Fuksikysely kevät 2023

- ✓ **Vastaathan kyselyyn Aalto-sähköpostiin saamasi henkilökohtaisen linkin kautta. Linkki on lähetetty ke 15.2.**
- ✓ **Kyselyn teemoja: kokemukset ja ajatukset opiskelusta sekä opinnoista ensimmäisen opiskeluvuoden keväällä**
- ✓ **Kyselyssä on mahdollisuus kertoa, mistä opiskeluun liittyvistä asioista tarvitsisit ja/tai haluaisit tietoa ja opinto-ohjausta juuri nyt**
- ✓ **Vastaaminen vie 10-15 minuuttia ja jokainen vastaus on tärkeä!**
- ✓ **Kyselyn tuloksia hyödynnetään korkeakoulun opetuksen ja opinto-ohjauksen kehittämisessä**
- ✓ **Lämmin kiitos vastauksestasi!**

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KIG-C1010 Introduction to geoinformatics

Lecture 11: Geospatial data issues

Aalto University
School of Engineering

Jussi Nikander

15.2.2023

Based on materials developed by Paula Ahonen-Rainio

Topics for today

- **Uncertainty in geoinformatics**
  - Uncertainty in data quality and analysis results
- **Sharing geospatial data**
  - Metadata
  - Standards
  - Spatial data infrastructures

Examples of exam questions relating to this lecture

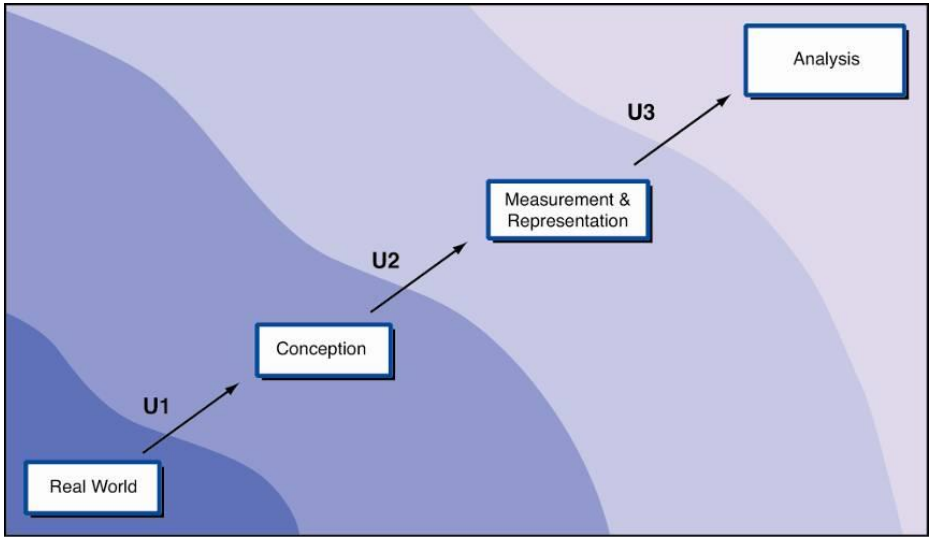
- **Network services for geographic data are an essential part of the implementation of INSPIRE directive and of spatial data structures in general. Name these network services, and explain what they are needed for.**
- **What is metadata of geographic data, what is it needed for, and what are the main contents of it?**
- **Describe the ways in which uncertainty can appear in geoinformatics in the chain "Conception – Measurement and representation – Analysis". Consider this from the viewpoints of both discrete objects and fields as well of spatial and attribute data.**
- **Paikkatiedon verkkopalvelut ovat keskeinen osa INSPIRE-direktiivin toimeenpanoa ja paikkatiedon infrastuktuuria yleensäkin. Nimeä nämä verkkopalvelut, ja selitä mihin niitä tarvitaan.**
- **Mitä paikkatiedon metadata on, mihin sitä tarvitaan ja mikä sen pääasiallinen sisältö on?**
- **Kuvaile, millä tavoilla epävarmuus voi ilmetä geoinformatiikassa ketjussa "Conception – Measurement and representation – Analysis". Tarkastele asiaa sekä diskreettien kohteiden että jatkuvien ilmiöiden ja sekä sijainnin että ominaisuuksien osalta.**

Uncertainty

Uncertainty in geographic information

- **Geospatial data represents the real world… imperfectly**
  - Not everything is included ⟹ simplification
  - Nothing can be measured exactly ⟹ inaccuracy
  - Not everything an be categorized perfectly ⟹ ambiguity
  - Etc.

- **Uncertainty is present in all data analysis processes**



Longley et al. (2015) Ch. 5

Modeling the real world

- **Uncertainty accounts for the difference between a dataset and the phenomenon**
  - The imperfection is partially by design: we don’t need to include everything in order to get usable results
  - And trying to include everything would just make the model unusably complex
- **Imperfection leads to approximation**
  - All our models and analysis methods work by simplifying reality
  - Therefore, the results are not a perfect recreation of the real situation
- **Means to handle uncertainty in data management and analysis are required**

Uncertainty in the conception of geospatial data

Conception = käsitteenmuodostus

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The uncertainty of the conception of geospatial data

- **The first source of uncertainty is in how we define the data we use**
- **Units of analysis used**
  - Natural (or usable) unit for specific analysis
    - “Where do we draw the line separating areas?”
  - Analysis requires discrete elements, but reality is continuous

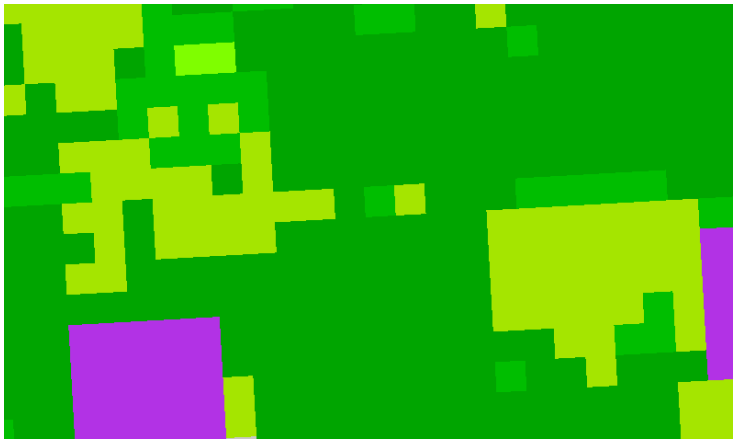
- **Climate, soil type, or animal populations probably don’t change**
- **Nor does the weather stop here**

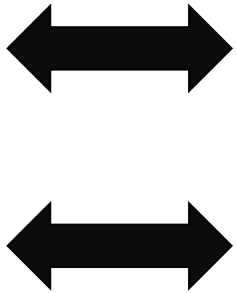
Vagueness and Ambiguity

- **Vagueness (epämääräisyys)**
  - Robustness of labelling (i.e. which class/category)
    - e.g. forest zones: what makes a pine woodland?
  - Is the boundary of the zone clear and well-defined?

- **Ambiguity (monitulkintaisuus)**
  - Indirect indicators
    - Available data is used as a substitute for data that’s not available
  - Differences in classifications and definitions
    - Makes the comparison between two datasets difficult

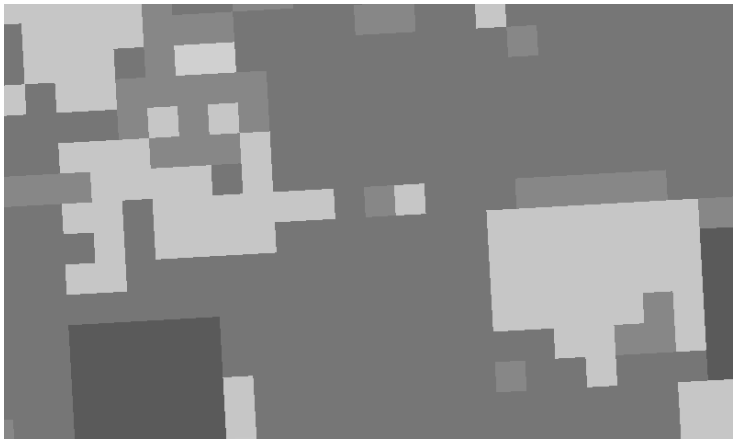
Vagueness and ambiguity

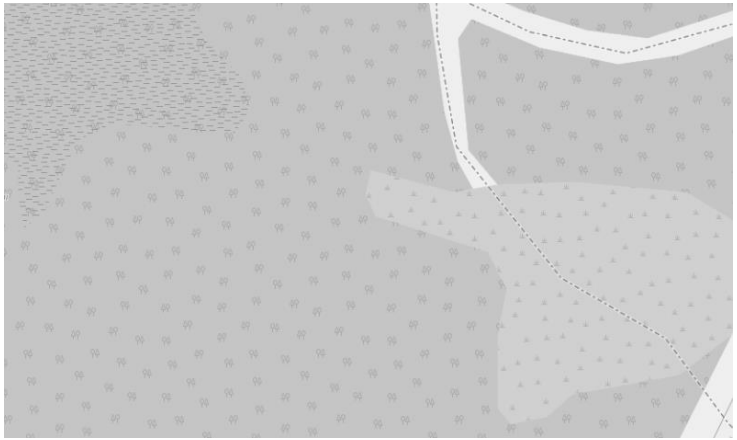


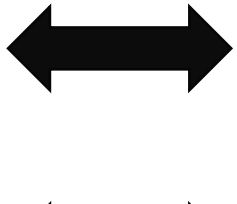


- **So, where are the actual zone boundaries?**

Vagueness and ambiguity







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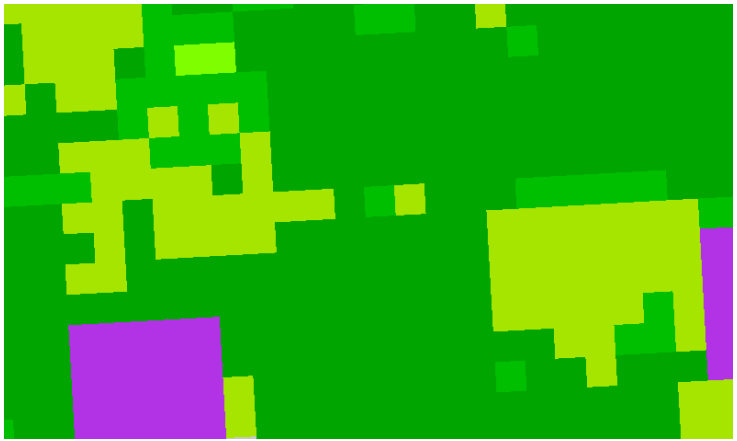

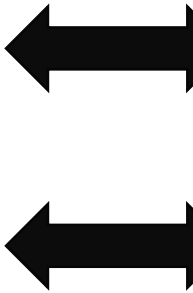

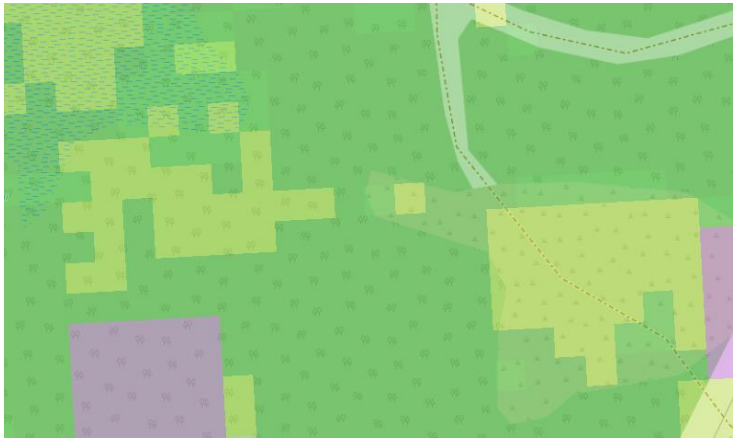

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  - Datasets are Corine land cover and OSM (satellite image from Google maps)

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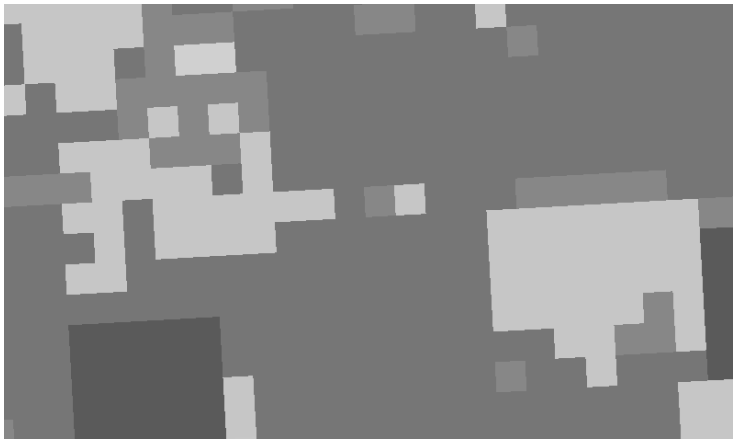

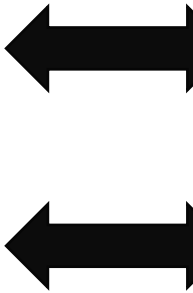

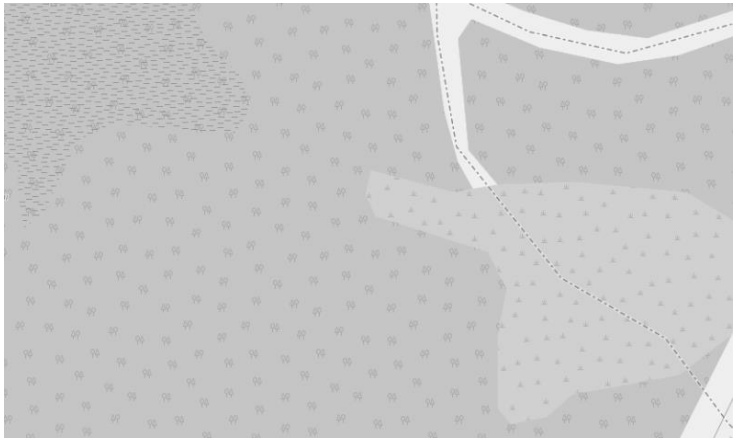

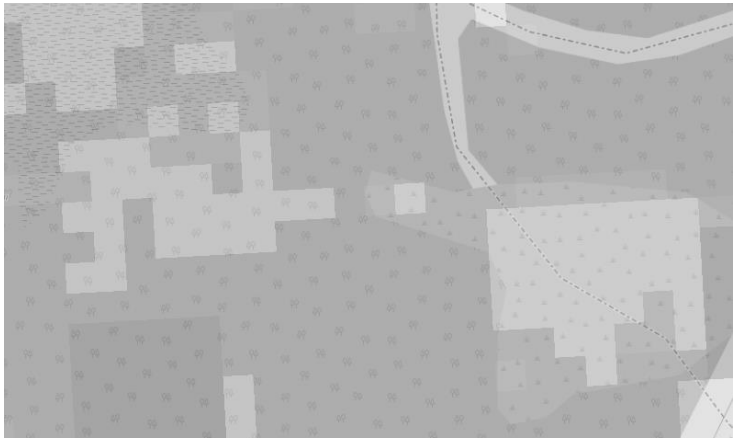

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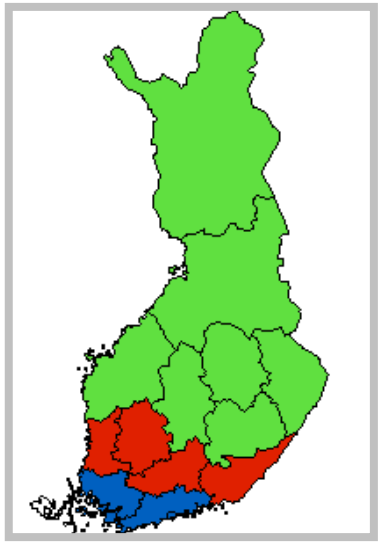
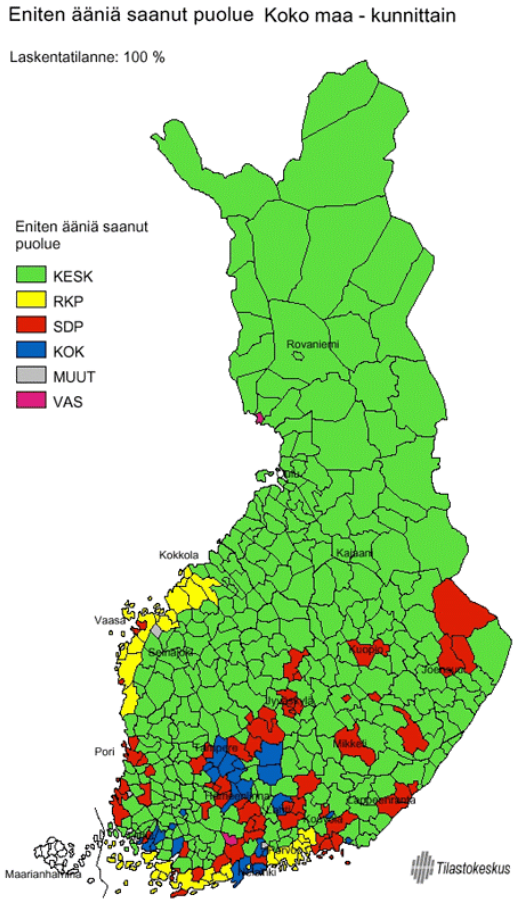
Scale of geographic units matters

- **Municipal election results on the level of single municipalities report results on the actual level used in the phenomenon**

Kunnallisvaalit 2000



Area units make a difference!



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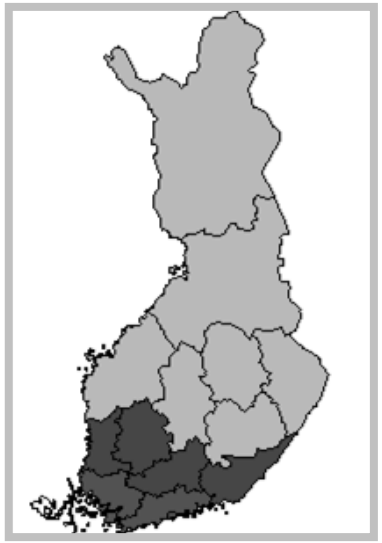

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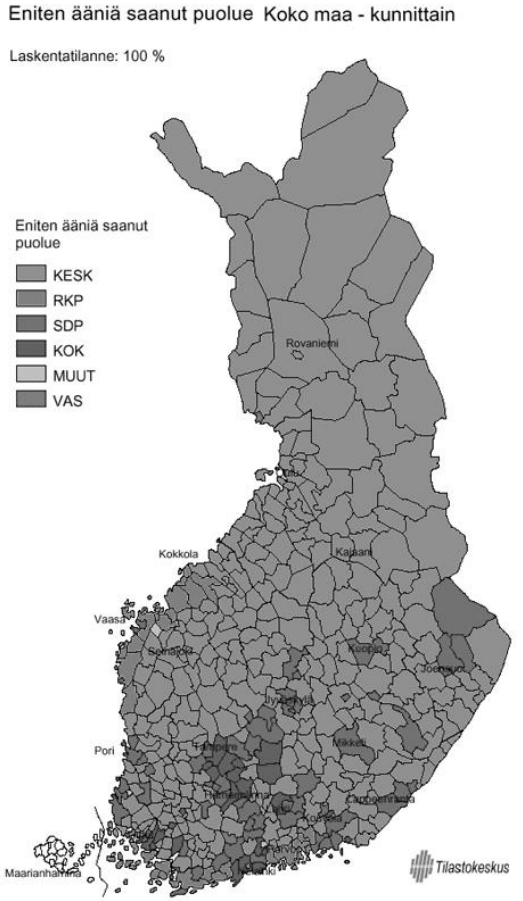

Fuzzy classification

- **In reality categories rarely are absolute**
  - In addition to “dry land” and “water” there are various degrees of “shoreline”
- **In fuzzy set theory (sumea joukko-oppi) it is possible to have partial membership of a set**
  - Thus locations can be “dry land”, “water” or “sometimes dry”
  - Membership degree can vary from 0 to 1
    - E.g. 0.4 dry, 0.6 water

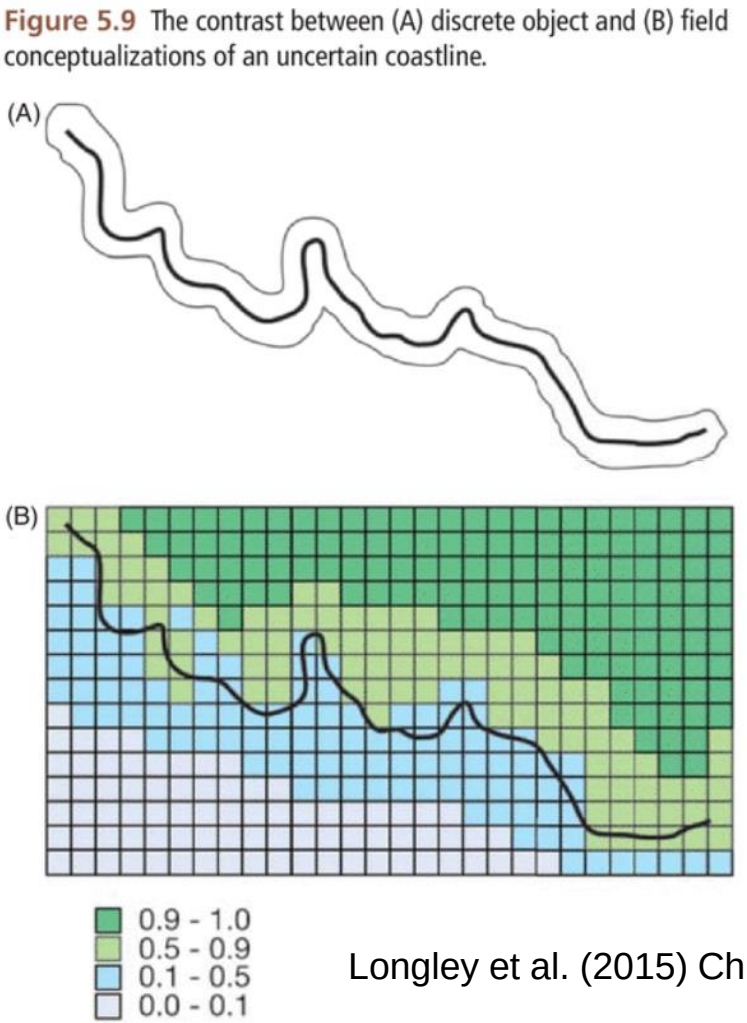

Figure 5.9 The contrast between (A) discrete object and (B) field conceptualizations of an uncertain coastline.

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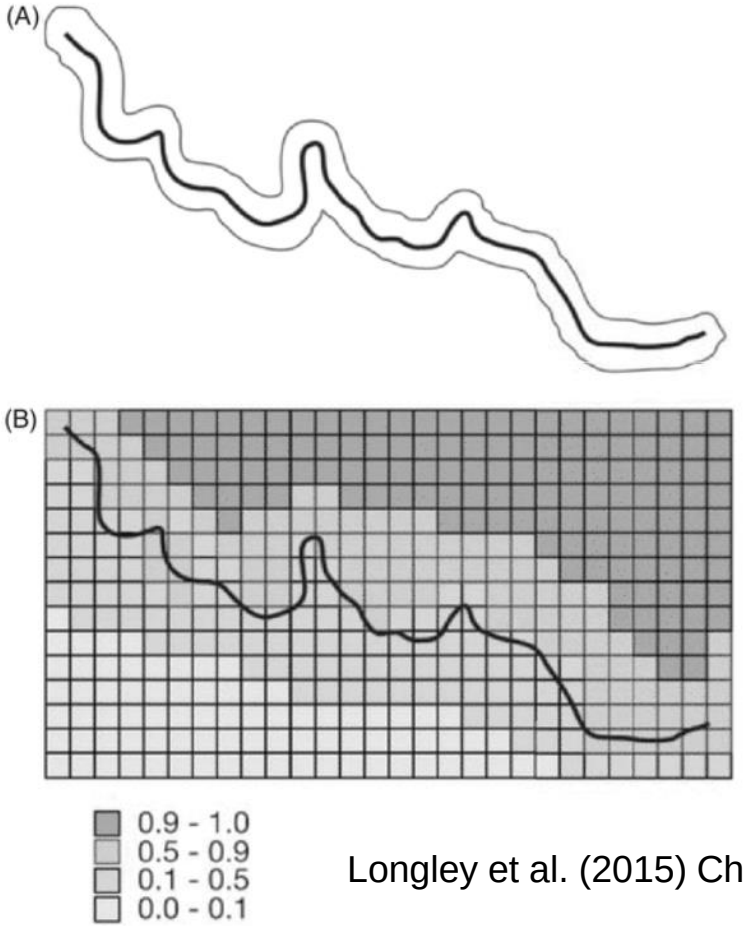

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https://presemo.aalto.fi/enyc2005/

Uncertainty and statistics: misclassification matrix

- **Misclassification matrix (väärinluokittelumatriisi) compares recorded classes (data) to an accurate source (reference)**
- **Allows calculation of e.g. percent of correctly classified elements or equivalence statistics (Kappa index)**

As in the database \ As in the field	A	B	C	D	E	Total
A	80	4	0	15	7	106
B	2	17	0	9	2	30
C	12	5	9	4	8	38
D	7	8	0	65	0	80
E	3	2	1	6	38	50
Total	104	36	10	99	55	304

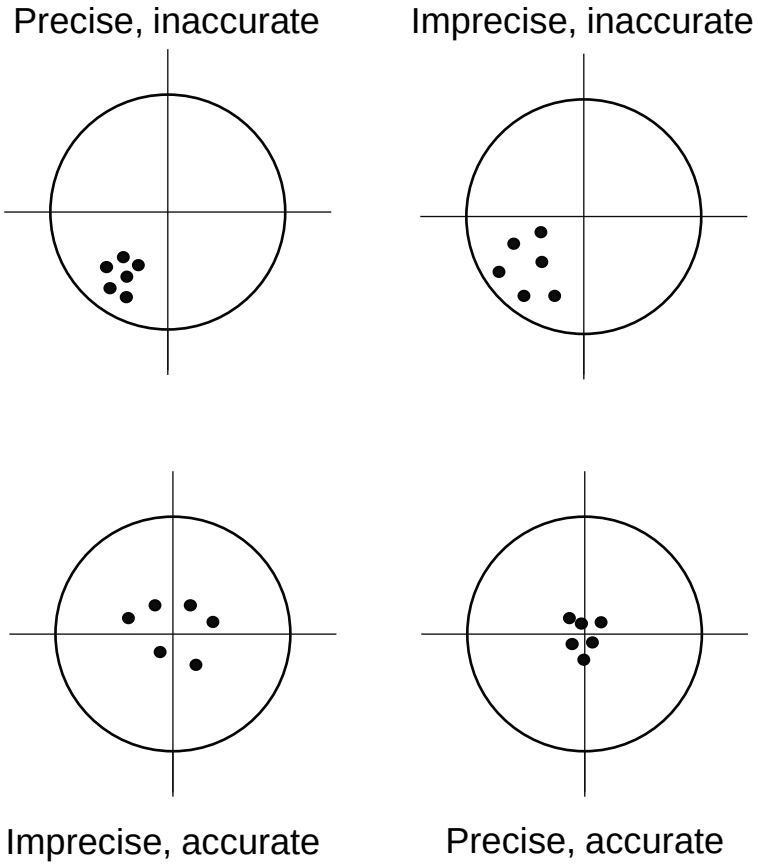
9 of the 10 reference points (90%) are recorded as Class C in the database

9 of the 38 data points (24%) in the database are Class C in the reference

Uncertainty in measurement

Uncertainty in measurement

- **No measurement is perfect, and all have uncertainty in…**
- **Accuracy (ulkoinen tarkkuus)**
  - Distortion from the true value
- **Precision (sisäinen tarkkuus)**
  - Variation between repeated measurements
  - (also number of significant digits in reporting)
- **Reporting should always reflect accuracy**
  - If measurement accuracy is 1m, reporting should have no digits



Example: bad reporting accuracy in real data

- **The data is from the DigiRoad dataset**
- **Coordinates are in TM35FIN**
  - Thus coordinate values are in meters
- **For some reason the data is reported at attometer (10^{-17}) precision**
  - Measurement accuracy is unlikely to be smaller than 1cm
  - For comparison, uncertainty in the definition of the meter is around 0.1 nm (10^{-10})

wkt_geom ID LINK_ID KUNTAKOODI ALKU_M LOPPU_M MUOKKAUSPV VAIK_SUUNT ARVO SEGM_ID length speed Minutes

LineStringZM (407436.**33399999997345731** 7334506.**059999999059021807** 0 0, 407454.**09600000001955777** 7334510.5 0 18.**30849999999918509**, 407491.**52899999998044223** 7334519.**95199999958276749** 0 56.**91640000000188593**, 407533.**80999999999767169** 7334532.**213999999968707561** 0 100.**93959999999788124**, 407564.**02799999999115244** 7334541.**71200000029057264** 0 132.**61509999999501019**)

2169098569476 8845 0 132.615 02.07.2015 12:29:01 1 80 845_78437 132.615133728 80 0.099461748143

Error correlation

- **Errors over short distances are often correlated**
  - Especially if they are from the same set of measurements
- **Absolute error (accuracy) may be large but relative error (precision) small**
  - As a consequence, some errors may cancel each other out in some calculations
    - E.g. area of a polygon, length of a line

Magnitude of the difference is maybe 30-40m
(width of the border strip is 10m)

The actual location of the border in the image

Which is closer to reality: the satellite image or the border data?

The difference does not change (significantly)

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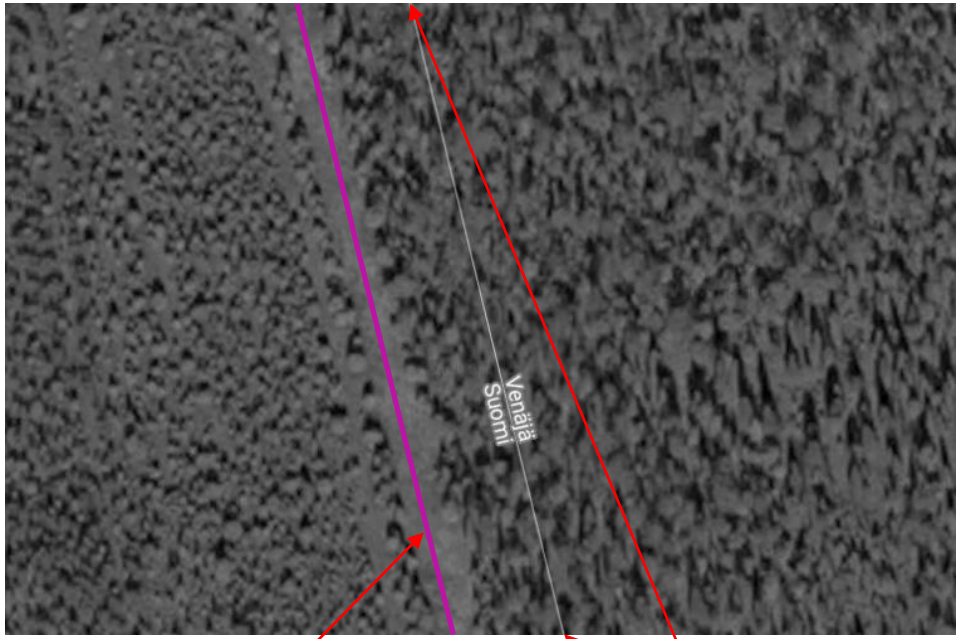

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Uncertainty in analysis

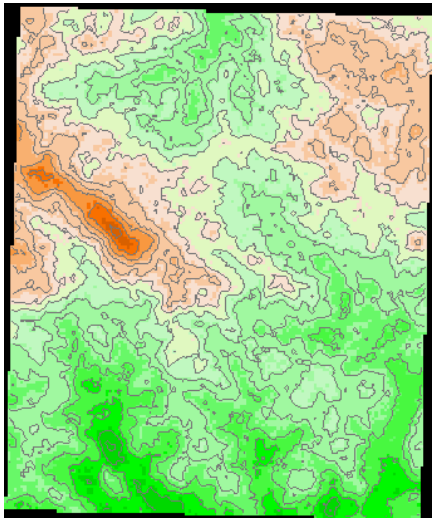
Uncertainty in analysis

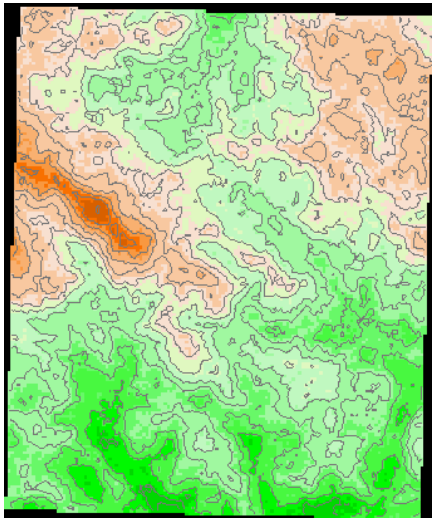
- **The data we use in all geospatial analysis processes always contains uncertainty**
  - Therefore, every analysis result also contains uncertainty
  - In principle, this uncertainty should be reported in every GIS data set
    - E.g. confidence limit for the result

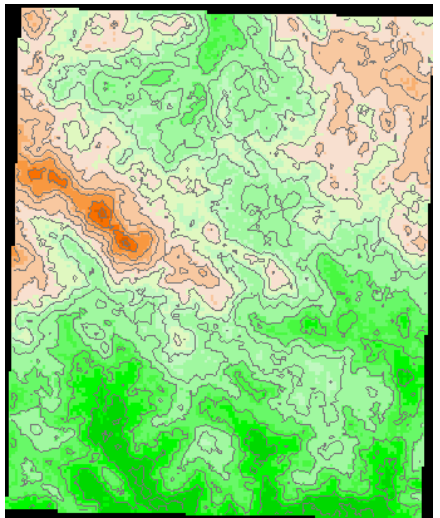
- **Uncertainty can be analyzed**
- **Internal validation is the process of assessing how errors are likely to affect the result**
- **External validation is the process of comparing results to reference data**

Internal validation and spatial autocorrelation

- **Spatial autocorrelation affects errors in spatial analysis**
- **This makes it possible to estimate magnitude of the error at different areas**
- **On right are three realizations of an error simulation for a DEM**
  - Results show clear autocorrelation







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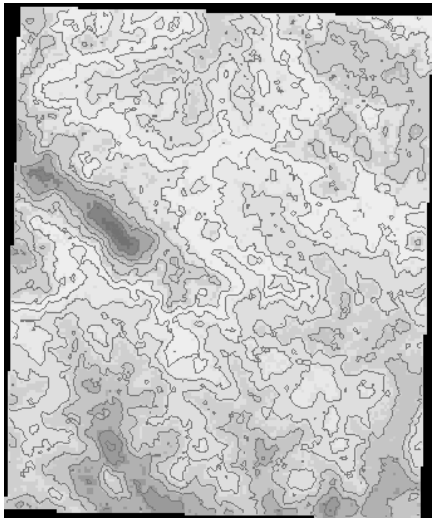

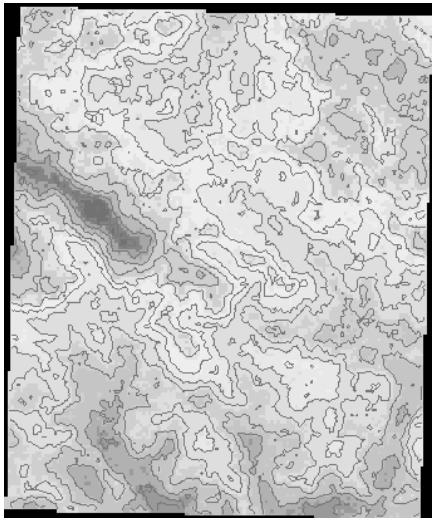

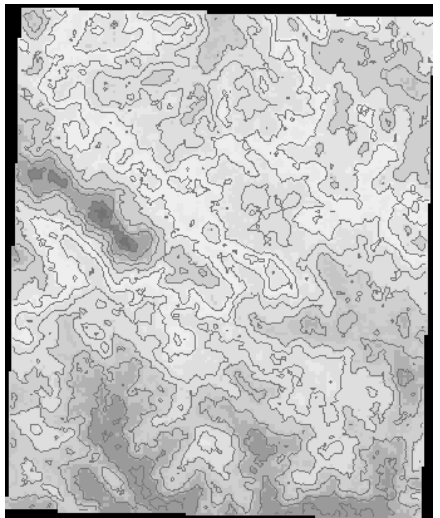

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External validation

- **In external validation the data is compared to a reference dataset**
- **The reference dataset needs to be from an independent data source**
  - Otherwise, both data sets will show similar errors
  - Data source independence can sometimes be challenging to establish
- **Background color in the figure on the right represents error magnitude**
  - light background correspond to large errors
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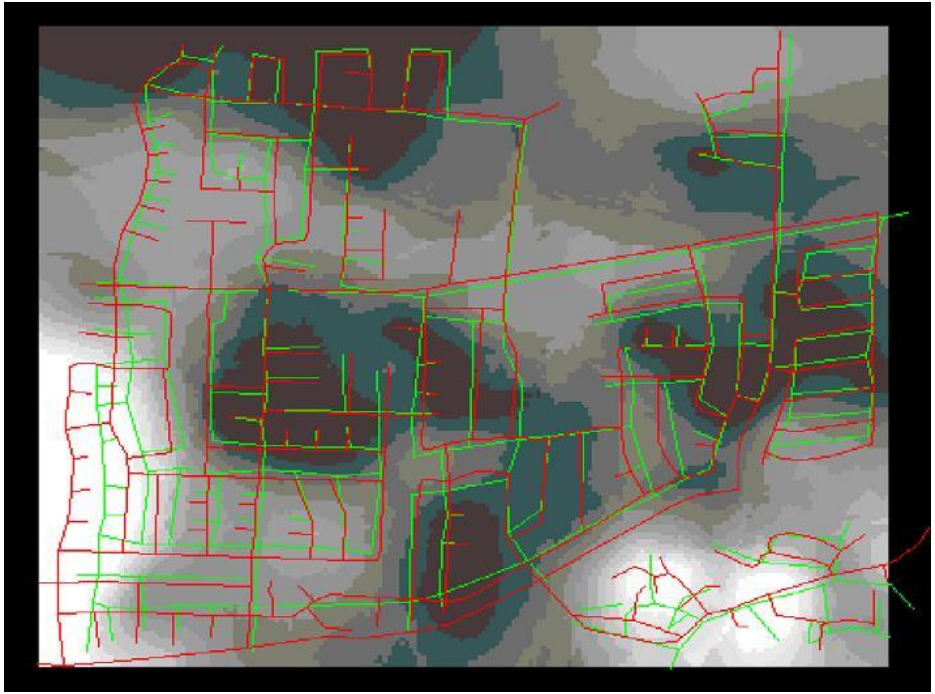

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Modifiable Areal Unit Problem

- **MAUP is a fundamental problem in spatial analysis**
  - Areas used for analysis **will** affect the result
- **The problem is fundamentally unsolvable, but using a large number of zoning schemes can alleviate the problem**

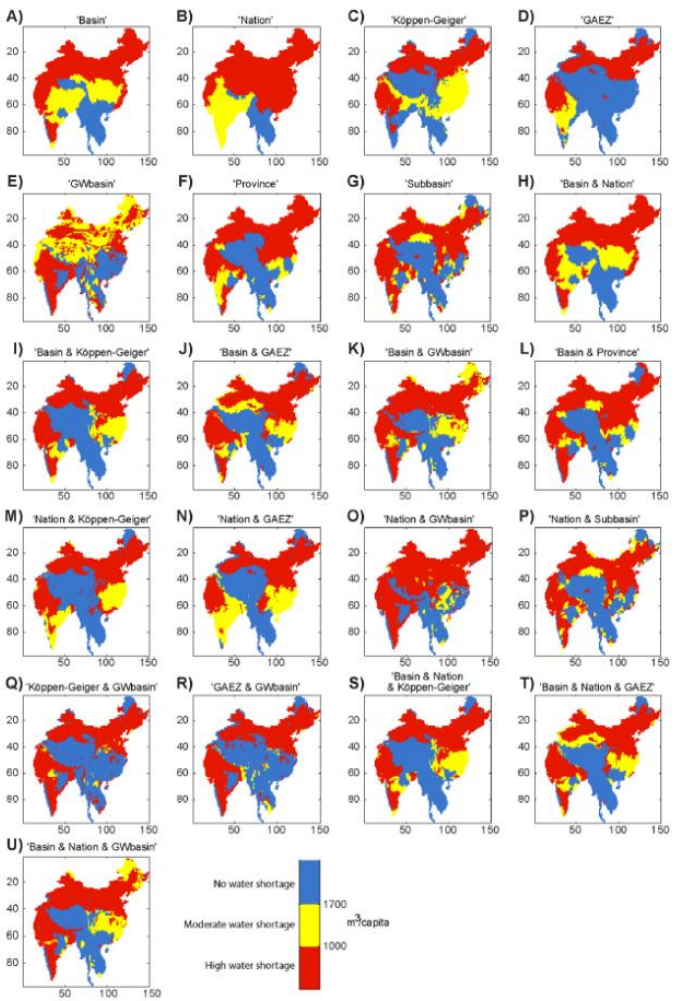

Figure 3. Water shortage expressed in terms of available water resources per capita (m^3/cap/year) with different zonings.

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Salmivaara, et al. (2015). Exploring the Modifiable Areal Unit Problem in Spatial Water Assessments: A Case of Water Shortage in Monsoon Asia. Water 7(3): 898-917.

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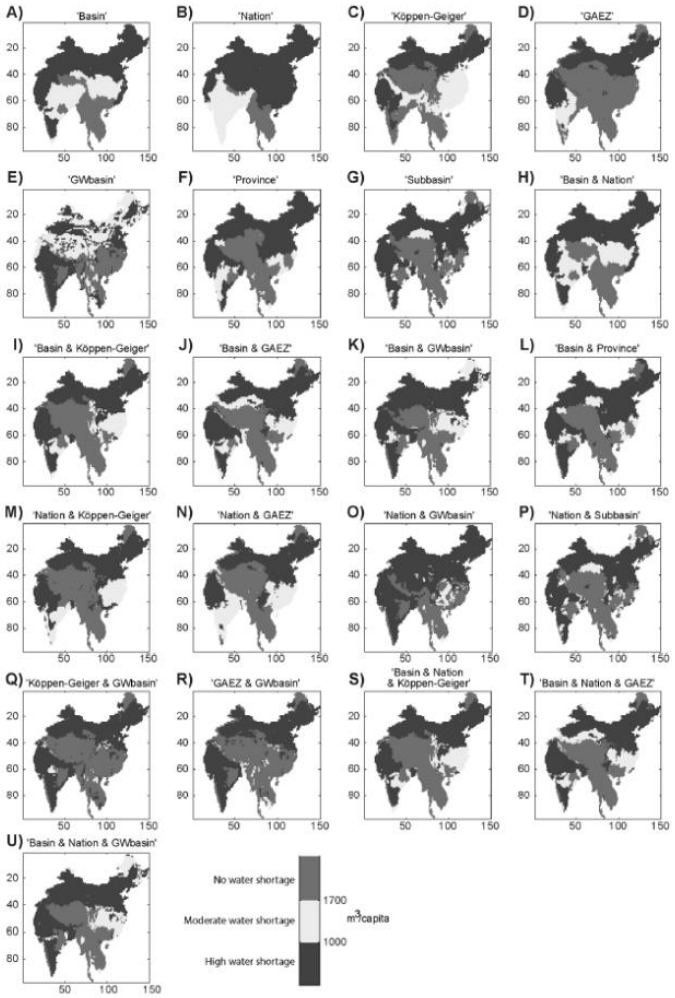

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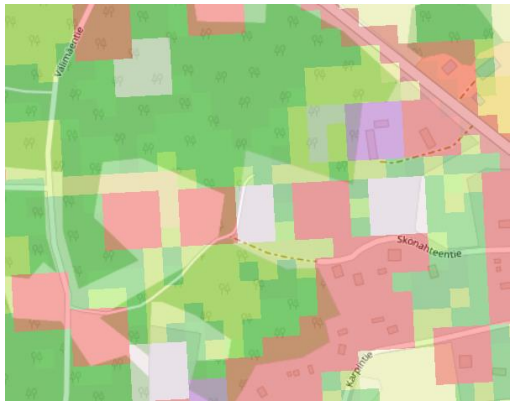
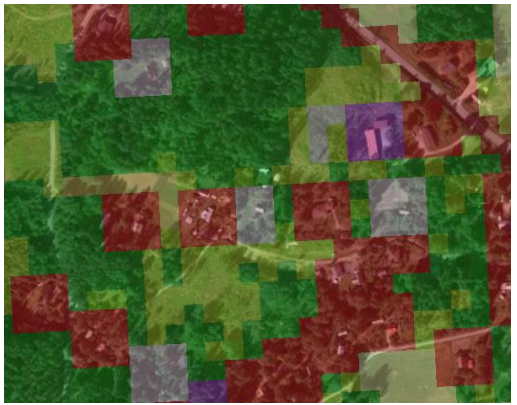
Living with uncertainty

- **It is easy to see the importance of uncertainty in GIS**
  - but much more difficult to deal with it effectively
  - but we may need to, especially in disputes that are likely to involve litigation
- **Data obtained from others should never be taken as truth**
  - efforts should be made to determine quality
- **Effects on GIS outputs are often much greater than expected**
  - there is a tendency to regard outputs from a computer as the truth...

- **Use as many sources of data as possible**
  - and cross-check them for accuracy
- **Be honest and informative in reporting results**
  - add plenty of caveats and cautions





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Data sharing and standardization: gaining benefit from spatial data

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Gaining benefit from spatial data

- **Spatial data is valuable**
  - Especially for the users
- **Significant amounts of spatial data is produced by the public sector**
  - Essentially on taxpayer money
- **Real value from spatial data is gained by combining data from several sources**

- **Data collection is costly**
  - It requires special equipment
  - It takes time and skill
  - At least if you’re planning to gather large-scale, reliable data sets
- **Data availability does not help if data cannot be found or used by the data recipients**

Gaining benefit from spatial data

- **Availability of spatial data requires**
  - Users to be able to find the data they need
  - Users to be able to access it
  - Users to be able to use the data for their own purposes
- **Thus, a method is required for**
  - Learning about data
    - Where it is
    - What phenomena it represents and how it represents these phenomena
  - Gaining access to data
    - Data use and ownership issues
  - Using the data

Metadata and metadata standards

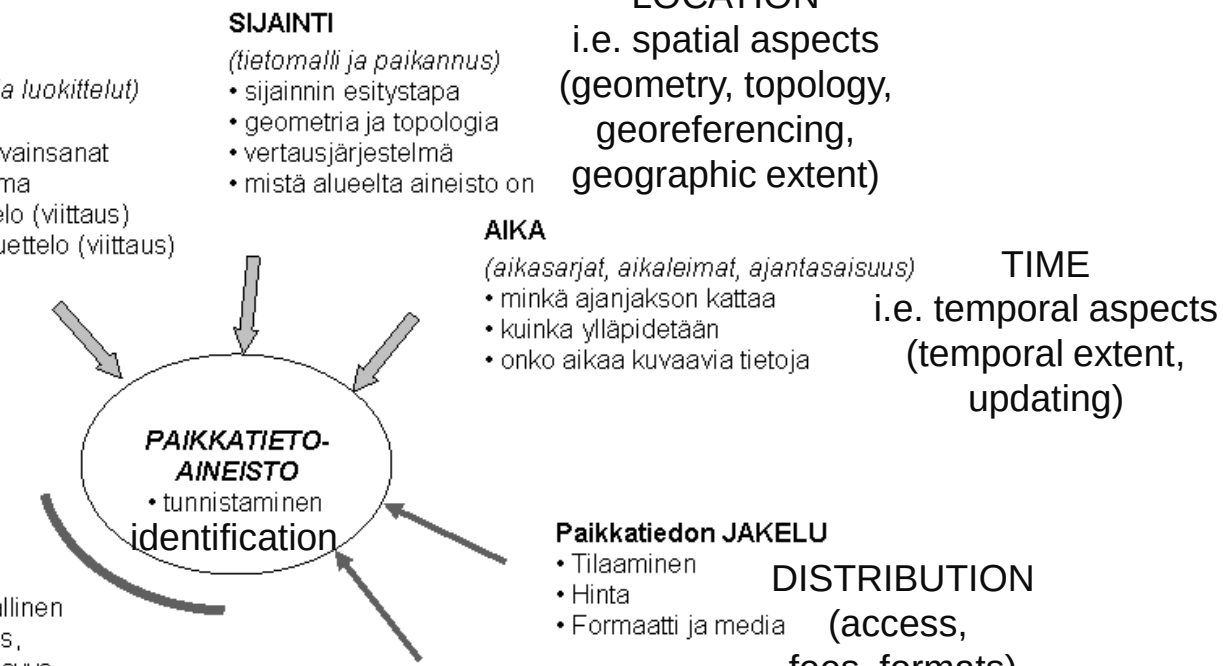
Metadata – the what

- **Metadata is data (actually information) about data**
  - Answers questions regarding what is in the data set
- **Metadata standards define standard data descriptions that also enable comparison of datasets**

- **There are both international and national metadata standards**
  - ISO 19115-1:2014 Geographic Information – Metadata – Part 1: Fundamentals
  - INSPIRE implementation rules for metadata (~subset of ISO 19115)
  - JHS 158 (2005/2012) Paikkatiedon metatiedot
- **National standards often based on international ones**
  - But allow distribution of information in the native language

Metadata contents

THEME
i.e. data content
(abstract,
keywords,
object
catalogue)



LOCATION
i.e. spatial aspects
(geometry, topology,
georeferencing,
geographic extent)

TIME
i.e. temporal aspects
(temporal extent,
updating)

QUALITY
(qualitative
and
descriptive
quality
elements)

DISTRIBUTION
(access,
fees, formats)

WHOSE
i.e. owner, maintainer,
distributor etc.

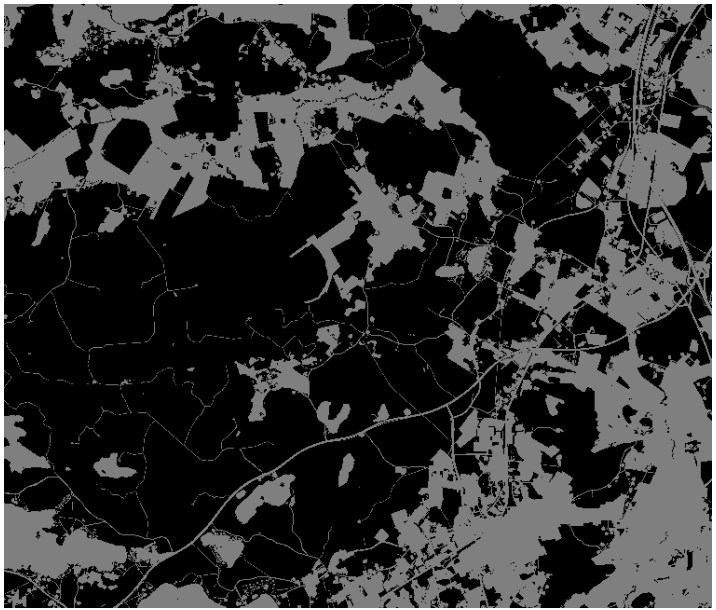
https://presemo.aalto.fi/enyc2005/

Metadata: what needs to be known about data (before use)

- **Consequences of geometric modelling**
  - e.g. gridded data (resolution & origin and orientation) & vector data
  - e.g. measurement points, sample points – effects of interpolation
  - Notice: the coordinate reference systems
- **Consistency on the level of detail ~ scale, generalization of datasets**
  - do datasets fit geographically
- **Semantic consistency (cf. conceptual model)**
  - object classes, classifications of attributes/variable
  - enumeration units
- **Consistency in quality**
  - Up-to-dateness, or rather the consistency of dates, e.g. when integrating real-time data with static framework data (such as, traffic data for real-time navigation & road network: construction and maintenance work)

- **Up-to-dateness: which map is (more) correct?**

Example: consistency of dates



The field data in the 2015 **products were up-dated to correspond the situation on 31 July, 2015**. The length of the up-dating period was calculated for each field plot from the date of the field measurement to the up-dating date 31 July, 2015. The start of the tree growth was supposed to be on May 1.

Source: National forest inventory, Natural Resources Institute Finland

Spatial data quality

- Data produced (and used) should be of good quality
- In order to establish what is quality data, widely accepted and sufficiently objective measures are required
- Again, standards provide an agreed framework

- JHS 160 (2006/2012) Paikkatiedon laadunhallinta (Quality Management for Geographic Information) based on earlier ISO 191xx standards, in Finnish
- ISO 19157:3013 Geographic information – Data quality

Data quality element	Data quality subelement QUANTITATIVE DATA QUALITY
Completenss (Täydellisyys)	Commission (Ylimääräinen tieto)
	Omission (Puuttuva tieto)
Logical consistency (Looginen eheys)	Conceptual consistency (Käsitteellinen eheys)
	Domain consistency (Arvojoukkoeheys)
	Format consistency (Formaattieheys)
	Topological consistency (Topologinen eheys)
Positional accuracy (Sijaintitarkkuus)	Absolute or external accuracy (Absoluuttinen sijaintitarkkuus)
	Gridded data position accuracy (Rasteritiedon sijaintitarkkuus)
	Relative or internal accuracy (Suhteellinen sijaintitarkkuus)
Temporal accuracy (Ajallinen tarkkuus)	Accuracy of a time measurement (Ajan mittauksen tarkkuus)
	Temporal consistency (Ajallinen eheys)
	Temporal validity (Ajanmukaisuus)
Thematic accuracy (Temaattinen tarkkuus)	Classification correctness (Luokittelun oikeellisuus)
	Non-quantitative attribute correctness (Ei-kvantitatiivisen ominaisuustiedon oikeellisuus)
	Quantitative attribute accuracy (Kvantitatiivisen ominaisuustiedon oikeellisuus)

Data quality element	**Data quality subelement** OVERVIEW DATA QUALITY
Lineage (Historiatiedot) - information about the events or source data used in constructing the data specified by the scope or lack of knowledge about lineage	Process history (Prosessointihistoria) - information about an event or transformation in the life of a dataset including the process used to maintain the dataset
	Source (Alkuperätiedot) - information about the source data used in creating the data specified by the scope
Purpose (Käyttötarkoitus) - summary of the intentions with which the resource(s) was developed	
Usage (Käyttökokemukset) - provides basic information about specific application(s) for which the resource(s) has/have been or is being used by different users	

Geospatial data standards

Geospatial data standards – how the data is modeled

- **Metadata describes what a data set represents**
  - The contents of a data set
- **A data standard defines how the data in the set is arranged**
- **This tells the software how the data needs to be read (and how it can be manipulated)**
  - The structure of the data set

- **Data standards are typically international**
- **There are several bodies involved in standardization**
  - OGC Open Geospatial Consortium – international, independent organization
  - ISO/TC 211 Geographic information – international committee under ISO
  - CEN/TC 287 Geographic information – EU committee
- **Roughly: OGC develops consensus-based standards for geoinformation, ISO is the big international body of standardization, which spreads them globally, and CEN arranges those standards to be implemented in Europe**
  - SFS arranges CEN standards to be adopted in Finland

Geospatial data standards – OGC and ISO

- **Simple Features – vector data format standard**
- **GeoTIFF – raster data format standard**
- **Geopackage – database container standard**
- **Geography Markup Language (GML) – XML for geospatial features**
  - KML – the corresponding Google XML – is also under OGC these days
- **Web Feature Service, Web Map (Tile) Service – standards for providing geospatial data as internet service**
- **Etc.**

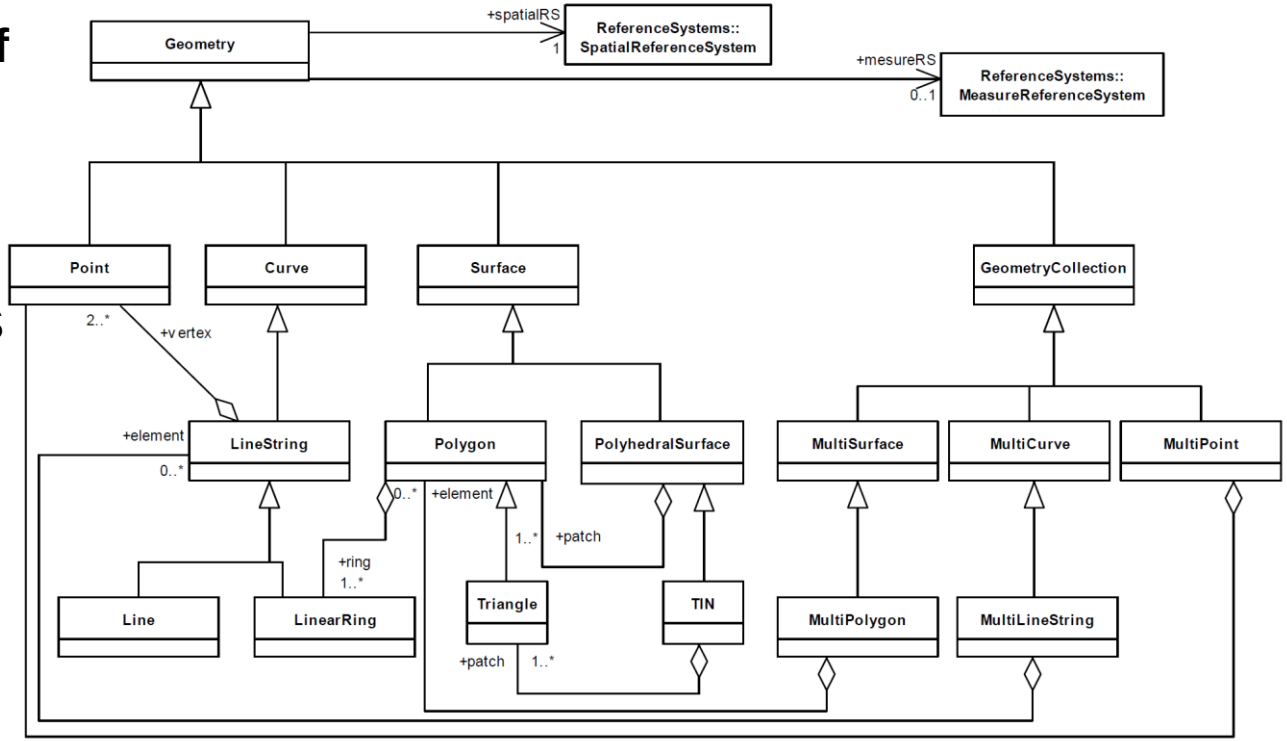
- **Web feature service, Web Map Service, Simple Features, and GML have all been adopted as ISO standards by the ISO/TC 211**
- **ISO standards base covers a lot more than what OGC has developed**
  - E.g. ISO 19111:2007 Geographic information – Spatial referencing by coordinates

Geospatial standards in Finland

- In Finland geospatial data standards have been published as JHS (Julkisen Hallinnon Suositus), made by JUHTA (Julkisen hallinnon tietohallinnon neuvottelukunta)
- JUHTA was abolished in 31.12.2019, and thus work on JHS ended
- How the work will be continued in the future has not been made public yet
- This has not, however, made JHS standards any less relevant

Geospatial data example: Simple Features Access

- **OGC specification of spatial elements in geographic data vector format**
  - Data transfer and interoperability of GIS systems
  - Contains basic geometric elements and operations on them



Geospatial data example: Simple Features Access

Topological queries
⇒ Out put is a boolean value

- Equals – same geometries
- Disjoint – geometries share common point
- Intersects – geometries intersect
- Touches – geometries intersect at common boundary
- Crosses – geometries overlap
- Contains – geometry completely contains
- Within – geometry within
- Overlaps – geometries of same dimension overlap
- Relate – intersection between interiors or boundaries

Spatial analysis operations
⇒ Output is a geometry (or distance)

- Distance – shortest distance*
- Buffer – geometric buffer
- ConvexHull – smallest convex polygon geometry
- Intersection – points common to two geometries
- Union – all points in geometries
- Difference – points different between two geometries
- SymDifference – points in one, but not both of input geometries

Spatial data infrastructures

Spatial data infrastructures

- **When non-trivial amounts of spatial data is being produced, managed and shared by an organization, planning, infrastructure and such are required**
  - Metadata tells what data represents
  - Spatial data standard tells how it represented (or distributed)
  - SDI governs how geospatial data is shared

"National Spatial Data Infrastructure" (''NSDI'') means the **technology, policies, standards, and human resources** necessary to **acquire, process, store, distribute, and improve utilization** of geospatial data."

Executive order 12906, White House, April 11, 1994

"An SDI is a coordinated series of **agreements on technology standards, institutional arrangements, and policies** that enable the **discovery and use** of geospatial information by users and for purposes other than those it was created for."

Kuhn, W. 2005

Infrastructure for spatial information in Europe (INSPIRE)

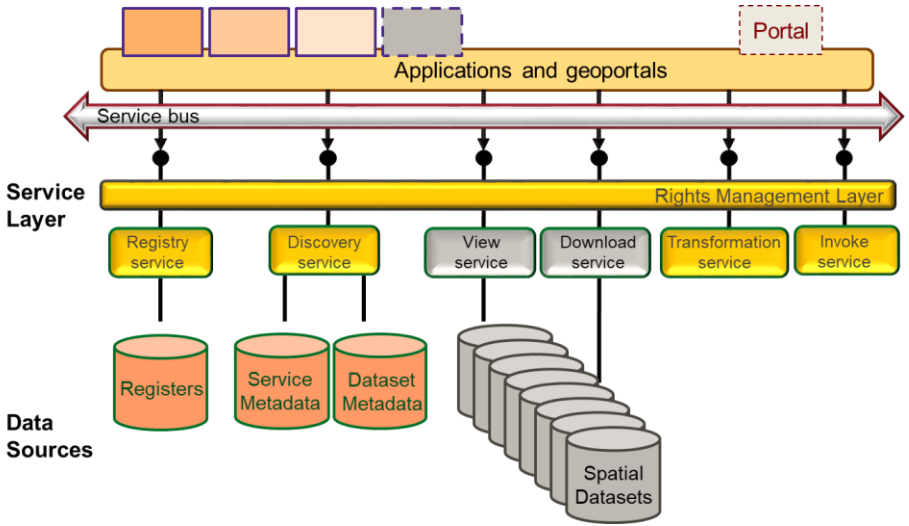
INSPIRE is the pan-European SDI for managing geospatial data in the European Union

“The INSPIRE Directive aims to create a European Union spatial data infrastructure for the purposes of EU environmental policies and policies or activities which may have an impact on the environment. This European Spatial Data Infrastructure will enable the sharing of environmental spatial information among public sector organisations, facilitate public access to spatial information across Europe and assist in policy-making across boundaries.”

https://inspire.ec.europa.eu/about-inspire/563

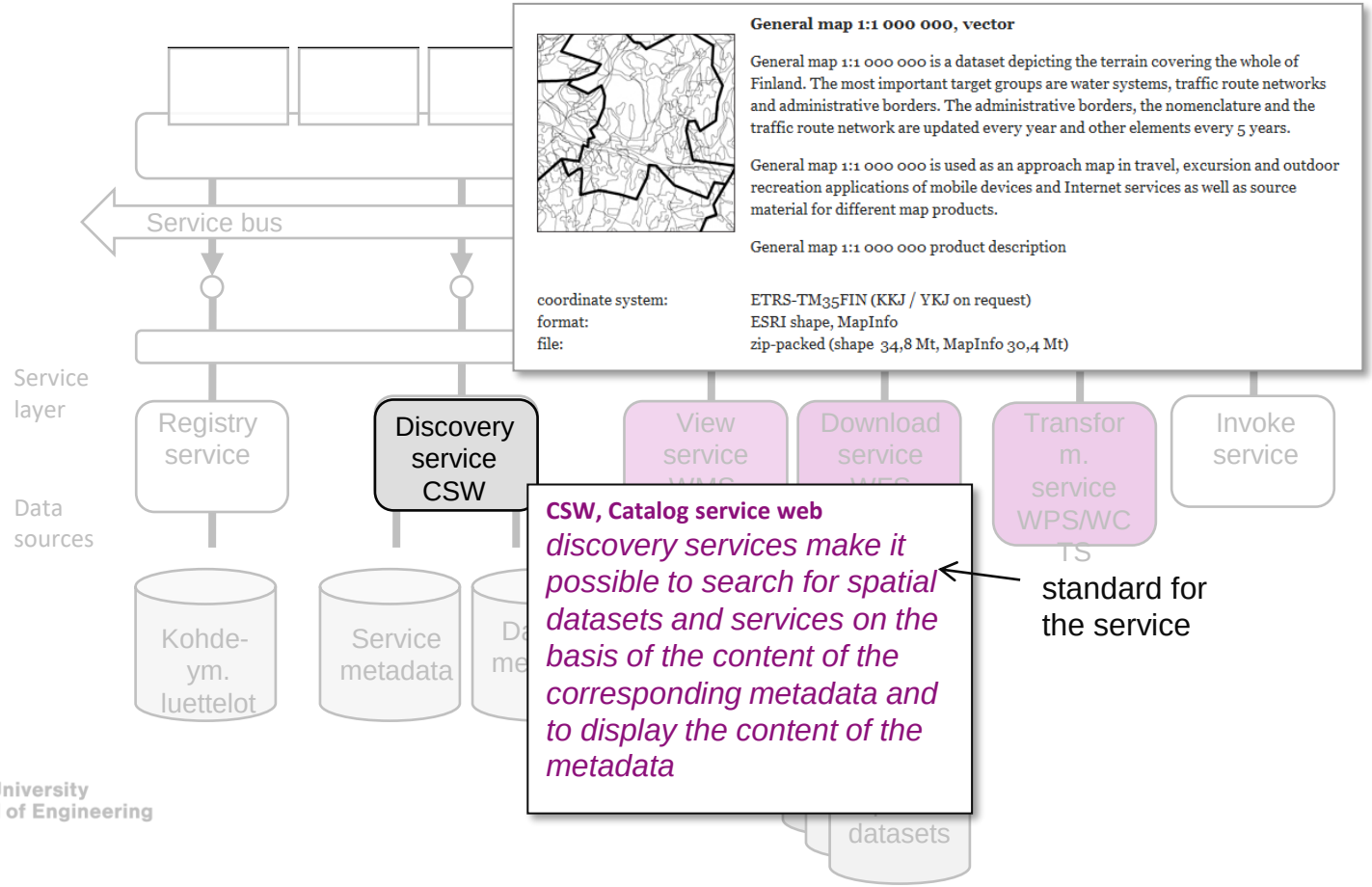
Inspire Network Services

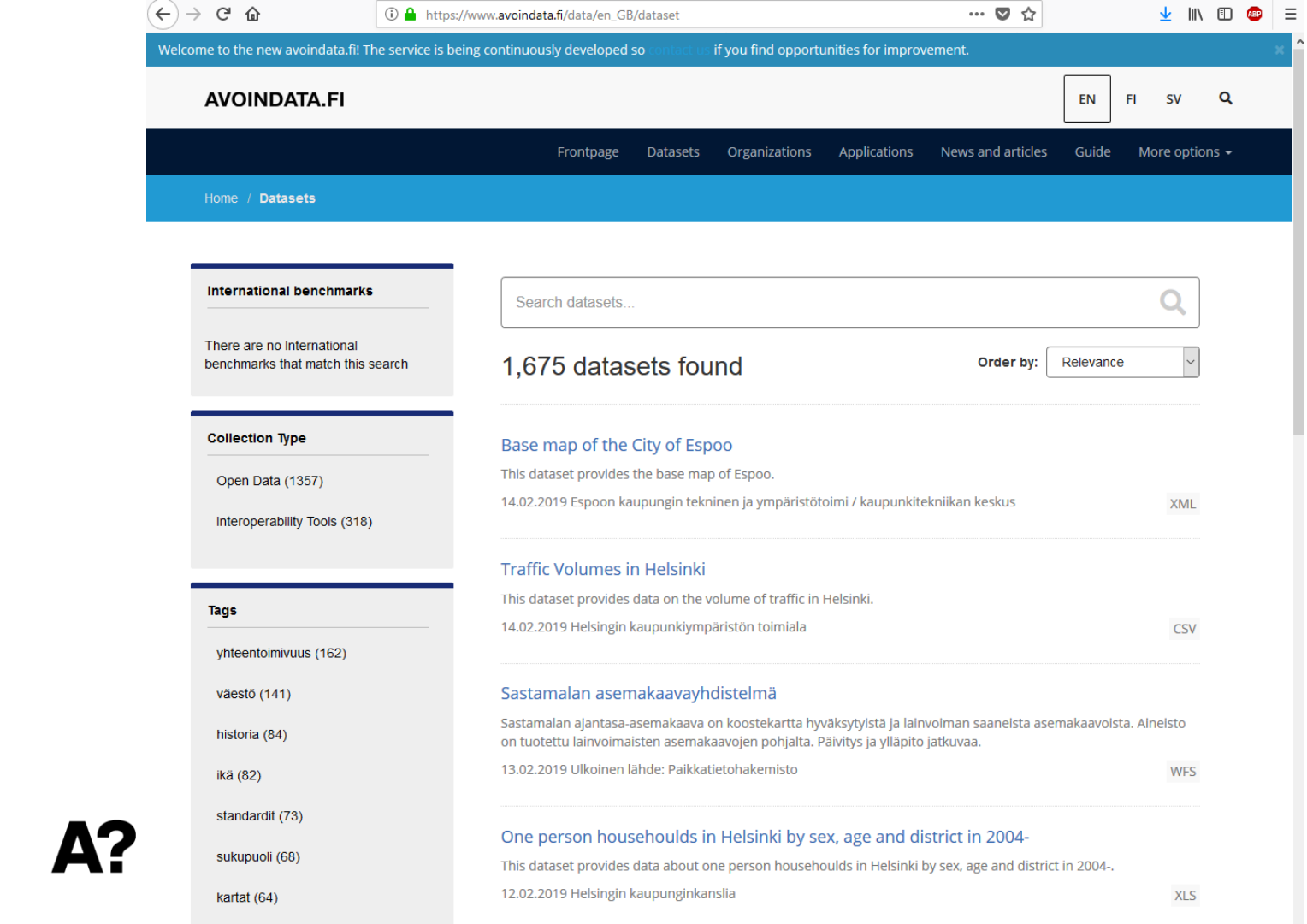
- **Defines how data is provided for users according to INSPIRE**
- **Registration service:** publish a service for others to use
- **Discovery service:** find out which service can fulfill your request
- **View service:** view spatial data on the web
- **Download service:** download spatial data to your own computer
- **Transformation service:** transform spatial data sets for the goal of achieving interoperability
- **InvokeSD service:** service to invoke other INSPIRE services (allows for creation of more complex service combinations)



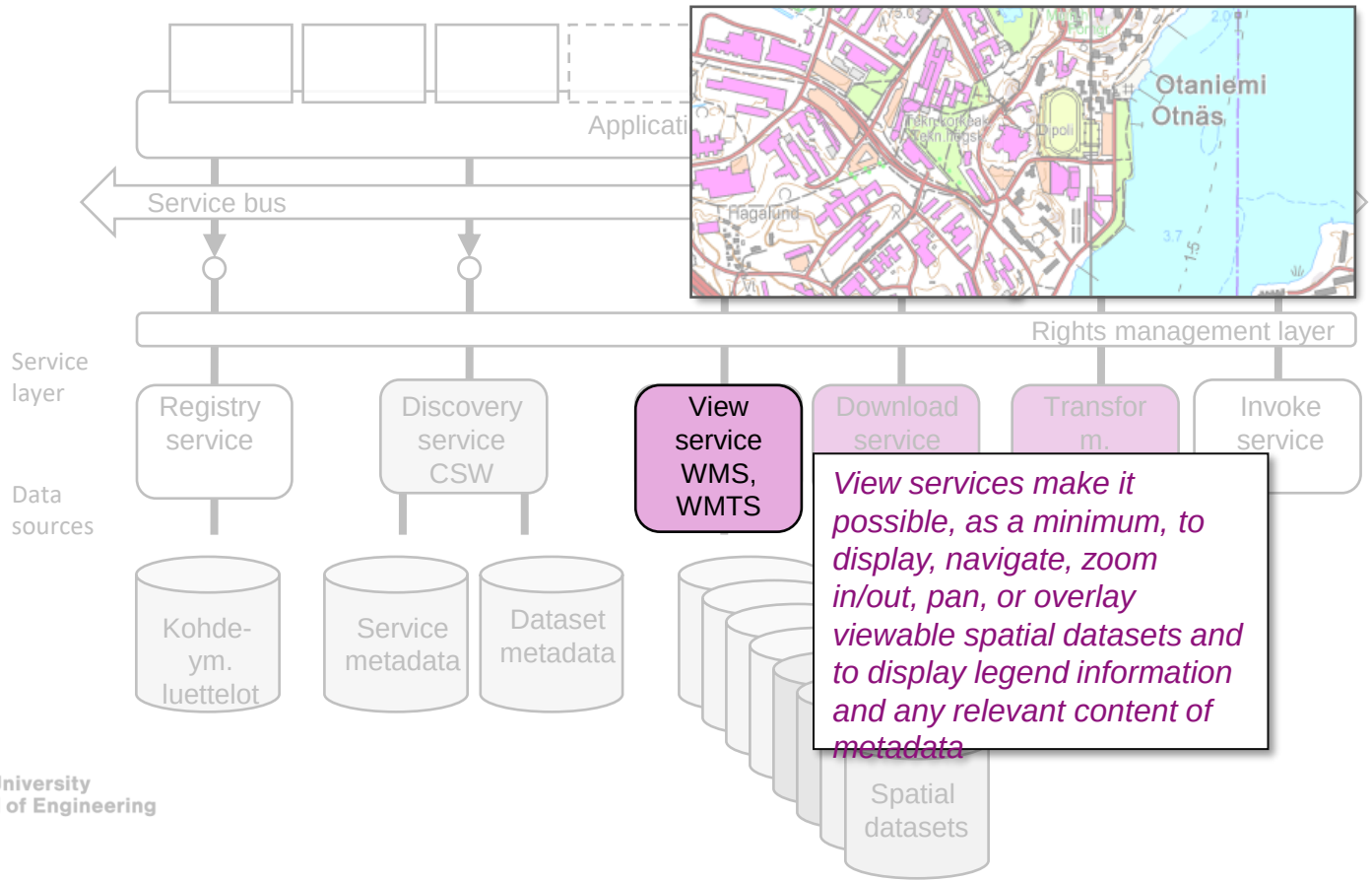
Most important services for data users highlighted

Discovery service

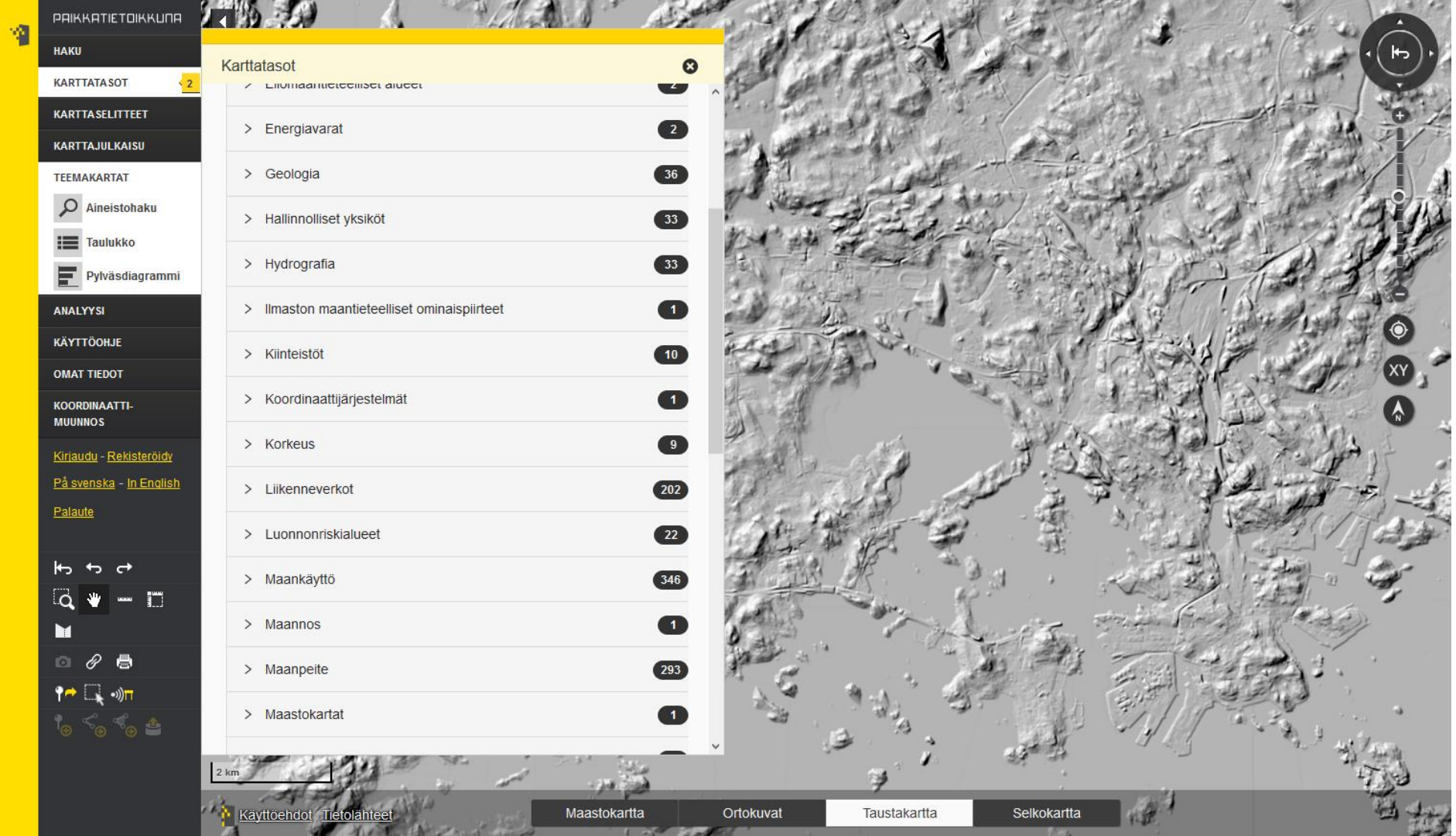



https://www.avoindata.fi/data/en_GB/dataset
Welcome to the new avoindata.fi! The service is being continuously developed so contact us if you find opportunities for improvement.
AVOINDATA.FI
EN
FI
SV
Frontpage
Datasets
Organizations
Applications
News and articles
Guide
More options
Home / Datasets
International benchmarks
There are no International benchmarks that match this search
Collection Type
Open Data (1357)
Interoperability Tools (318)
Tags
yhteentoimivuus (162)
väestö (141)
historia (84)
ikä (82)
standardit (73)
sukupuoli (68)
kartat (64)
Search datasets...
1,675 datasets found
Order by:
Relevance
Base map of the City of Espoo
This dataset provides the base map of Espoo.
14.02.2019 Espoon kaupungin tekninen ja ympäristötoimi / kaupunkitekniikan keskus
XML
Traffic Volumes in Helsinki
This dataset provides data on the volume of traffic in Helsinki.
14.02.2019 Helsingin kaupunkiympäristön toimiala
CSV
Sastamalan asemakaavayhdistelmä
Sastamalan ajantasa-asemakaava on koostekartta hyväksytyistä ja lainvoiman saaneista asemakaavoista. Aineisto on tuotettu lainvoimaisten asemakaavojen pohjalta. Päivitys ja ylläpito jatkuvaa.
13.02.2019 Ulkoinen lähde: Paikkatietohakemisto
WFS
One person households in Helsinki by sex, age and district in 2004-
This dataset provides data about one person households in Helsinki by sex, age and district in 2004-.
12.02.2019 Helsingin kaupunginkanslia
XLS

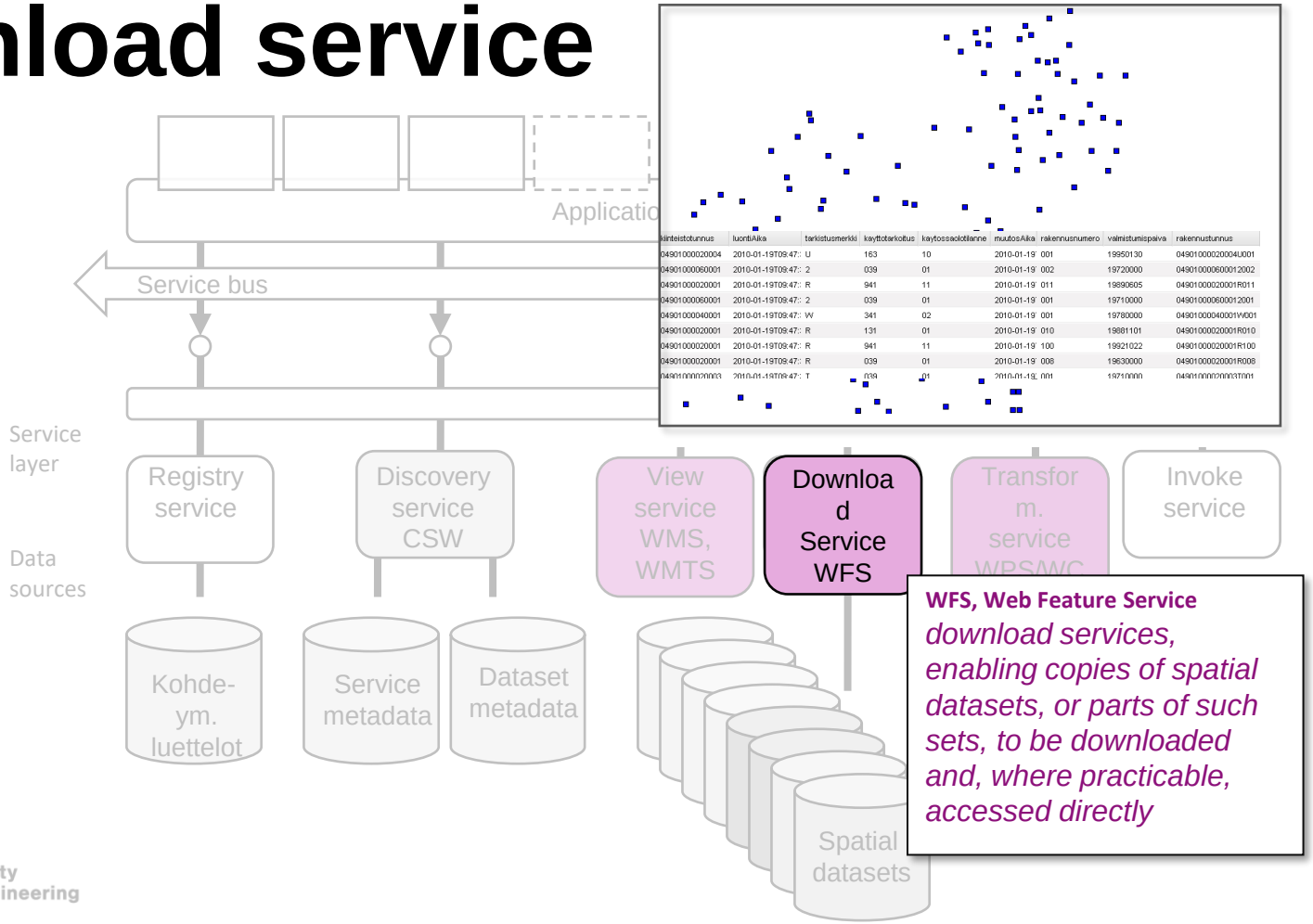
View service



View services make it possible, as a minimum, to display, navigate, zoom in/out, pan, or overlay viewable spatial datasets and to display legend information and any relevant content of metadata.


PAIKKATIETOIKKUNA
HAKU
KARTTATASOT 2
KARTTASELITTEET
KARTTAJULKAISU
TEEMAKARTAT
Aineistohaku
Taulukko
Pylväsdiagrammi
ANALYYSI
KÄYTTÖOHJE
OMAT TIEDOT
KOORDINAATTI-MUUNNOS
Kirjaudu - Rekisteröidy
På svenska - In English
Palaute
Karttatasot
Energiavarat 2
Geologia 36
Hallinnolliset yksiköt 33
Hydrografia 33
Ilmaston maantieteelliset ominaispiirteet 1
Kiinteistöt 10
Koordinaattijärjestelmät 1
Korkeus 9
Liikenneverkot 202
Luonnonriskialueet 22
Maankäyttö 346
Maannos 1
Maanpeite 293
Maastokartat 1
2 km
Käyttöehdot Tietolähteet
Maastokartta
Ortokuvat
Taustakartta
Selkokartta
XY

Download service



STATISTICS FINLAND

Open data

Open database data

Geographic data

RELATED TOPICS

Terms of Use

Geographic data

Statistics Finland's open geographic data are part of the national geographic information interface and they have also been published in the national geographic information portal Paikkatietoikkuna. As part of the infrastructure, the data and services are integrated with other data belonging to the spatial data infrastructure. The standards that define the services and part of the data can be found in the following regulations:

- Inspire directive (2007/2/ EC)
- Act on spatial data infrastructure (421/2009)
- Government decree on spatial data infrastructure (725/2009).

On this page you can find Statistics Finland's geographic data that can be used as an interface service (WMS/WFS). The interface service is a technological user access by means of which you can access Statistics Finland's map server and retrieve the data you need. The use of interface services require that you have access to a spatial data software or a self-programmed application that makes requests to the server. The data can be read or transferred to your own application using the interface addresses given in the table below.

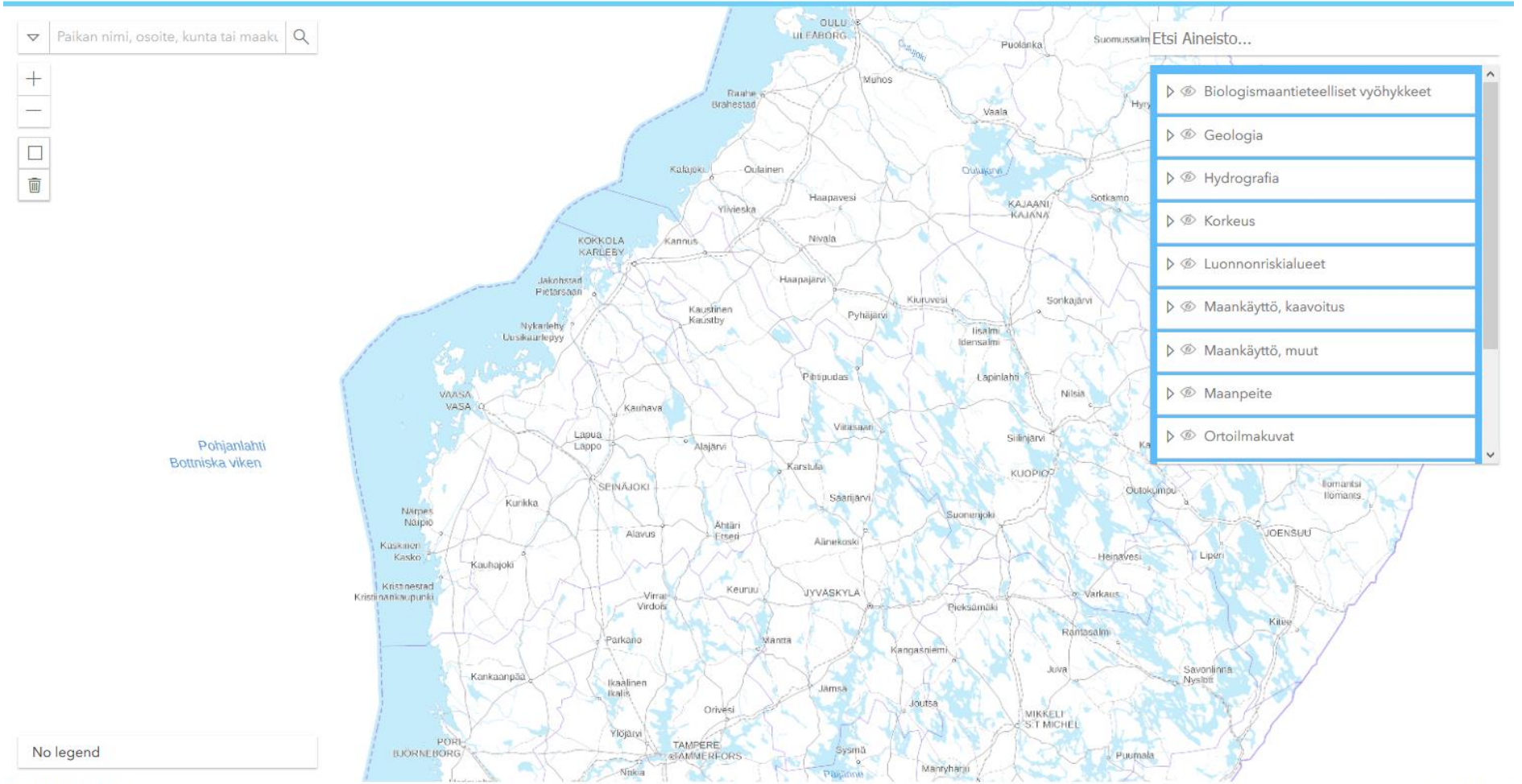
Direct downloading from the interface with queries is another way to utilise the data. You can define the characteristics of the data to be downloaded in the query, like the file format or the desired area.

The metadata descriptions of each data can be found in Paikkatietohakemisto (spatial data index).

Open this table as a bigger version

Data presentation	Interface addresses of the service	Descriptions in Paikkatietohakemisto (spatial data index)
Municipality-based statistical units	http://geo.stat.fi/geoserver/tilastointialueet/wms http://geo.stat.fi/geoserver/tilastointialueet/wfs	Metadata description
Population by municipality-based units	http://geo.stat.fi/geoserver/vaestoalue/wms http://geo.stat.fi/geoserver/vaestoalue/wfs	Metadata description
PAAVO – Open data by postal code area	http://geo.stat.fi/geoserver/postialue/wms http://geo.stat.fi/geoserver/postialue/wfs	Metadata description
The statistics grid 1 km x 1 km	http://geo.stat.fi/geoserver/tilastointialueet/wms http://geo.stat.fi/geoserver/tilastointialueet/wfs	Metadata description
Population grid data 1 km x 1	http://geo.stat.fi/geoserver/vaestoruutu/wms http://geo.stat.fi/geoserver/vaestoruutu/wfs	Metadata description

Latauspalvelu LAPIO



Reading for the lecture

Longley et al. (2015): Chapter 5 and 9.5

INSPIRE Network Services Architecture, Ch. 5-6
http://inspire.ec.europa.eu/reports/ImplementingRules/network/D3_5_INSPIRE_NS_Architecture_v3-0.pdf

That’s all, folks!
Thank you for attending the course

And apologies for any inconveniences this year’s extra-large course caused for you!