Introduction to Computational Social Science

Session 5: Geo-spatial data

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Room B U103, Tue 14:00–18:00 (bi-weekly)

Today's session

Lecture

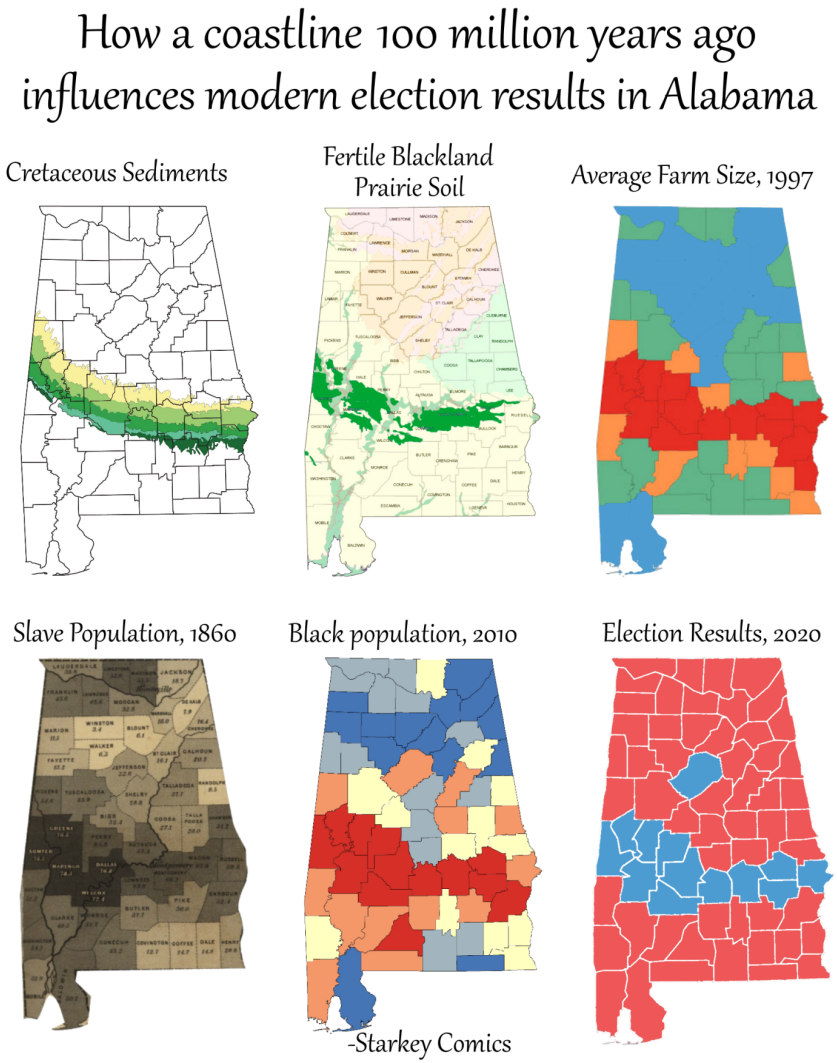
1. Introduction to geospatial data
2. Data acquisition and preparation
3. Spatial Analysis

Introduction to geospatial data

Introduction to geospatial data

- In political science we are used to working with cross-sectional or time-series cross-sectional data
- But our observations are often not only rooted in time but also in space

Example: Alabama



Data types

1. Vector data
2. Raster

Vector data

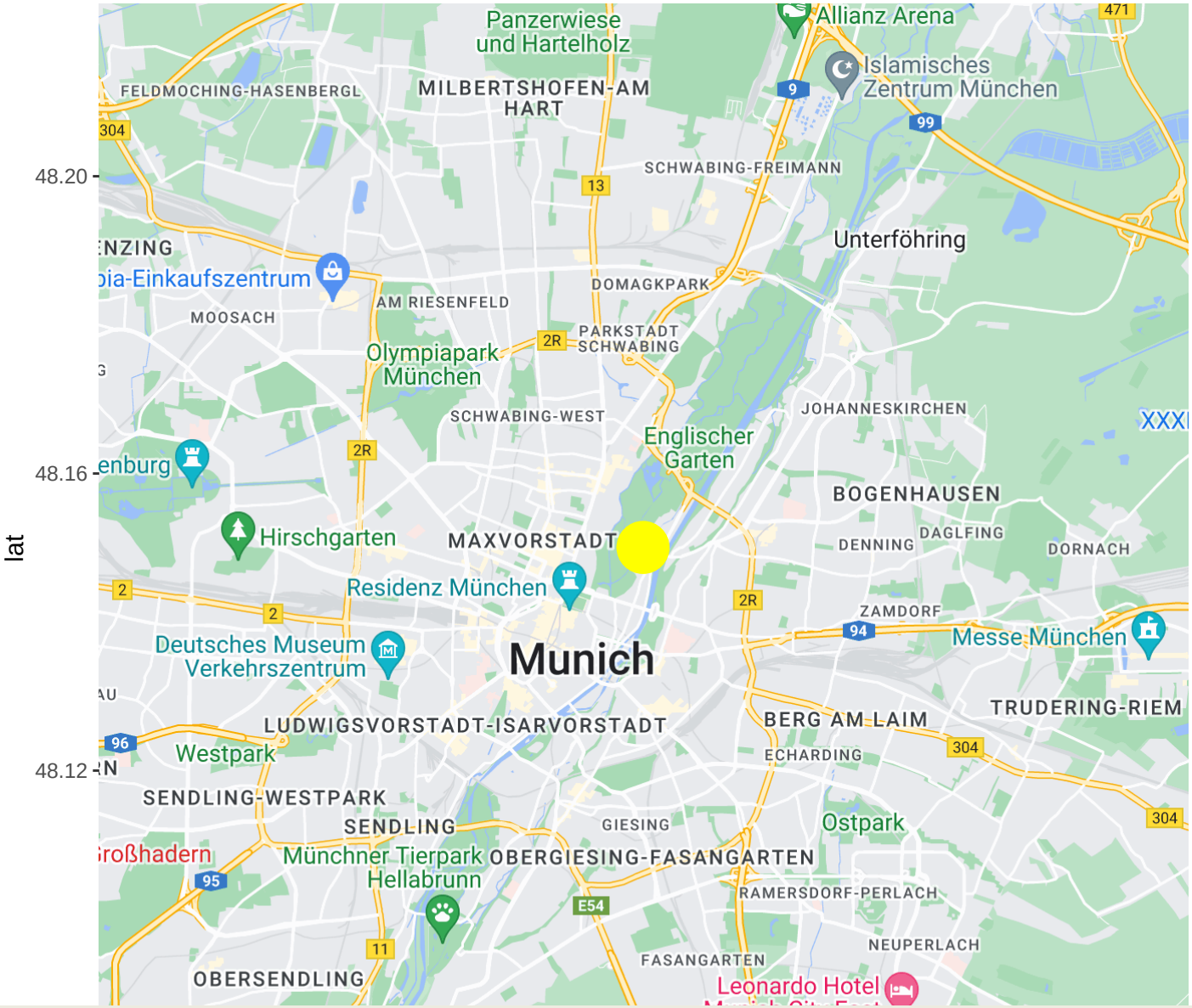
Consists of:

1. Points
2. Lines
3. Polygons

Vector data: Points

- Points map a singel observation to a location
- Are expressed as x,y coordinates (longitude, lattitude)

Vector data: Points Example



Vector data: Lines and Polygons

- Lines and polygons are a sequence of connected points
- Lines are open (e.g. streets or train lines)
- Polygons are closed (e.g. country borders)

Raster data

- Continuous surfaces
- Created by dividing spaces into equal sized cells

Example: Raster data

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## Warning: Removed 390 rows containing missing values (geo
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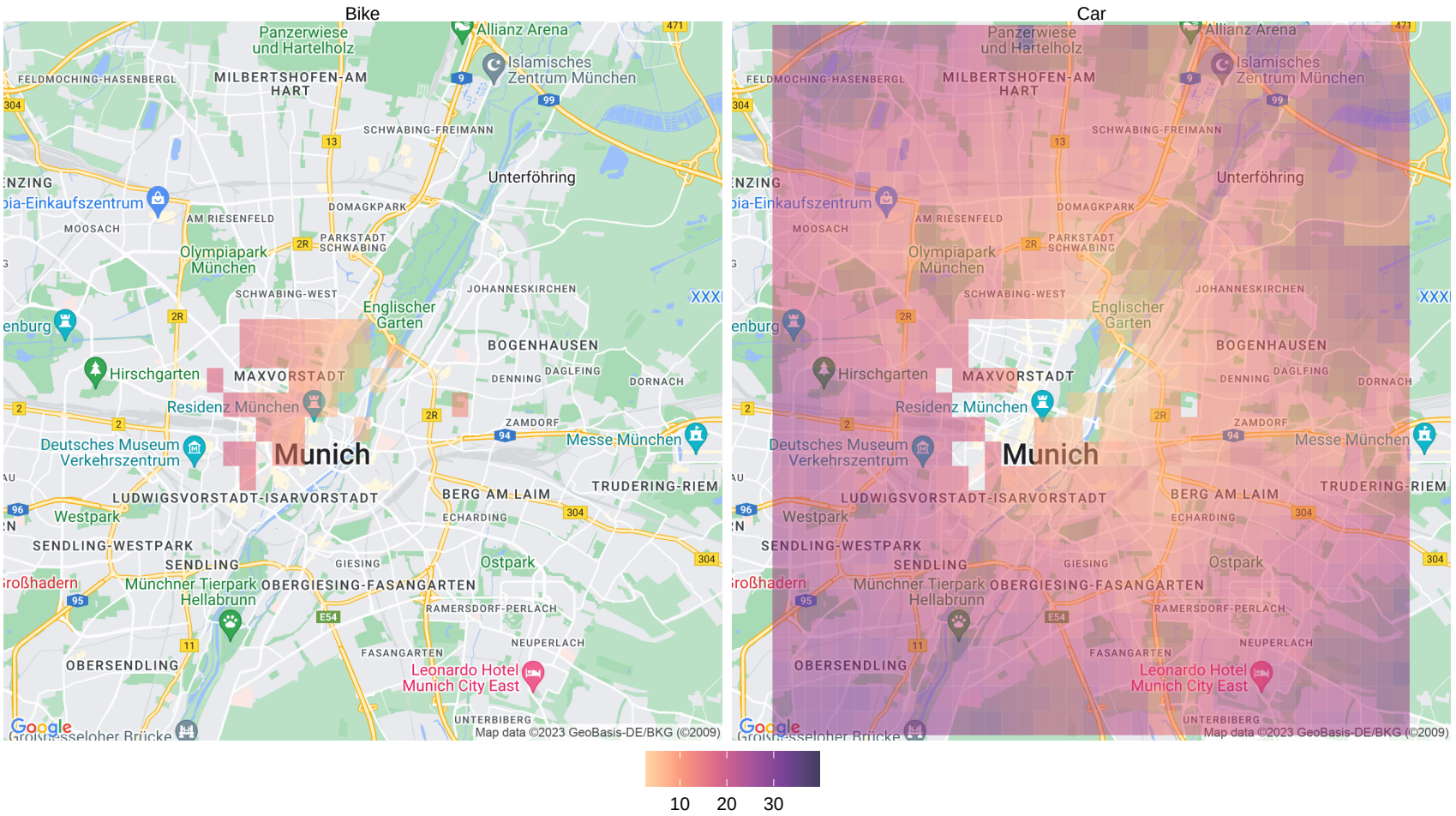


Coordinate systems and projections

Definition

- Spatial data is defined in horizontal and vertical coordinate systems
- Horizontal: Locate data across the surface of the earth
- Vertical: Relative height or depth

Horizontal

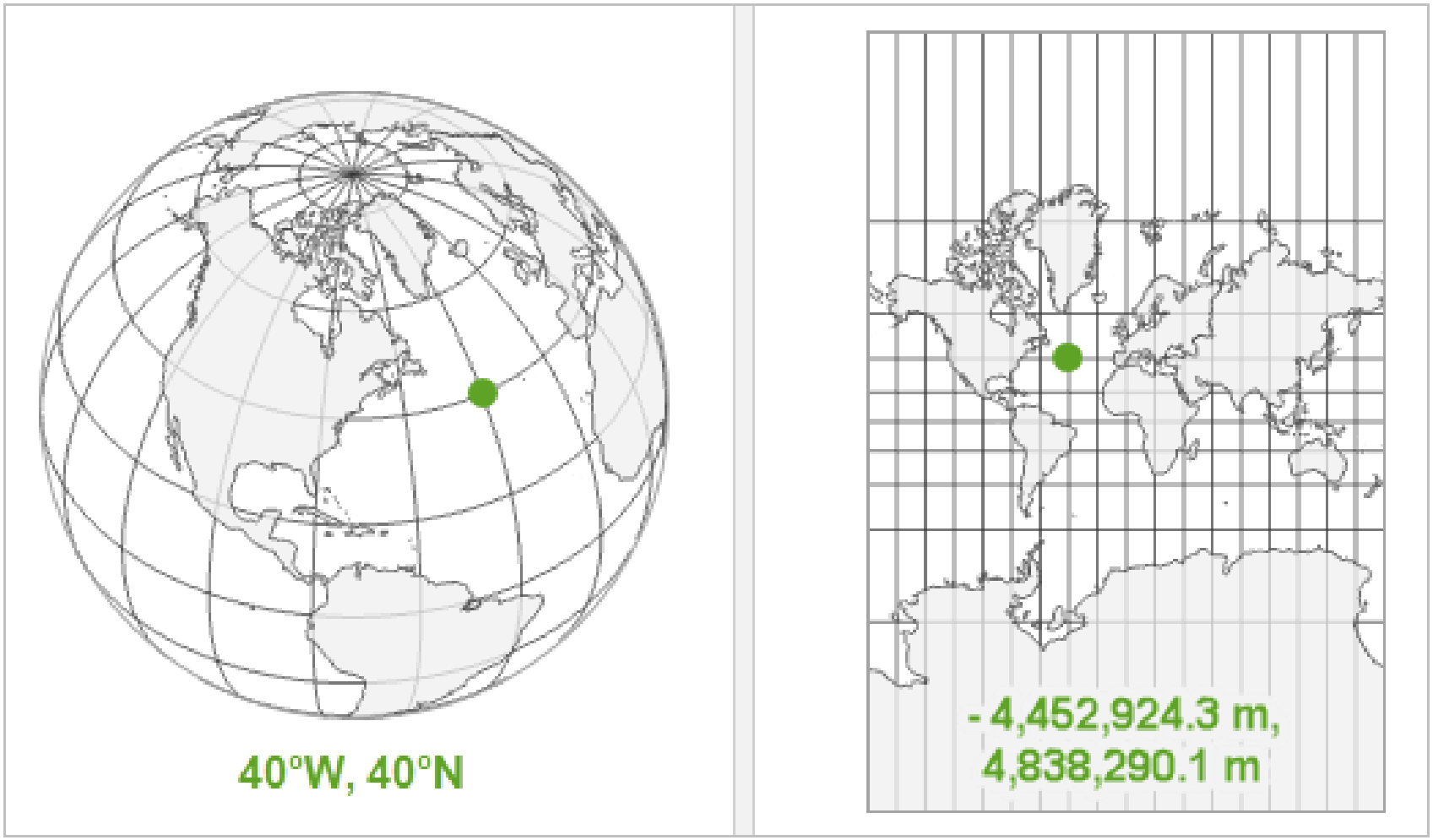
Horizontal coordinate systems can be one of three types:

- Geographic
- Projected (linear measurements)
- Local (relative local reference point)

Horizontal: Geographic

- Units typical in decimal degrees
- Degrees of longitude (x-coordinates) and degrees of lattitude (y-coordinates)
- Location expressed as positive or negative numbers
- positive x and y for north of equator and east of prime meridan
- negative x and y for south of equator and west of prime meridan

Geographic vs Projected



Projections

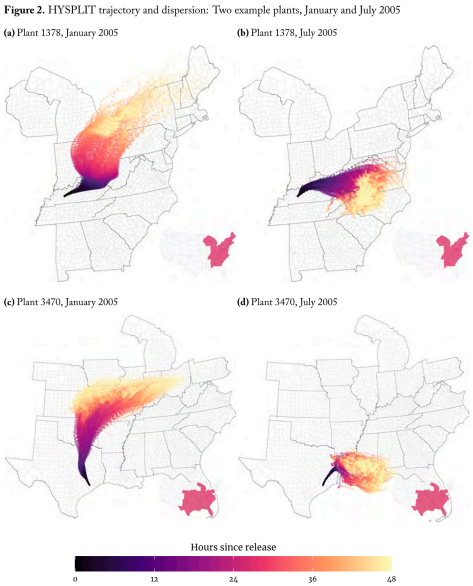
- Projections are used to display the coordinate system and the spatiald data on a flat surface
- This *always* causes distortions
- See: https://www.thetruesize.com

Example for data sources

Sources: Govermental data

- Vast amounts of spatial data is available directly from governmental sources
- This data often already very well prepared
- E.g. Census data, weather data …

Example:Govermental data

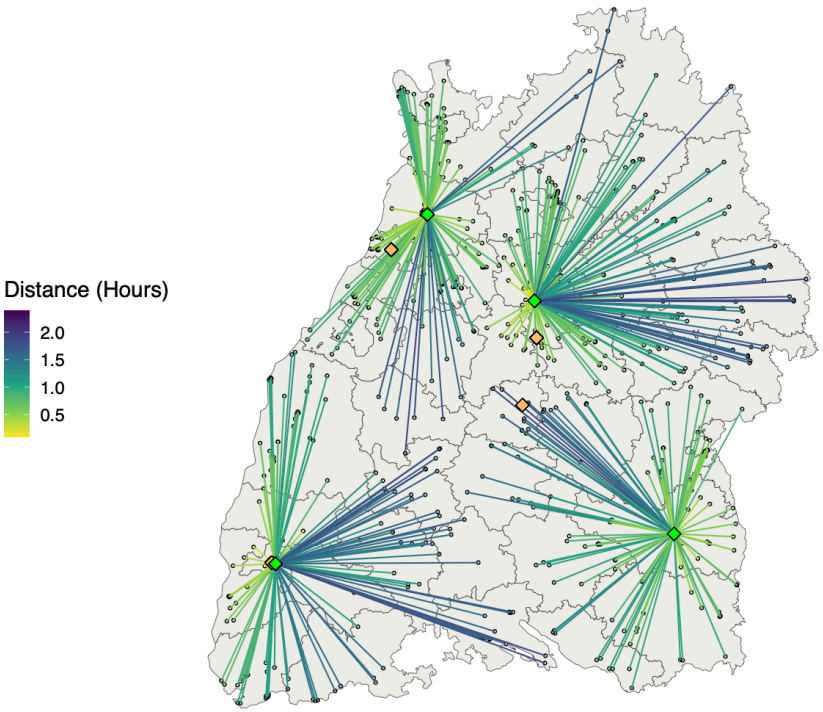


Source: https://www.thecgo.org/research/downwind-and-out-the-strategic-dispersion-of-power-plants-and-their-pollution/

Sources: Geocoding from adresses

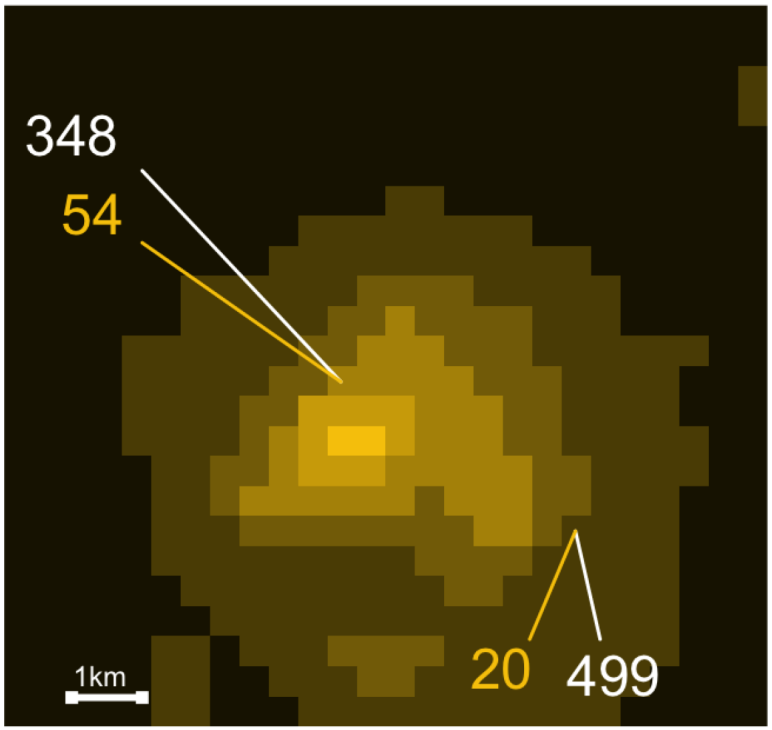
- Alternatively, often times we find data with associated addresses
- Addresses can be converted into spatial point data by geocoding it
- This can be done by using for example the Google Maps API

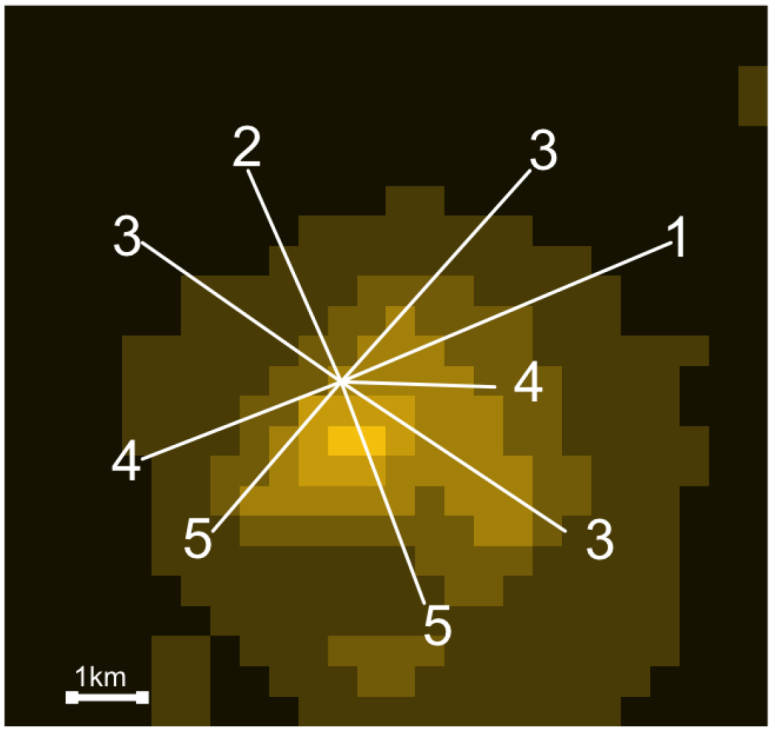
Example: Drive time of environmental inspectors



Sources: Satellite imaging

- Lastly spatial data can be extracted directly from satellite imaging





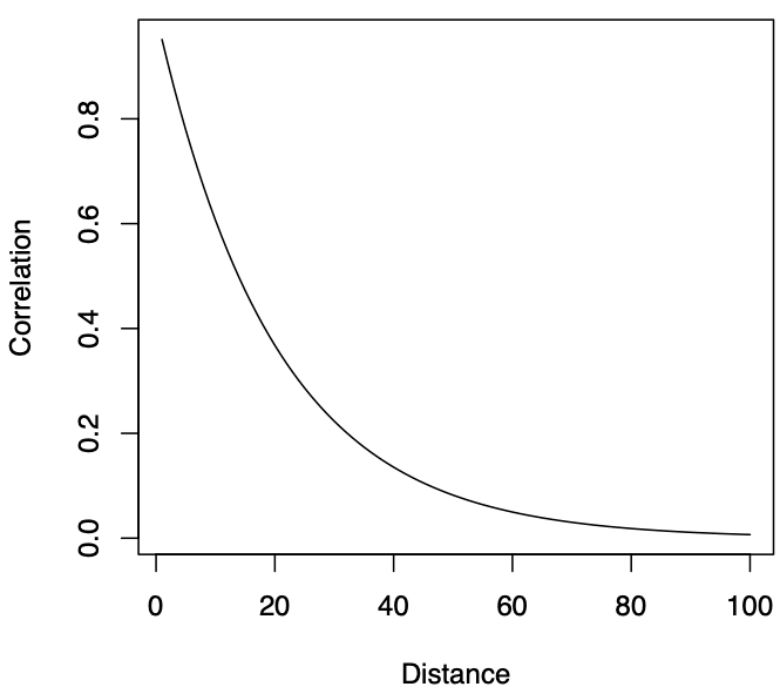
Spatial Analysis

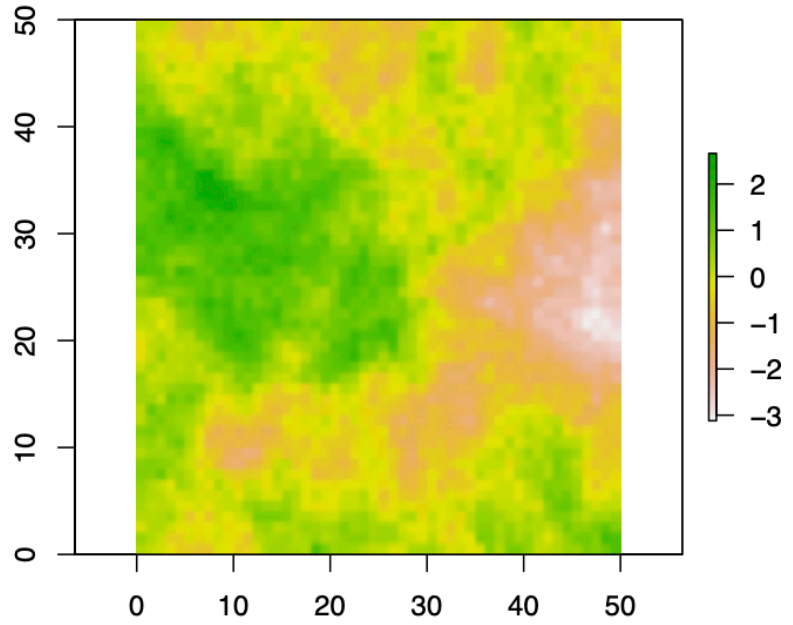
Spatial autocorrelation

Idea: “Everything is related to everything else, but near things are more related than distant things” (Tobler,1970)

More precise: “The property of random variables taking values, at pairs of locations a certain distance apart, that are more similar (positive autocorrelation) or less similar (negative autocorrelation) than expected for randomly associated pairs of random observations” (Legendre, 1993)

Example: Spatial autocorrelation





How to detect: Moran‘s I

Are closer locations more similar than we would expect randomaly?

$$I = \frac{N \sum \sum w_{ij}(x_i - \tilde{x})(x_j - \tilde{x})}{W \sum (x_i - \tilde{x})^2}$$

How to solve (one example): Spatial autogregressive models

1. We define a neighborhood matrix W
2. We lag the dependent variable Y based on the weight matrix

Resulting model (SAR):

$$Y = \beta_0 + \lambda WY + X\beta + \epsilon$$

Example: Neighborhood matrix