2012

M.Sc. and P.G.Diploma in
Geoinformation Science and Earth Observation

Specialisation

Natural Hazards and Disaster Risk Management (NHDRM)

under
IIRS – ITC Joint Education Programme

Course Syllabus & Study Guide

M.Sc. (Sep 2012 – Mar 2014)
PGD (Sep 2012 – Jul 2013)

Indian Institute of Remote Sensing
Indian Space Research Organisation
Dehradun - 248001

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Introduction

In recent times, the Geoinformatics Technology (GIT) has made significant progress due to availability of high resolution spatial data, information extraction techniques and mechanism/protocols for timely dissemination and utilization of such information. Acknowledging this significant progress and easy availability of technological solutions, disaster managers around the world are aiming at using GIT for mitigating the disastrous effect of natural and man-made disasters. Several international initiatives have been taken up to institutionalize the effective use of the GIT mainly Earth Observation data utilization through national and international frame work of disaster management. While executing such international and national initiatives to infuse GIT for Disaster Management (GIT4DM), it was widely felt and agreed that the key issue is the development of capacity to interpret, analyze and "put to use" such technological innovations through trained manpower and requisite facility. In order to address this, IIRS in collaboration with Faculty of Geo-Information Science and Earth Observation (formerly known as ITC), Twente University (TU), The Netherlands has introduced M. Sc and PG Diploma on Geoinformation Science and Earth Observation with specializations in Natural Hazards and Disaster Risk Management (NHDRM). These courses are being successfully organized as Joint Education Programme (JEP) between two institutions since 2001. The JEP has emerged as evolving programme moving in tandem with GIT which is growing at a rapid pace due to current advances in computing, communication and earth observation techniques.

- **Post Graduate Diploma in Geoinformation Science and Earth Observation with specialization in Natural Hazards and Disaster Risk Management (NHDRM):** It aims to develop expertise in applications of geo-informatics technology in assessment, quantification and spatial mapping of natural hazards and its role in disaster risk management.

- **M. Sc in Geoinformation Science and Earth Observation with specialization Natural Hazards and Disaster Risk Management (NHDRM):** It aims to develop research skills in developing advanced methodologies, modelling techniques and applications of remote sensing and geo-information science, specifically applied to natural hazards and disaster risk management.

Specialisations: These courses offer three specialisations as mentioned.

1. Environmental hazards	2. Geological hazards	3. Hydro–meteorological hazards
Land degradation Erosion Pest and diseases Drought Deforestation Forest fire hazards Forest degradation	Earthquake Landslides Ground water pollution Ground subsidence Mining hazards Urban hazards (geological)	Flood GLOF, avalanches Coastal hazards- erosion, salt water intrusion Tsunami Storm surge

COURSE PROGRAMME
M. Sc/ PG Diploma (NHDRM), 2012-14

Module and Duration	M. SC / PGD	Module Coordinators
Module 1 24.09.12 to 12.10.12	**Principle of Remote Sensing**	Vinay Kumar
Module 2 15.10.12 to 02.11.12	**Principles of GIS**	Rasmit Singh
05.11.12 to 09.11.12	Examination week for Module 1 and 2	
Module 3 12.11.12 to 30.11.12	**Principle of database**	Harish Karnatak
Module 4A 03.12.12 to 21.12.12	**Mathematics and Programming in Geoinformatics for Disaster management**	Kapil Oberai
Module 4B	**Mathematics and Programming in Geoinformatics for Disaster management (To continue from Module 5 to 10, 1st and 2nd Wednesday)**	Prasun Gupta
24.12.12 to 04.01.13	Winter Vacation	
Module 5 07.01.13 to 25.01.13	**Natural Hazards and Disaster Management: Concepts and Overview**	P.K. Champati ray
Module 6 28.01.13 to 15.02.13	**Image Interpretation and Analysis for Natural Hazards Assessment**	Ajanta Goswami
Module 7 18.02.13 to 08.03.13	**Application of Geo-informatics to Natural Hazards Mapping and Monitoring (Environmental / Hydro-Meteorological / Geological)**	Ajanta Goswami (Geological) Praveen Thakur (Hydromet.) Arijit Roy (Environmental)
Module 8 11.03.13 to 29.03.13	**Advance Remote Sensing for Natural Hazards study**	Heena Pandey
Module 9 01.04.13 to 19.04.13	**Advance GIS for Natural Hazards study**	Kapil Oberai
Module 10 22.04.13 to 10.05.13	**Application of Geo-informatics to Natural Hazards Modelling (Environmental / Hydro-Meteorological / Geological)**)	Ajanta Goswami (Geological) Praveen Thakur (Hydromet.) Arijit Roy (Environmental)
	PG Diploma Project Work (13 May-19 July 2013)	Project Guides (PG D)
Module 11 13.05.13 to 31.05.13	**Research Skill Development and M SC draft proposal development**	Shashi Kumar, P.K. Champati ray
03.06.13 to 07.06.13	Catch up week for VISA and proceed to ITC	
Module 12 to 15 10.06.13 to 31.08.13 (At ITC)	**Advance topics-1** **Advance topics-2** **Group/ individual Project** **Research Proposal Development**	Dr. Nicholas Hamm ITC Course Coordinator
02.09.13 to 06.09.13	Catch up week for return from ITC	
Module 16 to 23 09.09.13 to 21.03.14	**Thesis research work**	Thesis supervisors (M.Sc.)

PG Diploma in Earth Observation and Geoinformation Science
(Specialization: Natural Hazards and Disaster Risk Management)

Module Code	Module	Hours		Marks (Internal + Module end exam)	Credit
		Lecture	Lab/ Tutorial		
1- RS	Principle of Remote Sensing	26	72	100	5
2- GIS	Principles of GIS	26	72	100	5
3- D	Principle of Database		72	100	5
4A-MP	Mathematics and Programming in Geoinformatics for Disaster management	26	72	100	5
4B-MP	Mathematics and Programming in Geoinformatics for Disaster management (To continue from Module 5 to 10, 1st and 2nd Wednesday)	12	48	Audit	0
5- NHDM	Natural Hazards and Disaster Management: Concepts and Overview	26	72	100	5
6- IIA	Image Interpretation and Analysis for Natural Hazards Assessment	26	72	100	5
7- NHMM	Application of Geo-informatics to Natural Hazards Mapping and Monitoring (Environmental / Hydro-Meteorological / Geological)	26	72	100	5
8- ARS	Advance Remote Sensing for Natural Hazards study	26	72	100	5
9- AGIS	Advance GIS for Natural Hazards study	26	72	100	5
10- NHMD	Application of Geo-informatics to Natural Hazards Modelling (Environmental / Hydro-Meteorological / Geological)	26	72	100	5
11-14-PW	Project work		400	100	20
	Total				**70**

M.Sc. in Geo-information Science and Earth Observation
(Specialization: Natural Hazards and Disaster Risk Management)

Module Code	Module	Lecture (hr.)	Lab/ Tutorial (hr.)	Marks (Internal +Module end exam)	Credit	
1- RS	Principle of Remote Sensing	26	72	100	5	MSc +PGD
2- GIS	Principles of GIS	26	72	100	5	MSc +PGD
3- D	Principle of Database	26	72	100	5	MSc +PGD
4A-MP	Mathematics and Programming in Geoinformatics for Disaster management	26	72	100	5	MSc +PGD
4B-MP	Mathematics and Programming in Geoinformatics for Disaster management (To continue from Module 5 to 10, 1st and 2nd Wednesday)	12	48	Audit	0	MSc +PGD
5- NHDM	Natural Hazards and Disaster Management: Concepts and Overview	26	72	100	5	MSc +PGD
6- IIA	Image Interpretation and Analysis for Natural Hazards Assessment	26	72	100	5	MSc +PGD
7- NHMM	Application of Geo-informatics to Natural Hazards Mapping and Monitoring (Environmental / Hydro-Meteorological / Geological)	26	72	100	5	MSc +PGD
8- NHMD	Advance Remote Sensing for Natural Hazards study	26	72	100	5	MSc +PGD
9- ARS	Advance GIS for	26	72	100	5	MSc

	Natural Hazards study					+PG D
10-AGS	Application of Geo-informatics to Natural Hazards Modelling (Environmental / Hydro-Meteorological / Geological)	26	72	100	5	MSc +PG D
11- RSD	Research Skill Development	26	72	100	5	Module 11 to 14 Project work for PG Diploma (11 weeks) PG D Thesis Defence
12- AM-1	Advance Module (Optional)*	26	72	100	5	
13- AM-2	Advance Module (Optional)*	26	72	100	5	
14- GRP	Group research project*	-	100	100	5	
15- RP	M.Sc. Research Proposal Development and defense*	-	100	100	5	
16-23- T	M.Sc. Thesis research work		800	100	40	
Total					**115**	

* Modules offered at ITC, The Netherlands
Lectures and practical will be decided by ITC module coordinators

MODULE 1. RS: Principles of Remote Sensing

a) Theory

Unit No.	Subject	L (hr)	Topics Covered
1	Remote Sensing	10	Remote Sensing, EM radiations, RS systems, EO platforms & sensors, Microwave RS, Error sources & corrections in RS data, Visual Interpretation of aerial photos & satellite imagery.
2	Photogrammetry	3	Aerial photogrammtery, Overview of digital Photogrammetry & Orthophoto generation.
3	Digital Image Processing	13	Digital Image Processing - Image pre-processing, Image Enhancement –contrast enhancement, spectral ratioing, filtering, image transformation, Image Classification – unsupervised, supervised and classification accuracy assessment.
	Total	**26**	

b) Practicals/ tutorials/ self study

Unit. No.	Subject Code	P (hr)	Topics covered
1	RS	25	Interpretation on Single Vertical A.P., Comparision of Four Spectral Types of A.P., Study of Digital Refencing System, Identification of Objects on Different Data Products, Microwave Data Interpretation, Satellite Data Interpretation
2	PH	7	Stereo Test, Determination of Photo/Image Scale
3	NHDM-P3	40	Familiarization With Dip S/W, Data Display, Import & Subset, Radiometric Correction, Geometric Correction, Image Enhancement, Image Filtering, Band Ratio, Principal Component Analysis, Unsupervised Classification, Supervised Classification, Accuracy Assessment
	Total	**72**	

c) Field Exercise: Ground Truth (3.5 hrs.)

Text Books/ Reports

1. Lillesand Thomas M., Kiefer Ralph W. and Chipman Jonathan, 2008: Remote Sensing and Image Interpretation, 6th Edition, John Wiley.
2. Sabins, F.F., 2007. Remote Sensing, Principles and Interpretation., W.H. Freeman & Co., San Francisco, USA (3rd Ed.).
3. M Mather, P.M., 2004. Computer processing of remotely sensed images: an introduction
4. Gonazalez, R.C. and Woods R.E., 2008. Digital image processing
5. Jensen, J.R., 1996. Introductory Digital Image Processing.
6. Paul R Wolf, Bon A Dawitt, 3rd Edition, Elements of Photogrammetry with applications in GIS, Mc Graw Hills.

Websites:

NRSC, India: www.nrsc.gov.in
NASA Remote Sensing Tutorial: rst.gsfc.nasa.gov/Front/tofc.html
Canada Centre for Remote Sensing: http://www.ccrs.nrcan.gc.ca/resource/
ESA: http://earth.esa.int/
JAXA: http://www.jaxa.jp/index_e.html
Journal of Indian Society of Remote Sensing:
http://www.springer.com/earth+sciences+and+geography/journal/12524

MODULE 2. GIS: Principles of GIS

a) Theory

Unit No.	Subject	L (hr)	Topics Covered
1	Introduction to GIS GIS and spatial data types	6	Introduction and Potential of GIS, **Geographic Phenomena, Computer Representations of Geographic Information, Organizing spatial data, Temporal dimension,** Hardware and software trend, Overview of GI System, Database Management System.
2	Data Entry and Preparation, Spatial Data Analysis and data visualisation	12	Spatial Data Inputting, Spatial Referencing, Data preparation & transformation, **Retrieval, Classification & Measurement, Overlay functions, Neighbourhood functions,** Maps & Visualisation process, Visualisation strategies, Cartographic concepts, Viewing different type of data.
3	Data Quality, Metadata & Policy	6	Basic Concepts & definitions, Measures of location error on maps, Error propagation in spatial data processing, Metadata and data sharing, Policy Issues and Hurdles.
4	GPS Concepts, Techniques & Applications	2	Concept behind Positioning Technique, GPS Satellite Constellation, Data gathering mechanism – static, differential, Future systems, Issues and Accuracy
	Total	**26**	

b) Practicals/ tutorials/ self study

Unit. No.	Subject Code	P (hr)	Topics covered
1	GIS EX-1	3	Introduction to Arc Catalog
2	GIS EX-2	3	Introduction to Arc Map
3	GIS EX-3	3	Structuring Data
4	GIS EX-4	3	Geographical Phenomena and Computer Representations -120
5	GIS EX-5	3	Spatial referencing
6	GIS EX-6	3	Tabular data and basic queries
7	GIS EX-7	3	Data entry and digitizing

8	GIS EX-8	3	Point Data Transformations
9	GIS EX-9	3	Spatial Queries
10	GIS EX-10	3	Vector Analysis
11	GIS EX-11	3	Raster Analysis
12	GIS EX-12	3	Spatial Data Visualization
13	GIS EX-13	3	DEM Generation
14	GA/IA/SS/ O	33	Group assignment including workshop, project and presentations Individual assignment including library and discussions, Self study, Overhead including opening, assignment, library and exam.
	Total	**72**	

Text Books/ Reports

Suggested Reading Material

1. Otto Huisman and Rolf A. de By, (2009), 'Principles of geographic Information Systems – An introductory Text Book (Fourth edition), ITC Educational Text Book Series; 2, ISBN 978-90-6164-269-5 ITC, Enschede, The Netherlands
2. Burrough, PA and McDonnell, RA , (1998), Principles of Geographical Information Systems. Oxford: Oxford University Press,. xiii, 333p. ISBN : 198233655. 910.285 B94P
3. Raju PLN (Ed), Agarwal Vandana (Ed), Verma Mamta (Ed), Jeganathan (Ed) and Srivastava Vandita (Ed),(2001), Geographical Information Science: Reference Material / by .-- Dehradun: Indian Institute of Remote Sensing. vi, 296p. 910.285 R812G
4. Basic GIS Coordinates. / by Sickle Jan Van-- New York: CRC Press, 2004. 173p. ISBN : 0-415-30216-1. 910.285 S12B
5. Basics of Geomatics. / by Gomarasca, M.A.-- New York: Springer, 2010. xli,656p. ISBN : 9781402090134. 550 G1B
6. Beyond Maps: GIS and decision making in local government / by O'Looney John.-- California: ESRI Press, 2000. vii, 222p. ISBN : 1-879102-79-X. 910.285 L87B
7. Datums and Map Projections : For Remote Sensing and GIS Surveying. / by Ilifffe, Jonathan and Lott, Roiger--2nd ed.: CRC Press, 2008. 192p. ISBN : 9781420070415. 526.8 I5D
8. The ESRI Press Dictionary of GIS Terminology. / by Kennedy Heather (Ed)-- California: ESRI Press, 2001. 116p. ISBN : 1-879102-78-1.910.285 K38D
9. Exploring Spatial Analysis in Geographic Information Systems. / by Chou Yue-Hong-- Africa: OnWord Press, 1997. xiii,474p. ISBN : 1566901189. 910.285 C34E
10. Foundations of Geographic Information Science. / by Duckham Matt (Ed), Goodchild Michael F (Ed) and Worboys Michael F (Ed)-- London: Taylor and Francis, 2003. 257p. ISBN : 0-415-30726-0. 910.285 D85F

11. Geographic Information Analysis. / by O'Sullivan David and Unwin David-- New Jersey: John Wiley and Sons, ISBN : 0-471-21176-1. 910.285 S53G

12. Geographic Information Analysis. / by O'Sullivan, David and Unwin, David J.--2nd ed.-- New Jersey: John Wiley and Sons, 2010. xix,405p., ISBN : 9780470288573. 910.285 S53G Geographica Information Systems and Science. / by Longley, Paul A, Goodchild Michael F and Maguire David J-- New York: John Wiley and Sons, 2001. xviii, 454p. ISBN : 0-471-89275-0..285 L85G

13. The Global Positioning System and GIS: An introduction / by Kennedy Michael.--2nd ed.-- New York: Taylor and Francis, 2002. xxxii, 345p. ISBN : 0-415-28608-5. 910.285 K367G

MODULE 3. DB: Principles of Databases

a) Theory

Unit No.	Subject	L (hr)	Topics Covered
1	Basic Concepts	3	What is a database system?, Operational Data, Why would we use a database?, Database Management Systems, An architecture for a database application
2	Relational Data Model	3	History and Setting, Relational Model Concepts, Relational Model Constraints, Defining Relations, Normalization
3	SQL-The Relational database language	3	Introduction, Queries in SQL
4	SQL-The Relational database language	3	Null Values, Sub queries, Nested queries Views, Complex queries
5	Essential Mathematics	2	Introduction, Outlook, First Order Predicate Logic, Query expressions
6	Design and Implementation of Geospatial databases	3	Geospatial databases, Design and implemenmtation using PostGreSQL/Post GIS
7	Advanced SQL	2	Data mining, Dataware housing , Dataware housing Applications
8	Open Source tools	1	Free Software tools beyond proprietary standards
9	Case study	5	Database design and implementation of Geospatial Weather Information System, DB organization of Biodiversity,DGIS tool for real time data entry and management for Health related data.
10	Research Challenges	1	Research Challenges in Spatial Databases
	Total	**26**	

b) Practical

Unit No.	Subject	P (hr)	Topics Covered
1	Getting acquainted	3	Starting up the Access package, Table creation, Key constraints, Inserting /Importing of data
2	Access queries	3	SQL Queries in Access package

3	Introduction to Oracle	3	Introduction to managing data, Basic concepts of Oracle DBMS, Oracle clients side tools.
4	Data definition and manipulation	3	Interactive SQL, Oracle data types, DDL, DML, Primary key, Foreign key and check constraints, SQL statements
5	PostGreSQL tools	6	PostGreSQL, Database generation, Selection using PostGreSQL
6	pgAdmin	3	PostGreSQL management, Administration tools, Graphical query builder
7	PostGIS	3	Geospatial databases, Support for the geographic object to postgresql, PostGIS for geospatial analysis and mapping, Linking of db connectivity with Quantum GIS
8	Database migration	3	Import / Export of geospatial datasets in RBMS.
9	Group Assignment	16	Group assignments and quiz
10	Self study	29	Unsupervised practical on the database generation and problem solving using RDBMS tools. Mini project development on the database design and implementation using given RDBMS package.
	Total	**72**	

Text Books/Reports

1. C.J. Date. 2008. An introduction to database systems
2. A. Silberschatz, H.F.Korth, S. Sudarshan. 2010. Database System concepts
3. Rolf A. de By. 2009. Principles of Databases. International Institute for Aerospace Survey and Earth Sciences, Hengelosestraat 99, Enschede, The Netherlands.

MODULE 4A -MP: Mathematics and Programming in Geoinformatics for Disaster Management-1

a) Theory

Unit No.	Subject	L (hr)	Topics Covered
1	Differential Calculus	4	Functions, limits, continuity, differentiation, integration, ordinary and partial differential equations
2	Linear Algebra	4	Set of linear equations, matrix algebra, vector space, algebra in vector space
3	Basic Statistics and Theory of Probability	4	Basic statistics, ANOVA, probability tests, regression, correlation and trend analysis
4	Introduction to Programming	4	Overview of computer programming languages, programming concepts, interpreter, compiler, program, program development life cycle, flowchart, algorithm, pseudo code, debugging, statements, branching and iterations
5	Python Introduction, Variables, Expressions and Statements	4	The Python programming language , installing Python, using IDLE, Built-in functions, simple I/O, first program, values and types, variables, variable names and keywords, statements, operators & operands, expressions, order of operations, string operations
6	Functions, Conditionals & Recursion and Fruitful Functions	6	Why functions?, function calls, type conversion functions, Math functions, creating new functions, definitions and uses, flow of execution, modulus operator, Boolean expressions, logical operators, conditional execution, chained conditionals, nested conditionals, parameters and arguments, fruitful and void functions, recursion
	Total	**26**	

b) Practical

Unit. No.	Subject Code	P(hr)	Topics covered
1	P1	3	Euclid's Algorithm – Develop the Euclid algorithm (in Python) that solves the GCD problem. Given positive, natural numbers n and m, find their greatest common divisor
2	P2	3	Currency Conversion – Defining conversion functions between the British pound sterling (£) and the euro and vice-versa

3	P3	3	Exercise on variables, expressions and statements, raw input, operators, arithmetic operators, math module, strings exercise
4	P4	3	Functions – writing Python functions for following tasks; write a function called "area_of_circle" to calculate the area of a circle with a given radius, write a function called "compare" that compare two numbers and returns 1 if x>y, returns 0 if x==y and returns -1 if x<y, write a function to find the GCD, write a function that checks whether a given string is a palindrome
5	P5	3	Conditionals & Recursion - write a function that determines the type of a triangle (equilateral, isosceles or scalene), write a recursive function "div_by_2" that determines how often a number can be divided by 2
6	P6	3	Puzzles on Iterations – drawing different shapes with iterations
7	A/SS	54	Mathematics - Assignment, Self Study Programming- Assignment, Self Study
	Total	**72**	

Books

- Barry Paul (2010). Head First Python, O'Reilly Media
- Davis, J.C. (2002). Statistics and Data Analysis in Geology, 3rd Edition, Wiley
- Downey Allen B. (2009). Python for Software Design: How to Think Like a Computer Scientist, 1st ed., Cambridge University Press
- Gupta & Goyal (2006).Matrices, Student's friends and company
- Matthews K. R. (2010). Elementary Linear Algebra, Department of mathematics, university of Queensland
- Pitman, J. (1993). Probability, Springer
- Ray, M and Sharma, Harswarup (2004). Differential Equations, Student's friends and company
- Sinha, K.C.(2010). Differential Calculus, Eduwiser Publishing Group
- Spiegel, Murray, Schiller, John and Srinivasan, A. (2002). Schaum's Outline of Probability and Statistics, McGraw-Hill
- Swaroop C. H. (2008). A Byte of Python.

Websites/Online Resources

- Introduction to Programming (http://www.deansdirectortutorials.com/Lingo/IntroductionToProgramming.pdf)
- Introduction to Programming Languages (http://courses.cs.vt.edu/csonline/ProgrammingLanguages/Lessons/index.html)
- A Gentle Introduction to Programming Using Python (http://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-189-a-gentle-introduction-to-programming-using-python-january-iap-2011/)

MODULE 4B - MP (5-10): Mathematics and Programming in Geoinformatics for Disaster Management - 2

a) Theory

Unit No.	Subject	L (Hrs)	Topics Covered
1	Computer Programming with Python – Complex Data types	3	Strings
			Lists
			Tuples & Dictionaries
2	Advanced Libraries for Computer Programming with Python	9	Solving equations with matrices
			Plotting graphs
			Image and hyperspectral data processing
			Database connectivity
			Accessing data via the web
			Geoprocessing using ArcGIS
	Total	**12**	

b) Practicals/ tutorials/ self study

Unit No.	Subject Code	P (Hrs)	Topics Covered
1	Computer Programming with Python – Complex Data types	12	Exercises on strings, lists, tuples and dictionaries
2	Advanced Libraries for Computer Programming with Python	36	Exercises on solving equations, plotting graphs, Image and hyperspectral data processing, Database connectivity, Accessing data via the web, Geoprocessing using ArcGIS etc…
		48	

Text Books/ Reports

Downey, Allen, Jeffrey Elkner, and Chris Meyers. How to Think Like a Computer Scientist: Learning with Python.
(Can be downloaded from http://greenteapress.com/thinkpython/)

Swaroop C H, A Byte of Python.
(Can be downloaded from http://www.swaroopch.com/notes/Python)

Journal Articles

Butler H. 2004.A guide to the Python Universe for ESRI users. Annual ESRI International Conference, San Diego, 2004

Travis E. Oliphant, "Python for Scientific Computing," Computing in Science and Engineering, pp. 10-20, May/June, 2007

Websites

http://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-189-a-gentle-introduction-to-programming-using-python-january-iap-2011/readings/

http://python.org/

http://resources.arcgis.com/

http://www.learnpython.org/

numpy.scipy.org

www.scipy.org

www.pythonware.com/products/pil/

pypi.python.org

MODULE 5- NHDM: Natural Hazards And Disaster Management: Concepts And Overview

a) Theory

Unit No.	Subject	L (hr)	Topics Covered
1	Overview of natural hazards	8	Introduction to natural hazards, impact and mitigation in Global and Indian context; causes and consequences of geological hazards, flood, drought and climate change issues, forest hazard, tsunami and coastal hazards, cyclone hazards, snow avalanche, GLOF and glacier related hazards, extreme weather events , urban and industrial hazards
2	Fundamentals of vulnerability and risk assessment	6	Introduction to vulnerability and risk assessment, socio-economic and physical aspects of vulnerability and elements of risk mapping, assessment, and reduction strategies
3	Earth observation: Data availability and key operational issues for DM	6	EO systems for natural hazards study: present (operational) and future systems; multi-temporal data sources, multi-temporal database organisation: Key operational issues, data normalisation (geometry, radiometry and atmospheric correction issues) in temporal domain, utilisation of geoinformation products for disaster management (available through International cooperation e.g. International Charter etc.)
4	Disaster management framework: Indian and international initiatives	6	Disaster management framework of India and recent initiatives by Govt. of India with special emphasis on DRR HFA 2005-2015, MDG and SAARC comprehensive framework for DRR Disaster Management Support (DMS): Status in India for use of space inputs Mainstreaming DRR in Development Planning Sustainable development in the context of Climate Change Disaster Recovery-Strategy and case examples
	Total	**26**	

(b) Practicals/ tutorials/ self study

Unit. No.	Subject Code	P(h)	Topics covered
1	NHDM-P1	32	EMDAT-Hazard and disaster database analysis Earthquake and landslide hazard analysis - case examples GLOF and glacier related hazard assessment Flood hazard analysis - case examples Drought hazard assessment Forest hazard assessment Coastal and cyclone hazard assessment Urban and industrial hazards
2	NHDM-P2	8	Elements of risk mapping and vulnerability assessment
3	NHDM-P3	8	Multi resolution and temporal satellite data management
	NHDM-P4	8	Atmospheric corrections and data normalisation of temporal data sets
	NHDM-P5	4	Assessment of geoinformation products for disaster management (available through International cooperation)
4	NHDM-P5	4	Assessment of DM frame work of India with respect to earthquake, landslide, flood and drought
	NHDM-P6	4	Assessment of HFA/ MDG
	NHDM-P7	4	Assessment of SAARC Disaster Management Framework
	Total	**72**	

Text Books/ Reports

Keith Smith and Petley David, 2008. Environmental Hazards : Assessing Risk and Reducing
Disaster, Routledge

Janathan Li Sisi, Geomatic solutions for Disaster Management, Springer

van Oosterom Peter, Zlatanova Siyka and Fendel Elfriede, 2005. Geo-information for Disaster Management, Springer-Verlag.

Showalter, Pamela S. and Lu, Yongmei, 2010. Geospatial Techniques in Urban Hazards and Disaster Analysis. Springer.

Lin, Aiming and Ren, Zhikun, 2010. The Great Wenchuan Earthquake of 2008: A Photographic Atlas of Surface Rupture and Realted Disaster, Springer.

Stoltman JP, Lidstone J and Dechano LM., 2004. An International Perspective on Natural Disaster: Occurrence, Mitigation and Consequences, Kluwer Academic Publishers.

NDMA, 2004. Disaster Management in India, A Status Report, National Disaster Management Division, Ministry of Home Affairs, India

Bryant Edward, 1991. Natural Hazards, Cambridge University Press.

Pine, John C., 2009. Natural Hazards Analysis : Reducing the Impact of Disasters, CRC Press.

Hyndman, Donald and Hyndman, David, 2009. Natural Hazards and Disaster, Cengage Learning.

Dao, H. and Peduzzi, P., 2003. Global Risk and Vulnerability Index Trends Per Year (GRAVITY), Technical report, UNDP/BCPR, Geneva, 2003

NDMA, 2007. National Disaster Risk Management Framework Pakistan, National Disaster Management Authority, Govt. of Pakistan.

UNDP, 2006. Development of a Disaster Risk Profile for Maldives, Vol 1, UNDP, Maldives.

MOHCA, 2006. National Disaster Risk Management Framework, Reducing Disaster Risks for a Safe and Happy Bhutan, Pub. By, Disaster Management Division, Dept. of Local Governance, Ministry of Home and Cultural Affairs, Bhutan

Naude, W., McGillivray, M., Rossouw, S., 2008. Measuring the vulnerability of subnational regions, UNU-WIDER Research Paper no. 2008/54

Websites

NDMA: www.ndma.gov.in
UNOOSA: www.oosa.unvienna.org/oosa/unspider/index.html
UN-SPIDER: www.un-spider.org
UNESCAP: www.unescap.org
UNISDR: www.unisdr.org
SDMC: saarc-sdmc.nic.in
ADRC: www.adrc.asia
ADPC: www.adpc.net
ASC (earthquake database): www.asc-india.org

Building Materials and Technology Promotion Council, India provides vulnerability atlas of India: http://www.bmtpc.org/disaster.htm

Lamont-Doherty Earth Observatory, The earth Institute, Columbia University
http://www.ldeo.columbia.edu

Assessments of Impacts and Adaptations to Climate Change (AIACC) in Multiple Regions and Sectors
http://www.aiaccproject.org/resources/ele_lib_docs/gyoheindicators.doc

UN Institute for Training and Research (UNITAR) Operational Satellite Applications Programme for Disaster Management
http://unosat.web.cern.ch/unosat/

Dartmouth Flood Observatory, USA, provides all flood inundation maps mainly from satellite data
http://www.dartmouth.edu/~floods/index.html

Center for Research on the Epidemiology of Disasters: EM-DAT
http://www.em-dat.net/

Prevention web providing details about multiple hazards
http://www.preventionweb.net/

MODULE 6 –IIA: Image Interpretation and Analysis for Natural Hazards Assessment

a) Theory

Unit No.	Subject	L (hr)	Topics Covered
1	Image interpretation and analysis for geological hazards	8	Optical (moderate and high resolution) and radar image interpretation for geological (lithological and tectonic), geomorphological, and terrain analysis, geological hazard interpretation and analysis
2	Image interpretation and analysis for hydrometeorological hazards	6	Optical (moderate and high resolution) and radar image interpretation for flood and coastal hazard assessment (inundation, storm surge and erosion)
3	Image interpretation and analysis for environmental hazards	6	Optical (moderate and high resolution) and radar image interpretation for land degradation, soil erosion, drought impact assessment, forest type and forest degradation mapping
4	Ortho-image generation, 3-D mapping- case study	6	High resolution image orthorectification (Cartosat-1/ ALOS Prism) and image map generation, elements of risk and hazard related feature mapping and database generation
	Total	**26**	

b) Practicals/ tutorials/ self study

Unit . No.	Subject Code	P(h)	Topics covered
1	D-IIA-P1	16	Basic geological interpretation and analysis Geological hazard interpretation and mapping
2	D-IIA-P2	16	Flood and coastal hazard mapping
3	D-IIA-P3	16	Soil erosion and land degradation mapping Forest type and degradation mapping
4	D-IIA-P4	24	DGPS survey, high resolution image orthorectification (Cartosat-1/ ALOS Prism) and image map generation using LPS, 3-D GIS and anaglyph based mapping, elements of risk and hazard related feature mapping and GIS database generation
	Total	**72**	

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Lillesand Thomas M., Kiefer Ralph W. and Chipman Jonathan, 2008: Remote Sensing and Image Interpretation, 6th Edition, John Wiley.

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Prost, G. L. 2001. Remote sensing for geologists: A guide to image interpretation

Cooke, R.U., Doornkamp, J.C., 1990 – Geomorphology in environmental management – a new introduction. Clarendon Press, Oxford.

Keller, E.A., and Pinter, N., 2002. Active Tectonics - Earthquakes, Uplift, and Landscapes

NRSC, 2009. Manual for National Geomorphological and Lineament Mapping on 1:50,000 scale.

Websites

NRSC, India: www.nrsc.gov.in
NASA Remote Sensing Tutorial: rst.gsfc.nasa.gov/Front/tofc.html
Canada Centre for Remote Sensing: http://www.ccrs.nrcan.gc.ca/resource/
ESA: http://earth.esa.int/
JAXA: http://www.jaxa.jp/index_e.html

MODULE 7 -NHMM: Application of Geo-informatics to Natural Hazards Mapping and Monitoring

Specialisation: Geological hazards

a) Theory

Unit No.	Subject	L(hr)	Topics covered
1	Generation of geological database for natural hazards	6	Geological database creation for natural hazards: Geology, geomorphology and geological structures
2	Landslides and earthquakes hazard assessment using EO data	8	Landslide types, processes and mechanism, Landslide mapping and monitoring using aerial photo and satellite images. Fundamentals of earthquake, seismic waves and their characterization, intensity, magnitude, acceleration and seismograms, Mapping and monitoring of potential seismic hazards
3	Role of geo-informatics in assessing glacial, volcanic and lahar hazards	4	Snow/glacier mapping for GLOF and avalanche hazard assessment. Volcano/lahar mapping and monitoring
4	Application of geo-informatics to assess urban and coastal hazards	8	Mapping of building vulnerability and damage assessment. Concepts of multi - hazard and multi-risk characterization in urban environment. Remote Sensing application for coastal erosion, salt water intrusion and tsunami
	Total	**26**	

b) Practicals/ tutorials/ self study

Unit No.	Subject code	P(hr)	Topics covered
1	NHMM-P1 NHMM - P2 NHMM - P3	16	RS data analysis for • lithological • structural/tectonics • geomorphological mapping
2	NHMM - P4	20	• RS data analysis for landslide mapping/ monitoring. • RS data analysis for surface deformation/liquefaction

	NHMM - P5		mapping (EQ related).
3	NHMM - P6 NHMM - P7	16	• Volcano monitoring/ mapping. • Snow and glacier mapping and monitoring for GLOF assessment
4	NHMM - P8 NHMM - P9	20	• Mapping of building vulnerability and damage assessment. • RS data analysis for coastal hazards/ Tsunami
	Total	**72**	

Text Books/ Reports

Soeters, R.; Van Westen, C.J. 1996. Slope instability recognition, analysis, and zonation. In Landslides, Investigation and Mitigation; Turner, A.K., Schuster, R.L., Eds.; Transportation Research Board Special Report 247; National Research Council: Washington, DC, USA, 1996; pp. 129-177.

Keller, E.A., and Pinter, N., 2002. Active Tectonics - Earthquakes, Uplift, and Landscapes

Burbank D.W., and Anderson, R.S. 2001. Tectonic Geomorphology

Yeats, R.S., Sieh, K.E., and Allen, C. R., 1997. The Geology of Earthquakes

Bull W.B., 1991. Geomorphic Responses to Climatic Change, The Blackburn Press.

Elorza M. G., Benito G., 2005. Climatic Geomorphology, Elsevier.

Irikura Kojiro, Kudo Kazuyoshi and Okada Hiroshi , 1998 and 1999. The Effects of Surface Geology on Seismic Motion Vol. 1 and 3, Recent Progress and New Horizon on ESG Study, Balkema.
Casale Ricardo and Margottini Claudio, 1999. Floods and Landslides: Integrated Risk Assessment, Springer-Verlag.

Ayala, Irasema Alcantara and Goudie, Andrew, 2010. Geomorphological Hazards and Disaster prevention, Cambridge University Press.

John Heinz H., 2000. The Hidden Costs of Coastal Hazards: Implications For Risk Assessment And Mitigation, Island Press

Journal Articles

Bannerjee, P., Burgmann, R., 2002. Convergence across the northwest Himalaya from GPS measurements. Geophysical Research Letters 29(13), 30-1-30-4.

Bilham, R., Larson, K., Freymueller, J., Project Idylhim members, 1997. GPS measurements of present-day convergence across the Nepal Himalaya. Nature 386, 61-64.
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Francis, P. W. and Rothery, D., 2000. Remote sensing of active volcanoes. Annual Review of Earth and Planetary Science, 28, pp. 81-106.

Clark JR. Coastal zone management handbook. USA: Lewis Publishers; 1996. 694 p.

Sudara S. Who and what is to be involved in successful coastal zone management: a Thailand example. Ocean & Coastal Management 1999;42: 39–47.

Websites

NRSC, India: www.nrsc.gov.in
NASA Remote Sensing Tutorial: rst.gsfc.nasa.gov/Front/tofc.html
JPL: http://www.jpl.nasa.gov/
Canada Centre for Remote Sensing: http://www.ccrs.nrcan.gc.ca/resource/
ESA: http://earth.esa.int/
JAXA: http://www.jaxa.jp/index_e.html
Earthquakes and Plate Boundary Processes: cires.colorado.edu/~bilham/
USGS: earthquake.usgs.gov
Journal of Indian Society of Remote Sensing: http://www.springer.com/earth+sciences+and+geography/journal/12524

MODULE 7- NHMM: Application of Geo-informatics to Natural Hazards Mapping and Monitoring

Specialisation: Environmental hazards

a) Theory

Unit No.	Subject	L (hr)	Topics covered
1.	Fundamentals of soil science/ land use / land cover mapping	6	Fundamental concepts of soil science and soil survey, land use/land cover mapping for environmental change
2.	Land degradation and soil erosion	6	Land degradation types, processes and causes of land degradation, mapping and monitoring of land degradation
3.	Drought, desertification and crop pest and deceases	6	Fundamentals of agro-meteorology, meteorological drought indices, drought assessment, desertification concepts, processes, indicators and mapping, crop pest and diseases monitoring and assessment
4.	Forest hazards	8	Introduction of Indian forests, forest cover type mapping and monitoring, forest fire mapping and monitoring, forest degradation, deforestation, shifting cultivation mapping and monitoring
	Total	**26**	

b) Practicals/ tutorials/ self study

Unit No.	Subject Code	P (hr)	Topics covered
1	NHMM-P1	6	Laboratory visit, soil texture, pH, EC, etc., and physiographic soil analysis
	NHMM -P2	6	Land use/land cover mapping
	NHMM -P3	6	Digital land use/land cover mapping
2	NHMM -P4	10	Degraded land mapping: visual and digital methods
3	NHMM -P5	6	Computation of meteorological indices
	NHMM -P6	8	Drought assessment and monitoring using multi-temporal RS data
	NHMM -P7	8	Desertification mapping and monitoring
4	NHMM -P8	4	Forest cover mapping (visual) using RS techniques
	NHMM -P9	6	Digital forest cover (type and density) analysis
	NHMM -P10	6	Forest fire mapping and monitoring
	NHMM -P11	6	Forest degradation mapping and change detection
	Total	**72**	

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Lal, R., Blum, W.E.H., Valentine, C. and Stewart, B.A., eds. 1997. Methods for Assessment of Land Degradation. Boca Raton: CRC Press

Morgan, RPC, Morgan, RPC and Morgan, Sally. 2005. Soil Erosion and Conservation, Wiley-Blackwell Publication. P.320

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Lal, R. 2005. Encyclopedia of Soil Science, Second Edition, The Ohio State University, Columbus, USA

Drought In India : Challenges & Initiatives. Poorest Areas Civil Society (Pacs) Programme 2001-2008, Www.Empowerpoor.Org

Ramakrishna, Y. S. and GGSN Rao (2007). Agricultural drought : Aspects of micrometeorology, CRIDA Publication

Vijendra K. Boken, Arthur P. Cracknell and Ronald L. Heathcote (2005). Monitoring and Predicting Agricultural Drought A Global Study Oxford University press

Thenkabail, P. S., Gamage, M. S. D. N. and Smakhtin, V. U. The Use of Remote Sensing Data for Drought Assessment and Monitoring in Southwest Asia, Research Report, International Water Management Institute PO Box 2075, Colombo, Srilanka

Glantz, M.H. 1994. Drought, desertification, and food production. Pages 9-30 in Drought Follows the Plow (M.H. Glantz, ed.). Cambridge University Press, Cambridge

Thiruvengadachari, S.; Jeyseelan, A.T., Harikishan, J. and Krish¬na Rao, P.V. (1991). Satellite Surveillance of Agricultural Drought Condition in India. In book on "Applications of Remote Sensing in Asia & Oceania - Environmental Change Monitoring (Ed. Shunji Murai) - 37-50 pp.

Sivakumar MVK , Motha RP, and Das HP, 2005. Natural Disasters and Extreme Eventsa in Agriculture: Impact and Mitigation, Springer

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Journal Articles

Z.Wang, P.Wang, et al. (2004). "Using MODIS Land Surface Temperature and Normalized Difference Vegetation Index products for Monitoring Drought in the Southern Great Plains,USA." International Journal of Remote Sensing Vol.25 (No.1): pp.61-72

P.Singh, R., S. Roy, et al. (2003). "Vegetation and Temperature Condition Indices from NOAA AVHRR data for Drought Monitoring over India." International Journal of Remote Sensing Vol.24 (No.22): pp.4393-4402.

D.A.Wilhite (2000). Drought as a Natural Hazard: Concepts and Definitions. Drought: A Global Assessment. W. D.A., Routlegde. Vol.1: pp.1-3.

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Santilli, M., Moutinho, P., Schwartzman, S., Nepstad, D., Curran, L. and Nobre, C. 2005. Tropical deforestation and the Kyoto Protocol. Climatic Change 71(3): 267-276.

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www.wamis.org/agm
dmc.kar.nic.in
http://www.cpc.ncep.noaa.gov/products/monitoring_and_data/drought.shtml
http://dms.iwmi.org/default.asp
www.earlywarning.nl
http://www.fao.org/
http://www.ipcc.ch/
http://www.unep.org/
http://cdm.unfccc.int/index.html
http://unfccc.int/kyoto_protocol/items/2830.php
http://www.un-redd.org/
http://www.fire.uni-freiburg.de/photos/in/in.htm
http://forestfireindia.org/
http://www.fao.org/docrep/article/wfc/xii/ms12a-e.htm

MODULE 7 - NHMM: Application of Geo-informatics to Natural Hazards Mapping and Monitoring

Specialisation: Hydro-Meteorological hazards

a) Theory

Unit No.	Subject	L(Hrs)	Topics Covered
1	Hydrologic cycle & its components	8	Hydrologic cycle and its components Evapotranspiration-concept and estimation of ET using conventional techniques SEBAL method of ET estimation Rainfall measurements and rainfall data analysis Infiltration capacity and soil moisture estimation Runoff estimation: Rational method, NRCS CN method
2	Watershed studies, Hydrograph analysis and glacier hazards	6	Watershed hydrology and DEM analysis for water resources Hydrograph, its components and hydrograph analysis, snow hydrology and glacier hazards study using RS and GIS
3	Flood mapping using RS & GIS	4	Flood and mapping using RS & GIS Flood hazards zoning
4	Remote sensing applications for coastal hazards	8	Remote sensing for monitoring of coastal inundation (tides, storm surge, tsunami) & oil spill mapping Cyclonic hazard assessment and prediction (tracking, landfall determination, inundation) Remote sensing applications for coastal erosion Tsunami and its impact assessment Salt water intrusion into Costal aquifer
	Total	**26**	

b) Practicals/ tutorials/ self study

Unit No.	Subject Code	P (Hrs)	Topics Covered
1	NHMM- P1	4	ET estimation using CROPWAT
	NHMM-P2	12	ET estimation using SEBAL
	NHMM- P3	6	Rainfall data analysis
	NHMM- P4	6	Infiltration & soil moisture estimation
	NHMM- P5	8	Runoff estimation using NRCS method
2	NHMM- P6	6	DEM Hydro processing
	NHMM- P7	4	Hydrograph analysis
	NHMM- P8	6	Snow and glacier mapping using RS
3	NHMM- P9	6	Flood mapping using SAR data
4	NHMM-P10	8 6	Coastal inundation and hazards mapping from satellite data

	NHMM-P11		Cyclone analysis
	Total	**72**	

Books/ Reports

Maidment D.R. (ed.) (1993). "Handbook of Hydrology", McGraw-Hill.

Michaelides S. (ed.) (2008). "Precipitation: Advances in Measurement, Estimation and Prediction". Published by Springer-Verlag, Berlin, Heidelberg.

Rees W. G. (2006). "Remote Sensing of Snow and Ice." Published by CRC Press, Taylor and Francis Group.

Schultz G.A. and Engman E.T. (2000). "Remote Sensing in Hydrology and Water Management" Springer-Verlag, Berlin, Germany

Subramanya, K. (2008). "Engineering Hydrology". 3rd Edition, Tata McGraw-Hill Publishing Company Ltd., New Delhi, India.

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http://www.chikyu.ac.jp/precip/
http://www.imd.gov.in/
http://www.unesco-ihe.org/
http://www.hec.usace.army.mil/
http://nsidc.org/glaciers/
http://clic.npolar.no/

MODULE 8 -ARS: Advance Remote Sensing for Natural Hazards Study (Combined Module for M.Sc./PGD of GI and NHDRM courses)

a) Theory

Unit No.	Subject	L (Hrs)	Topics Covered
1	Advance Classifiers and feature extraction methods	5	Fuzzy, ANN and sub-pixel based classification menthods Automatic feature extraction methods (deterministic objects)
2	Segmentation and Texture Analysis	5	Image segmentation and texture analysis of satellite images
3	Image Fusion and Change detection	5	Image fusion and change detection case studies
4	Hyperspectral Image Analysis	5	Atmospheric correction, MNF, end–member selection, n-dimensional visualization, PPI, Spectral Angular Mapper, Linear Pixel Unmixing
5	InSAR and LIDAR *(to be attended by NHDRM participants only)	6	Co-registration, despekling, geocoding, interferogram generation, phase unwrapping, height and deformation detection Basics of LIDAR, generation of DEM and derivatives
	Total	**26**	

c) Practicals/ tutorials/ self study

Unit No.	Subject Code	P (Hrs)	Topics Covered
1	ARS-P1	12	Advance classifiers and feature extraction methods
2	ARS-P2	12	Image segmentation and texture analysis of satellite images
3	ARS-P3	12	Image fusion and change detection case studies
4	ARS-P4	12	Hyperspectral Image Analysis
5	ARS-P5	24	InSAR and LIDAR data processing techniques, DEM generation using InSAR and LiDAR data.
	Total	**72**	

Text Books/ Reports

1. Mather, P.M., 2004. Computer processing of remotely sensed images: An Introduction.

2. Gonazalez, R.C. and Woods R.E., 2008. Digital Image Processing
3. Jensen, J.R., 1996. Introductory Digital Image Processing.
4. Gao, J. 2009. Digital Analysis of Remotely Sensed Imagery, McGraw Hill.
5. Pratt William K.: Digital Image Processing, John Wiley and Sons, New York
6. Meer F. V. and Jong, S.M.D. 2001. Imaging spectrometry: basic principles and prospective applications, Volume 1
7. Ketelaar, V. B. H. 2009. Satellite Radar Interferometry Subsidence Monitoring Techniques, Remote Sensing and Digital Image Processing, Vol. 14, Springer.
8. Varshney, P. K., & Arora, M. K. (Eds.). (2004). Advanced Image Processing Techniques for Remotely Sensed Hyperspectral Data : Springer Verlag.

Journal Articles

1. Multisensor image fusion in remote sensing: Concepts, Methods and Applications. C. Pohl, and J. L. Van Genderen. Int. J. Remote Sensing, 1998, vol. 19, no. 5, 823± 854
2. Recent advances in techniques for hyperspectral image processing. Remote Sensing of Environment 113 (2009) S110–S122. Antonio Plaza et al
3. A survey of image classification methods and techniques for improving classification performance. International Journal of Remote Sensing . Volume 28, Issue 5, 2007 . D.Lu and Q.Weng
4. Blashke, T. (2010): Object based image analysis for remote sensing. ISPRS International Journal of Photogrammetry and Remote Sensing 65 (1), 2-16.
5. Automatic Road Network Extraction Using High Resolution Multi- Temporal Satellite Images. Vinay Pandit, Sudhir Gupta, K.S. Rajan. (http://researchweb.iiit.ac.in/~vinaypandit/IGARSS.pdf)
6. Artificial Neural Networks for Beginners, Carlos Gershenson. (http://arxiv.org/ftp/cs/papers/0308/0308031.pdf)
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1. *The GLCM Tutorial Home Page: http://www.fp.ucalgary.ca/mhallbey/tutorial.htm*
2. www.**isprs**.org
3. ieeexplore.ieee.org-IEEE Transactions on Image Processing, IEEE Transactions on Geoscience and Remote Sensing.

MODULE 9- AGIS. Advance GIS for Natural Hazards study

a) Theory

Unit No.	Subject	L (Hrs)	Topics Covered
1	Web GIS	6	Overview, client-server architecture, dissemination of map data using open source, distributed GIS, Arc IMS, OGC WMS Services
2	Multicriteria based analysis	6	Concepts and case examples
3	Spatial Decision Support System (SDSS)	6	Concepts and case examples
4	Multivariate and Geostatistics	8	Random variables and distributions, ANOVA, Statistical Tests, Regression Analysis (Multiple and logistic regression), Trend surface analysis, correlation and PCA (with case examples), Regionalized variables, semivariogram, assessment of various estimation (using Kriging methods) and interpolation techniques
	Total	**26**	

b) Practical/ tutorials/ self study

Unit No.	Subject Code	P (Hrs)	Topics Covered
1	AGIS-P1	20	Client-server architecture, dissemination of map data using open source, distributed GIS, ARC IMS, OGC WMS Services
2	AGIS-P2	16	Multicriteria based analysis case examples
3	AGIS-P3	16	Spatial Decision Support System (SDSS) case examples
4	AGIS-P4	20	Multivariate statistics and Geostatistics
	Total	**72**	

Books

- Bonham-Carter, G.F.(1994). Geographic Information Systems for Geoscientists. Love Printing Service Ltd., Ontario, Canada.
- Burrough, P.A. and McDonnell, R (1998). Principles of GIS for land resources assessment. Oxford Scientific Publ., Claredin Press, Oxford, U.K. (Monograph on Soil and Resources Survey No. 12).
- Davis, J.C. (2002). Statistics and Data Analysis in Geology, 3rd Edition, Wiley
- Peng, Zhong-Ren, Tsou, Ming-Hsiang (2003). Internet GIS: Distributed Geographic Information Services for the Internet and Wireless Network , Wiley
- Pinde Fu, and Jiulin S. (2011). Web GIS: Principles and Applications. ESRI Press, Redlands, California.
- Pitman, J. (1993). Probability, Springer
- Scott, D. (2007). GIS for Web Developers: Adding Where to Your Web Applications. Pragmatic Bookshelf, China (Edition-1).
- Spiegel, Murray, Schiller, John and Srinivasan, A. (2002). Schaum's Outline of Probability and Statistics, McGraw-Hill

Websites/Online Resources

- The R Project for Statistical Computing: http://www.r-project.org/
- Geostatistics portal: http://www.itc.nl/library/portals/geostatistics/software.aspx
- GEOG 585: Open Web Mapping
- (https://courseware.e-education.psu.edu/courses/geog585/content/home.html)
- Introduction to GeoServer (http://workshops.opengeo.org/geoserver-intro/)
- ArcIMS (http://www.esri.com/software/arcgis/arcims/index.html)
- Adobe Dreamweaver tutorial (http://www.adobe.com/devnet/dreamweaver/articles/first_website_pt1.html)
- Server-side Scripting Primer (http://www.w3schools.com/web/web_scripting.asp)
- UMN Mapserver (http://mapserver.org/)

MODULE 10 –NHMD: Application of Geo-informatics to Natural Hazards Modelling (Specialisation: Geological Hazards)

a) Theory

Unit No.	Subject	L(hr)	Topics covered
1	Spatial modelling of landslides	6	Landslide hazard zonation, vulnerability risk analysis using spatial modeling techniques, Rainfall threshold based modeling, early warning issues and disaster preparedness
2	Modelling earthquake hazards	6	Potential seismic hazard assessment, modeling for ground shaking, microzonation, liquefaction and seismically induced landslide modeling, surface rupture/ deformation mapping and modeling (DInSAR), palaeoseismicity analysis, seismic disaster preparedness and early warning issues (Precursors and Multi-sensor approach)
3	EIA, Mining, GLOF, Glacier, Groundwater hazard modelling	6	Environmental impact assessment, mapping fire and subsidence (DInSAR) hazards due to mining activities. GLOF modeling, early warning and preparedness issues. Groundwater pollution and hazard analysis
4	Application of urban and coastal hazards	8	Urban growth modeling for future planning and risk mitigation. Seismic risk assessment in urban areas using RADIUS. Modeling salt water intrusion/erosion using RS/GIS. Tsunami modeling and early warning.
	Total	**26**	

b) Practicals/ tutorials/ self study

Unit No.	Subject	P(hr)	Topics covered
1	NHMD-P1	16	Data integration techniques for landslide hazard Zonation
	NHMD-P2		Landslide vulnerability and risk assessment
2	NHMD-P3	16	Mapping and modeling seismo-tectonic hazards.
3	NHMD-P4	20	Analysis of RS data and ground based observations for mining hazards assessment.
	NHMD-P5		Analysis of RS data and ground based observations for ground water quality and pollution studies.
	NHMD-P6		GLOF modeling
4	NHMD-P7	20	Urban growth modeling for suitability analysis for safe urban development.

	NHMD-P8		Data collection and analysis for seismic risk assessment in urban areas using RADIUS/HAZUS.
	NHMD-P9		RS data analysis and modeling techniques for coastal hazards and Tsunami early warning
	Total	**72**	

Text Books/ Reports

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NASA landslide site: http://earthobservatory.nasa.gov/Study /Landslide/
USGS landslide program: http://landslides.usgs.gov/index.html
FEMA Landslide fact sheet: http://www.fema.gov/hazards/landslides/landslif.shtm

Journal of the International Consortium on Landslides, Landslides: http://www.springer.com/new+%26+forthcoming+titles+(default)/journal/10346

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MODULE 10-NHMD: Application of Geo-informatics to Natural Hazards Modelling

(Specialisation: Environmental Hazards)

a) Theory

Unit No.	Subject	L (hr)	Topics covered
1.	Drought monitoring and desertification	6	Advances in drought monitoring and prediction, crop modeling for assessing impact of drought on agriculture, desertification hazard zonation and mitigation
2.	Crop disease detection and climate change	6	Advances in RS techniques for crop pest disease detection and plant protection, climate change and sustainable agriculture
3.	Soil erosion modeling and watershed characterization	6	Empirical models, process based models, factors of soil erosion and erosion processes, watershed terrain analysis, watershed characterization and prioritization for soil conservation planning
4.	Forest hazard modeling	5	Forest cover dynamics and predictive modeling, forest fire risk zonation, advances in forest fire monitoring and modeling, assessment of disturbance regime at landscape level
5.	Case studies	3	Industrial hazard and air pollution examples from Jaipur and Haldia, waste disposal site selection using multi-criteria modeling Mapping and monitoring urban heat islands/ fire.
	Total	**26**	

b) Practicals/ tutorials/ self study

Unit No.	Subject Code	P (hr)	Topics covered
1	NHMD-P1	6	Drought risk assessment
	NHMD -P2	6	Drought prediction and loss estimation
	NHMD -P3	6	Desertification risk assessment
2	NHMD -P4	8	Crop disease detection and plant protection
3	NHMD -P5	8	Soil erosion modeling: RUSLE & MMF and process based models
	NHMD -P6	8	Soil erosion modeling and conservation planning
	NHMD -P7	6	Watershed delineation and terrain analysis
	NHMD -P8	4	Infiltration measurements in field
4	NHMD -P9	4	Forest cover dynamics modelling
	NHMD -P10	4	Forest fire modeling
	NHMD -P11	4	Forest disturbance analysis
5	NHMD-P12	8	Industrial hazard and air pollution examples from Jaipur

			and Haldia waste disposal site selection using multi-criteria modeling Urban heat island/ fire mapping and monitoring
	Total	**72**	

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Heywood, V.H. and Watson, R.T. 1995. Global Biodiversity Assessment. Cambridge University Press, U.K.

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Detwiler, R.P. and Hall, C.A.S. 1988. Tropical Forests and the Global Carbon Cycle. Science 239(4835): 42-47.

Roy, P.S. and Tomar, S. 2000. Biodiversity characterization at landscape level using geospatial modeling techniques. Biological Conservation 95(1): 95-109.

Additional text books/ articles as under Module 6 (Specialisation: Environmental hazards)

Websites

As given under Module 6 (Specialisation: Environmental hazards)

MODULE 10 –NHMD: Application of Geo-informatics to Natural Hazards Modelling (Specialisation: Hydro-Meteorological hazards)

a) Theory

Unit No.	Subject	L (Hrs)	Topics Covered
1	Flood models, Flood modeling: flood peak estimation and flood routing	8	Overview of Flood models Hydrologic analysis: Defining input data, calculating peak discharge (HEC-HMS, GeoHMS), Flood modeling: flood peak estimation and flood routing (HEC-RAS, GeoRAS, Mike 11 HD, Mike11 GIS), Flood modeling and early warning
2	Flood depth, vulnerability and risk assessment	6	Flood risk Analysis: flood frequency analysis, depth. duration and risk analysis
3	Dam break modeling, Snow Avalanche and Altimetry for surface water level and discharge	6	Fundamental of Dam Break, Cloud burst, GLOF, hydrologic analysis, Dam break/cloud burst/GLOF modeling and Snow Avalanche theory and modeling Altimetry for surface water level and discharge
4	Storm surge, Tsunami modeling and ocean study with microwave remote sensing	6	Storm surge analysis and modeling Oceanography parameter retrieval from Microwave Remote Sensing (MRS) Cyclone tracking, landfall modeling and early warning Tsunami modeling and early warning
	Total	**26**	

b) Practicals/ tutorials/ self study

Unit No.	Subject Code	P (Hrs)	Topics Covered
1	NHMD-P1	3	Flood data analysis & Flood frequency Analysis
	NHMD-P2	10	Flood peak estimation & modeling (GeoHMS & HEC-HMS)
	NHMD-P3	10	Flood modeling & routing (GeoRAS and HEC-RAS)
2	NHMD-P4	6	Flood depth, duration and risk analysis
	NHMD-P5	8	Elements at risk mapping and flood hazard zoning
3	NHMD-P6	8	Dam break and avalanche modeling (Mike11 and RAMMS)

	NHMD-P7	6	Water level & Discharge estimation from altimeter (BRAT, MATLAB)
4	NHMD-P8	6	Strom surge analysis & modeling
	NHMD-P9	9	Tsunami modeling
	NHMD-P10	6	Oceanography parameter retrieval using MRS
	Total	**72**	

Text Books/ Reports

Zschau Jochen and Kuppers A. N., 2003. Early Warning Systems for Natural Disaster Reduction, Springer-Verlag.

Nayak, Shailesh and Zlatanova, Sisi , 2008. Remote Sensing and GIS Techniques for Monitoring and Prediction of Disaster, Springer, 2008

Maidment D.R., and Djokic D. 2000. Hydrologic and Hydraulic Modeling Support with GIS, ESRI Press, Redlands CA, USA.

Murty T.S. and El-Sabh M.I., 1984. Cyclones and strom surges in the Arabian Sea: A brief review. Elsevier Publication.

Robert Stewart,2005. Oceanography in the 21st Century. An online Textbook. http://oceanworld.tamu.edu/resources/oceanography-book/contents.htm.

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Narayana, A.C., Tatavarti, R. and Mudrika Shakdwipe. (2005). Tsunami of 26th December 2004: Observations on Kerala Coast. Jour. Geol. Soc. India. 65(2), 239-246.

Sundar D., Shankar D. and Shetye S. R., 1999, Sea level during storm surges as seen in tide-gauge records along the east coast of India. Current Science, VOL. 77, NO. 10, 25 November 1999.

Additional text books/ articles as Module 6 (Specialisation: Hydrometeorological hazards)

Websites

As given under Module 6 (Specialisation: Hydrometeorological hazards)

Module 11 to 14: PG Diploma Project work

During these modules students carry out a project work (under supervision) for which first they undertake literature survey and defend a proposal, once it is approved then they collect spatial and non-spatial data, undertake satellite data processing, field investigation, data base preparation, analysis and write a thesis/report. Finally, the thesis is evaluated as per ITC procedures and results are announced.

MODULES EXCLUSIVELY FOR MSC

MODULE 11. -RSD: Research Skills Development

a) Theory

Topics	L (hr.)	Detailed Information
The scientific method	2	Characteristics of scientific knowledge, Self-criticism , Evidence-based, Theory-based, Transparency, No appeal to authority, Naturalism, Science as a human activity, Types of sciences , Science vs. engineering , Scientific inference, Scientific explanation, Proximate and ultimate causes, Parsimony of explanation, Parsimony in statistical inference, Levels of certainty, Hypotheses , Theories, Laws, The deductive-inductive scientific method, Logic in scientific explanation, Induction and deduction, Assumptions, Proof, Statistical inference.
Research	2	General structure of research, Description, review, and argumentation, Description, Review, Argumentation, Types of research, Natural vs. social sciences.
Research proposal and thesis	3	Research proposal , Common elements of a research proposal, Examples of research proposals , Research problem, Research objectives, Expected outputs, Research questions, Research Questions related to Research Objectives, Hypotheses, Assumptions, Verifying assumptions, Research methods, Finding methods, Description of methods, Sequence of methods, The “research” thesis, Study area, The “design” thesis, The “social” or “organizational” thesis, Social Organizational, The “modelling” thesis.
Literature review, Citations, and List of references	2	Information, Information literacy, Personal information infrastructure, Literature review, Types of sources, Quality of information sources, How to Search, Citations, List of references.
Critical Reading and Abstracting	2	Critically reading a research paper, Difficulties reading research papers, How to approach a research paper, Abstracting a research paper or thesis, Purpose of abstracting, The “Paper in miniature” abstract.

Argumentation and Technical Writing	6	Structured technical writing, Structuring a document by outlining, Paragraphs, Writing paragraphs by topic sentences, Example of writing with topic sentences, Resources, Technical English, Writing clearly, Revising and re-writing, Voice, Punctuation.
Ethics & professionalism in science	4	Ethics, Fraud, Data fabrication, Data falsification, Plagiarism, Intellectual property and fair use, Copyright, The concept of 'fair use', License agreements, Restrictions on Datasets, Copyleft and open-source software, Professionalism, Professional societies, Codes of conduct, The social responsibility of the scientist, Selection of a research topic.
Statistical inference for research	5	The inferential paradigm, Sampling design, Statements of fact vs. inference, Frequentist and Bayesian interpretations, Bayesian concepts, Frequentist concepts, Frequentist hypothesis testing, The null and alternate hypotheses, Significance levels and types of error, Deciding on a significance level, Building a statistical model, The nature of statistical models, Structure and noise in statistical modeling, Evidence that a model is suitable, Model calibration vs. model validation, Conceptual issues in correlation and regression, Correlation vs. causation, Description vs. prediction, Types of models, Structural Analysis, Selecting the correct regression model.
Total	**26**	

Practical Exercises

S No	Hours	Practical Exercise
1	2	Searching research information
2	4	Discussion (Research Articles)
3	6	Self Study: research problems, objectives, questions, Q&A session: research problems
4	10	Practical: End Note, Practical: Open source tools for research & citation
5	10	Assignment 1: Abstracting, Q&A session: reading a paper
6	10	Self Study : micro- English , Q&A session: micro- English; Assignment:2
7	8	Self Study: argumentation, Q&A session: argumentation outlining Q&A session: scientific inference; Assignment 3,
8	8	Self Study: scientific ethics, Q&A session: ethics; Assignment 4,
9	8	Self Study : Structure design , Q&A session: scientific structure of thesis; Assignment 5
10	12	Self Study: Statistical inference , Q&A session: inference; Assignment 6
Total	**72**	

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1. Rossiter, D.G. 2011. *Research Concepts & Skills*, Vol. I-III (http://www.itc.nl/~rossiter/teach/lecnotes.html#l1)
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12-AM1: Advance Module (at ITC)

Students can select one of the following topics offered at ITC. The topics highlighted may be of more relevance to NHDRM course, but students have full freedom to select any topic of their choice. However, it is advisable to select a topic that is of relevance to the course as well as to the project work to be carried out during Module 16-23.

(a) Advanced image analysis

(b) Geostatistics

(c) Laser scanning

(d) Modelling natural resources degradation

(e) Hyperspectral remote sensing

(f) Spatial data for disaster risk management

(g) SAR and SAR interferometry, with applications

(h) Design and Implementation of Spatial Databases

(i) Time series

(j) Monitoring our changing planet with web based processing techniques

(k) Assessment of the Effect of Climate Change on Agro-ecological Systems Using Optical and SAR Remote Sensing and GIS

(l) Managing geoinformation systems in the public sector

(m) Spatial planning support systems and scenario development

(n) Participatory GIS - principles and applications

(o) Cost Benefit Analysis: Concepts and Practice in Spatial Policy and Planning

(p) BioAqua: Remote sensing methods for deriving geo-biochemical properties of aquatic ecosystems

(q) Hydroland: Retrieval of land surface hydrological parameters

(r) SAR and SAR interferometry with applications

13-AM2: Advance Module (at ITC)

Students can select one of the following topics offered at ITC. The topics highlighted may be of more relevance to NHDRM course, but students have full freedom to select any topic of their choice. However, it is advisable to select a topic that is of relevance to the course as well as to the project work to be carried out during Module 16-23.

(a) 3D Geoinformation from imagery

(b) Advanced Geostatistics

(c) Geophysics and 3D geo-visualization of the subsurface

(d) Data analysis in earth, water and natural resources studies

(e) Design and implementation of Geoinformation Services for SDI

(f) Use, users and usability

(g) Spatial modelling of biological ecosystem properties

(h) Strategic Environmental Assessment (SEA) and Environmental Impact Assessment (EIA) applying Spatial Decision Support tools

(i) Spatial change and spatial interaction modelling

(j) Land administration and geoinformation in post disaster areas

(k) Applying research methods for public sector geoinformation management

(l) Scenario analysis and collaborative decision support

(m) Large Scale Process Modelling and Data Assimilation

(n) Climate change impacts and adaptation - Analysis and monitoring techniques of climate change

14-GRP: Group research project (at ITC)

The purpose of the group project is:

- To let the student place his/her own MSc research project and research interests in a wider scientific context; To give the student an opportunity to practise - under supervision of a tutor - conducting a research project before starting to work on his/her individual MSc research project;
- To give the student an opportunity to practise undertaking research in a team;
- To give student the opportunity to share knowledge and ideas in a multi-disciplinary context.

  These activities are considered an important preparation for conducting the individual MSc research in Block 4 (Module 16-23), as well as for the student's future professional academic working practice, in which projects are often conducted in (multi-disciplinary) groups.

  The projects are defined by the scientific departments with a view to catering for a variety of research approaches and interests, as well as the relevance of these to society. Projects are described with a title, a problem definition, and, if appropriate, the available dataset. The student group, consisting normally of a maximum of five students, is responsible for working this out into various activities according to an agreed plan. The student group has the freedom to make its own choices, supported by a tutor. The available projects will be made known before the start of module in order to give the participants the opportunity to select a project that matches their research interest. The choice has to be submitted before the start of module and should be justified within the MSc pre-proposal.

  In a plenary session at the start of module 14, the IIRS/ITC faculty will introduce the various MSc subjects and their interrelation in the framework of the research of his/her group, and introduce the research assignments. A tutor will be appointed to guide each student group during module 14.

15-RP: M.Sc. Research Proposal Development and defense (at ITC)

The MSc research proposal is finalized by the student in mutual agreement with his/her MSc supervisors, appointed in Module 11. The research proposal should be a logical and ordered exposition of the envisaged research (as introduced in Module 11), including data availability, (fieldwork) methods, a flowchart, and time planning. In the last week of Module 15, the research proposal is presented before a Thesis Admission Committee (see MSc assessment regulations paragraphs 5.1 and 5.4, Annexure-2).

When presenting the proposal, the student must also satisfy the Thesis Admission Committee that all the required data is available or, if not, that steps (including fieldwork if appropriate) will be taken to acquire these data in time. Likewise, requirements for hardware and/or software should be specified to ensure that these can be made available as required.

Acceptance of the proposal is a prerequisite for the start of the individual research (Modules 16-23). The MSc student will draft a supervision plan in consultation with the two appointed MSc supervisors.

16-23-T: M.Sc. Thesis research work

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 (see module 15) connected to one of the research themes of IIRS/ITC (Annexure-1). In this final block of the course, the students further develop their research skills, interact with their fellow students, PhD researchers and staff members and, finally, demonstrate that they have achieved the course objectives for the Master of Science degree by research, on a satisfactory academic level.

At the end, a Thesis Assessment Board (TAB) will assess the individual assessment based on the written thesis and a presentation plus oral defence. The assessed aspects are:

- ✓ Research skills;
- ✓ Contribution to the development of the scientific field;
- ✓ Ability to work independently;
- ✓ Critical and professional thinking;
- ✓ Scientific writing;
- ✓ Presentation and defence.

Annexure-1: Broad Research Areas for M. Sc/ PG Diploma Project Work of NHDRM

Geological Hazards

Landslide

- ✓ Landslide mapping, monitoring (automated detection) using multi-temporal data sets
- ✓ Object Based Image Analysis using Fuzzy Membership Functions for Detection of Landslides
- ✓ Landslide hazard zonation using knowledge driven and probabilistic approach
- ✓ Quantitative landslide vulnerability/risk assessment using spacio-temporal modeling
- ✓ Rainfall threshold for topsoil saturation and modeling for shallow landslides
- ✓ Process based landslide modelling
- ✓ Reservoir induced landslide modeling
- ✓ Spatio-temporal analysis of satellite based rainfall estimation for natural hazard assessment
- ✓ Landslide detection and analysis using InSAR/DInSAR

Earthquake

- ✓ Crustal deformation and active fault mapping and analysis (Using optical/ DInSAR/ GPR)
- ✓ Surface deformation/ change detection (man-made features/natural objects) mapping and analysis
- ✓ Earthquake vulnerability modeling (urban related) / damage assessment
- ✓ Seismic micro and macrozonation
- ✓ Liquefaction modeling
- ✓ Seismicity induced landslide modeling

Glacier

- ✓ Glacier landform dynamics and GLOF potential assessment (using high resolution optical data and DInSAR)

Mining and environment

- ✓ Mining induced land subsidence modelling (by space-borne D-InSAR, ground-based in-situ measurements and predictive modelling approach)
- ✓ PolSAR-based target (indicators) characterization for EIA of opencast mining
- ✓ Detection and estimation of methane emission by hyperspectral data analysis
- ✓ Detection and monitoring of piezometry-induced land subsidence phenomena by D-
- ✓ InSAR/PS-InSAR technique
- ✓ Gully erosion and land degradation mapping and analysis

Ground water

- ✓ Combining imaging spectrometry, geochemical and hyperspectral data for characterizing heavy metal pollution
- ✓ Point spread analysis for ground water pollution modeling using Strauss model
- ✓ Ground water depletion assessment using space gravity measurements

Environmental Hazards

Soil and agriculture related hazards

- ✓ Interannuality variability in drought severity under varying climate change scenario
- ✓ Desertification indicators retrieval from satellite remote sensing
- ✓ Crop epidemiology and satellite remote sensing
- ✓ Soil erosion modeling
- ✓ Land use/ land cover dynamics modeling in the context of global/climate change

Forest fire and degradation related hazards

- ✓ Forest fire risk modeling
- ✓ Forest fire spread modeling
- ✓ Forest vulnerability assessment
- ✓ Deforestation monitoring and predictive modeling
- ✓ Forest degradation assessment and monitoring

Urban hazards

- ✓ Industrial fire/ chemical hazard impact assessment

Hydrometeorological hazards

Flood

- ✓ Flood hazard mapping and flood risk zonation
- ✓ Flood frequency analysis
- ✓ Safe evacuation route identification during flood
- ✓ Flood forecasting and flood modeling
- ✓ Flood inundation mapping, monitoring and depth - duration analysis

Coastal and marine hazards

- ✓ Estimation of coastal inundation and its impact though RS/GIS/models (Tsunami, Storm surge, cyclone)
- ✓ Development of storm surge models for river basins
- ✓ Coastal erosion study through remote sensing and GIS
- ✓ Salt water intrusion in coastal aquifer for low lying coastal flats
- ✓ Cyclone disaster: Monitoring & assessment from RS and ancillary data
- ✓ Detection and characterization of algal bloom in open ocean
- ✓ Oil spill study and its impact in coastal region
- ✓ Assessment of Coral bleaching from remote sensing and meteorological parameters

Annexure-II

ITC[1] ASSESSMENT REGULATIONS

FOR COURSES LEADING TO A MASTER OF SCIENCE (MSc) DEGREE2 OR POSTGRADUATE DIPLOMA

– September 2011 –

Appendix: Bodies and persons involved in management and quality assurance of ITC's MSc and Postgraduate Diploma courses

These ITC Assessment Regulations for the Master of Science (MSc) degree and Postgraduate Diploma courses were approved by the Examination Board on 1 September 2011 and by the Dean on 22 September 2011.

1. Range of application

1.1 These assessment regulations apply to all courses that are offered by the Faculty ITC of the University of Twente and are leading to a Master of Science (MSc) degree or a Postgraduate Diploma (PGD) starting from September 2011 onwards and replace all previous ITC Assessment Regulations for Master of Science Degree Courses and ITC Assessment Regulations for Postgraduate Diploma courses.

1.2 The MSc and Postgraduate Diploma course can be an ITC course only (fully taught at the Faculty ITC of the University of Twente) or a joint course (partly taught by one or more of ITC's partners and partly by ITC). The course can be taught fully face-to-face or be a combination of face-to-face and distance components. In all cases, ITC monitors and assures the quality of the whole course.

1.3 In most cases where the MSc / Postgraduate Diploma course is taught in conjunction with a partner, the two institutes will agree upon new procedures which may take precedence over these 'ITC Assessment Regulations for courses leading to a Master of Science degree or Postgraduate Diploma'. The Course Director of the course concerned will inform the participants which assessment regulations and procedures apply.

1.4 Any changes made in the management of education of ITC during the course will be incorporated in these assessment regulations.

Decisions taken at central level of the University of Twente during the course may overrule these ITC Assessment Regulations.

1.5 In all cases that are not dealt with in these rules, the Course Director of the course concerned will decide upon an appropriate course of action. Disputes about the interpretation of these regulations shall be referred to the Dean of ITC, who will determine the interpretation and action that should be taken.

1.6 In exceptional circumstances, the Portfolio-holder Education, Head Education and/or Course Director may deviate from these assessment regulations, but only with the approval of Examination Board of ITC.

2. Management, structure and organization of the M.Sc. and Postgraduate Diploma course

2.1 The MSc course is organized into four blocks with a total of 23 modules[3] and three additional weeks for introduction and catch-up activities and graduation ceremonies.

Block 1: modules 1-3
Block 2: modules 4-10
Block 3: modules 11-15
Block 4: modules 16-23
The first year of three blocks and 15 modules consists of coursework. The last 6 months (block 4; 8 modules) focus on individual research.

The sequence of modules is fixed. The rules for deviations are described in section 3.

The Postgraduate Diploma course consists of the first two blocks (10 modules) of the MSc course, one or two introduction weeks and a Final Assignment of four weeks duration.

The MSc and Postgraduate Diploma courses are taught in English.

[3]*A module consists of related subjects and has duration of 3 weeks. Courses may contain elements of two or more combined modules.*

2.2 The duration of the MSc course is 18 months fulltime. The duration of the Postgraduate Diploma course is nine months fulltime (in India, it is 10 months). Participants in both courses may spread the modules over a maximum of five years.

2.3 The study load per module is 5 ECTS[4] credit points. The total study load of the MSc course is 118 ECTS credit points. The total study load of the Postgraduate Diploma course is 62 ECTS credit points.

[4]*European Credit Transfer System. In ECTS, 60 credit points represent the study load of one academic year. In ITC 29 hours of study are needed for 1 ECTS credit point.*

2.4 The formal curriculum of the MSc course and the Postgraduate Diploma course has been approved by the Dean. Responsibility for detailed development and implementation of the approved course rests with Head Education, who delegates this responsibility to the Course Director. Responsibility for quality assurance of the course rests with the Portfolio-holder Education. The Examination Board decides on the eligibility of the MSc participant to receive the MSc Degree and whether the participant in the Postgraduate Diploma course will receive the Postgraduate Diploma. (See also the appendix 'Bodies and persons involved in management and quality assurance of ITC's MSc and Postgraduate Diploma courses').

2.5 During and at the end of the course, a participant's competence in the field of study will be assessed through tests, examinations and/or assignments (in written, oral and/or practical form) and/or based on participation. Assessments will be used to:

- Provide feedback to participants so that they may improve their performance (formative assessment), or,
- Grade participants' work with a mark or quality description on a scale which indicates their competence in the field of study (summative assessment).

Before any assessment, participants shall be told which of the above two functions applies. These regulations describe the conditions and procedures concerning summative assessments.

2.6 At the beginning of the MSc and Postgraduate Diploma course each participant shall receive a study guide that contains:

- Descriptions of the course objectives and content of the course and modules
- The name of the MSc degree/Postgraduate Diploma to be received on successful completion of the course
- The course-specific conditions relating to that MSc degree / Postgraduate Diploma
- Which module assessments will result in a mark and which modules in 'completed /fail'.

2.7 The relationship between mark ranges, 'completed/fail' and grades is as follows:
Mark: Grade:
90 – 100 Excellent
80 – 89 Very good
70 – 79 Good
60 – 69 Pass
0 – 59 Fail
'completed' Pass or higher
'fail' Fail

3. Admission to the course and individual changes in the curriculum

3.1 Applicants that meet the entry requirements for the MSc / Postgraduate Diploma course, as stipulated in the current course brochure, may be registered for the MSc / Postgraduate Diploma course at the discretion of the Course Director.

3.2 Because of the contents of the MSc / Postgraduate Diploma course, applicants with visual or physical disabilities may only be registered when the handicap is not a major obstacle for meeting the course objectives. At the start of the course the Course Director and the handicapped participant will discuss what and how course activities and assessments will be adapted for this participant in such a way that the handicap of the participant is not an obstacle for meeting the course requirements.

3.3 Participants in the Postgraduate Diploma course who wish to take the whole MSc course have to re-apply for the (second part of the) MSc course. In such cases the maximum time between the starting date of the Postgraduate Diploma course and the graduation date of the MSc course is five years (see rules 2.2 and 3.4).

3.4 Participants may be given exemption for a module of the course when they have shown they have already mastered the content of the module. An exemption for a module may lead to direct admission to the next module or to exchange of the module for a module in another ITC course. Exemptions are subject to the approval of the Examination Board and, in case of exchange for a module in another course, approval of the Course Director of that course.

3.5 Exemption for a module will be given when this module was successfully completed by the participant:

(1) As part of another course in the same ITC domain as the MSc / Postgraduate Diploma course and
(2) No longer ago than five years before the participant is expected to complete the MSc/ Postgraduate Diploma course (see rule 2.2).

At least 50% of the MSc / Postgraduate Diploma course has to be taken to be eligible for the MSc degree / Postgraduate Diploma. Therefore, exemption can be given for a maximum of 11 modules of the MSc course and for a maximum of five modules of the Postgraduate Diploma course.

Requests for exemption that do not meet these conditions will be considered on an individual basis, at the discretion of the Examination Board. In such cases, exemption can be given for a maximum of eight modules in the MSc course and four modules in the Postgraduate Diploma course.

Exemption can never be given for (part of) the thesis research work in the MSc course.

3.6 In exceptional cases, a participant may also exchange a module of which the content has not been mastered for a module given in another ITC course, provided that the Course Director of that course approves. Such an exchange is up to a maximum of two modules and subject to the approval of the Examination Board.

3.7 Any change in sequence of modules that is not described yet in 3.3 to 3.5 requires the approval of the Examination Board.

3.8 Rules 3.3, 3.4, 3.5 and 3.6 concerning exemptions do not apply to joint courses and other cases where ITC has an agreement with a partner institute that participants who have

successfully completed a specific curriculum in the partner institute can be given direct admission to a later part of the MSc or Postgraduate Diploma course.

4. Assessment of modules (excluding research period and final assignment)

4.1 Organization of module assessment

4.1.1 Each module will be assessed by means of a test, examination, assignment and/or based on participation. More than one assessment per module is allowed but must result in a single module mark (0 - 100) or 'completed / fail'. For combined modules (e.g. core modules, thesis), one overall assessment is allowed. Up to three of the first 11 modules in the MSc course may be assessed by 'completed/fail'. The other module assessments must result in a mark.

The assessment of modules 12 and 13 may not be based on participation only and must result in a mark.

4.1.2 In case of more assessments per module, participants shall be informed before the first assessment of:

- the weight of each assessment in the overall module mark;
- the required minimum mark per assessment

4.1.3 For admission to the research part (see rule 5.4.1) and for the calculation of the average of all modules (see rule 7.3); the result obtained for combined modules will be given to each separate module.

4.1.4 Participants shall be informed of the date, subject, objectives and form of the assessment (practical, written, oral or computer-based, open or closed book), at least one week before an assessment.

4.1.5 The maximum duration of each assessment shall be as follows: Written theoretical exam 3 hours Computer-based theoretical exam 2 hours Practical assignment determined by the Course Director Oral theoretical or practical exam 45 minutes

Participants shall be informed at the start of each assessment of:

- the duration of the assessment;
- if there is a choice, the number of questions to be answered;
- the weight of each question;
- whether books and/or notes may be used.

Two staff members must be present at an oral assessment.

4.2 Feedback to participants and re-sits

4.2.1 Participants shall be informed, individually, of the results of an assessment by the staff responsible for the assessment or by the Course Secretary, within two weeks of an assessment. The marks awarded for each question or assignment shall be made known to each participant.

4.2.2 Marked scripts shall be shown to participants so that they may know the strengths and weaknesses of their answers. Answers to questions and results of assignments shall be reviewed in a class session, through the distribution of answer sheets or through comments on scripts. Staff responsible for the assessment is required to give an explanation of the marks awarded.

Scripts will be retained for at least two years after the results are officially recorded.

4.2.3 The following rules apply to re-sits:

(1) Only those participants who fail an assessment at the first attempt (i.e. who achieve a mark less than 60 or 'fail') may re-sit that assessment. Only one re-sit per assessment is allowed. In case of two or more assessments in a module, the option to re-sit an assessment does not exist when the overall module mark is at least 60 or 'completed'. The module coordinator may deviate from this rule, provided the new rule is communicated in writing before the first assessment takes place.

(2) Participants who re-sit an assessment may obtain only a maximum mark of 69 (or PASS grade) or 'completed' for that assessment.

(3) The previous mark or 'fail' will only be superseded when participants achieve a higher mark or 'completed' in the re-sit.

(4) Only the final module mark or grade will be shown in the MSc Diploma Supplement or on the Course Record, without any indication whether the final mark or grade was obtained through a re-sit or not.

(5) Participants who have failed due to serious circumstances (at the discretion of the Course Director) can apply for a new assessment, provided they have reported their circumstances in writing to the module coordinator or staff member responsible for the assessment before the scheduled assessment time.

4.2.4 In the case of practical assignments of long duration (practical exercises, a case study with fieldwork) the possibility of repetition can be considered only in exceptional circumstances and subject to approval by the Course Director.

4.2.5 A participant not attending a scheduled assessment, not completing an assignment or not presenting the required work within the specified time, will be considered as having failed. The participant will be given a 'fail' or a mark of 0 (zero). If an acceptable reason (at the discretion of the Course Director) can be offered, the participant can apply in writing for a new assessment or extension of the deadline for submission of the assignment.

4.2.6 In case of plagiarism or other types of fraud, the participant(s) concerned will be considered to have failed and a mark 0 (zero) will be given (see also rules 9.3 and 9.5).

4.2.7 The grade sheets managed by the Course Secretary are the official record of the results of assessments. In case of discrepancies between this official record and marks and grades presented to participants in other ways, the marks and grades in the official record apply.

5. Research orientation and research period (MSc course)

5.1 Research orientation (block 3)

5.1.1 At a specified date before the start of Module 11 participants must submit:

(1) The research theme they will join,
(2) A motivated choice of modules 12 and 13, and
(3) The preliminary title of the individual MSc research topic and its main thrust.

The choices will be assessed by the Course Director and the research theme leader concerned (or delegate).

Approval of these choices leads to admission to the research theme and two MSc supervisors will be appointed (see rule 5.3.1).

5.1.2 The final MSc research proposal (approximately 8 pages) must be presented in module 15.

5.1.3 Participants have freedom to choose from the advanced subjects on offer in modules 12 and 13, with the limitation that modules will only be given when sufficient participants will participate.

5.2 The individual research period and thesis (block 4)

5.2.1 The MSc research period focuses on individual research. The research requires that the MSc participant carries out the research and reports on progress to the supervisors according to an agreed schedule for the research and preparation of the thesis.

5.2.2 The research work will be assessed on three occasions:

(1) The detailed research proposal and presentation, leading to admission/ no admission to the research period (end of module 15).
(2) The mid-term presentation. No mark is given. The participant receives feedback from the research theme leader (or delegate) and at least one of the supervisors. In the case of weak performance, the participant will receive a written warning from the Course Director (see rule 9.1).

(3) The assessment and oral examination of the thesis.

In addition to these formal assessments, the participant will receive feedback on his/her performance from the supervisors throughout the research period.

5.2.3 A participant not presenting the (draft) research proposal, not making the mid-term presentation, not submitting the thesis or not attending the final oral examination within the specified time, will be considered to have failed. Only in exceptional cases, and for reasons beyond the control of the participant (at the discretion of the Course Director), the participant may apply in writing for a new opportunity to meet the above requirements.

5.2.4 The thesis, approximately 50 pages of text (approximately 350 words per page and presented in the standard ITC format for theses), excluding appendices, shall constitute an ordered, logical and critical description of the research and should afford evidence of reasoning power, critical attitude, competence in the scientific discipline (application and/or development of knowledge and skills), and knowledge of relevant literature.

5.2.5 The thesis may describe work done in conjunction with a supervisor or any other person, but the extent of the participant's personal contribution must be certified by the supervisor concerned.

5.2.6 With the explicit approval of the supervisor, a participant may be permitted to incorporate in his/her thesis a limited amount of unpublished work undertaken by the participant prior to the start of the research. A participant may not incorporate in his/her thesis material which has been submitted for achieving the award of a degree from any other educational institution.

5.2.7 The source of any photograph, map, or other illustration shall be indicated, as shall the source, published or unpublished, of any material not resulting from the participant's own work. If material from other work is incorporated verbatim, without proper acknowledgement of the source (plagiarism), the Thesis Assessment Board will decide not to assess the thesis. This means that the MSc degree cannot be awarded (see also rule 9.3 and 9.5).

5.3 Supervision of the proposal phase and the research work

5.3.1 In module 11, in consultation with the research theme leader and the MSc participant, the Course Director shall recommend a primary and secondary supervisor to the supervisor's department(s). PhD students and AiO's may be involved in the supervision as advisor and support the work of the supervisors. Supervisors and advisors are appointed by the management team of the department.

5.3.2 The two supervisors and, if applicable, the advisor shall divide the supervision tasks and make a supervision plan and meeting schedule with the participant.

5.3.3 Supervisor(s) shall:

(1) Guide the MSc participant in the formulation of a detailed research proposal.
(2) Establish a schedule of regular supervisory meetings with the MSc participant (on an average once per fortnight). Additional meetings may be arranged by agreement.
(3) Provide general advice and guidance on the execution of the research.
(4) Provide feedback on draft written work, normally within 10 days of receipt.
(5) Where appropriate, forward any comments on the performance of the participant to the Course Director.
(6) Inform the Course Director when the progress of a participant gives cause for concern so that action can be taken in accordance with these regulations (see rules 9.1 and 9.2).

5.3.4 If an MSc participant considers that he/she is not receiving the quality of supervision required in the regulations, the participant should report this to the Course Director.

5.3.5 Replacement of a supervisor may be considered if the research is found to be outside a supervisor's area of expertise, or at the request of the supervisor and/or of the participant.

5.4 Admission to the research period

5.4.1 For admission to the research part of the course, at least all but two of the previous modules (see rule 7.3 to see which modules are to be included) must have been successfully completed and no mark below 50 is allowed. The second requirement for admission to the research part, which is as important as the marks obtained in previous modules, is the ability to undertake independent research. This ability will be developed and assessed during the first 15 modules and finally assessed on the basis of the detailed, written and orally presented, research proposal (end of module 15).

5.4.2 The Course Director will nominate, and the Examination Board will appoint, a Thesis Admission Committee. This Committee will assess the proposal and the presentation by the participant. The Thesis Admission Committee is accountable, via the Course Director, to the Examination Board.

5.4.3 Each Thesis Admission Committee has 3 members: the research theme leader or delegate (chair), the first supervisor and the second supervisor or delegate. The Course Director and involved PhD students or AiO's (see 5.3.1) may be present as advisors.

5.4.4 The research proposal will be assessed based on the written proposal, a presentation and oral defence. The presentation and oral defence have duration of a half hour. The participant will receive the result and remarks in writing.

5.4.5 The oral defence of the research proposal is open and will be announced as such. In exceptional cases the Course Director can decide to have the oral defence of individual participants closed to observers other than ITC staff.

5.4.6 When the Thesis Admission Committee is of the opinion that the research proposal is not of a level required for the start of the individual research period, the participant will receive feedback and will have a second opportunity to defend a revised proposal within two weeks. In case the second proposal presentation is not satisfactory, the candidate will not be admitted to the individual research period.

5.4.7 A participant who is not eligible for admission to the individual research period of the course but has completed modules 1 to 14 of the MSc course successfully (see rule 8.1) will receive a Postgraduate Diploma.

5.5 Submission of the thesis

5.5.1 The participant must submit a well-organized copy of all digital files associated with the research work on DVD, and a hard-copy of graphic output, at least two weeks before the examination date or as specified by the Course Director.

5.5.2 ITC will produce sufficient printed copies of the thesis, including two for the participant. The participant must bring one of his/her copies of the thesis to the oral examination.

5.5.3 One copy of the thesis will be sent to each member of the Thesis Assessment Board. The Institute will retain two bound copies if a degree is awarded, one of the copies being lodged with the Institute Librarian and the second copy in the course archive.

5.5.4 When work has been done in cooperation with others, the supervisor must submit a written statement to the Thesis Assessment Board indicating the part of the work done by the participant.

5.5.5 Postponement of the submission date of the thesis (which results in extension to the research period) can be given when:

(1) The main cause of the unsatisfactory level of the thesis has been beyond the control of the participant (at the discretion of the Course Director),
(2) The extension could lead to an acceptable thesis and examination (at the discretion of the supervisors),
(3) Financing for the extension is available,
(4) The request is made before the thesis is submitted.

The participant will take the initiative and apply in writing for extension to the Course Director. If the Course Director is of the opinion that all conditions are met, he/she will forward the request to Head Education for decision.

5.5.6 The maximum total duration of extensions to the research period is three months. Extensions are allowed only when the participant stays at ITC or, in the case of a joint course, at the partner institute. Participants who study part-time are allowed to work on the thesis in the home organization. Since the MSc course may be spread over a period of maximum five years (see rule 2.2) they may work on the thesis until about a month before the end of the five year period. In such cases, no extensions are possible.

5.6 Thesis examination

5.6.1 For the thesis examination, the Course Director nominates and the Examination Board appoints a separate Thesis Assessment Board for each participant. The Thesis Assessment Board is, via the Course Director, accountable to the Examination Board. Each Thesis Assessment Board has 3 to 5 members: one or both supervisor(s), an ITC professor or associate professor in a relevant discipline (who cannot be one of the supervisors), an external examiner and, if necessary, other staff members of the ITC. The involved AiO or PhD student (see 5.3.1) and the Course Director may be present as advisors. In many cases, the external member comes from outside the Faculty ITC, preferably being an academic staff member of a university or a knowledge institute. In the remaining cases, the external member comes from a scientific department of ITC that has not played a major role in the course and research theme. The Thesis Assessment Board is chaired by the ITC (associate) professor. In exceptional cases one of the other members, but not (one of) the supervisor(s), can be the chair.

5.6.2 The thesis examination consists of the assessment of the thesis and the oral examination that includes a presentation and defence. The oral examination has duration of one hour.

5.6.3 The Course Director assigns a date for an oral examination and informs the participant at least one month in advance of this date.

5.6.4 All members of the Thesis Assessment Board shall read and assess the quality of the thesis as an ordered, logical and critical exposition of research work in the approved field. A minimum of three members of the Thesis Assessment Board must be present at the oral examination. (In case the ITC (associate) professor cannot attend, Head Education will appoint another ITC (associate) professor to replace him or her.) These members of the Thesis Assessment Board will assess the participant's reasoning power, critical attitude, competence in the scientific discipline, and knowledge of the relevant literature, will raise questions concerning the thesis and will decide on the mark.

5.6.5 The oral examination is open and will be announced as such. In exceptional cases the Course Director can decide to have the defence of individual participants closed to observers other than ITC staff.

5.6.6 On the basis of the assessment of the participant the Thesis Assessment Board shall take one of the following decisions:

(1) The thesis is satisfactory. One single mark is given.
(2) Subject to minor corrections (that can be implemented within three working days and implemented before the official end of the course) in the thesis, the thesis is satisfactory. One single mark is given, subject to the corrections in the thesis being made.
(3) The written thesis is not satisfactory and a FAIL grade is given. However, the presentation and defence have shown that the participant is capable of performing principal research tasks. Subject to major changes, the participant may re-submit the written work within three months and a new oral examination will be scheduled.
(4) The thesis is not satisfactory and is given the FAIL grade.

5.6.7 No changes may be made in the thesis after submission for the thesis examination, only an errata list may be added. If the Thesis Assessment Board requires minor corrections to the thesis, these, and only these, corrections must be made and must be checked and approved by one of the supervisors. In all other cases changes can only be made when the thesis is to be re-examined by the Thesis Assessment Board.

5.6.8 Participants who are eligible to re-submit (5.6.6 option 3) are allowed to complete the thesis outside ITC. There is no right to supervision. The maximum mark for the thesis after the re-examination will be 60. Extension to the three-month period in which the participant has to re-submit is not possible.

5.7 Access to the thesis

5.7.1 The primary function of the Institute is the development and dissemination of knowledge. Theses are lodged with the Institute Librarian and shall be made available for consultation, inter-library loan and photocopying. Theses that meet the following criteria will also be made available in digital format at the ITC website:

(1) Have been awarded a mark of 75 or more.
(2) Contain no material of which the copyright rests with third parties
(3) Contain no confidential data or information.

5.7.2 Any staff member who publishes results from MSc research work or the related thesis is obliged to make a proper reference to the MSc participant's work.

6. Final Assignment (Postgraduate Diploma course)

6.1 The Final Assignment and result

6.1.1 The Final Assignment period focuses on the application of knowledge, methods and techniques in the subject of the course to the task performed or to the topic investigated. Depending on the course, the Final Assignment will be done individually or in small groups.

(1) At the start of the Final Assignment period, participants will receive terms of reference from supervising and coordinating staff.

(2) Subsequently, participants will have to plan and carry out the assignment according to the terms of reference.

(3) Part of the output of the assignment will be a final report and a documented database.

(4) The output of the assignment will be presented and discussed in public.

6.1.2 A participant or group not completing the Final Assignment within the specified time will be considered to have failed. Only in exceptional cases and for reasons beyond the control of the participant/group (at the discretion of the Course Director), the participant/group may apply in writing for a new opportunity to meet the above requirements.

6.1.3 A participant or group may not incorporate material that has been submitted for achieving certification from any other educational institution, in the Final Assignment result.

6.1.4 The source of any photograph, map, or other illustration shall be indicated, as shall the source, published or unpublished, of any material not resulting from the participant/group's own work. If material from other work is incorporated verbatim, without proper acknowledgement of the source (plagiarism), the Course Director may decide that the Final Assignment will not be assessed. This means that the Postgraduate Diploma cannot be awarded.

6.2 Supervision of the Final Assignment

6.2.1 The coordinator of the Final Assignment period, in consultation with the Course Director, will set up a scheme indicating which staff is available for consultation and supervision throughout the Final Assignment period. The supervising staff has to be appointed by the management team of their department.

6.2.2 The supervising staff shall:

(1) Provide the participant/group with clear terms of reference.

(2) Establish a schedule of supervisory meetings with the participant/group.

(3) Provide general advice and guidance on the execution of the Final Assignment.

(4) Provide feedback on work, normally within three days of submission.

(5) Forward, where appropriate, any comments on the performance of the participant(s) to the Course Director.

(6) Advise the Course Director when the progress of a participant gives cause for concern so that action can be taken in accordance with these regulations (see 9.1 and 9.2).

6.2.3 If a participant/group considers that he/she is not receiving the quality of supervision required in the regulations, the participant/group should seek action from the Course Director.

6.3 Submission of the Final Assignment result

6.3.1 The participant/group must submit a well-organized copy of all digital files associated with the Final Assignment work on DVD, and copies of hard-copy graphic output, to the supervising staff on the date of the Final Assignment assessment or as specified by the coordinator of the Final Assignment period in consultation with the Course Director.

6.3.2 Where the Final Assignment has been executed in groups or where individual Final Assignment work submitted has been executed in cooperation with others, the supervisor(s) must provide a written statement, indicating the extent of the share of the work that each participant has done.

6.4 Assessment of the Final Assignment

6.4.1 Participants will be assessed individually based on the output of and the presentation of the Final Assignment.

6.4.2 The Course Director assigns a date for the Final Assignment assessment and informs the participant/group of this date at least two weeks in advance.

6.4.3 Criteria for the assessment of the Final Assignment will be provided at the start of the Final Assignment period, i.e. at the time of providing the participants with the terms of reference for the Final Assignment.

6.4.4 The Final Assignment result will be assessed by a committee of two or three staff members: at least one staff member holding a PhD in a relevant discipline and at least one staff member who has been involved in the supervision during the execution of the Final Assignment. One examiner will be asked as chair; this will not be (one of) the supervisor(s). At least two examiners must be present at the oral examination.

6.4.5 The presentation of the Final Assignment is open and will be announced as such. In exceptional cases the Course Director can decide to have the presentation of individual participants closed to observers other than ITC staff.

6.4.6 On the basis of the assessment of the participant(s) the assessing committee shall take one of the following decisions:

(1) That the Final Assignment is satisfactory. One single mark is given.

(2) That subject to minor corrections (that can be implemented within three working days and implemented before the official end of the course) in the Final Assignment result, the Final Assignment is satisfactory. One single mark is given, subject to the corrections in the Final Assignment result being made.
(3) The Final Assignment is not satisfactory and is given the FAIL grade.

6.4.7 In exceptional cases extension may be given for the Final Assignment work, but only before the Final Assignment assessment and only when:

(1) Financing for the extension is available, and
(2) The main cause of the unsatisfactory level of the Final Assignment has been beyond the control of the participant/group, at the discretion of the Course Director.

The participant will take the initiative and apply in writing for extension. If the Course Director is of the opinion that condition 2 is met he/she will forward the request to Head Education for decision.

6.4.8 Extensions have a maximum duration of 50% of the standard duration of the Final Assignment. Extensions are only allowed when the participant/group stays at ITC. This rule does not apply to participants who study part-time. They are allowed to work on the Final Assignment in the home organization until the end of the period of five years counting from the official starting date of the course (see rule 2.2). In such cases, no extensions are possible.

7. Assessment of MSc degree and Postgraduate Diploma

7.1 On the basis of the assessment results of the MSc course participant, the Examination Board decides whether the participant will be awarded the MSc Degree or, in case the MSc degree will not be awarded, whether the participant will be awarded a Postgraduate Diploma or Certificate. On the basis of the assessment results of the PGD course participant, the Examination Board decides whether the participant will be awarded the Postgraduate Diploma or, in case the Postgraduate Diploma will not be awarded, whether the participant will be awarded a Certificate. In case the Examination Board does not award any certification, the Course Director will decide whether the participant will be awarded a Certificate of Attendance.

7.2 At the end of the MSc course / Postgraduate Diploma course, after receipt of the assessment results of the thesis / final assignment, the Examination Board shall take one of the following decisions:

(1) That the thesis / final assignment and overall course performance of the participant are satisfactory. The degree of MSc / Postgraduate Diploma shall be awarded.

(2) That the thesis / final assignment and overall course performance of the participant are such that the MSc degree / Postgraduate Diploma shall be awarded 'cum laude' (with distinction).

(3) That subject to minor corrections in the thesis / final assignment the thesis/ final assignment and overall course performance are satisfactory.The degree of MSc/ Postgraduate Diploma shall be awarded subject to the corrections in the thesis /Final Assignment result being made before the official end of the course.

(4) For MSc candidates: That the research work / final assignment and/or overall course performance are not satisfactory. The degree of MSc shall not be awarded.
The participant may receive a Postgraduate Diploma (see 8.1).
For Postgraduate Diploma course participants: That the final assignment and/or overall course performance are not satisfactory. The Postgraduate Diploma shall not be awarded. The participant may receive a Certificate (see 8.1).

7.3 The criteria for the award of an MSc degree and the award of a Postgraduate Diploma are:

(1) The average of all final module marks must be at least 60. When a module is assessed with 'completed' or 'fail': a 'completed' will not be included in the average, a 'fail' will be counted as a mark of 50. In case of one overall assessment for combined modules, the overall mark will be given to each separate module, before calculation of the average.

(2) No more than two of the modules may have a mark below 60 or 'fail' and no module mark below 50 is allowed.

(3) The thesis (that counts for 8 module marks) in the MSc degree course must have a mark of at least 60. The final assignment in the Postgraduate Diploma course (that counts for 2 modules) must have a mark of at least 60.

Only results of modules that are part of the formal curriculum of the MSc or Postgraduate Diploma course are included in the calculation of the average and counted for the number of marks below 60 and below 50. Therefore results of a module that is taken in addition to the formal curriculum or in exchange for a module of the formal curriculum for which exemption was given, will not be included. However, a module that was taken in exchange because of a reason other than exemption (see rule 3.4), is (only for the application of this rule 7.3) considered as part of the formal curriculum.

If results of modules were obtained more than five years before the end of the course, then the validity of these modules must be confirmed by the Examination Board. (See rule 3.4.)

7.4 To be entitled to receive an MSc degree or Postgraduate Diploma 'cum laude' (with distinction) the average of all module assessments (see rule 7.3 which modules are to be included) must be 80 or above. The thesis or Final assignment must have a mark of 80 or

above. No marks below 70 or 'fails' are allowed. Participants who have made changes in the formal curriculum of their MSc or Postgraduate Diploma course (exemptions or exchanged modules) that affect more than four (MSc course) or two (PGD course) modules are not entitled to receive an MSc degree or Postgraduate Diploma 'cum laude'.

8. Awards and certification

8.1 A **Master of Science degree in Geo-information Science and Earth Observation** will be awarded to a participant who has been officially admitted to an MSc course (as approved by the Dean) and has fulfilled the assessment requirements of that course.

A **Postgraduate Diploma in Geo-information Science and Earth Observation** will be awarded to a participant who has been officially admitted to a PGD course (as approved by the Dean) and has fulfilled the assessment requirements of that course. A Postgraduate Diploma ('cum laude' will not be possible in this case) and a Certificate for the remaining modules will also be awarded to a participant who (1) has been officially admitted to an MSc course, (2) has not been admitted to the research period or has failed the thesis, (3) has completed modules 1 to 14 of the MSc course successfully (average of all module marks is at least 60, not more than two marks between 50 and 60 and no marks below 50), and (4) has not received exemption for more than seven of the modules 1-14.

A **Certificate** will be awarded to a participant who (1) has been officially admitted to an MSc course or Postgraduate Diploma course but has not fulfilled all assessment requirements for that course, and (2) who has fulfilled the assessment requirements of at least one summatively assessed module of that MSc or Postgraduate Diploma course. The Certificate will mention that the participant 'has followed individual modules in Geo-information Science and Earth Observation' and the course domain and/or stream.

A **Certificate of Attendance** will be given to participants who have been officially admitted to an MSc course or Postgraduate Diploma course, but have not fulfilled the assessment requirements of any summatively assessed module. The Certificate of Attendance will mention that the participant 'has attended individual modules in Geo-information Science and Earth Observation', the course domain and/or stream and the period of study. Only the names of the modules in which the participant has participated for at least 80% will be mentioned on the Certificate of Attendance.

No qualification other than 'cum laude' will be indicated on any MSc degree or Postgraduate Diploma.

8.2 MSc Degrees, Postgraduate Diplomas and Certificates are issued under the responsibility of the Examination Board. Certificates of Attendance are issued under the responsibility of the Course Director.

8.3 MSc Degrees and Postgraduate Diplomas are signed by the Chair or Vice-Chair of the Examination Board. Certificates are signed by a member of the Examination Board. Certificates of Attendance are signed by the Course Director.

8.4 MSc degrees are accompanied by a Diploma Supplement, signed by the Chair or Vice-Chair of the Examination Board. The MSc Diploma Supplement describes the nature, level, context, content, study load (in ECTS credit points) and status of the MSc degree and MSc course and the names of and the marks or grades obtained for the modules and thesis. The assessments 'completed' or 'fail' will appear as such in the MSc Diploma Supplement.

8.5 Postgraduate Diplomas and Certificates are accompanied by a Course Record, signed by a member of the Examination Board. The Course Record will show the period of study, the names of and marks or grades obtained for the modules that have been finished successfully or that the participant has participated in for at least 80% but not finished successfully. The assessments 'completed' or 'fail' will appear as such in the Course Record. ECTS credit points will be mentioned for modules that have been finished successfully.

8.6 The names of the modules that are part of the formal curriculum of the course are mentioned in the MSc Diploma Supplement or on the Course Record. The marks or grades obtained or, in case of exemption, the word 'Exemption' will be added.

Only in case the Examination Board has approved that another ITC module could be taken in exchange of a module of the formal curriculum, the name of the new module will be mentioned.

The names of modules (and the results obtained) that are taken in addition to the formal curriculum of the course are also listed in the MSc Diploma Supplement or on the Course Record under the heading 'Extra'.

9. Early termination of the course

9.1 Where a Course Director and/or Head Education are/is of the opinion that a participant's progress gives cause for concern the participant shall be informed of the situation by the Course Director. Where a participant's performance is such that she/he is unlikely to obtain an MSc Degree / Postgraduate Diploma without a significant improvement in performance, the participant shall be advised in writing by the Course Director of the situation and the implications (Oral and/or written advice by the Course Director is not always given when the concern arises after the mid-term presentation of the thesis or after the approval of the Final Assignment plan.).

9.2 In cases of obvious non-performance, Head Education may decide at any time that a participant must discontinue his/her course. Such a decision will not be taken without consulting the Examination Board and the participant having received one written warning and being given time to improve performance.

In case of fraud during an exam or in assignments, the participant(s) concerned will be considered to have failed and a mark 0 (zero) will be given.

In case of plagiarism in the submitted thesis, the Thesis Assessment Board will decide not to assess the thesis. Extensions of the thesis period are then not possible. This means that the MSc degree cannot be awarded. The participant will get a Postgraduate Diploma or Certificate (see rule 8.1).

In case of plagiarism in the submitted final assignment of the Postgraduate Diploma course, the Course Director may decide that the final assignment will not be assessed. This will mean that the Postgraduate Diploma cannot be awarded; the participant will get a Certificate.

9.3 In case of severe or repeated fraud or plagiarism, Head Education, in consultation with the Examination Board, will decide that the participant is expelled from the course. Expulsion from the course means that the participant will not receive any certification.

9.4 ITC will use plagiarism detection software or other tools to detect fraud. In submitting a text, the participant implicitly consents to the text being entered in the database of the detection software concerned.

9.5 In case of other types of misbehaviour, Head Education will consider expulsion from the course.

10. Student complaints and requests procedures

10.1 In case of problems of a general or structural nature in the course, the Student Association Board (SAB) may be consulted.

10.2 In the event that a participant disagrees with decisions taken by a staff member, examination committee or Thesis Assessment Board, he/she may present this decision for reconsideration to the Course Director.
Where a participant finds that he/she is not receiving the quality of thesis / final assignment supervision required in the regulations, the participant should also seek action from the Course Director.
Requests for reconsideration must be made in writing. The Course Director will respond in writing.

10.3 If not satisfied with the decision of the Course Director, participants have a right of complaint/request with the Examination Board when the disagreement is related to an examination or with Head Education for all other issues. A complaint or request will only be accepted if:

- The previous steps of dealing with complaints and requests (complaint or request has been discussed with the lecturer, examination committee or Thesis Assessment Board and has been presented to the Course Director for reconsideration; see rule 10.2) have not led to agreement;
- The complaint or request has been made before the official end of the course.

Complaints and requests should be addressed in writing to the Chairman of the Examination Board/Head Education.

10.4 Where unequal treatment of participants is claimed, copies of all relevant scripts shall be made available for review by those investigating the complaint or request.

10.5 The Examination Board/Head Education may hear all parties involved (including the Course Director) for relevant information, before the final decision is taken and communicated in writing to the student. In case the complaint or request is supported, the Examination Board/Head Education will propose remedial actions, which may include extension of the fellowship. If the complaint or request of the participant is rejected, the reasons will be described.

10.6 The Examination Board/Head Education should deal with the case within two weeks of receipt of the complaint or request. If necessary the fellowship will be extended for the duration of the complaint/request procedure.

10.7 Support to a request for reconsideration or complaint concerning the assessment of the thesis cannot lead to overruling the assessment of the thesis, carried out by a Thesis Assessment Board that is composed according to these regulations. Acceptable remedial actions do include a re-sit for the oral part of the thesis examination (only when a reason beyond the control of the participant has caused underperformance in the oral part) or an extension to the research period (only when the main cause of unsatisfactory level of the thesis has been beyond the control of the participant) in combination with a full re-examination. Support to a request for reconsideration or complaint concerning the assessment of the final assignment in the Postgraduate Diploma course cannot lead to overruling the assessment of the final assignment, carried out by an assessing committee that is composed according to these regulations. Acceptable remedial actions do include a re-examination (only when a reason beyond the control of the participant has caused underperformance in the oral part) by the same assessing committee or two other ITC staff members with sufficient expertise in the subject of the Final Assignment.

10.8 No further complaint or request within ITC will be possible.
If still not satisfied, students have the right to appeal to the central complaint desk of the University of Twente.

Appendix: Bodies and persons[5] involved in management and quality assurance of ITC's MSc and Postgraduate Diploma (PGD) courses

[5]ITC will make changes in the management of education. The changes made during the course will be incorporated.
[6]The Dean of the Faculty ITC will use the title 'Rector of ITC' outside the Netherlands.
[7]Dutch law requires that every master-level course or program has an OER that describes the structure and contents of the course and the assessment regulations for that course. The OER of your course is the combination of these ITC Assessment Regulations and the objectives, structure, teaching approach and main contents of the course as described in the Study guide.
[8]The Students' Charter of the University of Twente describes the services for and the rights and obligations of UT students. The program-specific part describes the ITC specific services for and rights and obligations of ITC students.
The mentioned tasks and responsibilities must be carried out in accordance with the 'ITC Assessment Regulations for courses leading to a Master of Science degree or Postgraduate Diploma'

Dean

The Dean[6] is responsible for the overall management of the Faculty ITC and all its activities. This includes:

- Decision on Faculty Regulations for management and administration
- Decision on the degrees, diplomas and certificates that ITC offers
- Decision on the curricula of the degree, diploma and certificate courses including admission criteria and final examination criteria
- Decision on ITC's Education and Assessment Regulations (OER7)
- Monitoring of the implementation of the OER
- Appointment of the Faculty Council, Examination Board, Program Board, Portfolio-holder Education, Head Education and Course Director

Although the Dean has the overall responsibility for education and takes the final decisions, the daily coordination is delegated to the Portfolio-holder Education in the Management Team of the Faculty ITC.
The Dean is accountable to the Executive Board ('College van Bestuur') of the University of Twente.

Portfolio-holder Education

The Portfolio-holder Education is responsible for:

- Monitoring of the implementation of ITC's programs and courses by Head Education
- Quality and quality assurance of ITC's degree, diploma and certificate courses including initiation of internal and external reviews
- Preparation of new policy on education

Faculty Council (FC)

The Faculty Council has the right to advice the Dean on any matter pertaining to the overall management of the Faculty ITC, including advice on regulations, procedures and policies regarding education.
Moreover, in many cases the Faculty Council has the right of approval:

- Approval of policy and strategic plans of the faculty, including those regarding education
- Approval of ITC's quality assurance system
- Approval of the program-specific part of the Students' Charter8
- Approval of the Faculty Regulations for management and administration including rules for appointment of the Program Board and Examination Board
- Approval of most aspects of the OER and advice on the remaining aspects (that mainly deal with objectives and contents of the programs)

The Faculty Council consists of 50 % staff and 50% students. Staff members are elected by all ITC staff and student members are elected by the ITC student community.

Program Board (PB)

The tasks of the Program Board are to give advice to the Dean and Head Education on any matter pertaining to ITC's master-level courses and non-degree courses that are implemented by Head Education. This includes:

- Advice on the curricula of the degree, diploma and certificate courses, including admission criteria and examination criteria for final assignment and thesis
- Advice on ITC's quality assurance system and course-specific elements of this system
- Advice on ITC's Education and Assessment Regulations (OER)
- Annual evaluation of the courses and the way in which the OER has been implemented
- Advice on education policy

The Program Board consists of 50% staff and 50% students enrolled in the courses. All members are selected and appointed by the Dean.

Examination Board (EB)

The Examination Board decides whether a student has all knowledge, skills and attitudes that are defined in the OER for award of the degree, diploma or certificate. This responsibility includes:

- Assures the quality of all examinations in the degree, diploma and certificate courses
- Appoints all assessors / examiners and examination committees like the Thesis Admission Committee and the Thesis Assessment Boards
- Establishes and approves all assessment regulations and instructions for examination committees
- Decides on and awards the degree (plus Diploma Supplement), diplomas and certificates to individual students
- Decides on deviation of the formal curriculum by individual students

The Examination Board consists of staff members that are experts in the field of the courses, have expertise in assessment and are involved as lecturer/supervisor in at least one of the courses.
The members are selected and appointed by the Dean.

Academic Board (AB)

The Academic Board is an advisory board to the Dean, mainly on matters related to the development of the scientific fields of ITC and the contents of the education programs offered in these fields. This includes:

- Advice on the degrees, diplomas and certificates that ITC offers
- Advice on the curricula of the degree, diploma and certificate courses including admission criteria and examination criteria for final assignment and thesis
- Advice on policy and strategic plans, including those regarding education

The Academic Board consists of the Dean (chair) and all full and part-time professors of ITC.

Research theme leader

The Research Theme leader is responsible for all research carried out by the scientific staff and MSc participants connected to that theme. This responsibility includes:

- Admission of the MSc participant to the research theme

- Monitoring of the quality of the research supervision given to MSc participants under the theme
  Research theme leaders are ITC (associate) professors.

Head Education (HE)

Head Education is responsible for implementation of the degree, diploma and certificate course curricula (as approved by the Dean), ITC's quality assurance system (as approved by the Faculty Council and the Dean) and ITC's educational policy (as approved by the Faculty Council and the Dean).
Head Education focuses mainly on supra-course and supra-domain aspects. The actual implementation per domain is done by the Course Director.

Course Director (CD)

The Course Director is responsible for:

- Implementation of the degree, diploma and certificate courses in his or her domain, ITC's quality assurance system and ITC's educational policy, as delegated by Head Education
- Implementation of decisions taken by Head Education
- Day-to-day co-ordination and execution of the course
- Counselling of participants in matters concerning their studies

Thesis Admission Committee (TAC)

The Thesis Admission Committee is responsible for assessment of the thesis proposal and admission to the research part of the MSc course.
The Thesis Admission Committee is appointed by the Examination Board.

Thesis Assessment Board (TAB)

The Thesis Assessment Board is responsible for assessment of the thesis and oral examination of the participant on completion of the research.
The Thesis Assessment Board is appointed by the Examination Board.