FACULTY OF RESOURCE SCIENCE AND TECHNOLOGY

Academic Programme Handbook

Post-Graduate Diploma in Peatland Management

Supported by

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UNIVERSITI MALAYSIA SARAWAK (UNIMAS)
Post-graduate Diploma Programme in Peatland Management

INTRODUCTION

The greater proportion of the world's 11 million hectares of tropical peatlands occurs in the coastal regions of South-east Asia. Many of these regions, including those in Sarawak are earmarked for agricultural development. Being some of the largest remaining areas of lowland forest in South-east Asia, these peatlands have global ecological significance because of their unique and diverse ecosystem having vital roles as reservoirs of biodiversity, as carbon stores and as hydrological buffers. They also play an important regional economic role by providing forest products and land for settlement. Owing to a lack of awareness and understanding about sustainable land management practices, however, many peatland development projects fail to achieve their declared objectives, leading to serious environmental degradation and impoverishment of local communities.

In response to the above, PEATWISE, an EU funded education project undertaken by a consortium of two South-east Asian universities (Universiti Malaysia Sarawak and the University of Palangka Raya, Kalimantan, Indonesia) and two European universities (Wageningen University and Research Centre, The Netherlands and the University of Leicester, U.K.) have developed a curriculum on the management of peatlands, focusing on the peat-covered lowlands of Borneo. This unique curriculum uses innovative educational methods and tools to make available course materials and training modules that incorporate up-to-date research results and advice for enhancing skills and expertise needed to promote the wise use of natural resources in socio-economic development, particularly in the areas of Sarawak and Central Kalimantan.

CURRICULUM STRUCTURE

This Program comprises three modules worth **26 credit hours**. The module and course titles and their credit hours distribution are as follows:

Core Module (12 credit hours) comprising three courses, namely:
- Ecology, Natural Resources and the Environment (4 credit hours)
- Water Resources and Hydrology of Peatland Catchments (4 credit hours)
- Peat Soils and Land Use (4 credit hours)

Complementary Module (8 credit hours) comprising two course, namely:
- Human Dimensions and Resource Economics in Peatland Management (4 credit hours)
- GIS and Remote Sensing for Peatland Management (4 credit hours)

Experiential Module (6 credit hours) comprising three components:
- Cross-disciplinary Research Methodologies (3 credit hours)
- Project Paper (3 credit hours)

ADMISSION REQUIREMENTS

The candidates for this Programme must possess:
- A bachelor of science or agriculture or engineering degree with a minimum CGPA of 2.5 or an equivalent second Class Honours from a recognised University, or
- A bachelor of science or agriculture or engineering degree with at least two years of full-time relevant working or professional experience, or
- Other equivalent qualifications approved by the Senate.

The priority shall be accorded to mid-career professionals in the government or private sectors assigned to jobs related to the management and development of peatland.

COURSE DURATION

The course duration is 12 months or less (depending on the preferred mode and schedule of course delivery). This period shall comprise approximately nine months of coursework and three months of mini research/project paper activity. Based on 14 contact hours per credit and weekend classes of 10 – 12 hours per weekend, the course schedule may appear as follows:

	Course Title	Credit	Duration (week)
1	Ecology, Natural Resources and Environment	4	5
Break			1
2	Water Resources and Hydrology of Peatland Catchments	4	5
Break			1
3	Peat Soils and Land Use	4	5
Break			1
4	Cross-disciplinary Research Methodologies	3	3.5
Break			1.5
6	Human Dimensions and Resource Economics in Peatland Management	4	5
Break			1
7	GIS and Remote Sensing for Peatland Management	4	5
Break			1
8	Research Project	3	12
Total		**26**	**47**

COURSE OUTLINE

The outlines and other specifications for all the courses offered in this Programme are given in **Appendix 1**.

MEDIUM OF INSTRUCTION

The Programme is international in nature (opened to foreign students); as such the courses shall be conducted in English.

ASSESSMENT

Students are required to register and pass all the courses offered in order to qualify for the conferment of Post-graduate Diploma (Peatland Management).

The Programme requires that students attend at least 80% of the total lecture hours in order to qualify for assessment. Assessment shall be in the form of test and examinations, assignments, field reports, technical presentations, project paper or a combination of these. The grading system shall be as follows:

Grade	Marks	Grade Point	Level of Achievement
A	80 -100	4.00	Excellent
A-	75 – 79	3.67	Very good
B+	70 - 74	3.33	Very good
B	65 – 69	3.00	Good
B-	60 – 64	2.67	Good
C+	55 – 59	2.33	Fair
C	50 – 54	2.00	Fair
C-	45 – 49	1.50	Fail
D	40 – 44	1.00	Fail
F	<40	0.00	Fail

The Post-graduate Diploma will be awarded to students who have fulfilled all requirements, including a **Cumulative Grade Point Average (CGPA) of 2.5** for the whole programme. To secure this CGPA students must try to obtain grades of not lower than B- for all courses.

EXPECTED LEARNING OUTCOME

The Programme is specifically aimed at disseminating contemporary knowledge to first degree holders and mid-career professionals whose responsibility include planning, research, supervision, development and conservation of peatland. The range of courses offered in this Programme is expected to enhance their capability in attending to the peatland management challenges in a more skilful, integrated and sustainable manner.

Upon successful completion of this Programme the graduates are expected to have the necessary competence in assessing the prevailing potential and position of a peatland area in the context of geographical situation and socioeconomic significance. They should also be able to develop the appropriate planning frameworks on the utilisation, management and monitoring of a peatland area and further, capable of implementing the plan in a successful and effective manner. These capabilities are based on a sound and comprehensive understanding of both the theoretical and practical knowledge of the hydrology, ecology and soil properties of peatland besides having the necessary skills in the technological tools relevant to the resource inventory and other management tools that take into account both the human and economic dimensions, locally and nationally.

BOARD OF STUDIES

International Advisory Board

Prof Jack Riley (Nottingham University, UK)
Dr Susan Page (Leicester University, UK)
Ir Suwido Limin (Universitas Palangka Raya, Indonesia),
Prof Dr Murtedza Mohamed (Unimas, Malaysia) and
Ir Henk Ritzema (Wageningen University, The Netherlands)

Faculty/Programme Board of Studies

Assoc Prof Dr Shabdin Md Long, Dean
Prof Dr Murtedza Mohamed
Prof Dr Wan Sulaiman Wan Harun
Assoc Prof Dr Mustaffa Abd Rahman
Asoc Prof Dr Mohd Tajuddin Abdullah
Assoc Prof Dr Lau Seng
Dr Ismail Jusoh

RESOURCE PERSONS

Resource persons identified for this Programme are listed in **Appendix 2**.

SANCTIONING OF DEGREE

The assessment of students performance and sanctioning of this Post-graduate Diploma (Peatland Management) shall be subjected fully to the rules and regulations stipulated in the Unimas Post-Graduate Studies Regulations (**Appendix 3**).

APPENDIX 1

COURSE 1: ECOLOGY, NATURAL RESOURCES AND THE ENVIRONMENT

<table>
<tr><td>Course code</td><td>STP5114</td><td>Week</td><td>1 - 5</td></tr>
<tr><td>Course title</td><td>Ecology, Natural Resources and the Environment</td><td>Credit (Hours)</td><td>4 credits (56)</td></tr>
<tr><td>Course facilitator</td><td>Siti Rubiah Zainudin</td><td colspan="2">E-mail
zsrubiah@frst.unimas.my</td></tr>
<tr><td>Resource person(s)</td><td>Dr Siti Rubiah Zainudin
Assoc Prof Dr Mustafa Abd Rahman
Assoc Prof Dr Andrew Alek Tuen
Assoc Prof Dr lau Seng
Prof Murtedza Mohamed</td><td colspan="2">E-mails</td></tr>
<tr><td colspan="2">Course objectives
The main objectives of this course are to:
• provide a general understanding of the ecological basis of the environment and its current state; the earths hierarchical level of organization and the linkages between the major ecosystems;
• identify and understand the importance of environmentally sensitive areas focusing on aquatic and terrestrial biodiversity and conservation of tropical peatland;
• explore various conventions, policies, laws and regulations pertaining to the environmental management at the States, national, regional and global levels;
• introduce fundamental concepts pertaining to environmental management systems.
• introduce ISO 14000 series for strategic environmental management;
• explore the theory and practice of Environmental Impact Assessment (EIA).
Upon successful completion of this module, students would be able to:
• explain the basic principles of biodiversity conservation
• describe and explain the principal issues, objectives and provisions of various conventions, declarations, policies, Acts, Orders, Ordinance and Regulations in Malaysia, within ASEAN countries as well as those by the United Nations
• propose or decide on management and conservation strategies for environmentally sensitive areas particularly pertaining to tropical peatland based on the above and on a broad understanding of fundamental concepts of environmental management systems including the ISO14000.
• participate effectively in Environmental Impact Assessment (EIA) undertakings</td><td colspan="2">Learning Units
LU1. Introduction to ecological systems

LU2. Principles of biodiversity conservation.

LU3. Environmentally sensitive area and conservation strategies

LU4. Peatland characteristics and management

LU5. Environmental Policy, Laws and Conventions

LU6. Environmental Management System (EMS) and Environmental Impact Assessment (EIA)</td></tr>
<tr><td colspan="2">Course synopsis.
In this course, the importance of ecology as the basis for environmental management, the importance of environmentally sensitive areas such as aquatic and terrestrial habitats in biodiversity conservation and the role of biological indicators as signs of habitat degradation will be discussed. Special focus will be on tropical peatlands, their wise use and management. Principles of environmental and water resources management will be elaborated. There will also be deliberations on EIA processes and case studies.</td><td colspan="2"></td></tr>
</table>

Course contents	
LU 1	Definition of environment, resources, ecology, ecosystem and the concept of sustainability. Review of current state of the environment and resources – problems, causes and connections. Examples of ecological imbalances leading to environmental instability and degradation. Hierarchical classification of the biosphere: Biomes, ecosystems, communities, and populations. Definition and examples of each level of classification. Energy: Law of Thermodynamics. Definition of ecological succession, importance of achieving climax state and ecological stability. Succession in aquatic systems, eutrophication. Classification of aquatic organisms and their diversity, key characteristic features (identification) of selected groups of organisms, habitat preferences. Endangered and exploited species. Commercial species. Bioprospecting. The habitat as a tool for understanding and managing water resources. Definitions of bioindicators.
LU2	Definition of biodiversity, diversity measurements (diversity indices, species richness, etc). A review of the Biodiversity Conventions leading to the legal implications of protecting biodiversity. Principles and guidelines in biodiversity conservation. Current issues on the implementation of the biodiversity conservation laws and regulations.
LU 3	Environmentally sensitive environments. Terrestrial and aquatic environment. Highlands environment. Catchment processes, riparian effects, instream / river processes. Importance of wetlands. Impacts of degradation of sensitive ecosystems on the physical, biological and human environments. Relevance of riverine ecology to the protection of water resources. Management strategies for environmentally sensitive areas.
LU 4	Peatland characteristics and management: Unique, endemic and threatened, overview of the nature of tropical peats and peat soils, location and extent, origin and genesis, natural resource functions of tropical peatlands: Carbon balance, hydrological, climatic, biodiversity and related forest resource functions, productivity and nutrient cycling, other ecological and landscape functions. Socio-economic importance and values, impacts of landuse on tropical peatlands. Peatland Management: Lessons learned and new approaches, conservation, sustainable use and management strategies in South East Asia. Wise Use Guidelines for tropical peatlands,
LU 5	Global and regional conventions on environment and water resources (UNCED, Ramsar, Dublin Statement, WWForum etc); Agenda 21: Environmental politics and reality; the Federal Constitution and legal framework for environmental management; the national Policy on Environment; institutional framework for environment and water resources management. The Environmental Quality Act, 1974 and subsequent amendments; Regulations/Orders, guidelines and standards made pursuant to EQA. Other legislations under other Federal Ministries applicable for environmental management and natural resources conservation. Other legislations under other State governments applicable for environmental management and natural resources conservation.
LU 6	Paradigm shift in natural resource and environmental management; organisational EMS; integration of business and environmental objectives; ISO14000 series of standards; the 17 elements of an effective EMS; strategies and tools for implementation of EMS. The concept of sustainable development and the role that EIA can play in implementing the concept. The scenario of 'no-EIA'. General perspectives of EIA procedure and requirements and specific reference to Malaysia (EQA). Overview of key procedural stages in EIA such as screening, scooping, assessment, review and public participation put into perspective as part of the overall EIA process. EIA reporting and review. Discussion on the elements of Environmental Management Plan (EMP), which include resource requirement, monitoring and auditing programmes. Devolution of environmental management in Malaysia. EIA in practice.

Key references

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Clark B.D. 1996. Introduction to environmental assessment, environmental management and sustainable development In *UNEP/EEU Training Resource Manual*.

Department of Standards Malaysia. 1996. ISO14001: *Environmental Management Systems – Specifications with Guidance for Use*. SIRIM Publication. Shah Alam.

DOE 1997. EIA: Procedure and requirements in Malaysia.

Downes, B. J., L. A. Barmuta, P. G. Fairweather, D. P. Faith, M. J. Keough, P. S. Lake, B. D. Mapstone, and G. P. Quinn. 2002. *Monitoring ecological impacts: concepts and practice in flowing water.* Cambridge University Press, New York, New York, USA.

Duinker P. 1996. Effects Monitoring in Environmental Impact Assessment. In *UNEP/EEU Training Resource Manual.*

Ebisemiju F. S. 1996. EIA: Making it work in developing countries In *UNEP/EEU Training Resource Manual.*

Fiedler, P L., and P. M. Kareiva. (editors). 1998. Conservation Biology: For the Coming Decade. Second Edition. New York, NY: Chapman & Hall, 420 pp.

Gaston, K.J. 2000. Global patterns in biodiversity. *Nature*. 405:220-227.

IPCC. 2000. Summary for Policy Makers. *Land Use, land Use Change and Forestry.* Watson, R.T., Noble I.R., Boiln, B., Ravindranath, N.H., et al. (eds), pp. 1-20. Cambridge University Press.

Jain R.K., Urban L. V., Stacey G. S., Balbach H. F. 1996. Environmental assessment methodologies In *UNEP/EEU Training Resource Manual.*

Landner, L 1992. Simplified assessment of environmental effects (SAEE). Network for Industrial Environmental Management (NIEM) Phase II Training Package 2. SIDA-UNEP Bangkok.

Mitsch,W and Gosselink,J. 2000. Wetland*s*. 3 rd Edition, John Wiley & Sons, 920pp.

Muhamad Awang et al. 1999. *Environmental Management Standards (ISO14000): Towards a Sustainable Future*. UPM Press. Serdang.

Olson, D.M., and E. Dinerstein. 1998. The Global 200: a representation approach to conserving the Earth's distinctive ecoregions. *Conservation Biology* 12:502-515.

Patterson, J. 1999. Wetlands and Climate Change: feasibility investigation of giving credit for conserving wetlands as carbon sinks. *Special Publication 1-1999*, Wetlands International, Ottawa, Canada. 35 pp. Roulet, N.T. 2000. Peatlands, carbon storage, greenhouse gases, and the Kyoto Protocol: Prospects and significance for Canada. *Wetlands* 20(4), 605-615.

Schulze, E. D and Mooney, H.A. 1994. *Biodiversity and Ecosystem Function*. Springer, pp 525.

Shugart, H.H. (1998) Terrestrial Ecosystems in Changing Environments. Cambridge Studies in Ecology. Cambridge University Press, Cambridge. 537 pp

Talling, J. and Lamoalle, J. 1998. *Ecological Dynamics of Tropical Inland Waters*. Cambridge University Press, Cambridge. 441 pp.

Watkins, D. & Parish, F. 1999. Review of wetland inventory information in Asia. In: C.M. Finlayson & A.G Spiers (eds), *Global Review of Wetland Resources and Priorities for Wetland Inventory.* Wetlands International for the Ramsar Convention on Wetlands.

Winter, T.C. 2000. The vulnerability of wetlands to climate change: A hydrologic landscape perspective. *Water Resources Journal* 206, 50-57.

Wood, A., P. Stedman-Edwards, and J. Mang, editors. 2000. The Root Causes of Biodiversity Loss. World Wildlife Fund and Earthscan Publications, Ltd., London, UK. 304 pp.

Course highlights

Ecological processes and its impacts on mankind. Biodiversity issues
Tropical ecology with emphasis on aquatic ecosystems and peat land management
Participation in activities related to EMS elements such as development of Environmental Policy Statement, determination of environmental aspects, EMS audits, identification of environmental performance indicators etc.
Involvement in a 'mock' EIA study and EIA report preparation.

Assessment

Written examination:	50%
Term papers, reports:	50%

COURSE 2: WATER RESOURCES AND HYDROLOGY

<table>
<tr><td>Course code</td><td>STP 5124</td><td>Semester</td><td></td></tr>
<tr><td>Course title</td><td>Water Resources and Peatland Hydrology</td><td>Credit (Hours)</td><td>4 (56)</td></tr>
<tr><td>Course facilitator(s)</td><td>Dr. Lau Seng</td><td>Email</td><td>lauseng@ibec.unimas.my</td></tr>
<tr><td>Resource person(s)</td><td>Assoc Prof Dr Lau Seng
Dr. Tie Yu Leong and Ir. Dr. Henk Ritzema</td><td>Email</td><td></td></tr>
<tr><td colspan="2">Course objectives
The course is aimed at providing (a) an overview on hydrological aspects of water resource science, (b) an understanding of basic hydrological concept within peatland catchments, and (c) the fundamental water resource management concept particularly for peatlands and coastal areas.

Course synopsis
1. Overview of hydrology as a science related to water resource management;
2. Exposure and understanding of the main hydrological processes and their importance in the management of the water resources in peatland catchments;
3. Develop skills of applying and identifying hydrological analysis for sustainable development of catchment and water resource.
4. Discussion on water chemistry, water quality standards, monitoring and treatments and pollution control measures for peatland areas.
5. Introduction of water resource applications software for management of groundwater, surface water and water quality assessments.</td><td colspan="2">Learning Units
1. General introduction to hydrology and water resources;
2. Hydrological processes – precipitation, river flow, evapotranspiration, inflitration, geohydrology and hydrographs;
3. Peatland hydrology
4. Peatland catchment management.
5. Water management
6. Concept in surface and groundwater modelling
7. Water resource management tools for peatland areas</td></tr>
<tr><td colspan="4">Course contents</td></tr>
<tr><td>LU 1</td><td colspan="3">General introduction to hydrology and water resources
Hydrology from different perspectives - engineers, environmentalists, agriculturists, water managers. The hydrologic water balance – global, regional, national. Relationship between weather and hydrology – heat balance, radiation, thermal circulation, earth’s rotation, weather fronts, humidity. Definition of river basin and catchment area. The hydrological station. How hydrology fit in the general scheme of Intergrated Water Resource Management (IWRM).</td></tr>
<tr><td>LU 2</td><td colspan="3">Hydrological processes
Precipitation – types (cyclonic, convective, orographic), measurements, precipitation data analysis, IDF curves. Streamflow – river stage and gauging, discharge measurements, Stage-Discharge relationship, rating curves, streamflow data interpretation, hydrographs, streamflow variations(annual, seasonal, daily). Evaporation and Transpiration – Controlling factors, measurements, Penman-Monteith Equation. Infiltration – fundamental process and infiltration methods. Geohydrology – definitions and terminologies, Darcy’s Law. Hydrograph analysis.</td></tr>
<tr><td>LU 3</td><td colspan="3">Peatland hydrology
A. Introduction to Peatlands: Classification systems; peat landforms; peat landform survey
B. Hydrology of peatlands: Hydrology and water balance; water movement within peatlands; outflows; hydrochemistry and chemical processes within peatlands; environmental gradients – water source gradient, acid/base gradient, fertility gradient, and water table gradient.</td></tr>
</table>

LU 4	**Peatland Catchment Management.** A. Changes in Peatlands i. Peatland archive – peatland chronologies ii. Autogenic changes – internal conditions iii. Allogenic changes – external conditions iv. Environmental feedbacks B. Resource Management i. Peatland values – economic, wildlife conservation, functional values and value to society ii. Impacts of drainage, peat extractions, agriculture and other disturbances iii. Conservation management and restoration iv. The future for peatlands in the 21st century.
LU5	**Water Management in Peatland** *Principles of water management in tropical peatlands*: Why is water management needed?; Water management issues in peatlands; Concept of a water management system in tropical peatlands; Leading principle "Control of the Water Level "; Design approach Design Considerations: System layout; Spacing of drains; Drain dimensions; Water level control; Structures; On-project water storage; Water quality
LU 6	**Concepts in Modelling and Modelling Tools** *Types of models used in IWRM tools*: conceptual, mathematical and numerical models, "black box" and physically based models, lumped and distributed models, empirical, deterministic and stochastic models. *Process of building a model:* schematisation, data, discretisation, calibration, verification and simulation. *Numerical methods*: numerical integration, solution of equations, method of finite differences and method of finite elements. *Optimization techniques:* Introduction to linear programming, dynamic programming, genetic algorithms. *Introduction to new Information Technologies:* Artificial intelligence, expert systems, neural networks.
LU 7	**Model set-up, data collection, calibration, verification, and interpretation** *Model set-up:* Introduction of concept modeling setup. (e.g. setting the boundary conditions, determining the model domain area, grid sizes, time-step etc). Introduction to the formulation of modeling setup (e.g. formulation of objectives, review of theoretical background, formulation of the model, creation of model structure, formulation of equation, formulation methods of solution, production of computer programs, calibration and validation, sensitivity analysis.) *Data Collection:* Methods of data capture. Field data (sampling points, duration, frequency etc.) and office data (existing maps, discharge records, rain, wind, tidal and wave records etc) collection. Role of data in modelling and decision making. Instrumentation, data logging, data processing, quality control, database use. *Calibration:* Short-term calibration dataset (parameters), Long-term dataset for inference. Location of calibration points, quality of calibration and verification data. Other methods of formulating and calibrating models. Parameters such as water levels, velocity, river discharge etc. *Verification:* Accuracy (parameter calibration/ model structure). Reliability *Sensitivity analysis:* Parameter optimization. State variable sub-spaces. Parameter uncertainty. Sensitivity gradients ***I**nterpretation of model outputs*. The application of statistical and systems engineering techniques in the analysis of models output. Model output accuracy. Physical meaning of the model outputs. Hypothesis testing and regression modeling. Error analysis (e.g. Kalman filters, Monte Carlo).
AU 1	**Case studies (Practical)** *Surface Water Modelling:* Study of the physical processes of the hydrologic cycle and the application of hydrologic tools for engineering design. Design methods based on peak discharge equations and unit hydrograph models; Stormwater management design, flood routing, and reservoir routing. The principles of surface erosion and channel scour. Catchment modelling and model types. Integrated catchment response. Rainfall-runoff processes. Modelling of watershed processes (biophysical/ecological). Large basin modeling. Spatially distributed flow and transport modeling. Governing equations for flow, sediment transport and contaminant transport. Case study and practical. XP-SWMM (Storm Water Management Model), MIKE 21, MIKE SHE (A Watershed Scale Model for Soil and Water Resources Management), SHESED (Basin Scale Water Flow and Sediment Transport Modelling System)

	Groundwater Modelling: Introduction to groundwater hydraulics and modeling approaches; Concepts related to the development of groundwater resources, hydrogeology, hydrodynamics of flow through porous media, hydraulics of wells, artificial recharge, sea water intrusion, basin-wide groundwater development; Introduction to chemical and bio-chemical migration and transformation processes and modelling approaches. The ecology of groundwater and natural attenuation; Contaminated land and landfill environments. Source and plume assessment strategies. Source-Pathway-Target; Containment methods: physical and hydraulic; Remediation Methods: pump and treat; soil vapour extraction; sparging; multiple extraction point systems; natural attenuation; Case study and practical. ASMWIN, MODFLOW *River Basin Modelling:* Fundamental principles and applications of river engineering. River flow, river channel formation, physical characteristics of rivers, responses of rivers to natural and human-made changes, analytical methods of design and evaluation, mathematical and computer modelling of river channel changes. Classification of flows and models. A review of open channel steady flow modelling. Gradually and rapidly varied flow. Sub-critical and supercritical flow. Water surface profile computations. Floodway delineation. Bridge and culvert analysis. Application of HEC-RAS steady-state software. A review of the St. Venant dynamic and continuity equations and their solution methods. Unsteady flow modelling. Flood routing. Fully dynamic modelling. Model calibration. Applications of the ISIS-FLOW software. Case study.

Key References

Abbott, M.B. and Refsgaard, J.C. 1996. *Distributed Hydrological Modelling*. Dordrecht, The Netherlands: Kluwer.

Arnold Herschy, R.W. (ed). 1978. *Hydrometry: Principles and Practices.* John Wiley.

Beven, K. 2000. *Hydrologic Modelling A Primer.* J. Wiley & Sons.

Black P.E. 1996. *Watershed Hydrology*. Ann Arbor Press. Chelsea, MI.

Chin D.A. 2000. *Water Resources Engineering*. Prentice-Hall Inc. Upper Saddle River, NJ.

Clark, Viesman and Hammer. 1977. Water *Supply and Pollution Control*, Haper and Row.

Fetter W. 1994. *Applied Hydrogeology***.** Prentice Hall

Gribbin J.E. 1997. *Hydraulics and Hydrology for Stormwater Management*. Delmar. Albany, NY.

Haan C.T, Barfield C.J. and Hayes J.C. 1994. *Design Hydrology and Sedimentology for Small Catchment*. Academic Press, New York.

Hammer and Hammer, 2001. *Water and Wastewater Technology*, Prentice-Hall.

HEC-RAS User's Manual. Latest version.

ISIS-FLOW User Manual. Halcrow/H.R. Wallingford [1995]

JPS 2000. *Manual Saliran Mesra Alam*. Percetakan Negara Malaysia

Lamb, J.C. 1985. *Water Quality and Its Control*, John Wiley Sons.

Linsley, *et al*. 1992. *Water Resources Engineering*, Mc Graw-Hill Inc.

Loucks, and Daniel, P. 1981. *Water Resources Systems Planning and Analysis*, Prentice-Haall .

Mays, L.W. and Tung, Y.K. 1992. *Hydrosystems Engineering and Management*. New York: McGraw Hill Inc.

Metcalf and Eddy. 1998. *Wastewater Engineering, Treatment Disposal Re-use*, McGraw-Hill International Editions, Civil Engineering Series,

Newson, M. 1994. *Hydrology and the River Environment.* Oxford: Oxford University Press.

Oweis I.S., Khera R.P. 1998. *Geotechnology of Waste Management*, PWS Publishing Co.

Revelle. 1981. *The Environment: Issues and Choices Society*, Willard Grant Press.

Singh V.P.1992. *Elementary Hydrology*. Prentice-Hall, Englewoods Cliffs, NJ.

Singh, V.P. (ed). 1995. *Computer Models of Watershed Hydrology*. Highlands Ranch, Colorado, USA: Water Resources Publications.

Assessment

Written examination	(50%)
Assignment	(30%)
Group work/project	(20%)

COURSE 3: PEAT SOILS AND LAND USE

Course code	STP5134	**Week**	13 - 17
Course title	**Peat Soils And Land Use**	**Credit (Hours)**	4 (56)
Course facilitator	Wan Sulaiman bin Wan Harun	**E-mail**	whwsulaiman@frst.unimas.my
Resource person(s)	Dr Tie Y.L.	**E-mail**	ecocon@streamyx.com

Course objectives

The module is aimed at providing an understanding of the complexities of peat soils and issues related to their use based on theoretical frameworks, philosophies, ideologies, current thinking and practices in the areas of land use and natural resource utilization. At the end of the module candidates would be able to:

- describe the nature of soils in broad terms
- describe the genesis of peat soils and explain their characteristics
- discuss soil quality as well as principles and approaches to land evaluation
- make simple appraisal about the sustainability of land use plans
- make an evaluation on the suitability of a given peatland for various land uses and provide detail implications on management and conservation

Course Synopsis

Beginning with a broad overview of soils, the module goes into an in-depth treatment on the nature of peat soils, examines the various concepts relevant to soil quality and sustainable use, and introduces the various principles and techniques in land evaluation and land-use planning. Present and future sectoral land use, and their impacts are then discussed through case studies, with special reference to peatlands. The final part of the module deals with the general concepts of integrated soil conservation management, and in particular, integrated catchment/watershed management (ICM) as an approach towards "wise use" of peatlands.

Course Outline

- Overview of soils: formation, concept of individual soils, basic properties (physical, chemical and biological), soil taxonomy, wetlands
- Peat soils: genesis, properties and behaviour, taxonomy and mapping
- Soil Quality and Performance: concept of soil quality/soil health and its assessment, soil resistance and resilience, carrying capacity and sustaining biological productivity, soil remediation
- Land evaluation: land evaluation for land-use planning, interpretations for various soil uses, controls in land-use planning
- Sectoral land use: agriculture, forestry, plantation, nature, infrastructures, etc., land-use conflicts, wise sectoral land use
- Land use change: spatial and temporal monitoring of changes, impact on ecosystems, the peatland case
- Soil conservation management: land degradation (focus on erosion and peat soil subsidence), integrated approach to peat soil/land conservation, agricultural land and water management on peatland

Learning Units

LU1. General understanding of soil with a comprehensive treatment of peat soils

LU2. Concept of soil quality and performance, and principles and practices in land evaluation for land-use planning as related to resource evaluation, allocation and utilization

LU3. Land use - Sectoral needs and conflicts, land use change and impact, and case analyses for peatland

LU4. Integrated Soil Conservation Management with emphasis on agricultural development of peatland.

Course contents

LU 1	Overview of soils and peat: Targeting at postgraduate students from different disciplinary backgrounds, this LU will introduce soils from historical and philosophical perspectives as much as from the scientific and utilitarian perspectives. Topics include concepts in soil formation and of individual soils; basic physical, chemical and biological behaviour and how these relate to soil's use and the environment; organizing soil information covering soil survey and classification including Soil Taxonomy; and brief overview of wetlands. The treatment is then extended to peat soils and the attendant issues pertaining to peat soils use. Reading list includes recent comprehensive textbooks on soils, compendiums on soils and sustainable land use, and on peatlands.

LU 2	Soil quality, performance and land evaluation: This learning unit deals with concepts in resource evaluation, allocation, and use. Theoretical background is covered under various topics that include concept of soil quality or soil health and methods of assessment/evaluation; soil resistance and resilience; carrying capacity and sustaining biological productivity; soil remediation. The second part of the learning unit deals with land evaluation for land-use planning, land capability classification systems, land evaluation and site assessment, interpretations for various soil uses, land potential ratings, and controls in land-use planning.
LU 3	Land use: This learning unit will discuss principles, ideals and realities of landuse management and practices in Malaysia and in other countries for comparative evaluation. Techniques and tools for monitoring of land use change and its impacts will also be elaborated. Formal instruments in landuse management will include the landuse and natural resources policies and strategies as embodied in the National Development Plans, Structure Plans and published agendas such as the "Strategi Pembangunan Mampan dan Agenda 21 Selangor". Included too are the codified guidelines of the Department of The Environment, Forestry, Fisheries, Land and Mines with regards to landuse and resource utilization. The learning unit should be heavily oriented towards case analysis that will illustrate the success and failures; uses and abuses; management and mismanagement and impacts on the larger ecosytem. Suggested studies are as follows: • Pros and cons of the Green Revolution as landuse and resource enhancement strategies in relation to rice production in Asia. • Sustainable Development of Wetland Habitats. • Case studies on successes of pineapple and oil palm on peat, problem cases like sago plantation development and Kalimantan mega rice project, and sustainability of smallholder approach. • Nature conservation areas such as Sarawak's Loagan Bunut National Park.
LU4	Integrated soil conservation management: LU4 deals with problems of land degradation with emphasis on soil erosion and peat soil subsidence. Attention will be given to water management aspects in peatland conservation and utilization especially for agriculture. Integrated catchment management (ICM) concept will be introduced and subsequently elaborated for peat basins – these include watershed management approach, issues and conflicts, analysis and planning, preventive measures and action plans, institutional framework and challenges in ICM.

Key references

Brady, N.C., and R.R. Miller, 2002. The Nature and Properties of Soils, 13th edition. Prentice Hall, New Jersey.

Dasmann, R.F., Milton and Freeman, 1973. Ecological Principles For Economic Development, John Wiley & Sons Ltd., London.

Doran, J.W., and A.J. Jones (eds). 1966. Methods for Assessing Soil Quality. SSSA Special Publication no.49. Madison, Wis., Soil Sci. Soc. Amer.

Fischer, A.C., 1983. Resource And Environmental Economics, Cambridge University Press, Cambridge.

Miller, R.W. and D.T. Gardner. 2001. Soils in Our Environment, 9th edition. Prentice Hall, New Jersey.

O'Callaghan, J.R. 1996. Land use: The interaction of economics, ecology and hydrology. Chapman & Hall, London.

Pierce, D.W. and Turner, R.K., 1990. Economics of Natural Resources and the Environment, John Hopkins University Press, Baltimore.

Pimentel, D. (ed), 1993. World soil erosion and conservation. Cambridge Univ. Press, Cambridge.

Sarre, P., Hodder and Stoughton (eds), 1991. Environment, Population and Development.

Syers, J.K. & D.L. Rimmer (ed), 1994. Soil science and sustainable land management in the tropics. CAB International, Wallingford.

William Thomas Jr. (ed), 1966. Man's Role in Changing The Face Of The Earth,Werner Green Foundation For the Anthropological Research and the National Science Foundation, University of Chicago Press.

Chan, H.T., Ong, Gong and Sasekumar, 1993. The socio-economic, Ecological and Environmental Ecosystems in Malaysia and the Present state of conservation in Southeast Asia and Pacific Region, International Society For Mangrove Ecosystem.

Jabatan Alam Sekitar (JAS), 1993. Buku Panduan Kawasan Sensitif Alam Sekitar Malaysia, Kementerian Saions, Teknologi dan Alam Sekitar.

Jabatan Perancangan Bandar dan Desa (JPBD), 1997. Garis Panduan Perancangan Pemeliharaan Topografi Semulajadi di dalam Perancangan dan Pembangunan Fizikal Mengikut Akta Perancangan Bandar dan Desa 1976.

Jabatan Perhutanan Malaysia, 1995. Manual Perhutanan Semenanjung Malaysia.

Malaysian Institute of Economic Research (MIER), 1990. Economic Policies for Sustainable Development: Implementing the Brundtland Commission in Malaysia.

Oh, C.,1998. Highland Development : An Integrated Approach to Policy, Planning and Management, Bengkel Alam Sekitar JPBD, Semenanjung Malaysia.

Perancangan Bandar Dan Desa Negeri Selangor Darul Ehsan dan Lestari Unuversiti Kebangsaan Malaysia, 1999. Strategi Pembangunan Mampan dan Agenda 21 Selangor.

Ramakrishnan, S., 1998. Pembangunan Tanah Lembah: Isu-isu Berkaitan, Bengkel Alam Sekitar Jabatan Perancangan Bandar dan Desa Semenanjung Malaysia.

Structure Plans, Local Plans of the various districts, municipalities and selected towns and cities of Malaysia published by the Town and Country Planning Department, throughout the nineties.
The Seventh and Eight Malaysia Plans.

Course highlights

Exposure and analysis of case studies on successes and problems/failures in land use planning and peatland utilzation

Assessment

Written examination: 50%

Assignments: 30%

Classroom attendance, presentation skills and participation: 20%

COURSE 4: HUMAN DIMENSION AND RESOURCE ECONOMICS

Course Code:	STP5144	**Week**	28 - 32
Course Title:	**Human Dimension and Resource Economics**	**Credit (Hours)**	4 (56)
Course Facilitator(s):	Assoc. Prof. Dr. Gabriel T. Noweg	**Email**	
Resource persons		**Email**	

Course Objectives:

The objectives of the course are:

1) To provide students with a broad knowledge of the planning requirements in development.
2) To expose students to simple (common techniques) in economic analysis, project planning and appraisal.
3) To familiarize students with various aspects of the human dimension in both the planning and management stages of development projects.

After completing the course students would be able to:

(a) Undertake simple economic analysis of development plans
(b) Draw up plans for small development projects
(c) Making appraisal and economic evaluation of development projects

Course Synopsis:

The course deals with development planning, resource and environmental economics with special emphasis on their human dimensions. Topics include project plans and its relationships to national development objectives and plans; project appraisal & economic evaluation encompassing environmental and social impact assessment as a requirement in national development planning. Key human (social) elements associated with the planning and economic decision making processes in development are also discussed.

Learning Units

LU1: Appraisals of human dimension and issues in development economics, planning and evaluations.
LU2: Nature and scope of development planning; development objectives, project cycles and planning processes.
LU3: Basic Concepts in Development and Key Environmental Concerns
LU4: Economics of pollution and environmental degradation.
LU5: Natural Resource Economics, Resource Utilization, and Natural Resource Accounting
LU6: Economic Appraisals and the Human Elements in Development
LU7: Environmental and Social Impacts Assessment (SIA) in Development Planning
LU8: Project Planning and Management for the Future
LU9: Case studies: Economic analysis of local plans or development projects.

Course contents

Course contents

LU 1	Appraisals of human dimension and issues in development economics, planning and evaluations. - Social and economic Issues in development - Introduction to Development Planning - Concepts of Development Economics and Development Planning - Levels of planning (both operational and spatial); planners and planning agencies - Planning in Developing countries. Ref: Conyers and Hills (1984); Kasliwal (1995).
LU 2	Nature and scope of development planning; development objectives, project cycles and planning processes. - Project and project management: definitions, parameters and scope - Project and development plans: contexts in local, national and regional developments - Project plans in relations to development objectives: private versus societal goals - Project cycles, planning cycle, and economic tools - Planning goals and the stakeholders' question (developer and the society) Ref: Ayob (1989); Noweg (2000), Weiss and Wysocki (1992); Kerzner (1995)

LU 3	Basic Concepts in Development and Key Environmental Concerns - Fundamental environmental issues in Development Planning and Management - Environmental management concepts - Principles and theories in natural resource and environmental economics - Institutions, ethics, risks and future generation. Ref: Tietenberg (2000); Perman et al. (2003)
LU4	Economics of Pollution and Environmental Degradation - Concepts in pollution economics - Taxation and optimal pollution - Environmental standards and measurements of environmental damages - Pollution control and policy
LU5	Natural Resource Economics, Resource Utilization, and Natural Resource Accounting - Concepts of resource economics and resource use - Renewable and exhaustible resources - Resource utilization, sustainable yield and natural resource accounting - Forest resource management and timber rents - Sustainable resource management: the politics and challenges for developing countries Perman et al. (2003); Tietenberg,(2000)
LU6	Economic Appraisals and the Human Elements in Development - Appraisal and project evaluation: concepts and techniques. - Pricing and valuing costs and benefits, valuation of environmental and natural goods; intangibles; ethical issues in evaluations - Economic feasibility; Project worth: benefit-cost ratio, net present value, social net benefits; - Inter-generational issues: - resource exploitation and rate of discount, etc. - Human resource development – community empowerment, organization, training. Ref: Kerzner (1995); Ayob (1989); Gittinger (1982); Cocker and Richards (1992); Perman et al. (2003); Georgiu et al. (1997).
LU7	Environmental and Social Impacts Assessment (SIA) in Development Planning - Impacts assessment: role and relationship to planning to planning, policy, politics and management - Briefs on environmental Impact Assessment (EIA) and its relation to Social Impact Assessment (SIA) - Elements of SIA; SIA and sustainable development; SIA and the planning process; - Case discussions: (1) conservation areas; (2) relocation, resettlement and migration, (3) hazards and diseases - Issues, problems and future challenges in SIA. Ref: Barrow (1997); Glasson et al. (1999); Morgan (1998); Hanley and Spash (1995).
LU8	Project Planning and Management for the Future - Contemporary issues in project management: customer/clientele focus, program management, stakeholder analysis, organizational changes - The roles of various laws (Federal laws, State Laws [Ordinances], Native Land Rights, Customary Rights). - Project planning and management in contemporary environments - Excellence in project management; Quality Management: ISO 9000 series, etc. Ref: Weiss and Wysocki (1992); Kerzner (1995).
LU9	Case Studies: analysis of local project plans - Cases of local project plans will be discussed. The focus will be on human problems and issues associated with these plans. Students will work in groups. Materials to be used in this exercise will be made available to students ahead of time to allow sufficient time for pre-class review and group discussions. Each group will present its analysis both orally and in the form of a brief report.

Key References:

Ayob, A.M. 1989. Perancangan dan penilaian projek pembangunan. Kuala Lumpur: DBP. 231 pp.

Barrow, C.J. 1997. Environmental and social impact assessment: an introduction. London: Arnold. 310 pp.

Carew-Reid, R., S. Prescott-Allen, S. Bass and B. Dalal-Clayton. 1994. Strategies for national sustainable development: a handbook for their planning and implementing development. London: Earthscan Publications Ltd. 203 pp.

Carley, M. and I. Christie. 1992. Managing sustainable development.London: Earthscan Publications Ltd. 303 pp.

Coker, A. and Richards, C. (Eds.) 1992. Valuing the environment: economic approaches to environmental evaluation. A proceeding of a workshop held at Langrove Hall, Middlesex Polytechnic. London: Balhaven Press. 183 pp.

Conyers, D. and P. Hills. 1984. An introduction to development planning in the Third World. New York: John Wiley & Sons Ltd. 271 pp.

Farrington, J., A. Bebbington, K. Welland and D.J. Lweis. 1993. Reluctant partners: non-governmental organizations, the state and sustainable development. 222 pp.

Georgiu, T., D. Whittington, D. Pearce, and D. Moran. 1997. Economic values and the environment in the developing world. Cheltenham: Edward Elgar. 167 pp.

Glasson J, A. Therival and A. Chadwick. 1999. Introduction to environmental impact assessment: principles and procedures, practice and prospects. London. UCL Press Limited. 496 pp.

Hanley, N. and C.L. Spash. 1995. Cost-benefit analysis and the environment. Brookfield, Vermont USA: Edward Edgar Publishing Ltd. 278 pp.

Morgan, R.K. 1998. Environmental impact assessment: a methodological perspective, London: Kluwer Academic Publishers. 307 pp.

Mosse, D., J. Farringdon and A. Rew. 1998. Development as a process: concepts and methods for working with complexity. London: Routeledge. 202 pp.

Perman, R., Y. Ma, J. McGilvray and M. Common. 2003. Natural resource and environmental economics. Harlow: Pearson Education Limited. 699 pp.

Szirmai, A. 1997. Economic and social development: trends, problems and policies. London: Prentice Hall. 483 pp.

Spinner, M. 1992. Elements of project management: plan, schedule, and control. Englewood Cliffs, New Jersey: Prentice Hall. 211 pp.

Tietenberg, T. 2000. Environmental and natural resource economics. New York: HarperCollins Addison-Wesley. 630 pp.

Gittinger, J.P. 1982. Economic analysis of agricultural projects. Baltimore: The John Hopkins University Press. 505 pp.

Wysocki, R., R. Beck and D. Crane. 2000. Effective management. New York: Wiley & Sons, Inc. 359 pp.

Other references (for case studies/evaluations) *** subject to changes

Bowie, A. 1991. Crossing the industrial divide: state, society, and the economic transformation in Malaysia. New York: Columbia University Press. 222 pp.

Clearly, M. and P. Eaton. 1992. Borneo: Change and Development. Oxford University Press. 271 pp.

Cleary. and P. Eaton. 1996. Tradition and Reform: land tenure and rural development in South-East Asia. Oxford University Press. 148 pp.

IDEAL. 1999. Tanah Pengidup Kitai (Our Land is our Livelihood). Sibu, Sarawak: IDEAL. 90 pp.

Course highlights

1. Role –playing in decision-making process in planning based on economic and environmental analytical tools – a hypothetical planning problem is discussed where each student is assigned a role to play
2. Economic analysis of selected planning problem or development projects (actual cases in Sarawak, Malaysia).

Assessment

a. Writing assignments: 20%
b. Case Analysis of projects: 30%
c. Examinations: 50%

COURSE 5: GIS AND REMOTE SENSING FOR PEATLAND MANAGEMENT

Course code	STP5154	**Session**	2005/2006
Course title	**GIS and Remote Sensing for Peatland Management**	**Credit/ Hours**	4 (56 hrs)
Course facilitator	Dr Harwant Singh	**E-mail**	terratee@frst.unimas.my
Resource person(s)	Dr Harwant Singh (UNIMAS) Daniel de Roo (Wageningen University, Holland)		

Course objectives

The objective of the RS/GIS Module is to impart the understanding and relating basic conceptual notions in geo-information science to the geographical reality through understanding the processes of geo-data capture, storage and handling/processing.

After completing the module students would be able to:

1. Describe the methodology of data captured in Remote Sensing
2. Understand the data and its significance
3. Awareness of the approach in interpreting the data
4. Describe the components of G.I.S. technology
5. Realization of the concept of abstraction of reality
6. Understand the data-integration phase in the geo-information cycle
7. Appreciate the limitations of the geo-data.

Learning Units

LU1 Remote Sensing I
LU2 Remote Sensing II
LU3 Introduction to G.I.S.
LU4 Data Integration in G.I.S.

Course synopsis

The Module consists of essentially two independent subject areas as follows.

1. Remote Sensing
2. Geographical Information Systems

In the Remote sensing part the course coves the essential aspects, namely, the use of electromagnetic radiation through the description of the techniques for data collection, understanding the spectral signatures and the techniques for imagery analysis focusing on vegetation. Aerial Photography utilizing the concerned parts of the EM spectrum is also covered.

For Geographical Information System part the 'tool' aspect of this technology is explained but more vitally, this course imparts the realization and appreciation that earth is dealt with as an abstraction of reality. The components of the 'tool' are explained followed by the crucial understanding of what the manipulations of this 'tool' represent and seek to achieve.

Course contents

LU 1	Remote Sensing I 1. Introduction to Remote Sensing The basic concepts of Remote sensing (RS) in obtaining information about objects or areas at the Earth's surface by using electromagnetic radiation without being in direct contact with the object or area will be introduced.
	2. Aerial Photography The basic concepts of Aerial Photographic systems utilizing the visible and the near-infrared (NIR) parts of the EM spectrum will be presented.
	3. Multi-Spectral Scanning This part will take a closer look at the remote sensing platforms and sensors and the data they collect in greater detail.

LU2	Remote Sensing II 1. Introduction to Visual Image Interpretation This part will focus on the process of acquisition of information by visual image interpretation. It deals with the elements of visual perception and photo interpretation and understanding how these elements can be used in comprehensive image interpretation 2. Introduction to Spectral Image Interpretation (a) Spectral Signatures The concept of a "spectral signature" i.e. variations of reflected (or absorbed) EM radiation as function of wavelengths, the widely used approach to identifying and separating different materials or objects with the main focus on vegetation using multispectral data obtained by remote sensors will be studied. (b) Introduction to Digital Image Processing and Classification Meaningful information is extracted from remote sensing data through interpretation and analysis of the imagery. The process of identification of various targets in an image will be discussed.
LU3	Introduction to G. I. S. The Geographical Information System is a tool for recording and obtaining information from "Geospatial data". These characteristics of natural features and boundaries on the earth represent an abstraction of reality. The understanding of the conceptualization or the creation of a model of reality and the components of the 'tool' aspect of G.I.S. will be covered.
LU4	Data Integration in G. I. S. The next **data-integration phase** in the geo-information cycle enables the data available in a geo-database to be made usable. The stages involved will be discussed and it is essential to understand how these stages manipulate the data. 1. Data Handling, Querying and Data Action Model The analytical data handling options of the data-integration phase for geographical data for such options ranging queering to complicated and complex analyses such as linking data in a step-by-step process to derive new information. The application of geo-information systems and other geo-data handling software to handle a geo-data handling task (analytical data handling options ranging from queering to complicated and complex analyses such as linking data in a step-by-step process to derive new information) requires its breaking down into a data handling procedure which requires the understanding of the types of data structures as well as the data handling procedures. The framework of the classification of the three main data handling procedure classes will be studied and the so-called data-action model, an instrument to conceptually define the geo-data handling procedure, will be described. 2. Transforming and processing This part describes the theoretical concepts transforming data (raster-vector transformation; vector-raster transformation) and introduces the three classes of processing (attribute processing; neighbourhood processing and 'overlay' processing procedures).

Key references

Buiten H.J. & Clevers, J.G.P.W., 1993. Land Observation by Remote Sensing Theory and Applications. Gordon and Breach Science Publishers, Reading. 642 pp.

Burrough, P.A., 1986. Principles of geographical information systems for land resources assessment. Oxford: Claridon Press.

Burrough, P.A. and McDonnell, R.A., 1998. Principles of geographical information systems, Oxford Uni. Press

Campbell, J.B., 1996. Introduction to Remote Sensing. Guilford, New York.

Clevers, J.G.P.W., 1986. Application of remote sensing to agricultural field trials. Ph.D. Thesis, Agricultural University Wageningen Papers 86-4, 227 pp.

Clevers, J.G.P.W., 1988.. The derivation of a simplified reflectance model for the estimation of leaf area index. Remote Sens. Environ. 25: 53-69.

Colwell R.N. (Ed.), 1983. Manual of Remote Sensing. Second Edition. Vol I: Theory, Instruments and Techniques. American Society of Photogrammetry and Remote Sensing ASPRS, Falls Church.

Curran P.J., 1985. Principles of Remote Sensing. Longman Group Limited, London. 282 pp.

Elachi C., 1987. Introduction to the Physics and Techniques of Remote Sensing. Wiley Series in Remote Sensing, New York, 412pp.
Hoffer, R.M. & C.J. Johannsen, 1969. Ecological potentials in spectral signature analysis. In: Remote Sensing in Ecology. Ed. P.L. Johnson, Univ. of Georgia Press, Athens, Georgia, pp. 1-16.
Hyatt E., 1988. Key Guide to Information Sources in Remote Sensing. Mansell Publishing Limited, London.274 pp.
Jensen, J.R., 2000. Remote Sensing of the Environment – An Earth Resource Perspective. Prentice Hall, Upper Saddle River, NJ.
Knipling, E.B., 1970. Physical and physiological basis for the reflectance of visible and near-infrared radiation from vegetation. Remote Sens. Environ. 1: 155-159.
Küchler, A.W. and Zonneveld, I.S., 1988. Vegetation Mapping. Kluwer, Dordrecht.
Lillesand T.M. & Kiefer R.W., 2000. Remote Sensing and Image Interpretation. John Wiley & Sons, New York. 724 pp.
Maguire, D., M. Goodchild and D. Rhind, 1991. Geographical Information Systems, Longman Scientific
Shay, J.R. et al., editors, 1970. Remote Sensing, with special reference to agriculture and forestry. Washington, Nat. Acad. of Sciences, 424 pp.
Star, J. and Estes, J., 1990. Geographic information systems, Englewood Cliffs New Jersey: Prentice Hall.
Tomlin, D., 1990, Geographic Information Systems and Cartographic Modelling, Prentice Hall
Wielemaker, W.G., and Ketner, P, 1997. Aerial photography and interpretation. In: Epema, G.F. (Ed.), Remote Sensing for Landscape Analysis. Wageningen University, pp. 23-71.

Course highlights

Practical exercises will be carried out where appropriate to illustrate the concepts. In doing so students will be exposed to Arc GIS and an appropriate RS softwares

Assessment

Written examination:	60%
Assignments:	40%

COURSE 6: CROSS DISCIPLINARY RESEARCH METHODOLOGIES

<table>
<tr><td>Course code</td><td>STP5113</td><td>Week</td><td>19 - 22</td></tr>
<tr><td>Course title</td><td>CROSS DISCIPLINARY RESEARCH METHODOLOGIES</td><td>Credit/ Hours</td><td>3 Credits</td></tr>
<tr><td>Course facilitator(s)</td><td>Assoc Prof Dr Lau Seng</td><td colspan="2">E-mail</td></tr>
<tr><td>Resource person(s)</td><td>Prof Murtedza Mohamed
Assoc Prof Dr Gabriel Tonga Noweg
Assoc Prof Dr Lau seng
Assoc Prof Dr Mustafa Abd Rahman
Dr Charlie Laman
Dr Lee Nyanti</td><td colspan="2">E-mail</td></tr>
<tr><td colspan="2">Course objectives
The objective this course is to impart to the students the necessary skills in both qualitative and quantitative natural and social scientific methods relevant to the needs of natural resources management. The specific objectives are to enable students to:
• understand the major theoretical and philosophical approaches to research in natural and social sciences and their relevance to natural resources management.
• acquire skills in research problem formulation, proposal writing, research design, and data collection.
• become familiar with the major techniques in natural and social scientific research, particularly in areas relating to hydrological measurements, ground and surface water and wastewater sampling and analysis, biological methods, soil analysis, socio-economic appraisals, perception and opinion surveys, and statistical methods.</td><td colspan="2">Learning Units
LU 1. Statistical Methods
LU 2. Natural scientific methods
LU 3. Social scientific methods</td></tr>
<tr><td colspan="4">Course synopsis
Statistical methods: Definitions; population and sample, data distributions, probability plots; parametric and non-parametric tests for 2 and multiple sample comparisons: simple linear regression; ANOVA and Chi-square tests. Interpreting and communicating research statistics and findings.
Natural scientific methodologies: Surface water, groundwater and wastewater sampling and analysis; introduction to hydrological methods; river classification; soil sampling and analysis; biological methods;
Social scientific methodologies: Introduction to social research; empiricism vs subjectivism; study population, sample and sampling procedures; interviews and etiquette in social inquiry; questionnaires and household surveys; participatory action research (PAR) and participatory rural appraisal (PRA).</td></tr>
<tr><td colspan="4">Course contents</td></tr>
<tr><td>LU 1</td><td colspan="3">The definition and basic steps of statistical data analysis; the concepts of data collection methods, population versus sample, quantitative and qualitative data, hypothesis testing,. Overview of the normal distribution; probability plots, transformations of a given variable, descriptive statistics, the 95% confidence interval; Parametric and non-parametric tests for 2 sample comparisons: Independent sample t-test, Mann Whitney test and Wilcoxon-sign rank test; simple linear regression and Pearson’s correlation coefficient and Spearman’s rho correlation coefficient. Parametric and non-parametric tests for multiple sample comparisons: One-way and two way ANOVA, Kruskal-Wallis test and Friedman’s test; Chi-square test for discrete data in a contingency table. Interpreting and communicating research statistics and findings. Tutorial sessions of statistical computations using statistical packages.</td></tr>
<tr><td>LU 2</td><td colspan="3">Introduction to social research: Philosophy, epistemology, empiricism versus subjectivism, qualitative approaches in social sciences, quantitative approaches in social sciences.</td></tr>
</table>

	Study population, sampling, sampling design and procedure: Definitions – census versus sample, determining study population and sample, and sampling design. Data Collection: Secondary data collection and use, sources of secondary data, advantages of using secondary data, limitations and pitfalls. Primary data collection, use, advantages and limitations, instrumentation, interviews and etiquette in social inquiry; Rapid Rural Appraisal (RRA) and Participatory Rural Appraisal, definition and distinctions between RRA and PRA.
LU 3	Natural scientific methodologies: Methods for groundwater, surface water and wastewater sampling, sample preservation and sample analysis; introduction to hydrological methods (flow, channel profile, rainfall etc); river classification. Soil sampling and analysis; methods for measurement of subsidence, water table, hydraulic conductivity, bulk density, pH etc.; biological methods: random and systematic sampling (line and belt transects), plant sample collection, biomass estimation; assessment of aquatic resources; indicator species for stream pollution; biological indices.

Key references

Latest edition of APHA Methods for Water and Wastewater Analysis.

Gunston H (1998). *Field Hydrology in Tropical Countries: A Practical Introduction*.

DOE Technical Report: Development of Water Quality Criteria and Standards - River Classification.

Dumanski, J (1997). Criteria and indicators for land quality and sustainable land management. *Proc. Intern. Conf. on Geoinfo. for Sustainable Land Management.* Enschede, NL. CD-ROM.

Landon J R (1991). *Booker Tropical Soil Manual – A Handbook for Soil Survey and Agricultural Land Evaluation in the Tropics and Sub-Tropics*. Longman. London.

Soepadmo, E. (1987). Structure, above ground biomass and floristic composition of forest formations at Gunung Janing Barat, ulu Endau, Johore, Malaysia. *Malayan Nature Journal Vol. 41*: 275-290

Yamakura, T., Hagihara, A., Sukardjo, S. and Ogawa, H. (1986). Aboveground biomass of tropical rain forest stands in Indonesia Borneo. *Vegetation 58*: 71-82.

Martin G. (1993). *Ethnobotany: A Methods Manual*. Chapman & Hall, London.

Babbie, E. 1998. The Practice of Social Research. 8 th. Edn. Belmont, CA: Wadsworth Publishing Company. 112 pp.

Black, T. R. 1999. Doing Quantitative Research in the Social Sciences: an integrated approach to research design, measurement and statistics. London: SAGE Publications Ltd. 751 pp.

McCall, C. H. 1982. Sampling and Statistics Handbook for Research. Ames, Iowa: Iowa State University Press. 340 pp.

Marshall, C. and G. B. Rossman. 1999. Designing Qualitative Research (3 rd. Ed.) London: SAGE Publications. 224 pp.

Pratt, B. and P. Loizos. 1992. Choosing Research Methods: data collection for development workers. Oxford: Oxfam. 120 pp.

O'Sullivan and Rassel, Research Methods for Public Administrators, 3rd ed., 1999, Longman

Foster, J. J. 1998. Data Analysis Using SPSS for Windows. A beginner's Guide. Sage Publications, London.

Harraway, J.A. 1997. Introductory Statistical Methods and the Analysis of Variance. University of Otago Press, Dunedin.

Ott, L. 1988. An Introduction to Statistical Methods and Data Analysis. 3rd. Edition. PWS-Kent Pub. Co., Boston.

Steel, R.G.D. and Torrie J.H. 1980. Principles and Procedures of Statistics. A Biometrical Approach. McGraw-Hill, Singapore.

SPSS Inc. (1999). The Basics: SPSS for Windows 10.0. SPSS Inc. Training Department, Chicago.

SPSS Professional Statistics 7.5. SPSS Inc. Training Department, Chicago.

SPSS Advanced Statistics 6.1. SPSS Inc. Training Department, Chicago.

Zar, J.H. 1996. Biostatistical Analysis, 3rd. Edition. Prentice Hall., New Jersey.

Course highlights

- Cross-disciplinary exposure to research methodologies (preparation and testing of questionnaires)
- Exercises for river classification exercise, biomass estimation etc.
- Use of statistical software (SPSS Version 10.0 and MS-Excel).

Assessment

Written examination: 50%

Assignments: 50%

APPENDIX 2

RESOURCE PERSONS

- Prof Dr Murtedza Mohamed – Fac. of Resource Science & Technology;
- Prof Wan Sulaiman Wan Harun – Fac. of Resource Science & Technology;
- Assoc Prof Dr Andrew Alek Tuen
- Assoc Prof Mustafa Abdul Rahman (Dr) – Fac. of Resource Science & Technology;
- Assoc Prof Cheksum Tawan - Fac. of Resource Science & Technology;
- Assoc Prof Dr Lau Seng – Fac. of Resource Science & Technology;
- Assoc Prof Dr Gabriel Tonga Noweg – Fac. of Social Science;
- Dr Siti Rubiah Zainudin - Fac. of Resource Science & Technology;
- Dr Harwant Singh - Fac. of Resource Science & Technology;
- Prof Salim Said – Fac. of Engineering;
- Dr Nabil Bessaih – Fac. of Engineering;
- Dr Lee Nyanti – Fac. of Resource Science & Technology;
- Dr Petrus Bulan – Fac. of Resource Science & Technology.

Guest Lecturers

- Dr Tie Yiu Liong (Agrosol Sdn Bhd, Sarawak);
- James Dawos Mamit (Natural Resource & Environment Board, Sarawak);
- Yogeswaran Mailvaganam (Geological Survey Department - retired);
- Counterparts from Wageningen University.
- Counterparts from University of Leicester

APPENDIX 3

UNIMAS POST GRADUATE STUDIES REGULATIONS (PGSR)
Regulations for Masters Degree and Postgraduate Diploma via Coursework

These regulations, as from time to time amended, shall apply to all postgraduate students of Coursework Programmes, and shall be deemed a part of the terms and conditions under the Unimas Postgraduate Studies Regulations and the Faculty's Regulations.

1. Admission Requirements

   A candidate for a Coursework Programme must possess:

   1.1 A bachelor's degree with a minimum CGPA of 2.5 or an equivalent second Class Honours from a recognised University, or

   1.2 A bachelor's degree with at least two years of full-time relevant working or professional experience, or

   1.3 Other equivalent qualifications approved by the Senate.

2. Registration

   2.1 A candidate must register as full-time or part-time and pay all stipulated fees at the time of registration.

   2.2 Enrolment into a coursework programme shall normally be conducted at the beginning of semester 1 and semester 2.

   2.3 A student may enrol either as a full time or part time candidate.

   2.4 A candidate is not allowed to register after the fourth week of the semester. In exceptional circumstances, a candidate may be permitted at the discretion of the Dean of the Centre for Postgraduate Studies to register on other days; and in such cases, and additional late registration fee may be charged to the candidate.

3. **Interruption of Studies**

   3.1 A registered candidate may interrupt his/her registration due to valid reasons acceptable to the Senate. This interruption will not be considered part of the duration of study.

   3.2 The interruption shall be for a period of not less than one semester and not more than two semesters.

   3.3 a candidate who has been granted permission to interrupt his/her studies will not be considered as a registered student. With that, he/she is not allowed to use the facilities provided by the University except for consultations with their supervisors regarding his/her study.

4. **Fees**

4.1 Tuition fees are payable on semester basis.

4.2 Examination fees are included in the tuition fees, but any fee for re-examination shall be paid separately.

4.3 A candidate may request a review of his/her evaluation results if he/she is not satisfied with them. In such a case, the Faculty Postgraduate Committee will review the results as requested after the student has paid a review fee.

4.4 Additional incidental fees may be charged for specific services, such as late registration, conversion from full-time to part-time student or vice versa, library fines, special courses, and field trips.

4.5 All fees are non-transferable.

4.6 A refund of any fee shall be made only in exceptional cases.

5. **Duration of Study**

5.1 The duration of full-time study is from two to six semesters; and for the part-time study; it is from three to ten semesters;

5.2 The period of interruption of registration will not be considered part of the duration of study.

6. **Course Requirements**

The course requirements are subjected to individual Faculty programmes, and may range from 20 to 30 credits for Postgraduate Diploma and 36 to 46 credits for masters degree.

7. **Examinations**

7.1 The Faculty will establish a board of examiners for each programme. Each board shall include all the examiners who are involved in the teaching of the courses in the programme, who shall have regard to the totality of each degree programme and who shall be involved and particularly influential in the decisions relating to the award of every degree. The board be able to specifically comment and give judgment on the validity and integrity of the assessment process and the standard of student attainment.

7.2 Examination procedures shall ensure that assessment is and can be demonstrated to be fair and impartial.

7.3 In the case of students failure to satisfy the criteria for progression, the Faculty Postgraduate Committee will specify the form of re-evaluation (e.g. by re-examination or repeating a course) and the time needed before the student can proceed with his/her studies.

7.4 Schemes of examination shall be prescribed in the individual programmes regulations and unless the individual programme regulations indicate otherwise shall include the submission of a significant piece of individual work in the form of an essay, report or dissertation which may be based on a project of fieldwork.

7.5 A candidate wishing to defer sitting one or more examinations must first obtain the support of his or her supervisor and submit a written application for deferring the sitting of the specific examination to the Faculty Postgraduate Committee. Where such an essay/report/dissertation is submitted later than the specified date the faculty shall at its discretion either disregard its lateness or not consider it at all or, having considered it, award lower marks or grades for it than would otherwise have been awarded.

7.6 If the essay, report or dissertation is adequate except that it requires minor amendment the examiners may required the candidate to make within one month the amendment specified by them or one of their number nominated by them.

7.7 In exceptional circumstances examiners shall have the discretion to require a student to be examined orally in one or more components of his/her examination.

7.8 Where the regulations permit a candidate to offer work written outside the examination room, the work submitted must be certified to be his/her own and any quotation from the published or unpublished works or other persons must be acknowledged.

8. Student Responsibilities

8.1 The student is fully responsible for the completeness and accuracy of registration and payment of all fees.

8.2 Students shall state at the time of registration their full addresses (home, office and e-mail) and phone numbers where they can easily be contacted. The Faculty must be informed of any change of correspondence address within 14 days of the change.

8.3 Students shall comply with all requirements of the rules, regulations and procedures of the University and the Programme, at the time being in force.

8.4 Students who fail to conform to any of the University regulations, or who are responsible for any form of academic dishonesty or misconduct in the course of their academic pursuits, are subjected to administrative action and/or disciplinary penalties, which may include expulsion from the University.

9. Conferment of Degree

9.1 The degree will be awarded to candidates who have fulfilled all requirements;

9.2 The degree will be conferred by the Senate of the University upon recommendation from the Centre for Postgraduate Studies.

10. Termination of Candidature

10.1 A student's candidature may be terminated at any time by the University in the event that the candidate is:

10.1.1 deemed unfit to further his studies in the University, as certified by a Medical Board selected by the University;

10.1.2 convicted of any crime which, in the opinion of the University is likely to bring the University into disrepute.

10.1.3 Guilty of insobriety or gross impropriety or misconduct.

10.2 The candidate has the right to appeal in writing against decisions made by the University related to his/her termination of study, and disciplinary matters.

10.3 An appeal to re-register will be considered within a period of one to three calendar years after withdrawal or dismissal from the University. Such an appeal will be granted only after the student's conduct, academic record and work experience have been reviewed by the Faculty Postgraduate Committee.