Graduate Program Assessment Plan (PhD)

Department of Natural Resources and Environmental Management

Curriculum Map

Assessment of student learning outcomes from NREM core courses in terms of Knowledge Gain (K), Comprehension (C), Application (Ap), Analysis (An), Synthesis (S) and Evaluation (E).

Course Number	NREM Program Student Learning Outcomes			
	Skills acquired to solve Natural Resources and Environmental Management Problems	Quantitative Reasoning/Critical Thinking	Communication	Practical Experience
NREM 600	K, C ,Ap ,An ,S, E	Ap	An, S, E	Ap
NREM 601	K, C ,Ap ,An ,S, E	K, C, Ap, An	S, E	Ap, An, S, E
NREM 605	K	K	C, Ap	
NREM 611	K, C, Ap, An	K, C ,Ap ,An ,S, E	K, C ,Ap ,An ,S, E	K, C ,Ap ,An ,S, E
NREM 612	K, C ,Ap ,An ,S, E	K, C ,Ap ,An ,S, E	Ap, E	Ap
NREM 660 /CEE 625	K, C, Ap, An, S, E	K, C, Ap, An, S, E	K, C, Ap, An, E	K, C, Ap, An, E
NREM 662	K, C, Ap, An, E	K, C, Ap, An, E	K, C, Ap, An, E	K, C, Ap, An, E
NREM 664	K, C, Ap, An, E	K, C, Ap, An, E	K, C, Ap, An, E	K, C, Ap, An, E
NREM 665	K, C, Ap, An, S, E	K, C, Ap, An, S, E	K, An, S, E	K, Ap, An, S, E
NREM 680	K, C, Ap, An, S, E	K, C, Ap, An, S, E	K, C, Ap, An, S, E	K, C, Ap, An, S, E
NREM 682	K, C, Ap, An, S, E	K, C, Ap, An, S, E	K, C, An, S, E	K, C, Ap, An, S, E
NREM 691	K, C, An, S, E	K, C, An, Ap, S, E	K, An, Ap, S, E	K, An, Ap, E

Course #	Description	Skills acquired to solve Natural Resources and Environmental Management Problems	Quantitative Reasoning/Critical Thinking	Communication	Practical Experience
NREM 600	To analyze the biophysical potential and limitations of natural resource management approaches and evaluate the success or failure of actual management programs	Group participation. Literature and data searching. Soil and water modeling. Report writing	Soil and watershed modeling	Final project report and oral presentation; journal article review and discussion	Literature and data searching; interviewing; field and laboratory training; application of soil and watershed modeling to a real-world event
NREM 601	To introduce students to an economic framework for assessing natural resource and environmental management issues. It covers key issues and concepts; It applies economic methods to evaluate environmental issues. The evaluation helps students understand the behavioral sources of environmental problems and provide a foundation for developing and assessing innovative management and policy solutions	Literature, data searching and collecting. Application of economic principles to devise policies and evaluating natural resource and environmental problem. Economic modeling. Presentation skills and report writing	A research paper written by each student is required for the course to look at the following: how economic policies impact an issue, investigate the use and efficacy of economic methods of analysis for the paper. Either a conceptual framework or an empirical model is applied to analyze the problem that is being researched. Students are required to provide critical assessment of other students presentations of their research topics. Case studies were provided for students to provide constructive criticism based on the concepts and knowledge learned from the course	Final project report of > than 15 pages and an oral presentation of the paper are required of all students	Primary data collection and interviewing; application of economic and business modeling to a real environmental problem

NREM 605	To assist the new NREM graduate student in developing skills necessary to design a research project. To achieve this objective, the course covered the following topics: the nature of scientific inquiry, elements of a good research proposal, making good use of MS Office, grant proposal writing and process, effective research presentations, NREM research partners, and learning about projects/interests of NREM faculty.	Introduction to research on NREM	Introduction to statistics, experimental methods and research design; Introduction to research ethics (including human subjects) and research philosophy	Several oral presentations (PowerPoint), written exercises, and a research proposal	

NREM 611	To provide a clear understanding of the conceptual/ theoretical, institutional, and policy dimensions of natural resources development, management, allocation and markets/pricing, focusing on their environmental impacts. Emphasis on policy analysis using analytical approaches, market and non-market valuation techniques, case studies, and empirical modeling.	A thorough grounding in the key economic concepts underlying natural resource and environmental policy making; informed insights into the complex issues involved in resource production, pricing, consumption, and allocation; hands-on experience in writing a research paper in close accordance with the guidelines of a peer-reviewed journal in the field; and resource-specific policy analysis skills.	Original research paper calls for the formulation of specific objectives, testable hypotheses, selection and application of procedures involving the use of a variety of econometric models, collection, tabulation and analysis of field-data and/or secondary data, empirical analysis, and crafting of clear and coherent policy prescriptions; class presentations require the identification of key concepts in assigned papers, a critical analysis of these concepts in terms of specific criteria, and suggestions for further refinements and additional research to advance the discourse; demonstration of ability to ferret out specific policies for implementation and an elucidation of their potential impact on the stakeholders, wherever possible in quantitative terms	The three required class presentations, structured along clearly-defined guidelines, are meant to develop and apply the student's oral communication skills; the research paper, fashioned after a refereed journal article, is designed to develop and augment the ability for clear, coherent and concise writing; the essay-type tests help advance the ability for quick thinking and effective writing.	Primary data collection, questionnaire development, use of survey techniques and interviewing; economic modeling and empirical analysis; identification, review and in-class discussion of media-items on relevant emerging issues in the natural resources field (e.g. climate change, natural disasters, energy price, water conservation)

NREM 612	This course considers the historical context of degradation, the current status, and the different types of degradation (physical, chemical, biological). The majority of the course will focus on degradation issues associated with different types of human-dominated ecosystems including forest, rangeland, agriculture, urban, wetland, coastal, and island. The later part of the course will investigate appropriate conservation and restoration approaches to mitigate the effects of degradation.	Upon completing this course students should be able to: (1) Understand the historical context and current status of degradation that occurs in human-dominated ecosystems, (2) Be able to discuss verbally or in writing concepts of stability, resistance, resilience, and sustainability, (3) Be familiar with the causes and effects of physical, chemical, and biological degradation, (4) know how to calculate species richness, evenness, use the USLE and WEQ to calculate water and wind erosion, (5) Have a better understanding of the relationship between land-use and degradation, (6) Gain an appreciation for degradation issues unique to tropical islands, (7) Be capable of suggesting appropriate conservation, rehabilitation, or restoration measures to mitigate degradation in various types of human-dominated ecosystems, (8) Be able to evaluate the scientific merit of papers in the field of ecosystem degradation, and (9) Demonstrate more effective participation in and facilitation of group discussions.	Starting in the 3rd week of class, students are required to write weekly critiques of scientific papers that deal with various degradation issues. Then, during class students lead discussion on the objectives, methods, key results, strengths, and weakness of these papers. Students also do take home problem sets in which they perform calculations or use quantitative skills learned in class. A final project is also required where students can conduct a literature search, perform a GIS analysis, analyze data, develop a model of degradation. These projects will be presented orally at the end of the semester as well as written up as a final paper.	Students are required to lead an in-class discussion of a current scientific paper. Students also participate in a best degradation paper contest, where they make oral presentations as to why they have selected the best degradation paper. A final project report of approximately 20 pages and an oral presentation of the paper are required of all students.	Students learn how to calculate species richness and evenness from real-world data, how to estimate water and wind erosion, and how to work with island biogeography models. Students also critically read and assess current scientific literature and lead discussions of this literature. A field trip also introduces students to degradation issues on the island of Oahu.

NREM 691: Forest Nutrition and Biogeochemistry (eventually to become NREM 686)	1) Learn the basic processes of biogeochemistry in relation to forest nutrient cycling 2) Understand the interactions between forest nutrient limitation and cycling rates 3) Evaluate the effects of various fertilization regimes on nutrient limitation and cycling	1) Knowledge of biogeochemistry, forest nutrient cycling, and fertilization. 2) Ability to read and evaluate peer-reviewed scientific literature 3) How to develop and write a research grant proposal 3) Improved presentation and report writing skills.	1) Students will learn to use a systems dynamics perspective to conceptualize complex systems. 2) Students will be required to critically evaluate peer-reviewed scientific literature 3) Students will learn to apply knowledge of biogeochemistry within a forest management context	1) Biweekly scientific article presentations are required as part of class discussions 2) A presentation on the final project is required	1) Scientific literature database searching 2) Grant proposal writing
NREM 680	Graduate level course on terrestrial ecosystem ecology (i.e., interactions between organisms & their environment as an integrated system). A range of topics are covered focusing on the factors controlling ecosystem structure and function, with emphasis on forest ecosystems within the context of human impacts and global change. Topics covered include: production ecology & carbon cycling; H2O & energy balances; nutrient dynamics; cycling of major elements (C, N, P, etc.) across plant-soil-atmosphere boundaries; biodiversity; anthropogenic and natural disturbances; and global change biology (climate change, land-use change, invasive species, etc.).	In each topical area covered, students develop an in-depth understanding of biological, ecological, and physical principles and concepts, science background, and quantitative skills required to understand and manage terrestrial ecosystems. Specific goals of the course are: to learn the basic principles and concepts of ecosystem ecology; to introduce current controversies and uncertainties in ecosystem ecology; to increase awareness of global change and its impact on ecosystem processes; and to increase awareness of human dependency on ecosystem processes, and how an understanding of ecosystem processes can be applied to the management of ecosystems	A final exam/research paper is assigned were each student designs a research project, in the form of a proposal, to address a significant issue remaining in this field. The choice of topics/ research areas is limited only in that: (i) it must be in the broad field of terrestrial ecosystem ecology, (ii) it must be a significant area of research (i.e., one in which their research proposal, if funded, would likely lead to a better understanding of a critical topic area), and (iii) it must be, in some important aspect, novel (i.e., it hasn't already been examined, documented, and resolved by someone else).	Weekly, student-led discussions on assigned readings from the peer-reviewed literature that supplement lecture material. Final exam/ research paper of 10-12 pages.	Knowledge and experience with theory of ecosystem ecology, methods available for quantifying ecosystem structure and function, and current areas of critical research needs.

NREM 682	Graduate level seminar course that explores the foundations of restoration ecology and the application of ecological theory to the practice of restoration. Application of restoration principles to restoring Hawaiian and other ecosystems are considered. Ecological restoration is the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed (SER, 2004). Restoration ecology, in turn, includes the theoretical principles underpinning the field and the application of these principles to the restoration of ecosystems (i.e., ecological restoration).	Through completion of NREM 682 students will: (i) understand the basic theoretical underpinnings of restoration ecology; (ii) understand how ecological principles are applied to restore ecological systems; and (iii) demonstrate comprehension, skill, and competency in the following: (1) the historical development and empirical foundations of restoration ecology; (2) relationship between “restoration ecology”, “ecological restoration”, and the “practice of restoration”, including the role and value of science in restoration; (3) use of reference ecosystems as endpoints for ecological restoration; (4) how a subset of ecological principles in soil science, ecosystem ecology, population biology, community ecology, etc. are used to restore ecosystems; (5) interrelation of ecological factors and processes governing ecosystem structure and function in disturbed and degraded ecosystems; and (6) current research efforts and future research needs in restoration ecology	Equal weight is given to each of 3 categories: (i) discussion leader, (ii) discussion participation, and (iii) final comprehensive examination. All students are expected to read required materials prior to class, and come prepared to critically analyze and discuss the topics/literature/case studies for that day.	Weekly, student-led discussions on assigned readings from the peer-reviewed literature that supplement lecture material.	Knowledge and experience with theory of restoration ecology, methods available for restoration of ecosystem structure and function, and current areas of critical research needs.

NREM 665	The study of salt marshes, mangroves, sea grass beds, and coral reefs with an emphasis on the formation, hydrology, biogeochemistry, and community dynamics of these systems. Management, policy, and restoration strategies will also be discussed.	Upon completion of this course students should: (1) Understand the historical changes and current status of coastal and wetland ecosystems, (2) Be able to discuss verbally and in writing the functions and values of coastal and wetland ecosystems, (3) Gain an in-depth knowledge of wetland and coastal ecosystems and their formation, hydrology, biogeochemistry, and community dynamics, (4) Know how to classify wetlands and deepwater habitats according to the Cowardin classification system, calculate a water budget, balance redox reactions, assess the status of wetlands, sea grass beds and coral reefs, (5) Be familiar with current issues in coastal and wetland management such as sea level rise, invasive species, eutrophication, coral bleaching, ecological restoration, etc., and (6) Be able to analyze resource problems for coastal and wetland ecosystems and suggest appropriate management strategies.	Students are assigned 3 take home problem sets in which they work with real data to perform calculations or use quantitative skills learned in class. Students also are required to read and discuss the strength and weakness of current scientific literature in the field of coastal ecology and management. A midterm exam is required of all students. Students can choose whether to take a final exam or do a final project (i.e. literature search, perform a GIS analysis, analyze data, or develop a model of coastal ecosystem dynamics). These projects are presented orally at the end of the semester as well as written up as a final paper.	Students are required to participate in small group and in class discussion of current scientific papers. Student who chose to do a final project are required to present their research to the class orally.	Students learn how to calculate a wetland water budget, and a wetland N budget with real world data. Students also learn have to balance redox reactions and classify wetland and deepwater habitats according to the Cowardin System that is currently used by federal agencies in the U.S. Students also learn to critically read and assess current scientific literature. Various optional field trips also introduce students to water quality and fish sampling, coral reefs, invasive species management, and ecosystem restoration on Oahu.

NREM 664	This course will introduce students to process-based modeling of watershed with emphasis on concepts, logical and mathematical sequence of watershed modeling, and current model applications. It deals with the characterization and simulation of small watershed systems including land and channel phase hydrologic processes and pollutant transport processes. Significant time will be given to the investigation of the structure, algorithm, and capabilities of current watershed computer models. The student will have an opportunity for "hands-on" use of some currently available watershed models, interpret and evaluate the model results in a scientific way, and will be expected to use computers extensively.	Through this course students can explore the role of scales in watershed modeling, can review current approaches for watershed modeling, and can acquire systematic knowledge of parameter analysis and model evaluation techniques and applications. Upon completing this course, students should be able to: (1) Critically evaluate the usefulness and suitability of a model for a given particular site; (2) Decide what type of input data required to be collected for a model; (3) Apply a model to meet stated objectives and a particular situation; (4) Modify certain parts of a model if required according to the needs; and (5) Be able to understand the advantages and disadvantages of watershed modeling.	The course consists of 1 lecture and 1 Laboratory session per week, and students are required to maintain significant class participation and Laboratory assignments/ Homework. A combined lecture-discussion method of presentation uses extensive input from the students. Students are required to write weekly critiques of scientific papers that deal with small watershed modeling, as well as to write critiques of the watershed models. Term project is also required where students can focus on a detailed study of a particular watershed computer model including oral presentation of the selected model to the class. Term project is intended for students to provide constructive criticism based on the concepts and knowledge learned from this course, which include a written report on the model, and documentation of an actual application of the model by the student, to a specified watershed.	Weekly, student-led discussions in the combined lecture-discussion based lecture and Laboratory sessions. Students are required to write and discuss critiques of published papers and the models. The course includes Laboratory assignments/ Homework and Two Exams. Term project report and oral presentation are required.	Knowledge and experience with theory and application of process-based modeling of watershed, with emphasis on concepts, logical and mathematical sequence of watershed modeling, and current model applications. Use of some currently available and widely used watershed models and their evaluation. Application and a detailed evaluation of a particular watershed computer model to address real watershed problems.

NREM 660	The course begins with an overview of the basics of soil physical properties. Then it covers the hydrologic processes in soil including water flow, solute movement and gaseous transport in the variably saturated (saturated/unsaturated) zones. Public domain packages (RETC and Rosetta) will be used to analyze and estimate soil hydraulic properties. A public domain numerical model HYDRUS-1D will be introduced and used in several practical and theoretical exercises. Students will have the opportunity to use these models to simulate problems of their interest.	Upon completing this course students will have an advanced understanding of the topic and the expertise to use numerical models as a research and teaching tool for simulating or predicting water flow, solute or pollutant movement and gaseous transport in the variably saturated (saturated/unsaturated) zones of the soil or porous media.	The course consists of 2 lectures per week and a total of 6 Laboratory sessions. Students are required to thoroughly analyze, present, and write the data for the reports of each laboratory. Data analyses require the use of spreadsheet software for data analysis, interpretation, and presentation. Reports should be adequately presented. Students are required to follow original research paper format for reports. Students are required to complete a research project during the course of the course where students can choose a field or a laboratory experiment and can also conduct a literature review or a modeling exercise using HYDRUS-1D or 2D. Students are required to prepare 1-2 page project proposals, first draft, and final version of manuscripts, and to perform 12 min oral presentation. Students are also allowed to choose any topic related to water flow and solute transport from given topics or topics of their own interests or related to your research.	The course consists of 2 lectures per week and a total of 6 Laboratory sessions. The course includes homework problems, reports of each laboratory, and three Exams. Reports of each laboratory are due 2 weeks after the date of the laboratory session. Students are required to complete a term paper of the research project and to prepare 1-2 page project proposals, first draft, and final version of manuscripts, and to perform 12 min oral presentation.	Knowledge and experience with theory and application of numerical modeling tools to apply for simulating water flow, solute movement and gaseous transport in the saturated (saturated/unsaturated) zones. Literature, data collection and analysis, field and laboratory training. Application and evaluation of numerical models to address real to water flow and solute transport related problems.

NREM 662	This course will provide students with a fundamental understanding of the hydrologic cycle, the interactions among the hydrosphere, atmosphere and land-use management (forest, agriculture and urban) effects on the amount, timing and quality of water resources. This course will develop the ability to quantify the magnitude of hydrologic entities in small watersheds. The student will have an opportunity for "hands-on" use of hydrologic analysis in watershed management such as rainfall, effective rainfall, canopy interception, evapotranspiration, infiltration, stream flow and hydrographs.	Upon completing this course students will have a fundamental understanding of watershed hydrology, and hydrologic analysis in watershed management such as rainfall, effective rainfall, canopy interception, evapotranspiration, infiltration, stream flow and hydrographs, particularly: (1) the rainfall-runoff-stream flow relationship; (2) hydrologic information to land use management and impact of different management practices on natural resources; and (3) impact of different watershed management on hydrology, water quality of the surface and groundwater resources, and flooding.	The course consists of 1 lecture and 1 Laboratory/field/homework per week, and students are required to attend and participate. Students are required to weekly discuss their reading assignments. Students are required to complete a research project during the course of the course where students can choose a field or a laboratory experiment. They can also conduct a literature review or a modeling exercise using one of the watershed models (WMS, N-SPECT, and AnnAGNPS). Students are allowed to choose any topic related to watershed hydrology or topics of their interests or related to their research. Students can also utilize publicly available data sets for analysis (e.g., USGS, NOAA, HI-DLNR, etc.)	The course consists of 1 lecture and 1 Laboratory/ field/homework per week. Labs/Homeworks and “Hands-on” include **w**atershed hydrologic measurement, data analysis, modeling and model application and evaluation. Students are required to complete a term paper of the research project and to prepare 1-2 page project proposals, first draft, and final version of manuscripts, and to perform 15 min oral presentation.	Fundamental knowledge and experience with theory and application of watershed hydrology. Application of hydrologic analysis in watershed management such as rainfall, effective rainfall, canopy interception, evapotranspiration, infiltration, stream flow and hydrographs. Literature, data collection and analysis, field and laboratory training. Through term paper, students can develop their investigative and analytical skills, and constructive criticism based on the concepts, application, and knowledge learned from this course on watershed hydrology.