STUDY GUIDE
2005-2006

NATURAL RESOURCES
MANAGEMENT
**Natural Resources Management**

The world is rapidly changing. Growing population densities lead to scarcity of land and widespread changes in land use. Excessive human activities cause deforestation, overgrazing, depletion of land and water resources and a wide variety of environmental problems. To solve these problems and to make sure that future generations can enjoy the benefits of the earth's natural resources, better and more careful management of these resources is needed.

Sustainable development requires the implementation of ecologically sound, economically viable and socially acceptable resource management policies. To achieve this, planners, managers and researchers must understand the complexity of factors involved in the management of natural resources. They must collect and interpret the required data and work together with specialists from other disciplines.

A large amount of information is needed to make informed decisions about the planning and management of the use of land. The only practical way to store, manipulate and access this information is through the use of computerised databases. The Natural Resources Management educational programme provides knowledge and technical skills needed for the collection, interpretation and management of spatial information, using remote sensing and geographic information systems, to support planning and decision-making processes.

**Master and MSc course objectives**

ITC offers two types of degrees within the Natural Resources Management programme: a 12 months Master (M) degree, and an 18 months Master of Science (MSc) degree.

The Master course aims at professionals who, individually or as members of a team, contribute to information generation for improved planning and decision-making. Graduates typically work as project leaders or as high-level technical support to projects. The course is designed to increase the student’s operational knowledge and technical skills needed to analyse problems and identify and structure relevant information. Participants learn how to manage projects and to work in a multidisciplinary team to solve practical problems in Natural Resources Management (NRM).

On completion of the Master course, participants are able to:

- Apply conceptual and operational knowledge to design and manage processes to solve a problem encountered in professional NRM practice.
- Apply appropriate methods for spatial data acquisition, verification and quality control
- Use GI science and earth observation technology to generate, analyse and display spatial data
- Select and apply relevant and appropriate methods and models for data analysis and problem solving in NRM
- Work in multi-disciplinary teams to contribute to decision making in NRM.

The course includes fixed course work and elective modules, followed by a Group Project (including fieldwork) and an Individual Final Assignment. Successful completion of the course leads to the degree of Master in 'Geo-Information Science and Earth Observation' in one of the offered specialisations.

The MSc course aims at individuals with an interest in building up critical understanding and competence in applied research. It emphasises the strengthening of academic research skills and culminates in the execution of an independent research project.

On completion of the MSc course, participants are able to:

- Analyse a problem encountered in NRM practice and develop an appropriate method to study and/or solve the problem
- Apply appropriate methods for spatial data acquisition, verification and quality control
- Use GI science and earth observation technology to generate, integrate, analyse and display spatial data
- Evaluate and apply relevant and appropriate methods and models for data analysis and problem solving in NRM.
• Apply research skills to formulate and carry out an independent research project
• Communicate and defend findings of this research work.

The MSc programme includes fixed course work, research training and elective modules, followed by an individual research project (usually including fieldwork) resulting in an MSc. thesis. Successful completion of the course leads to the degree of Master of Science in 'Geo-Information Science and Earth Observation' in one of the offered specialisations.

**General Outline**
The programme consists of a number of modules. Each module lasts three weeks and comprises theoretical lectures, workshops and practical assignments.

The first five *programme modules* are common to all NRM programme participants. These five modules prepare participants for a role as natural resource geo-information specialist, working at the interface of natural resources management, natural resource data acquisition & analysis and geo-information technology. Students master the principles of GIS, remote sensing and information technology applied to NRM.

During the *specialisation* modules, participants develop expert knowledge and skills in the selected field of specialisation. In addition, the role and contribution of different fields of expertise in the NRM process are emphasised.

**NRM Specialisations**

**Planning and Co-ordination in Natural Resource Management (PCNRM)**
Decision-makers in natural resource management seek solutions that satisfy the varied interests of the different parties involved. The specialisation "Planning and Co-ordination in Natural Resource Management" addresses the co-ordination and reconciliation of the diverse interests of the stakeholders in natural resource management. Within this focus the specialisation emphasises the application of geoinformation in planning and decision-making processes for sustainable NRM.

Therefore the specialisation block within the programme will deal with subjects such as Concepts of Planning and Decision-making Processes in NRM, Problem Identification, Analysis and Formulation, Stakeholder Analysis, the Use of Indicators, Socio-economic Data Collection, Design of Alternative Solutions or Scenarios, and Multi-criteria Evaluation Techniques to Select from Alternatives.

**Sustainable Agriculture (SA)**
Materials to meet basic human needs, such as food, fuel, fibre and shelter, are obtained through agricultural land use. Land uses change continually, and their impacts on the resource base are adjusted continually in response to the changing demands of the growing population.

Management of natural resources is the essence of land use. Its impact may be undesired, e.g. because of induced erosion, pollution or climate change. This affects future production possibilities and threatens bio-diversity and habitats.

The survey and study of agricultural land uses, their sustainability and their impacts on the environment are the core subjects of the Sustainable Agriculture (SA) specialisation. Modern Remote Sensing techniques and Geographical Information Systems (GIS) will be used to collect and map, in a statistically sound way, geo-referenced information to support (multi-sectoral) Land Use Planning.

At the end of the course, you are an agricultural system expert who can use RS and GIS products for surveying, mapping and modelling agricultural systems and who is able to recommend practical interventions to client organisations.
**Geo-information for Biodiversity Conservation (BioCon)**

Biodiversity is a major concern worldwide. Comprehensive data sets on biodiversity are an important requisite for policy-making and management purposes. Decision-making processes from the local to the global level are increasingly demanding information about spatial and temporal dynamics indicative of biodiversity status and changes over time. This specialisation aims to train participants in techniques to acquire and analyse spatial information for the management of natural ecosystems and biological diversity. The spatial information focuses on ecological processes in rangelands, woodlands, forests and wetlands.

At the end of the course, you are an ecosystem expert who can use RS and GIS products for surveying, mapping and modelling ecosystems and is able to recommend practical interventions to client organisations.

**Forestry for Sustainable Development (FSD)**

Forests, woodlands and trees in rural areas, provide a wide range of ecological, economic and social benefits and in this way play an important role in rural land use systems and rural livelihoods throughout the humid and dry tropics. In many countries, however, growing populations with their increasing demand for agricultural land and increasing demand for tree products are causing deforestation and degradation of these resources. This pressure on the forests, woodlands and trees in rural areas increasingly calls for their sound utilisation and management in order to safeguard both their continued existence as well as their continued productivity.

The Forestry for Sustainable Development specialisation emphasises the place and functions of forests and trees outside the forest and the contribution these resources make to sustainable development. It does so from several different perspectives, including traditional forest management and community forestry, and emphasises that there is synergy rather than conflict between these different approaches to forestry and that forests and trees outside forests are complementary to each other rather than separate entities.

The specialisation focuses on well established as well as (relatively) new forestry application domains, such as bio-diversity conservation, arresting deforestation and forest rehabilitation, criteria and indicators for sustainable forest and tree resources management, and carbon sequestration.

At the end of the course, you are a forest and tree resources management expert who can use RS and GIS products for mapping, assessment and modelling of forestry based systems and who is able to recommend practical management interventions to client organisations.

**Soil Information Systems for Sustainable Land Management (SISLM)**

Reliable and appropriate information on soil resources plays an important role in multidisciplinary studies in support of land use planning and decision making for natural resources and environmental management.

Information on soil resources varies widely in quality, quantity and form. Often information on the nature and properties of soils and on their spatial distribution is not available, or difficult to access and mobilise. At the same time soil information is increasingly required to answer questions about the nature and causes of land degradation, including accelerated soil erosion, and about the consequences of land management alternatives.

With the changing demands for soil information also the requirements to soil information specialists are changing. They increasingly are becoming client-oriented providers of soil geo-information and related land resource data that natural resource managers actually require for decision making.

The specialisation ‘Soil Information for Sustainable Land Management’ addresses the increasing need to improve user access to geo-information on soils and related land resources. The course is intended to develop expert knowledge and skills in soil geography and in the use of modern techniques of remote sensing, databases and geographic information systems for land resource assessment and modelling. Specific attention is given to the modelling of spatial variation of soil properties, the construction and use of
soil geographical databases, automated landscape analysis, soil survey interpretation and land resource evaluation, land degradation assessment, mapping and monitoring and environmental soil science.

**Environmental System Analysis and Management (ESAM)**

Environmental management aims at sustainable use of renewable resources, while preserving the quality of life and our environment. It identifies the problems arising from the interaction of people with their environment.

The Environmental System Analysis and Management specialisation deals with the application of RS and GIS techniques for environmental management in terrestrial ecosystems. Ecosystems are complex systems, with feedback mechanisms and the ability of self-organisation. One of the ways to simplify and structure such complex and dynamic systems is to apply modelling techniques and scenario analysis. Ecosystem models attempt to capture the effects of changes in land use on the abiotic and biotic environment. Natural ecosystem models describe the development of vegetation and animals in relation to abiotic conditions and management. In agro-ecosystem models the effects of natural and human influences on agricultural and pastoral systems are illustrated.

At the end of this course you will be able to use remote sensing, GIS and decision support systems for mapping, monitoring and assessment of the environment, impact studies and environmental management. In the course particular emphasis will be on novel techniques for image classification and GIS modelling. Attention also will be given to the modelling of time dependant processes.

**Electives**

A series of elective modules enables participants to compose an optimal study programme directed to individual training needs. Electives are freely chosen from the ITC electives on offer.

**Group project (Master)**

Following the specialisation and elective modules, participants take part in a group project. The project demonstrates the role and contribution of different fields of expertise in a real world case of NRM. During a fieldwork period of several weeks, participants practise field techniques and implement strategies for natural resource data acquisition and analysis using remote sensing and GIS. Emphasis is placed on working in teams and on information delivery to planners and decision makers.

**Individual Final Assignment (Master):**

Towards the end of the course, each Master participant undertakes an Individual Final Assignment (IFA), tailored to his or her particular situation and interests. Participants may have data and other material from their home country for this purpose, or they may use data collected during the group project.

**MSc Research training and thesis**

Following the first 10 modules, common to all participants in the NRM programme, the MSc programme continues with research training and preparation of a research proposal. During the MSc research, emphasis is placed on problem definition, method selection, data acquisition, analysis and thesis writing. An external examiner will be part of the degree assessment board.

**Management and organisation of the NRM programme**

Management and organization of the programme is the responsibility of the Programme Director (PD). Programme Directors are responsible for the implementation of ITC’s education programmes. This includes approval of structure and contents of the modules of the course. Furthermore, Programme Directors deal with matters arising prior and during the course, such as selection of candidates, administration and logistics of the course, and fieldwork. Programme Directors also implement quality assurance measures, and approve IFA topics for the PM and thesis topics for the M.Sc. courses. The Programme Director is authorized by and accountable to the Head Education.

The Programme Director is assisted in all matters related to implementation of the course by a Programme Implementation Unit (PIU). The PIU consists of module coordinators and
study advisors. Assessment of student performance is carried out by the PD, with assistance from the PIU. Module coordinators are responsible for management and execution of the individual modules, under the overall supervision of the Programme Director. The study advisors are contact persons for students from a particular specialisation within the NRM Programme.

Each programme is monitored by a Programme Board (PB). The Programme Boards consist of professors and associate professors of scientific departments, primarily involved in the programme. The Programme Board advises the Rector of ITC about the quality of a programme and advises the Programme Director on content and relevance of the programme. Furthermore, the Programme Board acts as the Degree Assessment Board.

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<tr>
<th>Programme Management</th>
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<tr>
<td>Dr. Michael Weir (Programme Director)</td>
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<td>Ms. Ceciel Wolters (secretary)</td>
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<tr>
<td>V. Venus</td>
<td>SA</td>
<td>4-134</td>
<td>549</td>
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<tr>
<td>Dr. A. Farshad</td>
<td>SISLM</td>
<td>4-037</td>
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<tr>
<td>Ms. Dr. I. van Duren</td>
<td>ESAM</td>
<td>4-137</td>
<td>313</td>
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<tr>
<td>Ir. M.F. Gelens</td>
<td>FSD</td>
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<td><strong>Drs. E. Westinga</strong></td>
<td><strong>BioCon</strong></td>
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<td>Dr. D. van der Zee</td>
<td><strong>PCNRM</strong></td>
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<tr>
<td>Mr. J. Duim (technical assistant)</td>
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<tr>
<td>Mr. A.S. Masselink (technical assistant)</td>
<td>4-126</td>
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<tr>
<td>G.H.M. Leppink (computer cluster manager)</td>
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**Programme Board**

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<tr>
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<tr>
<td>Prof. Dr. A. de Gier (chairman)</td>
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<td>Prof. Dr. A. Stein</td>
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<td>Dr. D. Rossiter</td>
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<td>Prof. Dr. A.K. Skidmore</td>
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<td>Dr. M.K. McCall</td>
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## Programme Natural Resources Management

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<th>Module</th>
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<tr>
<td><strong>Programme modules</strong></td>
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<tr>
<td>Module 1</td>
<td>Introduction to Natural Resources Management</td>
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<tr>
<td>Module 2-3-4</td>
<td>Principles and Applications of GIS and Remote Sensing</td>
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<tr>
<td>Module 5</td>
<td>Geographical data as a source of information for NRM</td>
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<td><strong>Specialisation Modules</strong></td>
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<td><strong>Forestry for Sustainable Development (FSD)</strong></td>
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<tr>
<td>Module 6</td>
<td>Forestry and development: perspective and approaches</td>
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<td>Module 7</td>
<td>Remote Sensing and GIS for forest and tree resources management</td>
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<td>Module 8</td>
<td>Spatial analysis for forest and tree resource management</td>
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<td>Module 6</td>
<td>Sustainable Agriculture and Geo-information systems: measuring the immeasurable</td>
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<td>Module 7</td>
<td>Land Use Planning</td>
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<td>Module 8</td>
<td>Quantifying Production Levels at regional Scale in Support Food Security</td>
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<td>Module 7</td>
<td>Spatial Ecological modelling for Biodiversity Conservation</td>
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<td>Module 6</td>
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<td>Module 7</td>
<td>Ecosystem Modelling and Scenario Development for Environmental planning (rangelands and tropical forest management)</td>
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<td>Module 8</td>
<td>Spatial Decision Support Systems (SDSS) for Natural Resource Assessment and Environmental Impact Assessment.</td>
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<td>Module 11+12 M</td>
<td>Group Project</td>
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<td>Module 11 MSc</td>
<td>MSc Research Concepts and Skills</td>
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<td>Modules 12-13 MSc</td>
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<td>Module 15 MSc</td>
<td>Fieldwork Preparation</td>
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<tr>
<td>Module 16-23 MSc</td>
<td>MSc Research and Thesis</td>
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**Introduction to Natural Resources Management**

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<th>Module 1</th>
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<tr>
<td>Start: 3-10-05</td>
<td>Dr. F. Corsi</td>
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<td>End : 21-10-05</td>
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**Master/MSc**

**Introduction**

This module is the common start of all specialisations in the Master and Master of Science (MSc) courses in the Natural Resources Management (NRM) Programme. The module has a multi-disciplinary focus which challenges the participants to develop a common basis for the assessment of the multi-actor, multi-purpose and multi-disciplinary nature of NRM, thus recognizing the complexity and conflicts involved in NRM issues. This is achieved through the sharing of the professional background of the participants and their functions in relation to the tasks and processes of NRM. The concepts derived from the individual experiences are then further developed into a more general framework.

Particular care is given to highlighting the importance of geo-spatial data in the NRM processes. Participants are introduced to a selection of concepts, techniques and tools relevant to working with spatial information for natural resource management, both in the office and in the field. This introduction develops analytical reasoning and critical thinking when working with geographical data and products in the coming courses dealing, more in depth, with Remote Sensing and GIS technology.

**Contents**

The module covers the following topics:

- Introduction to the module
- Natural resources and natural resource management
- Actors and objectives in natural resources management
- Conflicts and participation in NRM problem situations
- Problem Structuring in NRM
- Case of multi-sector NRM planning in the Netherlands
- Introduction to disciplinary approaches and information requirements in NRM conflict situations
- Skills in Information sourcing and Presentation
- Basic concepts of geo-data processing
- Map reading and map measurement
- Positioning and navigation in the field

**Objectives**

Upon completion of the module, participants will be able to:

- To define Natural Resource Management and explain their own professional contribution to it.
- To outline the complex nature of Natural Resource Management and the major issues involved.
- To describe the role of sustainable development and Natural Resource Management
- To justify the need for multi-stakeholder approaches in Natural Resource Management.
- To outline the principles/approaches of collaborative Natural Resource Management.
- To apply some relevant planning and management tools for Natural Resource Management.
- To describe geo-spatial information requirements in Natural Resource Management.
- To explain the links between the NRM concepts and the topics developed in the modules that follow.
- To describe the basic concepts of geo-information handling and processing.
Elements of the educational approach:

The educational approach is based on the principles of experience-based learning and adult education.

This is done through reflecting upon the professional context of the participants’ functions in relation to the tasks and processes of Natural Resource Management. In line with the aim of the module, participants practice a multi-disciplinary teamwork approach.

The module is characterised by short presentations, individual and group exercises, “hands-on” learning, games and role play, video presentations, and field exercise. Participants are stimulated to contribute to an interactive learning environment.

Prerequisites
Not applicable

Recommended Knowledge
Basic computer knowledge

Hardware and software requirements
Personal productivity software tools, ArcGIS.

Teaching Materials
Required: Users’ guide to the NRM module 1; other hand-outs

Allocated time per teaching / learning method

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Time (in # of hours) allocated per major method:

L lecture,
SP supervised practical,
GA group assignment (e.g. workshop, project),
IA individual assignment (including Thesis, IFA),
S self study (incl. unsupervised practicals),
O overhead (e.g. QH, exam, opening)

Assessment
Participants will have to satisfactorily complete the various assignments given during the module. Participants will have to demonstrate that they can perform satisfactorily in an inter-disciplinary group work preparation, development of materials, and presentation.
Introduction
These modules introduce the principal concepts and techniques of geographical information systems (GIS) and remote sensing (RS). The modules consist of three interrelated parts: a theoretical part which focuses on the concepts, a practical part which aims at developing hands-on skills in using software tools, and, an application oriented part in which participants learn how to design and carry out sequential data processing steps for solving a typical application problem in natural resources management.

The concepts and techniques introduced in these modules will be further elaborated during subsequent modules of the programme.

Contents
The modules cover the following topics:

GIS and RS principles
- Geographic information and spatial data types
- Spatial data entry and preparation
- Spatial data analysis
- The electromagnetic spectrum
- RS Sensors and platforms
- Geometric aspects of remotely sensed data
- Image enhancement and visualisation
- Image classification and interpretation
- Spatial data visualisation
- Quality assessment of spatial data

GIS/RS applications in NRM
- RS data interpretation for land resource inventory
- RS and GIS for land resource change analysis
- GIS tools for landscape analysis

Objectives
The aim of these modules is to learn how to generate information about the earth from remote sensing and data stored in geographic information systems.

At the end of the core modules participants will be able to:

1. Explain the principles and use the vocabulary of RS and GIS.
- Describe the nature of geographic phenomena and their representation in the context of geo-informatics;
- Outline the principal data models for spatial and non-spatial data used in GIS databases;
- Outline the main components of a GIS and their functions;
- Explain the relationship between spatial data and coordinate systems;
- Outline the main spatial data analysis functions;
- Explain the role of RS in GIS;
- Describe the physical background of remote sensing and compare the main platforms and sensor systems;
- Explain the main digital image processing procedures;
- Describe the common methods of image analysis;
- Outline the principal rules for cartographic visualisation;
• Describe aspects of data quality and how various stages of spatial data handling affect it.

2. Carry out basic RS/GIS operations
• Carry out basic data preparation, geo-referencing and data entry into a GIS;
• Perform basic manipulation, analysis and visualisation operations using a GIS;
• Perform basic image processing techniques;
• Carry out a visual interpretation of an AP stereo pair and a satellite image;
• Apply basic data quality assessment procedures.

3. Apply appropriate RS/GIS methods for problem solving
• Understand the capabilities, uses and limitations of GIS and RS for geo-information production in a NRM context;
• Design and carry out sequential data processing steps for solving a typical application problem;
• Evaluate the results of data processing;
• Be aware of organisational issues of GIS development and implementation.

Prerequisites
Not Applicable

Recommended Knowledge
Basic computer skills

Hardware and software requirements
Standard network connected PC; Software: ERDAS and ArcGIS.

Teaching Materials
Principles of GIS ITC textbook and Principles of Remote Sensing ITC

Allocated time per teaching / learning method

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Legend:
L lecture,
SP supervised practical,
GA group assignment (e.g. workshop, project),
IA individual assignment (including Thesis, IFA),
S self study (incl. unsupervised practicals),
O overhead (e.g. QH, exam, opening)

Assessment
Form:
• Written closed book examination. Weight 1 module.
• Submitted results of selected exercises and assignments (weight: two modules).
Introduction
Geographical data become meaningful for NRM if they provide useful information. Modules 2, 3 and 4 dealt mainly with the handling of geographical data and with cartographic visualization techniques. This module focuses on the analysis and interpretation of geographical data to provide proper information for NRM. Relevant statistical techniques are used to extract and analyze information from geographical data. These analytical results can only be understood if they are accompanied by a correct interpretation and if the results and conclusions are properly reported and presented. At the end of the first of five modules participants will be able to describe spatially a NRM problem using RS&GIS techniques by integrating data from multiple sources and of multiple formats.

Contents
- From geographical data to information for NRM
- Looking at data - exploratory data analysis
- Producing data from various sources and formats
- Data obtained through sampling
- Statistics and cartographic visualisation
- Descriptive and inferential statistics
- Validity and reliability of final results
- Proper reporting of results and conclusions

Lectures and exercises in the module will be illustrated with cases from different disciplines. Participants will be given a problem-oriented assignment to demonstrate their skills in extracting information from geographical data.

Objectives
Upon completion of this module students should be able to:
- Translate a NRM problem into data and data-processing and analytical tools required to provide information
- Extract and integrate spatial and non-spatial data from multiple sources and multiple formats
- Explore, analyze and interpret information contained in geographical data
- Utilize descriptive and inferential statistical techniques as an analytical tool
- Assess the validity and reliability of analytical results
- Report and discuss the results of the analysis

Prerequisites
Completion of the modules 1, 2, 3 and 4 of the NRM educational programme

Recommended Knowledge
Basic skills in mathematics

Hardware and software requirements
Personal computers with access to printing facilities, ILWIS software, spreadsheet software (Excel); ArcGIS, ERDAS
Teaching Materials
Handouts and Web-references.

Allocated time per teaching / learning method

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Time (in # of hours) allocated per major method:
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IA individual assignment (including Thesis, IFA),
S self study (incl. unsupervised practicals),
O overhead (e.g. QH, exam, opening)

Assessment
Participants will be assessed on an assignment to be completed in pairs.
Introduction
This module addresses current concepts, approaches and major issues in forestry for sustainable development. It deals with current status, place and function of forest and tree resources (globally and locally), rural livelihoods, stakeholder participation, institutional change, carbon sequestration, bio-diversity and soil/water conservation, criteria & indicators for sustainable forest and tree management, and forest and tree resources degradation and rehabilitation.

Contents
The module examines the contribution of forestry to sustainable development from several different perspectives, including `traditional’ forestry & ‘community’ forestry.

The module demonstrates that there is synergy rather than conflict between these two different approaches to forestry and in this respect places particular emphasis on the identification of the different actors or stakeholders at different levels that play a role in forestry for sustainable development and on how they interact with each other in given institutional settings.

Within the larger context described above, the module explicitly distinguishes between `tree resources inside forests’ (TRIF) and `tree resources outside forests’ (TROF) and shows that these are complementary to each other rather than separate entities.

Using several different case-study settings, the module also explores the application of RS/GIS technology for the spatio-temporal assessment and analysis of processes of TRIF and TROF decline and development vis-a-vis changing institutional settings and livelihood strategies of rural people.

Objectives
Upon completion of this module students should be able to:

- Describe the role of forests and trees in sustainable development in general and natural resources management and peoples livelihoods in particular,
- Identify the different groups of people (actors or stakeholders) who interact in forestry for sustainable development & indicate their roles in policy formulation, planning and management,
- Describe current key issues in forest and tree resources management at various (i.e. ‘global’ as well as ‘non-global’ (i.e. national, sub-national, district, community)) levels,
- Critically assess the potential usefulness of RS/GIS applications to support forest and tree resources policy formulation, planning and management.

Prerequisites
NRM modules 2-5.

Recommended Knowledge
Not applicable

Hardware and software requirements
ERDAS, ArcGIS
Teaching Materials
Handouts and other reading material to be distributed by the lecturers.

Allocated time per teaching / learning method

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O overhead (e.g. QH, exam, opening)

Assessment
A written examination with questions from all given subjects.
**Remote Sensing and GIS for forest and tree resource management**

<table>
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<th>Module 7</th>
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<td>Start: 13-2-06</td>
<td>Ir. L.M. van Leeuwen</td>
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<tr>
<td>End: 3-3-06</td>
<td>Forestry for Sustainable Development M06-NRM-109</td>
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**Introduction**

This module concentrates on the use of remote sensing and GIS as tools used in support of forest and tree resources management.

This module deals specifically with the technical aspects of data and information acquisition, storage, analysis and presentation. It thereby focusses both on forest resources as well as tree resources outside forests.

**Contents**

Identification of data needs and exploration of existing data and sources:
- Analysis of forest- and agro-forest ecosystems,
- Spatial data & information requirements for management of these ecosystems,
- Principles of data quality and standardisation

Concepts of database design and organisational aspects of developing and maintaining spatial databases,

Techniques to collect new data:
- Sampling design for field data collection,
- Participatory techniques for local level spatial data acquisition,
- Use of mobile GIS for spatial data acquisition,

Techniques to process new data:
- Specific exercises on: assessment of forest; assessment of tree resources outside forests.

**Objectives**

Upon completion of this module students should be able to:
- Identify and use relevant applications of remote sensing and GIS to support forestry for sustainable development in the context of management, planning, and policy formulation,
- Identify spatial data & information requirements for different forest and tree resource management activities and translate these requirements into specifications for the design, development and maintenance of a spatial database,
- Apply selected procedures for the collection, processing and analysis of remotely sensed and other spatial data.

**Prerequisites**

NRM modules 2-5 & NRM/FSD module 6.

**Recommended Knowledge**

Not applicable

**Hardware and software requirements**

Computers with ArcGIS, ERDAS, FCD Mapper & ArcPad software, I-Paq and GPS receivers.

**Teaching Materials**

Lecture notes and other reading material to be distributed by the lecturers.
Allocated time per teaching / learning method

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IA individual assignment (including Thesis, IFA),
S self study (incl. unsupervised practicals),
O overhead (e.g. QH, exam, opening)

Assessment
Individual & group assignments and a short written examination with questions from all given subjects.
Spatial analysis for forest and tree resource management

**Module 8**
Start: 6-3-06  
End: 24-3-06  
Co-ordinating staff  
Dr. P. E. van Laake  
Master/MSc Forestry for Sustainable Development  
M06-NRM-113

**Introduction**
Effective management of forest and tree resources, in the broader context of regional and national policies and planning, requires a detailed analysis of those resources in relation to other sources of information. These other sources include, among others, information on biophysical parameters (e.g. DEM, soils, hydrology), socio-economic data (e.g. population, infrastructure), and development plans / economic policy (e.g. timber production, agriculture).

This module will introduce GIS-based spatial analysis techniques in support of forest and tree resource management, with special reference to the sustainable management of forest and tree resources.

**Contents**
Several spatial techniques will be introduced, such as spatial overlays, constraints analysis, and spatial optimization for forest and tree resource management and planning. These techniques build on the techniques introduced in module NRM/FSD 7.

This will be followed by the introduction and use of techniques to quantify the production of specific “products” from the resource base, the so-called ecosystem services. These techniques are characterized by using a limited number of variables of a biophysical and socio-economic nature, upon which a number of physical models will be applied. Given the specific scenarios of land use, the consequences for the forest and tree resource base will be identified and analyzed. Specific attention will be given to the creation of sustainable development scenarios.

**Objectives**
Upon completion of this module students should be able to:

- Combine relevant layers in a GIS with other relevant spatial and non-spatial data and integrate these with physical models,
- Analyze spatial overlays for constraints and optimizations,
- Carry out an assessment of the production and use of a defined forest or tree product, while applying sustainability criteria.

**Prerequisites**
NRM modules 2-5, NRM-FSD modules 6-7.

**Recommended Knowledge**
Not applicable

**Hardware and software requirements**
Computers with ArcGIS and ILWIS software, APM Model.

**Teaching Materials**
Presentations, lecture notes, exercise and other material, made accessible through BB during the module.
Allocated time per teaching / learning method

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- O overhead (e.g. QH, exam, opening)

Assessment
Individual & group assignments, short written examination, and a computer-based examination where the analysis techniques have to be demonstrated using a previously unused data set.
Introduction
The aim of the modules in the Planning and Co-ordination specialisation of NRM is to equip participants with a set of concepts, tools, techniques, and skills that enables them to play an active role in planning, co-ordination and decision making processes in the spatial planning components of NRM, while making optimal use of geo-information technology. To achieve this, a standard approach to (spatial) problem solving is followed that comprises four phases:

- Problem identification & formulation
- Analysis & Scoping of problems
- Identification & Design of alternative solutions
- Choice from among alternative solutions, and structural design for implementation.

Contents

- Problem formulation. Planning and decision making processes begin with a proper identification and analysis of the problems as perceived by key stakeholders. Problem analysis helps to identify the problem, gives it structure and reduces its complexity to a manageable level. The spatial dimension of the problems is emphasized.
- Analysis & scoping of problems. Approaches for selecting tools & methods for analysing spatial problems in NRM are reviewed. An essential step is the choice and development of socio-economic and bio-physical indicators as the basis for the appraisal and evaluation of any proposed solutions. The characteristics of good indicators will be examined. For the analysis of problems, data need to be collected and organized. Special attention is given to the collection of socio-economic information in spatial settings.
- Design of alternative solutions or generation of (spatial) scenarios. An overview of qualitative and quantitative methods for seeking alternative options and generating scenarios is given. Key methods are practiced.
- Choice of alternative solutions. To support the choice from the alternative solutions, a number of evaluation techniques, varying from purely qualitative to highly quantitative, are on offer. Emphasis is given to multi-criteria evaluation, based on its potential to support handling of spatial issues. Negotiation and group work and moderator skills are dealt with.

The topics are illustrated by a case study. Other examples and small cases are used to demonstrate the applicability of tools and techniques in different contexts.

Objectives
At the end of the specialisation modules, participants should be able to:

- discuss the basic concepts of planning and decision making
- identify, structure and formulate problems in NRM processes
- identify stakeholders and their characteristics and interests
- integrate the spatial dimension in the problem analysis
- select from among analytical tools & methods for analysing spatial problems in NRM
- develop indicators for problem description, monitoring and evaluation purposes in NRM
- practice and apply a number of techniques in socio-economic data collection
- summarize and apply a limited number of techniques for the generation of alternative solutions (scenarios development) in NRM
- apply and compare a number of techniques for evaluation of alternative solutions in NRM
• apply a framework of methods for designing the implementation of solutions
• assume different roles, tasks and responsibilities in group work

**Prerequisites**
Completion of the preceding modules

**Recommended Knowledge**
The knowledge and skills obtained in the preceding modules.

**Hardware and software requirements**
ILWIS MCE, Arc GIS

**Teaching Materials**
Hand-outs as provided.

**Allocated time per teaching / learning method**

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Time (in # of hours) allocated per major method:
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- **IA** individual assignment (including Thesis, IFA),
- **S** self study (incl. unsupervised practicals),
- **O** overhead (e.g. QH, exam, opening)

**Assessment**
Assessment will take place based on a number of tests and/or individual and group assignments resulting in short reports and presentations, resulting in three marks corresponding to the three consecutive modules.
Introduction
Agricultural land use activities support many basic human needs. In response to changing
demands, pressure is exerted on land to produce more and better products. At the same
time, widely spread sub-optimal land management results in production levels that are far
below (current) demands and degrade future production potentials through the depletion
of resources. Our incomplete understanding of agricultural land use systems is leading to
inadequate measures to avoid the so-called ?poverty trap?, often because spatial
components of these (often complex) systems are neglected. A formidable challenge lies in
the sound application of RS/GIS to support land use system analyses aimed at closing
occurring yield gaps and at improving the land use systems? sustainability.

Contents
This module is under revision. The module covers the following topics:
- Defining practical land use and land use classification concepts
- Agro-ecological zoning, crop selection methods, and water-yield relationships.
- Land cover survey techniques using RS-data and (mobile) GIS-solutions.
- Land use survey techniques, e.g. interview techniques, secondary data collection,
sample schemes, etc., using RS-data and (mobile) GIS-solutions.
- Land use data versus farming system data.
- Spatial data infrastructures for land use data sets.
- Quantitative analyses, relating attributes of land use and land resources to productivity
  and sustainability indicators; use of Land Quality Indicators (LQI's)
- Comparative performance analysis (in agro-ecosystems)
- Spatial crop growth modelling
- Satellite sensors for land use mapping and quantitative production monitoring
  (introduction).

Objectives
To provide knowledge and skills in designing and executing agricultural (land use) surveys
and studies, based on using remotely sensed images and GIS, in order to produce land use
maps and assessments concerning the performance of specific agricultural land use
systems, i.e.:
- skills in recording agricultural land use (management) information
- skills in selecting suitable crops by agro-ecological zone and estimating impact of water
availability on productivity.
- skills in handling, interpreting and classifying site-wise land use data
- skills in preparing, based on aerospace and ground data, a land use map
- skills in analysing land use data sets using crop growth modelling to assess yield gaps
and sustainability issues
- skills in interpreting land use data both bio-physical as socio-economical in the context
of farming systems.

Prerequisites
PhD thesis by C.A.J.M. de Bie titled: "Comparative Performance Analysis of Agro-
Ecosystems"; ITC bookshop.

Recommended Knowledge
Not applicable
Hardware and software requirements
Required software will be made available.

Teaching Materials
Additional lecture handouts and (digital) case study materials.

Allocated time per teaching / learning method

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S self study (incl. unsupervised practicals),
O overhead (e.g. QH, exam, opening)

Assessment
A written open-book exam with questions on all topics. All questions will have an equal weight; they can be open ended, multiple choice, based on a provided graph or table, or based on the provide module materials.
Introduction
During the first two weeks of the module, the SA participants will look at land use planning and the role of land evaluation this process. Special attention will be given to GIS applications to Land Evaluation procedures. In the third week, a multi-disciplinary case study will be carried out, and the participants will devide into stakeholder groups to mimic a multi-disciplinary Land Use Planning exercise.

Contents
The LUP module covers the following topics:
- Land use planning approaches
- Methods in regional and participatory land use planning
- Land capability classification
- FAO framework and guidelines for land evaluation
- Agro-Ecological Zones methodology
- Generation and appraisal of scenarios
- Decision support techniques
- The spatial aspect of the topics is emphasized and GIS is an important tool in the module.

Objectives
Upon completion of the module, participants should be able to:
- Compare different approaches and methods for land use planning and judge their applicability in specific situations in the context their own countries planning institutions.
- Apply methods, tools, skills and disciplinary knowledge acquired in previous modules of the specialisations of the NRM programme to generate and appraise alternative spatial solutions, to solve the identified problems.
- Integrate and appraise different solutions in a multi-sectoral setting using decision support techniques.

Prerequisites
Knowledge and skills from the preceding modules of one of the specialisations within the NRM programme, Basic GIS skills.

Recommended Knowledge
Some experience with land use planning issues is an advantage.

Hardware and software requirements
Computers, ILWIS.

Teaching Materials

Allocated time per teaching / learning method
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**Assessment**
Throughout the module a number of exercises has to be made. The last part is concluded by a series of presentations. The module is closed with an examination covering the whole module.
Quantifying Production Levels at Regional Scale in Support of Food Security

Module 8
Start: 6-3-06
End: 24-3-06
Co-ordinating staff
M.Sc. Valentijn Venus
Master/MSc Sustainable Agriculture

Introduction
Growing concerns on productivity and sustainability of agricultural land uses have increased the demand for information on current and future production levels at regional scales. (Semi-) quantitative methods introduced in this module help provide discussion makers with spatially explicit information on the "What (is grown)?", "Where (is it grown)?" and "How (much is growing)?" issues of food security. Combining these three, (type of) crop produce x acreage x yield, yields estimates of current production levels. In combination with weather forecast models (short, medium-term range), climate change models (long-term) and land use change models, the technique can be extended to produce food security projections for coming years and even future generations.

Contents
The module covers the following topics:
• Approaches and methods for satellite-derived production levels: an (historical) overview.
• "What (is grown)?": use of spectral vs. temporal signatures in crop identification, combining crop calendar information and multi-temporal Vegetation Indexes (VI).
• "Where (is it grown)?": disaggregating tabular statistics on cropping areas using multi-temporal VI-segmentation.
• "How (much is growing)?": semi-emphirical techniques, regression techniques, Monteith efficiency equation, crop growth modeling (photosynthesis, respiration, transpiration, ...), extending crop growth simulation to multi-process models, considerations for selecting a simulation time-step and choosing an appropriate satellite platform, techniques for inferring land surface and climate parameters (e.g. LAI, PAR, aPAR, Tcanopy, Tair) from space-born sensors, techniques to interface satellite-derived parameter values with agro-climatological production models.
• Current and future production levels: aspects of concern, validation, coupling of weather forecast models, land use change projections, and climate change projections in estimating future production levels.

Objectives
Upon completion of this module students should be able to:
• Compare and select for given objectives suitable approaches and methods for the quantification of production levels at regional scale.
• Identify mappable crop types by integrating crop calendar information with multi-temporal satellite observations
• Map crop types at regional scale to quantify acreages under different crop types
• Quantify yields/hectare for different crop types
• Apply quantitative remote sensing techniques for estimating parameter values
• Understand how information on production levels may contribute to food security
• Extend the applications of these estimation techniques to prepare projections for the future

Prerequisites
NRM Sustainable Agriculture Specialization Module 6.

Recommended Knowledge
Basic concepts of plant-soil-water relations. Skills in using computers.
Hardware and software requirements
Software will be provided through blackboard.

Teaching Materials
Various lecture notes, handouts and assignments (will be provided through blackboard).

Allocated time per teaching / learning method

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IA individual assignment (including Thesis, IFA),
S  self study (incl. unsupervised practicals),
O  overhead (e.g. QH, exam, opening)

Assessment
Performance during group and individual assignments. A written exam (open book) with questions from all topics.
Introduction
Biodiversity is worldwide a major concern. The goal of the 1993 Convention on Biological Diversity is "the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefit arising out of the utilization of genetic resources." For policy on and management of biodiversity, comprehensive geo-data sets about biodiversity are required. This information is essential to decision-making processes from local to global levels, which are increasingly seeking information about spatial and temporal dynamics indicative of biodiversity status and changes over time.

The Geo-information for Biodiversity Conservation specialization aims to train participants in techniques to acquire and analyse spatial information for the management of natural and human influenced ecosystems in view of conserving biological diversity. The spatial information focuses on ecological processes in rangelands, woodlands, forests and wetlands.

Conservation concepts, issues and management will be highlighted and the geo information needs are defined for modelling and management. Case studies shall be used in the training to explain different methodologies and procedures.

Contents
Spatial ecological modelling for biodiversity conservation.

This part of the course will deal with multi species approaches to conservation; species richness vs. rarity vs. complementarity as driving concepts for conservation strategies. Analysis will include the problem of habitat destruction and invasive species, two of the major causes of biodiversity loss. Spatial quantification of threat following the IUCN Red List criteria. Issues related to fragmentation and minimum patch size. Corridors and connectivity, Gap Analysis. Databases with plant, animal and environmental data are explored and analysed in thematic, spatial and temporal components for biodiversity and ecosystem management. Case studies include rangelands management, national parks management, conservation of tropical rainforest, and buffer zones.

Objectives
Upon completion of the course, participants should be able to master spatial information techniques to support spatial distribution assessment of plant and animal species.

Prerequisites
NRM modules 2-5.

Recommended Knowledge
Basic knowledge of GIS and Image processing. Basic knowledge of Ecology.

Hardware and software requirements
ERDAS, Arc GIS.

Teaching Materials
Lecture notes, handouts will be distributed by the lecturers.
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### Assessment
Exam and/or individual assignment.
Introduction
Defining biodiversity priorities is an exercise, which brings together the threats to the survival of the species and a broader picture of knowing where biodiversity occurs.

Individual species modeling developed during the first module of the course need to be integrated into a meaningful picture of biodiversity. Different indicators of biodiversity have been devised and each has its own advantage and disadvantages, the module will introduce these indicators and methods to assess them.

Similarly the IUCN Red List criteria define a reference point to assessment the conservation status and threat of species. A large part of the criteria are based on spatial consideration which can be of effectively supported through geo-spatial analysis. Within this context, concepts like fragmentation, minimum patch size and connectivity find their most immediate application.

Case studies will be developed for different regions of the world and different ecosystems using a variety of databases on animals and plants.

Contents
The last part of the course aims at spatial planning for biodiversity conservation. It deals with geo- data needs and spatial decision making. We will also pay attention to costs and benefits and legal aspects. In a case study using a real world dataset, students will design a spatial plan for biodiversity conservation.

Keywords: Planning of national parks and conservation areas, conservation and restoration measures ecological corridors and buffer zones, EIA, LUZ, costs and benefits, legal aspects.

Objectives
Upon completion of the course, participants should be able to master spatial information techniques for identifying status and threat to biodiversity.

Prerequisites
NRM modules 2-5. NRM module 6 Spatial Distribution of Biodiversity.

Recommended Knowledge
Basic knowledge of GIS and Image processing. Basic knowledge of Ecology.

Hardware and software requirements
Erdas, ArcGIS.

Teaching Materials
Lecture notes, handouts and geodata will be distributed by the lecturers.

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- O overhead (e.g. QH, exam, opening)

**Assessment**
Exam and/or individual assignment.
Introduction
The Geo-information for Biodiversity Conservation specialization aims to train participants in techniques to acquire and analyse spatial information for the management of natural and human influenced ecosystems in view of conserving biological diversity. The spatial information focuses on ecological processes in rangelands, woodlands, forests and wetlands.

Conservation concepts, issues and management will be highlighted and the geo information needs are defined for modelling and management. Case studies shall be used in the training to explain different methodologies and procedures.

Contents
Spatial distribution of Biodiversity. This module focuses on the various aspects of biodiversity and the tools to assess and express biodiversity. Basic concepts are highlighted in relation to geo information. Since land cover is one of the most important determining factors in terrestrial biodiversity, the relation between biodiversity and land cover aspects will be studied. Training focuses on satellite image interpretations, a subsequent field survey, and data analysis. Important topics related to biodiversity assessment that will be discussed are listed below:

Keywords:
- Biodiversity in plants, animals, ecosystems and land units
- Geographic information available and required for the distribution of plants and animals,
- Spatial unit of measurement
- Vegetation structure and floristic composition
- Rare, keystone, red list, endemic, endangered.

Objectives
Upon completion of the course, participants should be able to master spatial information techniques for the planning of conservation areas.

Prerequisites
NRM modules 2-5.
NRM module 6 Spatial Distribution of Biodiversity.
NRM module 7 Spatial Ecological modelling for biodiversity.

Recommended Knowledge
Basic knowledge of GIS and Image processing. Basic knowledge of Ecology.

Hardware and software requirements
Erdas, ArcGIS.

Teaching Materials
Lecture notes, handouts and geodata will be distributed by the lecturers.
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Time (in # of hours) allocated per major method:
- **L**: lecture,
- **SP**: supervised practical,
- **GA**: group assignment (e.g. workshop, project),
- **IA**: individual assignment (including Thesis, IFA),
- **S**: self study (incl. unsupervised practicals),
- **O**: overhead (e.g. QH, exam, opening)

### Assessment
Exam and/or individual assignment.
Introduction
Building further on the basic concepts and skills in remote sensing and GIS, students will master the basic concepts of solving real world problems from a systems analysis point of view. The variety in the World’s environmental systems is enormous and the types of problems that need a solution increase the variation in specific approaches exponentially. Dealing with environmental systems involves dealing with dynamic interactions of elements and processes in a spatial context. Therefore, it is essential to gain insight how we can measure, model and predict such interactions and their effects as well as in what way geo information can help us in doing so.

Contents
A limited number of lectures will introduce the students to the concepts of environmental system analysis. Students select a real world environmental problem of their own interest and choice and perform a literature study and analyses how elements and processes are related in this environmental system. They will also assess how changes in the environmental system can be measured, predicted or monitored and what type of remote sensing and GIS techniques are helpful in this.

Objectives
Identify environmental factors and processes within an environmental system. Identify how factors and processes within a system interact. Identify and select relevant environmental indicators to measure or model (predict) the state or the developments of our environment. Select and use the appropriate RS and GIS techniques for environmental measurements and modelling. Collect environmental information in the field.

Prerequisites
Basic concepts and skills in GIS and Remote Sensing (core module 2, 3 and 4). Basic concepts and skills in mathematics and statistics.

Recommended Knowledge
Other skills/knowledge recommended to follow this module.

Hardware and software requirements
ERDAS, ArcGIS, ILWIS, SPSS.

Teaching Materials
### Allocated time per teaching / learning method

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- **S** self study (incl. unsupervised practicals),
- **O** overhead (e.g. QH, exam, opening)

### Assessment
Exam and/or individual assignment.
Introduction
There is an increasing need to understand the functioning of ecosystems in order to relate biophysical aspects of ecosystems to socio-economic conditions. In addition, the demand is high to put relevant information in data-layers of a GIS in order to model the ecosystem in question for the purpose of running different management simulations.

Contents
This module will teach you to understand an ecosystem functioning through developing a concept in Analysing, Modelling and Simulating an ecosystem in a Spatial and Temporal context using GIS. The module will include theory and modelling pertaining to two different ecosystems, e.g., semi-arid rangelands (Kenya) and tropical rainforest (Indonesia). Both ecosystems are under heavy human pressure and impacts are high. The module is based on practical exercises in developing and applying models for analysing the environmental impact on the ecosystem and developing and applying scenario’s for a better sustainable management.

Objectives
Upon completion of this module students should be able to:

- Identify key-biophysical and socio-economic drivers that influencing the ecosystem dynamics;
- Select relevant ecosystem variables and design a conceptual model relating these variables;
- Combine relevant data layers in a GIS and model ‘causal’ links;
- Carry out simulations to predict the impacts of management options on the ecosystem involved.

Prerequisites
Basic knowledge in GIS and RS (Modules 2 + 3 + 4).

Recommended Knowledge
The participants should have knowledge of environmental issues, conservation and land use planning.

Hardware and software requirements
ArcGIS, ILWIS.

Teaching Materials
Lecture notes, handouts will be distributed by the lecturers.
### Allocated time per teaching / learning method

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- S self study (incl. unsupervised practicals),
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### Assessment
Exam and/or individual assignment.
Introduction
The rapid degradation of renewable resources due to changing land use and other human activities results in a need for planning to avoid or revert these unwanted developments. Environmental assessments are used to evaluate what would happen under business as usual conditions versus alternative planning scenarios. Spatial decision support systems (SDSS) are tools to assist decision makers to evaluate in a spatially explicit way the pros and cons of these various possible alternative planning options. They are based on multiple criteria evaluation (MCE) techniques, which allocate weights to assessment criteria in order to rank the alternative scenarios. An important advantage of a GIS based MCE approach in environmental assessment studies is the ease with which valuation criteria can be changed to visually illustrate the implications of spatial decisions.

Contents
- Introduction in Multiple criteria evaluation (MCE) and Spatial MCE (SMCE) for environmental assessment.
- Analysis and assessment of the conflict between mangrove conservation and shrimp culture development, using a spatial decision support system (ICOMIS) for coastal resource management.
- Execute environmental assessments using the LEDESS model developed at ALTERRA in Wageningen.

Objectives
Upon completion of this module participants should be able to:
- Understand MCE and SMCE
- Apply SMCE in Environmental assessment
- Map and monitor natural resources
- Develop and evaluate scenarios for environmental assessment
- Critically review SDS tools

Prerequisites
Basic knowledge in GIS and RS (modules 2, 3 and 4).

NRM - ESM modules 6 and 7.

Recommended Knowledge
NRM - ESAM modules 6 and 7.

Hardware and software requirements
ERDAS, ArcGIS, ILWIS, DEFINITE

Teaching Materials
Lecture notes, handouts will be distributed by the lecturers.
**Allocated time per teaching / learning method**

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- GA group assignment (e.g. workshop, project),
- IA individual assignment (including Thesis, IFA),
- S self study (incl. unsupervised practicals),
- O overhead (e.g. QH, exam, opening)

**Assessment**
Exam and/or individual assignment.
**Introduction**
The group project is an integral part of the Master degree course in all specializations of the NRM programme. It complements the lectures and exercises of all preceding modules and provides the participants with an opportunity to apply the knowledge and skills acquired in those modules under realistic working conditions.

The group project focusses on problems and issues in natural resources management in a real world setting and on the collection, generation and delivery of information that is relevant to planners and decision-makers. Emphasis is thereby on working in a multi / interdisciplinary manner. This does not, however, exclude working on certain tasks with a stronger specialisation focus.

**Contents**
1) Preparation phase (2 weeks)
   - Introduction to the fieldwork area
   - Problem analysis (including stakeholder analysis, analysis of the institutional setting, identification of focal areas for specializations)
   - Formulation of Terms of Reference (both for the integrative part of the group project as well as the part with a stronger specialization focus)
   - Design of a work programme (development of a plan for data acquisition and verification, selection of relevant procedures for data processing and analysis)

2) Fieldwork phase (4 weeks)
   - Fieldwork implementation in Tanzania (Bagamoyo District)
   - Presentation of preliminary results to local district authorities

3) Reporting phase (1 week)
   - Final (GIS) analysis
   - Report writing and compilation

**Objectives**
Common learning objectives for the group project are described below. Upon completion of the group project students should be able to:

- Identify key NRM problems in an area, formulate working objectives, identify associated data requirements and select appropriate methods & techniques for subsequent data collection, processing and analysis
- Collect and process the required data, and present the information required according to agreed upon Terms of Reference
- Analyse the data collected, and formulate relevant conclusions and recommendations based on this analysis
- Perform project activities as a professional team
- Review the process of working in an multi / interdisciplinary team and the individual contribution to this process

Depending on the specialization additional, more specific, objectives may still be added.

**Prerequisites**
NRM modules 1-10
Recommended Knowledge
Not applicable

Hardware and software requirements
PC`s with ERDAS and ArcGIS, GPS receivers, regular field equipment for (physical) field measurements and observations.

Teaching Materials
Hand-outs

Allocated time per teaching / learning method

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IA individual assignment (including Thesis, IFA),
S self study (incl. unsupervised practicals),
O overhead (e.g. QH, exam, opening)

Assessment
In the assessment the individual and the group performance will be balanced, taking into consideration both the products delivered and the learning process.
Introduction
The Individual Final Assignment (IFA) has to be completed at the end of the Master course. The students have to solve a relatively restricted problem from a real life situation through the application of skills and techniques learnt in the course. In this way the students have to demonstrate that they have achieved the objectives of the Master course. The topic of the assignment must be related to the specialisation.

Contents
The choice of an IFA topic is the responsibility of the student in consultation with the staff. For certain topics the material may be provided by ITC. If students prefer to work on a topic of the home country it is their own responsibility to obtain the necessary material.

The co-ordinating staff will provide a general framework for the IFA during module 7. In subsequent modules the student will discuss, write and present a proposal that has to be finalised and accepted before the start of the IFA modules. The IFA proposal should:

- Identify and select a relevant topic.
- Define objectives and methods or techniques to be used.
- Indicate planning of activities and resources required.
- Indicate the form of the final IFA product.

Two-weekly individual progress reports and progress meetings with the supervisors will monitor the progress on the IFA. The final outcome will be a report (hardcopy and/or CD-Rom) as well as an oral presentation and defence.

Objectives
The student must be able to:

- Define, plan and execute a project to solve a real life problem related to the specialisation
- Apply methods and skills learnt in the course
- Prepare a concise technical report
- Orally present and defend the work done

Prerequisites
Successful completion of module 1 to 13. This implies not more than two failed modules and no mark lower than 50 (for details see the Assessment Regulations 5.3 and 5.4.).

Recommended Knowledge
Not applicable

Hardware and software requirements
Hardware and software used during the modules 1 to 8 and 11 to 13 or with authorisation of the IFA supervisor.

Teaching Materials
Not applicable
Allocated time per teaching / learning method

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IA individual assignment (including Thesis, IFA),
S self study (incl. unsupervised practicals),
O overhead (e.g. QH, exam, opening)

Assessment
A Degree Assessment Board (DAB) will assess the IFA report, a presentation and oral
defence.

The assessed aspects are:

- Problem recognition and solving
- Work planning and organisation
- Skills in GI-science and earth observation
- Independent working
- Critical and professional thinking
- Final product
- Presentation and defence
Introduction
An understanding of the purpose and use of research and knowledge of appropriate research skills are required for the effective and efficient completion of the MSc thesis. Module 11 introduces MSc candidates to various aspects of scientific research through lectures and guided assignments.

Contents
Module 11 will cover:
- The scientific enterprise; position of ITC MSc research within the wider world, regional, and ITC research contexts
- Steps in the research process; the scientific method
- Ethics and professionalism in science
- Development of hypotheses and research questions
- Searching for information
- Citations, references, management of literature
- Structured technical English
- Report writing techniques (structure, style, terminology, expression, presentation)
- Steps in developing a research proposal
- How a thesis is assessed
- Skills for presenting research proposals and results

Objectives
Upon completion of this module students should be able to:
- Describe the purpose and use of research
- Describe and explain the main steps in the research process
- Formulate a research problem and research objectives
- Find (using on-line databases, library catalog, and abstracting CDs, and current journals), select and review relevant literature and prepare a bibliography with EndNote
- Structure and compose a well-argued scientific essay
- Abstract a research paper
- Present the results of research
- Evaluate a thesis according to defined criteria

Prerequisites
Working knowledge of MS-Word (basic level) and the ITC computer network.

Recommended Knowledge
A critical attitude will be helpful.

Hardware and software requirements
PCs with Endnote 5, MS Office (Word and PowerPoint); internet browser; connection to ITC library electronic research.

Teaching Materials
ITC Lecture Notes NRM.004 (D G Rossiter) Using EndNote 5 (ITC Library staff) Handouts by library, research coordinator, instructors.
**Allocated time per teaching / learning method**

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IA individual assignment (including Thesis, IFA),
S  self study (incl. unsupervised practicals),
O  overhead (e.g. QH, exam, opening)

**Assessment**
Five equally-weighted individual assignments:

- Literature search;
- Structured technical writing;
- Presenting a research paper;
- Evaluating a thesis;
- Abstracting a research paper
Research Proposal Writing

<table>
<thead>
<tr>
<th>Module 12-13</th>
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<tr>
<td>Start: 6-6-06</td>
<td>Dr. D.G. Rossiter / Dr. M.J.C. Weir</td>
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**Introduction**

Modules 12 and 13 are reserved for proposal preparation and will end with a formal evaluation of the candidate’s ability to undertake MSc research.

**Contents**

- Each student is assigned a primary coach for proposal preparation. Most of the time in the module is dedicated to literature review, formulation of research problems, objectives, questions, hypotheses and methods. The student, guided by the coach, may consult ITC staff and resources.
- The result of these modules is the MSc thesis proposal, which will be formally examined during the final week.
- Some capita selecta lectures and practicals will be offered according to student demand, especially as related to fieldwork areas and common methods. Examples: sampling plans, use of field equipment such as spectrometers. These will be generally advertised but are not compulsory and not assessed.

**Objectives**

Upon completion of this module students should:

- Produce a final research proposal (including problem definition, summary of relevant literature, proposed methods and plan of execution).
- Present and justify the proposed research problem and design in public presentation.

**Prerequisites**

NRM Modules 1-11.

**Recommended Knowledge**

Not Applicable

**Hardware and software requirements**

Standard networked PC and ITC applications; Endnote; ITC digital library.

**Teaching Materials**

Not applicable.

**Allocated time per teaching / learning method**
Time (in # of hours) allocated per major method:
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IA individual assignment (including Thesis, IFA),
S  self study (incl. unsupervised practicals),
O  overhead (e.g. QH, exam, opening)

**Assessment**
Final proposals for MSc thesis research will be assessed at the end of module 13.
Introduction
Most MSc research in the NRM programme involves data collection in the field. Although the necessary field skills are introduced in the taught modules, students generally require additional practice before going to the field to:

- Test methods indicated in the research proposal
- Develop routine in the handling of field equipment.

Contents
Approximately one week of the module is devoted to practical work in a field area near Enschede. The remaining time is two weeks of the module and is devoted to independent work related to preparation for the student's own fieldwork.

Objectives
Upon completion of this module the participant should be able to independently design a sample scheme, locate samples in the field and undertake all measurements and observations required for his/her research.

Prerequisites
Detailed outline of field methods as indicated in the research proposal (module 12 and 13).

Recommended Knowledge
Not applicable.

Hardware and software requirements
As required for the individual student’s research work.

Teaching Materials
Handouts relating to the fieldwork practice area.

Allocated time per teaching / learning method

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Time (in # of hours) allocated per major method:
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IA individual assignment (including Thesis, IFA),
S self study (incl. unsupervised practicals),
O overhead (e.g. QH, exam, opening)

Assessment
No formal Assessment.
**Introduction**

The final stage of the MSc course is dedicated to the execution of an individual research project. Each student works independently on an approved research topic from one of the broad research fields related to the programme.

In the project the students develop their research skills further and have to demonstrate that they have achieved the course objectives.

**Contents**

The supervisor(s) will provide guidelines for the research, based on the research proposal that has been finalised and accepted before the start of module 14 (in some cases, the thesis proposal may have to be revised). The research proposal should:

- Identify and select a relevant research topic, based on literature review.
- Define research objectives and methods or techniques to be used.
- Indicate planning of activities and resources required.
- Indicate the expected outcomes and end product.

During module 15 training in specific fieldwork skills and the formulation of a detailed fieldwork plan of operations will be given. After that, the necessary data collection will be executed in the selected or assigned field data analysis and thesis writing is done. In exceptional cases, instead of a real fieldwork project, research work using existing databases may be allowed.

Upon return from the field, data analysis and thesis writing is carried out. Regular progress meetings with the supervisors will monitor the progress of the student’s research. Regular progress reports have to be submitted to the NRM programme Director. The final outcome of the research will be a thesis (hardcopy and CD-Rom) as well as an oral presentation and defence.

**Objectives**

The student must be able to:

- Define, plan and execute a research project dealing with a problem related to the application of GIS and RS tools
- Write a concise, logical and well structured thesis describing the key elements of the research process and findings
- Orally present and defend the work done

**Prerequisites**

Successful completion of modules 1 to 15. This implies not more than two failed modules and no mark lower than 50 (for details see the Assessment Regulations 5.2).

Equally important is the ability to do research independently (as judged by the programme board, based on the thesis proposal and performance during modules 1-15).

**Recommended Knowledge**

Not applicable
Hardware and software requirements
Any hardware and software with authorisation of the supervisor

Teaching Materials
Not applicable

Allocated time per teaching / learning method

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IA individual assignment (including Thesis, IFA),
S self study (incl. unsupervised practicals),
O overhead (e.g. QH, exam, opening)

Assessment
A Degree Assessment Board (DAB) will assess the thesis and a presentation plus defence.
The assessed aspects are:
- Research skills
- Contribution to the development of the scientific field
- Independent working
- Critical and professional thinking
- Scientific report writing
- Presentation and defence
URBAN PLANNING
AND LAND
ADMINISTRATION