CIHEAM
Centre International de Hautes Études Agronomiques Méditerranéennes

Environmental Management

Organized by

Mediterranean Agronomic Institute of Chania

Environmental Management

Scientific Coordinator : Dr Ioannis Manakos
MAI Coordinator : Mr Alkinoos NIKOLAÏDIS

The programme of Environmental Management focuses on the ever growing demand for highly specialized and effectively trained scientists to tackle significant environmental issues in today's natural environment, agro-environmental issues and land use functions. Graduates, professionals and specialists from the Mediterranean and Balkan region majoring in a compatible discipline and background knowledge on Environmental issues have the opportunity to specialize on:

- Geographical Information Systems and Remote Sensing, their application to Environmental Management and other problems related to Environment,
- Utilization of quantitative and decision support tools to environmental impact assessment within the environmental policy and legislative framework of the European Union.

In this context and according to CIHEAM's academic regulation, the postgraduate spesialisation programme (1st year) delivers the following educational sections:

- Geographic Information Systems and Spatial Statistics.
- Remote Sensing and Image Modelling.
- Ecology & Management of Environmental Resources.
- Integrated Environmental Analysis using GIS/RS.
- Environmental Impact Assessment, Planning and Management

The qualified second year graduates (Master of Science Degree canditates) pursue their research in an environment fully equipped with modern facilities and the most recently updated software. Research addresses spearhead topics supporting national and EU Environmental policies within an interdisciplinary international scientific network.

Already undertaken research concerns:

- Desertification Monitoring,
- Environmental Resource Management,
- Environmental Impact Assessment,
- Landscape Ecology,
- Soil Erosion Risk Assessment,
- Agricultural Practices Monitoring,
- Precision Agriculture,
- Forest Fire Risk Assessment
- Fire Behaviour Modelling & Effectiveness of Fire Retardants,
- Management of Mediterranean Ecosystems, and
- Regional and Rural Development

The scientific results of graduate studies are usually announced in International Conferences and/or published in World Renowned Journals.

Students successfully completing the two year study and research program are awarded the M.Sc. Degree.

Part 1
Post graduate specialisation programme

The programme is organized in 4 sections

Tools **ENGLISH, COMPUTERS**

It is devoted to the fundamentals of English grammar, oral communication and the development of academic writing skills. It is also devoted to the supportive tools for environmental analysis, such as microcomputers, computer networks, communication protocols and database management.

Section 1 **INTRODUCTION TO GEOINFORMATION TECHNOLOGIES**

Section I is devoted in introducing and to training the students to geoinformation technologies and the corresponding physical background necessary to tackle with the acquisition, processing, analyzing, and interpreting of spatial data and information.

Section 2 **REMOTE SENSING AND GEOGRAPHIC INFORMATION SYSTEMS ANALYSIS TECHNIQUES**

Section II is devoted in providing students hands-on experience and enhancing their skills to apply geoinformation techniques upon a wide variety of case studies. Students are confronted with case studies on soil, wildfires, rangelands, watershed, forest, agrosystems, landscapes and water.

Section 3 **ECOLOGY AND ENVIRONMENTAL RESOURCES**

Section III provides extended knowledge about Mediterranean ecosystems and deals with Soil and Water Resource Management, the Ecology and Management of the Environmental Resources and Agricultural Systems.

Section 4 **ENVIRONMENTAL ASSESSMENT, PLANNING AND MANAGEMENT**

Section IV takes into account aforementioned acquired knowledge, experience and skills and deals with Environmental Legislation, Process and Methods of Impact Assessment, Landscape Ecology and Environmental Modelling, Decision Support using GIS, Spatial Planning and Environmental Assessment, Quantitative Analysis of Mediterranean Ecosystems, as well as related Environmental and Natural Resource Economics.

TRAINING SEQUENCE

Tools
(4 ECTS)
October

ENGLISH, COMPUTERS
Unit 1 – Scientific English/ English TOEFL/ English TWE (3 ECTS)
Unit 2 – Information technologies and database management (1 ECTS)

Section 1
(15 ECTS)
October - November

INTRODUCTION TO GEOINFORMATION TECHNOLOGIES
Unit 1 – Statistics (3 ECTS)
Unit 2 – Spatial statistics – Theory (3 ECTS)
Unit 3 – Spatial statistics – Practice (3 ECTS)
Unit 4 – Remote sensing (3 ECTS)
Unit 5 – Geographic information systems (3 ECTS)

Section 2
(12 ECTS)
November - January

REMOTE SENSING AND GEOGRAPHIC INFORMATION SYSTEMS ANALYSIS TECHNIQUES
Unit 1 – GIS applications and digital image analysis (3 ECTS)
Unit 2 – Basic geodesy and digital photogrammetry (3 ECTS)
Unit 3 – Remote sensing applications (3 ECTS)
Unit 4 – Integrated GIS/RS caste studies (3 ECTS)

Section 3
(12 ECTS)
January - March

ECOLOGY AND ENVIRONMENTAL RESOURCES
Unit 1 – Mediterranean agricultural environments (3 ECTS)
Unit 2 – Management of grasslands and phryganic ecosystment (3 ECTS)
Unit 3 – Management of shrublands and forests (3 ECTS)
Unit 4 – Soil and water resource management (3 ECTS)

Section 4
(21 ECTS)
March - June

ENVIRONMENTAL ASSESSMENT, PLANNING AND MANAGEMENT
Unit 1 – Environmental legislation (3 ECTS)
Unit 2 – Process and methods of impact assessment (3 ECTS)
Unit 3 – Landscape ecology and environmental modelling (3 ECTS)
Unit 4 – Decision support using GIS (3 ECTS)
Unit 5 – Spatial planning and environmental assessment (3 ECTS)
Unit 6 – Quantitative analysis of mediterranean ecosystems (3 ECTS)
Unit 7 – Environmental and natural resource economics (3 ECTS)

Comprehensive oral or written examination (Modalities and dates)

During Introduction, participants attend classes on English TOEFL and Computers. They are also obliged to attend a 45-hour course in Scientific English, equally distributed during sections, and take a written examination.

Participants take written examinations or submit projects for every unit within one section in the exam week which is scheduled at the end of every section, each unit being independently graded. Written exams consist of a set of questions that require a concise answer. Some of the questions are multiple choices. Lengthy questions are avoided.

Participants have the option of retaking course examinations of their preference equivalent of 9 ECTS credits during a weeklong retake period. There is no retake examination period for the last section.

A comprehensive oral examination conducted by an Examination Board takes place at the end of the academic year, representing 15% of the total grade.

Analytical syllabus

Tools **ENGLISH, COMPUTERS**

Unit 1 – Scientific english/English TOEFL/English TWE
Note-taking skills in order to better understand lectures; the study of scientific texts and their development; terminology related to the students' chosen field; a review of the fundamentals of English grammar with a view to studying advanced grammar skills for the purposes of writing a M.Sc. thesis; development of academic writing skills; public speaking, communication skills and theme-related discussions based on the students' chosen field of study. The final grade is awarded on the basis of the following:

- examination marks (based on grammar and scientific texts);
- presentation marks (based on oral and written presentations of students' own work);
- participation in classwork and attendance; homework assignments.

Unit 2 – Information technologies and database management
Introduction to microcomputer architecture hardware and operating systems (DOS, WINDOWS). Scientific and productive applications run on personal computers. Hands–on experience. Networking and communication protocols. Type of data, information, scale of measurements, records and files, electronic data sheets, hierarchical databases, relational databases object oriented databases, knowledge databases, programming with MSAccess database.

Section 1 **INTRODUCTION TO GEOINFORMATION TECHNOLOGIES**

Unit 1 – Statistics
Basic terms and concepts in Statistics. Descriptive statistics:

- Measures of central tendency
- Measures of dispersion and variability
- Measures of shape or relative position

Inferential problem solving and statistics, estimation of the mean and the variance, confidence interval estimation, comparison of the means (t-test, one- and two-way ANOVA). Probabilities and distributions:

- Probabilistic and deterministic processes (basic terms and concepts)
- Binomial distribution
- Poisson distribution
- normal distribution
- x2, t and F distributions

Sampling (basic concepts):

- Populations and samples
- Types of probability sampling
- Basic concepts in estimation in sampling
- Confidence intervals and estimation
- Sample size selection

Traditional Hypothesis testing (inferential) and test selection:

- P-value or Prob-value Hypothesis testing
- One-sample difference of means test (small sample)
- One-sample difference of proportions test

Two-sample and matched-pairs (dependent-sample) difference tests:

- two-sample difference of means test
- two-sample difference of proportions test
- matched-pairs (dependent-sample) difference tests
- Three-or-more-sample difference tests, analysis of variance (ANOVA).

Goodness-of-fit and categorical difference tests:

- goodness-of-fit tests
- contingency analysis and tables
- x2 tests of independence

Statistical relationship between variables (linear regression and correlations).
Correlation, its nature and related issues:

- autocorrelation
- interval vs. ratio variables
- ordinal variables

Regression:

- the form and strength of relationship in bivariate regression
- residual or error analysis in bivariate regression
- inferential use of regression
- multiple regression

Unit 2 – Spatial statistics - Theory

Basic statistical concepts in geography (statistics and maps), the context of statistical techniques (with examples), characteristics and preparation of geographic data (selected dimensions, concepts and levels of measurement, classification methods, graphic procedures), geographic problem-solving situations and scenarios.
The differences between classical and spatial statistics through techniques which account for geographical position, with emphasis to the most common methods of data visualisation, exploration and modelling.
Spatial data and descriptive statistics:

- Spatial mean
- Spatial Measures of central tendency
- Spatial Measures of dispersion
- Locational issues

Probability mapping (see STATS1).
Spatial sampling (see STATS1), inference and applications:

- Spatial universes and populations
- Sampling fundamentals and strategies
- Sampling a continuous universe
    - Point sampling of a continuous population
    - Areal sampling of a continuous universe

Inferential spatial statistics and spatial pattern analysis (see also STATS1):

- Point pattern analysis
- area pattern analysis

Analysis of Area data:

- indices of segregation and isolation
- principal components analysis (PCA)
- correspondence analysis
- cluster analysis
- factor analysis
- discrete analysis

Statistical relationship between variables (see STATS1):

- correlation and types of variables (interval, ratio and ordinal variables):
    - autocorrelation and thumb rules, to visualize spatial dependence
    - map complexity
    - use of correlation indices in map comparison
- regression (see STATS1):
    - multivariate regression, extrapolation from the bivariate regression in STATS1

Statistical models and the Geographic Weights Matrix:

- evaluation criteria:
    - mean response estimation
    - variance estimation
    - spatial autoregressive parameter “rho” (ρ) estimation

Aggregation effects in georeferenced data:

- spatial dependency of spatial data analysis
- spatial dependence and the averaging process
- impact of the Modifiable Areal Unit Problem (MAUP) on spatial data
- approaches to solving the MAUP
- analyzing data from different scales

Spatial statistics for the analysis of variance:

- autoregressive (AR) response model

AR-based and conventional ANOVA

Unit 3 – Spatial statistics - Practice

Computer applications using S-PLUS, JMP, SPSS statistical software packages. As a follow-up to STATS1 and SPATIAL STATS, students acquire individualized hands-on experience in powerful computerized tools. Specifically, Statistical Analysis Software (SAS) is used in the following procedures by employing existing research data:

- Regression (Proc. REG) - simple and multiple residual analysis.
- ANOVA (Proc. ANOVA and Proc. GLM) - one-way (multiple comparisons) and two-way (with and without interaction) residual analysis.
- Principal components (Proc. PRINCOMP).
- Factor analysis (Proc. FACTOR).
- Cluster analysis (Proc. CLUSTER).

Unit 4 – Remote sensing

This course examines electromagnetic radiation and its interaction with the Earth's surface and atmosphere, basic radiative transfer theory, and the performance of passive (i.e. aerial photography, airborne and spaceborne scanner data) and active (i.e. Lidar and SAR imagery) imaging systems.
The course also focuses on aerial photo interpretation, digital image processing and a wide range of satellite and airborne remote sensing technologies (including interferometric synthetic aperture radar, and hyperspectral and thermal infrared imaging). Emphasis is placed on the extraction of quantitative and qualitative information from remote sensing data, the integration of remote sensing and GIS technologies, and the operational aspects of remote sensing.

Unit 5 – Geographic information systems

Basics of geographic data, nature of spatial data, uncertainty in the analysis of geographic phenomena, cartographic databases, informatic databases. Elements of the geographical space and their attributes - data collection, sampling, and encoding (graphic, non-graphic elements). Co-ordinate systems, map projections, and datums. DEM. Digital terrain models (interpolation, extrapolation - automatic contouring - Perspective viewing, analytical hill shading, aspect, slope). GIS components - Data I/O, editing, polygon overlays, Boolean operations, distance operators, map composer. Cartography - thematic map design, spatial data, layer structures, map reproduction. GIS design - data base design, sources of information, data organisation into layers, specifications and accuracy, system development and evaluation. Examples with laboratory assignments (construction of a map by hand, construction of a map using digitiser and computer, construction of DTM, automatic contouring, perspective view, analytical hill shading).

Section 2 REMOTE SENSING AND GEOGRAPHIC INFORMATION SYSTEMS ANALYSIS TECHNIQUES

Unit 1 – GIS applications and digital image analysis

Geographic Information Systems (GIS) is the technology component of the science of Geographic Information and Analysis (GIA). Obviously, training in GIS prerequisites a lot of practice, however this must be very well linked to a thorough background; because GIS is not just cartography as it is not blind use of software. Consequently, the GIS scientist will be asked not only to use individual GIS functions, not only to manage the scanner, the plotter and the GPS, but also to supply his/her research group with suggestions and integrated GIS solutions; he will be required to model in GIS. Moreover, it will be necessary to combine GIS skills with those in Remote Sensing and Digital Image Analysis in a fruitful way, because the international trend these days is to bridge the gap between Remote Sensing (RS), Digital Image Analysis (DIA) and GIS.

Based on the above conclusions and teaching experiences in GIS and Image analysis internationally during the last years, the approach of this weekly post-graduate course is to merge the GIS, RS and DIA fields in a homogenised output. The design of the course follows a triple of a fundamental, short but adequate theoretical background, an on-line demonstration and students' practice through exercises on a daily basis. This participative training is more than necessary for the student in order to get a good acquaintance with three of the biggest commercial software packages, i.e. 'ArcGIS' (a fusion of former 'ArcVew' and 'ArcInfo') by ESRI, 'ERDAS Imagine' by Leica Photogrammetry, and 'Definiens Developer' (former 'eCognition') by Definiens. By completing this course, a scrupulous student will be ready to take part in project development teams very soon.

The content of the course begins with the modules (1) 'Concepts in GIS', 'Data input and management', and 'Data display and cartography', where the student will learn how to build and organise a geo-database including vector or raster datasets, how to use peripherals and external devices, and how to create outputs using internationally-established metadata and stand ards. The modules (2) 'Concepts in digital image analysis', 'Image display, enhancement and interpretation', and 'Raster analysis' which follow, teach the student the principles and practice of displaying, processing and analysing image and grid raster data, such as satellite images, air photos, and digital terrain models. Then, the modules (3) 'Data exploration' and 'Vector analysis' provide the student with skills on how to use data attributes, relations, and conditions in order to create data subsets or to implement functions towards decision support. 'Image classification' and 'Introduction to Object-oriented analysis' are the modules (4) of the course where the student will learn how to derive thematic information from raster or vector datasets and apply transformations, thus bridging the gap of GIS and image analysis. A summary and the discussion of a GIS project complete the last day of the course (5). Overall evaluation is based on a combination of students' efficiency in the class (through daily exercises), oral examination in software use, written exams in theory and mini project development.

Unit 2 – Basic geodesy and digital photogrammetry

This course focuses on the extraction of high-quality topographic information from remote-sensing imagery, in particular on the generation of digital elevation models (DEMs) from stereo aerial photographs and satellite imagery. Material covered includes a review of relevant cartographic issues; the use of GPS; basic principles of photogrammetry, including analog and digital photogrammetry; photogrammetric applications; controls on image quality; preparatory image analysis; automated DEM extraction; post-processing and use of photogrammetrically-acquired data; orthorectification; and recent developments in interactive measurements based on 3-D visualisations of aerial photographs.

Unit 3 – Remote sensing applications

Photo-interpretation of aerial photographs or digital imagery for: land cover/use mapping, forest and forest fire management. Case studies include: the CORINE land cover, forest management using GIS and Remote Sensing, forest fire management at national and European level, landscape analysis.

Unit 4 – Integrated GIS/RS caste studies

Case studies on environmental management and decision support using GIS and Remote Sensing. Examples from the recent years include *urban expansion monitoring* and *forest fire mapping and post-fire monitoring*.

Section 3 ECOLOGY AND ENVIRONMENTAL RESOURCES

Unit 1 – Mediterranean agricultural environments

Review of typical Mediterranean cultivations and practices, landscape changes by grazing and the role of fire. Examples of agrobiodiversity including non-timber forest products. Environmental impacts of current practices, including erosion, soil salinization and compaction, nitrate pollution, pesticide misuse, greenhouse gas emissions, and desertification. Approaches to sustainable agriculture: organic farming, integrated pest management, water management. Introduction of new technologies: Precision agriculture. Policy and regulations to promote sustainable practices.

Unit 2 – Management of grasslands and phryganic ecosystems

Introduction to Mediterranean environment and its ecosystems. Spatial heterogeneity of grasslands and phryganic ecosystems. Pattern development and characterization. Ecological factors and processes involved. Diachronic land use and pattern changes and their implications to populations, communities and landscapes. Anthropogenic impacts on patterns and changes including grazing, fire, farming, reforestation, conservation measures and social-economic changes. Sustainable management of Mediterranean grasslands and phryganic ecosystems.

Unit 3 – Management of shrublands and forests

Features of Mediterranean shrublands and forest, vegetation zones, diversity, natural distribution of the forest, natural succession, climax communities. Problems for Forest land in Mediterranean region (wildfires, grazing drought). Resilience of Mediterranean shrub communities to fires. Adaptation (morphological, phenological and physiological) of Mediterranean species to environmental constraints, adaptations. Sustainable multiple use forestry, Criteria and indicators for sustainable management of forest. Silvicultural systems in Mediterranean area, clearcutting and selective cutting, intermediate treatments, coppice forest. Forest restoration, natural regeneration, reforestation, seeding and planting, site preparation, planting stock quality, transplanting stress and field performance

Unit 4 – Soil and water resource management

The course provides a solid training in general biology, physicochemistry, and ecology, techniques that are required to quantify environmental systems, management and planning skills and an understanding of environmental issues and policy formulation.

The course aims to attract people who are interested in environmental management, or who anticipate responsibility for environmental policy formation, or a role in environmental education. The course extends the professional expertise of people working in such fields as agriculture, community welfare, economics, education, engineering, forestry, planning, public health, political economy, science, and resource management.

The course covers the following issues:

- Foundations of environmental management
- Natural resources and ecosystem functioning
- Soil and water resources management at watershed level
- Environmental risk assessment
- Pollution and degradation of soil and water resources
- Soil and water resources management in protected areas
- Pollution control technology
- Environmental planning and site analysis using GIS and remote sensing techniques.

Section 4 ENVIRONMENTAL ASSESSMENT, PLANNING AND MANAGEMENT

Unit 1 – Environmental legislation

Historical background:

The relevance for international environmental law of the developments in the EU:

- Adoption of the main principles concerning environmental protection at a regional regime level.

EU system's mechanism of implementing and executing its legal rules: sources, institutions and treaty modifications concerning European environmental policy (adoption of sustainable development theory).

The objectives and principles of EU environmental law:

- The integration principle and its impact on other European policies, especially the exclusive ones.
- The precautionary (preventive action) principle and the EU legislation on environmental matters.
- Rectification at source and mechanism of remedies in the EU legal order.

Implementation and enforcement of environmental law in the national legal orders:

- Supremacy, direct effect, implied powers doctrine.
- The decision-making process based on qualified majority.
- The preference for directives and the particular problems caused by their application in the member states.
- The individual (persons and companies) as direct addressee of European legal rules.
- The role of the European Court of Justice in environmental matters.

Environmental impact assessment: a technique for implementing international and European environmental rules:

- The integration of environmental considerations into socio-economic development and decision-making process in view of satisfying the preventive principle.
- Directive 85/337/EEC (as amended).

Unit 2 – Process and methods of impact assessment

Participants on the course will be provided with background information on the process of EIA and SEA, and will be asked to conduct a landscape and visual impact assessment on real development with the aim of obtaining practical experience in conducting an Impact Assessment and a deapened understanding of the role of science in impact assessment.

The aims of the course are to:

- Provide an introduction to analytical methods relevant for environmental planning decisions (e.g. Environmental Impact Assessment, Strategic Environmental Assessment);
- To provide hands on experience of conducting essential components of EIA.
- Use case studies to demonstrate how they can be used in practice;
- Provide sufficient background and the procedure to enable the critical review of impact assessments
- Provide experience of working in project teams and the practical implications of working on decision support problems a) with clients as a consultant and b) as a Local authority decision maker reviewing evidence.

Unit 3 – Landscape ecology and environmental modeling

Landscape ecology is able to provide GIS technology with logically integrated data necessary for various documentation, inventory, evaluation and modeling purposes. At the present, the most geospatial landscape data is stored in different format, scale, resolution, projection and cartographic design according to common practice used in thematic mapping. Landscape models and modeling processes need geodata in an integrated form, both geometrically and logically (from thematic viewpoint) to reduce level of errors in consequent data processing. The problem is being progressively solved by the digital landscape model construction and utilizing.

During the course, students will receive general information about landscape models (classification of geospatial models) necessary for landscape evaluation and modeling (verbal, numerical, iconic models). As example of a new logical integrated geospatial database, the digital landscape model (DLM) will be presented. It consists of three multiparameter layers and DEM. Principles of construction and utilizing will be taught. Various applications of DLM will be presented (reforestation, erosion risk assessment, land use pattern optimizing, etc.).

Practical part of course will be focused on practical construction of DLM on local example and its application in 2D and 3D (animated) viewing, as well as in erosion risk evaluation, landscape suitability assessment, and agricultural optimizing measures modeling.

Unit 4 – Decision support using GIS

The course will present the techniques to integrate databases, remote sensing and GIS to develop spatial decision support systems (SDSS) for the sustainable use of environmental resources (natural and artificial). Sustainability means that the use and conservation of biodiversity, soil and water should not represent conflicting activities but complementary objectives to be jointly achieved in management practices.

The Course will present:

- a summary of GIS technology with particular emphasis to the map object oriented approach
- the idea of Knowledge databases based on fuzzy set theory,
- the concepts of Decision making,
- an introduction to Multicriteria Decision Analysis,
- the notion of Spatial Decision Support System with applications for optimal sitting

The course will be articulated in lectures and demonstration of case studies using Arcview GIS and IDRISI.

Unit 5 – Spatial planning and environmental assessment

The course includes three different parts, each addressing specific theory, methods and tools for environmental assessment, with special emphasis on issues and case studies related to spatial planning of urbanized areas. The background and the assignments are introduced and explained in a written course manual.

In the first part the principles and the process of Environmental Impact Assessment (EIA) and Strategic Environmental Assessment (SEA) will presented in an introduction lecture. Some selected chapters of books will be studied and specific methods and tools, especially for scoping and evaluation, will be dealt with in practical assignments. The assignments include the use of matrices, multicriteria techniques and GAM (goals achievement matrix).

The second part of the course focuses at the use of environmental standards and zoning, with examples from case studies in Europe. Also area-based approaches are introduced, such as the environmental matrix. The methodological strengths and weaknesses of these, and other methods will be discussed, and the potential applicability of these methods within the context of environmental planning in other countries.

The third part of the course focuses on a specific case study. The students will examine the study area with the ArcView DSS-tool STEPP (Strategic Tool for integrating Environmental aspects into Planning Processes). The objective is to identify the most important issues and impacts in the area (i.e. scoping) and describe its present environmental quality.

For a selected smaller area an environmental advice for the local authorities should be written for the future urban development of the area, including residential and/or industrial areas. Several spatial scenarios (alternatives) should be presented, together with an assessment of the environmental consequences of each alternative with STEPP. It should be made clear what the different options are the local authorities have with regard to the future development of the selected area from environmental point of view. The results will be described in a short report with maps

Unit 6 – Quantitative analysis of mediterranean ecosystems

Place of ecological studies in the plans of Mediterranean land management and development. Ecological perception levels for the vegetation-environment relationship. Ecosystematic approximation. The notion of ecological groups-indicators. Ecological profiles. Information theory. Mapping of Mediterranean terrestrial ecosystems (ecological mapping) for land-use planning. Site evaluation, typology and productivity. Dynamics of ecosystems. Problems of desertification. Field trip: The description of vegetation in the field. The nature and properties of vegetation data, Phytosociology and the Zurich-Montpellier School. Numerical classification and phytosociology. Application of ordination and classification techniques on the same set of vegetation data. Vegetation mapping as a basis for nature conservation and rational management. Vegetation-ecological monitoring for conservation and management purposes.

Unit 7 – Environmental and natural resource economics

This course is founded on the conviction that economic reasoning has much to offer (though it is not a panacea) in addressing these challenges. The course is designed to provide the basic conceptual grounding for the use of economics to inform decisions regarding the proper use of the environment and natural resources. Beginning with the concept of “sustainability”, the course develops a framework for an economic assessment of environmental problems including the notion of market failures, valuation of environmental resources and policy design issues associated with using alternative economic incentives and instruments. The last part of the course examines principles of the economically efficient management of non-depletable and depletable (i.e., fossil fuels) resources. A number of applied settings are used to demonstrate the principles taught in the course.

Part 2
Masters of Science Program

Research Project (9 month duration)

Requirement : 60 ECTS credits

Research Subject Areas
(topics generally available for Master of Science thesis):

- Desertification Monitoring,
- Environmental Resource Management,
- Environmental Impact Assessment,
- Landscape Ecology,
- Soil Erosion Risk Assessment,
- Agricultural Practices Monitoring,
- Precision Agriculture,
- Forest Fire Risk Assessment
- Fire Behaviour Modelling & Effectiveness of Fire Retardants,
- Management of Mediterranean Ecosystems, and
- Regional and Rural Development

INDICATIVE MASTER THESIS REALIZED WITHIN THE AREA:

Title**:** Investigation of socio-cultural issue in management and monitoring in Protected Areas: development of participation guidelines
Author: Fabrizia Buono, Environmentalist, Italy
Place of realization: MAICH
Thesis Director(s): Prof. Gerrit Carsjens, Dr. Kalliope Pediaditi

Title: Development of a Method to Assess the Risk of Water Pollution from Olive Mill Wastewater Using Geographic Information Systems: The Case Study of Keritis Watershed
Author: Anas Altartouri, Civil Engineer, Jordan
Place of realization: MAICH
Thesis Director(s): Prof. Nikolaos NIKOLAIDIS, Dr. Kalliope Pediaditi

Title: An Investigation of Transboundary EIA Implementation Between Greece and Albania; Barriers and Recommendations of Harmonization
Author: Anila Tahiri, Forester, Albania
Place of realization: MAICH
Thesis Director(s): Dr. Jeroen M. Schoorl, Dr. Kalliope Pediaditi, Mr. Panagiotis Nyktas

Title: Pasture inventory of Albania
Author: Edmond Pasho, Forester, Albania
Place of realization: MAICH
Thesis Director(s): Prof. V. Papanastasis

Title: Fuel The Soil Seed Bank of Mediterranean Temporary Ponds in Western Crete
Author: Christina Aponte, Environmental Scientist, Spain
Place of realization: MAICH
Thesis Director(s): Prof. V. Papanastasis, Mr. G. Kazakis

Title: Fuel Type Mapping Using High and Very Spatial Resolution Satellite Imagery
Author: Mihai Andrei Tanase, Forestry Engineer, Romania
Place of realization: MAICH
Thesis Director(s): Prof. I. Gitas, Dr. I. Manakos

Title: Open source web mapping portal with spatial analysis system.
Author: Salahaldin Juba, Computer Systems Engineer, Palestine
Place of realization: MAICH
Thesis Director(s): Prof. V. Samoladas, Dr. I. Manakos

Title: A GIS Developed for Risk Assessment of Stream Pollution Caused by Olive Oil Factories in Kolymvari, Crete.
Author: Ioannis Sarakiotis, Environmentalist, Greece
Place of realization: MAICH
Thesis Director(s): Prof. G. Zalidis, Mr. C. Karydas

Title: Risk Assessment of Soil Erosion Using Rusle Model in the Olive Cultivation Area of Kolymvari, Crete
Author: Tijana Sekuloska, Agronomist, FYROM
Place of realization: MAICH
Thesis Director(s): Prof. N. Silleos, Mr. C. Karydas

Title: Mapping of Afromontane Forests and Vegetation of Bioko Island (Equatorial Guinea) Using LANDSAT ETM + data
Author: Nicholas Alexander Kasimis,, B.A. Philosophy, USA/Greece
Place of realization: University of Cordoba, Spain
Thesis Director(s): Dr. Rafael navarro, Dr. Margarita Clemente

Title: The Development of an Object-oriented Classification Model for Burned Area Mapping Using ASTER imagery
Author: Anastasia Polychronaki, Forester, Greece
Place of realization: Aristotle University/ MAICh
Thesis Director(s): Dr. I. Gitas

Title: The Application of a Quantitative Analysis and a Decision Support System for Spatial Development in Central Costa Rica
Author: Georgiana Manole,, Economist, Romania
Place of realization: MAICh
Thesis Director(s): Prof. E. Feoli

Title: Foundation and Automatisation of Novel Pre-moisaicing Spectral Adjustment Technique Through ERDAS IMAGINE Software's Capabilities
Author: Stefana Popova, Landscape Architect, Bulgaria
Place of realization: MAICh
Thesis Director(s): Dr. I. Gitas

Title: Soil Properties Mapping Using Spatial Interpolation Techniques
Author: Irene Koutsogiannaki, Oceanographer, Greece
Place of realization: MAICh
Thesis Director(s): Dr. I. Gitas and Prof. N. Silleos

Title: Identifying and Inventorying Demographical Patterns, Integrating Census and Remotely Sensing Data. A Case Study: The City of Tirana in Albania
Author: Michalis Agorastakis, Planning and Urban Development Engineer, Greece
Place of realization: University of Thessaly / MAICh
Thesis Director(s): Prof. B. Kotzamanis and Invited Prof. M. N. Duquenne

Title: Vegetation Changes and Desertification Processes in Chott El Beida Algeria . An Approach Based on Remote Sensing Techniques and Multivariate Analysis.
Author: Mouna Khaznadar, Forester, Algeria
Place of realization: MAICh
Thesis Director(s): Prof. G.H. Griffiths and Dr. I.N. Vogiatzakis

Title: Industrial sites assessment and land suitability identification for industrial development in Riuli Venezia Giulia (Italy) by GIS and Remote Sensing techniques.
Author: Jawad Youssef, Forester, Syria
Place of realization: MAICh
Thesis Director(s): Prof. E. Feoli

Title: Use of radar for in-burned area mapping.
Author: Azniv Petrosyan, Computer Systems & Informatics Engineer , Armenia
Place of realization: MAICh
Thesis Director(s): Dr. I. Gitas

Title: Mapping of the quarries areas and monitoring their expansions on the Mediterranean island of Thasos over the period of fifteen years using LANDSAT data.
Author: JaneHilal, Chemist, Palestine
Place of realization: MAICh
Thesis Director(s): Dr. I. Gitas

Title: Geology survey of the Aegean islands.
Author: Eirini Papadaki, Geologist, Greece
Place of realization: University of the Aegean , Mytilini , Greece
Thesis Director(s): Prof. N. Sulakelis

Title: Development of an object-oriented model for mapping and differentiating rangeland types in western Crete using IKONOS imagery
Author: Crina Belean, Ecologist, Romania
Place of realization: MAICh
Thesis Director(s): Prof. V. Papanastasis and Dr. I. Gitas

Title: Impact of piospheric points on Mediterranean rangelands
Author: Rodolphe Ghossoub, Agriculturalist , Lebanon
Place of realization: Aristotle University of Thessaloniki , Greece
Thesis Director(s): Prof. V. Papanastasis

Title: Impact mapping of distribution of exotic plant species on the Akrotiri Peninsula (Crete , Greece)
Author: Graham Loewenthal, Earth Science Engineer , United Kingdom
Place of realization: MAICh
Thesis Director(s): Dr. P. Hulme and Dr. I. Gitas

Title: The development of an object-oriented classification model for burned area mapping on the Mediterranean island of Thasos using LANDSAT TM Imagery
Author: George Mitri, Environmentalist, Lebanon
Place of realization: MAICh
Thesis Director(s): Dr. I. Gitas

Title: Cooperation of Remote Sensing and GIS in Water Management and Land Use Planning in El-Hamam Area, Northern Coast of Egypt
Author: Mahmoud Ali Gaber Mohamed, Agriculturalist , Egypt
Place of realization: Cairo University – Fayoum Branch , Egypt
Thesis Director(s): Dr. F. Attia and Dr. M. Shendi

Title: Change detection in Chania region (Crete , Greece) using a time series of normalized remotely sensed data
Author: Ouerdia Hadjarab, Forester, Algeria
Place of realization: MAICh
Thesis Director(s): Prof. N. Silleos and Dr. I. Gitas

Title: Integrated Use of Geographic Information Systems and Remote Sensing for Landscape Analysis in Fiuli-Venezia Giulia, Italy
Author: Rachid Rekouane, Geotechnologist , Algeria
Place of realization: University of Trieste , Italy
Thesis Director(s): Prof. E. Feoli

Title: Burned Area and Fire Severity Mapping on yhe Mediterranean Island of Thasos Using LANDSAT TM and IKONOS Images
Author: Rishmawi Khaldoun, Biologist, Palestine
Place of realization: MAICh
Thesis Director(s): Dr. I. Gitas

Title: Postfire fuel and vegetation dynamics in phryganics in an ungrazed phryganic community of Crete (Greece)
Author: Farid Belbahir, Agronomist, Algeria
Place of realization: MAICH
Thesis Director(s): Dr. A. Dimitrakopoulos

Title: The use of satellite data for the derivation of a desertification risk index for the Lebanon , and for desertification monitoring in the Bekaa Valley
Author: Talar Sahsuvaroglou, Health Environmentalist, Turkey
Place of realization: MAICh
Thesis Director(s): Dr. I. Gitas

Title: Computer Assisted Discrimination of Homogeneous Morpho-Units on the Basis of the Application of Multivariate Statistical Methods to Local Gradients Setting of Crete Island
Author: Ayodele Oluwatomi Adediran, Geographer, Nigeria
Place of realization: MAICh
Thesis Director(s): Dr. I. Parcharidis and Dr. M. Poscolieri

Title: The ecology and management of Merja Zerga wetland in western Morocco
Author: Fouad Telmani, Forester, Morocco
Place of realization: MAICh
Thesis Director(s): Prof. N. Papageorgiou

REFERENCES OF THE MAIN ACADEMIC STAFF TEACHING WITHIN THE M.SC.

More than 50 invited lecturers from about 12 countries participate in each edition of the M.Sc. programme of which, 46% came from Research Centres, 42% from Higher Education Institutions, 7% from Private Companies and 5% from International Centres. Considering their implication in the programme, the following academic staff is taken as reference (Annex I includes further details of these lecturers):

CZECH REPUBLIC

Higher Education Institutions

- Jaromir KOLEJKA, Mendel University of Agriculture and Forestry in Brno, Czech Republic

GERMANY

Research Centres

- Steffen KUNTZ, Infoterra GmbH, Friedrichshafen, Germany

GREECE

Higher Education Institutions

- Vasilios PAPANASTASIS, Aristotle Univ., Thessaloniki, Greece
- Ioannis ISPIKOUDIS, Aristotle Univ., Thessaloniki, Greece
- Alexandros DIMITRAKOPOULOS, Aristotle Univ., Thessaloniki, Greece
- Nicholaos SILLEOS, Aristotle Univ., Thessaloniki, Greece
- George ZALIDIS, Aristotle Univ., Thessaloniki, Greece
- Kostantinos VOUVALIDES, Aristotle Univ., Thessaloniki, Greece
- Ioannis GITAS, Aristotle Univ., Thessaloniki, Greece
- Thomas ALEXANDRIDES, Aristotle Univ., Thessaloniki, Greece
- Chronis MOYSSIADIS, Aristotle Univ., Thessaloniki, Greece
- Konstantinos PERAKIS, Univ. of Thessalia, Volos, Greece
- Nikolaos SOULAKELIS, Univ. of Aegean, Mytilini, Greece
- Ioannis HATZOPOULOS, Univ. of Aegean, Mytilini, Greece
- Metaxia-Lina KOUSKOUNA, Univ. of Athens, Greece
- Gerassimos ARAPIS, Agricultural Univ. of Athens
- Vasilios TSIOUKAS, Democritus Univ. of Thrace
- Periklis DRAKOS, Univ. of Crete, Rethymnon, Crete, Greece
- Athanasios MIGDALAS, Technical Univ. of Crete, Chania, Greece
- George MARKAKIS, Technical Educ. Inst. of Heraklion, Crete, Greece
- Athanasios GERTSIS, American Farm School of Thessaloniki, Greece
- Ioannis MANAKOS, Mediterranean Agronomic Institute of Chania, Greece
- Efthimios AVGERINOS, Mediterranean Agronomic Institute of Chania, Greece
- Christos KARYDAS, Mediterranean Agronomic Institute of Chania, Greece
- Dimitris ZIANIS, Mediterrranean Agronomic Institute of Chania, Greece
- Kalliope PEDIADITI, Mediterranean Agronomic Institute of Chania, Greece
- Prof. Christos CHALKIAS, Harokopion University, Athens, Greece

Research Centres

- Dr. Kalliope RADOGLOU, Institute of Forest Research, Thessaloniki, Greece
- Dr. Georgia VALAORAS, Astrale Geie - Prospect C&S s.a., Life Monitoring Team, Athens, Greece
- Dr. Stamatis STAMATIADIS, GAIA Environmental Research & Education Center, Athens, Greece

ITALY

Higher Education Institutions

- Enrico FEOLI, University of Trieste, Italy
- Masimo DRAGAN, University of Trieste, Italy
- Andrea CAMIA, University of Torino, Italy

Research Centres

- Jesus SAN-MIGUEL-AYANZ, European Commission – DG Joint Research Centre, Ispra, Italy
- Paulo BARBOSA, European Commission – DG Joint Research Centre, Ispra, Italy

NETHERLANDS

Higher Education Institutions

- Gerrit CARSJENS, Wageningen Univ. The Netherlands

Research Centres

- Norman KERLE, International Institute for Geoinformation Science and Earth Observation (ITC), Enschede, The Netherlands

UNITED KINGDOM

Higher Education Institutions

- Seraphim ALVANIDES, Univ. of Newcastle, U.K.
- Dimitris BALLAS, Univ. of Sheffield, U.K.
- Mike KIRKBY, Univ. of Leeds, U.K.
- Gabriel AMABLE, Univ. of Cambridge, U.K.
- Stephen MACKIN, University of Surrey, U.K.

UNITED STATES

Higher Education Institutions

- Andy MAVROMOUSTAKOS, Univ. of Arcansas, USA

Research Centres

- Michael SHELBY, U.S. Environmental Protection Agency, Washington DC, USA