

**Interreg**



CENTRAL EUROPE

European Union  
European Regional  
Development Fund

**Dynamic Light**

TAKING  
**COOPERATION**  
FORWARD

📍 5 Nov. 2018, Berlin, Germany

💬 **DYNAMIC PUBLIC LIGHTING - GIS SEMINAR & WORKSHOP**

👤 CE452 Dynamic Light | Anna Nowacka, Fabio Remondino

## The power of Geographic Information Systems (GIS) for managing dynamic street lighting data

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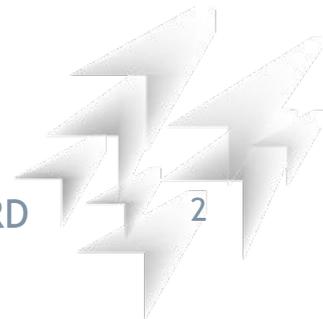
3D Optical Metrology (**3DOM**)

Bruno Kessler Foundation (**FBK**)

Trento, Italy

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<http://3dom.fbk.eu>



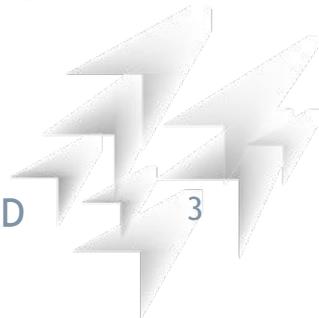
# The Project

Dynamic lighting is an innovative approach to increasing energy efficiency of public lighting and to minimize its negative effects (like light pollution).

The "**Dynamic Light**" project (15 partners from 7 countries) aims to develop dynamic light solutions (strategies, tools, best practices) in order to provide an improved quality of light with energy savings in public space.

The project includes **8 pilot demonstrations**, studies of different public lighting situations and regulations, *geospatial analyses* of existing lighting solutions, analyses and implementation of new technical lighting solutions, offer **trainings** for end users, policy makers and light planners, etc.

More info: <https://www.interreg-central.eu/Content.Node/Dynamic-Light.html>



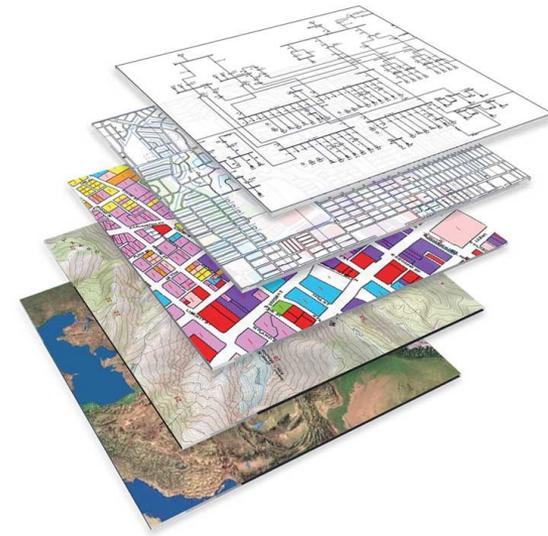
# Schedule of the module

14:00 - 15:30: Introductory lecture about GIS

15:30 - 16:00: Installation of QGis and data distribution

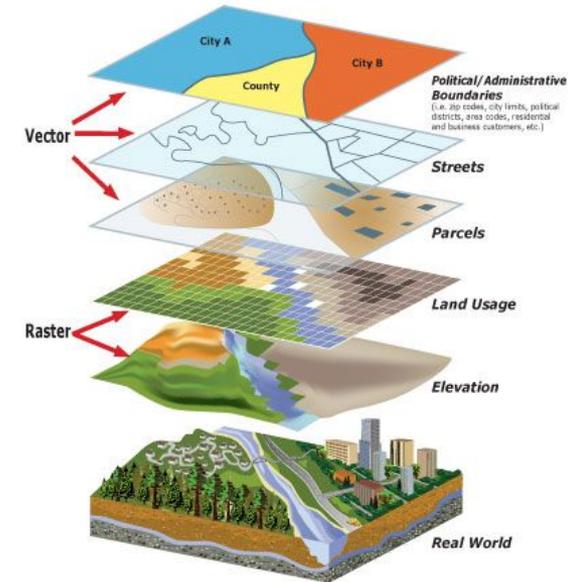
16:00 - 16:30: coffee break

16:30 - 18:00: practical work with QGis



# Contents of the GIS Module

- What is a GIS
- Data in GIS
- Data models in GIS
- Data attributes and Databases (DB)
- Coordinate Systems and Map Projections
- Maps in GIS
- 2D vs 3D GIS

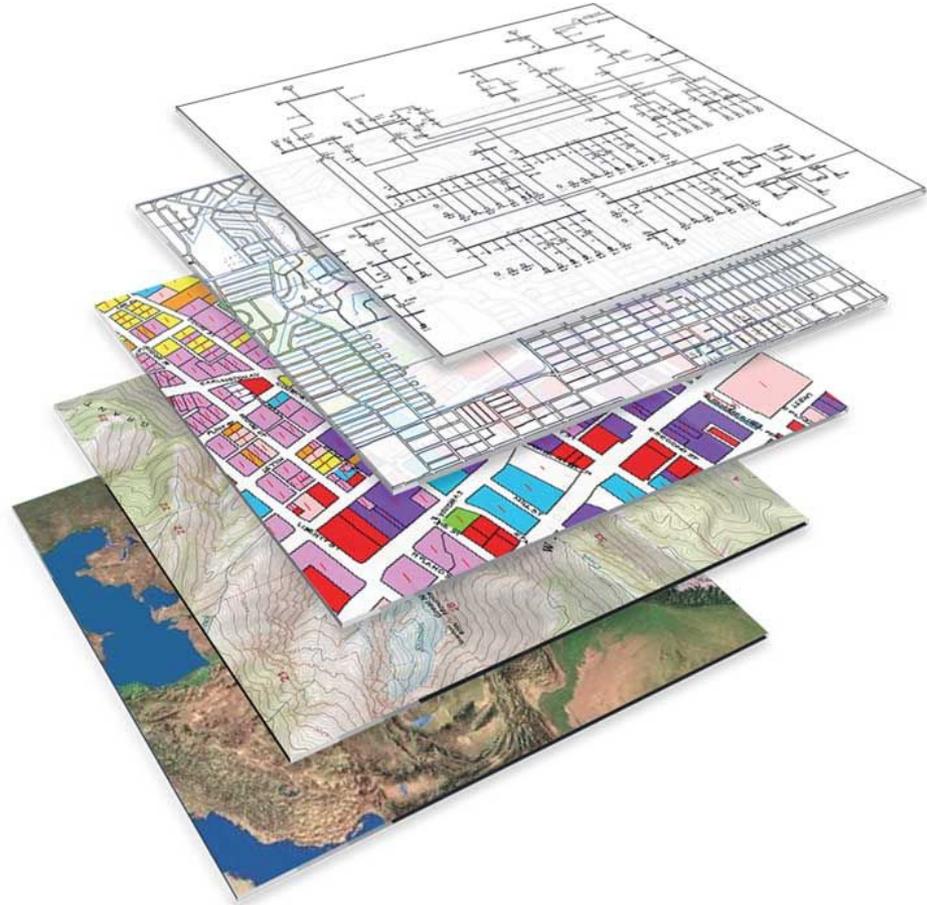




# What is Geographic Information System (GIS)

## KEYWORDS:

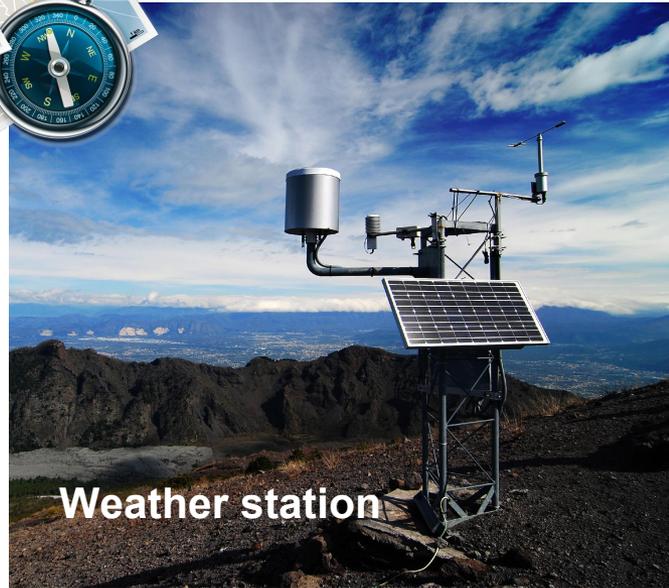
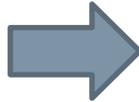
- data
- location(s)
- layers
- visualize
- knowledge
- understand
- wisdom



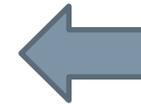
# What is Geographic Information System (GIS)

**(GEO)DATA > INFORMATION > KNOWLEDGE > WISDOM**

**-10 °C**  
**2,5 m/s NE**  
**1010 hPa**



**Weather station**



**22.10.2018**

**(X, Y, Z)**

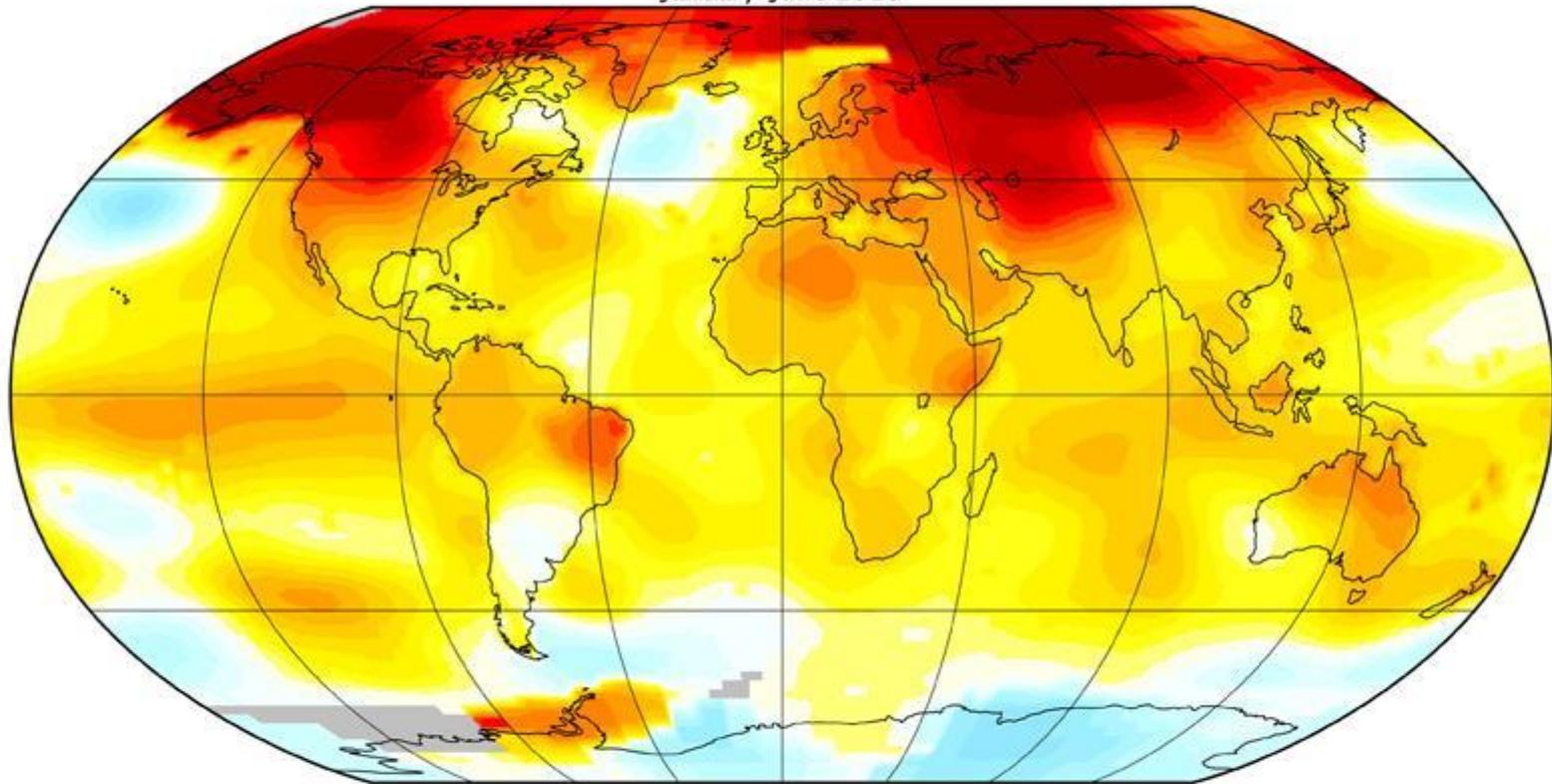


# What is Geographic Information System (GIS)

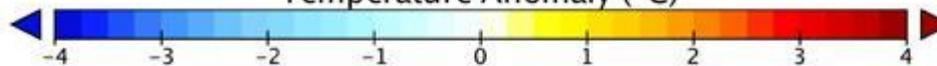
**(GEO)DATA > INFORMATION > KNOWLEDGE > WISDOM**

Global Mean Surface Temperature(GISS)

January-June 2016

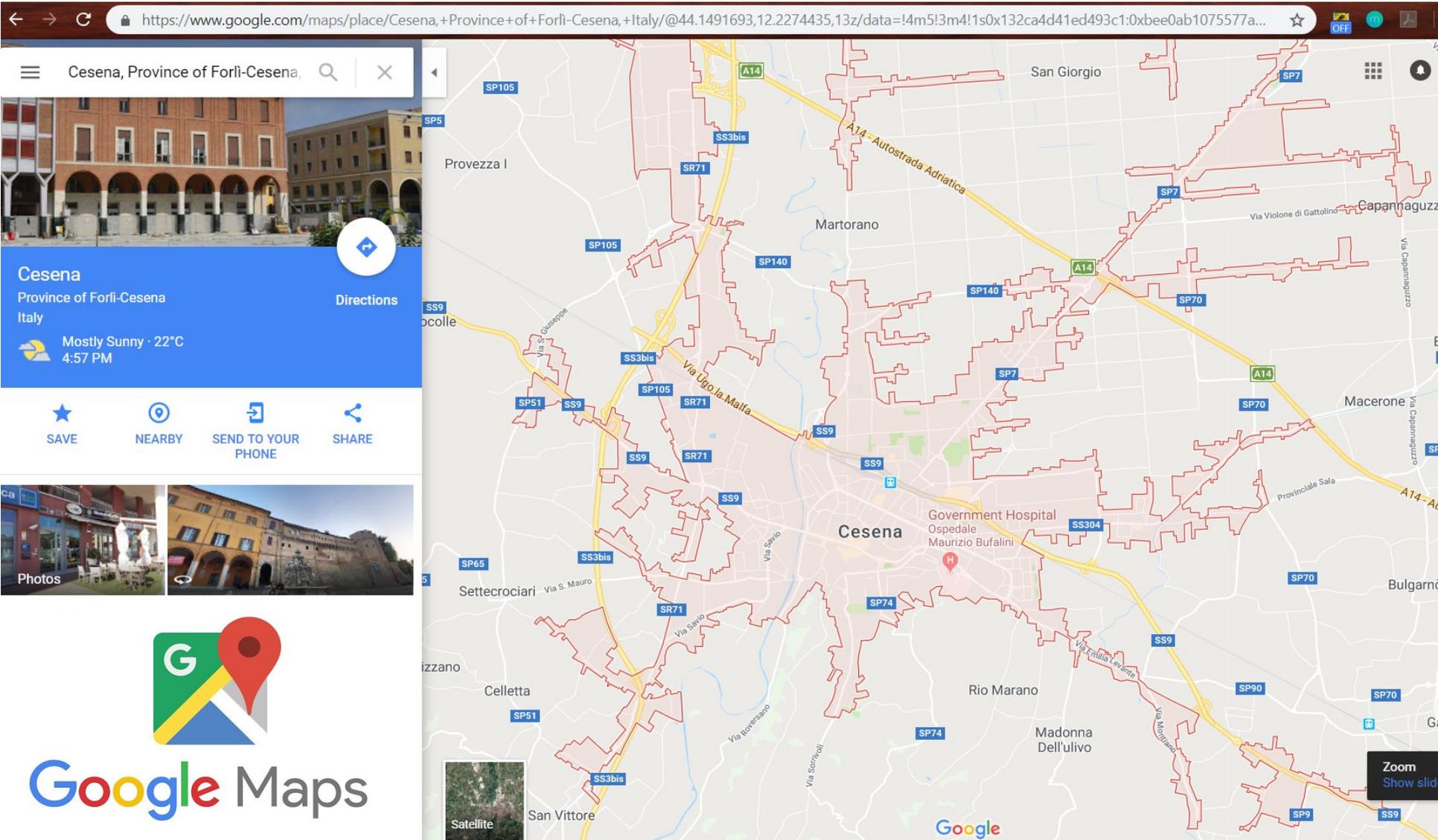


Temperature Anomaly (°C)



# What is Geographic Information System (GIS)

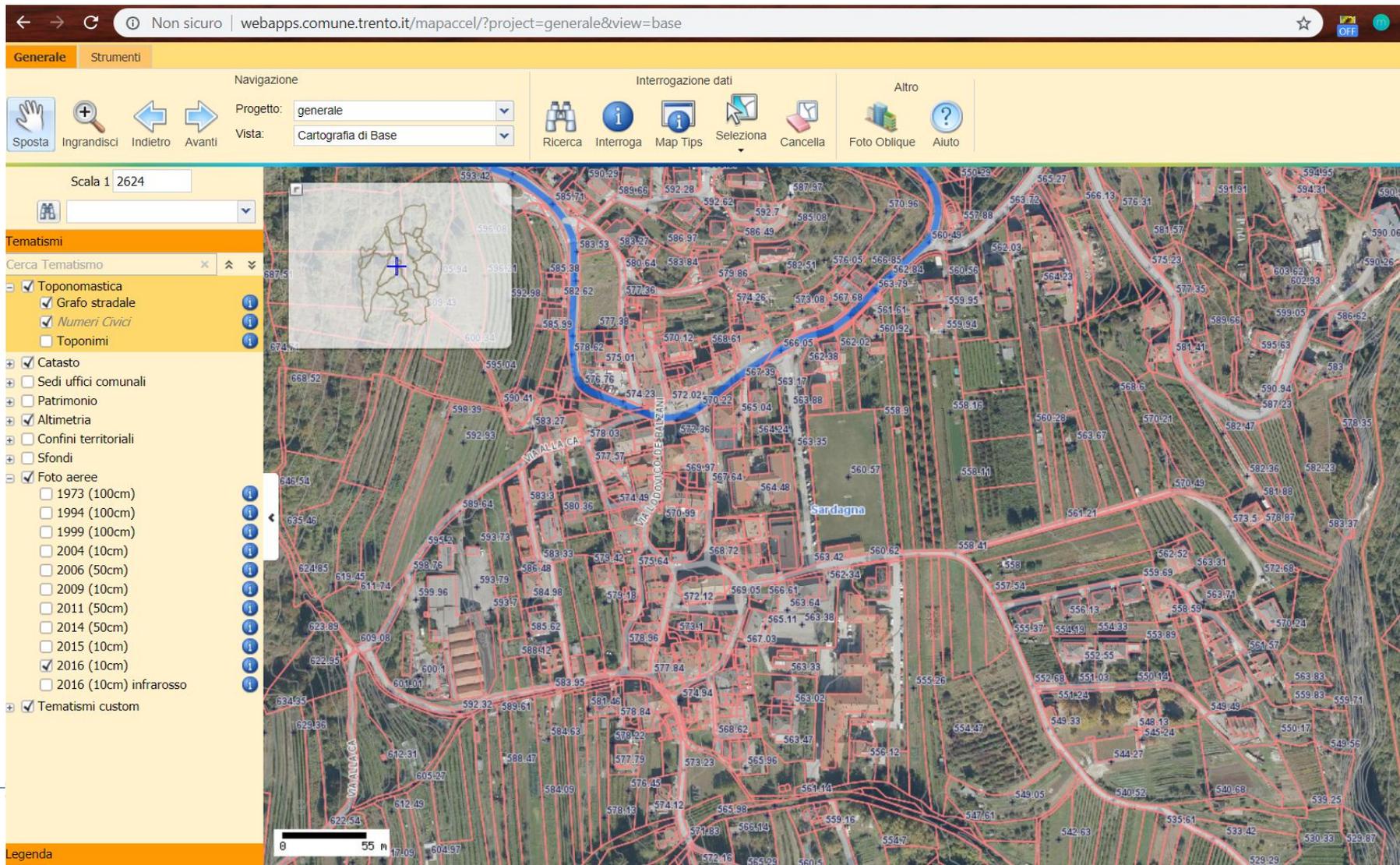
**(GEO)DATA > INFORMATION > KNOWLEDGE > WISDOM**



The screenshot shows a Google Maps interface for Cesena, Italy. The main map area displays the city's street network, with major roads highlighted in yellow and green. Key roads include the A14 Autostrada Adriatica, Via Ugo la Malfa, and Via Savoia. Landmarks such as the Government Hospital (Ospedale Maurizio Bufalini) and the Government Hospital (Ospedale Maurizio Bufalini) are marked. The map also shows surrounding areas like San Giorgio, Martorano, and Rio Marano. The interface includes a search bar at the top, a photo gallery on the left, and navigation controls at the bottom.

# What is Geographic Information System (GIS)

## (GEO)DATA > INFORMATION > KNOWLEDGE > WISDOM

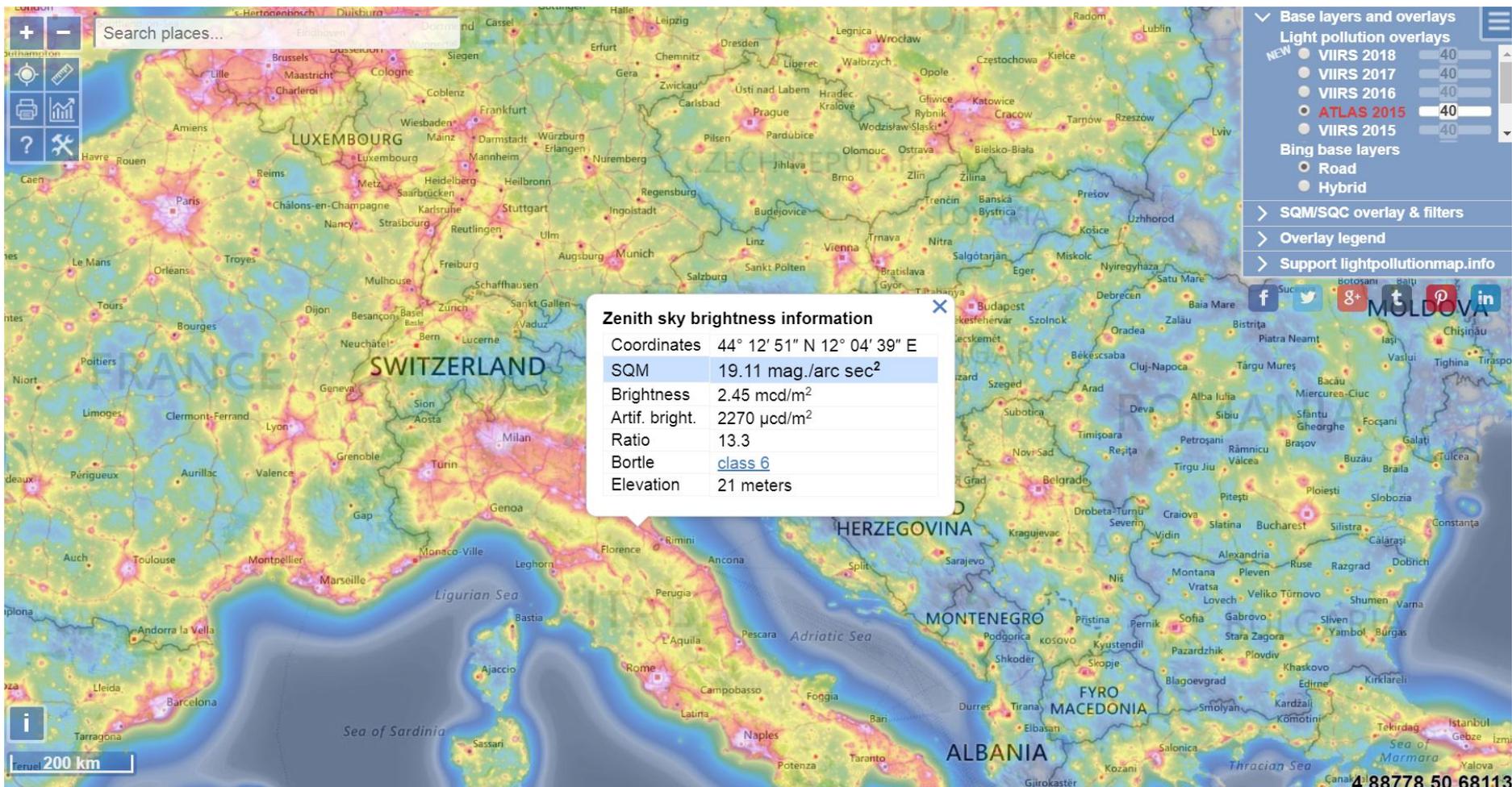


The screenshot displays a web-based GIS application interface. At the top, a browser address bar shows the URL `webapps.comune.trento.it/mapacel/?project=generale&view=base`. The interface is divided into several sections:

- Generale** (General): Includes navigation controls (Sposta, Ingrandisci, Indietro, Avanti) and a project dropdown menu set to "generale".
- Strumenti** (Tools): Includes a "Cartografia di Base" view selector and various tool icons for Ricerca, Interroga, Map Tips, Seleziona, Cancella, Foto Oblique, and Aiuto.
- Tematismi** (Thematics): A sidebar menu with a search field and a list of layers. The "Foto aeree" (Aerial photos) section is expanded, showing a list of years and resolutions: 1973 (100cm), 1994 (100cm), 1999 (100cm), 2004 (10cm), 2006 (50cm), 2009 (10cm), 2011 (50cm), 2014 (50cm), 2015 (10cm), 2016 (10cm), and 2016 (10cm) infrarosso. The "2016 (10cm)" layer is selected.
- Mapa**: The main map area shows an aerial view of a town with red lines representing cadastral boundaries and a blue line representing a river. Numerous elevation points are visible on the map.
- Legenda** (Legend): Located at the bottom left, it shows a scale bar from 0 to 55 meters.

# What is Geographic Information System (GIS)

(GEO)DATA > INFORMATION > KNOWLEDGE > WISDOM



# What is Geographic Information System (GIS)

**(GEO)DATA > INFORMATION > KNOWLEDGE > WISDOM**



## Australia's Dinosaur Trail

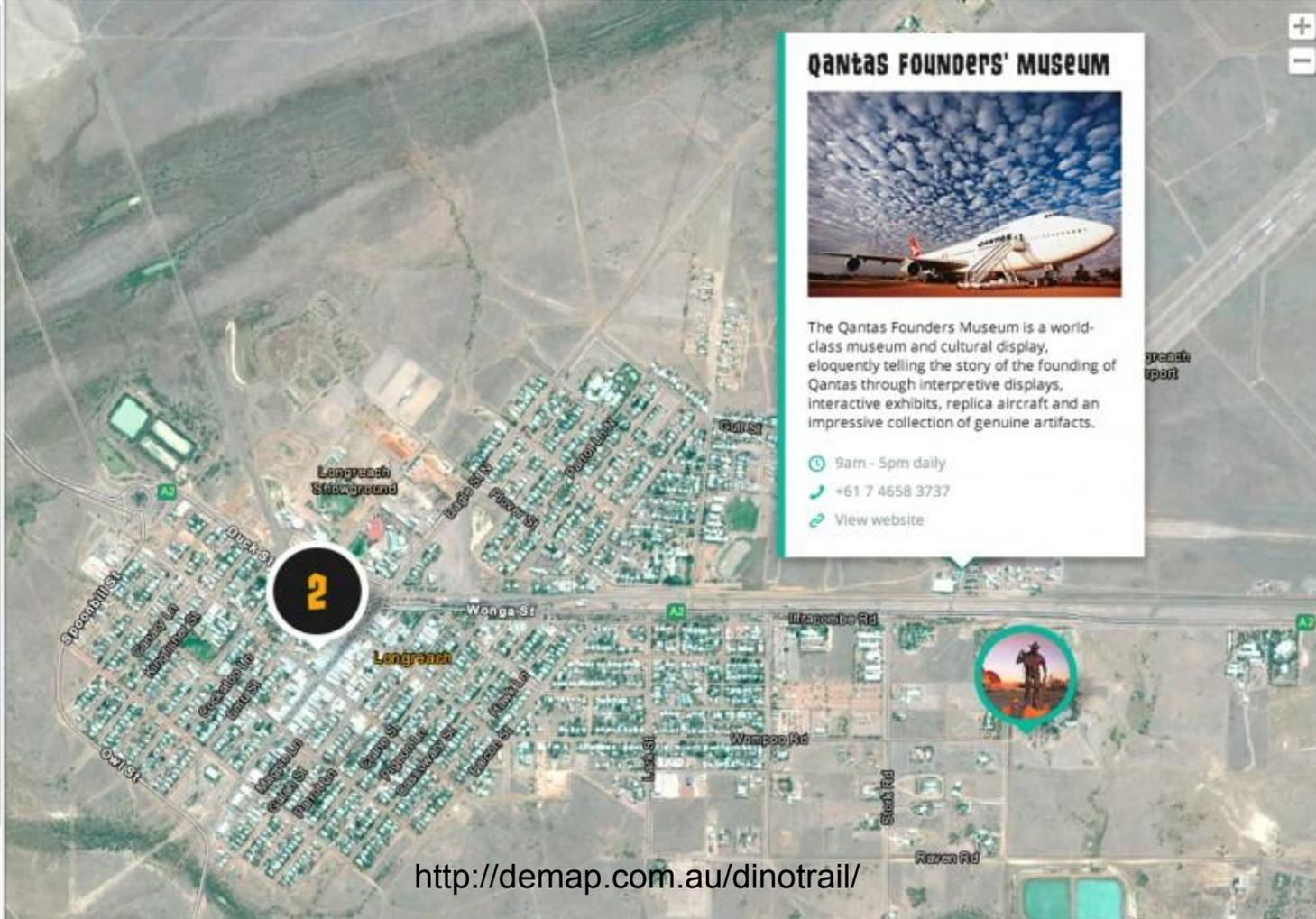
**Day 1  
LONGREACH**

Be sure to visit the Australian Stockman's Hall of Fame, the Qantas Founders Museum, jump aboard a Cobb and Co. Stage Coach, and spend a leisurely sunset cruising the Thomson River.

**Day 2  
LONGREACH-WINTON**

**Day 3  
WINTON**

**Day 4  
WINTON-RICHMOND**



**QANTAS FOUNDERS' MUSEUM**

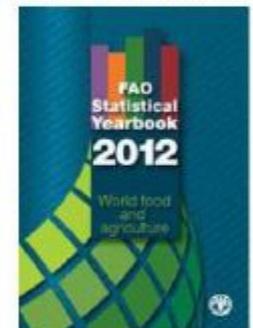
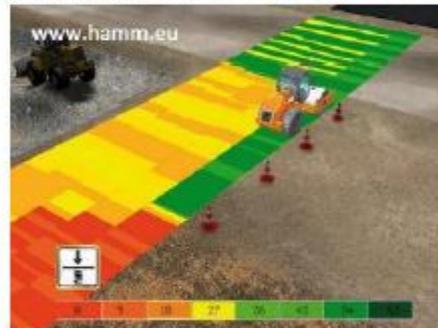
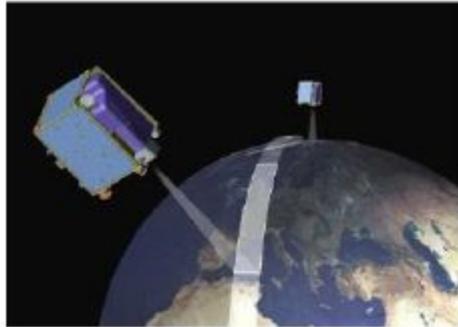


The Qantas Founders Museum is a world-class museum and cultural display, eloquently telling the story of the founding of Qantas through interpretive displays, interactive exhibits, replica aircraft and an impressive collection of genuine artifacts.

- 🕒 9am - 5pm daily
- ☎ +61 7 4658 3737
- 🌐 [View website](#)

<http://demap.com.au/dinotrail/>

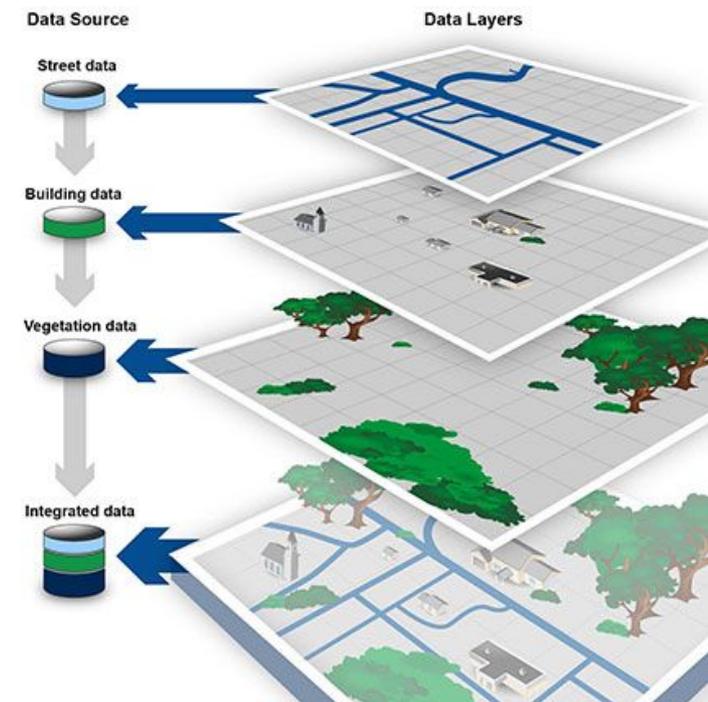
## GIS (GEO)DATA SOURCES to create a GIS



## Why create your own GIS?

1. Need to organize geospatial data
2. Data you need is on a paper map and needs to be converted to a digital format.
3. Data available is at a different scale than you need.
4. Data need to be accessed /used by multiple people at the same time.

...and many other reasons.

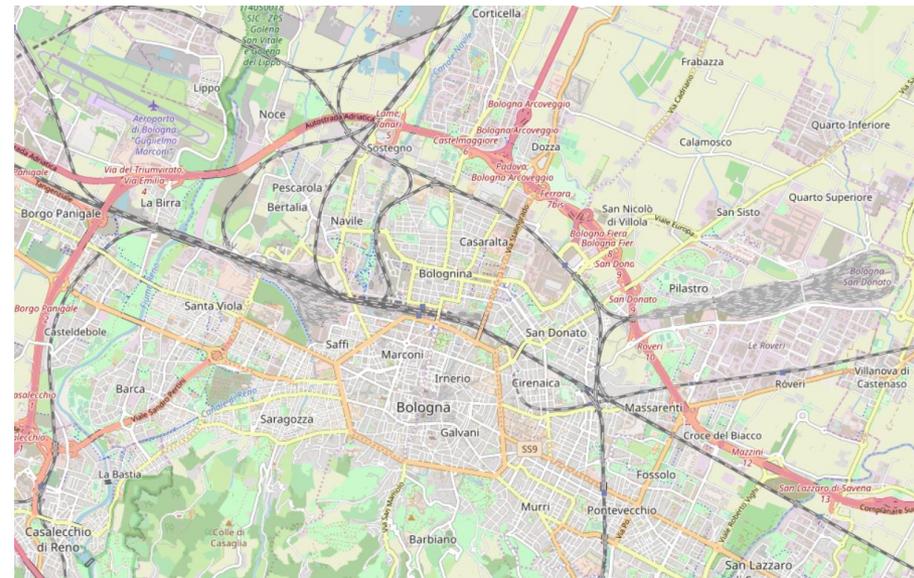


## TWO TYPES OF DATA SOURCES

### HARDCOPY



### DIGITAL



**Each of these data sources have their own positive and negative aspects as a way to store / display information.**



## TWO TYPES OF DATA SOURCES

### HARDCOPY

- **stable**
- **does not require hardware/software to use**
- **portable / tangible**
- **familiar to many users/audiences**
- **easily transferable**
- **not easily updatable**

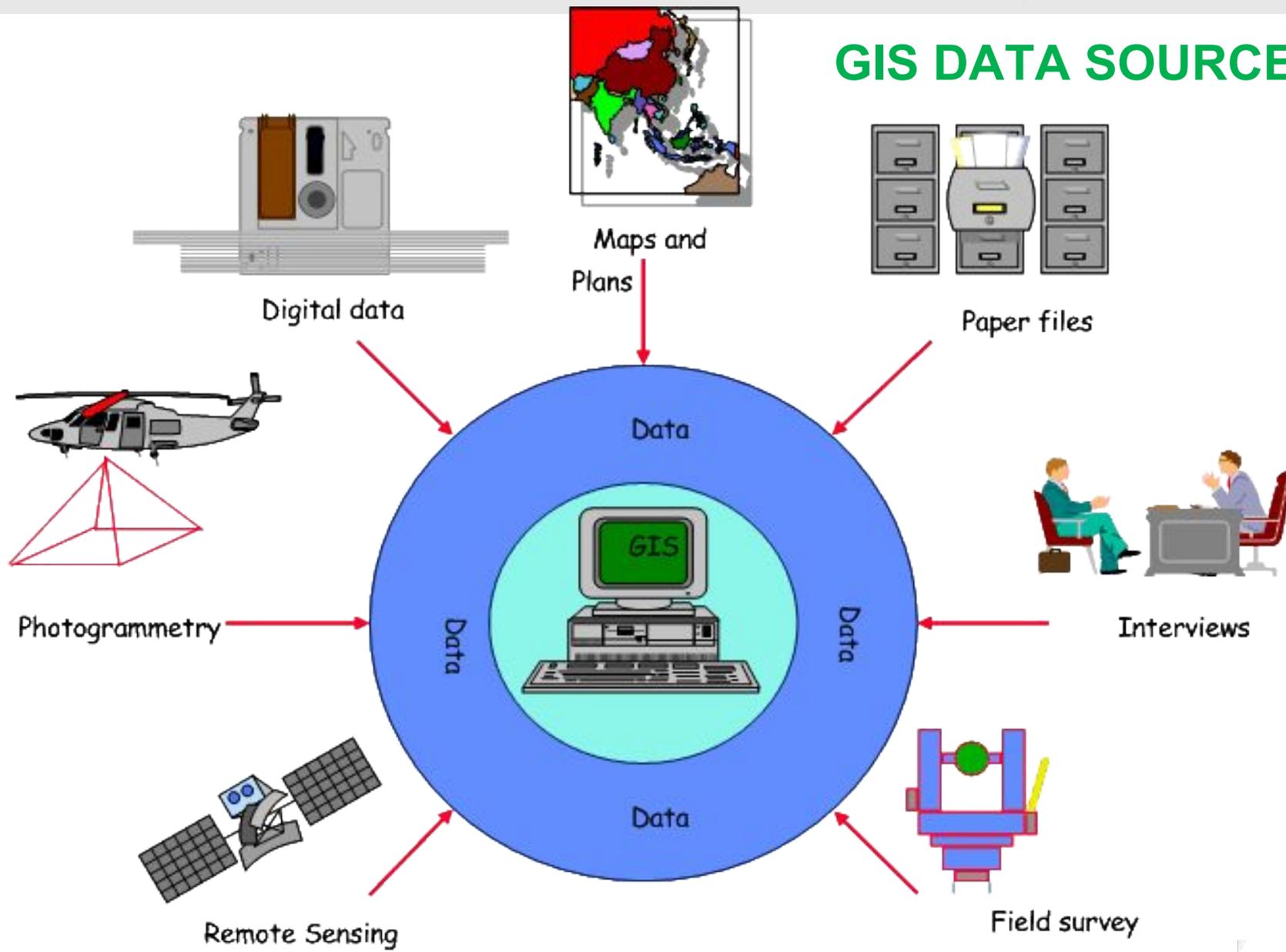
### DIGITAL

- **stable**
- **flexible**
- **easily updatable**
- **not portable without a device**
- **requires hardware/software to use them**
- **may be tied to specific hardware / software that may change over time**



# Creating a GIS...

## GIS DATA SOURCES

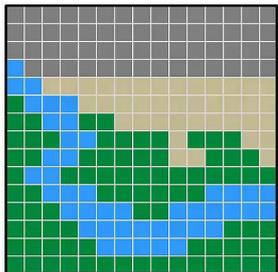


## GIS DATA SOURCES

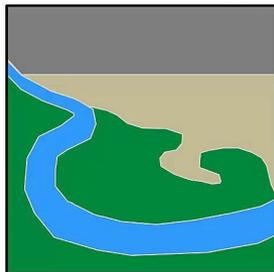
**PRIMARY:** - geographic data sources which are **collected** (obtained as a result of direct measurements) specifically for use in GIS

**SECONDARY:** - already **existing** data, e.g. in analogue or digital format  
- they are digitized or **processed** into GIS tools and reuse

**THE WORLD** can be represented in two ways:



**RASTER**



**VECTOR**



Classification of geographic data for data collection purposes		
	Raster	Vector
Primary	- Digital remote sensing images - Digital aerial photographs	- GPS measurements - Survey measurements
Secondary	- Scanned maps of photographs - Digital elevation models from maps	- Topographic maps - Toponymy (placename) databases

Source: Longley et al., 2001. *Geographic Information Systems and Science*, Chichester: Wiley.

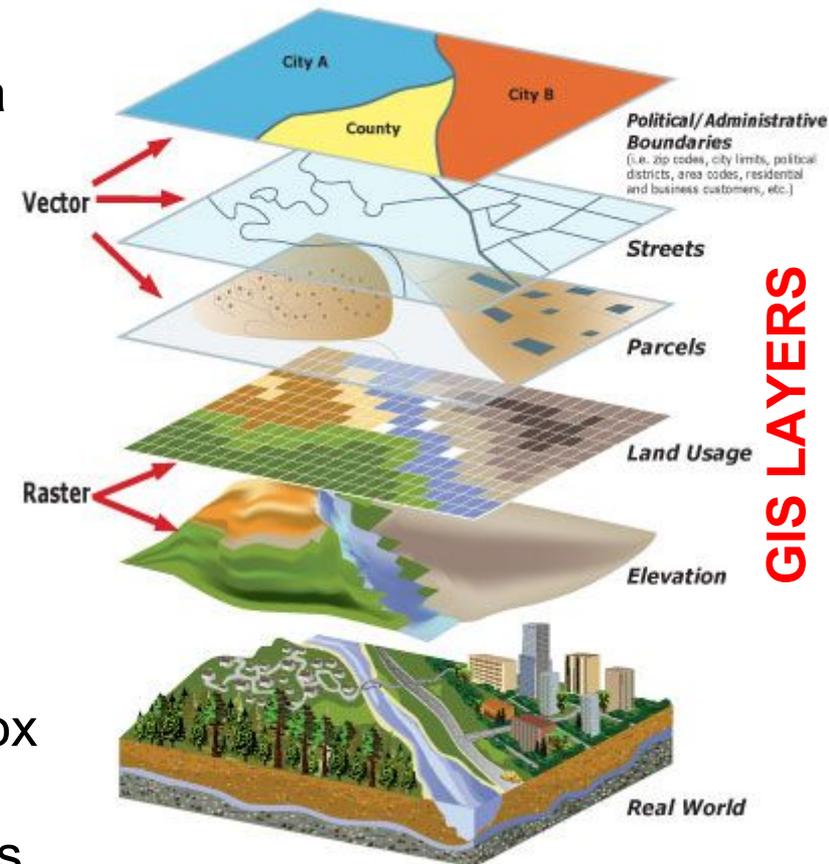
A **data model** is a way of defining and representing **real world surfaces** and characteristics in GIS.

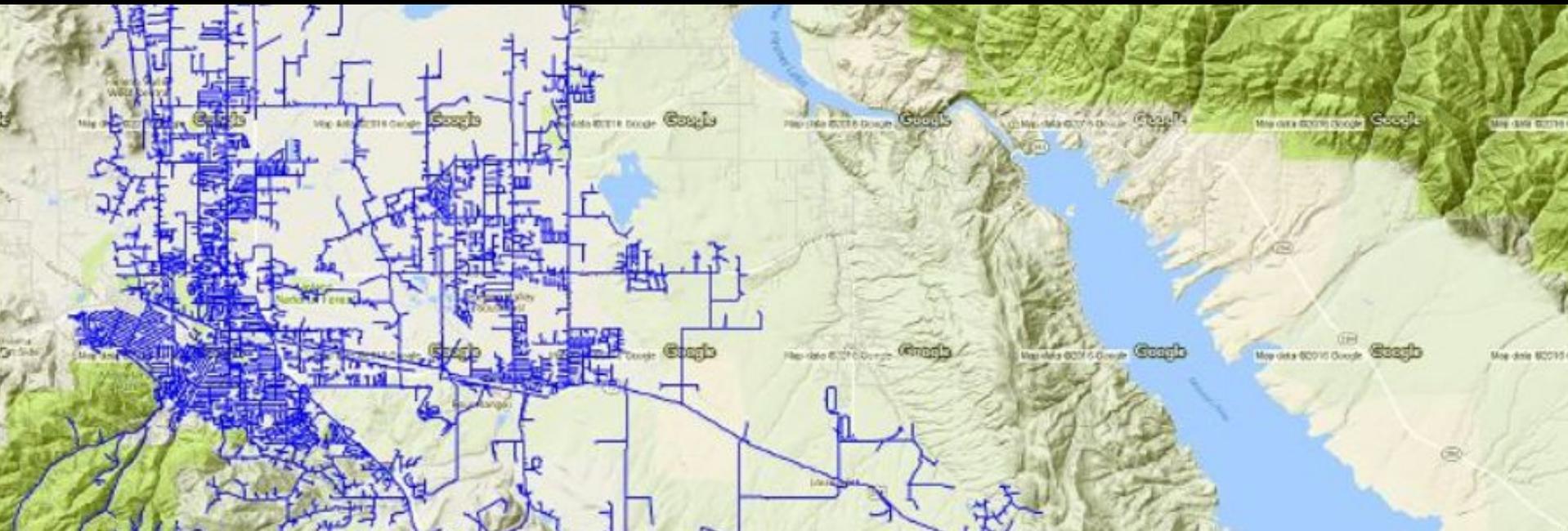
There are **two primary types** of spatial data model:

- **Vector** data represents features as discrete points, lines and polygons
- **Raster** data represents features as a rectangular matrix of square cells (i.e. images)

The modern literature on GIS includes also **other spatial data model**:

- **TIN** data represent surfaces as an approx of reality using connected triangles
- **3D models**, which represents 3D objects using a combination of different primitives







**Vector** data is very common, and is often used to represent **light poles**, **roads** and **boundaries**. They represent geographic features as **points**, **lines**, and **polygons**.

## Types of Vector Data

12° 14' 35.34" E, 44° 08' 20.76" N

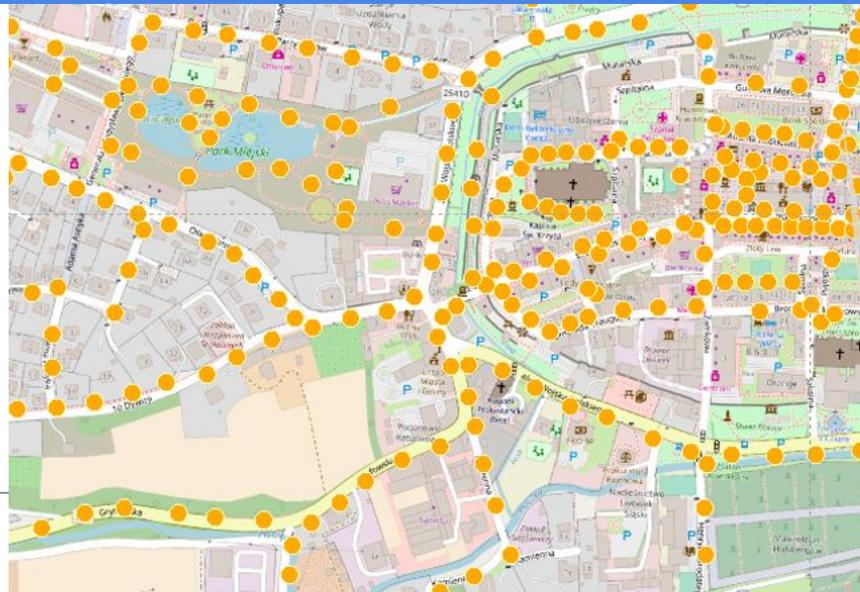
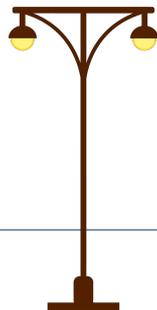


**Example: street light poles, pylons, restaurants, etc.**

### POINTS

- one pair of coordinates defines the location of a point feature

- individual X,Y



oprawa	SGS
moc	100W
mocowanie_	na wierzchooku
szeroko_j	6
typ_linii	kablowa
odlego_su	2
wysoko	8
nawierzch	asfalt
kategoria	droga
wysignikhl	0/1
kat_wysie	5
kat_oprawy	0
chodnik	po obu stronach jezdni
typ_opraw	
numer_lic	
uwagi_dod	
changed	2017-06-30-18-04-36
pictureFo	
pictureNa	
picturePa	
created	2017-06-30-18-01-38
altitude	253.0509
accuracy	12.0

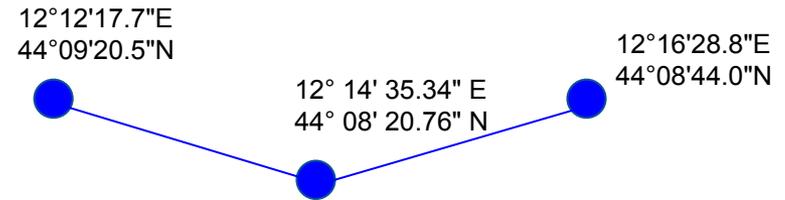




**Vector** data is very common, and is often used to represent **light poles**, **roads** and **boundaries**. They represent geographic features as **points**, **lines**, and **polygons**.

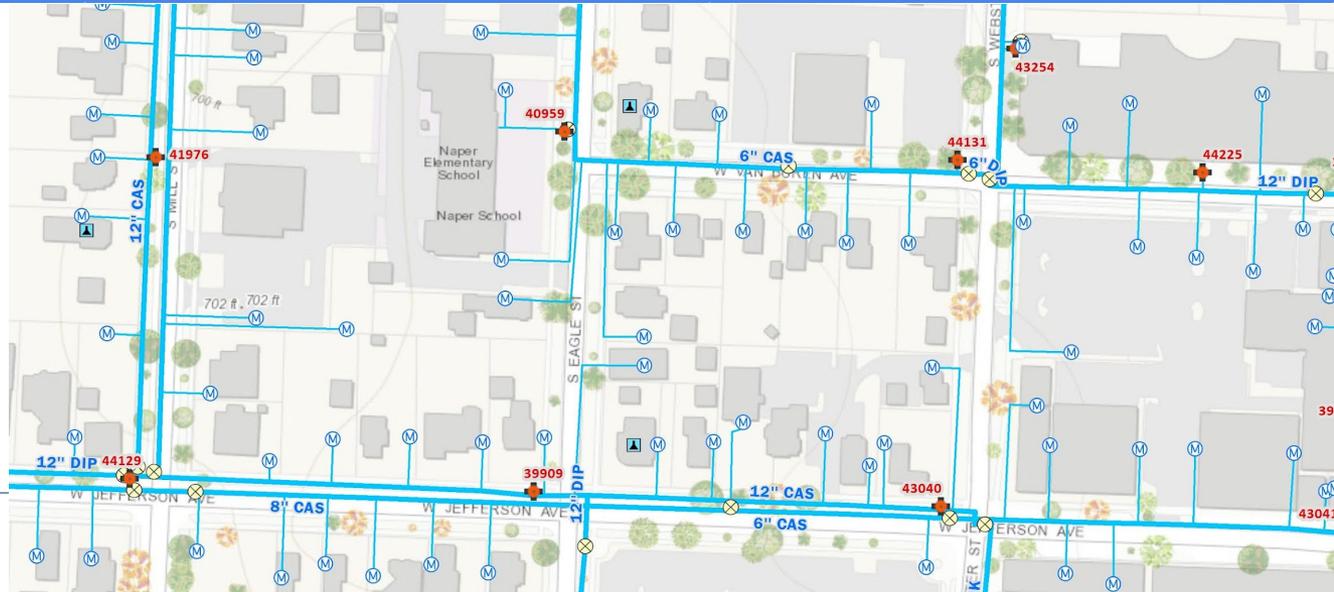
## Types of Vector Data

**Example: power lines, railways, etc.**



## POLYLINES

- two or more pairs of coordinates that are connected define a line feature
- a series of connected points actually, a set of series of connected points.

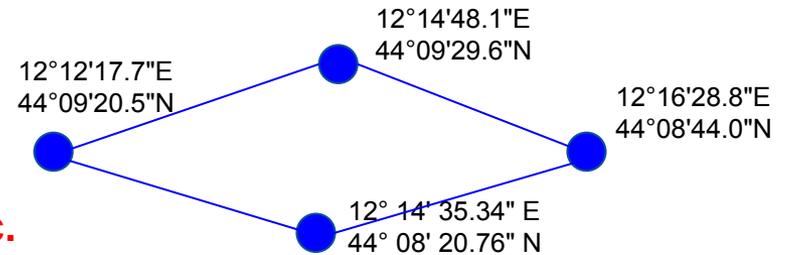




**Vector** data is very common, and is often used to represent **light poles**, **roads** and **boundaries**. They represent geographic features as **points**, **lines**, and **polygons**.

## Types of Vector Data

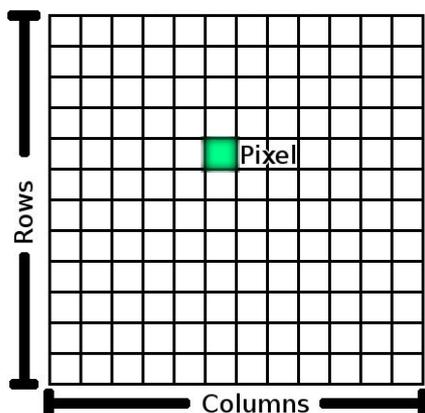
**Example: building footprints, green areas, etc.**



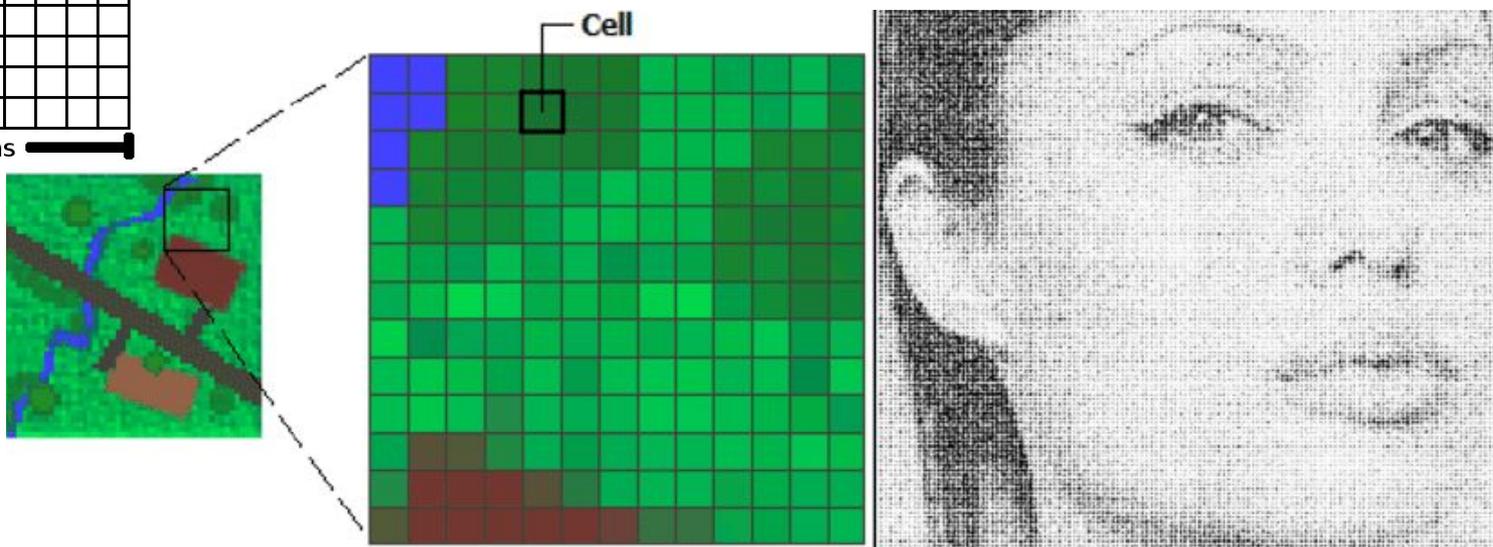
## POLYGONS

- multiple pairs of coordinates that are connected and closed define a polygon feature.
- a series of connected points that loop back to the first point
- the beginning and ending coordinates for a polygon are the same.





**Raster** data models represent surfaces as a matrix of cells or pixels that are organized into **rows and columns** (or a grid).



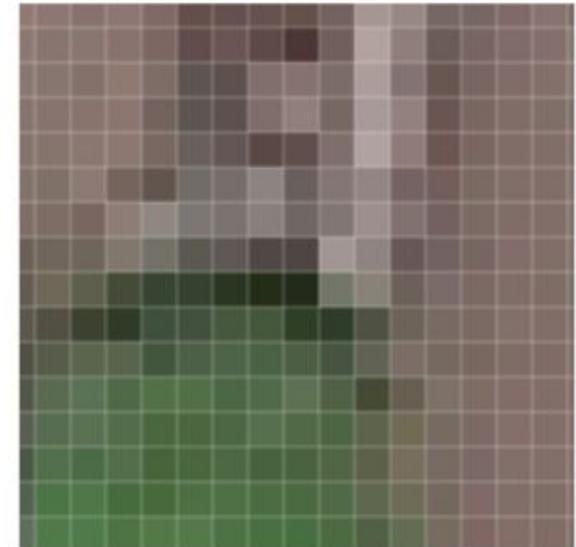
Each cell/pixel **contains a value representing data** (e.g. information such as temperature, height, PV potential, etc.).

**Raster's are:** orthophotos, satellite imagery or even scanned maps.

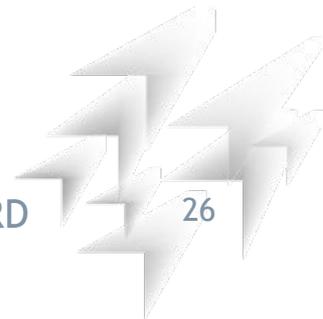


# Geospatial Data Models - Raster

All raster images are made up of up of thousands (or millions) of individual "picture elements" or pixels.



<http://gsp.humboldt.edu>

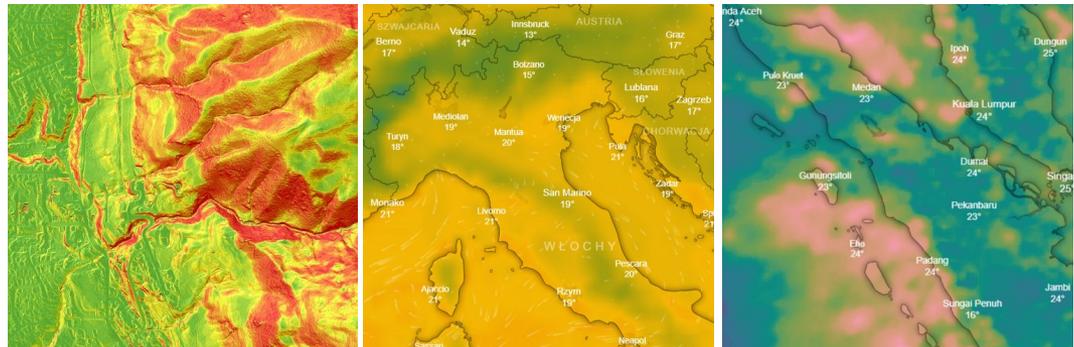


## Types of Raster Data

Rasters can represent a wide variety of data.  
The data can be **continuous** or **categorical**

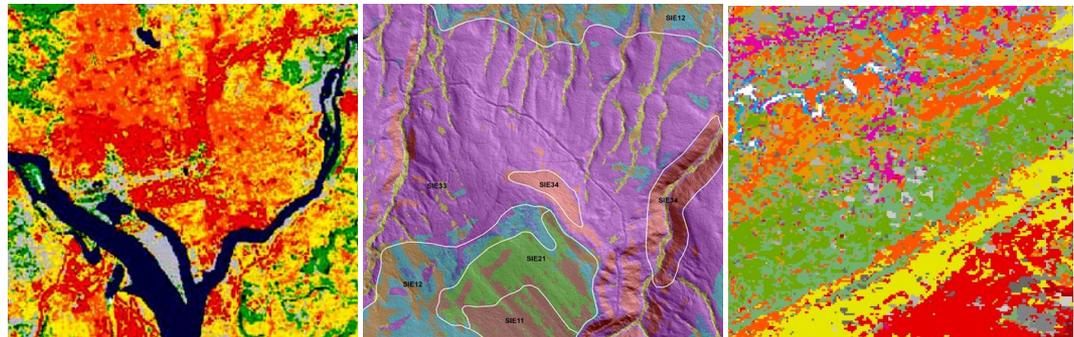
- **Continuous Data:**

- Elevation
- Temperatures
- Rainfall



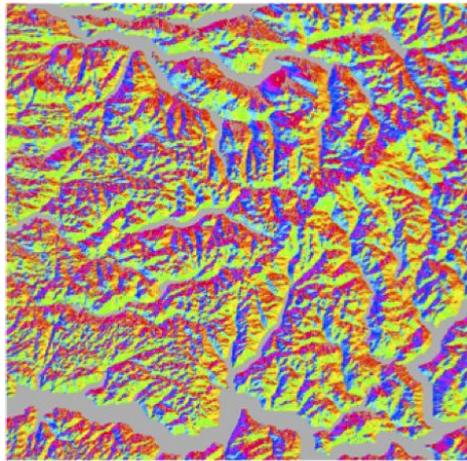
- **Categorical Data:**

- Land Cover Type
- Soil Type
- Vegetation Type



**Digital Elevation Model (DEM)** representing the heights of a territory, at a certain resolution (e.g. 1m). This is a primary data source

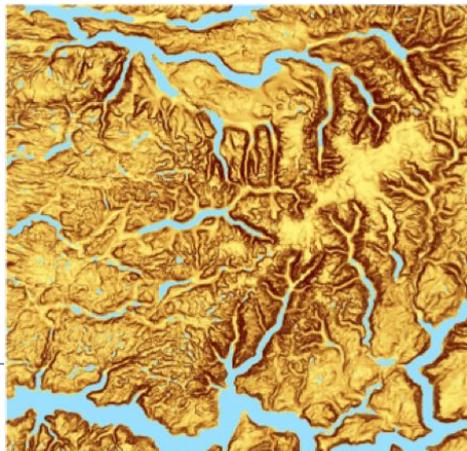
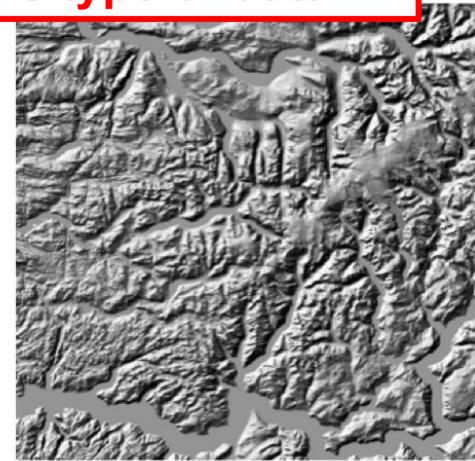
**What can you do with this type of data?**



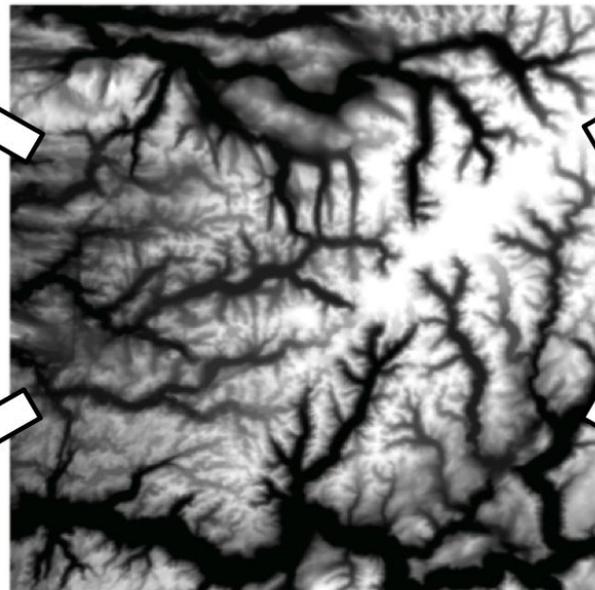
Aspect Map

Digital Elevation  
Model (DEM)

Hillshade



Slope Map

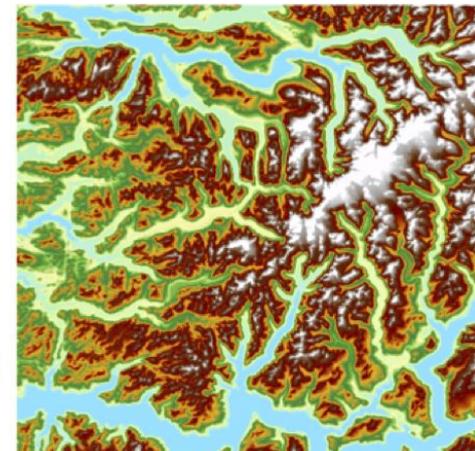


(Sognefjord, Norway -- 50 m)

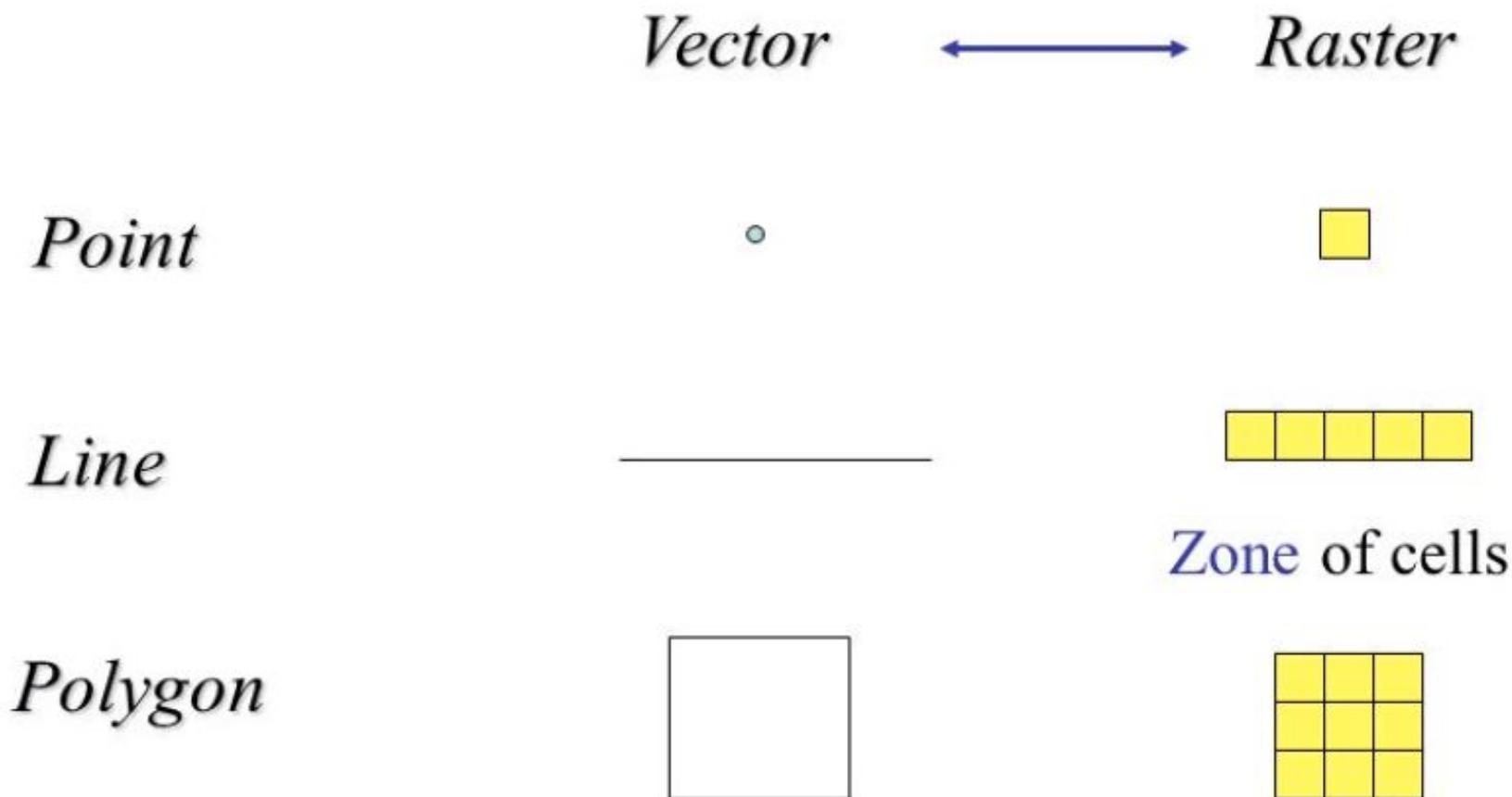
source: [data.kartverket.no / 50-m-utm-33](http://data.kartverket.no/50-m-utm-33)

Hillshade

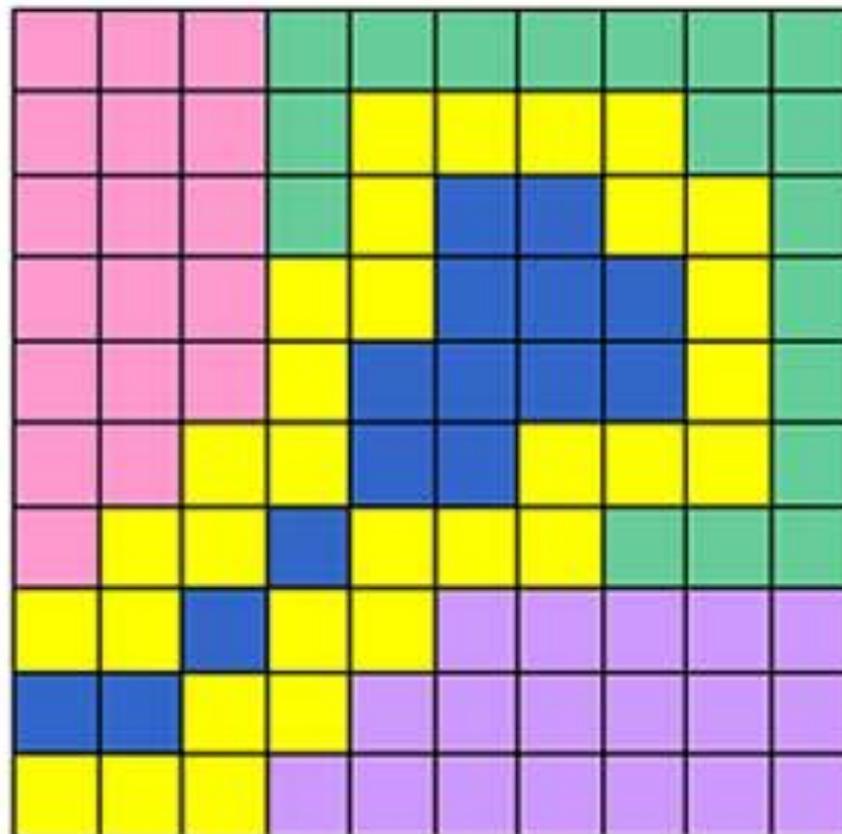
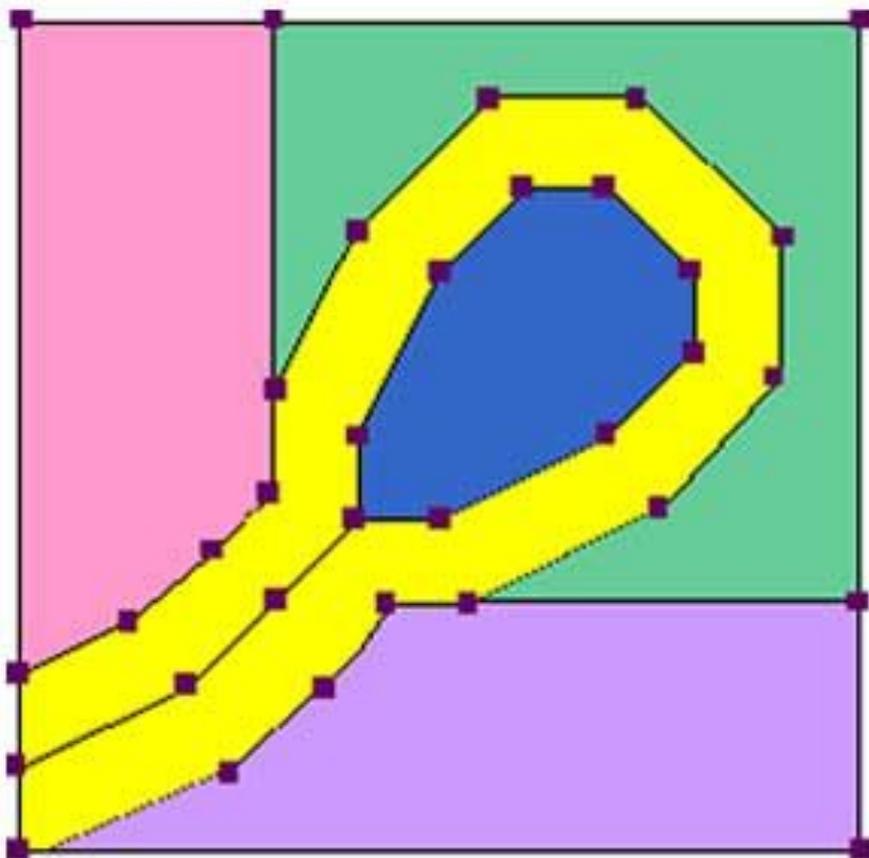
Elevation Tinted



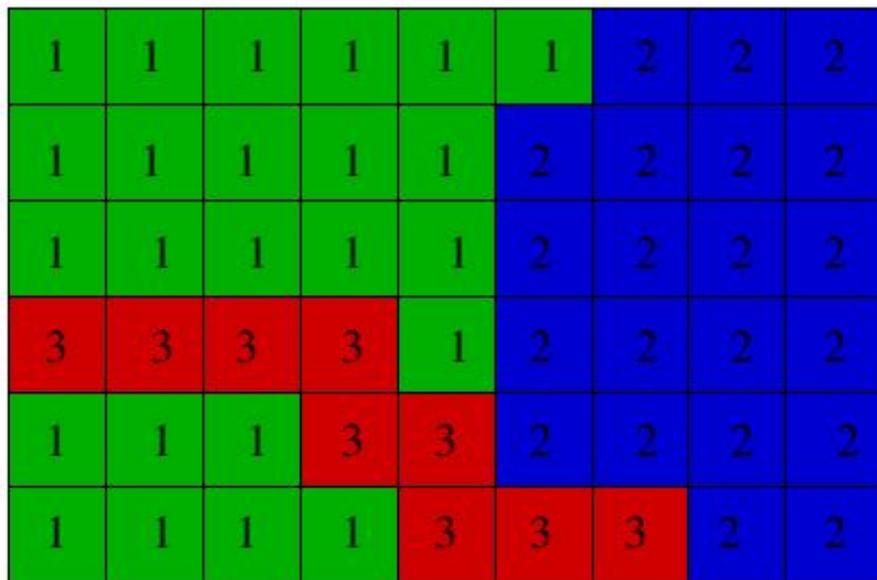
**Raster data are described by a cell grid, one value per cell**



which one is vector and which one is raster?

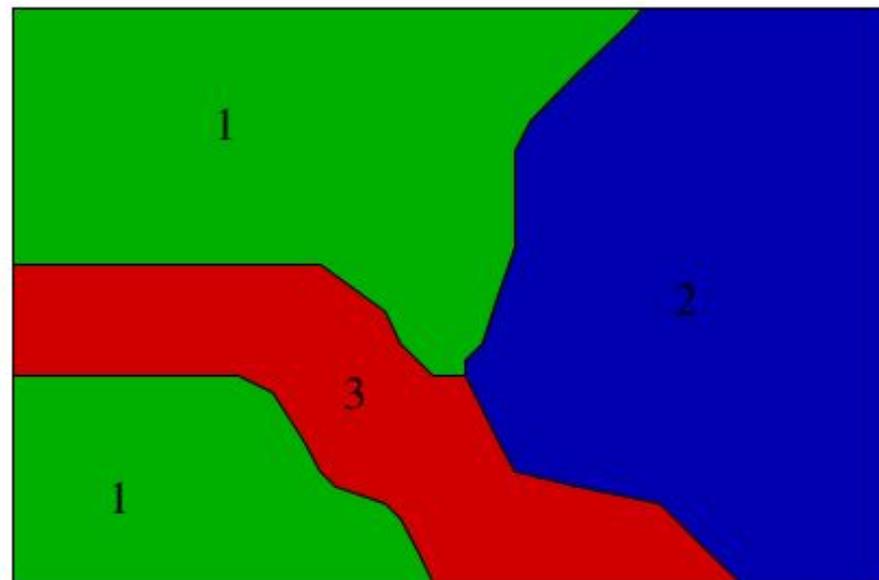


which one is vector and which one is raster?



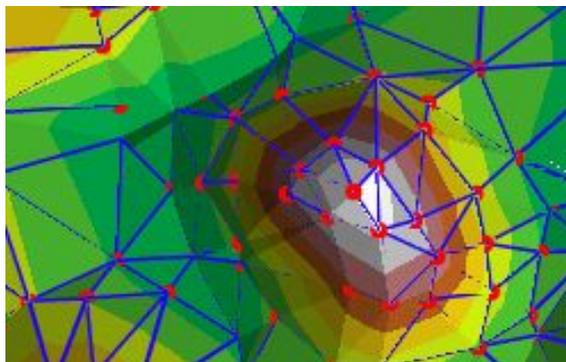
1 = greenland

2 = water



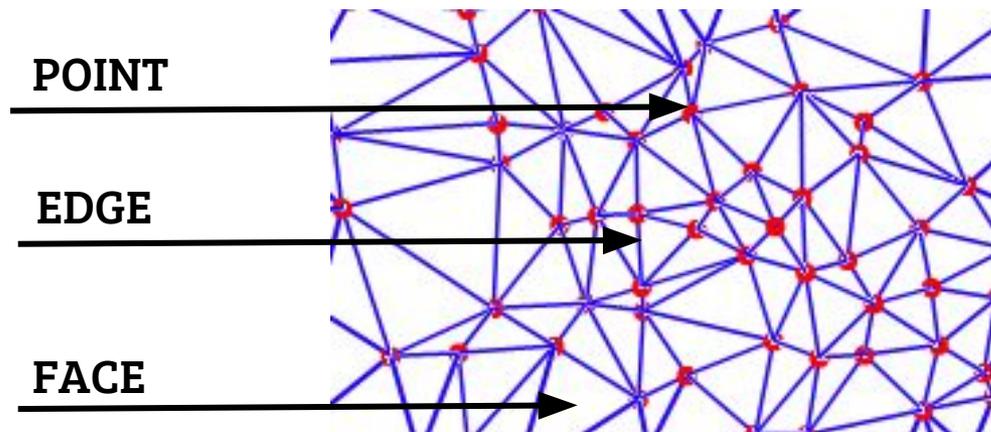
3 = urban area





**TIN** (*Triangulated Irregular Network*) is a network of triangles connected together to create a 2.5D surface where the triangles in this network are not crossing.

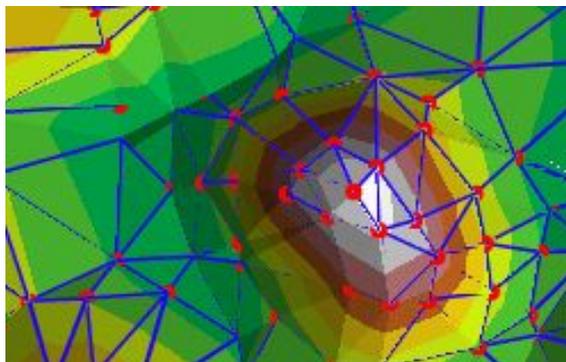
## Anatomy of a TIN



- **TIN:**

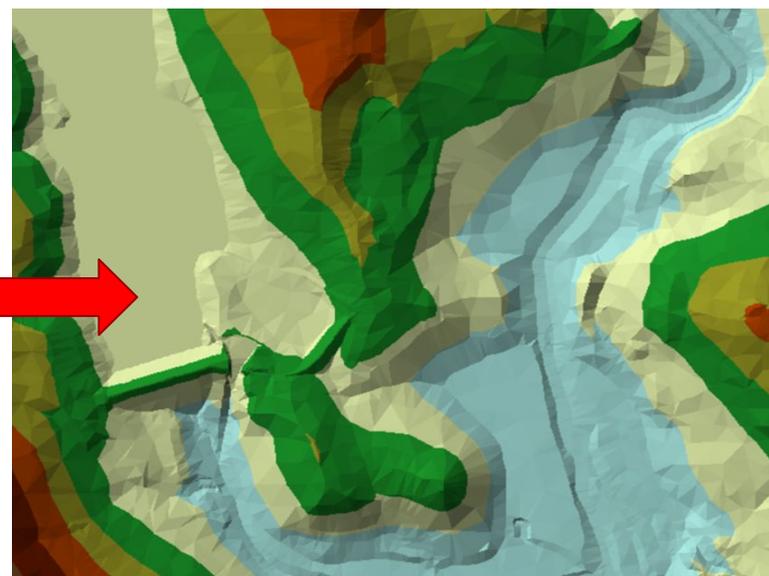
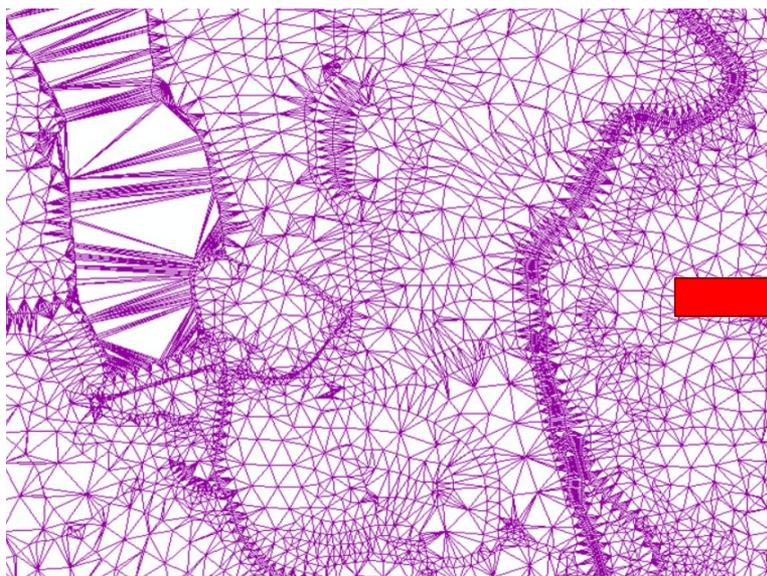
- more complex than rasters
- easily represent geometric and density changes with smoother transitions wrt rasters



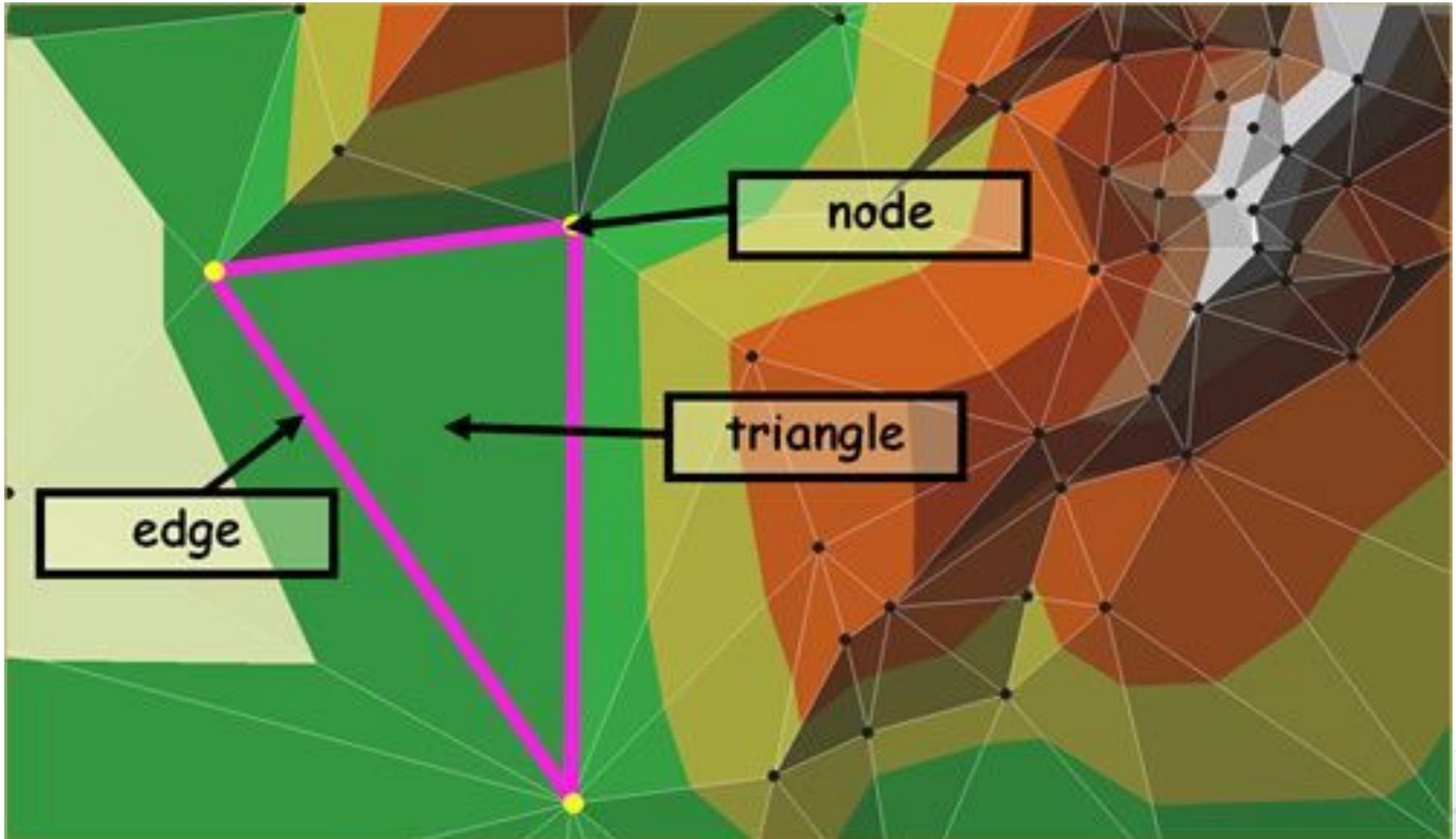


**TIN** (*Triangulated Irregular Network*) is a network of triangles connected together to create a 2.5D surface where the triangles in this network are not crossing.

**Applying Colors** based on the **elevation value**, help understand what TIN is representing.



# Geospatial Data Models - TIN Data Models





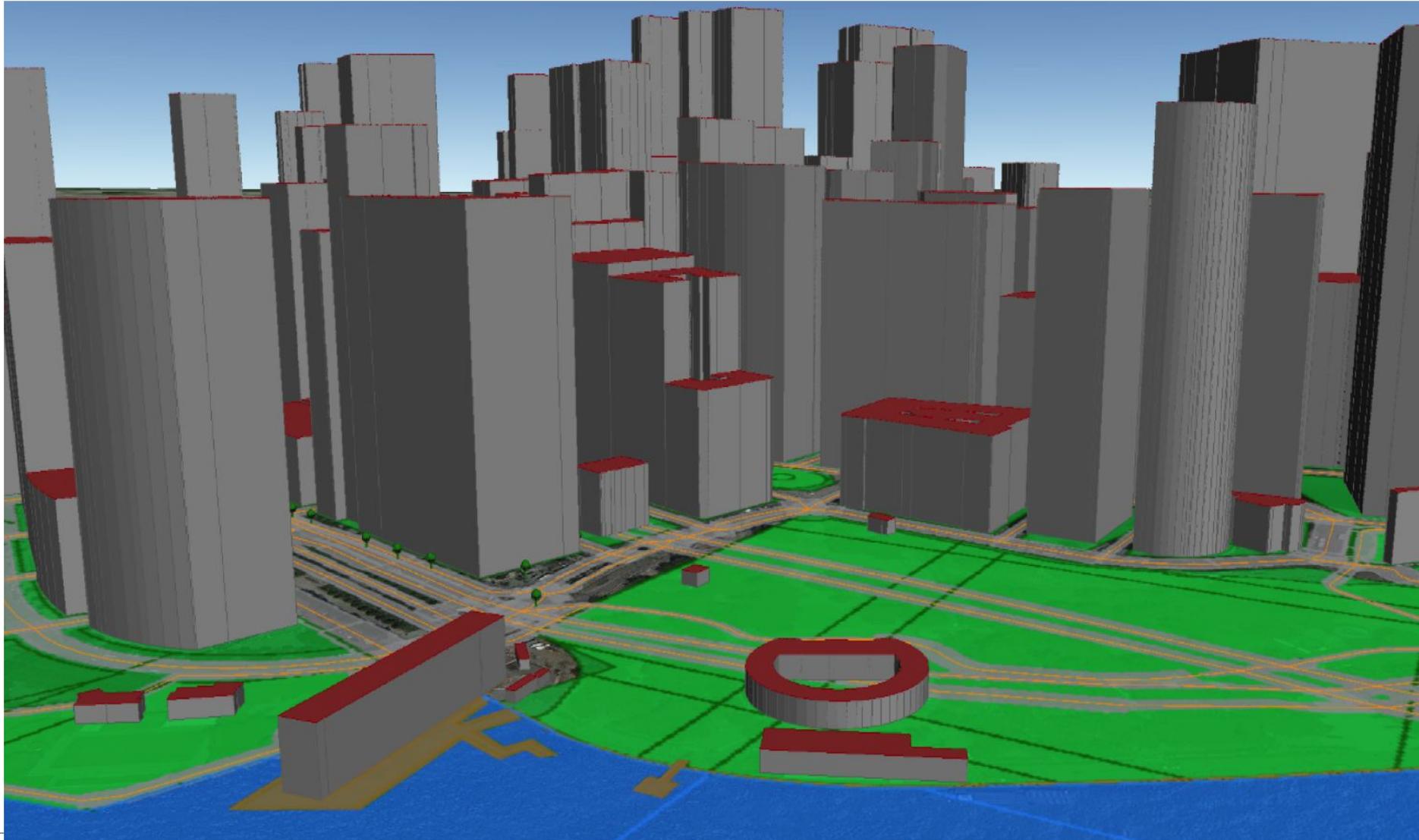
**3D data model** use a combination of geometric primitives to represent reality with 3D object. Attributes include positions, shape and size, beside textual and numerical information.

3D objects includes various geometric primitives and can be represented using different models, among:

- 3DFDS (Format Data Structure): the basis objects of the model are Body, Surface, Line and Point while the geometric elements are Node, Arc, Edge and Face.
- SSM (Simplified Spatial Model): it includes two geometric elements (Nodes and Face) and four basic objects (Point, Line, Surface and Body)
- UDM (Urban Data Model): it has four basic objects (Point, Line, Surface, Body) and two geometric elements (Node and Face)
- 3DTIN, OCTREE, CityGML, etc.



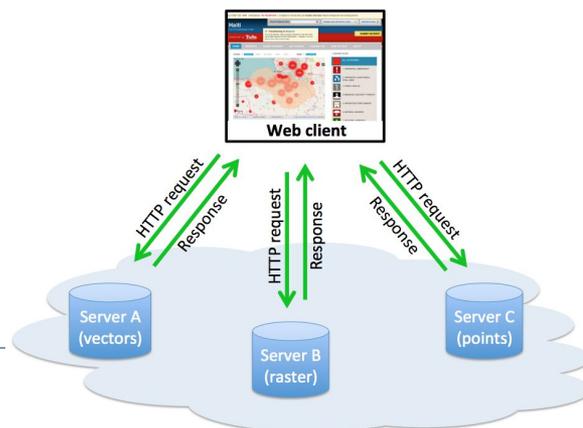
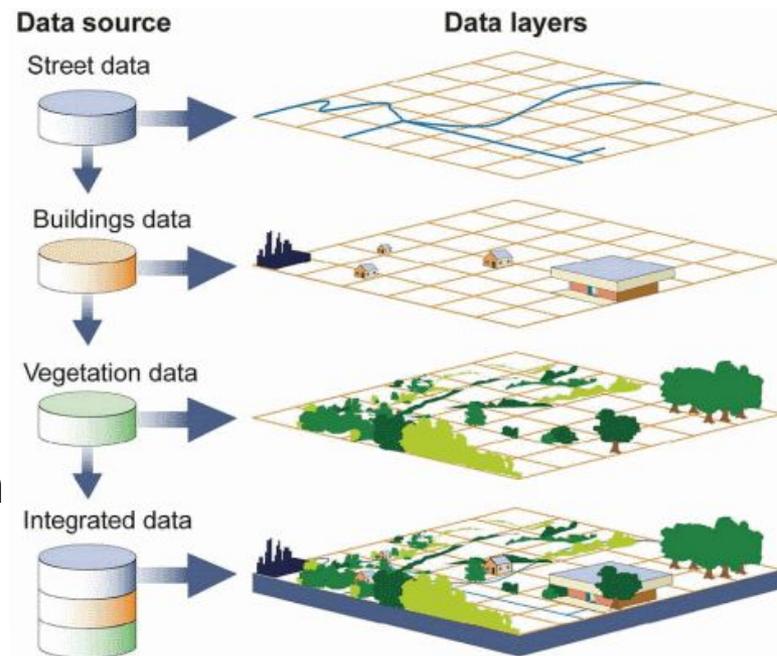
# Geospatial Data Models - 3D Models



# Geospatial Data Models - Offline vs Online

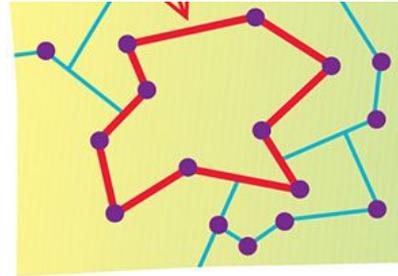
Data can be loaded and visualized into GIS environment from:

- local hard-disc of your computer
- a remote server thru specific protocols:
  - **WMS** (Web Map Service) which provides georeferenced map images,
  - **WFS** (Web Feature Service) which provide vector data
  - **WCS** (Web Coverage Service) which provides raster data.

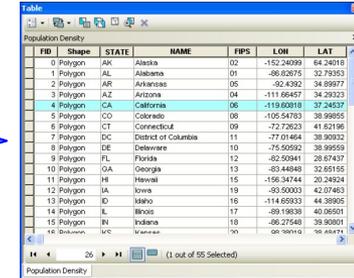


A geospatial data model is composed of two parts:  
**OBJECT** and **ATTRIBUTES**

Object



Attributes



FID	Shape	STATE	NAME	FIPS	LON	LAT
0	Polygon	AK	Alaska	02	-152.24099	64.24018
1	Polygon	AL	Alabama	01	-86.02675	32.79353
2	Polygon	AR	Arkansas	05	-92.45902	34.89977
3	Polygon	AZ	Arizona	04	-111.66457	34.28323
4	Polygon	CA	California	06	-119.69919	37.24537
5	Polygon	CO	Colorado	08	-105.54703	39.96955
6	Polygon	CT	Connecticut	09	-72.72623	41.62196
7	Polygon	DC	District of Columbia	11	-77.01464	38.90932
8	Polygon	DE	Delaware	10	-75.52692	38.99599
9	Polygon	FL	Florida	12	-82.50941	28.67437
10	Polygon	GA	Georgia	13	-83.44848	32.69155
11	Polygon	HI	Hawaii	15	-156.34744	20.24924
12	Polygon	IA	Iowa	19	-93.50003	42.07463
13	Polygon	IL	Illinois	17	-89.18939	40.26501
14	Polygon	IN	Indiana	18	-86.27548	39.80001
15	Polygon	KS	Kansas	20	-99.59521	37.33519

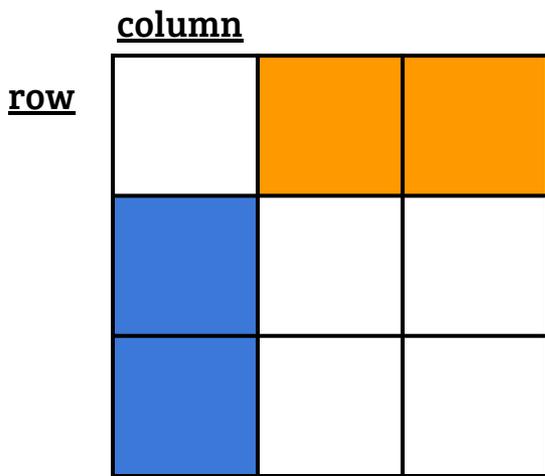
**The object** stores the geometry of the spatial phenomena that we are representing / modeling (e.g. a polygon, a vector, a point, a raster).

**The attribute** stores the descriptive information related to the object part of the geospatial data model.

Reality



# Geospatial Data Models - Attributes



**Attributes** are the non-spatial characteristics that describe spatial entities; are commonly arranged in tables.

**Row** = 1 entity of the what we are representing (e.g. a light pole in a street)

**Column** = 1 attribute (e.g. the height of the pole)

	xcoord	ycoord	ID	ID_pole	switchboard	fixtures
1	15.691667000000...	51.117381000000...	punkt 362	362	Bielanka SO-1	1
2	15.691115999999...	51.117297000000...	punkt 363	363	Bielanka SO-1	1
3	15.695456000000...	51.116553000000...	punkt 360	360	Bielanka SO-B	1
4	15.689043000000...	51.117167000000...	punkt 366	366	Bielanka SO-B	1
5	15.696315999999...	51.116475999999...	punkt 359	359	Bielanka SO-B	1
6	15.692712999999...	51.116998000000...	punkt 361	361	Bielanka SO-B	1

Attribute data are stored in a row x column table



Attributes can be split into **four different categories**:

- **nominal** provides descriptive information about the object such as: color, city name, plant type, etc; **may also be** images, movies, sounds.



ComputerHope.com



- **ordinal** attributes imply a **ranking** or **order** based on their values.  
Can be **descriptive text**, or **numerical**  
e.g. **high / low / medium** or **100 / 50 / 1**

In either case, these ordinal attributes allow us to specify **rank only**, and not scale.

**Example:** ranking the taste of the potato chips on a scale from **1- 10**.



- **interval** attributes imply a **rank order** and **magnitude** or **scale** and use numbers, however those numbers do not have a natural zero.

**Example:** calendar dates,  
temperatures in Celsius or Fahrenheit.



- **ratio** attribute implies **both rank order** and **magnitude** about a natural zero. Uses numerical attributes and addition, subtraction, multiplication, and division makes sense, as the values are absolute from a natural zero.

**Example:** monetary quantities, age, mass, length, rainfall.



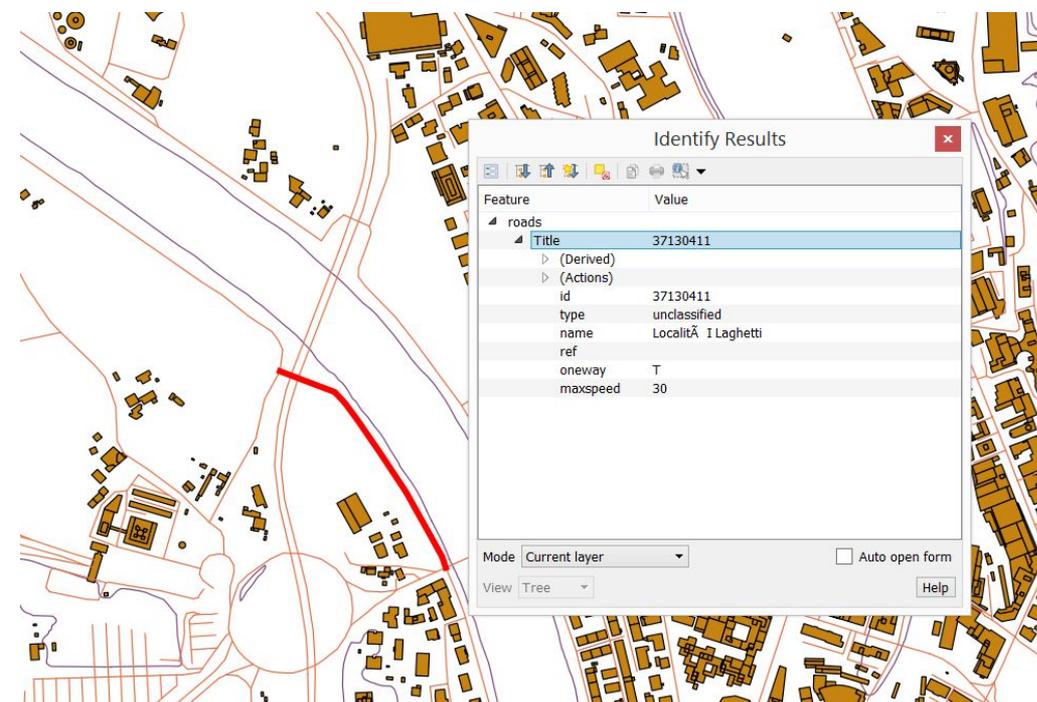
Attributes can be stored using **different type of representations:**

- **integer** is a **whole number**, such as the **number one**, the **number 2458**, and the **number -54**. Integers can be used for **mathematical calculations**, however, any resulting fraction of a whole number will be **rounded, or truncated**.
- **float or real** data type holds a **decimal number** such as the number 1.452, the number 254,783.1, or -845.157.
- **text or string** data type contains **characters** such as character “A”, the characters “GIS”, the characters “125 Main St.”, or the number “9”.
- **data** data type holds **time and date information** such as 12/10/2010, or 10/12/10, or **December 10, 2010**.
- **binary large object (BLOB)** a collection of binary data stored as a single entity. Blobs are typically **images, audio** or other **multimedia objects**.

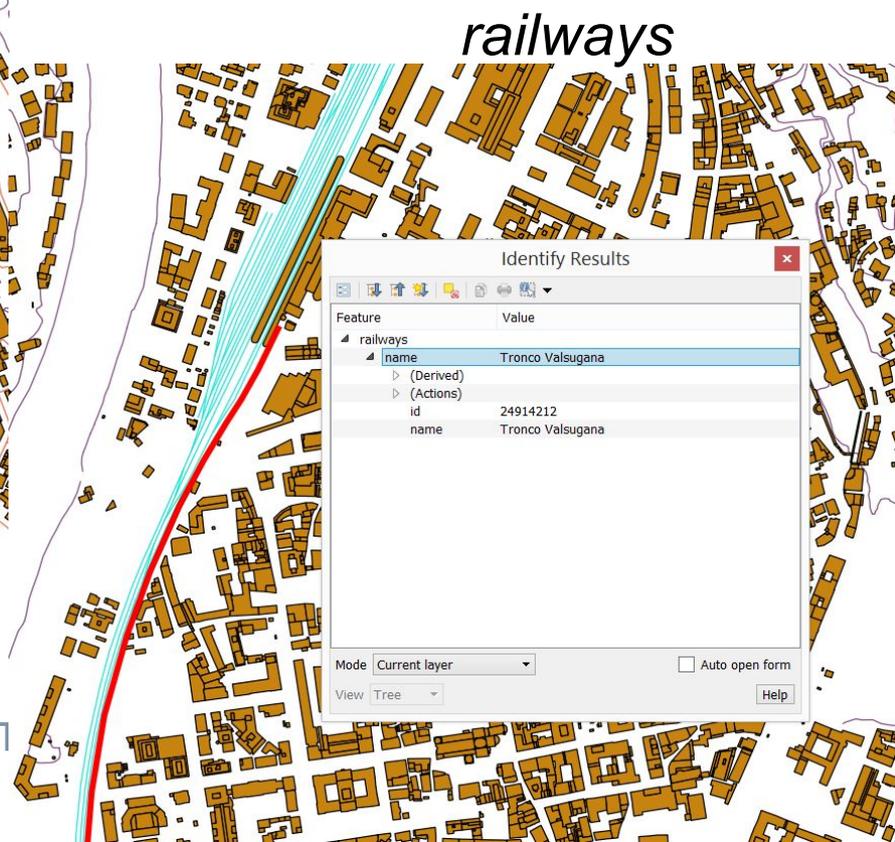


# Geospatial Data Models - **Attributes vs Databases**

- A **database** is a collection of **attribute** tables
  - streets, railways and bike paths are vector data (type = polylines) with different attributes



*streets*



*railways*



# Geospatial Data Models - **Attributes vs Databases**

- A **database management system** (DBMS) is an information system that people use to store, update and analyze non-geographic databases sharing a common attribute

Parcels feature class

Shape	ID	PIN	Area	Addr	Code
	1	334-1626-001	7,342	341 Cherry Ct.	SFR
	2	334-1626-002	8,020	343 Cherry Ct.	UND
	3	334-1626-003	10,031	345 Cherry Ct.	SFR
	4	334-1626-004	9,254	347 Cherry Ct.	SFR
	5	334-1626-005	8,856	348 Cherry Ct.	UND
	6	334-1626-006	9,975	346 Cherry Ct.	SFR
	7	334-1626-007	8,230	344 Cherry Ct.	SFR
	8	334-1626-008	8,645	342 Cherry Ct.	SFR

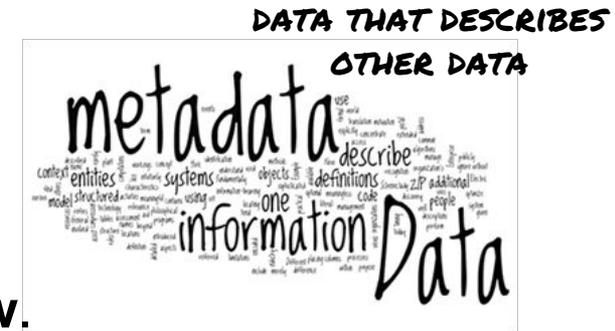
Related ownership table

PIN	Owner	Acq.Date	Assessed	TaxStat
334-1626-001	G. Hall	1995/10/20	\$115,500.00	02
334-1626-002	H. L. Holmes	1993/10/06	\$24,375.00	01
334-1626-003	W. Rodgers	1980/09/24	\$175,500.00	02
334-1626-004	J. Williamson	1974/09/20	\$135,750.00	02
334-1626-005	P. Goodman	1966/06/06	\$30,350.00	02
334-1626-006	K. Staley	1942/10/24	\$120,750.00	02
334-1626-007	J. Dormandy	1996/01/27	\$110,650.00	01
334-1626-008	S. Gooley	2000/05/31	\$145,750.00	02



## The **meta-DATA**:

- is an **identity card** of data,
- is the **documentation** of data,
- defines **who, what, when, where, why** and **how**.



- How, when, where, and by whom the data was collected.
- Availability and distribution information.
- Its projection, scale, resolution and accuracy.
- Its reliability with regard to some standard.

## Why use and create metadata?

- To help organize and maintain an organization's spatial data.
- To provide information to other organizations to facilitate data sharing and transfer.
- To document the history of a spatial data set.

# Geospatial Data Models - **Metadata**

Government authorities, businesses and citizens need to easily share and use spatial data for making the right decisions about our environment and well-being in a timely manner



The **Infrastructure for Spatial Information in Europe (INSPIRE)** is a European Directive 2007/2/EC of 25/04/2007



**Its goal** is for an Internet-accessible infrastructure of technologies and permissions to tie European geospatial information producers and users together into a single geospatial information-sharing community to improve decision making and operations in service of a productive and sustainable Europe.

## **INSPIRE METADATA**

INSPIRE hosts a **metadata catalog**.



# Geospatial Data Models - INSPIRE - Metadata

INSPIRE GEOPORTAL  
Enhancing access to European spatial data

EUROPEAN COMMISSION > INSPIRE > INSPIRE GEOPORTAL > Metadata Editor

New Open Validate Save Save as template Help About | INSPIRE Spatial Dataset - en

Metadata Identification Classification Keyword Geographic Temporal Quality&Validity Conformity Constraints Responsible party

### Metadata on metadata

▼ Metadata point of contact (\*) ⓘ

▼ Point of contact 1

▼ Organisation name (\*)

▼ E-mail (\*) ⓘ

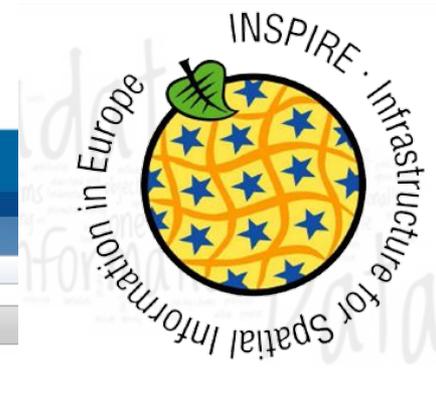
▼ Metadata date ⓘ

2018-10-16

▼ Metadata language (\*) ⓘ

english ▼

(\*) This field is mandatory

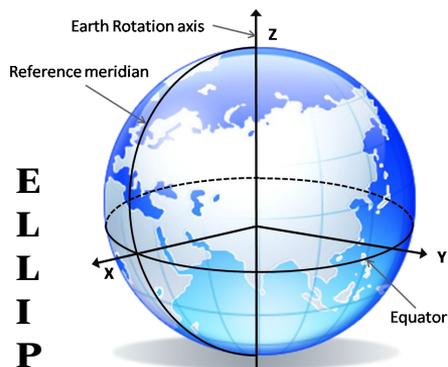
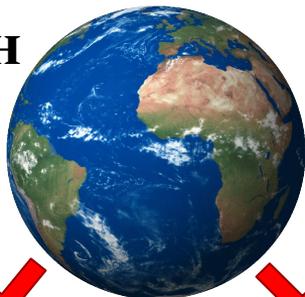


# Coordinate Systems and Map Projections

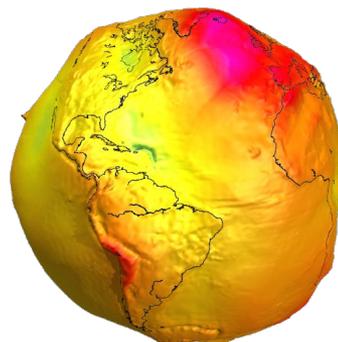


## EARTH AND ITS SHAPE

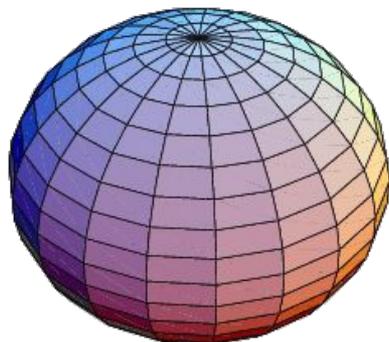
**EARTH**



E  
L  
L  
I  
P  
S  
O  
I  
D



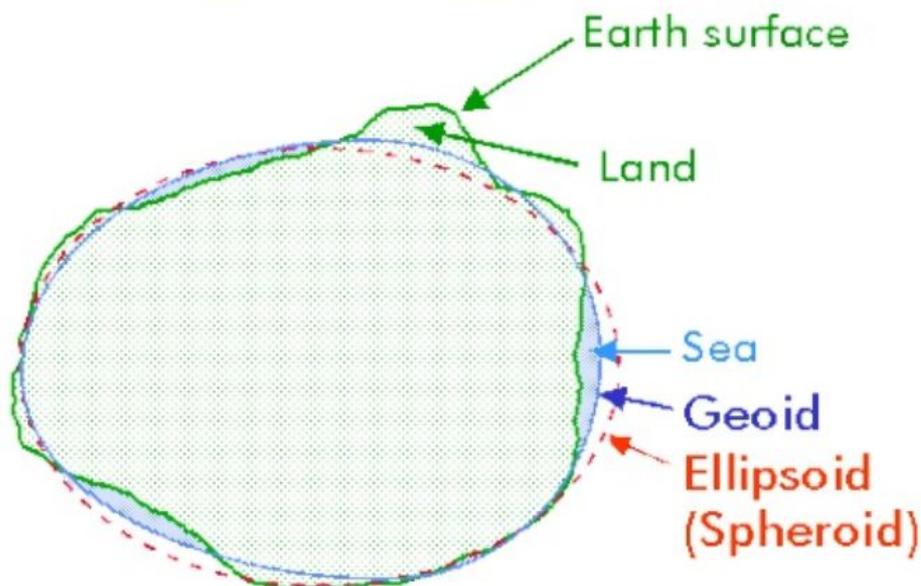
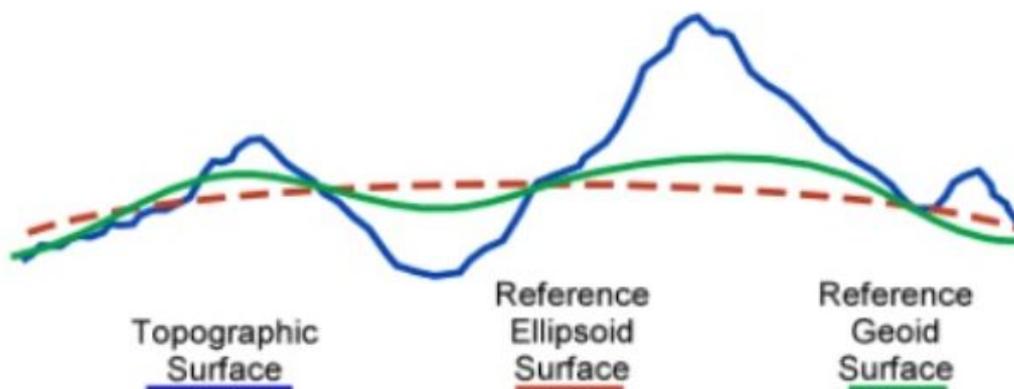
**GEOID**



- Earth is almost a sphere, **slightly flattened at the poles** and somehow **fat at the equator**.
- So, mathematically, the Earth is **not a sphere**.
- Mathematical regular shape: **Ellipsoid** i.e. a geometrical figure which would be obtained by rotating an ellipse about its **shorter axis**.
- Mathematical idealized and irregular representation: **Geoid**, i.e. a surface whose shape results from the uneven distribution of mass within and on the surface of Earth. Geoid is smoother than Earth's physical surface.

## ELLIPSOID VS GEOID

Surface Comparison



- The **reference ellipsoid** surface (a map of average sea level).
- The **reference geoid** surface- in continental areas, the reference geoid can be estimated as the level that would be taken by the surface of the sea in a set of criss-crossing canals stretching across the land from coast to coast. (a mean sea level surface).
- The **real surface** of the Earth (the ground) also called the **topographic surface**.

# Coordinate Systems and Map Projections

To uniquely identify a point on Earth, we need to define a **coordinate system**. It lets us define where a location is in space. In GIS, there are many types of coordinate systems, of which the two most used are **geographic (3D)** and **projected (2D)**.



**Geographic (3D)**

**Geographic Coordinate System** - uses **latitude** and **longitude** to represent the x, y position in space



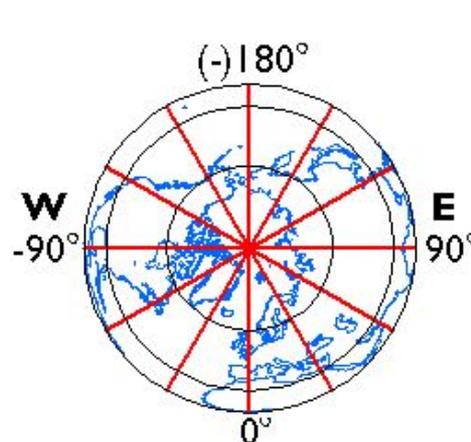
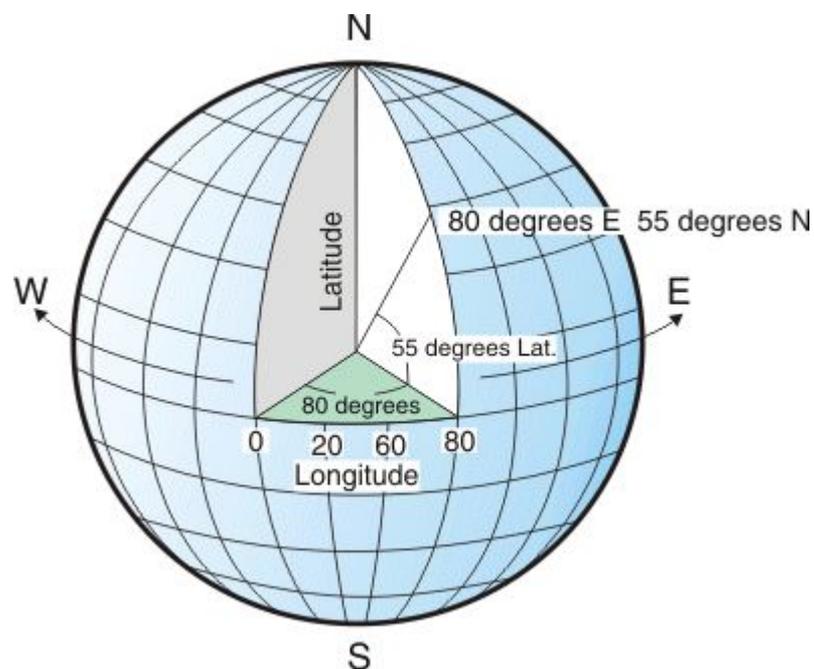
**Projected (2D)**

**Map Projection (Rectangular Coordinate System)** - the transformation of the Earth's spheroid (real world) to flat surface (abstraction)

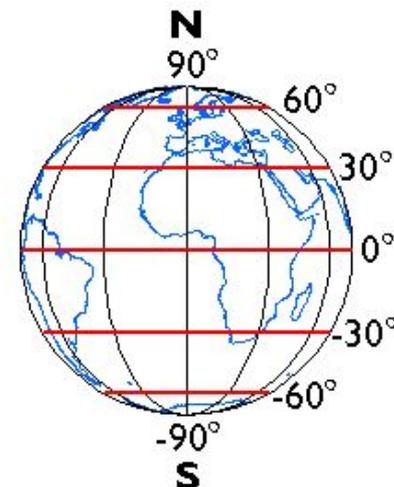
<https://communityhub.esriuk.com>



**Geographic Coordinate System (GCS)** uses a three-dimensional spherical surface to define locations on the earth. It defines a real world point on a 3 dimensional digital surface using 3 coordinates.



**Longitude**  
↓  
**Meridians**



**Latitude**  
↓  
**Parallels**

Among the most used GCS, we have the **WGS84** (World Geodetic Survey 1984), also used for GPS measurements.



## FROM **Geographic Coordinate System**

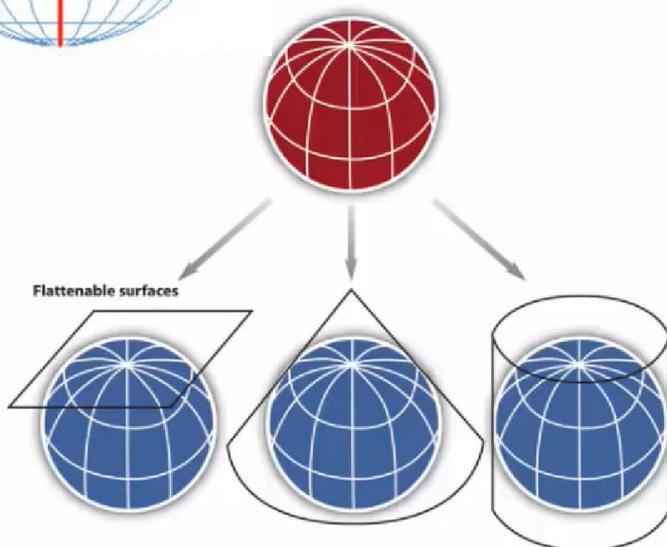
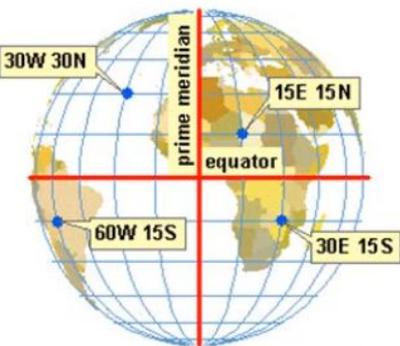
...we need a mathematical process to transform features from one (spherical) surface onto another (planar)

surface... this is called

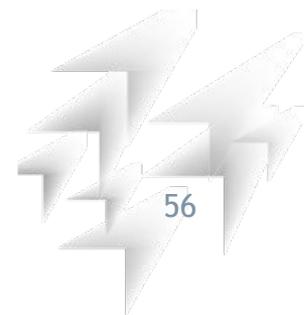
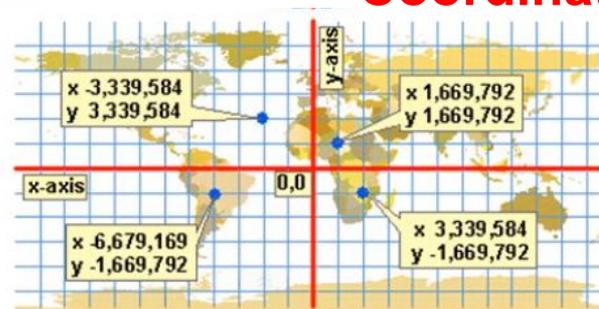
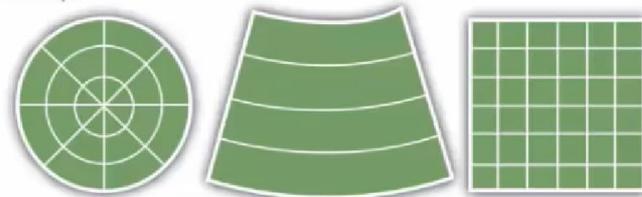
## MAP PROJECTION

TO **Plane/Rectangular Coordinate System**

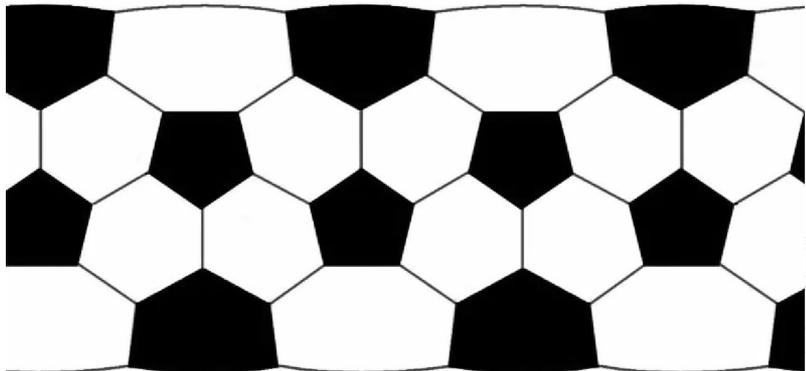
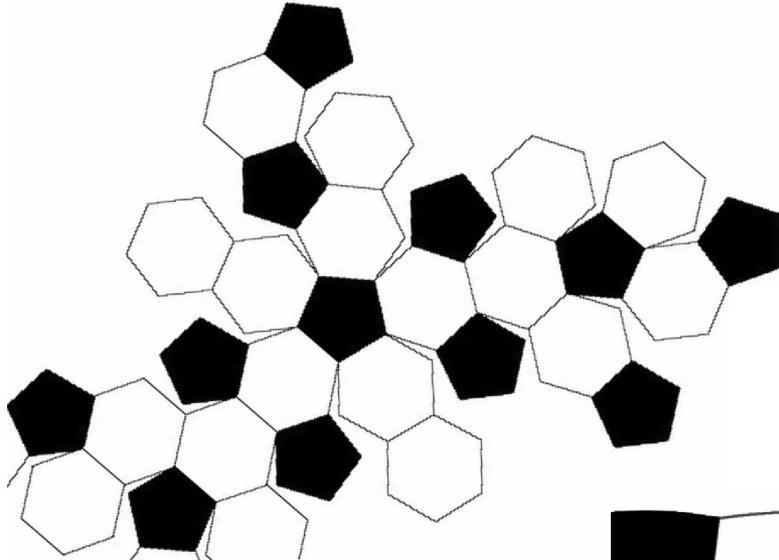
TRANSFORMATION



Flat maps

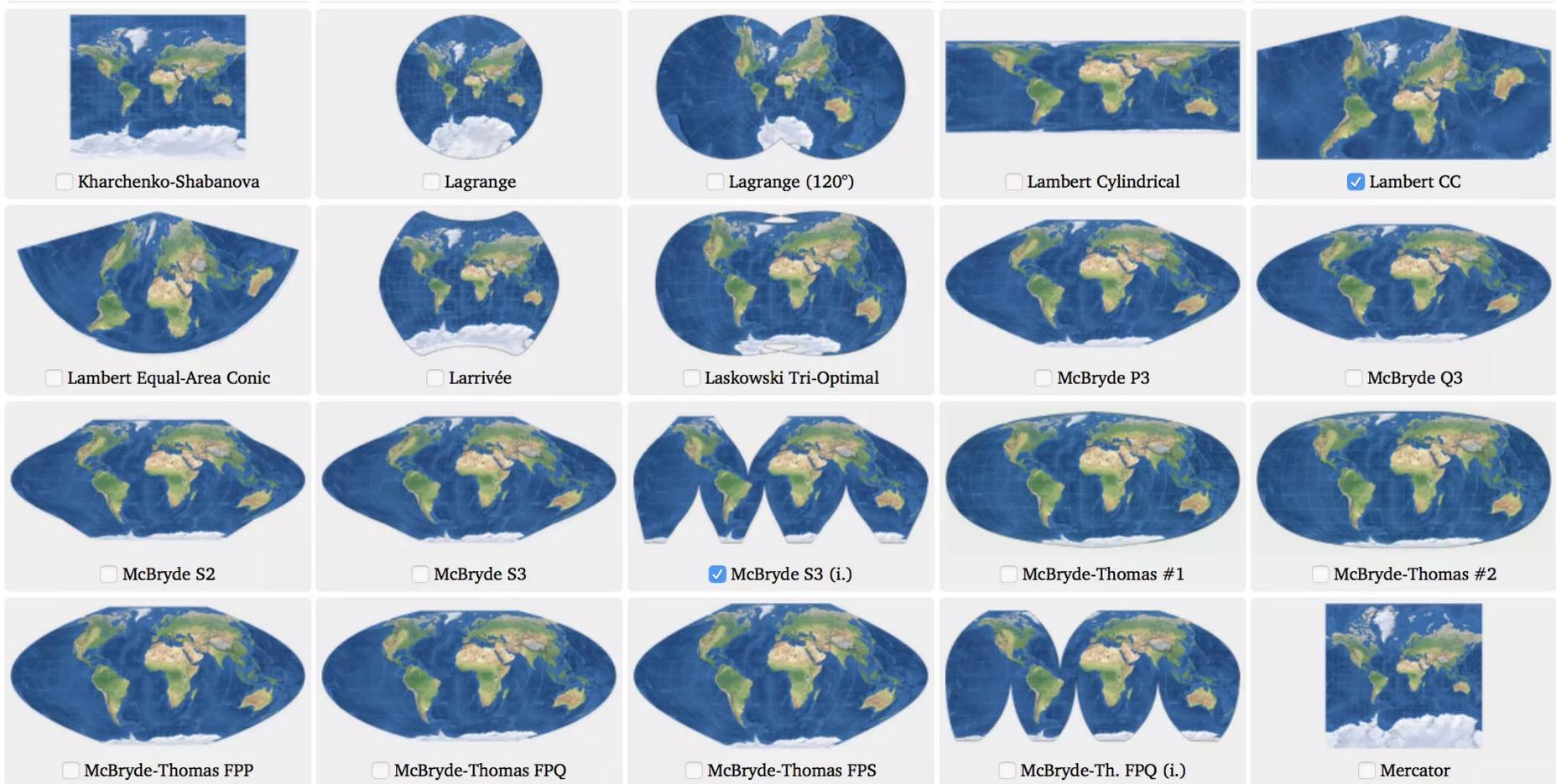


## TRANSFORMATION - EXAMPLE

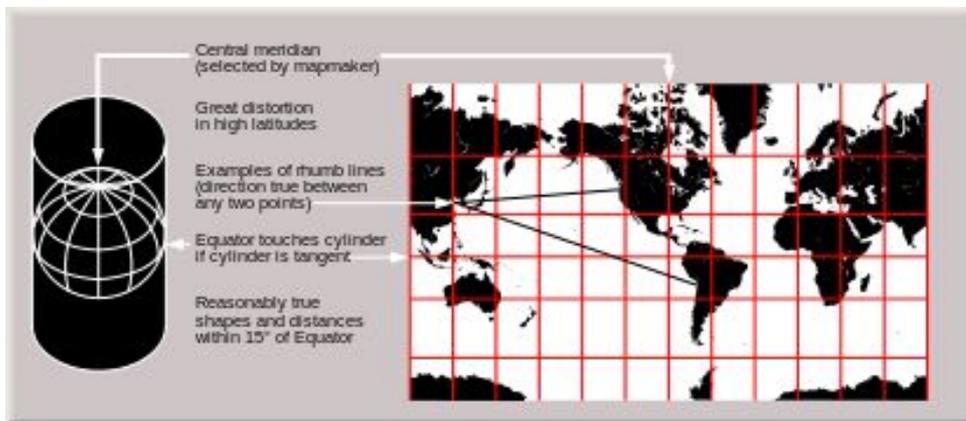


# Coordinate Systems and Map Projections

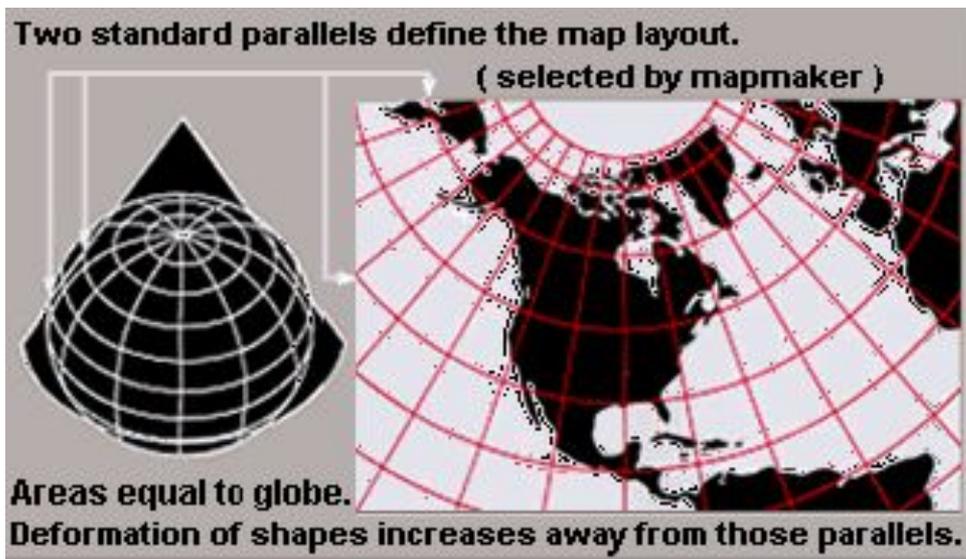
A map projection is based on **projection surface** (e.g. cylinder, cone, etc.) and **some assumptions** (e.g. same areas, same distances, same scale, etc.)



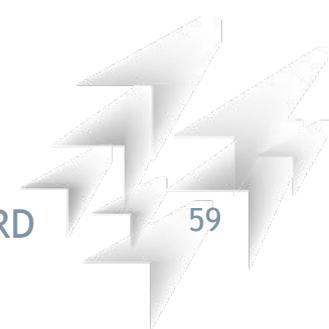
# Coordinate Systems and Map Projections



Cylindrical projection

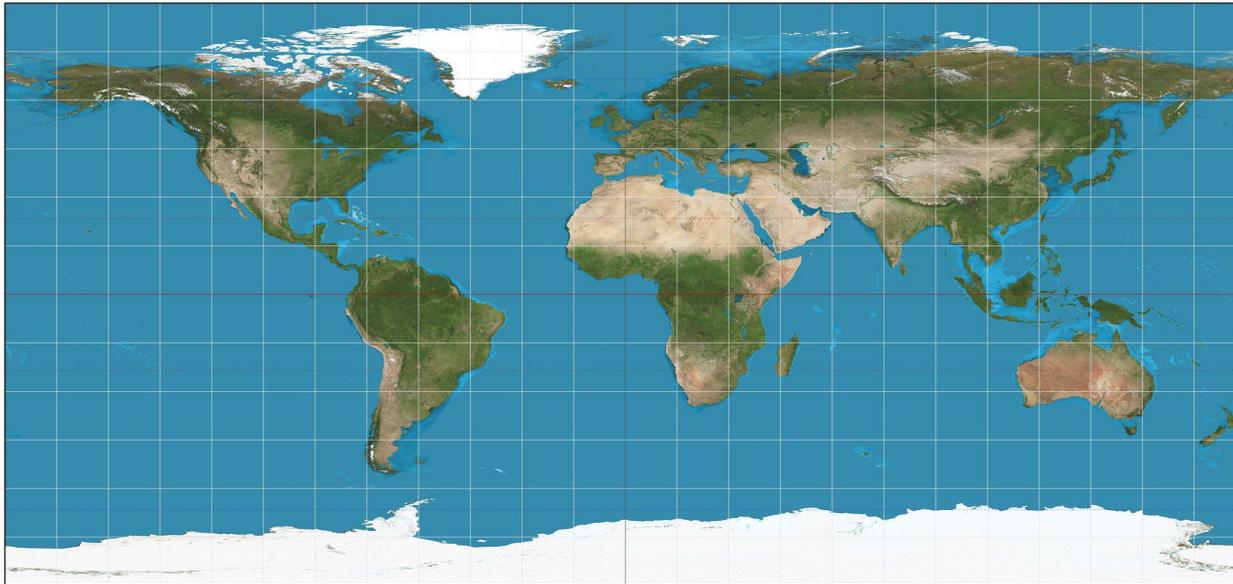


Conic projection

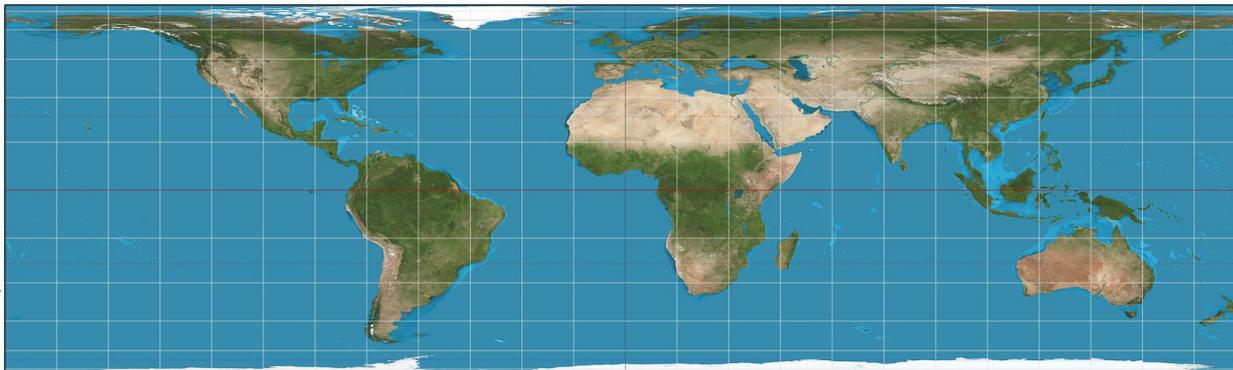


# Coordinate Systems and Map Projections

Assumptions, i.e. preservation of some metric properties: conformal (preserve angles and scale), equal-area (preserve area measure, generally distorting shapes), equidistant (distances), etc.

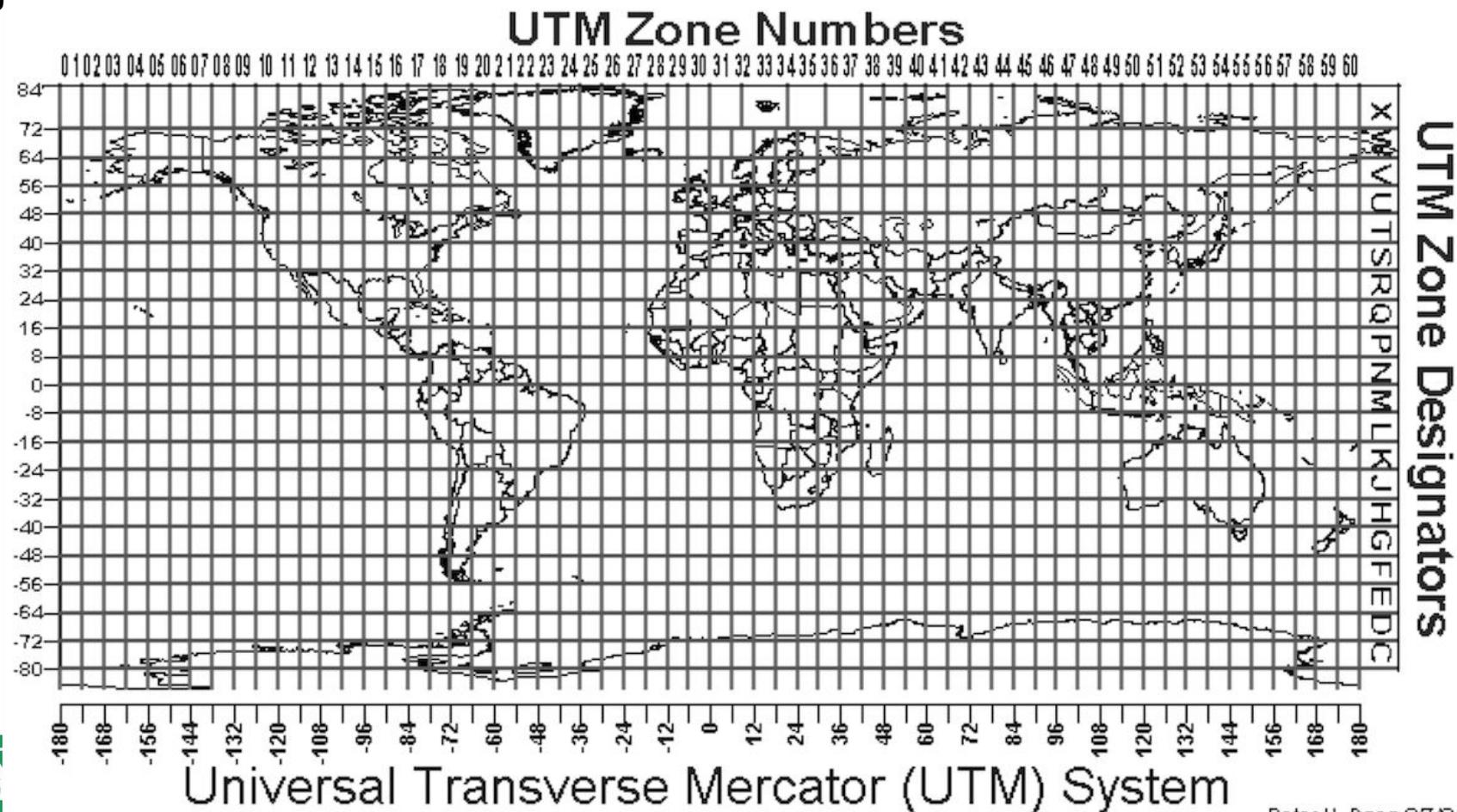


Cylindrical equidistant



Cylindrical equal-area

Plane coordinate system most frequently used: **UTM**  
**(Universal Transverse Mercator)**, i.e. a conformal cylindrical  
projection



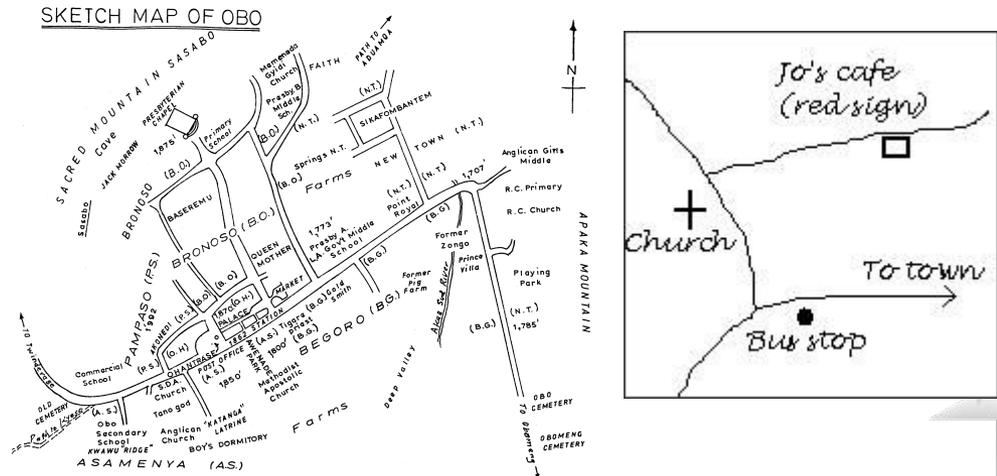
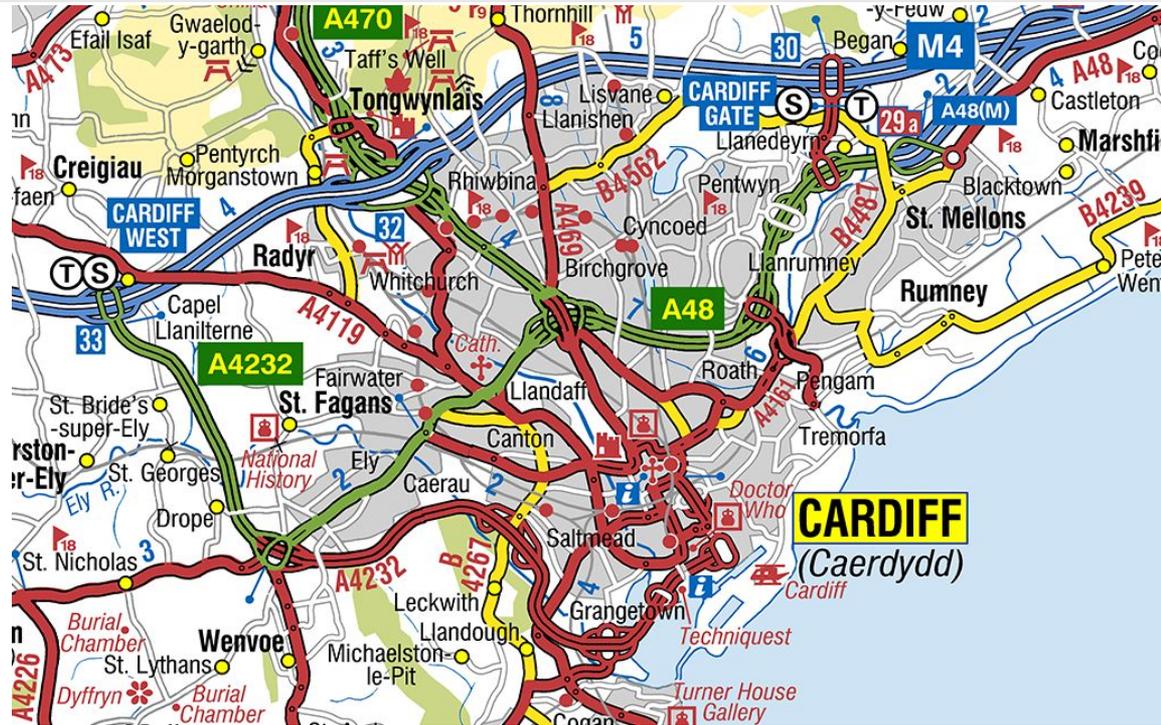
Generally there are two kinds of maps: **reference maps** and **thematic maps**.

## General Reference Maps:

- A highly generalized map type designed to show general spatial properties of features.
- Examples are **world maps, road maps, atlas maps, etc.**



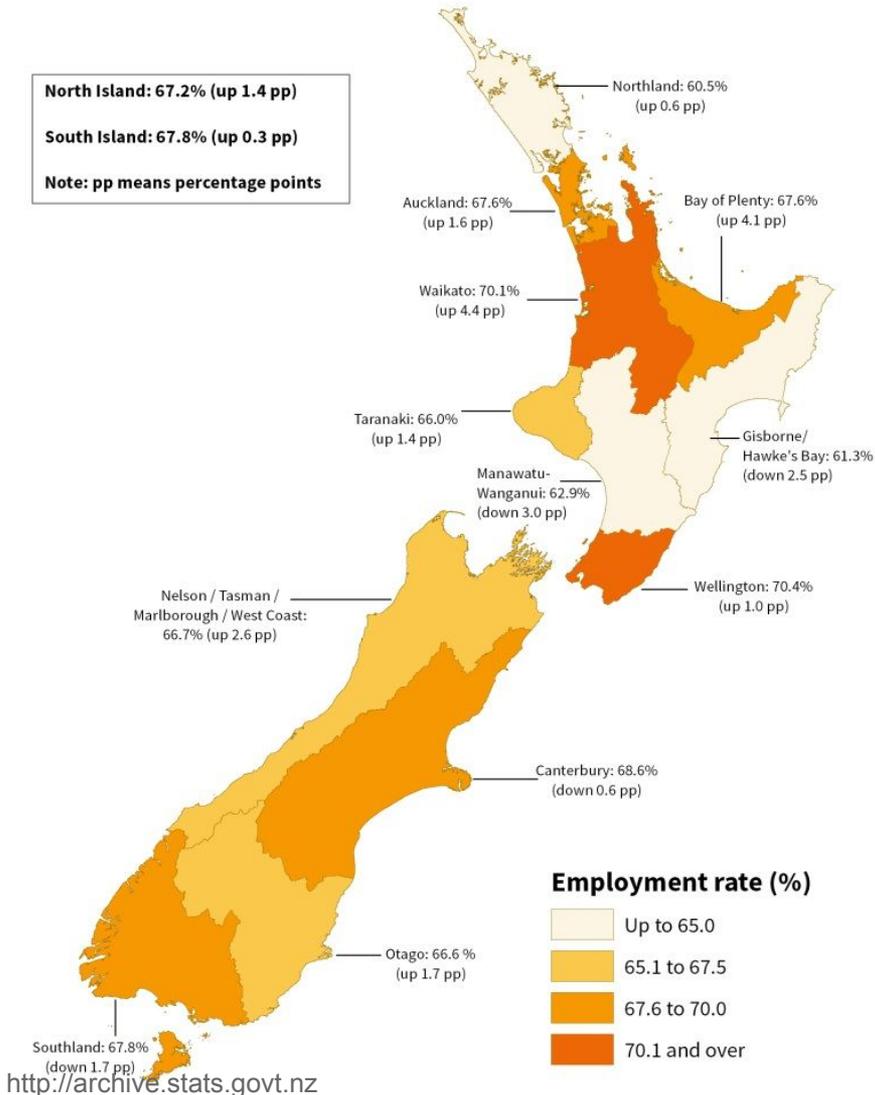
# MAPS in GIS



## Employment rates by regional council area

September 2017 quarter (compared with September 2016 quarter)

North Island: 67.2% (up 1.4 pp)  
South Island: 67.8% (up 0.3 pp)  
Note: pp means percentage points

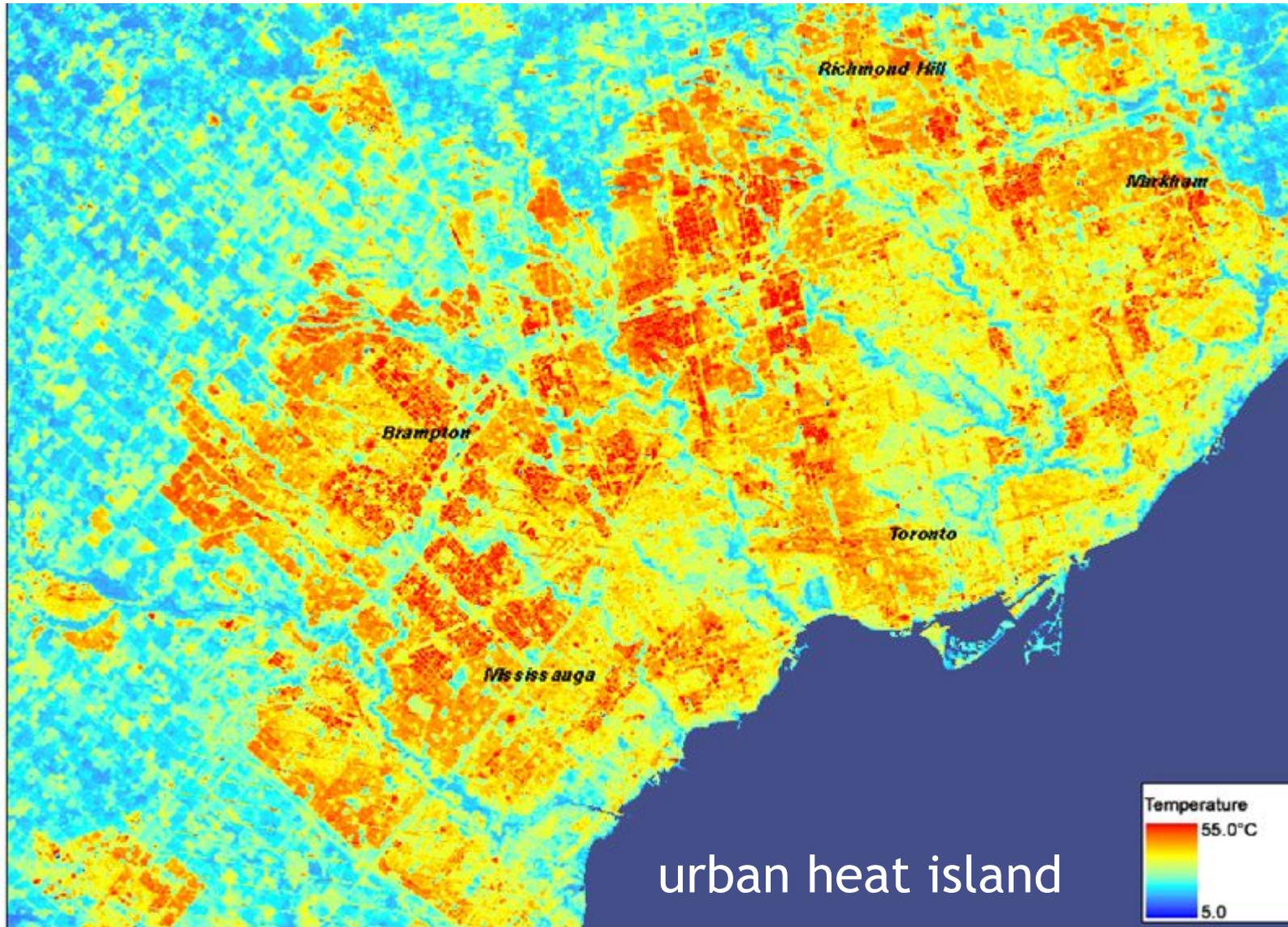


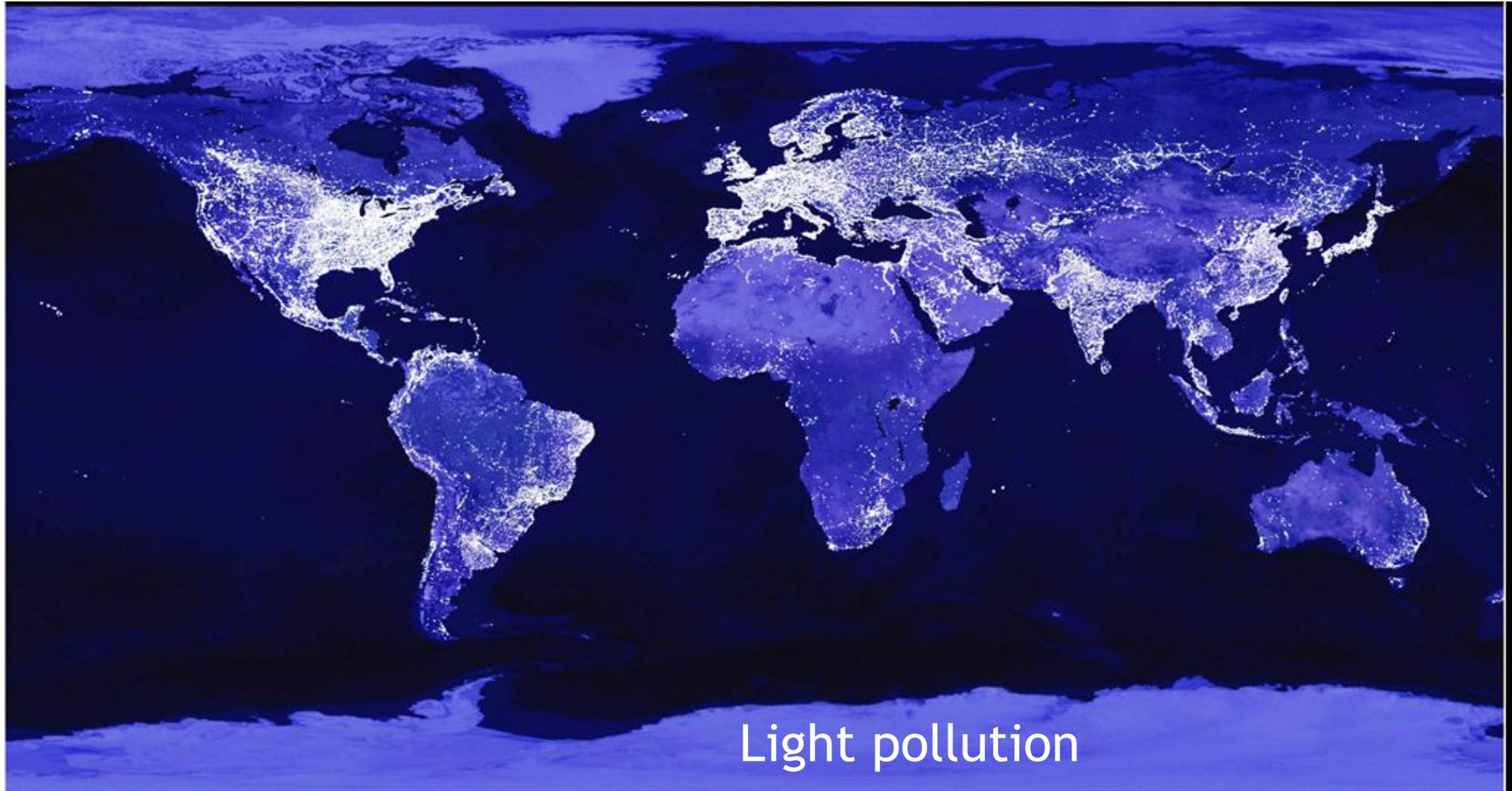
Generally there are two kinds of maps: **reference maps** and **thematic maps**.

## Thematic Maps:

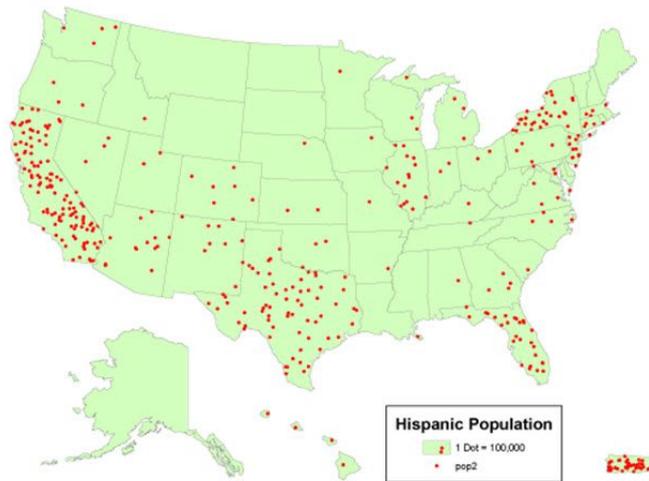
- A thematic map shows georeferenced data, numeric or character, by **colors** or **symbols**.
- **Specific data** displayed in this manner is referred to as a **theme**.
- Different types of thematic maps, useful for showing different types of thematic variables.
- Obtained “**manipulating**” attributes of layers
- Examples are **dot**, **isoline**, **choropleth** or **cartogram**.

# MAPS in GIS



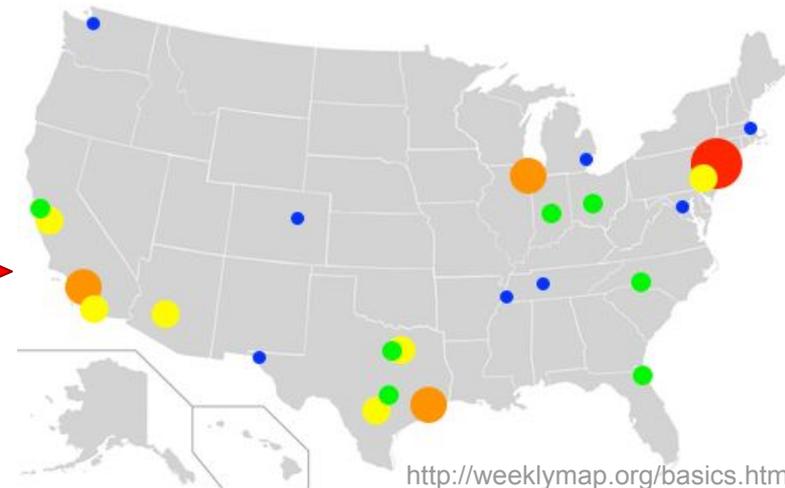


**Dot**, isoline, choropleth or cartogram maps

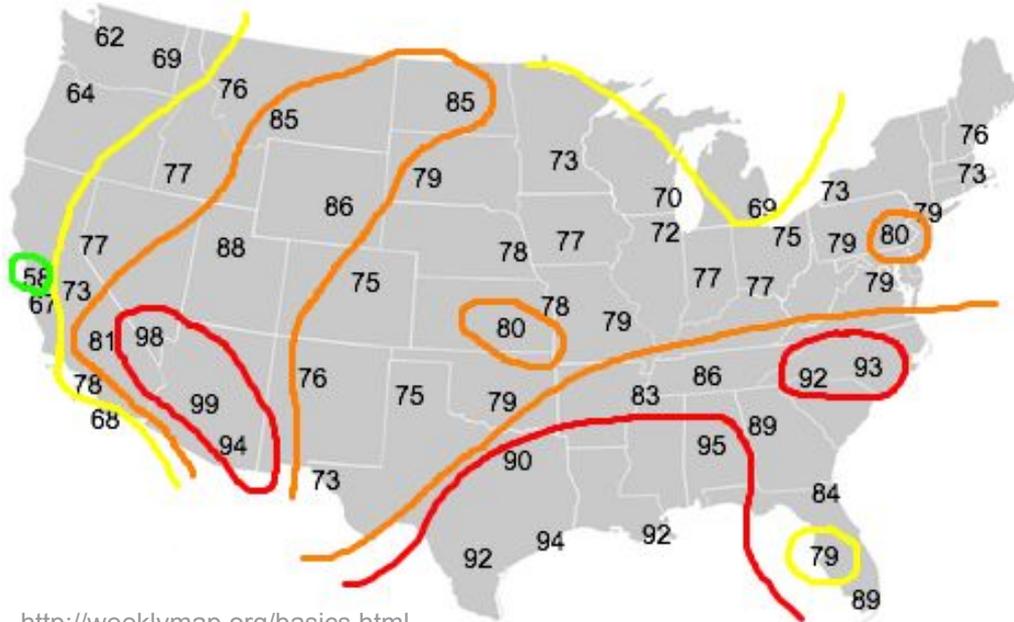


- The dots represent the **frequency of some variable**.

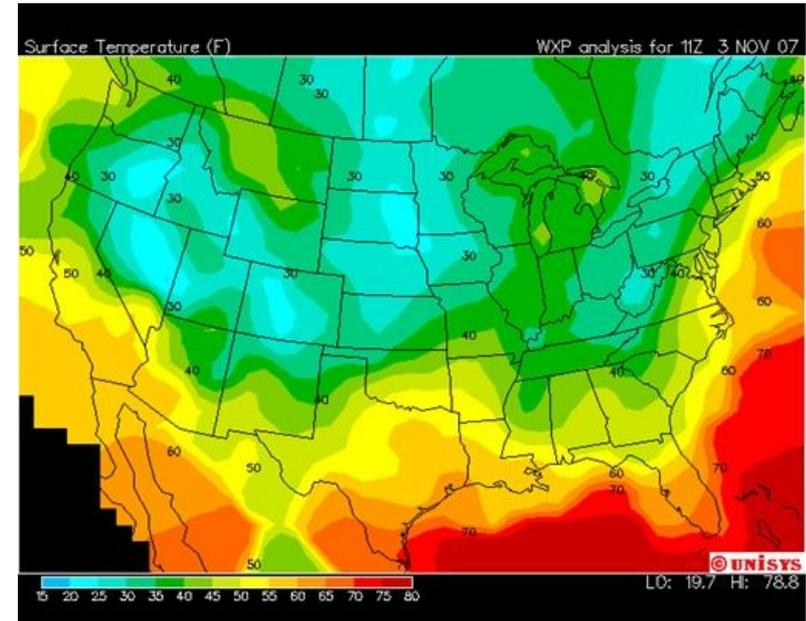
Dot maps can be unsatisfying, however, because they depict all data with dots of the same size. An alternative method is to use a **proportional symbol map**, which uses larger dots for data points of larger size.



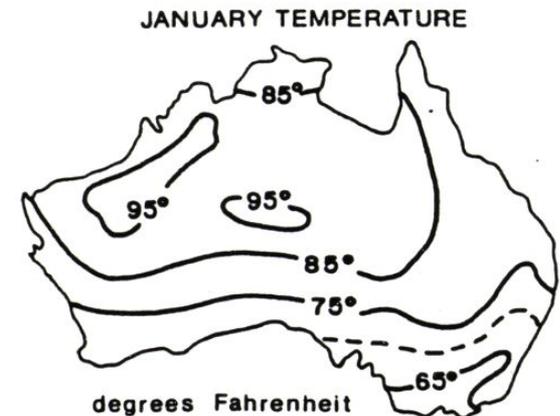
Dot, **isoline**, choropleth or cartogram maps



<http://weeklymap.org/basics.html>

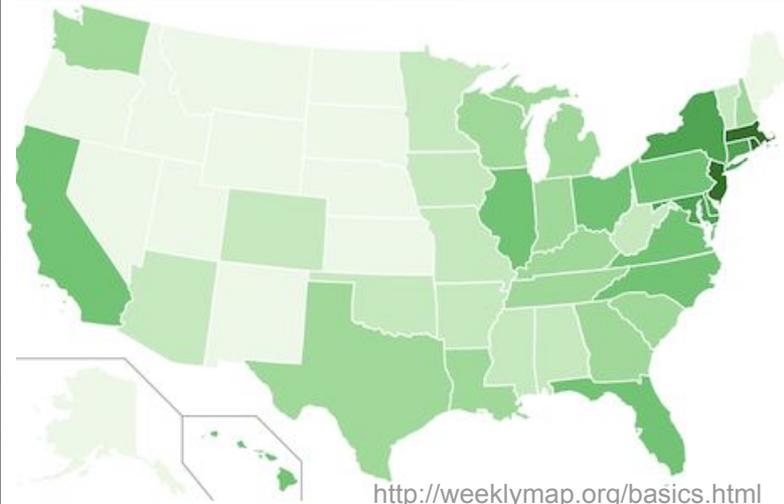
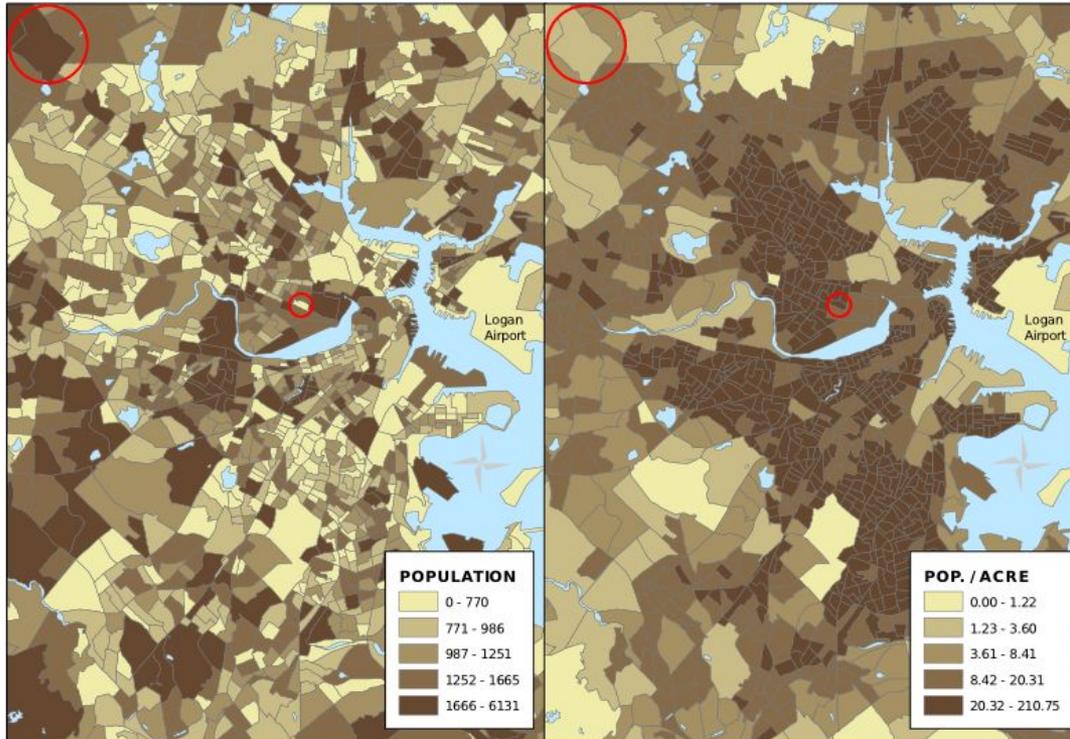


- connects points of equal value, e.g. a map showing temperature (isotherms), equal altitude (contour map), barometric pressure (isobars), etc.



## Dot, isoline, **choropleth** or cartogram maps

Total Population of 2000 Census Block Groups    Population Density of 2000 Census Block Groups

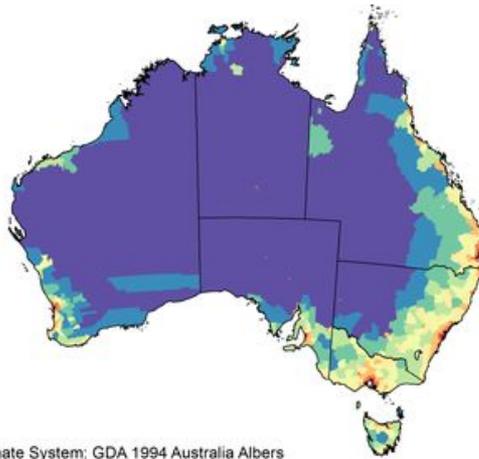


- Represents a **single** georeferenced **variable**.
- Shows variations over **discrete** regions.

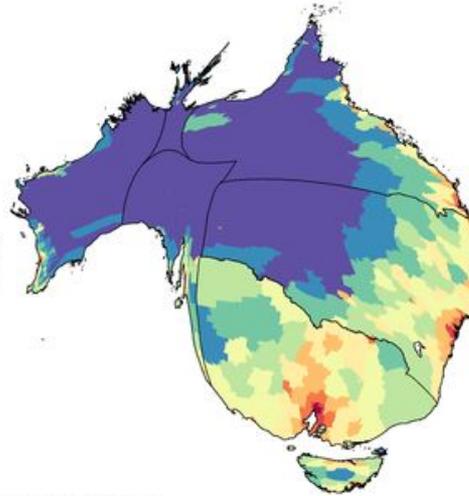


## Dot, isoline, choropleth or **cartogram** maps

LGA Populations (2016)



Cartogram of 2016 state populations



Cartogram of 2016 LGA populations



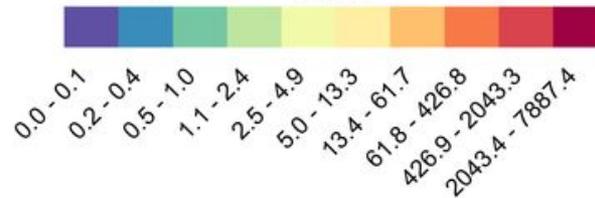
Coordinate System: GDA 1994 Australia Albers

Data sources:

<http://www.abs.gov.au/AUSSTATS/abs@.nsf/Lookup/1270.0.55.003Main+Features1July%202016>

<http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/3218.02015-16>

Population density (population/km<sup>2</sup>)



- a map with statistical information is shown in **diagrammatic form**.
- Cartogram - is a map in which statistics are **represented by distorting** the size of each part of the map to reflect the magnitude of a statistical variable (**Visualization with Exaggeration**).

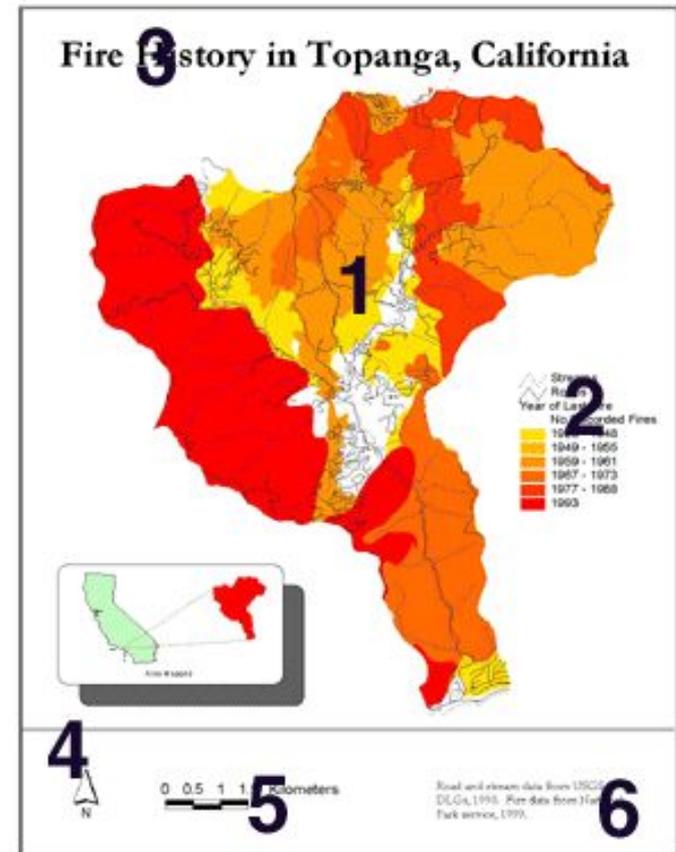
When designing GIS maps, you have complete control in manipulating the map components.

There are **several map components**:

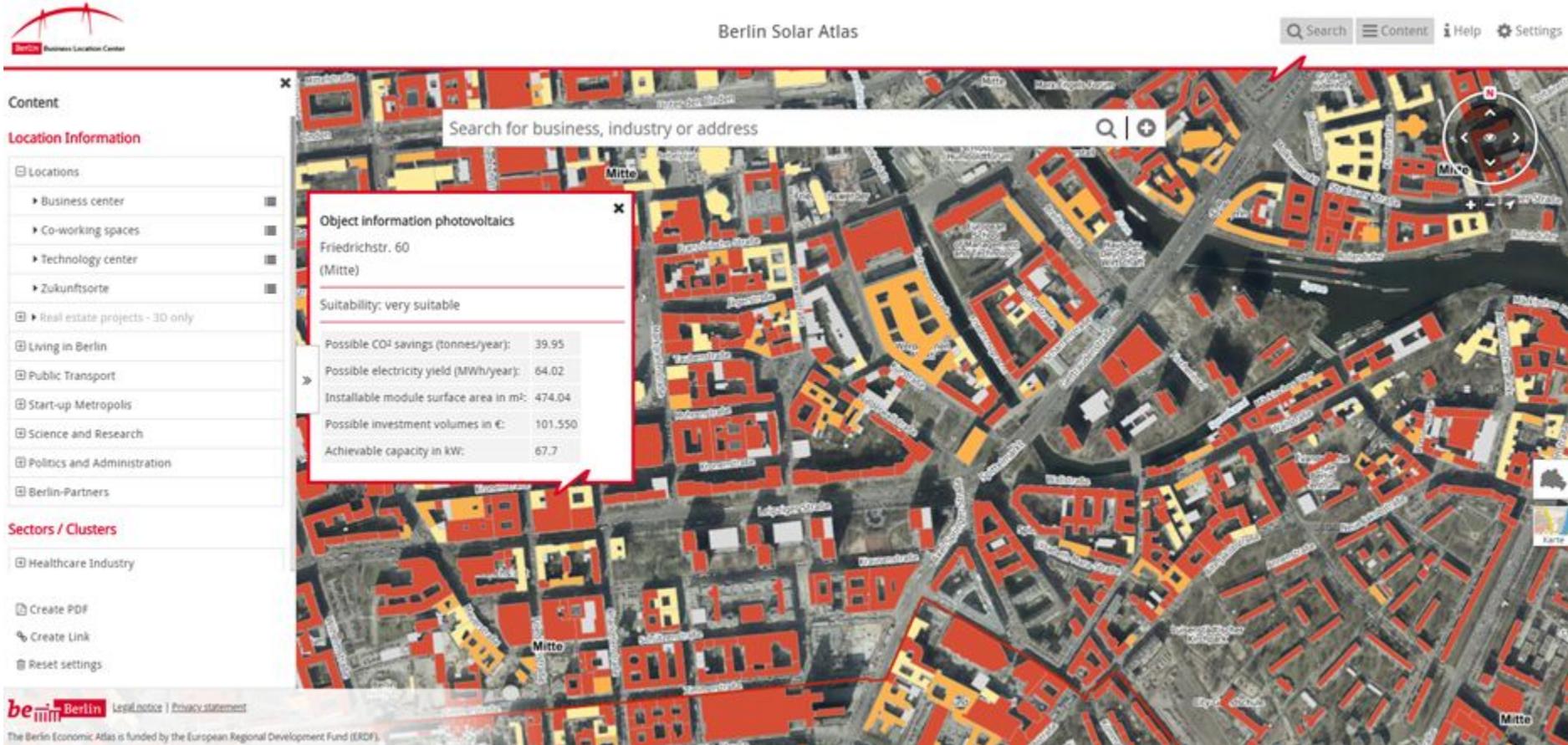
1. **Data Frame** - is the portion of the map that displays the data layers
2. **Legend** - should make the map contents clear
3. **Title** - should be dominant in size
4. **Directional Indicator** - north arrow
5. **Scale**
6. **Citation** - constitutes the metadata of the map

Supplementary Information:

- **Labels** - attribute or ancillary information directly placed on the map



# 2D GIS vs 3D GIS



**Object information photovoltaics**

Friedrichstr. 60  
(Mitte)

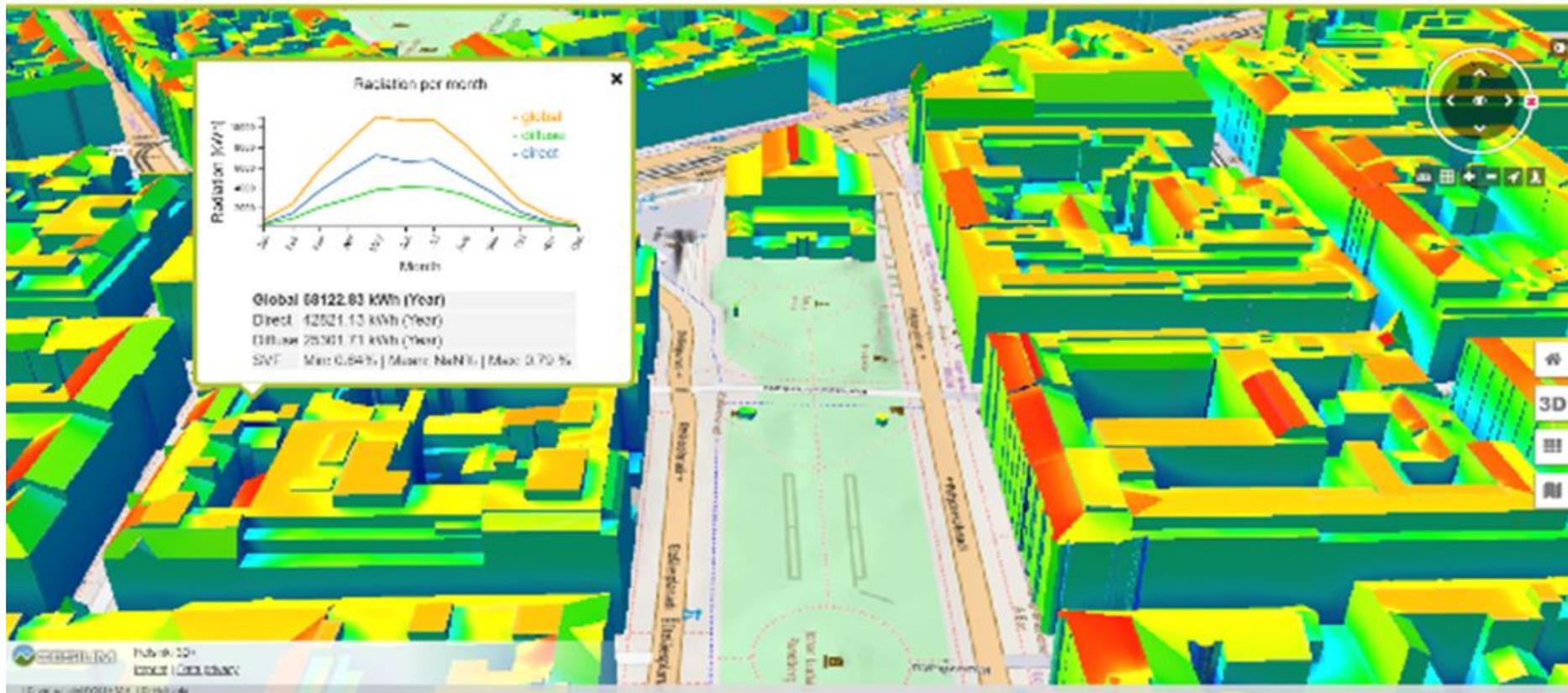
Suitability: very suitable

Possible CO <sub>2</sub> savings (tonnes/year):	39.95
Possible electricity yield (MWh/year):	64.02
Installable module surface area in m <sup>2</sup> :	474.04
Possible investment volumes in €:	101.550
Achievable capacity in kW:	67.7

<https://www.businesslocationcenter.de/en/berlin-economic-atlas>



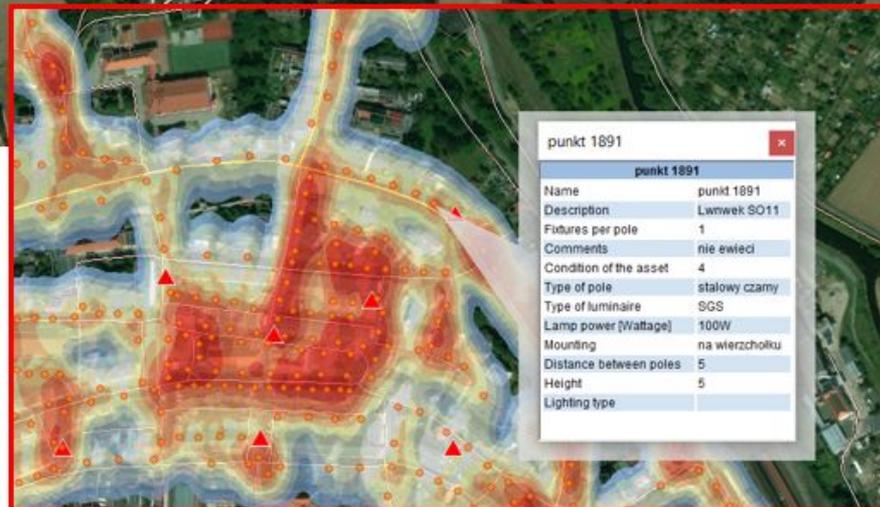
# 2D GIS vs 3D GIS



<https://kartta.hel.fi/3d/>



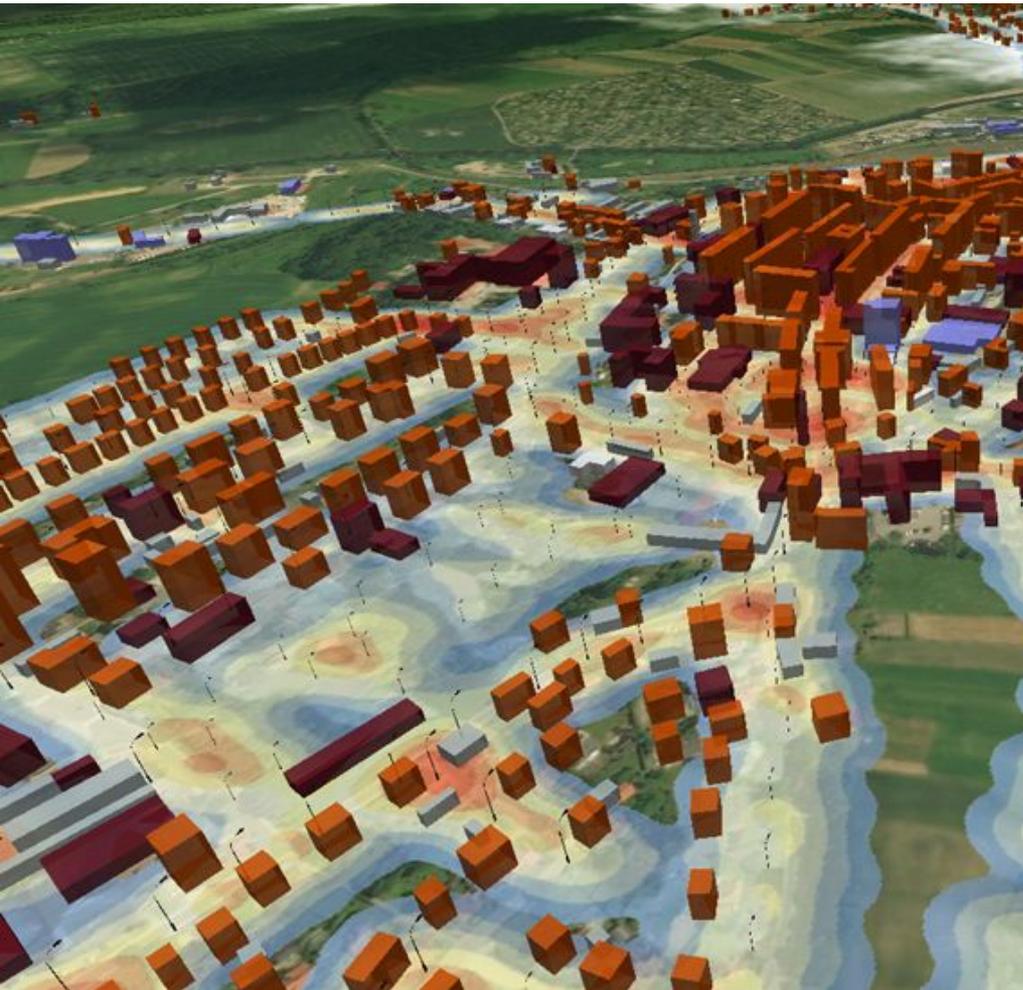
# 2D GIS vs 3D GIS



punkt 1891	
Name	punkt 1891
Description	Lampka SO11
Fixtures per pole	1
Comments	nie ewieci
Condition of the asset	4
Type of pole	stalowy czarny
Type of luminaire	SGS
Lamp power [Wattage]	100W
Mounting	na wierzchołku
Distance between poles	5
Height	5
Lighting type	

Street Light Power Density

# 2D GIS vs 3D GIS



punkt 2259	
FID	1180
name	punkt 2259
descripti	Lwnwek SO Bt
ilo_opraw	1
uwagi	brak
stan_supa	1
sup	stalowy czarny
oprawa	inna sodowa
moc	100W

# 2D GIS vs 3D GIS



**virtualcityMAP | 3D-Gebäudemodelle NRW**

Suche | Inhalte | Hilfe | Einstellungen

**Themen & Inhalte**

**3D-Gebäude**

Gebäude (LoD2)

Einfärbung nach Gebäudehöhe

< 5 m  
 < 15 m  
 < 30 m  
 < 65 m  
 > 65 m  
 nicht angegeben

Klotzchenmodell (LoD1)

**WMS-Dienste**

Digitales Orthophoto

**Grundkarten**

OpenStreetMap

**Gelände**

DGM5

**Ansichten**

Bonn  
Bottrop  
Dortmund  
Duisburg  
Düsseldorf

PDF erzeugen  
Link erzeugen

Alle Einstellungen zurücksetzen

**Gebäudeinformationen**

Höhe : 78.772  
Dachart : 1000  
Gebäudefunktion : 31001\_2100  
Gemeindegemeinschaft : 05111000  
Datenquelle Dachhöhe : 1000  
Datenquelle Lage : 1000  
Datenquelle Bodenhöhe : 1100

Realisiert durch virtualcitySYSTEMS GmbH | Geodaten aus Open Data Quellen  
Impressum | Datenschutzhinweise

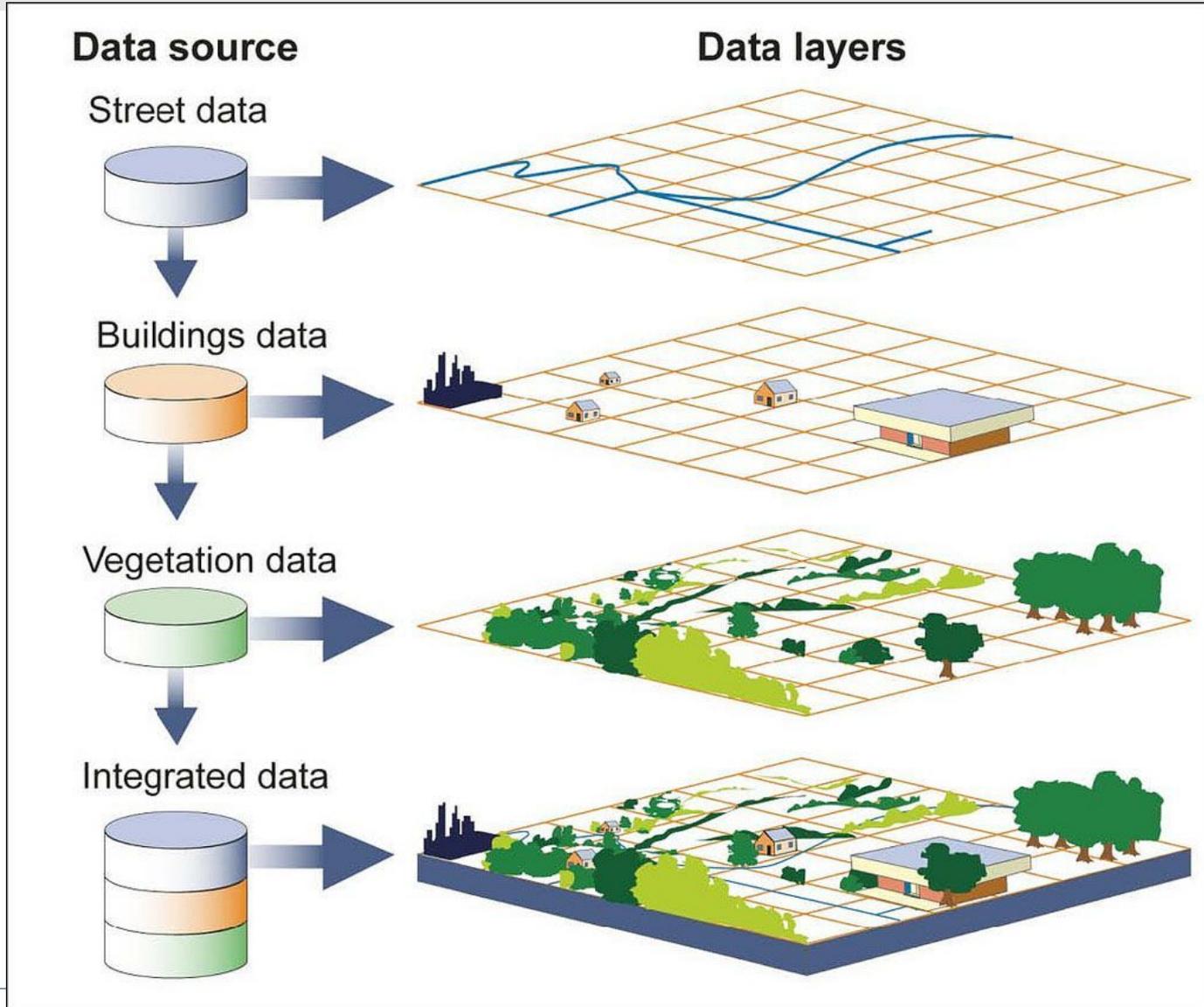
Möchten Sie das 3D-Gebäudemodell für die Stadtplanung nutzen?

<https://berlin.virtualcitymap.de/?lang=en>

TAKING COOPERATION FORWARD



# SUMMARY

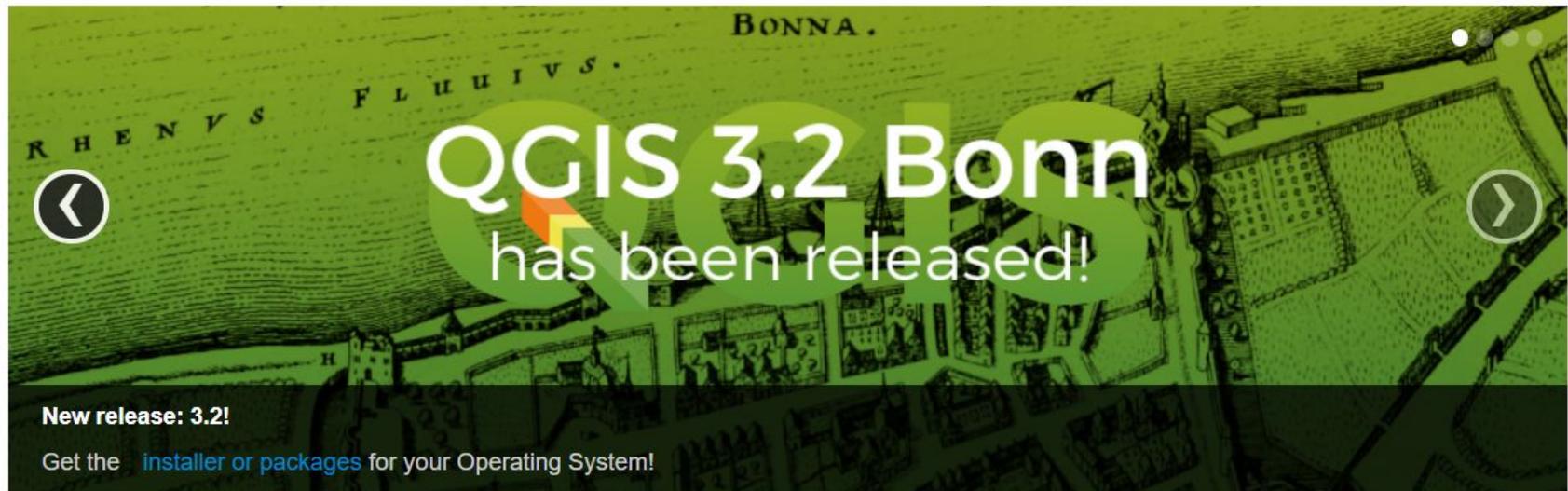


# Installation of QGIS & data distribution

<https://www.qgis.org>

## QGIS

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