

# L6:Maps as decision tools

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

## Why maps?

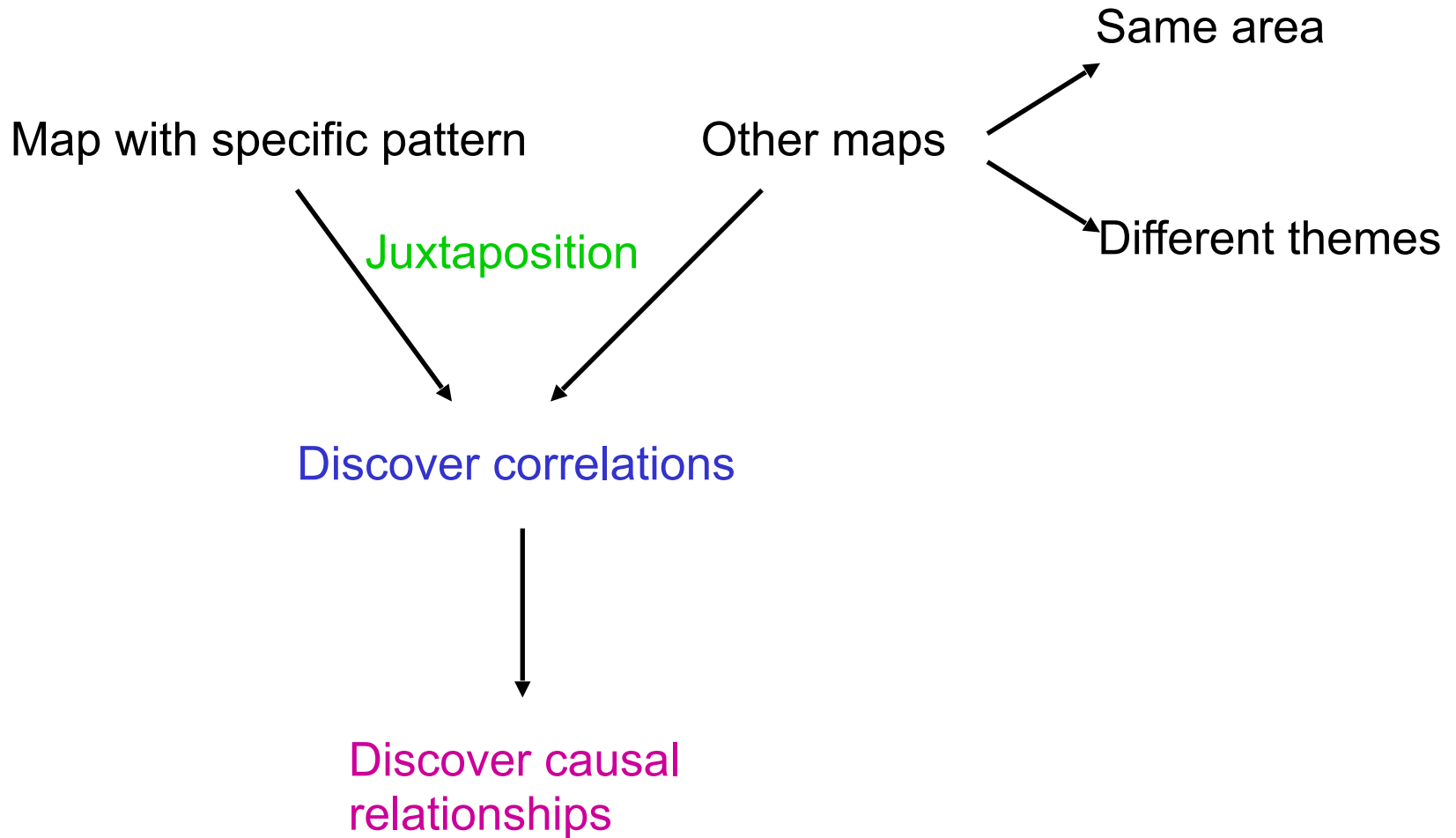
Role of maps in analysis and communication of geospatial information:

- 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

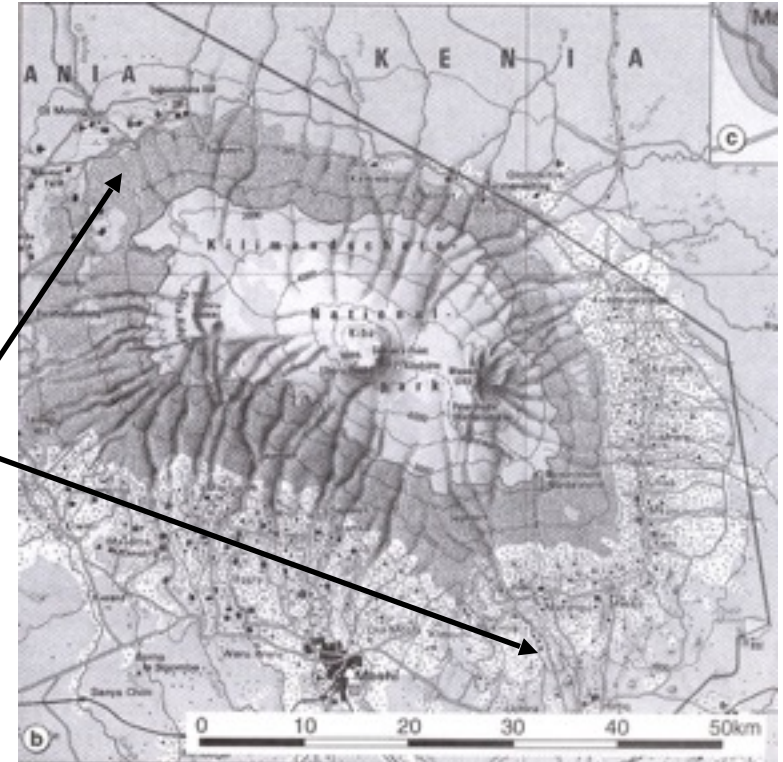
## Explaining patterns, comparison and analysis



## Relief map of Kilimanjaro



## Land use map of the same area



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

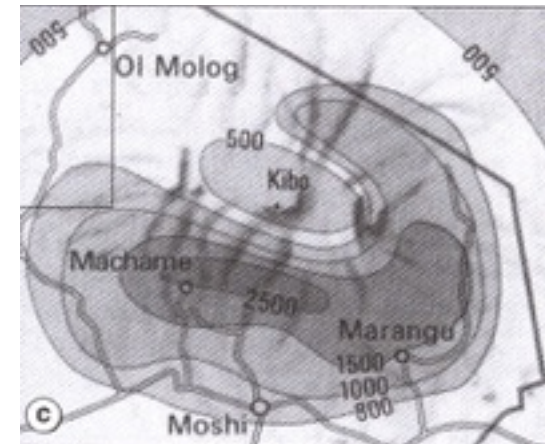
Why?

### 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



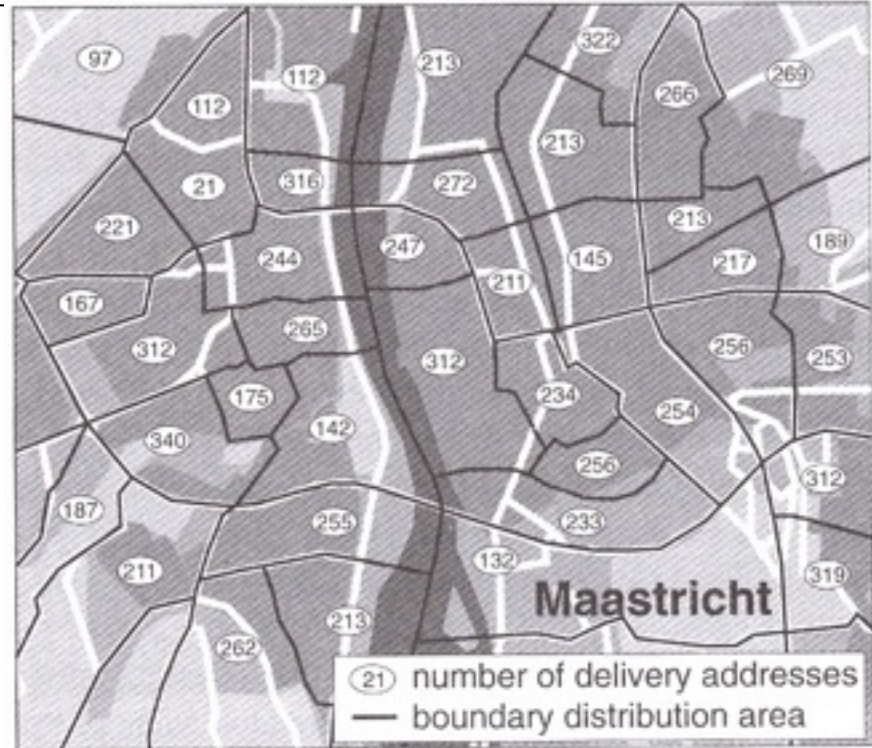
Juxtaposition of maps helps to discover the factors that explain the differences.



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.



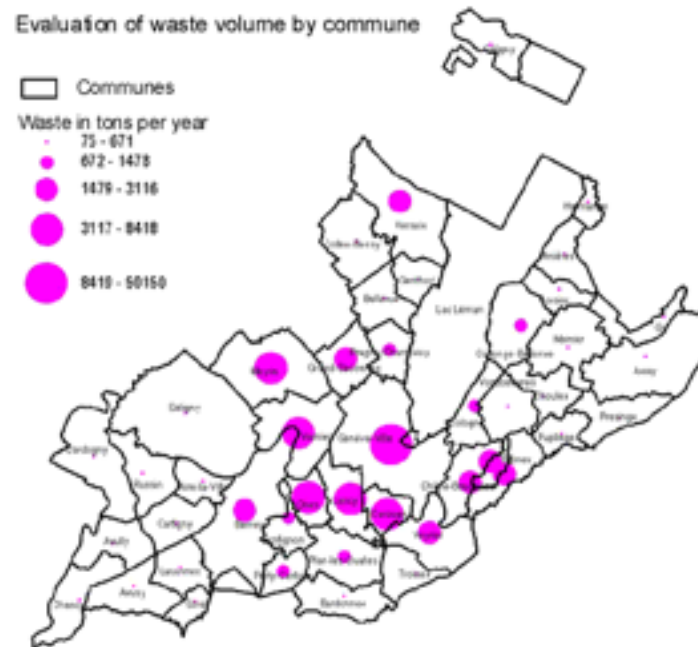
Decision

Newspaper's marketing department could arrange campaigns for larger sales based on the map of these areas:

- advertisement 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

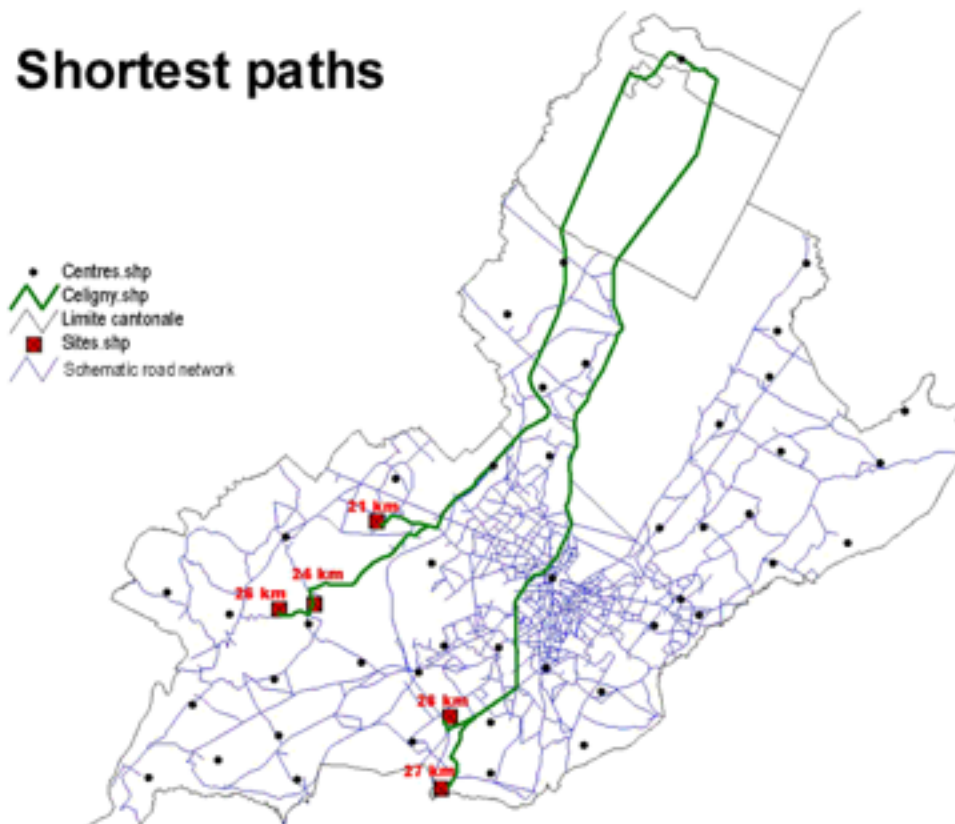


### Criteria

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

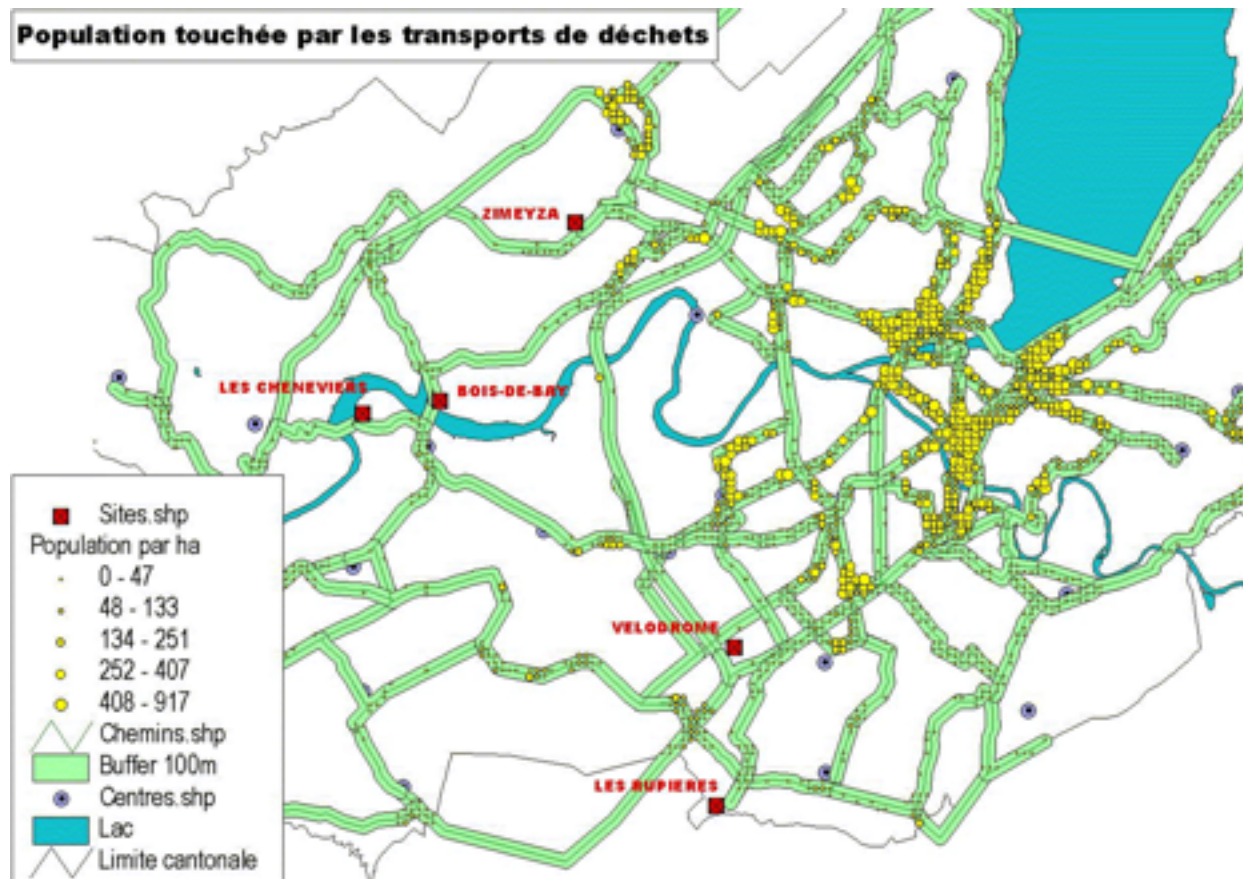
# Example: location of obnoxious facilities

## 3. Finding the shortest path



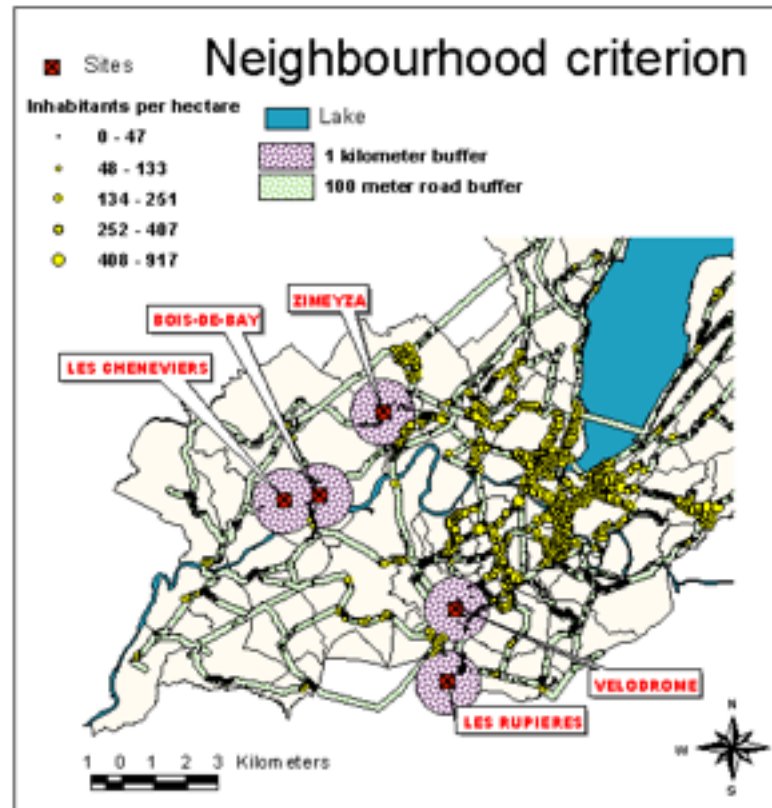
# Example: location of obnoxious facilities

## 4. Neighbourhoods affected, a) along routes



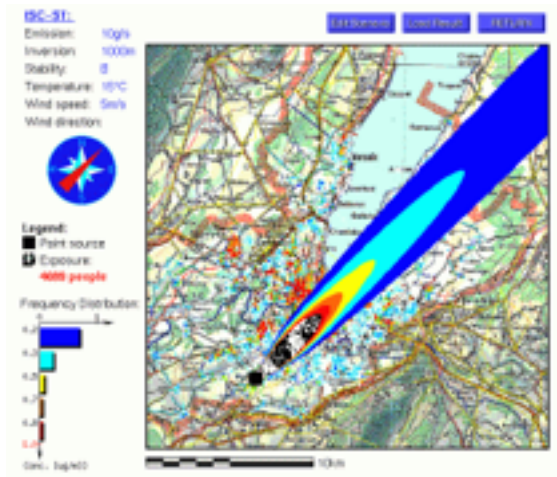
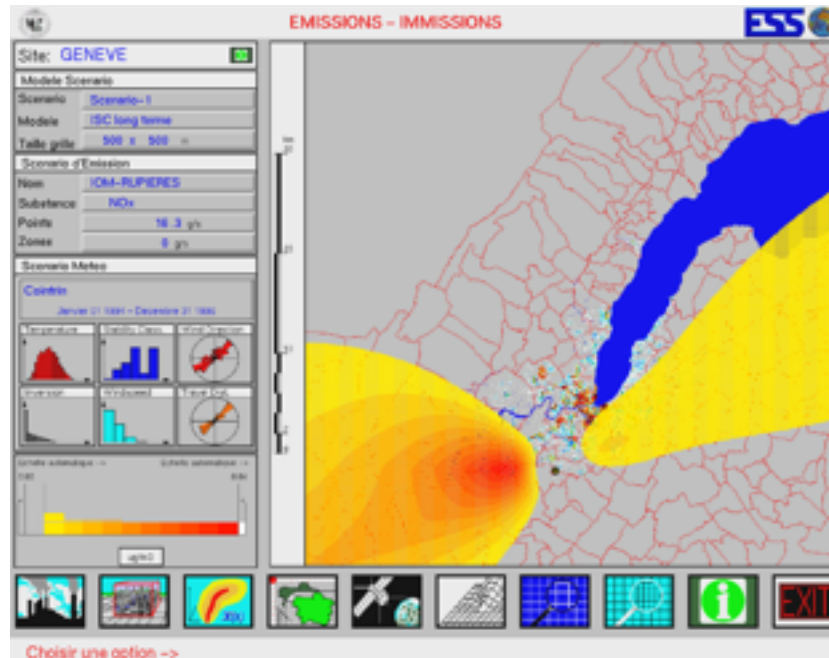
# Example: location of obnoxious facilities

## 4. Neighbourhoods affected, b) at sites



# Example: location of obnoxious facilities

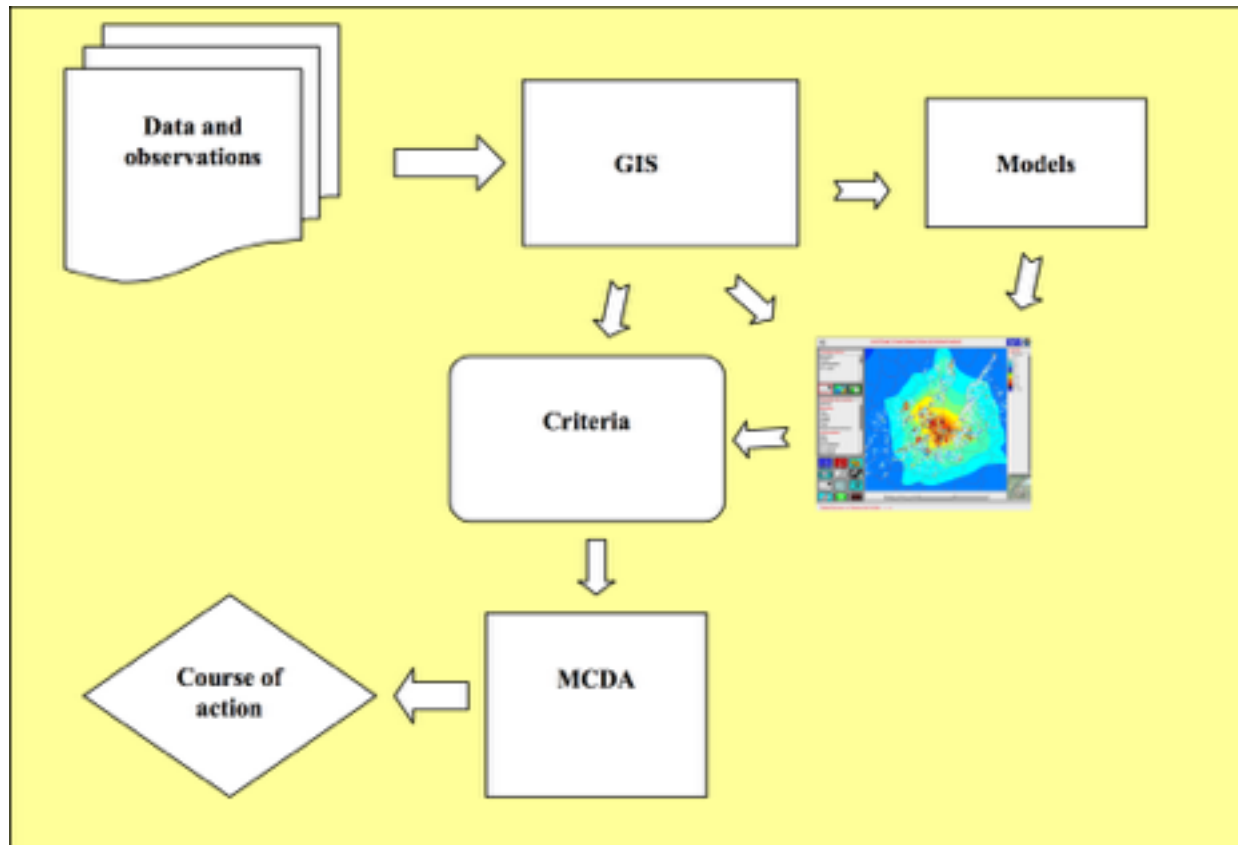
## 5. Regions affected by smoke plume



1. Emission or source characteristics
2. The nature of the pollutant material
3. Meteorological characteristics
4. The 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 pairwise weighting of all factors and Principal 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).

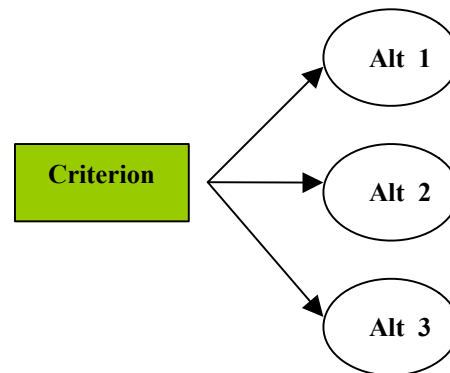
# Example: location of obnoxious facilities

## 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>.

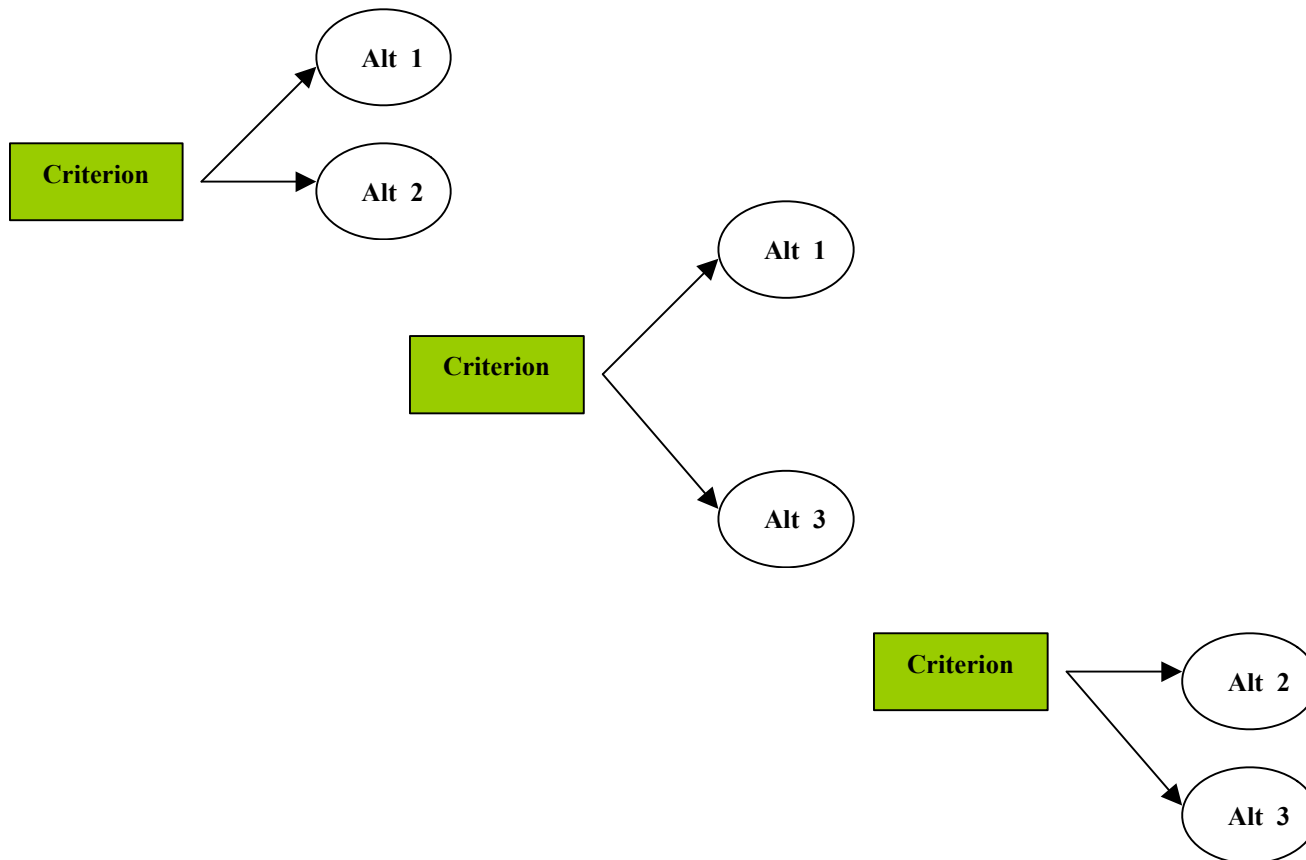
In Europe, other multi-criterion decision analysis tools have been successful, like Electre.





# Example: location of obnoxious facilities

## The Analytic Hierarchy Process



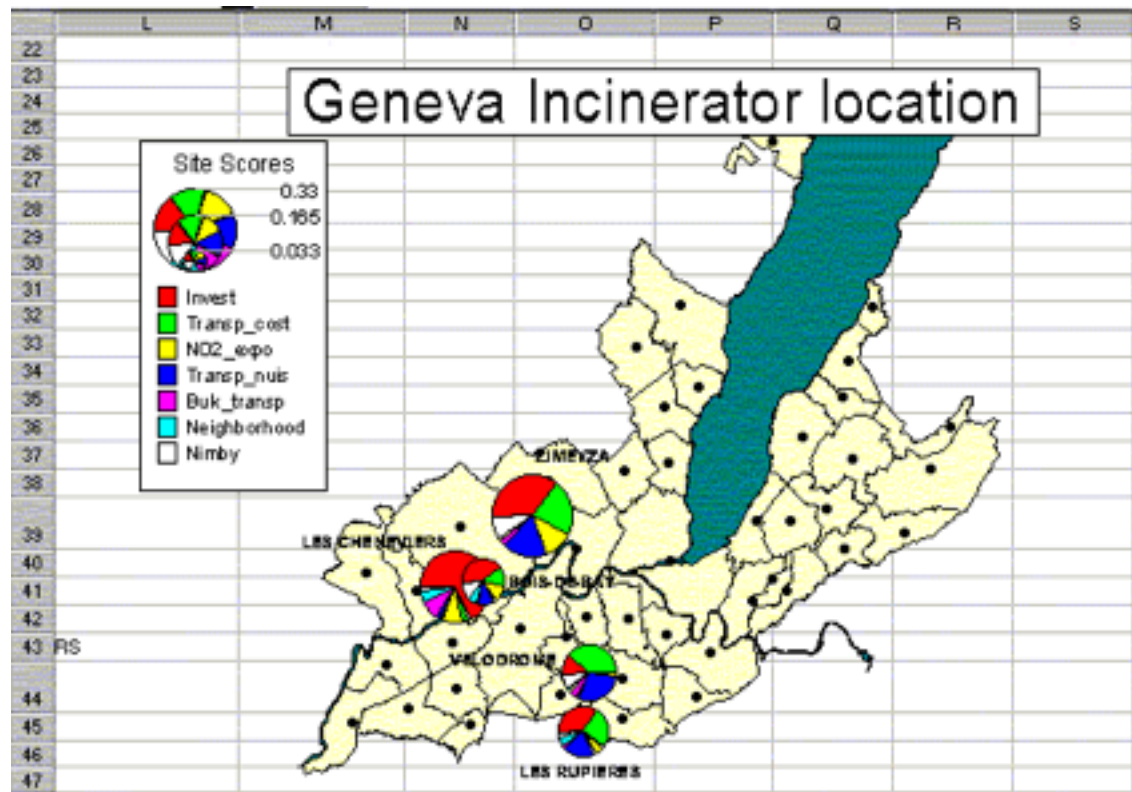
# Example: location of obnoxious facilities

## The Analytic Hierarchy Process

<b>Criterion X</b>	<b>Alternative 1</b>	<b>Alternative 2</b>	<b>Alternative 3</b>
<b>Alternative 1</b>	1	1/3	2
<b>Alternative 2</b>	3	1	6
<b>Alternative 3</b>	1/2	1/6	1

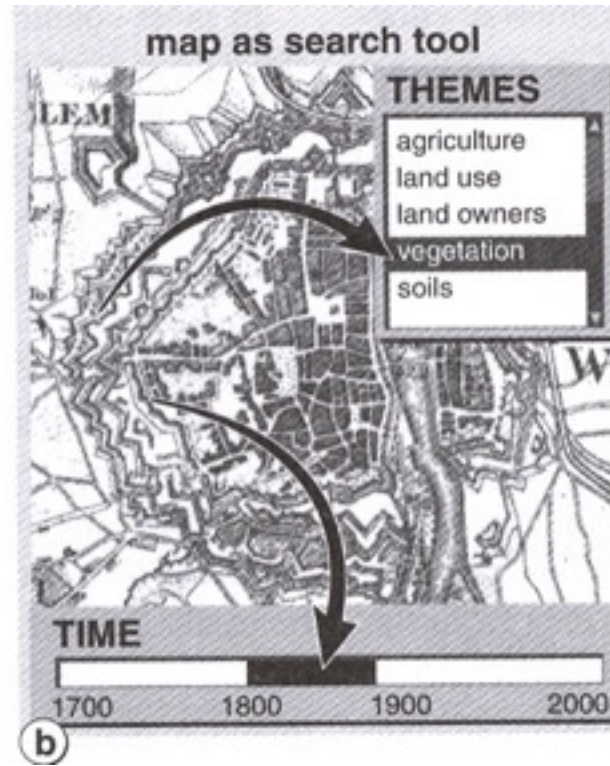
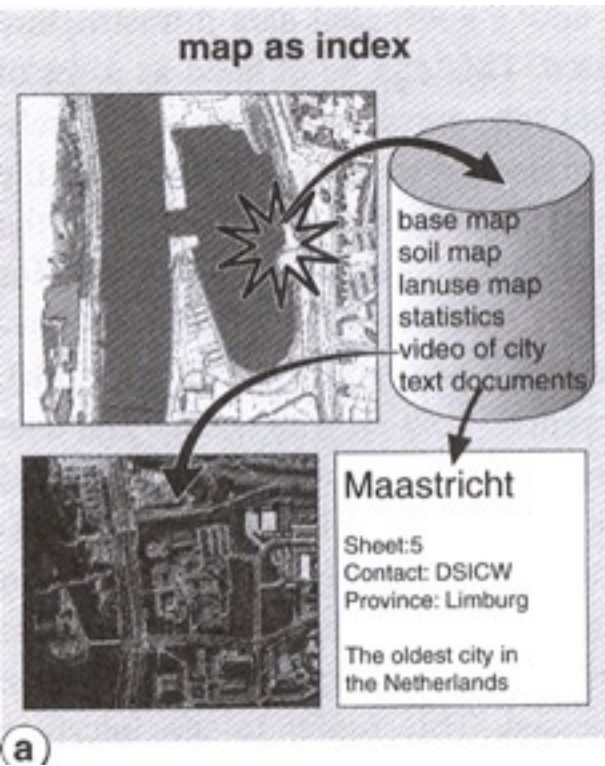
# Example: location of obnoxious facilities

## 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 transferred 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

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

Data Downloader / Preview Area - Netscape

File Edit View Go Bookmarks Tools Window Help

http://arcdata.esri.com/data\_downloader/DataDownloader Search

Mail Home Radio My Netscape Search Bookmarks

Store | Contact Us | Careers

**ESRI** GIS and Mapping Software

Search Google™

Home Products Services Industries User Showcase Training & Events Support About ESRI

**ArcData**

### Data Downloader

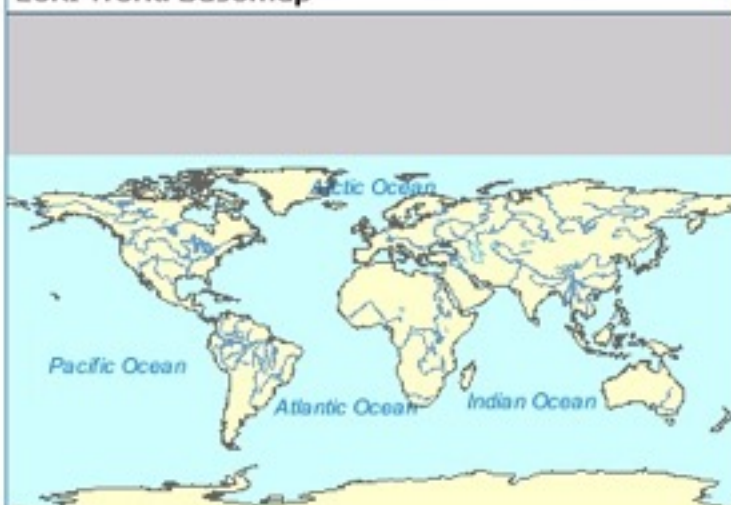
1. **Preview Area** 2. Select Data 3. Review Selection Help

Preview the area you are interested in by:

- Searching by place  
 **GO**  
(e.g., Boston)
- Using the zoom and pan tools

Next >

**ESRI World Basemap**



© 2004 ESRI 0 2000mi 0 3200km

Document: Done (2.422 secs)

File Edit View Go Bookmarks Tools Window Help

http://arcdata.esri.com/data\_downloader/DataDownloader

Search

Mail Home Radio My Netscape Search Bookmarks

Store | Contact Us | Careers

**ESRI** GIS and Mapping Software

Search Google™

Home Products Services Industries User Showcase Training & Events Support About ESRI

### ArcData

## Data Downloader

1. **Preview Area** 2. Select Data 3. Review Selection Help

Preview the area you are interested in by:

- Searching by place
  **GO**  
 (e.g., Boston)
- Using the zoom and pan tools

Next >

ESRI World Basemap

© 2004 ESRI

Document: Done (0.188 secs)



Data Downloader / Select Data - Netscape

File Edit View Go Bookmarks Tools Window Help

http://arcdata.esri.com/data\_downloader/DataDownloader Search

Mail Home Radio My Netscape Search Bookmarks

Store | Contact Us | Careers

**ESRI** GIS and Mapping Software Search Google™

Home Products Services Industries User Showcase Training & Events Support About ESRI

ArcData

### Data Downloader

1. Preview Area 2. Select Data 3. Review Selection Help

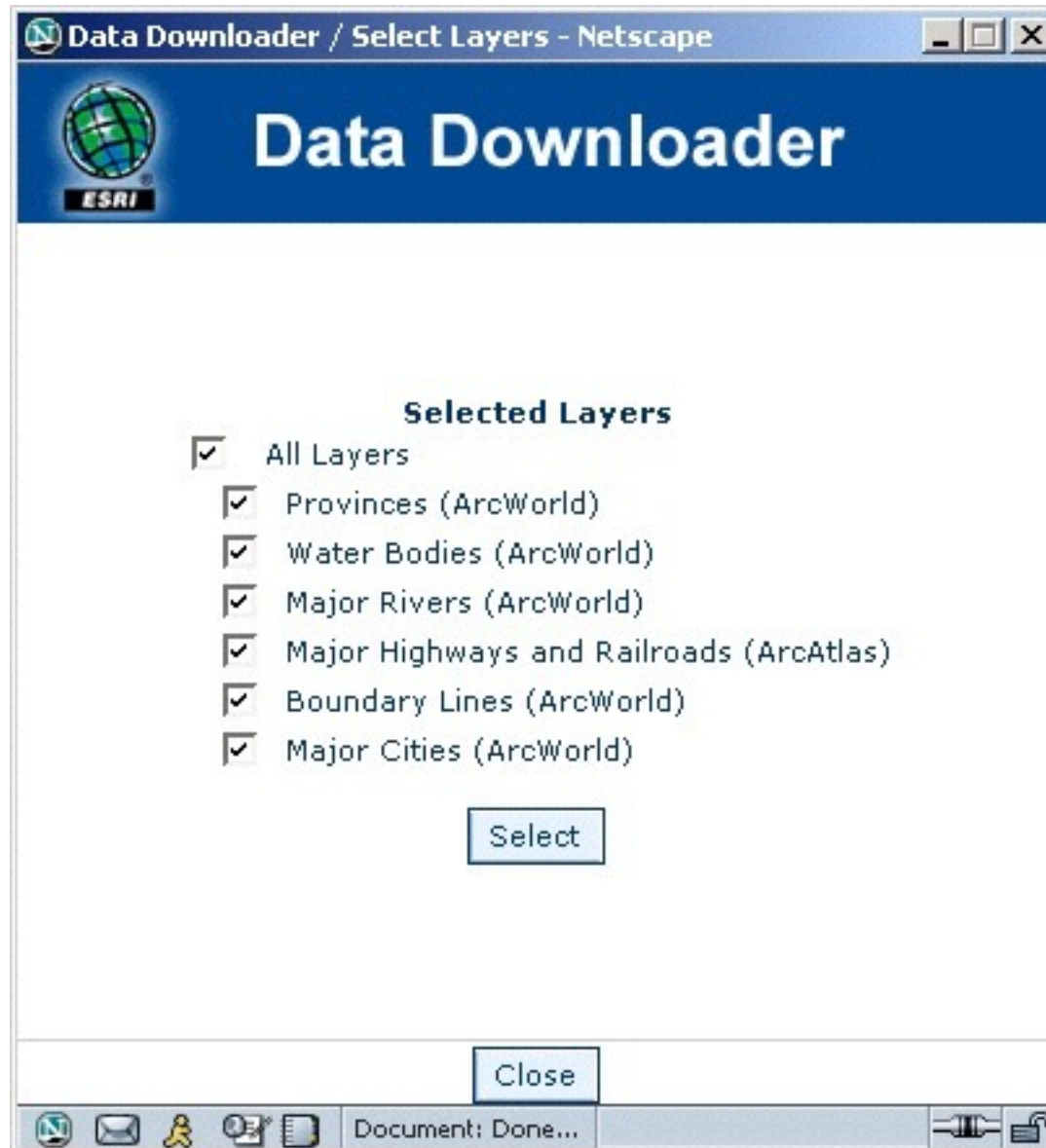
**Selected Area**  
select area size

Large  
 Medium  
 Small

< Back Next >

© 2004 ESRI


Document: Done (3.921 secs)



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](#)

[Close](#)

ESRI Web Sites


Document: Done (1.078 secs)

Downloaded dataset of the Stockholm area has information on the following:



# Data Downloader

### Map Legend

<ul style="list-style-type: none"> <li> Airports</li> <li> Coastlines</li> <li> Boundary Lines</li> <li> International Boundary</li> <li> Primary/1st Order</li> <li> Reefs</li> <li> Bridges</li> <li> Water Courses</li> <li> Major Roads</li> <li> Primary Route</li> <li> Secondary Route</li> <li> Unspecified Route</li> <li> Major Railroads</li> <li> Trails</li> <li> Depth Contours</li> <li> Inland Water Bodies</li> <li> Swamps</li> <li> Orchards</li> <li> Croplands</li> <li> Grasslands</li> <li> Trees</li> <li> Urban Areas</li> <li> Sea Ice</li> </ul>	<ul style="list-style-type: none"> <li> Land Ice</li> <li> Tundra</li> <li> Land</li> <li> Oceans and Seas Names</li> <li> Oceans and Seas</li> </ul>
---	--

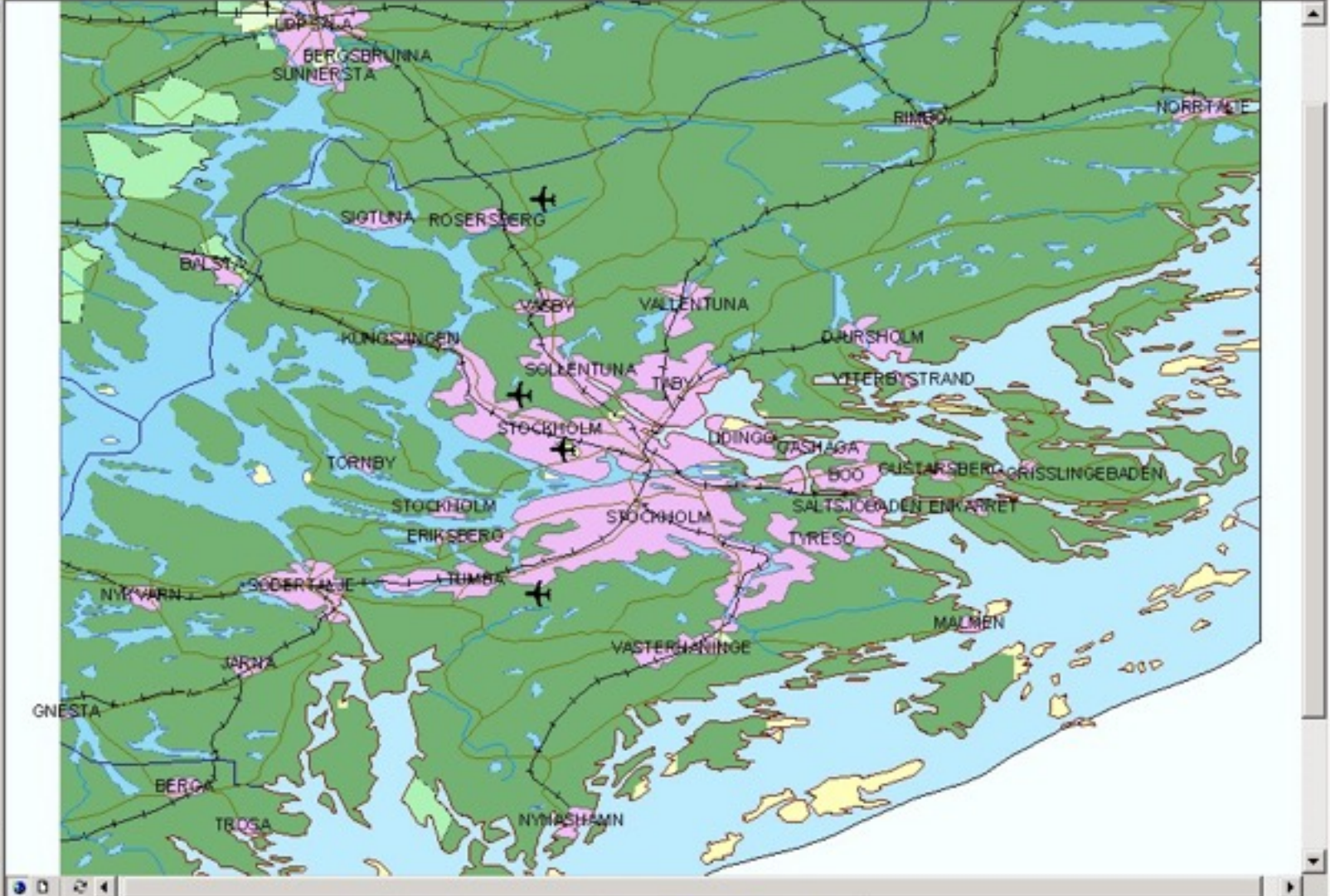
1:779,898

100%

**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 Box
- V0 Land

Display Source



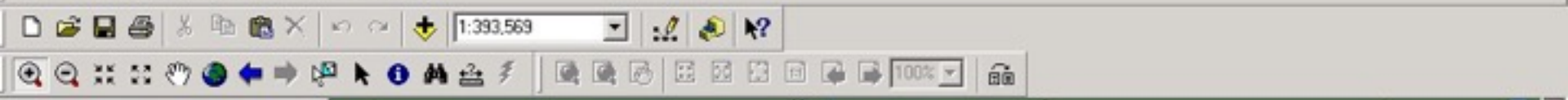
But **how suitable** is the ESRI World Basemap data?

OK for global analysis

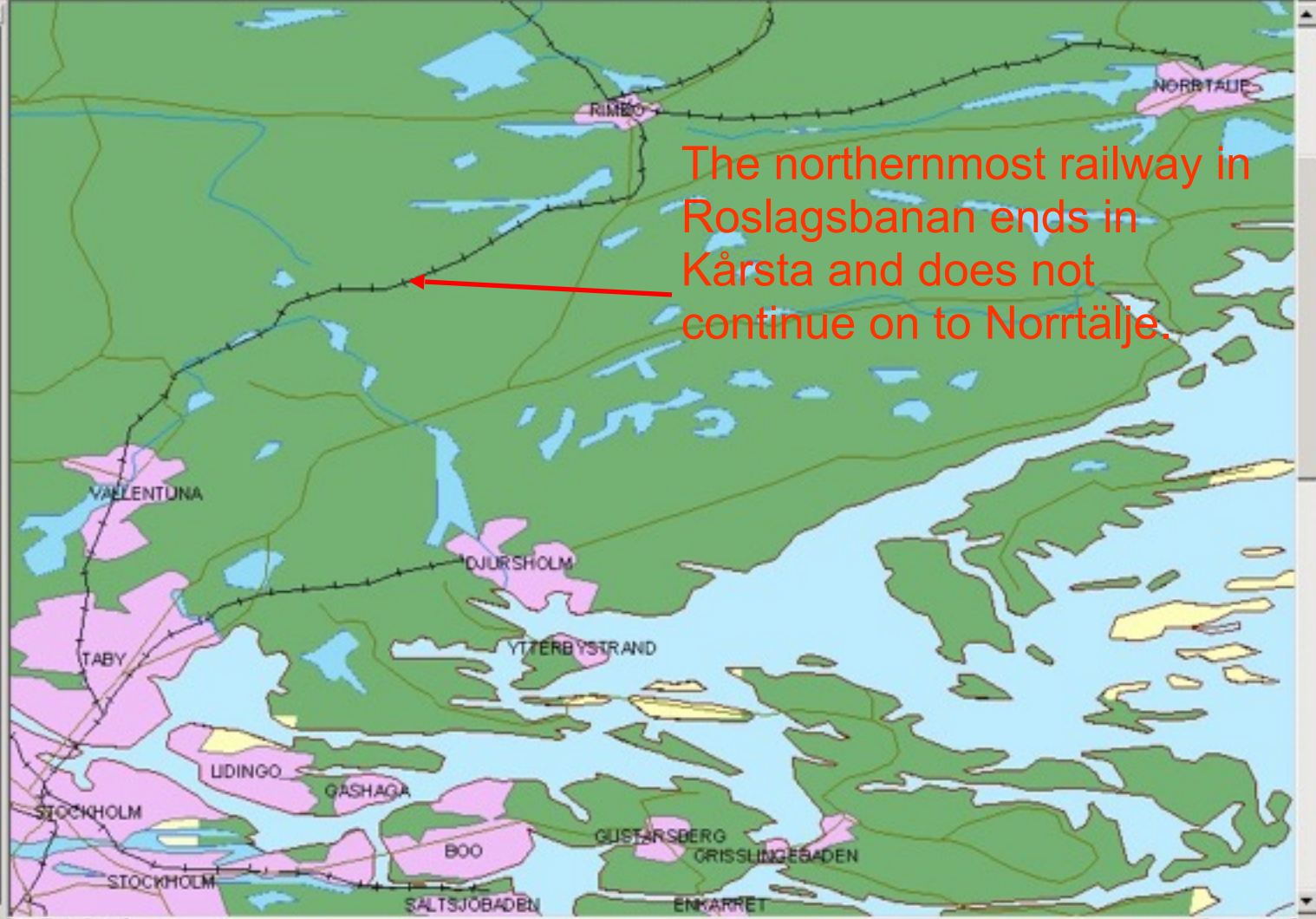
(i.e. map of Europe for exercises, where we were only interested in the countries)

Not OK for local analysis:

- mistakes in networks
- too generalised



- 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 Bodies
- V0 Land

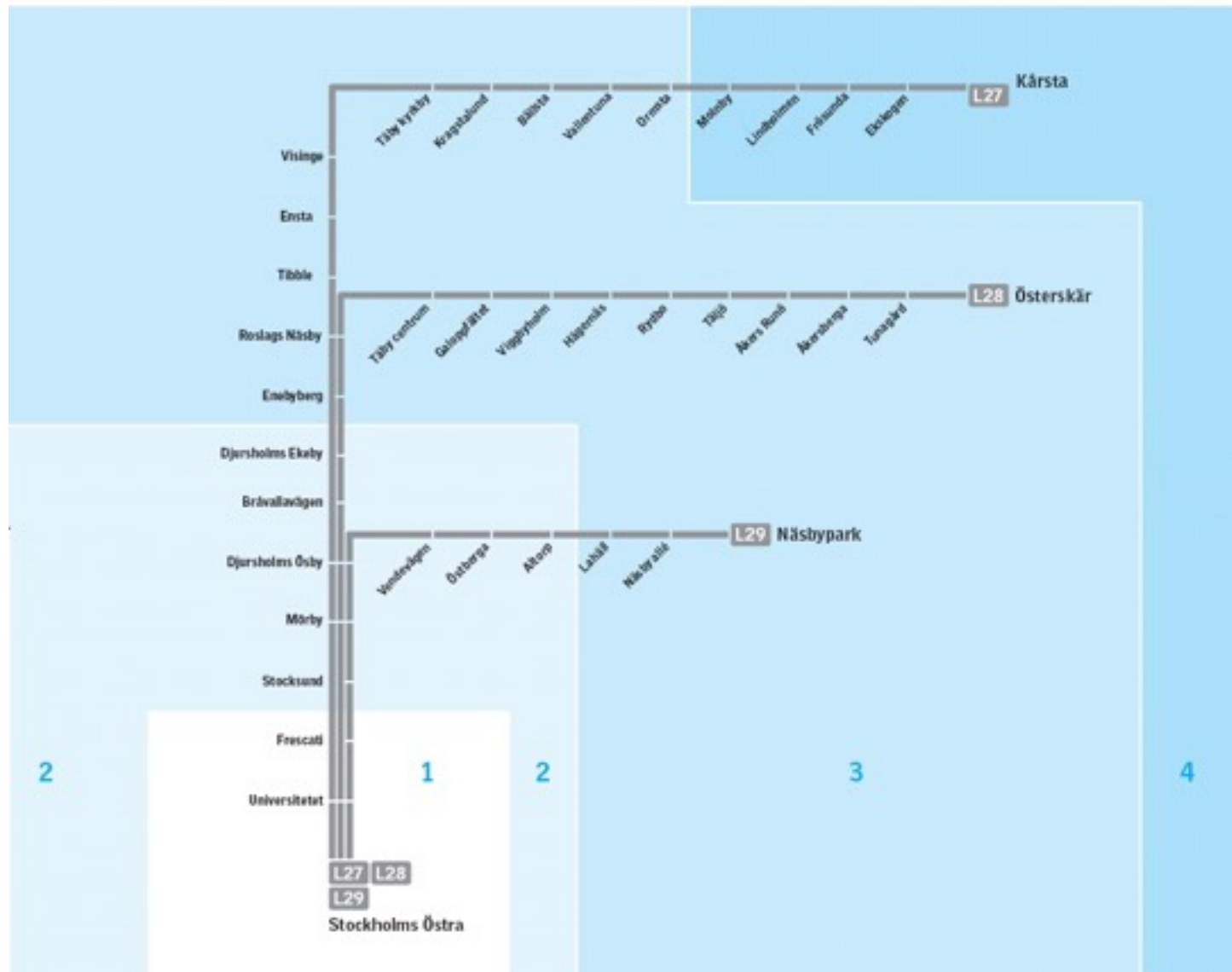


The northernmost railway in Roslagsbanan ends in Kårsta and does not continue on to Norrtälje.

# Roslagsbanan

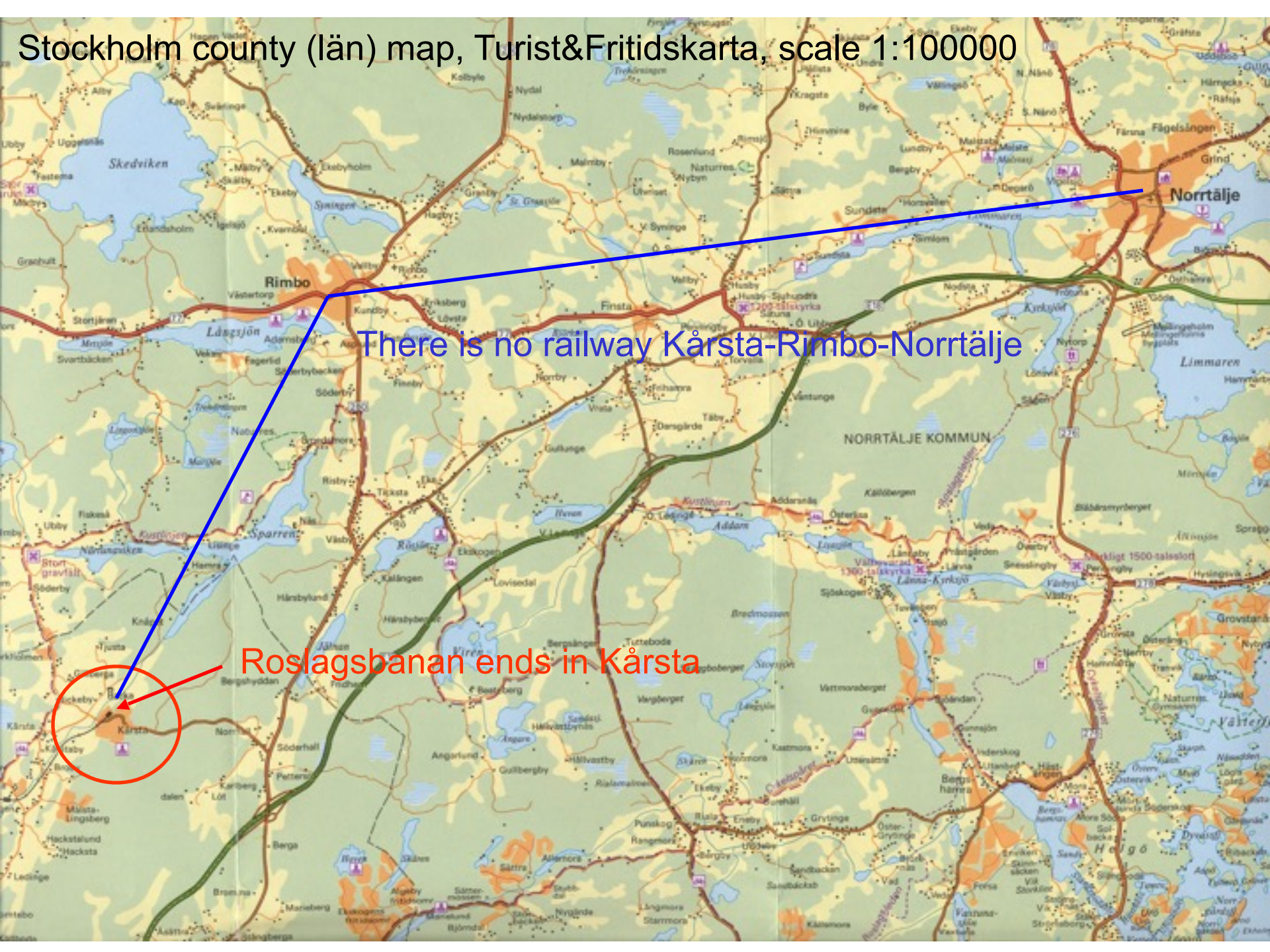
## Giltighetstid

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





# Stockholm county (län) map, Turist&Fritidskarta, scale 1:100000

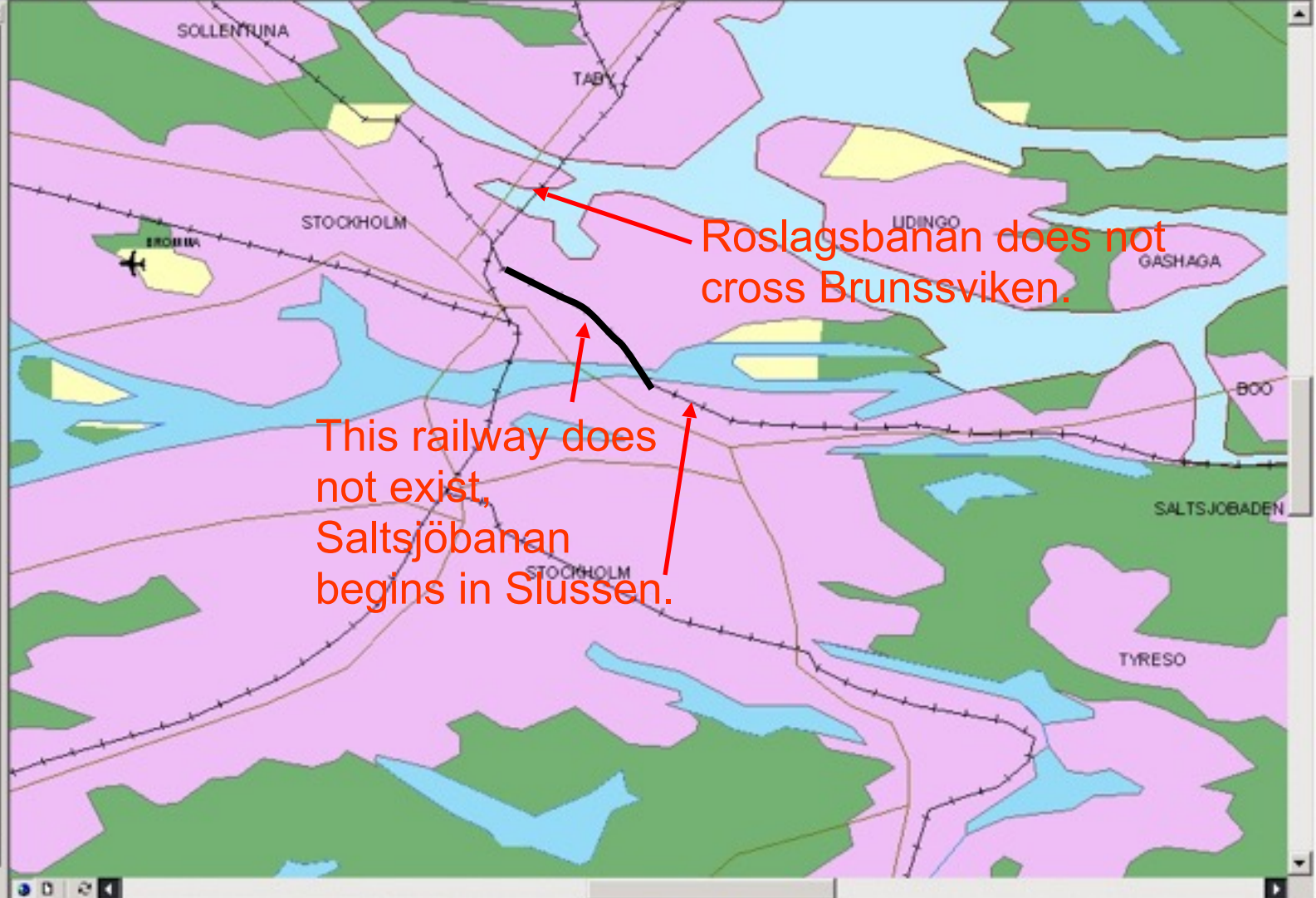


There is no railway Kårsta-Rimbo-Norrtälje

Roslagsbanan ends in Kårsta

**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 Bodies
- V0 Land



Roslagsbanan does not cross Brunssviken.

This railway does not exist, Saltsjöbanan begins in Slussen.



Roslagsbanan

Saltsjöbanan

Stockholm Blå kartan, scale 1:100000

## Conclusion:

be careful when using web data sources



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