the use of water resources and elaborate sustainable water management strategies. **Nutrient Management**: Students get to know relevant nutrient cycles, their importance for functioning forest ecosystems stability, robustness and resilience, and possibilities of influencing them as part of forest and water management strategies.
Content	The module will cover the two sub-topics in a closely connected approach. The scientific basis will be revisited and expanded, and the opportunities and challenges for forest management in a wider context of societal needs under different conditions will be explored Main focal points comprise • Differences between managed forests and natural forests in terms of water and nutrient cycles • Relevance of forest management for water regulation in the light of local to global change problems • Water and nutrients as key elements in maintaining sustainability of forest land use and of provision of other services • Reflection of forest and other land-use history as constraints of

	future strategies Context conditions and the role of social and political frameworks • Opportunities of decision support via models and scenario studies • Adaptation and resilience as central concepts of forest management for water and nutrients sustainability
Pursuing elective modules	-
Skills and competences	Thematic competences (50%), Methodological competences (50%)
Literature	Buckles, D. & Rusnak, G. (1999). Cultivating Peace: Conflict and Collaboration in Natural Resource Management. Washington: World Bank Institute. Kimmins, J. P. (2003). Forest Ecology. Third Edition; Prentice Hall, Oxford Pretzsch, H. (2009). Forest dynamics, growth and yield: From measurement to model. Springer Verlag, Berlin. vanDijk, A. I:; Keenan, R. J.(eds.) (2007). Planted Forests and Water. Forest Ecology and Management 251 (Special Issue), 128 pp.

Module	**Transformation and Innovation II**
Components	**New Products, processes and strategies**
Study program	Forestry System Transformation (FST)
Semester term	2. Sem.
Module coordinator	Prof. Dr. Alexander Pfriem alexander.pfriem@hnee.de
Status	Elective
Responsible	Prof. Dr.-Ing. Alexander Pfriem
Lecturer	Prof. Dr.-Ing. Alexander Pfriem et al.
ECTS - Credits	6
SWS	4
Max. participants	25
Learning / Teaching method	Lecture, exercises, group debates, self-study
Language	English
Examination form	Oral Report (OR)
Prerequisite for participation	-
Learning objectives	Students gain a solid understanding of the complexity of wood and the wood processing industry - as an optimization problem where maximal value yields are sought from a limited amount of the basic commodity, wood, which is sorted according to its characteristics in order to meet the demands posed on the final product in terms of both esthetic and technical properties. The students acquire special knowledge in material technology in order to understand complex and innovative materials manufactured according to the prior art, and products based on wood and other materials.
Content	The module deals with practical aspects of the special material technology of material composites of wood, wood components and other materials, using current issues by way of example. It describes conditions for an effective production chain, focusing on treatment, new products, material combination and property control. The five sections of the course are: - Wood Treatments and Modifications - Material Composites and High Performance Materials - New Products with Wood - Material Emissions - Determination of Characteristics of Materials
Pursuing elective modules	-
Skills and competences	Expertise (70%), Methodological competence (20%), Social Competence (10%)
Literature	*Literature will be announced at the beginning of the course*.

Module	**Transformation Pioneers**
Components	**1) Project design and management**
	2) Communication and marketing
Study program	Forestry System Transformation (FST)
Semester term	3. Semester
Module coordinator	Prof. Dr. Carsten Mann carsten.mann@hnee.de
Status	Mandatory
Responsible	Prof. Dr. Carsten Mann
Lecturer	Prof. Dr. Heike Walk
ECTS - Credits	6
SWS	4
Max. participants	25
Learning / Teaching method	Seminar (180h), project (720h)
Language	English
Examination form	Project Report (PR)
Prerequisite for participation	-
Learning objectives	**Project design and management**: The seminar helps students to plan their own transformation project of moderate size related to the study programme's content. It takes them step by step from the first idea to a detailed project concept. Students acquire further skills in interdisciplinary scientific work and self-management. Students do not need any previous knowledge to take part in this course. **Communication and marketing**: Students get to know strategies for scientific communication, moderation and marketing. They are able to communicate results to expert and lay audience and get to know a range of dissemination strategies and media.
Module content	The seminar deals with all relevant aspects of planning a project: defining aims and target groups; developing the strategy; planning the implementation of the project in terms of tasks, costs, team and time; developing a fundraising strategy; communicating and marketing the project. In the first part of the seminar we will reflect on the things we are concerned about with regards to the way our society is organized. We will gather these topics and talk about the obvious key aspects of an unsustainable growth. In a second part of this seminar we look at the role of social movements in modern societies and assess why they are important for certain phases. And in the third part we plan our own transformation project.
Pursuing elective modules	-
Skills and competences	Thematic competences (30%), Methodological competences (70%)
Literature	German Advisory Council on Global Change (WBGU), 2011: World in Transition - A Social Contract for Sustainability

	German Advisory Council on Global Change (WBGU), 2014: Climate Protection as a World Citizen Movement, Berlin Hamann, A., Zea-Schmidt, C., Leinfelder, R. (eds.) 2014: The Great Transformation. Climate - Can We Beat the Heat? Berlin Mc Call, B./ von den Dool, J. , 2013: Hosting Transformation" - Pioneers of Change, Melk, Donau, Austria