Aalto University
School of Engineering

Geoinformation in Environmental Modelling

Introduction to the topics

ENY-C2005

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9.1.2019

Slides originally by Paula Ahonen-Rainio and Jaakko Madetoja

Topics today

- Orientation to “geoinformation in environmental modelling”
  - to form the big picture and how the topics link and are necessary parts of the course
  - Recap of the learning outcomes of ENG-A1001 module C
- Outline of the course
  - how to learn on this course & practicalities
  - intro to assignments
  - NOTICE: First assignment published on Friday, first support session on Monday the 14th at 10:15
- Basics of data modelling
  - we’ll continue on this next Wednesday

Geoinformation in environmental modelling

Information (data)
with location relative to the Earth
- ISO 19100 series

In **digital form** for management and processing

In **visual form** for human users to perceive

Environment:
Concrete ↔ Abstract
Physica ↔ Sosio-economic
Natural ↔ Man-made

Objects ↔ Phenomena

Various scales, levels of detail

Changing over time
- timestamp needed

Model:
a representation that captures meaningful features for a purpose

For purposes, such as:
management,
explanation,
prediction,
planning…

Static or dynamic

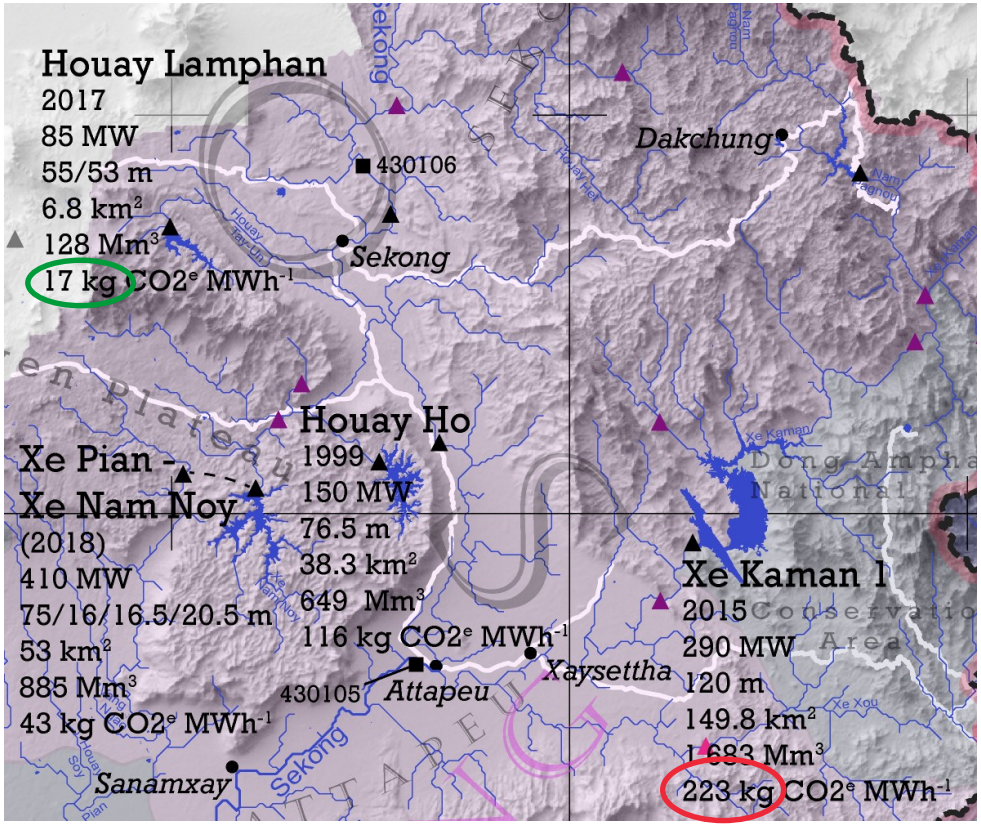
Objects ↔ Phenomena

Why geoinformation is important: a simple example

- The two pictures a field parcel in Northern Savonia on different years
  - Growing silage in the first picture and cereals in the second
- There is a fishbone-shaped drainage pipe in the field
- The pipe can be difficult to make out in the picture, but its effect is clear to the farmer when they see the pictures

Source: Mikko Laajalahti, Luonnonvarakeskus

A more complex example: CO2 footprint of hydrological power



- Pictured is part of study regarding the CO2 footprint of the hydrological power stations in the Mekong River basin
- As can be seen from the map, the footprint of different power stations are extremely different

Source: Räsänen et al.: Greenhouse gas emissions of hydropower in the Mekong River Basin

Map by Marko Kallio, Aalto University

Geoinformation in environmental modelling

When location matters, geoinformatics provides tools and techniques

- Locations, distribution, patterns
- Distances, directions, neighbours, overlap, intersections…

Areas of application include e.g.:

- Environmental engineering
- Water engineering, wastewater engineering
- Energy engineering
- Geology, mining, geotechnical engineering

Example: Level of detail

Generalization of the coast line – what is the purpose of the model!

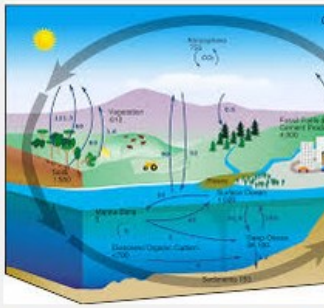
Wikimedia

almamedia.fi

Examples: environmental engineering

Google image search










Examples: geotechnical engineering

Google image search







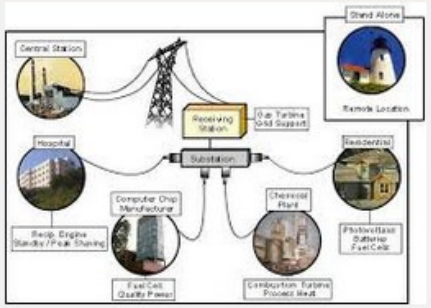


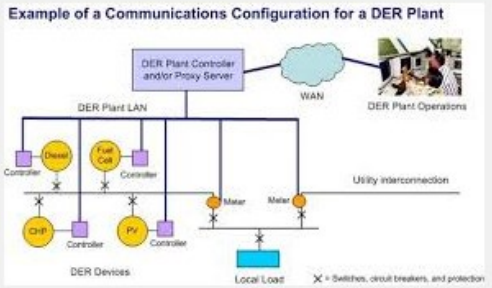


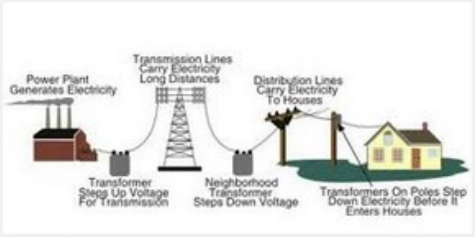


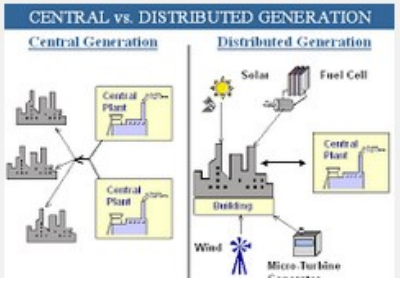

Examples: distributed energy resources

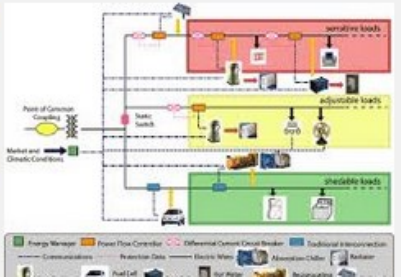
Google image search

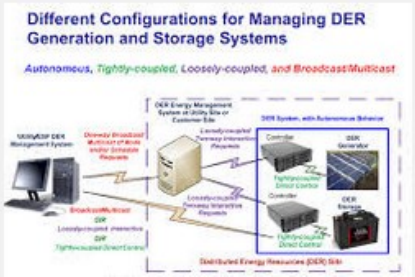


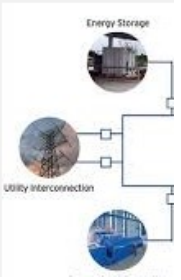












Geoinformation in environmental modelling

When location matters...

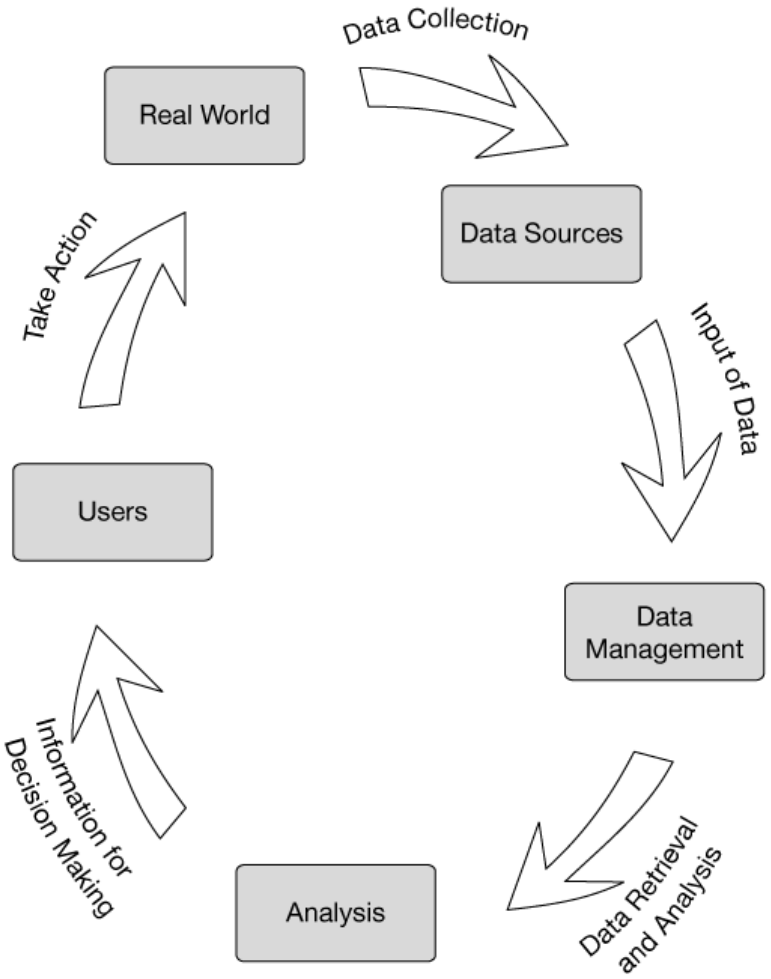
Teamwork, now:

- With you neighbours, list examples of cases for application of geoinformatics
  - what are the problems, what is critical, how to solve
  - consider what you did and learned in the GIS module of ENG-A1001 last spring

Data plays a crucial role in geoinformatics

Geospatial data processing cycle

Change in real world, partly caused by human actions, requires repeated updating of geographic data resources.

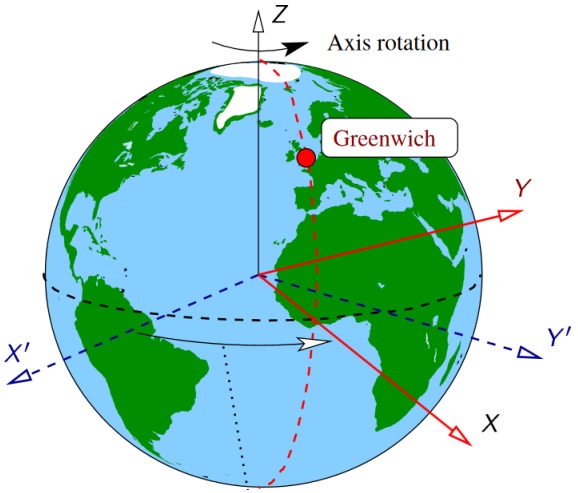


Source: gitta.info

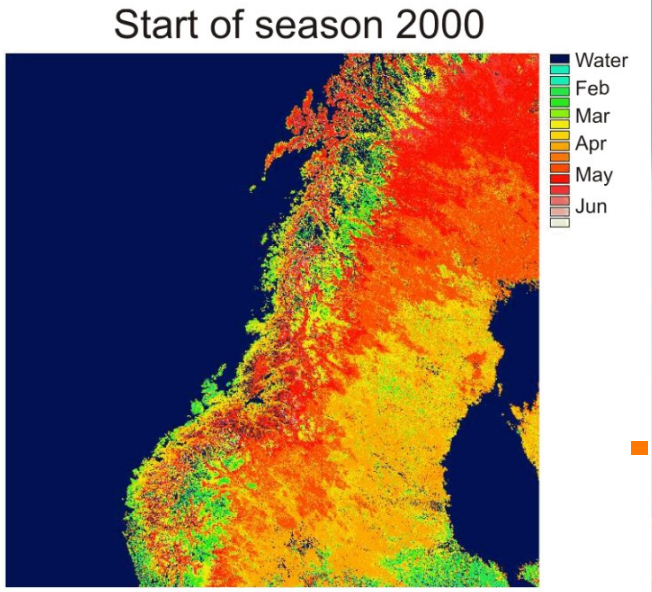
In this course…

- How to model and how to represent models in digital form $\Rightarrow$ data models (L1, L3)
  - Discrete objects, fields, and spatial relations
  - Vector data and raster data
    - Computer science, but “spatial is special”
    - Data management is not covered in this course

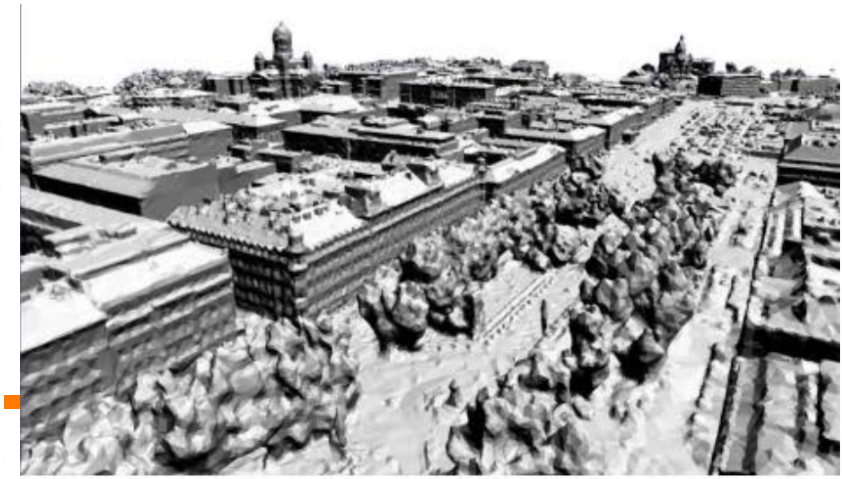
… in this course



- How to get the location data
  - Geodetic reference systems (L2)
    - What matters: type of data, spatial resolution and accuracy, access to attribute data, efficiency of measurements
  - Remote sensing (L6), laser scanning (L4), photogrammetry (L5); geodetic measurements, GPS



Images © Lars Eklundh



… in this course

- Value from data analysis
  - Models, spatial indicators, geostatistics, new geometries, optimised solutions, simulations (L7, L8, L9)
    - Mathematics, computation
  - Visual presentations, maps (L10)
    - For us humans to interpret, draw conclusions, make decisions

- Sharing of geoinformation (L11)
  - Data are expensive to collect and update
    - Shared use $\Rightarrow$ Spatial Data Infrastructures (SDI)
    - Data quality matters

Week	Lectures	
7.-13.1.	(Wed) L1 - Introduction	Jussi Nikander
	(Fri) L2 - Geodesy and georeferencing	Martin Vermeer
14.-20.1.	(Wed) L3 - Spatial data modelling	Jussi Nikander
	(Fri) L4 - Laser scanning	Petri Rönnholm, Juha Hyyppä (NLS/FGI)
21.-27.1.	(Wed) L5 - Photogrammetry	Petri Rönnholm, Matti Vaaja
	(Fri) L6 - Remote sensing	Miina Rautiainen
28.1.-.3.2	(Wed) L7 - Spatial analysis of grid data	Jussi Nikander
	(Fri) L8 – Introduction to spatial statistics	Kirsi Virrantaus
4.-10.2.	(Wed) L9 – From points to surfaces, network analysis	Jussi Nikander
	(Fri) L10 - Visual communication by maps	Jussi Nikander
11.-17.2.	(Wed) L11 - Geospatial data issues	Jussi Nikander
	(Fri) No lecture	

Week	Assignments	
14.-20.1.	A-1 Identification of potential locations for wind farms: Visibility and overlay analyses	A-4 GT simulator and spectrometer DL 22.1. (max 4 p.)
21.-27.1.	A-1 cont. DL 27.1. (max 15 p.)	A-5 Laser scanning study group DL 27.1. (max 4 p.)
28.1.-.3.2	A-2 NVDI: Working with satellite images DL 3.2. (max 8 p.)	A-6 Photogrammetric 3D modelling of indoors DL 3.2. (max 4 p.)
4.-10.2.	A-3 Habitat suitability modelling: Regression analysis	A-7 Effective communication: Maps for decision makers
11.-17.2.	A-3 cont. DL 17.2. (max 15 p.)	A-7 cont. DL 17.2. (max 10 p.)

Some practicalities

MyCourses

- General information & **News** for possible updates
- Lectures: slides, list of literature, example questions (~ learning outcomes)
- Assignments info: e.g. **Forum** for students: Q & A
- Assignments: instructions & submission of reports
- Teams for assignments – **Register your team** in MyCourses

Exam – Fri 22.2.2019 from 13 to 16 at hall Y203a in Kanditalo

Remember to register in WebOodi in time!

Grading – assignments (max 60 p./2) : exam (max 30 p.) = 1:1

Workload – 5 x 27 hours = 135 hours

Language – English is the primary language, Finnish and Swedish are accepted

… some practicalities

- Computer support sessions for assignments 1, 2, and 3: Mondays (10-12) and Fridays (8-10) at Maari C-D-E starting next Monday
- Assignments 1, 2, 3, and 7 in pairs
- Assignments 4, 5, and 6 in groups of four students
  - All members must return their report
- Longley et al. (2015), Chapter 1 Geographic Information: Science, Systems, and Society, 4th edition
  - Available as e-book; also 12 paper versions
  - Reading the book is highly recommended!

… some practicalities

- If you did not do the ArcGIS module (C) of ENG-A1001
  - Take some time to familiarize yourself with the software
  - Instructions and free tutorials can be found from MyCourses
- Intergrated English course
  - Teacher in charge is Nanna Qvist
  - All members of the assignment group should participate to the English module

Geospatial data, spatio-temporal data

- The elementary spatial characteristic is
  location: (x,y,z) [or (lat, long)]
  - it separates spatial data from all other data types
  - it requires special methods of modelling, storing, processing and analysing data efficiently and correctly
  - Each object, event or phenomenon on the Earth can be somehow defined by location in space

- Analogically, each event or phenomenon can get temporal characteristics
  - location + attributes = static model
  - + time = dynamic model: processes, change

Geoinformation as a model of environment

- Real world – our ideas, points of view
  - experience
  - information

- Model, representation
  - mental model, schemata
  - visual models (maps, diagrams, images)
  - digital models $\Rightarrow$ computation
    - formal information
    - data transfer and copying

Geoinformation as a model of environment

- Quick exercise (3 min):
  - Draw a map about how did you get here this morning
- Compare your maps with your neighbour
  - What are the common features? What are the differencies?

Geoinformation as a model of environment

What should we represent and how?

- complex, continuous, infinite real world
- a model is always selective and simplifying = interpretation
  ⇒ level of detail, accuracy/reliability

- Discrete objects or spatially continuous fields?

Example: Discrete objects

Spatially discrete objects – Building blocks & urban infrastucture

Wikimedia

Example: Field

Spatially continuos phenomenon – Depth of snow

yle.fi (Seppo Savolainen)

Example:
Discrete or continuous feature?

yle.fi

tekniikanmaailma.fi

Some core terms

- geographic information; geospatial information; geoinformation
- geographic data; geospatial data
    - "Geographic data is data with implicit or explicit reference to a location relative to the Earth." ISO/TC 211, 1999
- geoinformatics, GIS technology, geographic information science
- geographic information system (GIS)

- spatial … [information, data, analysis, etc.]

- spatio-temporal information