L6:Maps as decision tools

Kraak & Ormeling, Cartography – Visualization of Geospatial Data
- chapter 13: Maps as decision tools

Why maps?

Role of maps in analysis and communication of geospatial information:

- deciding what to analyse,

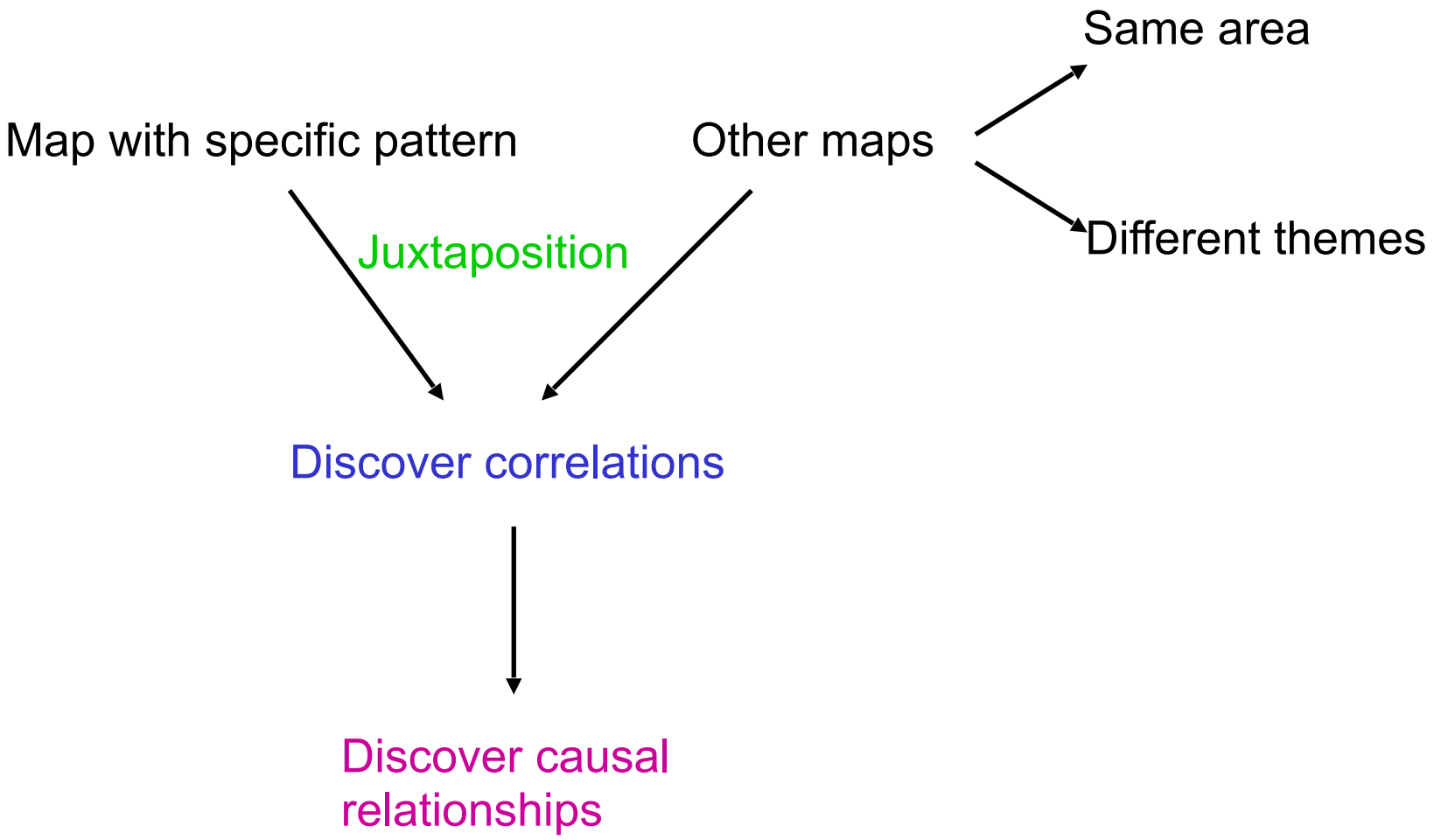
- support in decision making in issues with geospatial impacts,

- communication of decisions.

A sequence of individual actions when using a map for a task (navigation):

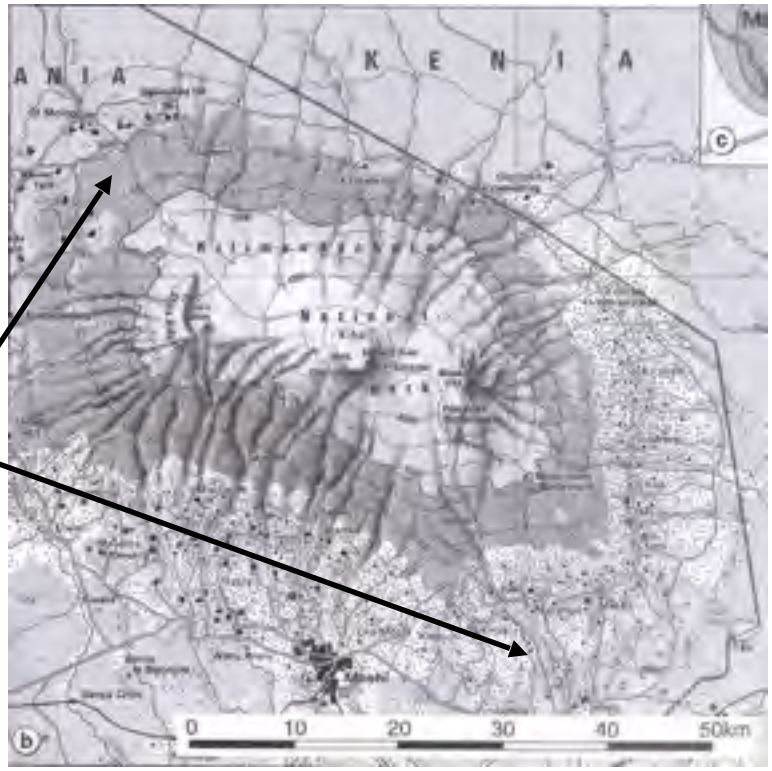
- search and locate one's position
- orient the map
- search, identify and locate one's destination
- determine options for alternative routes
- select one route
- set a course
- determine landmarks
- follow the course on the map
- check landmarks
- verify the destination
- verify the route

Explaining patterns, comparison and analysis



Relief map of Kilimanjaro

Land use map of the same area



A discrepancy in the infrastructure & settlements between NW & SE parts

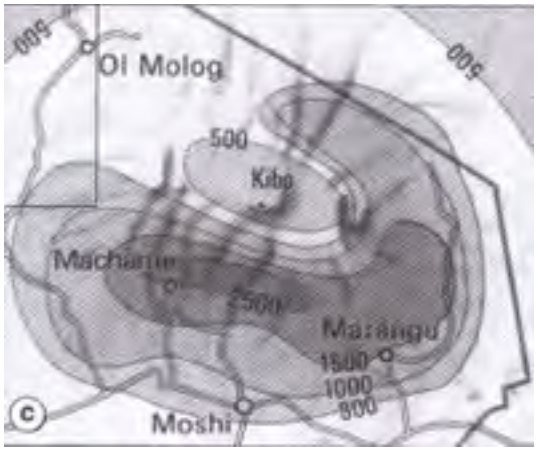
Why?

Arable land factors:

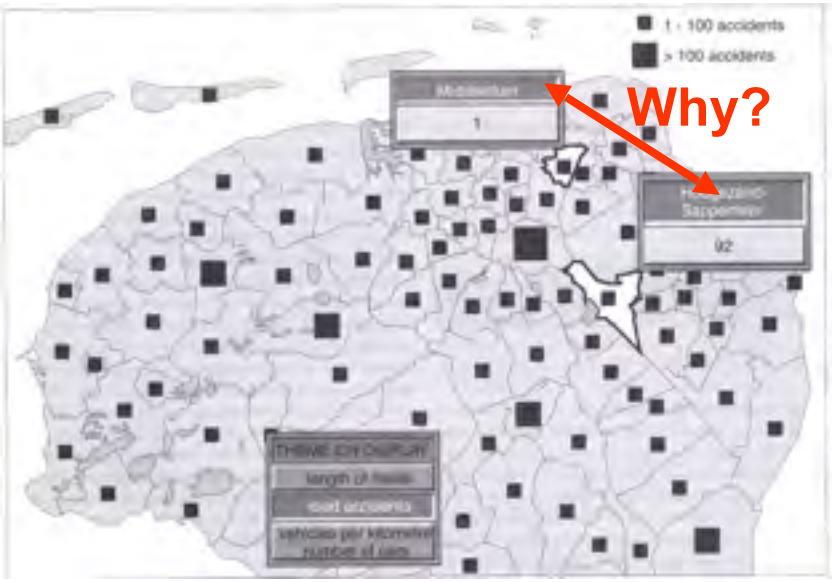
- soil patterns
- slopes
- elevation
- precipitation

} The same conditions around the mountain

Precipitation map



Road accidents in Dutch municipalities Middelstum and´Hoogezand-Sappemeer



Road network of the same area

Population distribution

Form a hypothesis:
more traffic accidents in municipalities with:
- more inhabitants
- motorway exits
- larger overall road length
- more cars

Form a hypothesis:

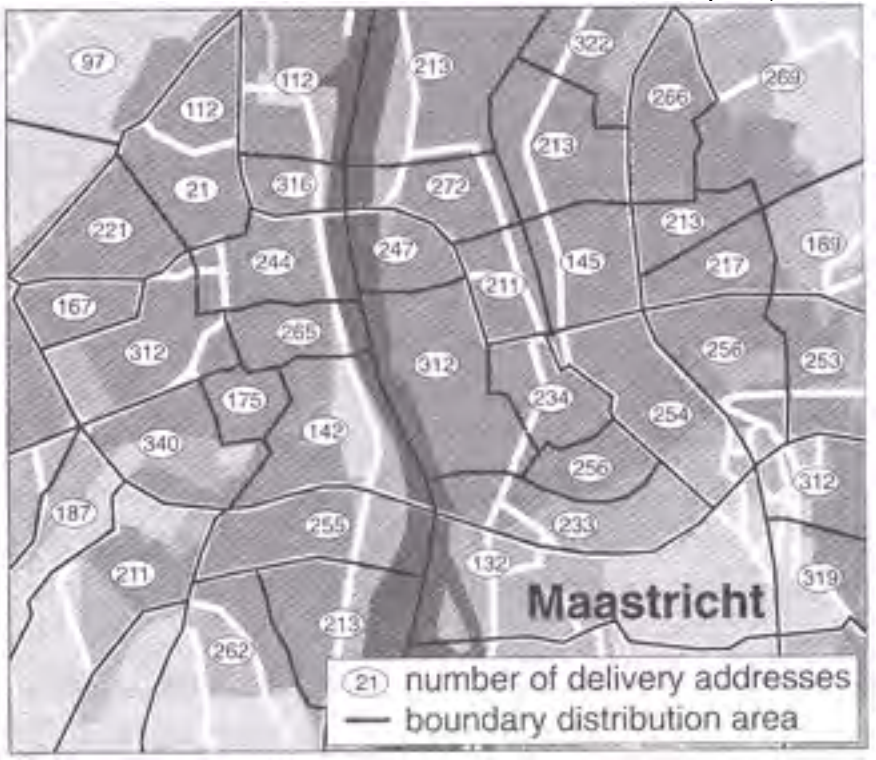
Search for a proof

Juxtaposition of maps helps to discover the factors that explain the differences.

Geovisualisation software should have the facility for the juxtaposition: showing maps simultaneously on the screen.

Analysis and decision-making

Newspaper sales in Maastricht



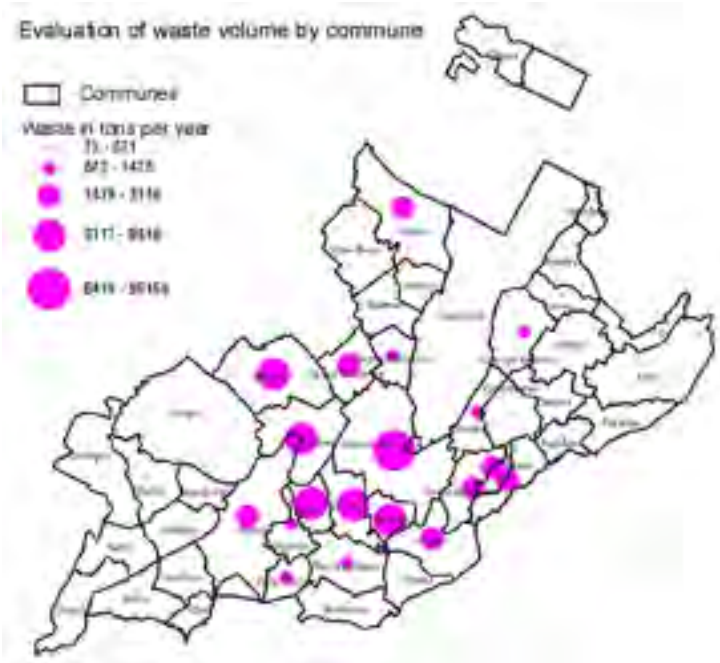
Compare the numbers of subscribers with number of households per distribution area -> discover areas where the newspaper distribution is low.

↓ Decision

Newspaper's marketing department could arrange campains for larger sales based on the map of these areas:
- advertisment campaigns
- special offers for trial subscriptions

Example: location of obnoxious facilities

1. Evaluation of waste volumes



Example: location of obnoxious facilities

2. Location of potential sites

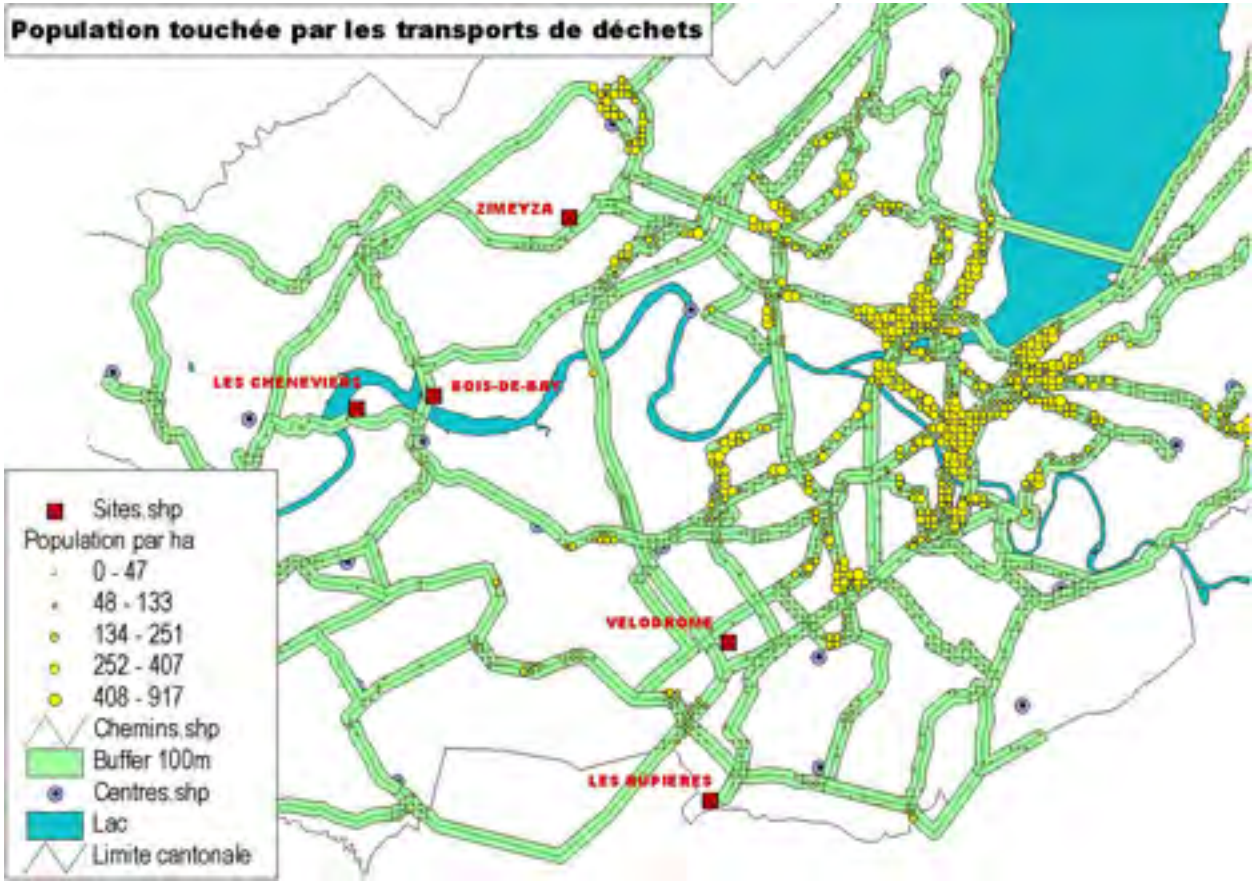
Criteria
- Industrial zones
- Open construction lots > 2 ha
- Publicly owned parcels

Example: location of obnoxious facilities

3. Finding the shortest path

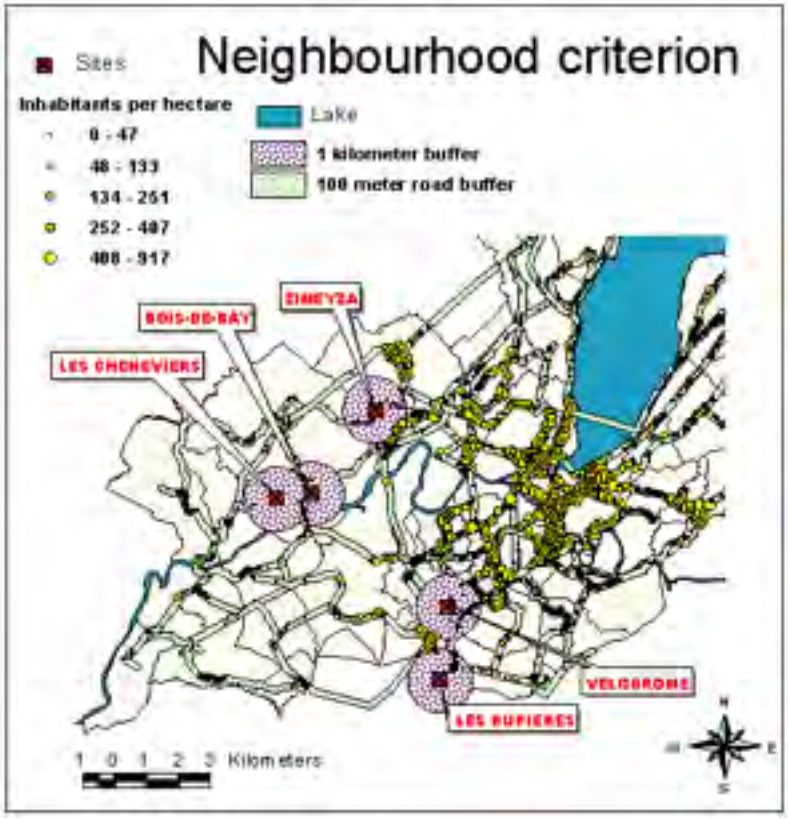
Example: location of obnoxious facilities

4. Nieghbourhoods affected, a) along routes



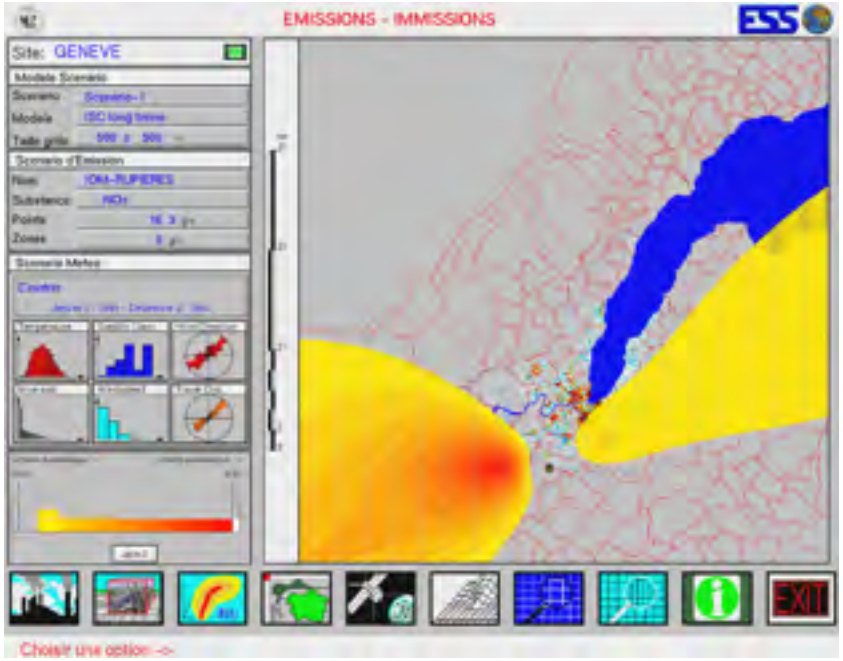
Example: location of obnoxious facilities

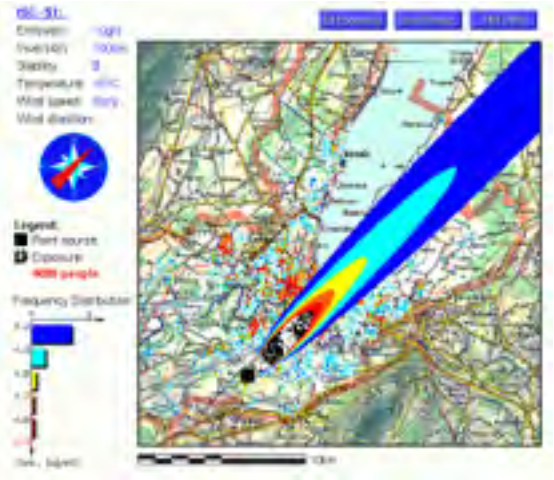
4. Neighbourhoods affected, b) at sites



Example: location of obnoxious facilities

5. Regions affected by smoke plume



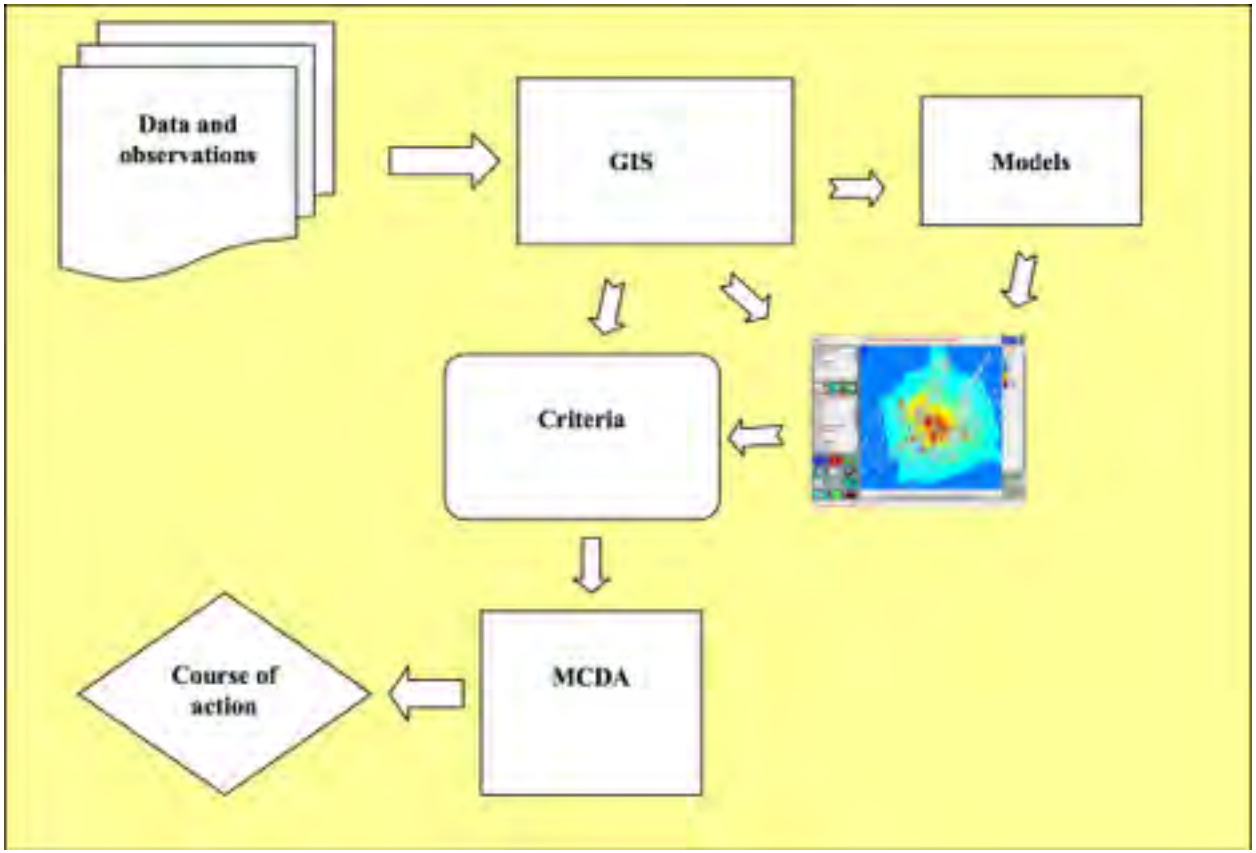


1. Emission or source characteristics
2. The nature of the pollutant material
3. Meteorological characteristics

4he effects of terrain and anthropogenic structures

Example: location of obnoxious facilities

6. Selecting the best site (Multi Criteria Decision Analysis)



Example: location of obnoxious facilities

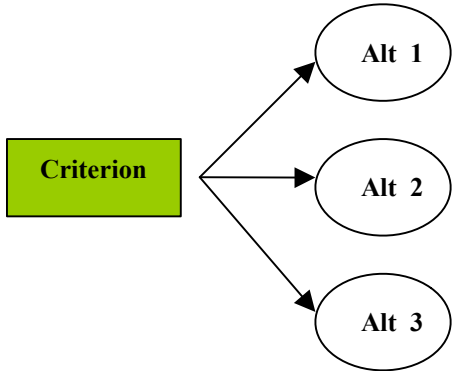
MCDA techniques

- **MCE** (Multi-criteria-evaluation)): the simplest technique, using pirwise weighting of all factors and Principa Component analysis to derive (consistent) weighting. Implemented in the GIS program IDRISI.
- **MAUT** (Multi-attribute utility theory): a technique based on the paradigm of decision tree and risk analysis and using a cardinal utility function. For a coupling of MAUT with a GIS see Keisler and Sundell (1987).
- **ELECTRE**: a technique originally developed by B. Roy (1991) to incorporate fuzzy (imprecise and uncertain) logic into decision making by using thresholds of indifference and preference.
- **Compromise Programming (CP)**: This technique is used to identify solutions that are closest to the ideal solution, as determined by some measure of distance. The solutions identified to be closest to the ideal solution are called *compromise solutions* and constitute the *compromise set.* The ideal solution is the one that provides the extreme value for each of the criteria considered in the analysis. For a coupling of CP with a GIS see Tkach et al. (1997).

Example: location of obnoxious facilities

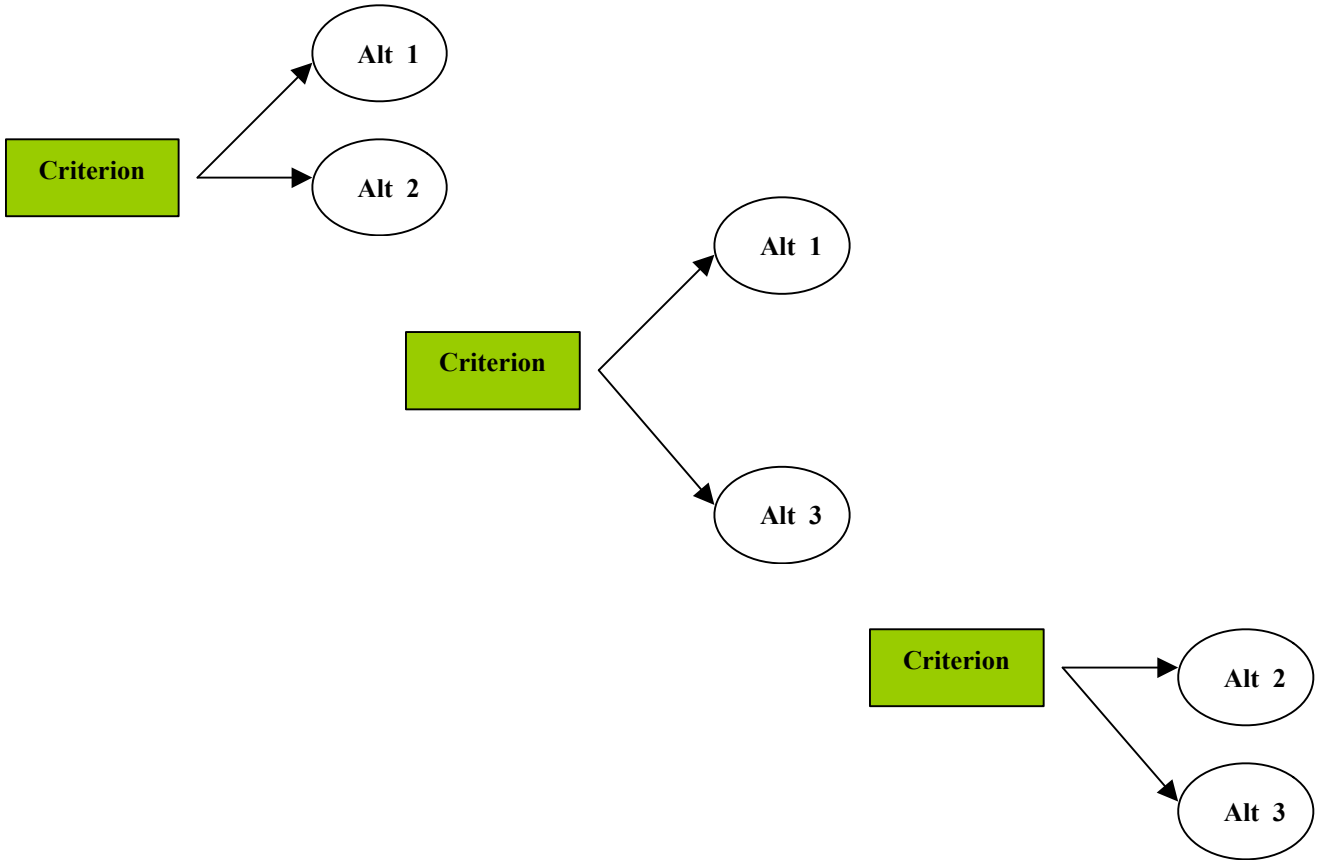
The Analytic Hierarchy Process

The Analytic Hierarchy Process (AHP) was developed by T. L. Saaty (1980) as a simple and yet powerful method for structuring almost any complex decision problem. The method is widely used in American decision science circles. You can find a long list of references on applications of AHP on the website
http://www.expertchoice.com/hierarchon/references/reflist.htm.
In Europe, other multi-criterion decision analysis tools have been successful, like Electre.



Example: location of obnoxious facilities

The Analytic Hierarchy Process



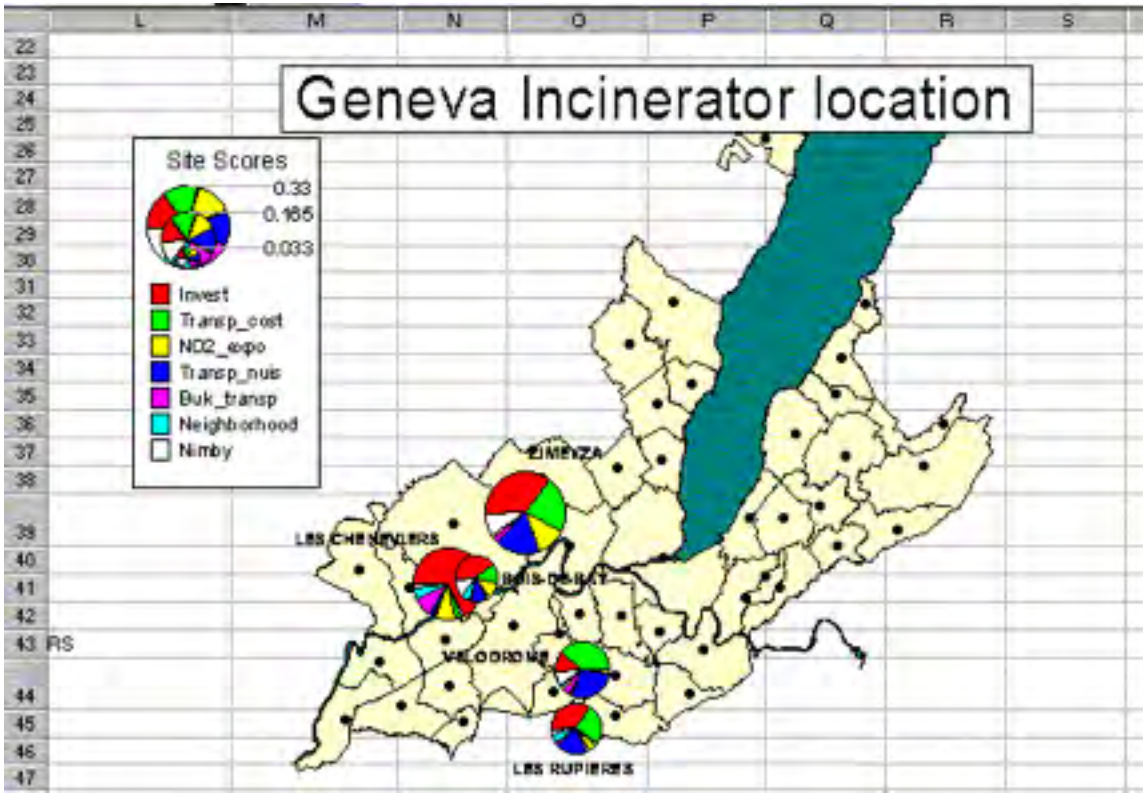
Example: location of obnoxious facilities

The Analytic Hierarchy Process

Criterion X	Alternative 1	Alternative 2	Alternative 3
Alternative 1	1	1/3	2
Alternative 2	3	1	6
Alternative 3	1/2	1/6	1

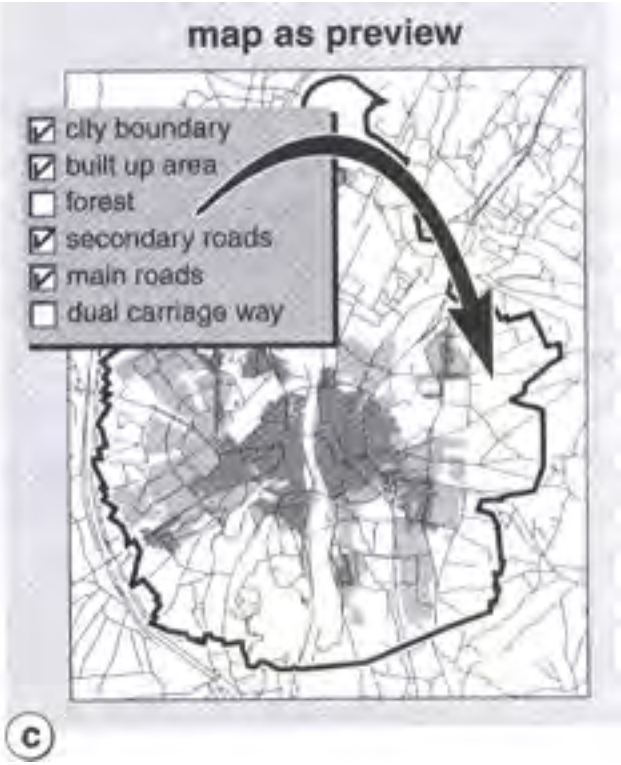
Example: location of obnoxious facilities

AHP Score results



Maps as interfaces with databases

Maps = graphical user interfaces (GUI) with databases:
search, index, preview, select data, etc.



Working with electronic atlases

”New” operations available in electronic environment (not existing in traditional paper atlases):

- clicking on map objects (query),
- aggregate thematic data on different levels than the basic area units,
- toggle between an absolute and relative view of a dataset,
- toggle between different map types of the same area (topogr+theme)
- highlight/mark a specific category or class,
- pan,
- zoom,
- save, download, copy, export, print – images are transfered to other data carriers,
- time/coordinates – return local time and geogr.coordinates,
- rank thematic data,
- filter data,
- calculate various functions and present the result as new maps,
- etc.

Availability of data for decision-making

Many electronic data sources available on internet

↓

http://www.geographynetwork.com
Database of geographic data from a global network of publishers

↓

ESRI World Basemap Data – a free data source for the whole world

Data Information

Name:	ESRI World Basemap Data
Provider:	ESRI
Coverage:	World
Scale:	Variable
Coordinate System:	Geographic Coordinates (NAD 83)
Units:	Decimal degrees
Delivery:	Compressed shapefile download
File size:	A compressed file ranges between 10 KB and 1 MB
Price:	Free

Data Downloader / Preview Area - Netscape
File Edit View Go Bookmarks Tools Window Help
http://arcdata.esri.com/data_downloader/DataDownloader
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ESRI World Basemap
Arctic Ocean
Pacific Ocean
Atlantic Ocean
Indian Ocean
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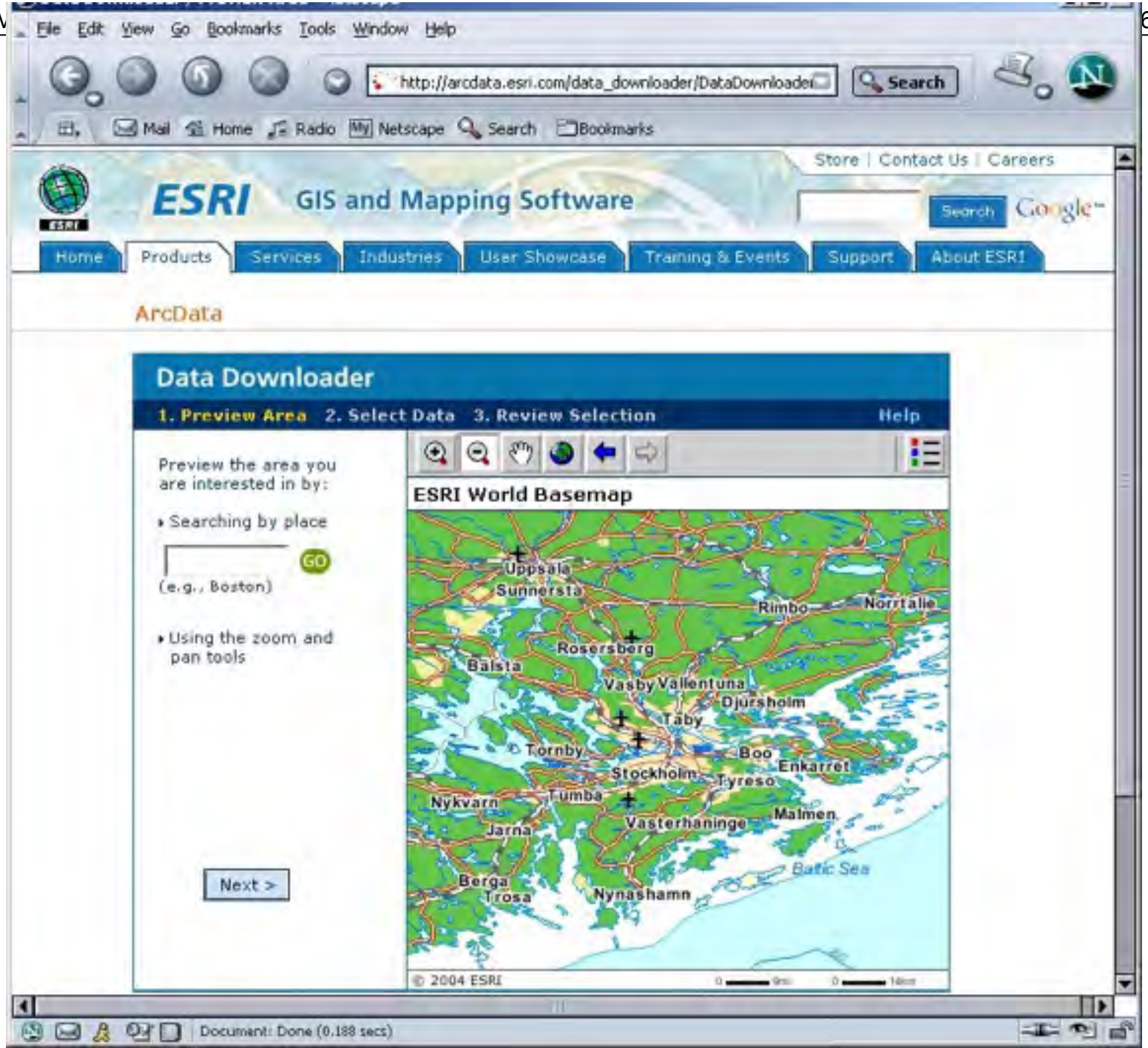
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ESRI World Basemap
Uppsala
Sunnersta
Rimbo
Norrtalje
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Vasby
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Djursholm
Taby
Tornby
Boo
Enkarret
Stockholm
Tyreso
Nykvarn
Tumba
Malmen
Vasterhaninge
Jarna
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Trosa
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Google
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ArcData
Data Downloader
1. Preview Area 2. Select Data 3. Review Selection Help
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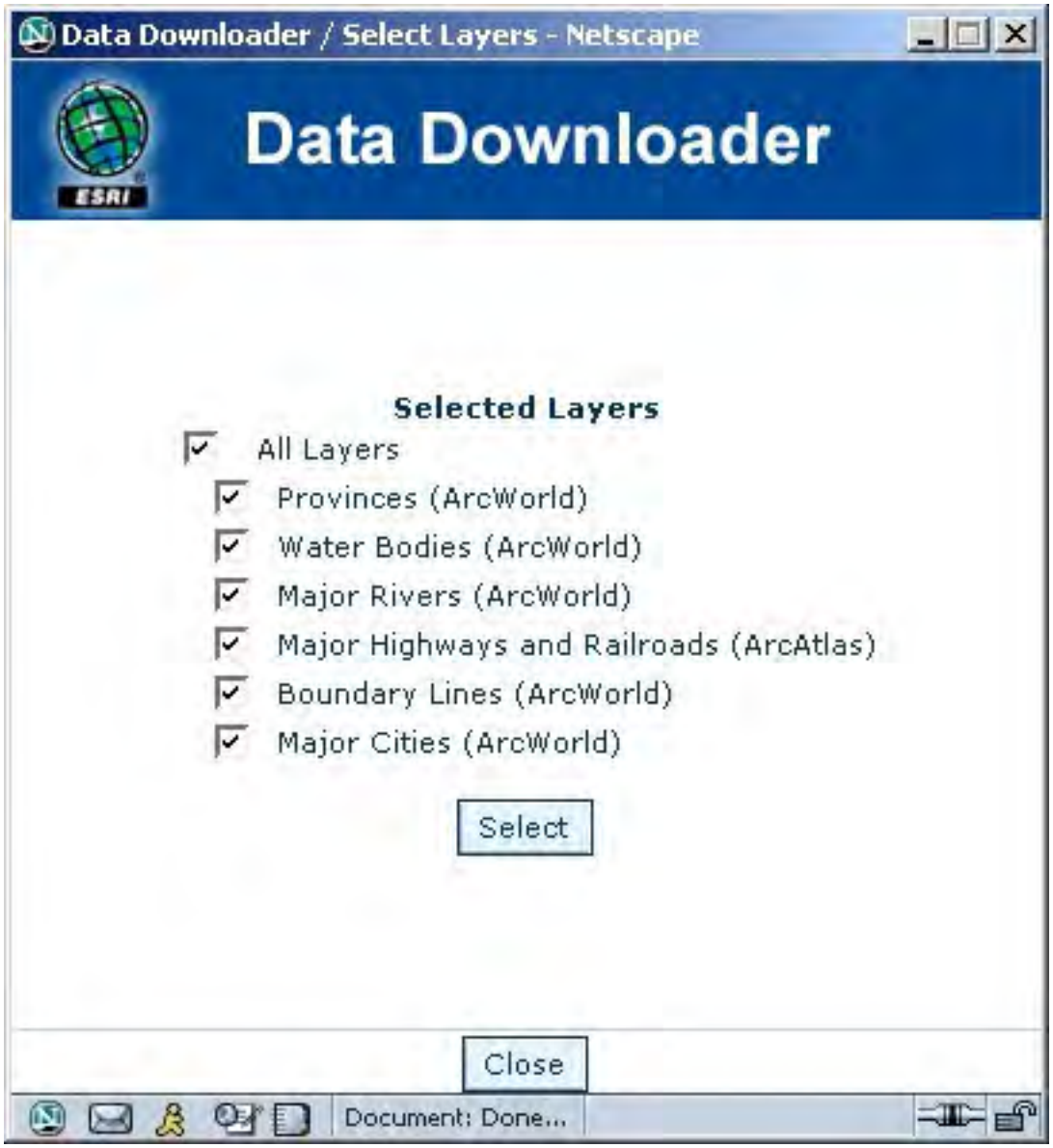
Data Downloader / Select Layers - Netscape
Data Downloader
ESRI
Selected Layers
All Layers
Provinces (ArcWorld)
Water Bodies (ArcWorld)
Major Rivers (ArcWorld)
Major Highways and Railroads (ArcAtlas)
Boundary Lines (ArcWorld)
Major Cities (ArcWorld)
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Close
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Data Downloader / Review Selection - Netscape
File Edit View Go Bookmarks Tools Window Help
Data Downloader / Download Data - Netscape
Data Downloader
Your Data File is Ready.
You can now download the selected data to your local system.
The ZIP file is approximately 54.87 KB.
Click Download File to retrieve your data file.
Download File
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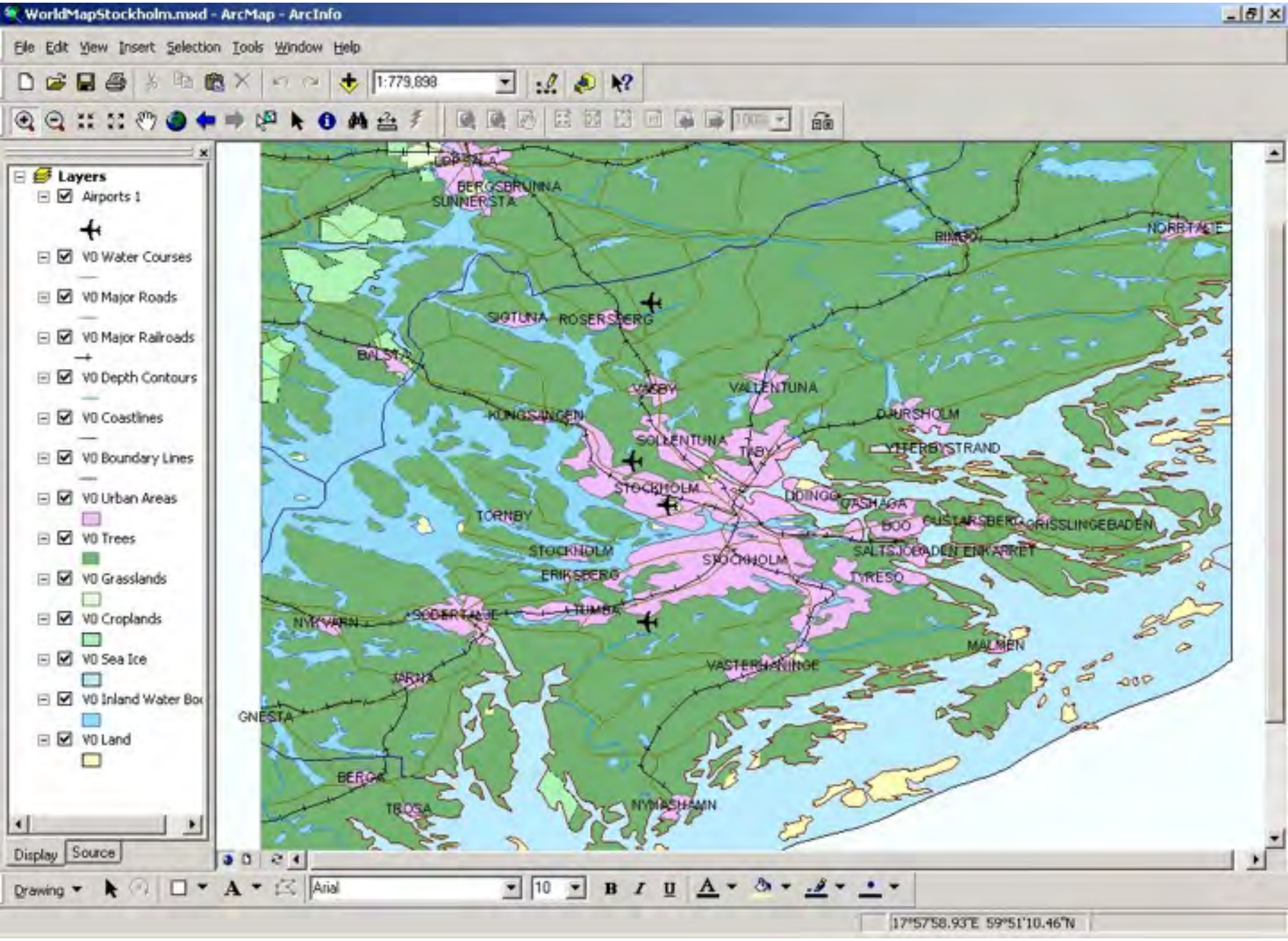
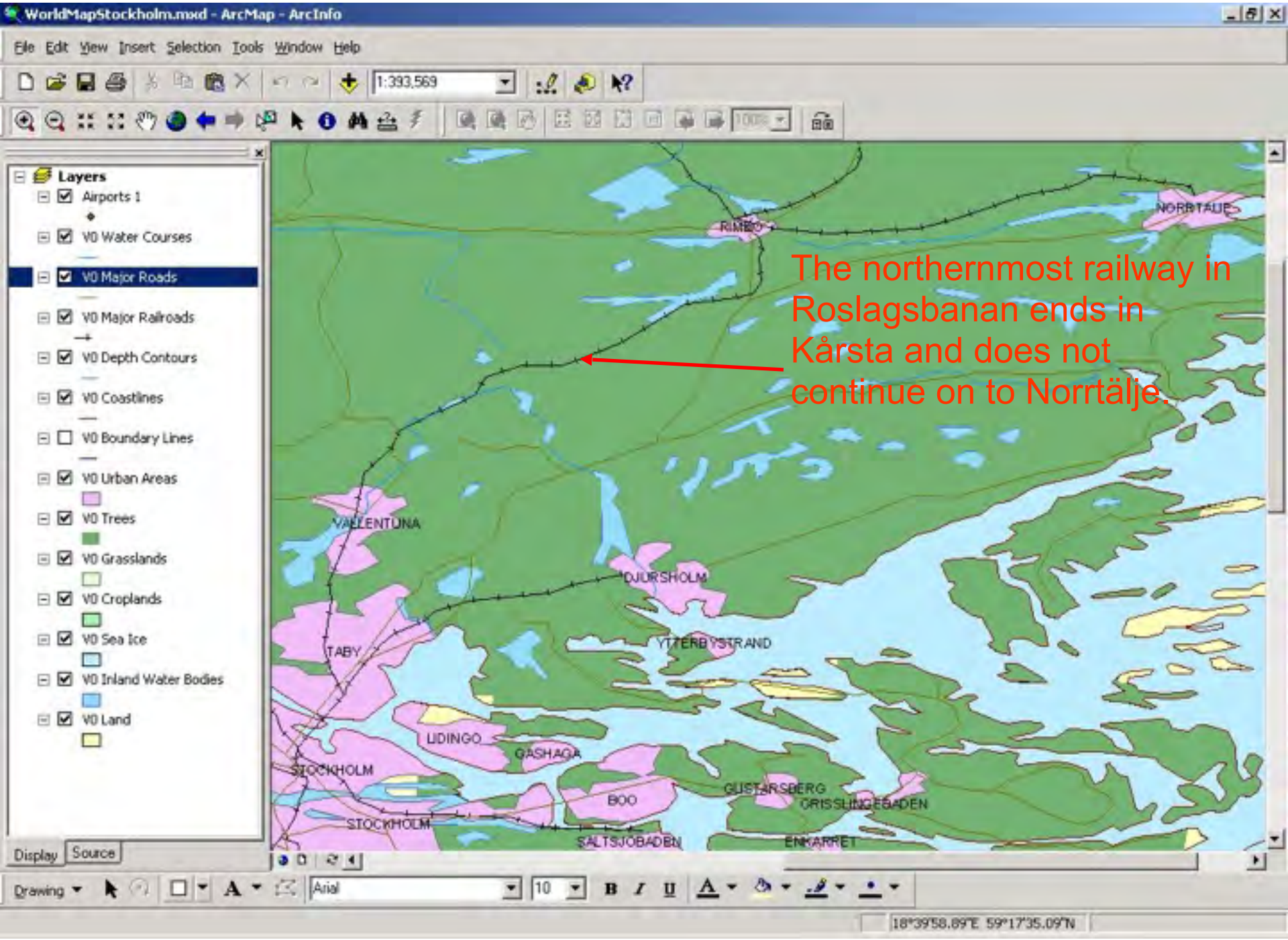
Downloaded dataset of the Stockholm area has information on the following:


WorldMapStockholm.mxd - ArcMap - ArcInfo
File Edit View Insert Selection Tools Window Help
1:779,898
Layers
Airports 1
V0 Water Courses
V0 Major Roads
V0 Major Railroads
V0 Depth Contours
V0 Coastlines
V0 Boundary Lines
V0 Urban Areas
V0 Trees
V0 Grasslands
V0 Croplands
V0 Sea Ice
V0 Inland Water Bo
V0 Land
Display
Source
Drawing
Arial
10
UPPSALA
BERGSBRUNNA
SUNNERSTA
SIGTUNA
ROSERSBERG
BALSTA
VALLENTUNA
DJURSHOLM
YTTERBYSTRAND
SOLLENTUNA
TABY
STOCKHOLM
TORNBY
ERIKSBERG
TYRESO
NYNASHAMN
MALMEN
GNESTA
17°57'58.93"E 59°51'10.46"N

But **how suitable** is the ESRI World Basemap data?

OK for global analysis
(i.e. map of Europe for exercises, where we were only intersted in the countries)

Not OK for local analysis:
- mistakes in networks
- too generalised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1:393,569
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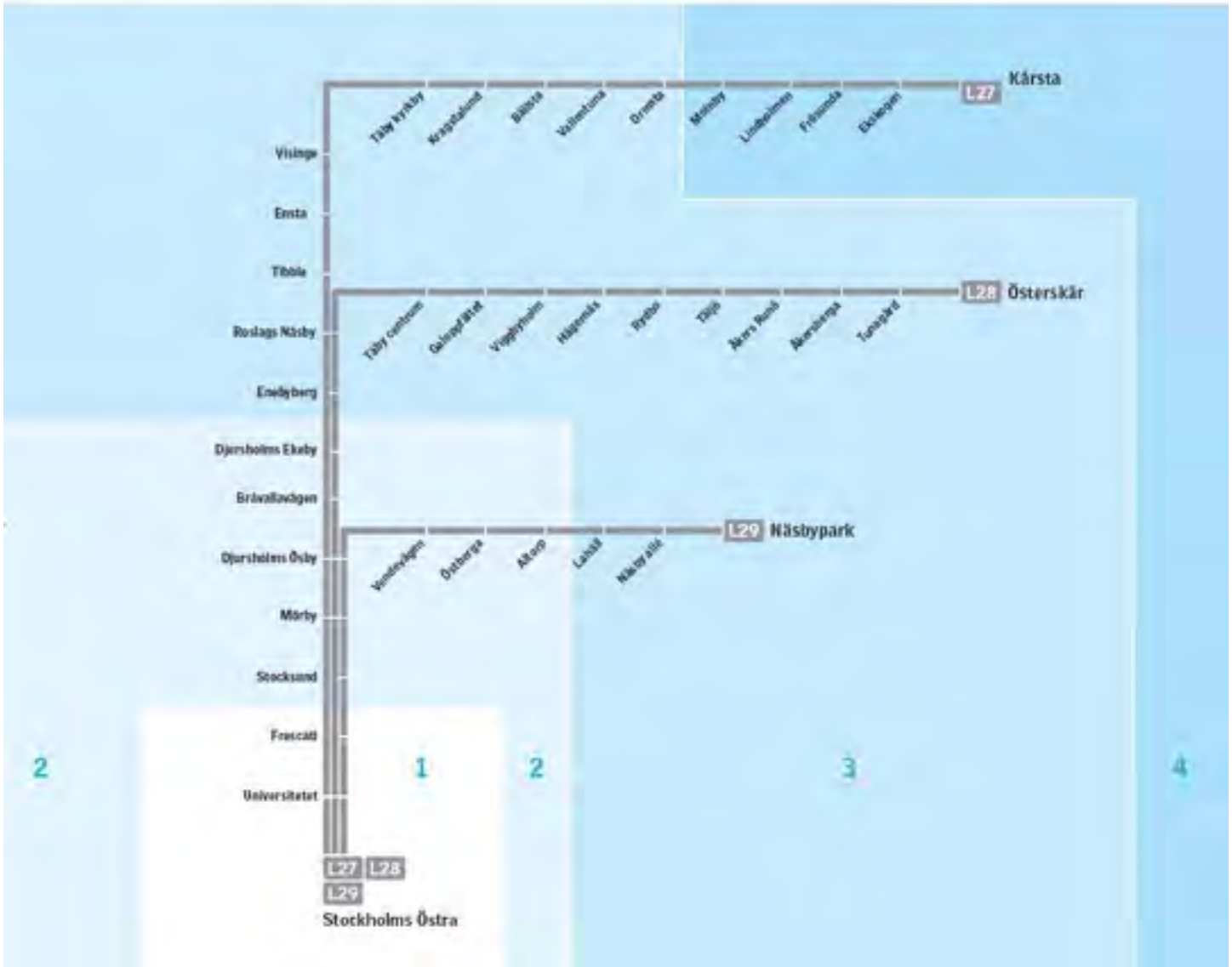
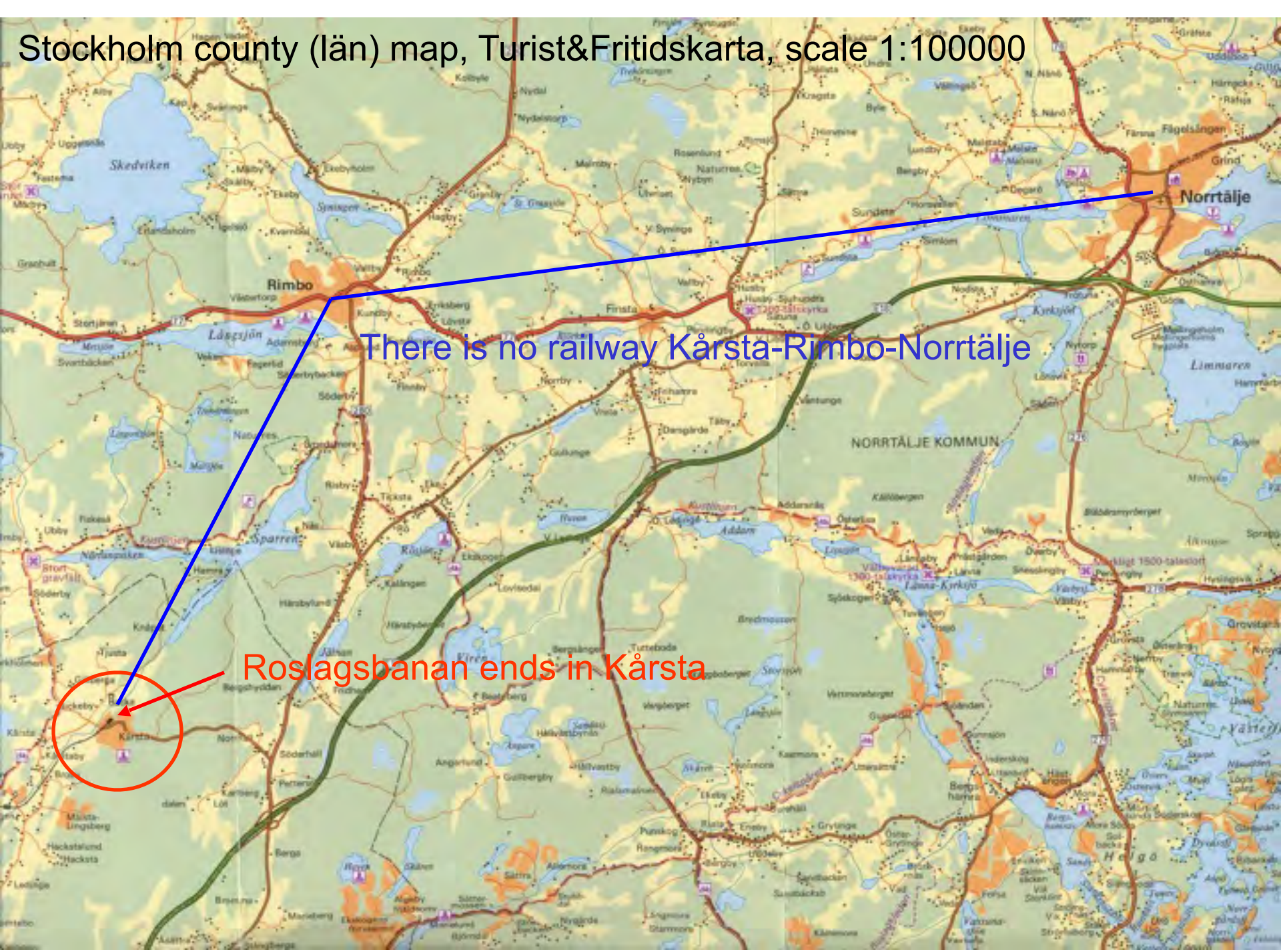
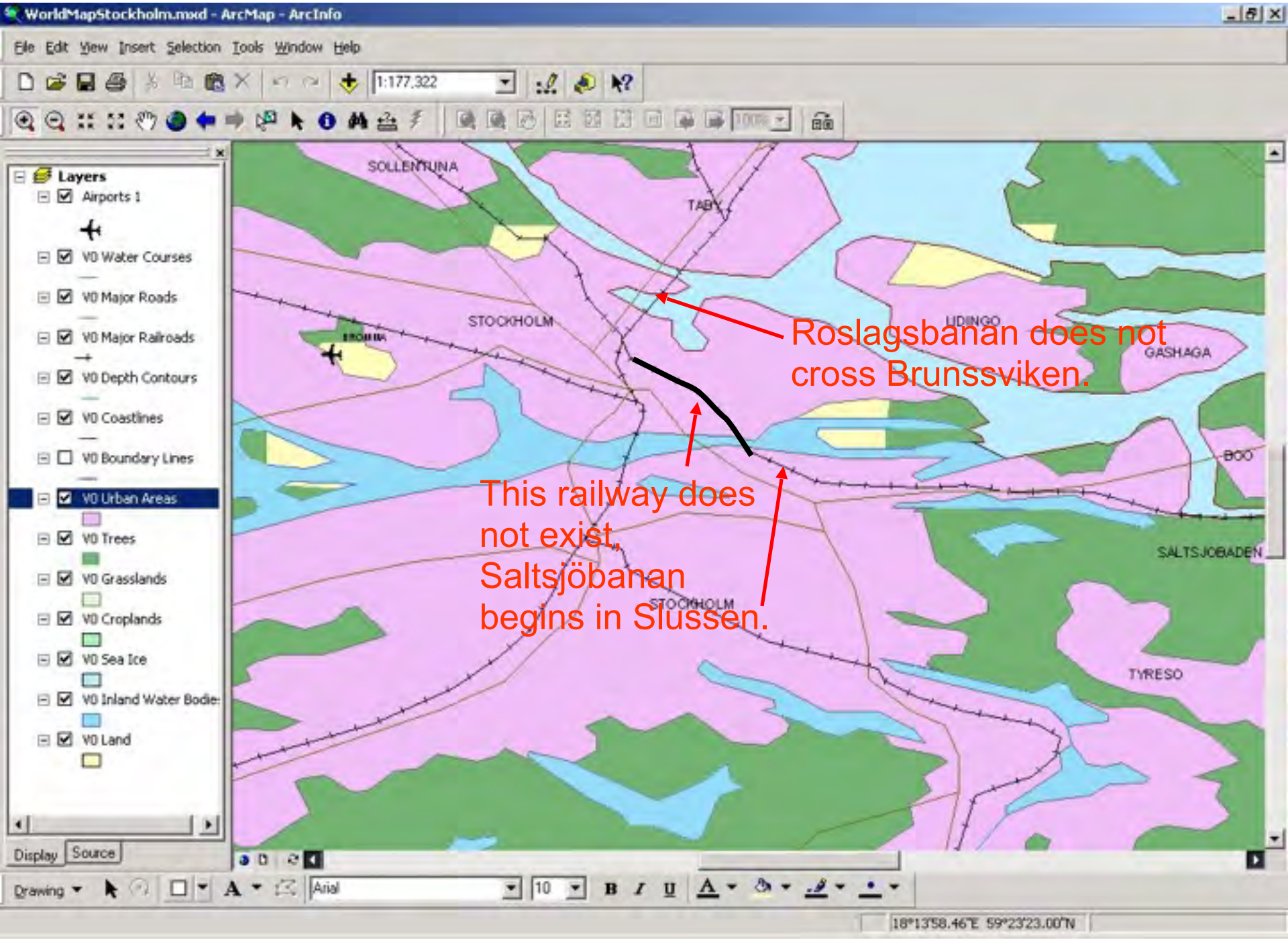
V0 Major Roads
V0 Major Railroads
V0 Depth Contours
V0 Coastlines
V0 Boundary Lines
V0 Urban Areas
V0 Trees
V0 Grasslands
V0 Croplands
V0 Sea Ice
V0 Inland Water Bodies
V0 Land
Display
Source
The northernmost railway in Roslagsbanan ends in Kårsta and does not continue on to Norrtälje.
NORRTÄLJE
VALLENTUNA
DJURSHOLM
YTTERBY STRAND
TÄBY
LIDINGÖ
GÄSHAGA
STOCKHOLM
BOO
GUSTAVSBERG
ORRESLINGEBADEN
SALTSJÖBADEN
ENKARRET
Drawing
Arial
10
18°39'58.89"E 59°17'35.09"N

Roslagsbanan

Giltighetstid
Från 23 augusti 2004 till juni 2005
med reservation för eventuella
trafikförändringar




Stockholm county (län) map, Turist&Fritidskarta, scale 1:100000
Norrtälje
Rimbo
There is no railway Kårsta-Rimbo-Norrtälje
NORRTÄLJE KOMMUN
Roslagsbanan ends in Kårsta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VD Urban Areas
VD Trees
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VD Croplands
VD Sea Ice
VD Inland Water Bodie
VD Land
Display
Source
SOLLENTUNA
TABY
STOCKHOLM
UDINGO
GASHAGA
BOO
SALTSJOBADEN
TYRESO
Roslagsbanan does not cross Brunssviken.
This railway does not exist, Saltsjöbanan begins in Slussen.
Drawing
Arial
10
18°13'58.46"E 59°23'23.00"N

Stockholm Blå kartan, scale 1:100000

Conclusion:

be careful when using web data sources

Select data approprate for your task (global or local analysis).
Always check data for possible inaccuracies and inconsistencies.