Geographic Information Technology Training Alliance (GITTA) presents:

Primary sources and methods

Responsible persons: Claude Collet, Helmut Flitter, Moe Myint

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1. Primary sources and methods

In this lesson, you will

- Discuss sources of digital data such as digital cartographic databases, automated surveying, Global Positioning Systems and Remote Sensing.
- Learn the basic steps of processing remotely sensed images.
- Get an idea on how to realize data acquisition in the field and its major steps.
- Obtain the basics on how to collect planimetric, height, slope, thematic and phenomena information in the field.

Learning Objectives

- Existing digital databases are ready to import a primary data source to a GIS Database, if the data meets the data quality standard of the GIS Project and data file formats are compatible to convert. You will visit the web sites that offer data format translation and conversion tools from various formats to your GIS software formats.
- Remotely sensed data is available in digital form or printed photographic form. Remote sensing data measures the spectral characteristics of spatial objects at a particular time and at a particular stage. It is surrogate data of particular object at a particular time and stage.
- Remote sensing data is not directly usable in GIS. To be usable in GIS, it has to be preprocessed and post-processed. Preprocessing and post-processing steps will be introduced. Remote Sensing is a large domain of application science based on multidisciplinary integration of available science and technology. Therefore, the subject is briefly introduce from the perspective of data capture and the additional optional web site is indicated if you wish to learn more detail on this subject matter.
- Field data collection is another primary source of data for GIS. You will be introduced to historical field survey methods such as chain, to modern field survey methods such as automated surveying.
- Global Positioning Systems are one of the greatest innovations by mankind in twentieth century. GPS is developed by multidisciplinary integration of Geodesy, Mathematics, Satellite Technology, Telecommunication, Electronic engineering, Physics, Geography and Computer Science. Therefore, the subject is briefly introduce from the perspective of data capture and the additional optional web site is indicated if you wish to learn more detail on this subject matter.

1.1. Digital Sources

Objectives

This unit will discuss sources of digital data such as digital cartographic databases of systematic data collection and data provision, automated surveying, Global Positioning Systems and Remote Sensing. This unit will not discuss the technical and processing details of each source of digital data. At the end of the unit, you will be able to locate the digital data sources for a particular project.

1.1.1. Digital Sources

Digital Data Sources
Download the PDF version of the page here.

1. digital databases
Following animation will explain **digital databases** as the primary source of digital data. Click on it to view the full animation.

Only pictures can be viewed in this version! For Flash, animations, movies etc. see online version. Only screenshots of animations will be displayed. [link]

2. Introduction to Remote Sensing as Primary Digital Source Data
The following animation will explain **remotely sensed data**as the primary source of digital data. Click on it to view the full animation.

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2.1 Remote sensing satellites: SPOT and Landsat
SPOT Satellite (optional link) is passive a remote sensing satellite launched by France. Visit their web site by clicking on the link above for additional information about the SPOT satellite and its applications.

Band	Wavelengths	Appears to us
Band-1	0.5-0.6µm	Visible Green wavelength
Band-2	0.6-0.7µm	Visible Red wavelength
Band-3	0.7-0.8µm	Near Infrared wavelength
Band-4	0.8-1.1µm	Mid Infrared wavelength

SPOT wavebands are useful to detect differences in water quality, vegetation, and rock.

The Landsat satellite (optional link) is also passive a remote sensing satellite, launched by United States of America. Visit the Landsat homepage by clicking the yellow link above, for additional information about the satellite and its applications.
The Landsat-TM satellite records values for seven bands at 30-meter resolution.

Band	Wavelengths	Appears to us
Band-1	0.45 to 0 .515µm	Visible Blue wavelength
Band-2	0.525 to 0.605µm	Visible Green wavelength
Band-3	0.63 to 0.690µm	Visible Red wavelength
Band-4	0.75 to 0.90µm	Near Infrared wavelength
Band-5	1.55 to 1.75µm	Mid Infrared wavelength
Band-6	10.40 to 12.5µm	Thermal Infrared wavelength
Band-7	2.09 to 2.35µm	Mid Infrared wavelength
Panchromatic	0.52 to 0.90µm	Visible wavelength at 15 m resolution

The Landsat wave bands are able to detect temperature, differences in water quality, vegetation, rock and snow.

3. Use of Remote Sensing Data
The following animation will explain the **use of remotely sensed data.**

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Exercises

1. To combine the data from different digital data sources for a project, what are the compatibility characteristics to the existing digital data to be considered?
2. How are the existing digital data distributed?
3. What kind of information can be collected with GPS? What kind of information does GPS provide?
4. What is the difference between Active Remote Sensing and Passive Remote Sensing?
5. What is the minimum pre-requisite to use remotely sensed data in a GIS database?

1.2. Remote Sensing

Objectives

This unit will briefly explain the essential steps in remote sensing such as the display of a remote sensing image, geometric correction, spatial enhancement, spectral enhancement and classification of remote sensing images. At the end of the unit, you will understand the basic steps to process the remotely sensed images and will be prepared to learn theoretical and practical digital image processing steps in the intermediate level.

1.2.1. Essential steps in Remote Sensing

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Remote Sensing Method

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1. Image Display

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2. Registration and Rectification

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3. Contextual Enhancement

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4. Multiband transformation: Indices

Multiband transformation techniques are used to create a new band for enhancing a feature of interest, reducing data size and redundancy. Multiband transformation techniques require more than one band of data and use the spectral information found in the multiple data bands. Indices and principle component analyses are multiband transformation techniques. Indices The following indices are commonly used.

Indices	Equation
Vegetation Difference Index	IR-R (infrared - red)
Vegetation Index	IR/R (infrared/red)
Normalized Difference Vegetation Index (NDVI)	(IR-R)/(IR+R)
Iron Oxide Ratio	R/B (red/blue)
Clay Mineral	Mid-infrared (1.55-1.74 micron) / Mid-infrared (2.08-2.35 micron)
Ferrous Mineral	Mid-infrared (1.55-1.74 micron)/Near Infrared
Mineral composite	Mid-infrared (1.55-1.74 micron) / Mid-infrared (2.08-2.35 micron) Mid-infrared (1.55-1.74 micron) / Near Infrared Near Infrared/Blue
Hydrothermal composite	Mid-infrared (1.55-1.74 micron) / Mid-infrared (2.08-2.35 micron) Red / Blue Near Infrared / Red

The following SPOT image illustrates the NDVI. The brighter values represent the vegetation, agriculture and forest area, and the darker values represent the non-vegetation area, road, harvested agriculture field, river and urban area.

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4. Multiband Transformation: Principal Component Analyses

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5. Classification

Unsupervised method or Clustering

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Supervised classification

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Pattern Recognition

List the different patterns or information classes or land cover classes, which you recognise based on the aforementioned presentations (Image display, Contextual enhancement, NDVI, PCA and classification) of Landsat TM and SPOT images of the Fribourg area.

1.2.2. Exercises

1. What is the basic requirement to use an image in GIS?
2. What is the purpose of spatial filtering?
3. What is the potential use of the Normalized Difference in Vegetation Index (NDVI)?
4. What is the purpose and application of Principal Component Analyses?
5. i.) What is the standard technique of unsupervised clustering?
   ii.) Under what scenario, will you apply unsupervised classification?
6. How are the training samples selected in supervised classification?

1.3. Field Data Acquisition

Objectives

In this unit, you will learn the process of field data acquisition and its major steps. Moreover, you will be able to relate this process to Spatial modelling (module B-SM) and following one on regionalisation and geographic database setup (GDB) (module B-AN).
Moreover, the unit will identify and illustrate concepts and techniques involved in this process.

1.3.1. Introductory Field Data Acquisition

Introduction

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What is field data acquisition process?

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1.3.2. Planning Field Data Acquisition

Planning Field Data Acquisition

Planning field data acquisition

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1.3.3. Data Collection

Data Collection

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The field data could be acquired in digital form or analog form. To be able to use in GIS for further processing such as regionalisation and analyses such as spatial analyses, the acquired field data must be transformed into the digital file with a compatible file format which is readable by a particular GIS system.

1.3.4. Questions

1. How can you measure phenomena behaviour according to the defined model of reality?
2. Describe field data acquisition processes?
3. Describe thematic representativity?
4. Describe spatial representativity?
5. Describe temporal representativity?
6. What are the component of an acquisition system?

1.4. Field Survey Techniques

Objectives

This unit will introduce some historical and modern methods to collect planimetric, height, slope, thematic and phenomena information in the field. Then the available equipment will be briefly introduced. However, the detailed use of equipment must be gained from the equipment manual. At the end of the unit, you will learn conceptual and mathematical methods, and be prepared to use instruments to capture planimetric, height and slope information in the field.

1.4.1. Field Based Method

Field Survey Techniques

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Measuring with Theodolite

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Levelling with the level

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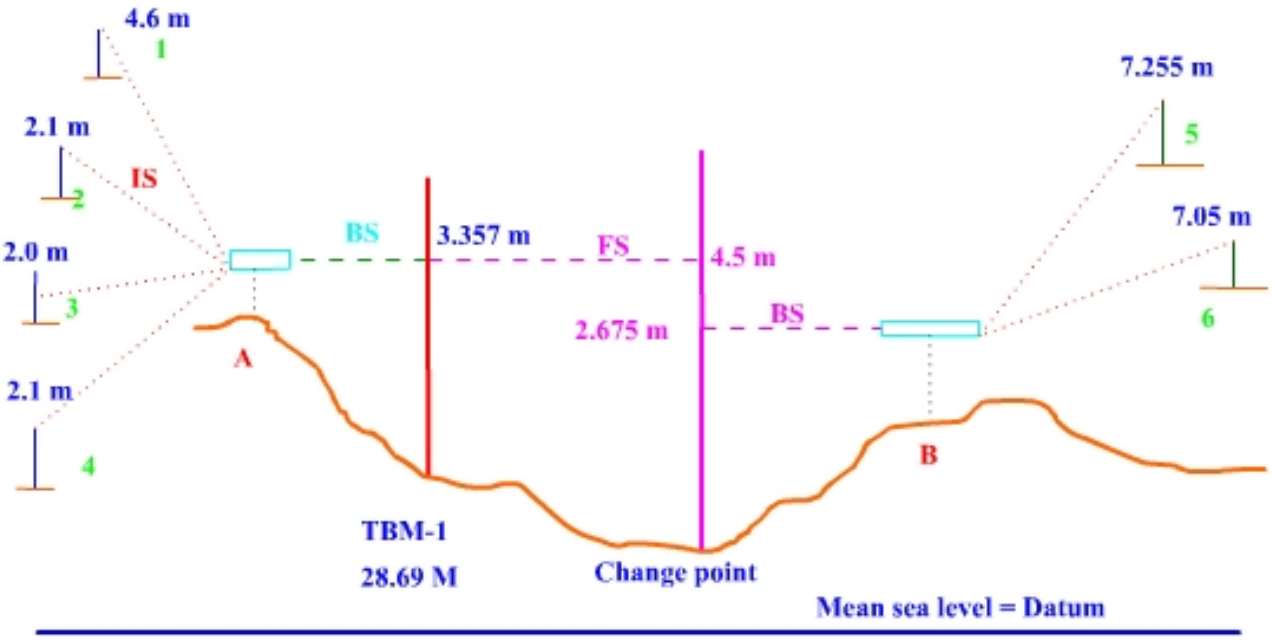
1.4.2. Calculation

Fill in the appropriate values in the columns Rise, Fall and Elevation in the following figure.

BS	IS	FS	RISE	FALL	Elevation (m)	Remark
2.65 m from 1					35.68	BM-A
4.010 m from 2		5.685 m from 1				TBM-1
	3.685 m from 2					Spot Ht.
3.685 m from 3		1.220 m from 2				TBM-3
4.010 m from 4		3.155 m from 3				TBM-4
		3.025 m from 4				BM-B

To find the elevation for TBM-1, Spot height, TBM-3, TBM-4.

Calculate the elevation of point-1, 2, 3, 4, 5, and 6 based on the level measurement in the following figure.



1.4.3. Share your result of calculation

Share your calculation results by submitting to the e-class share folder.

1.5. Bibliography

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