KIG-C1010 Introduction to geoinformatics

Lecture 1: introduction

Aalto University
School of Engineering

Jussi Nikander

11.1.2023

Individual study arrangements

Do you need individual study arrangements?

Please send email to
Jussi.Nikander@aalto.fi

Or come to my office at room 311 (K1-building)

Explain your situation briefly

Individual study arrangements

- **Some students may require individual study arrangements on the course**
- **Those students are asked to contact me as soon as possible**
- **Those who have an Aalto certificate for individual study arrangements are asked to provide it**
- **Those who do not have such, are asked to briefly describe the reason**

- **Individual arrangements provided by the course include**
  - Flexible deadlines for the exercises
  - Alternative methods of doing the course exam
  - Other arrangements (eg. material in dyslexic-friendly fonts) if necessary
- **Remember that individual study arrangements do not change the course requirements – the same course work is required to pass the course.**

Welcome to Introduction to geoinformatics!

- **Topics for today's lecture**
- **Introduction and practicalities**
  - What this course is about
  - What is the outline of the course
  - What you need to do in order to pass the course
- **The basics of the course**
  - What is geoinformatics and what it is good for

What's geoinformation? And what's geoinformatics?

- **Geoinformation is:**
  - information (data) with location relative to the Earth's surface
- **Geoinformatics is the science (with a smidgen of art mixed in) of managing and exploiting geoinformation**

- **In geoinformatics uses geoinformation in the following ways:**
  - Measure – acquire data
  - Model – formally represent data
  - Analyze – gain new information from data
  - Visualise – represent the information to users

Course practicalities

KIG-C1010 and your studies at Aalto

- **In case you're interested in learning more about geoinformatics**
  - **KIG-C1030** Management of spatial data
  - **KIG-C1040** Acquisition of geospatial data
  - Master's programmes in
    - Geoinformatics
    - Real Estate Economics
    - Water and Environmental Engineering
    - Spatial Planning and Transportation Engineering

- **In case you're more interested in other types of engineering**
  - Often, **location is important** in engineering
  - Therefore, **be aware** that in many cases it is beneficial for the project to have geoinformatics expertise on the team
  - **Understand** the basics of how location can be taken into account

Practical work on the course

- **2 lectures per week**
  - Wed at 10-12 and Fri at 12-14
  - Lecture hall C (Y205)
- **5 weekly assignments**
  - Exercise sessions on Mon at 10-12&14-16 and Thu at 12-14 & 14-16
  - Can be done alone or in pairs
  - Available at MyCourses
  - Deadline on every Sunday at 23.55

- **2 Group work assignments**
  - Groups of 4
  - Deadlines on Thursdays at 23.55
- **Exam, which is voluntary**
- **Groups for group work will be registered through MyCourses**
  - See the “Assignments information” page in MyCourses for further details

Course grading

- **Each weekly assignment is worth a maximum of 6 points (total 30)**
- **Each group work assignment is worth a maximum of 5 points (total 10)**
- **Maximum points from the exam is 30**
  - Minimum of 13 points required to pass the exam (failed exam will not be taken into account when calculating the grade)
  - Failed exam will **not** mean you'll fail the course
  - The exam will be held **on-campus**
- **Points will be added together**
- **Maximum grade without exam is 3**

- **To pass the course**
  - Return **every** weekly and group work assignment
  - Get sufficient total points (weekly + group) to pass the course
  - A total of **27 points** will guarantee a passing grade for the course

The Course Schedule and Staff: Lectures

Week	Lectures	Lecturers
9-15.1	L1 – Introduction (you are here) L2 – Geodesy and georeferencing	Jussi Nikander Maaria Nordman
16-22.1	L3 – Spatial data modelling L4 – Introduction to vector analysis	Jussi Nikander Jussi Nikander
23-29.1	L5 – Introduction to grid data analysis L6 – Laser Scanning	Jussi Nikander Matti Vaaja, Petri Rönnholm
30.1-5.2	L7 – Photogrammetry L8 – Remote sensing	Matti Vaaja, Petri Rönnholm Miina Rautiainen
6-12.2	L9 – Visual communication by maps L10 – Introduction to spatial statistics	Jussi Nikander Henrikki Tenkanen
13-19.2	L11 – Geospatial data issues L12 – In reserve	Jussi Nikander

Also, Jenni Korvala gives **English module LC-1117** in connection with the course (full)

The Course Schedule and Staff: Assignments

Week	Weekly assignment	Group work assignment
9-15.1	Find yourself a pair, if you want one	
16-22.1	WA-1 Georeferencing	Find yourself a group
23-29.1	WA-2 Map Overlay	Find yourself a group GW-1 Laser scanning
30.1-5.2	WA-3 Vector analysis	GW-1 Laser scanning GW-1 DL on 2.2
6-12.2	WA-4 Photogrammetry and 3D modeling	GW-2 Map Visualization
13-19.2	WA-5 Raster analysis with satellite data	GW-2 Map Visualization GW-2 DL on 16.2

Help and guidance for the weekly and group work assignments is given by our course assistants: Hilla Aho, Eljas Almusa, Sinna Andsten, Hang Li, Alarik Kuusela and Havu Pellikka

Software for the Assignments

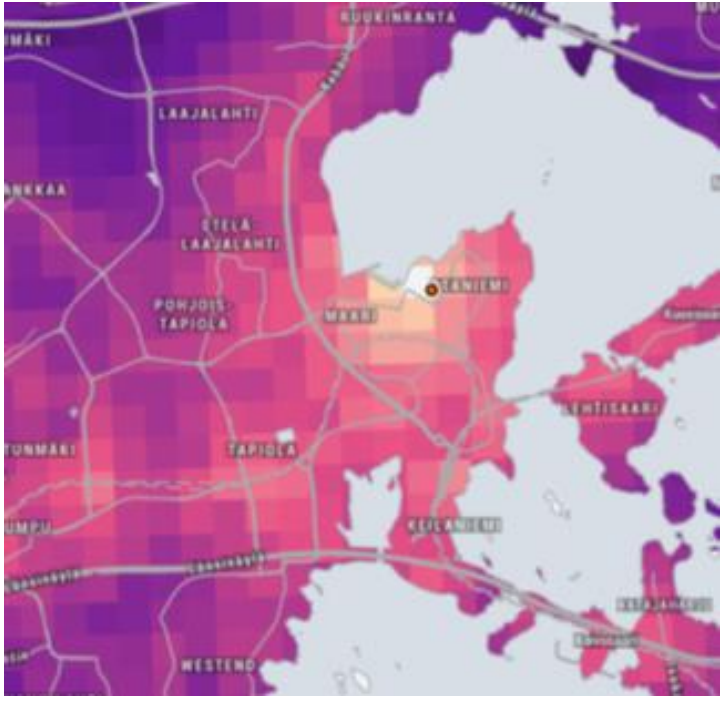
- **In order to solve the assignments you need to be able to work with the following tools**
  - Smartphone / GPS Device
    - WA-1
  - QGIS
    - Weekly assignments (and GW-2)
  - 3DF Zephyr Free
    - WA-4
- **You should reserve some time for getting familiar with these tools**
- **Training material available at the *Assignments information* page in MyCourses**

Help for the weekly assignments

- **We have five 2-hour exercise sessions per week**
  - Mon at 10-12 & 14-16, Tue at 10-12, and Thu at 12-14 & 14-16
- **All are in classroom Maari C-D**
- **In the sessions you can get assistance from our teaching assistants**
- **To ask for assistance, put your name on the queue for assistance, and an assistant will call you when it's your turn**
- **Outside sessions, you can ask for assistance in the course Teams channel**

Course Teams

- **The course has a MS Team. You can join the team with the code cn5uh0g**
  - **Code can be found in MyCourses**
- **In Teams you can ask for help on the exercises, or on the course in general**



Learning materials

- **Lecture slides, assignment instructions and materials**
- **We recommend the following book for the course: Longley, P. A., Goodchild, M. F., Maguire, D. J., & Rhind, D. W. (2015). *Geographic information science and systems*. John Wiley & Sons**

- **The book is available as e-book in the Learning Centre**
  - There are also a number of paper copies available
- **The book covers spatial data management and analysis**
- **Data acquisition is not covered in detail in the book**
  - Other learning material is recommended

Introduction to geoinformatics: Outline of the course

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Geoinformation uses environmental modelling

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

In **digital form** for management and processing

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

Environment:
Concrete ↔ Abstract
Physical ↔ 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

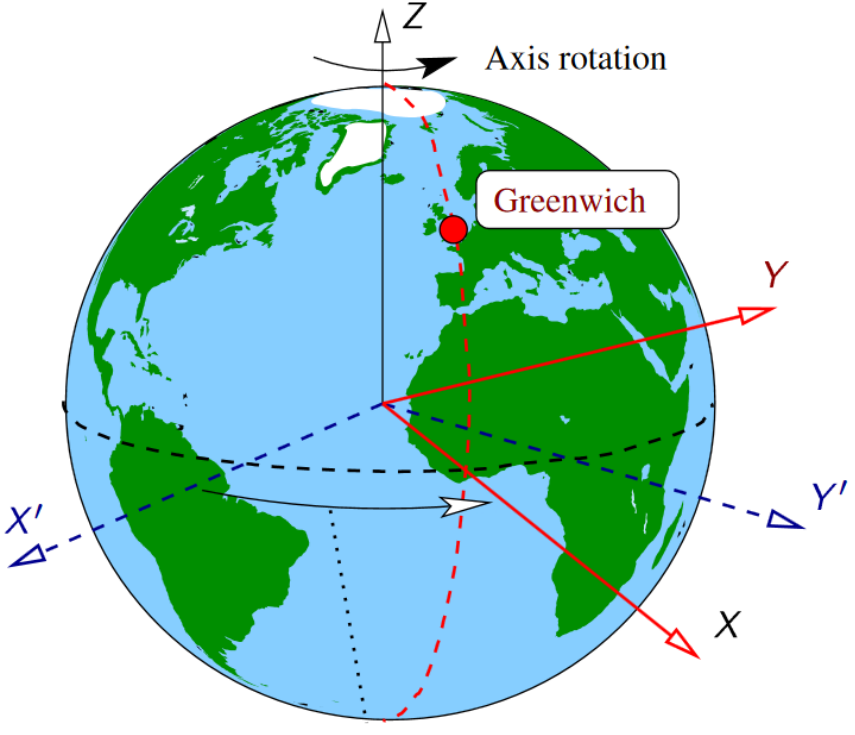
or purposes, such as:
management,
explanation,
prediction,
planning…

Static or dynamic

Objects ↔ Phenomena

Establishing the location (Details in L2 and WA-1)

- **Location is the most elementary part of spatial data modeling**
  - Planar (Cartesian) coordinates (x,y)
  - Geographic coordinates (lat, lon)
- **Location separates spatial data from other types of data**
- **Location requires specialized methods for efficient modeling and handling**



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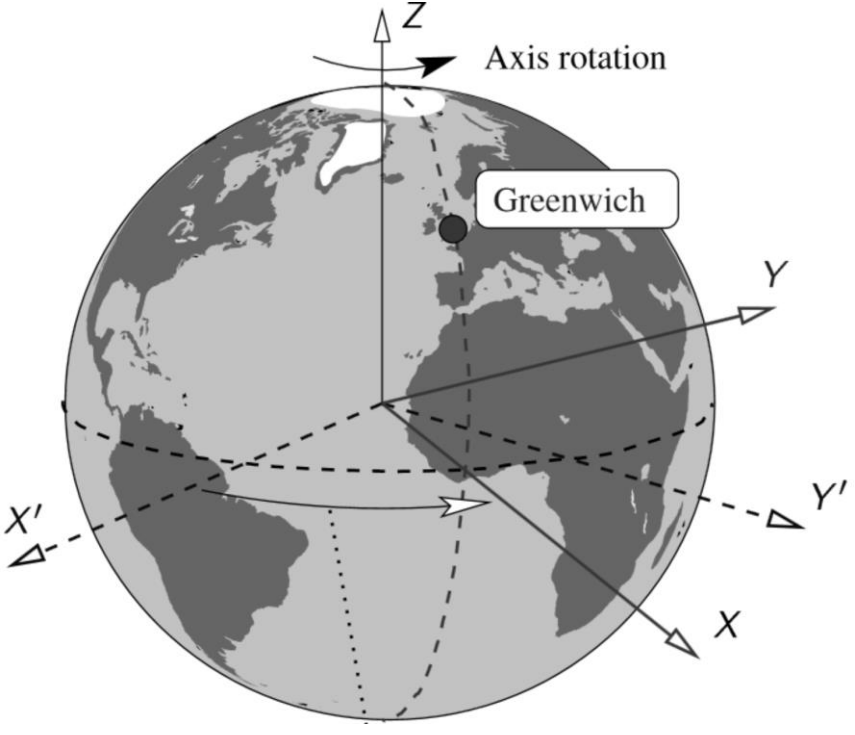
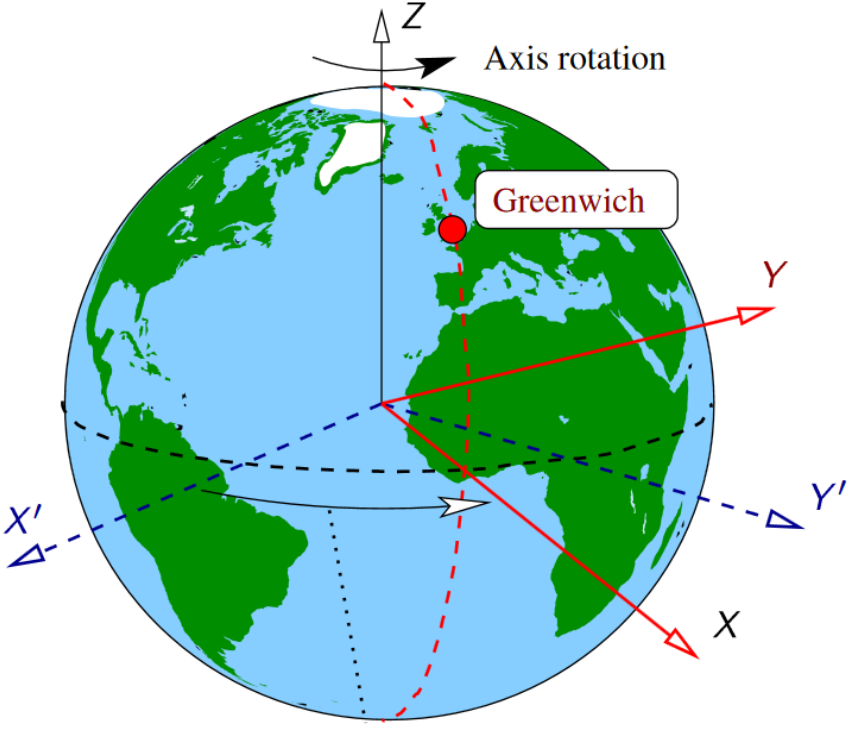


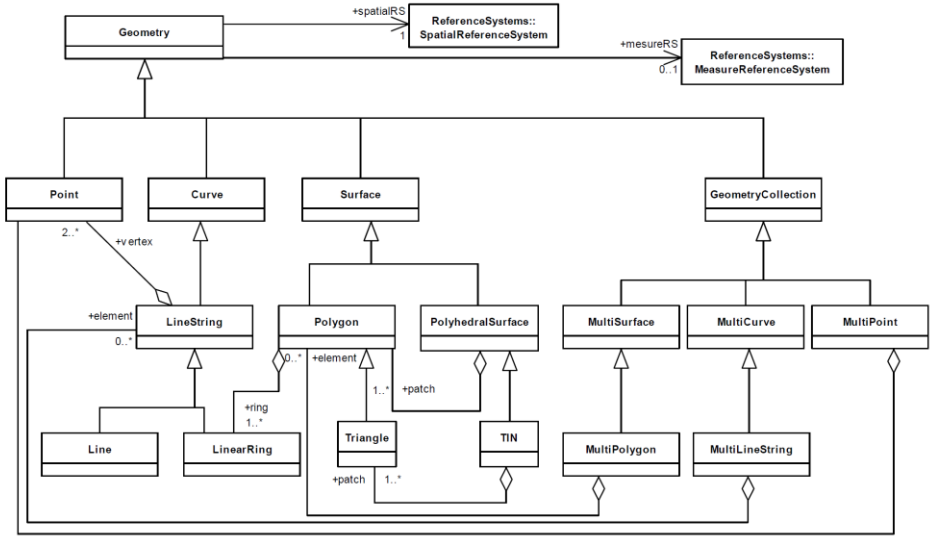
Establishing the location (Details in L2 and WA-1)

- **Spatial data is data that contains locations (coordinates) and attributes that describe the relevant phenomena in those locations**
  - Location + attributes creates a static model
  - Location + attributes + time creates a dynamic model



Spatial data modeling approaches (L3, WA-2,3,5)

- **Spatial data models the real world**
  - The model can be conceptual
  - Models can be visual (e.g. maps)
- **In geoinformatics, the models are digital**
  - Spatial data on a computer
  - Formally, precisely defined



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Picture source: OGC Simple Features Definition
https://www.opengeospatial.org/standards/sfa

Spatial data modeling approaches (L3, WA-2,3,5)

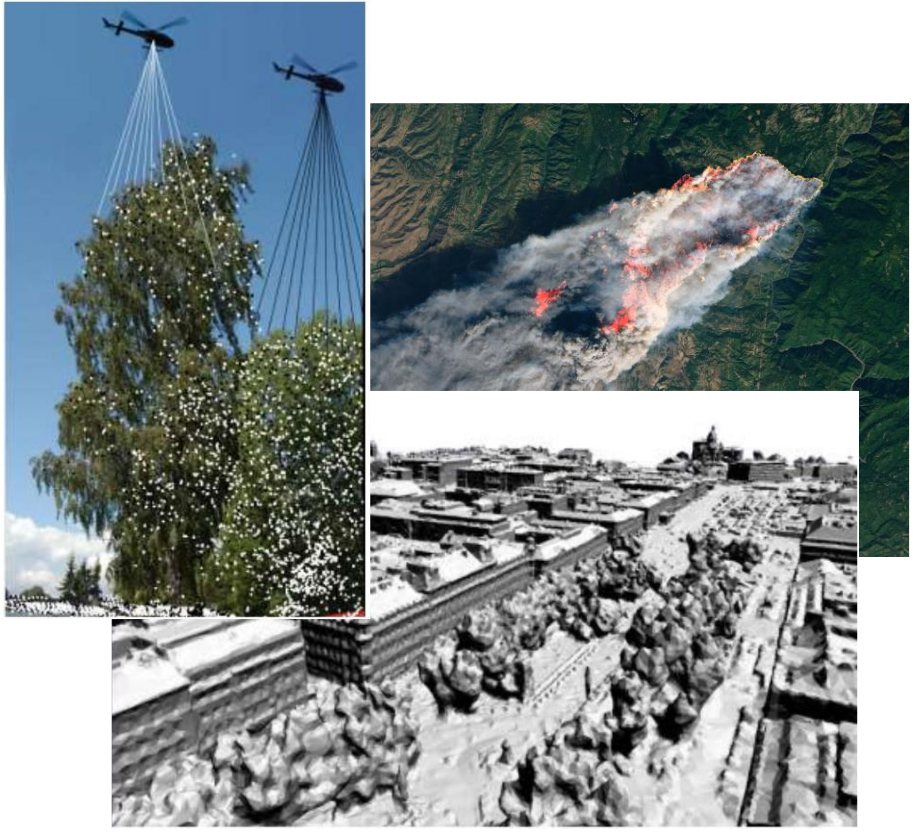
- There are two conceptually distinct approaches how to model the world
- The world can be modelled as empty space populated by discrete objects
- The world can be modelled as containing continuous phenomena that vary by location

Image source: wikimedia

Image source: yle.fi (Seppo Savolainen)

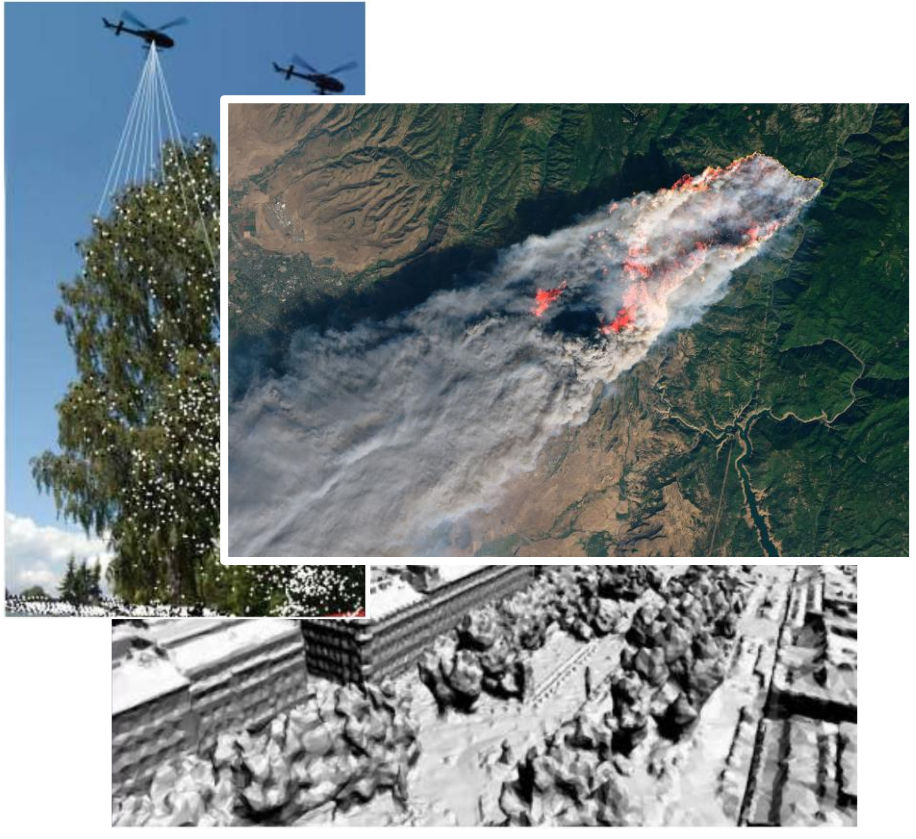
Spatial data modeling: data gathering (L5-7, GW-1, WA-4&5)

- Spatial data can be acquired with a large number of different methods
- The methods work at different resolutions, scales, and for different purposes
- Laser scanning and photogrammetry can provide detailed, high-resolution information



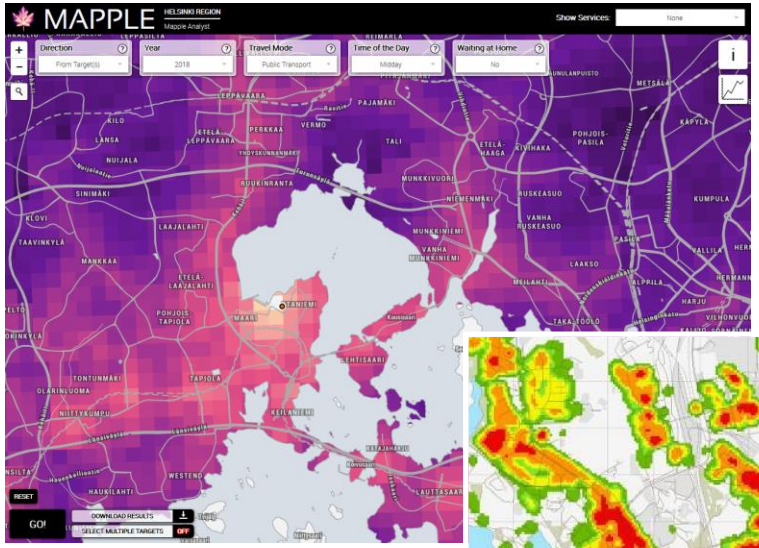
Spatial data modeling: data gathering (L5-7, GW-1, WA-4&5)

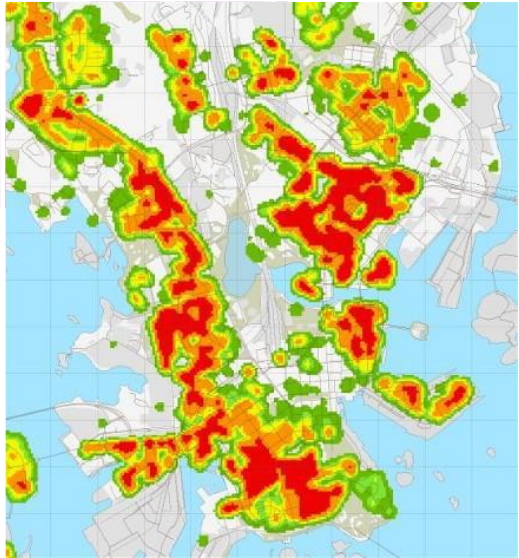
- Spatial data is gathered over large areas using various means of environmental monitoring
- Global coverage is acquired with satellite Earth observation
- The acquired data is then stored and analyzed for further use



Spatial data modeling: analysis (L3, 9-11 WA-1,2,3&5)

- Typically, spatial data is not immediately useful for a given purpose
- Spatial analysis refines data into a format that provides information required for a specific situation
- The analysis results can then be used in decision making





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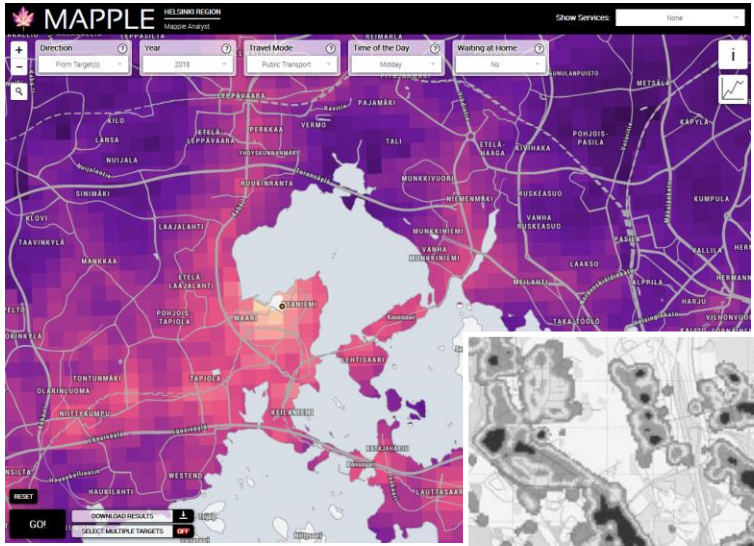
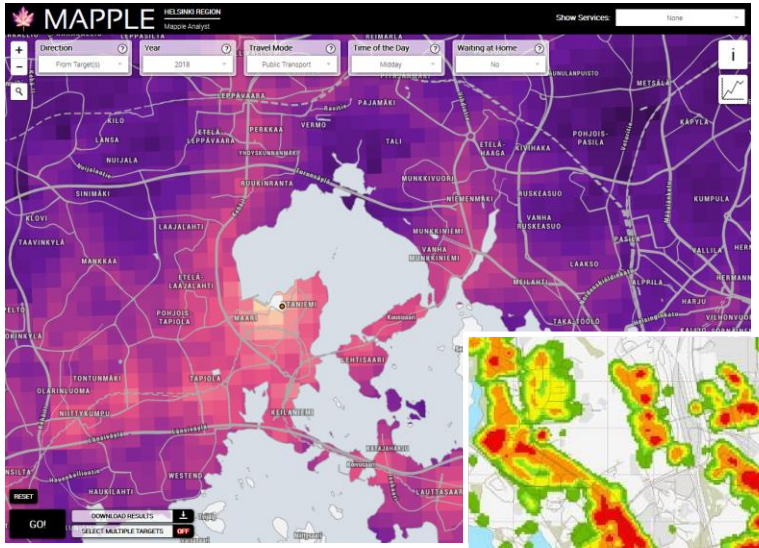
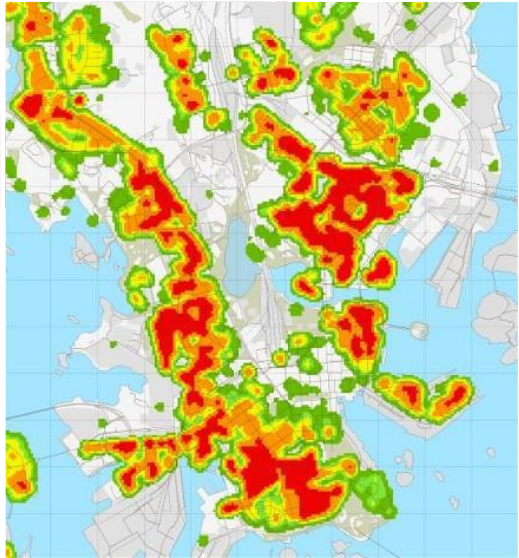


Spatial data modeling: visualization (L8, GW-2)

- The analysis results can be used in decision making
- The analysis results need to be communicated to users
- The primary means of communicating spatial data is through visualizations
- Maps are a common spatial data visualization method





Spatial data modeling: management and sharing (L11)

- **Value of spatial data is in reusability and sharing the data**
- **There are tremendous amounts of spatial data available**
  - As open data
  - As commercial services
- **Widely adopted standards and open data policies are needed to enable data sharing**
  - At the same time we need to be aware of the consequences of opening the data sets

Basics of spatial data modeling

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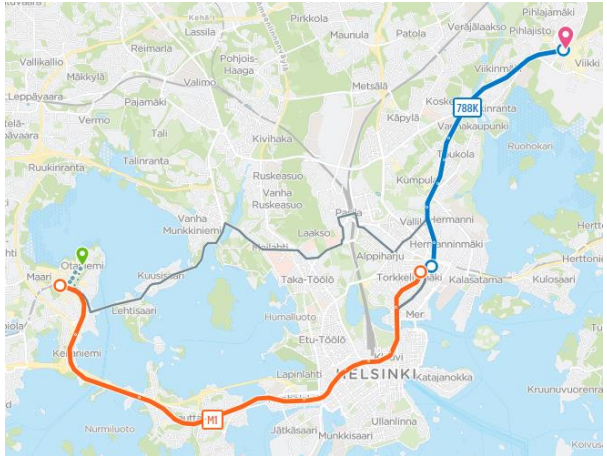
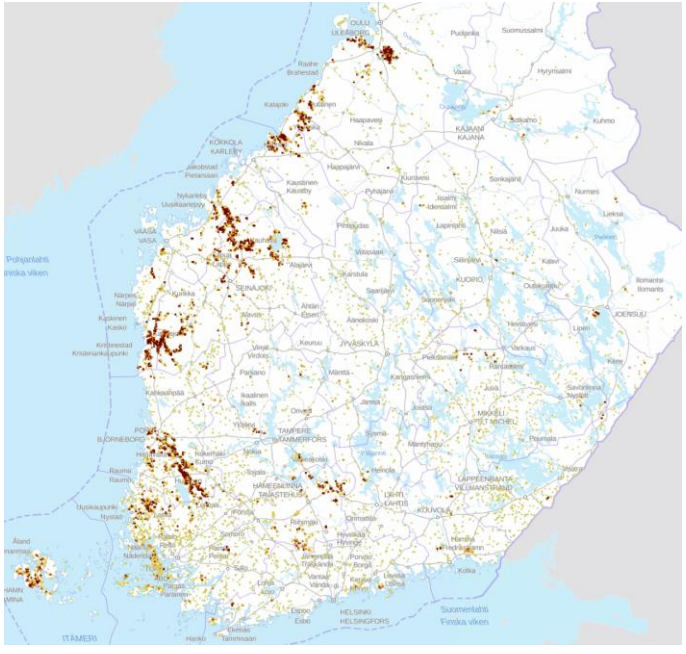
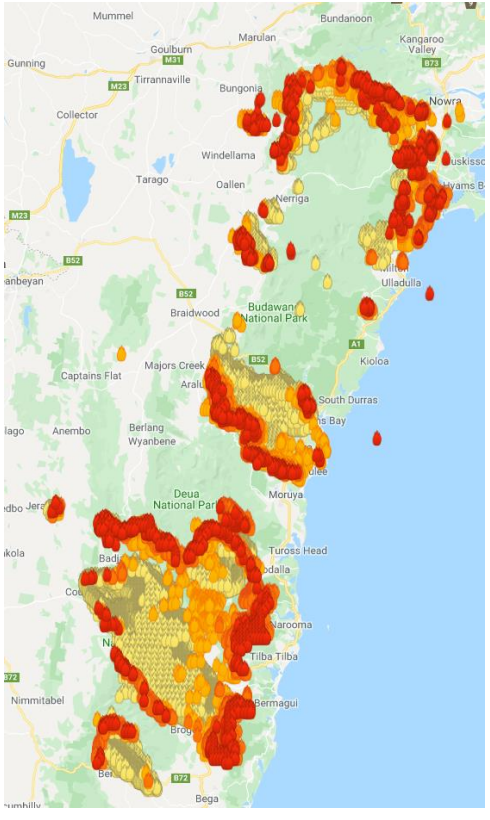
Why geoinformation is important?



HSL route planner: what is the fastest route from Otaniemi to Viikki?
(Colors represent movement type)
https://reittiopas.hsl.fi/



Where potato is grown in Finland?
(colors represent amount of field area per square km)
https://biomassa-atlas.luke.fi/



How Australian wildfires have spread?
(colors represent time; retrieved on Jan 2nd, 2020)
https://myfirewatch.landgate.wa.gov.au/

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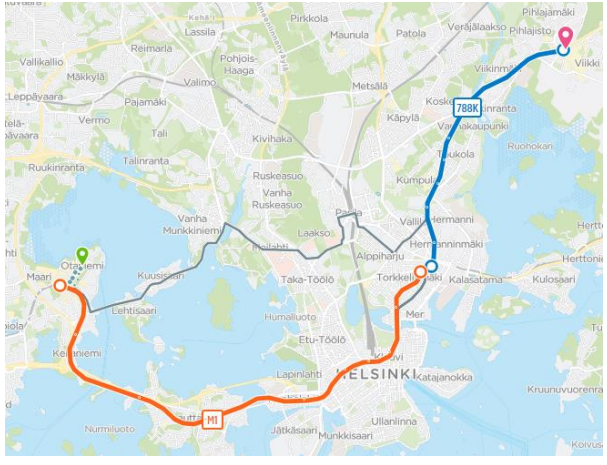

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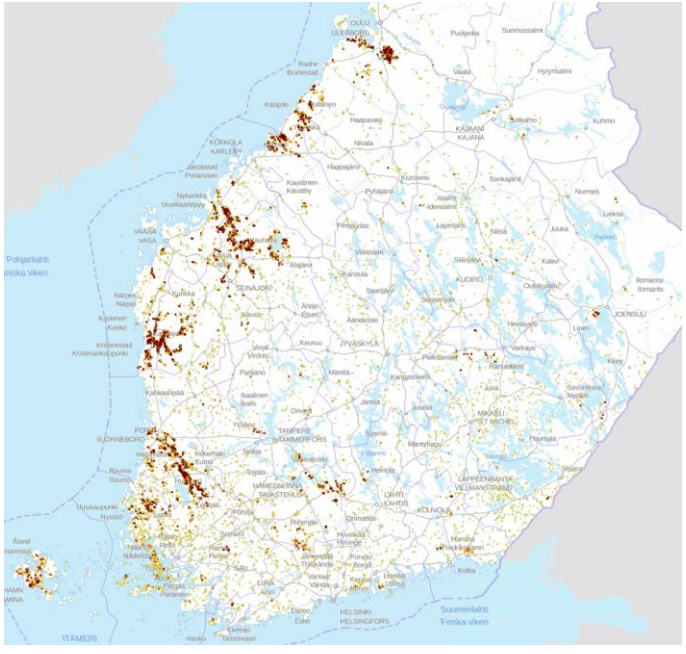

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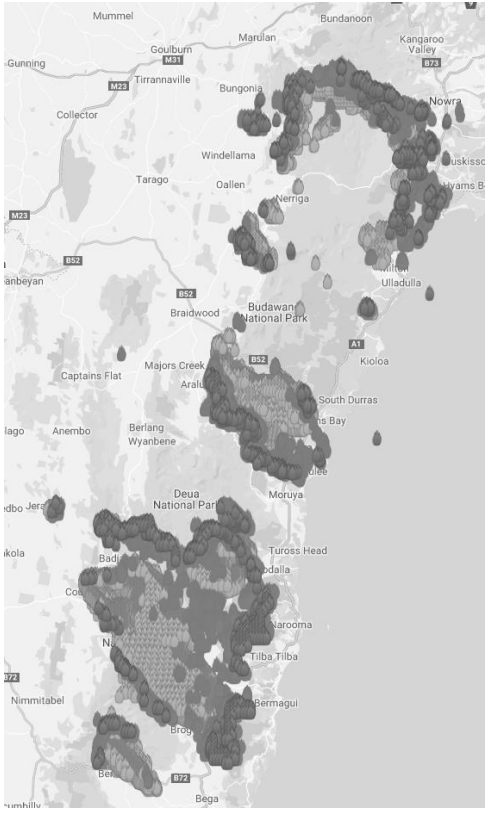

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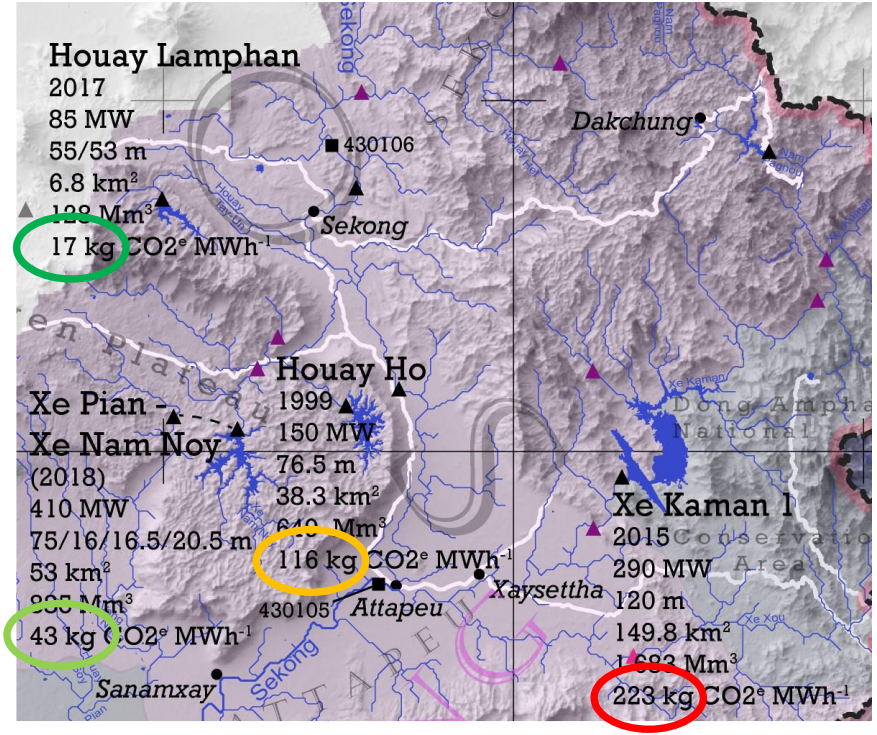
Geoinformation (spatial) analysis: a simple example

A?

- The two pictures show 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
- => the drainage pipe has effect on within-field growth potential which needs to be taken into account in farm planning

Source: Mikko Laajalahti, Luonnonvarakeskus

Geoinformation (spatial) analysis: a more complex example



- Pictured is part of a 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

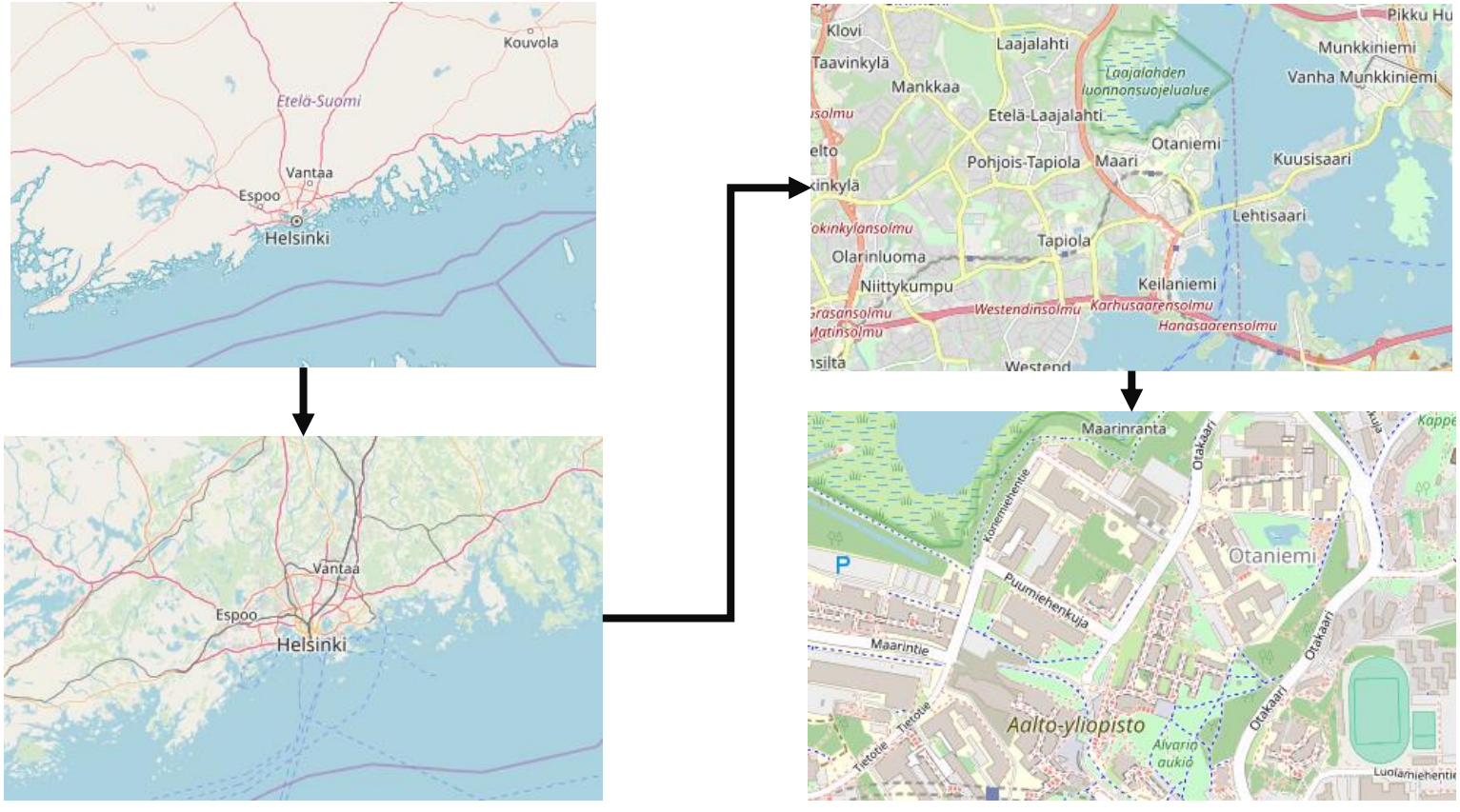
Map by Marko Kallio, Aalto University

Geoinformation: location, location, location

- **When the location matters, geoinformatics provides tools and techniques**
  - Management, planning, analysis, simulation
  - Locations, distributions, patterns, events, etc.
  - Distance, direction, topology, etc.

- **Geoinformatics can be applied to any phenomenon, where the location of activity is important**
  - Environmental, water, energy, geotechnical engineering
  - Transportation, socio-economics, climate sciences, rescue services, agriculture, etc, etc, etc.

Models depend on location and scale



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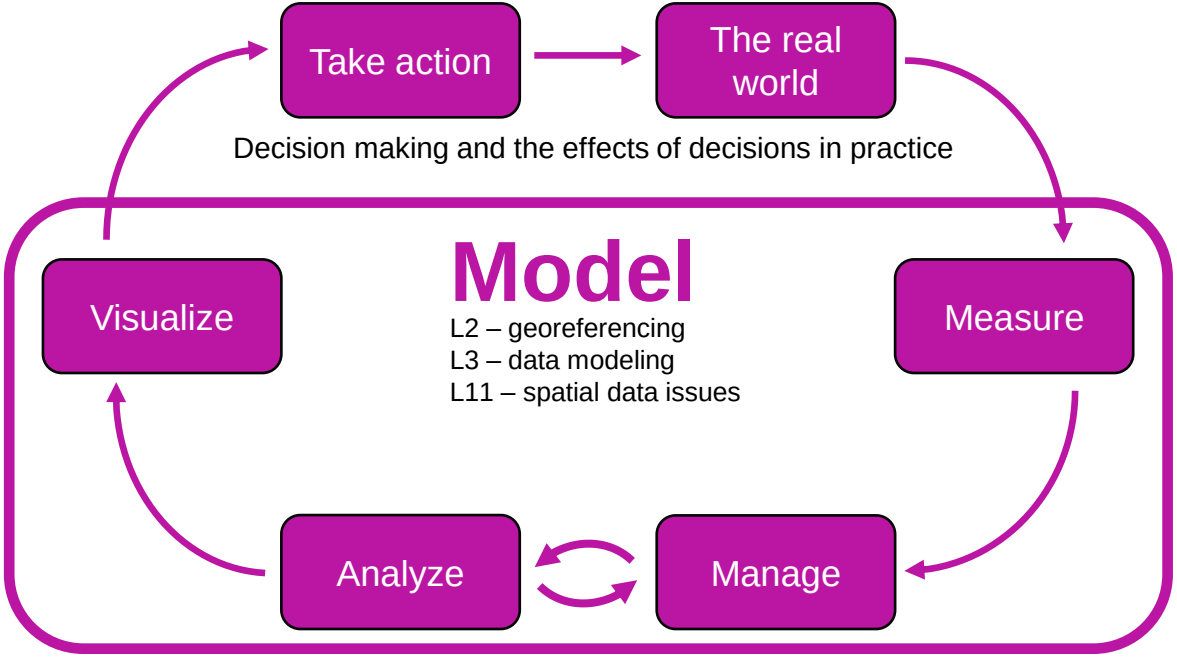
With increasing resolution, the model contains more details

Data processing in geoinformatics



L8 – visual communication

L5 – laser scanning
L6 – photogrammetry
L7 – remote sensing

L4 – vector analysis
L9 – spatial statistics
L10 – raster analysis

L3 – data modeling
L11 – spatial data issues

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Questions?