

## Principles of GIS Course

### Sequence of learning and related study material.

The daily programme to cover all the content is described detail.

#### Day 1:

Lecture 1: Gentle Introduction to GIS

Content

- What GIS is about?
- The GIS data management processing system.
- The three spatial components of the GIS.
- Overview of applications and capabilities in hydrology.

Material:

- Lecture PDF: Gentle intro to GIS
- Chapter 1 Head GIS book.

Lecture 2-3: Coordinate systems and georeferencing

Content

- Spatial referencing
- Reference systems: geographical and Cartesian coordinates
- Ellipsoids and datum
- Datum transformations
- Map projections: classification and properties
- UTM projection
- Optional: Aspects of georeferencing and Geocoding (extract of the RS course). This is due to overlap of this subject in the GIS and RS courses.

Material

- Lecture PDF: Coordinate systems
- Chapter 4 Head GIS book
- Point 6.3 of the Head book of RS.

Practical 1: Spatial georeferencing

Optional practical: ILWIS introduction

The objective of this practical is the study of coordinate systems and georeferencing of raster systems.

This practical is a repetition of the one in the RS course, so if this GIS course is implemented before the RS, then the course should have the following alternative:

- The students should receive a lecture on ILWIS introduction (included in the material)
- Do the exercise of ILWIS introduction included in the directory P01\_novices, of the first day
- Only then they should do the georeference practice (included in the directory P01 first day)

#### Day 2

Lecture 4: GIS and data types

Content

- Fields and objects
- Computer representations: tessellations and vector-based
- Representation for continuous and discrete fields and objects

Material

- Lecture PDF: GIS & data types

- Chapter 2 Head GIS book

## Lecture 5: Database management System

### Content

- Databases and database management systems (DBMS)
- DBMD functionality and architecture
- The relational data model
- Relations, tuples and attributes
- Primary and foreign keys
- Querying a relational database
- Data integrity
- Selection
- Attribute projection
- Joining
- Linking spatial and attribute data

### Material

- Lecture PDF: DBMS
- Chapter 3 Head GIS book

## Practical 2: Tabular information and queries

This entire exercises deals with tabular information, tables, columns and records to handle attributes to spatial data. ILWIS software does not have a very powerful Database Management system but it has most functions to manage practically any kind if requests of a small to medium project.

This exercise deals with:

- Creation of tables: table domains, attribute columns, records and attributes itself
- Edition of tables and columns
- Importing of tables, excel sheets and databases
- Calculation with columns
- Conditions and operators
- Classification in columns
- Statistics in tables
- Regression
- Aggregation functions: simple, grouped and weighted averages
- Joining columns and tables
- Graph display

## Day 3:

## Lecture 6: Data entry and data preparation (pre-processing)

### Content

- Data preparation
- Digitizing errors and vector cleaning operations (software related)
- Interpolation methods from point data
- Discrete methods
- Thiessen Polygon (nearest neighbor)
- Continuous : interpolation techniques
- Trend surface fitting (linear, quadratic)
- Moving window averages
- Inverse distance weighting
- Triangulation
- Geostatistics

### Material

- Lecture PDF: Data entry and preparation
- Chapter 5 Head GIS book

### Practical 3: Data entry methods and management

This exercise is mainly about digitizing techniques. Digitizing is both a repetitive but essential task in GIS data entry. Through the experience we have learnt that digitizing tasks are up to some extent boring and normally left to not well trained staff. This exercise is designed to create awareness of the dedicated task that digitizing is, the decisions the professional have to take along this task, and the error analysis and error correction to be performed after the process.

The exercise includes the teaching of some hydrological techniques that can serve in many sciences. It is advice to practice the technique on a printed contour map before going into the digitizing mode.

The aspects of correction of the digitizing is the most relevant part of the exercise. ILWIS offer some automatic correction techniques, but the exercises is meant to reject them to learn the manual correction of hidden polygons, overshooting and snapping faults. This practical requires the access to the help file menu in ILWIS 3.3.1 to study the digitizing technique and correction of digitizing errors in ILWIS.

### Lecture 8+9: Spatial data analysis

#### Contents

- Analytical models: description of analytical functions:
- Measurements
- Vector measurements
- Raster measurements
- Retrievals
- Spatial Selection by Attribute conditions
- Spatial Selection using topological relationships
- Classification
- User controlled classification
- Automatic classification
- Overlay functions: arithmetic, comparison and logical operators.
- Vector overlay
- Raster overlays
- Decision tables
- Neighborhood functions: functions

#### Material

- Lecture PDF (2): Spatial data analysis
- Chapter 6 Head GIS book

### Practical 4: Spatial data analysis with vector and raster

#### Content

This practical stands for double time (suggested 2 afternoons). The practical goes through the most commonly used GIS spatial operations:

- Retrieval, (re)classification & measurement operations
- Overlay operations
- Neighborhood operations
- Retrieval using the pixel information
- Retrieval of information by displaying attributes
- Reclassification with Map Calculation formulas
- Using a Map Calculation formula for data retrieval

- Data retrieval with a Boolean statement
- Classifying value maps with MapCalc formulas
- Reclassifying a map with attribute data
- Classifying a value map (Slicing)
- Temporary classification for display options
- Permanent classification using the slicing operation
- Permanent classification using the CLFY function in MapCalc
- Measurement operations on point maps
- Measurement operations on point data
- Calculating the number of points
- Point density
- Distance between points
- Point in Polygon
- Measurement operations on segment maps
- Segment histogram of value maps
- Segment directions and Rose diagrams
- Calculating segment density
- Measurement operations on polygon maps
- Measurement operations on raster maps

## Day 5

### Lecture 10: Interpolation

#### Content

This lecture is an extension of chapters 2 and 5 in the GIS book. And the lecture on Spatial Data types and Data entry

- Interpolation methods from point data
- Discrete methods
- Thiessen Polygon (nearest neighbor)
- Continuous : interpolation techniques
- Trend surface fitting (linear, quadratic)
- Moving window averages
- Inverse distance weighting
- Triangulation
- Geostatistics

#### Material

- Lecture PDF: Interpolation
- Head GIS book sections in chapter 2 and 5

### Lecture 11: Data visualization:

#### Content

- Visualization process
- Elements of...: functions, rules and conventions
- Nature of the data: nominal, ordinal, interval and ratios
- Basic representation elements: point, line and area symbols. Non geographical: text.
- Visual variables: form/shape, orientation, color, texture, lightness and size.  
Examples.
- The process of representation

#### Material

- Lecture PDF: Data visualization
- Head GIS book chapter 7