Optical and Laser Remote Sensing
Faculty of Aerospace Engineering
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An Introduction to GIS

(Course TA2060: Data Analysis and Geostatistics)

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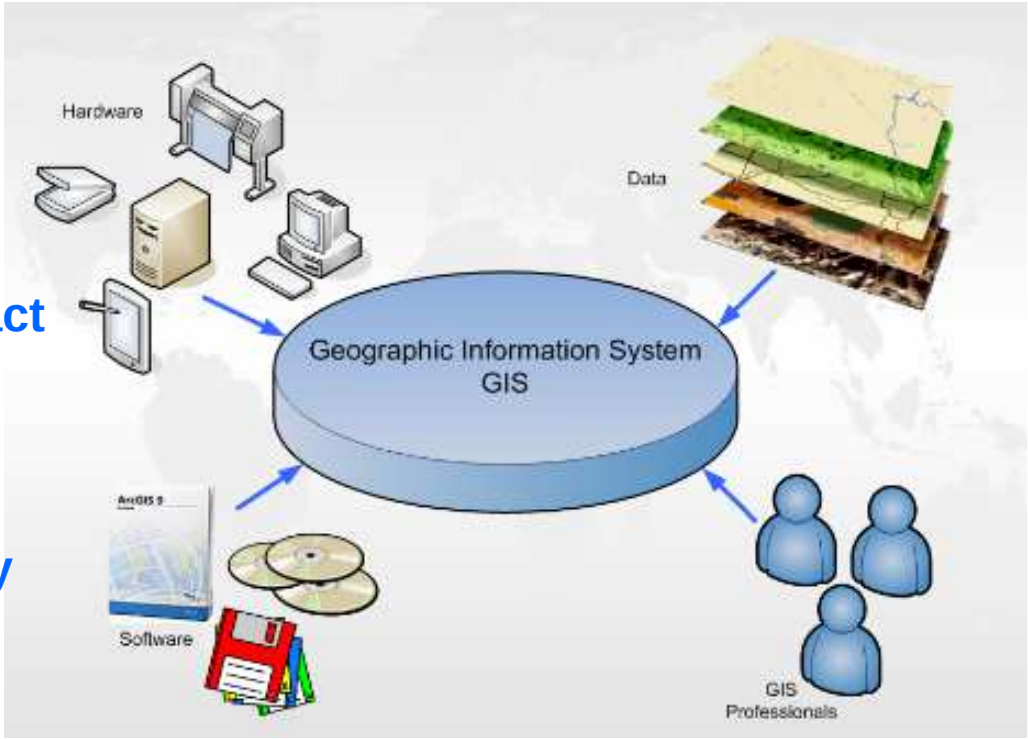
What is GIS?

- **What does GIS stand for?**

Geographic/Geospatial Information System (GIS)

- **GIS is an information system.**
- **A system: a group of connected entities and activities which interact for a common purpose.**
- **The common purpose in GIS is decision making for managing any spatially distributed activity.**

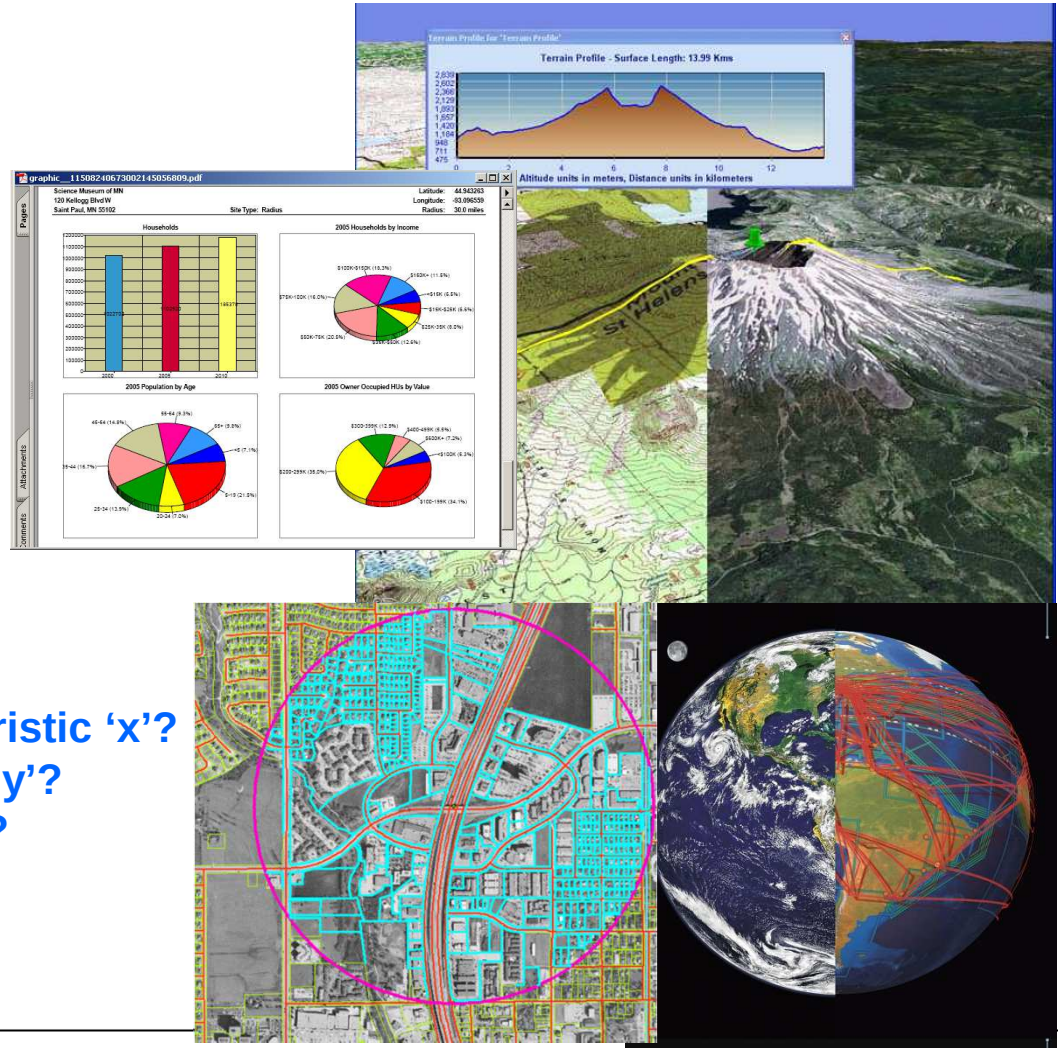


What is GIS?

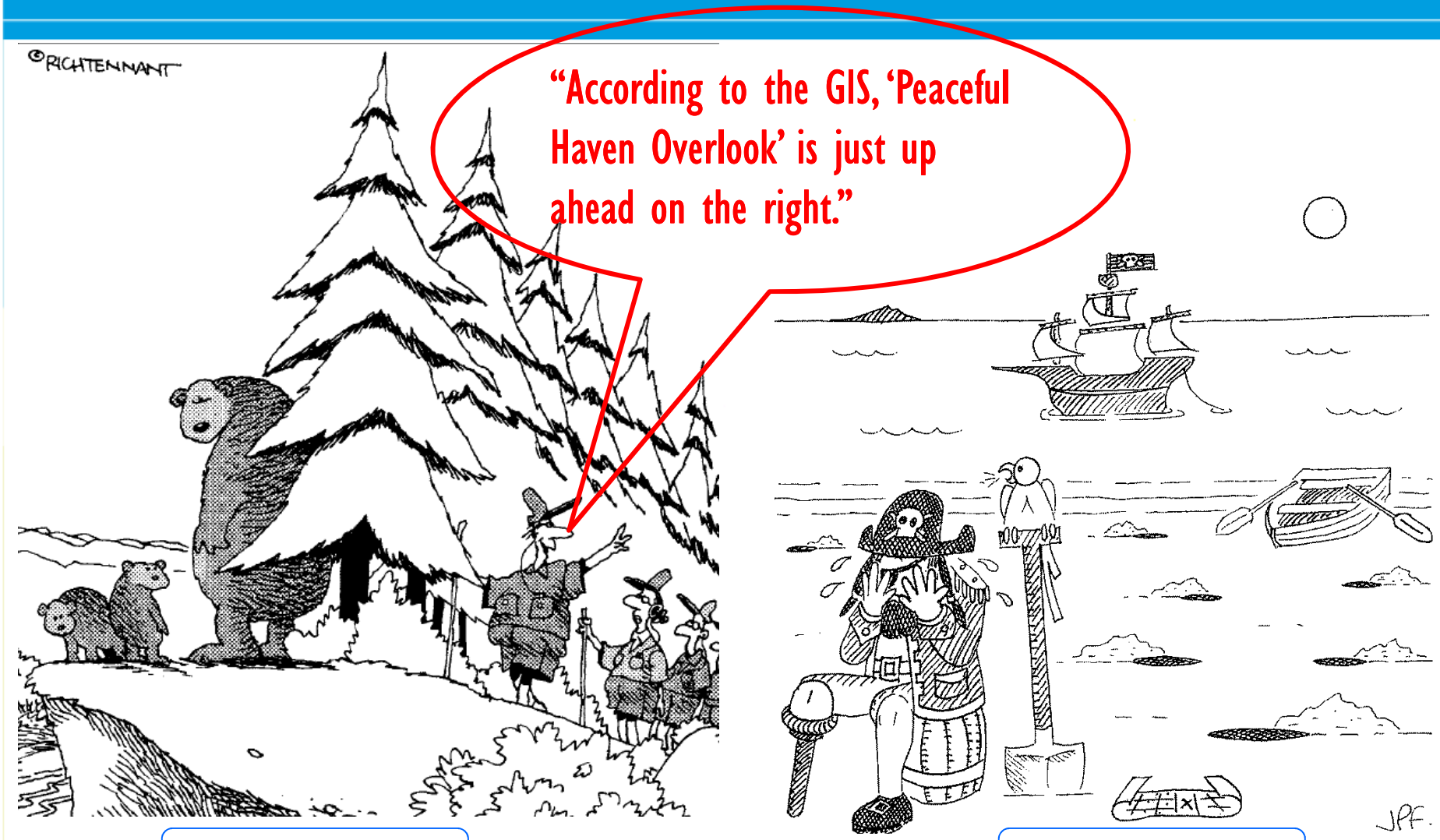
- **What does GIS for us?**
  Managing information about places.

- **How?**
  Linking maps and databases.

- **For what?**
  To answer questions such as:
  Where is it?
  What is its properties?
  What else is nearby?
  Where can I find objects with characteristic ‘x’?
  Where is the highest concentration of ‘y’?
  Where is the closest ‘z’ to my location?
  …



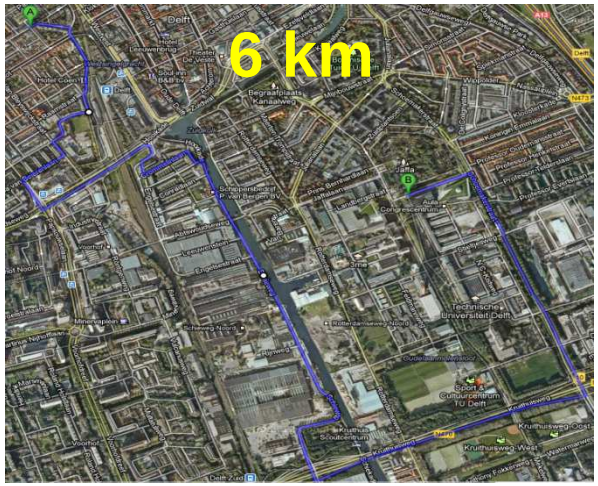
Who needs GIS?

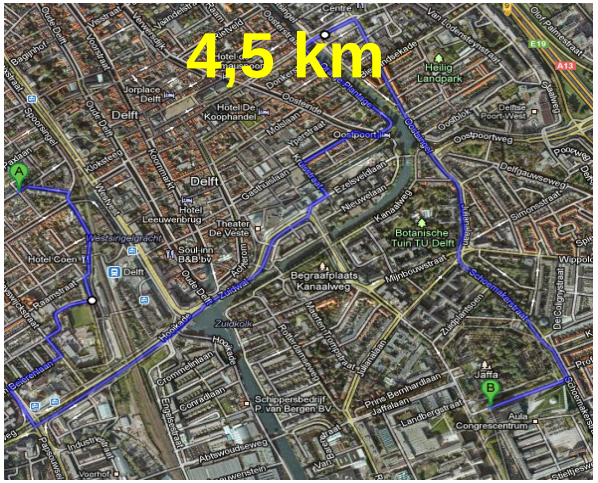


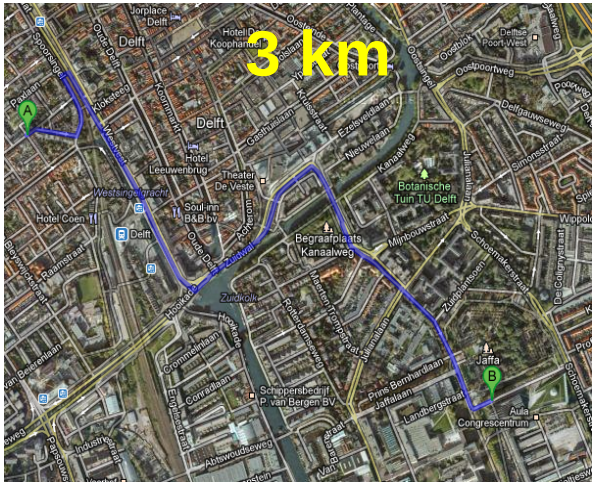
After GIS

Before GIS

A simple example?







How to reach from Point A to point B?

Using GIS network analysis

Who needs GIS?

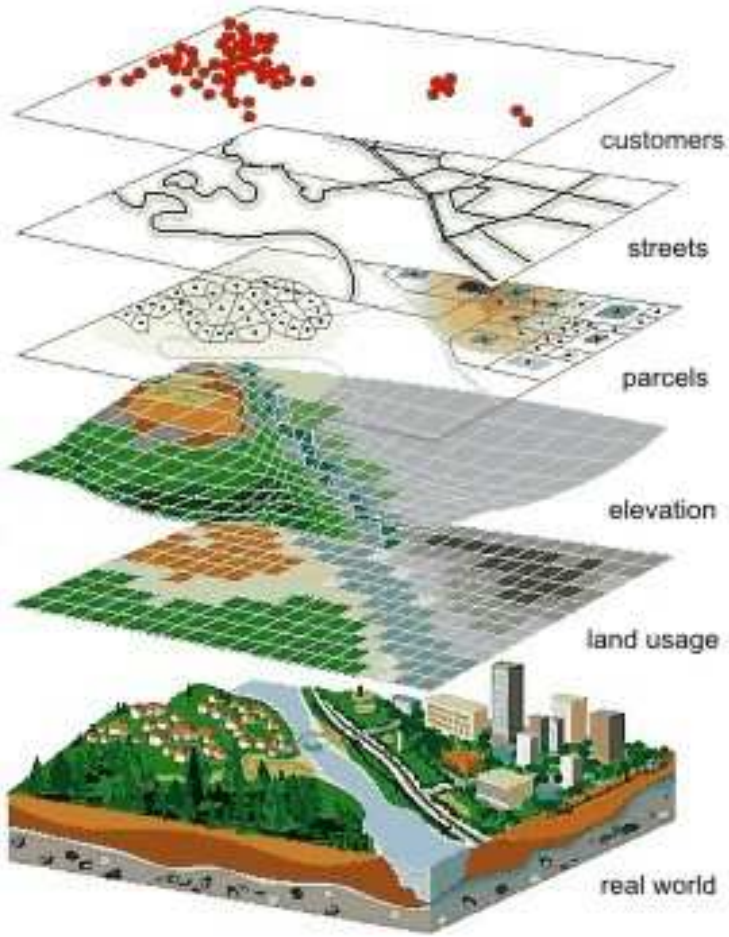
- **Urban Planning, Management & Policy**
  - Zoning, subdivision planning
  - Land acquisition
  - Economic development
  - Code enforcement
  - Housing renovation programs
  - Emergency response
  - Crime analysis
  - Tax assessment
- **Environmental Sciences**
  - Monitoring environmental risk
  - Modeling stormwater runoff
  - Management of watersheds, floodplains, wetlands, forests, aquifers
  - Environmental Impact Analysis
  - Hazardous or toxic facility siting
  - Groundwater modeling and contamination tracking
- **Political Science**
  - Redistricting
  - Analysis of election results
  - Predictive modeling
- **Civil Engineering/Utility**
  - Locating underground facilities
  - Designing alignment for freeways, transit
  - Coordination of infrastructure maintenance
- **Business**
  - Demographic Analysis
  - Market Penetration/ Share Analysis
  - Site Selection
- **Education Administration**
  - Attendance Area Maintenance
  - Enrollment Projections
  - School Bus Routing
- **Real Estate**
  - Neighborhood land prices
  - Traffic Impact Analysis
  - Determination of Highest and Best Use
- **Health Care**
  - Epidemiology
  - Needs Analysis
  - Service Inventory

Geographic data

We show everything in GIS as layers or themes.
Layers are comprised of two data types:

- **Spatial Data(where)**
  - **location**
  - **shape**
  - **relationship among features**
  - **stored in a shape file, geodatabase or similar geographic file**

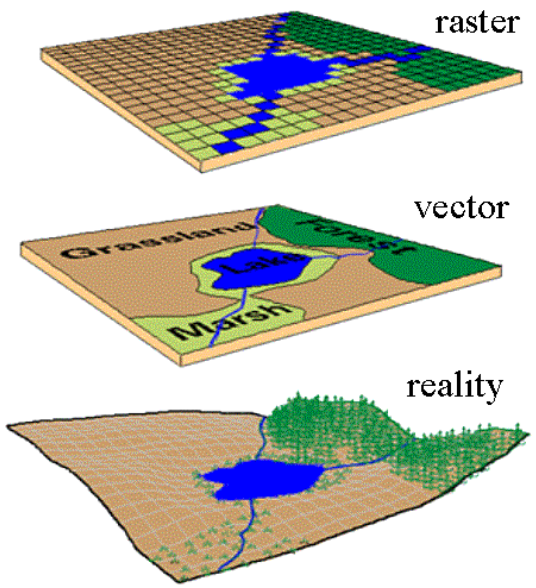
- **Descriptive Data**
  (what, how much, when)
  - **attributes, or**
  - **characteristics of the features**
  - **stored in a data base table**



Spatial data

Layers may be represented in two ways:

- **Vector**
  - Point (node)
  - Polyline (arc)
  - Polygon (area)
- **Raster**
  - Pixels (picture elements)



Spatial Encoding - VECTOR

POINT ⊕

- x, y

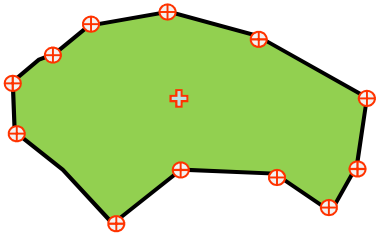
* a single node with NO area

LINE (Arcs)

- x1, y1
- x2, y2
- .
- .
- xN, yN

* a connection of nodes (vertices) beginning with a “to” and ending with a “from”

Area (Polygons)

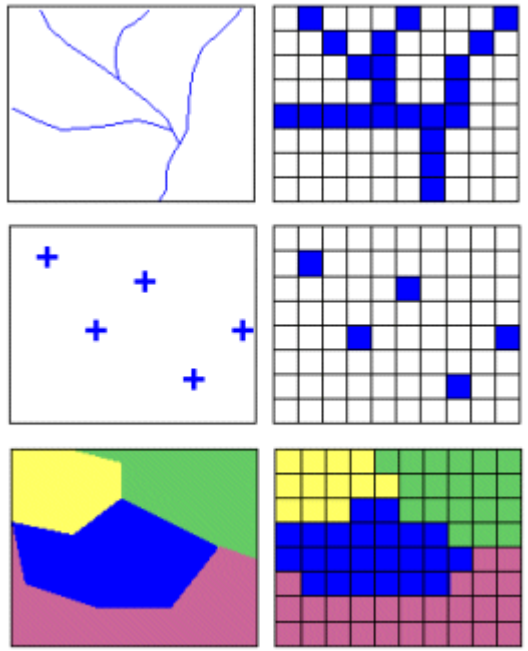


- x1, y1
- x2, y2
- .
- .
- xN, yN (closure Point)

* a series of arc(s) that close around a “label” point

Vector vs Raster

Vector:



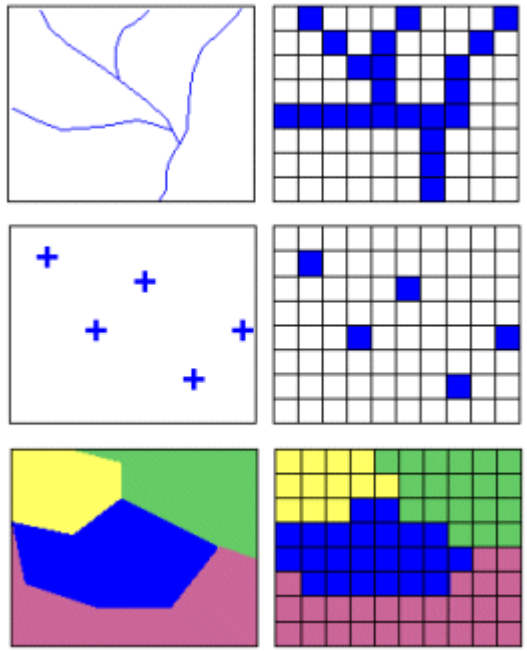
- Data can be represented at its original resolution and form (no generalization, resolution determined precision of coordinates)
- Works well with require boundaries
- Efficient storage of sparse data
- Accurate geographic location of data is maintained.
- Better graphical output.
- The location of each vertex needs to be stored explicitly.
- Continuous data, such as elevation data, is not effectively represented in vector form.

- Spatial analysis and filtering within polygons is impossible.
- Processing can require lots of computer time.

Vector vs Raster

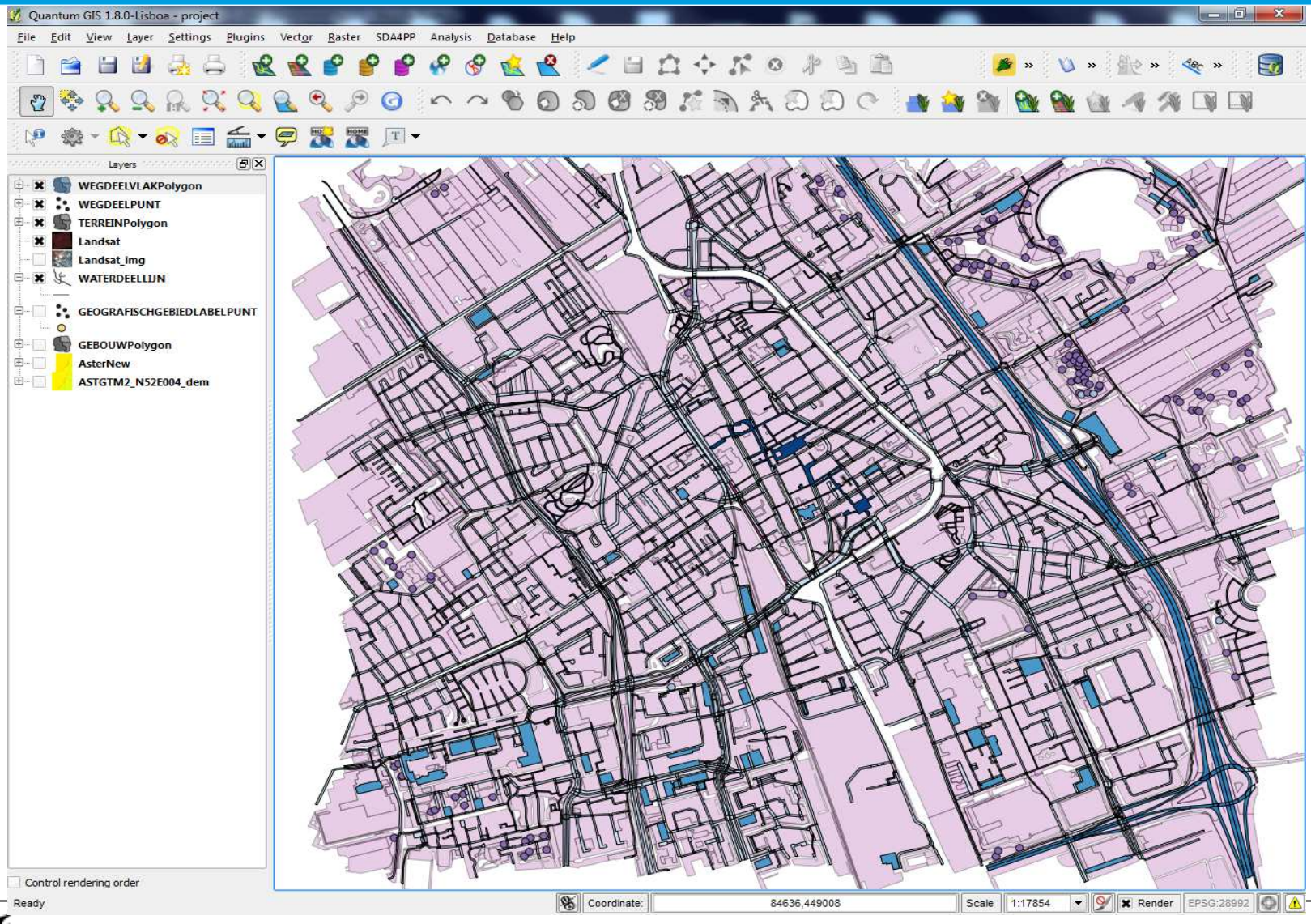
Raster:

- Easy data structure, easy to program and quick to perform.
- Easy creation from image data and easy to overlay.
- Representing continuous data, e.g. elevation data.



- The cell size determines the resolution at which the data is represented.
- Data integrity concerns due to generalization.
- Most output maps from grid-cell systems do not conform to high-quality cartographic needs.
- Deals poorly with linear features.
- Requires large amounts of storage space.

Quantum GIS


Quantum GIS 1.8.0-Lisboa - project
File Edit View Layer Settings Plugins Vector Raster SDA4PP Analysis Database Help
Layers
WEGDEELVLAKPolygon
WEGDEELPUNT
TERREINPolygon
Landsat
Landsat_img
WATERDEELLIJN
GEOGRAFISCHGEBIEDLABELPUNT
GEBOUWPolygon
AsterNew
ASTGTM2_N52E004_dem
Control rendering order
Ready
Coordinate:
84636,449008
Scale
1:17854
Render
EPSG:28992

ESRI shapefile

Esri Shapefile, a set of several files:

Three files are mandatory to store the core data:

***.shp => shape format;**

the primary geographic reference data in the shapefile.

***.shx => shape index format;**

a positional index of the feature geometry to allow seeking forwards and backwards quickly.

***.dbf => attribute format;**

columnar attributes for each shape, in dBase IV format.

GEBOUWPolygon.dbf	24-4-2013 11:54	DBF File	12.558 KB
GEBOUWPolygon.shp	24-4-2013 11:54	SHP File	568 KB
GEBOUWPolygon.shx	24-4-2013 11:54	SHX File	24 KB

ESRI shapefile

Optional files :

***.prj => projection format;**

the coordinate system and projection information,
a plain text file describing the projection using well-known text format.

***.sbn and *.sbx => a spatial index of the features.**

***.fbn and *.fbx => a spatial index of the features**
for shapefiles that are read-only.

***.ain and *.aih => an attribute index of the active fields in a table.**

***.ixs => a geocoding index for read-write shapefiles.**

***.mxs => a geocoding index for read-write shapefiles (ODB format).**

***.atx => an attribute index for the .dbf file**
in the form of shapefile.columnname.atx (ArcGIS 8 and later).

***.shp.xml =>geospatial metadata in XML format,**
such as ISO19115 or other XMLschema.

***.cpg => used to specify the code page (only for .dbf)**
for identifying the character encoding to be used