



## WATSAM

Support to Arba Minch Town water utility and Municipality in the water & sanitation sector through capacity building and partnership development with Italian water organizations

# Introduction to GIS

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hydr<sup>o</sup>aid

ADM Municipality



smat  
gruppo



# What is a GIS?

## What is a GEOGRAPHIC INFORMATION SYSTEM

A geographic information system (GIS) is a combination of procedures and informatic tools that allow to position (georeference) and analyse objects and events that occur in a particular spatially defined environment.

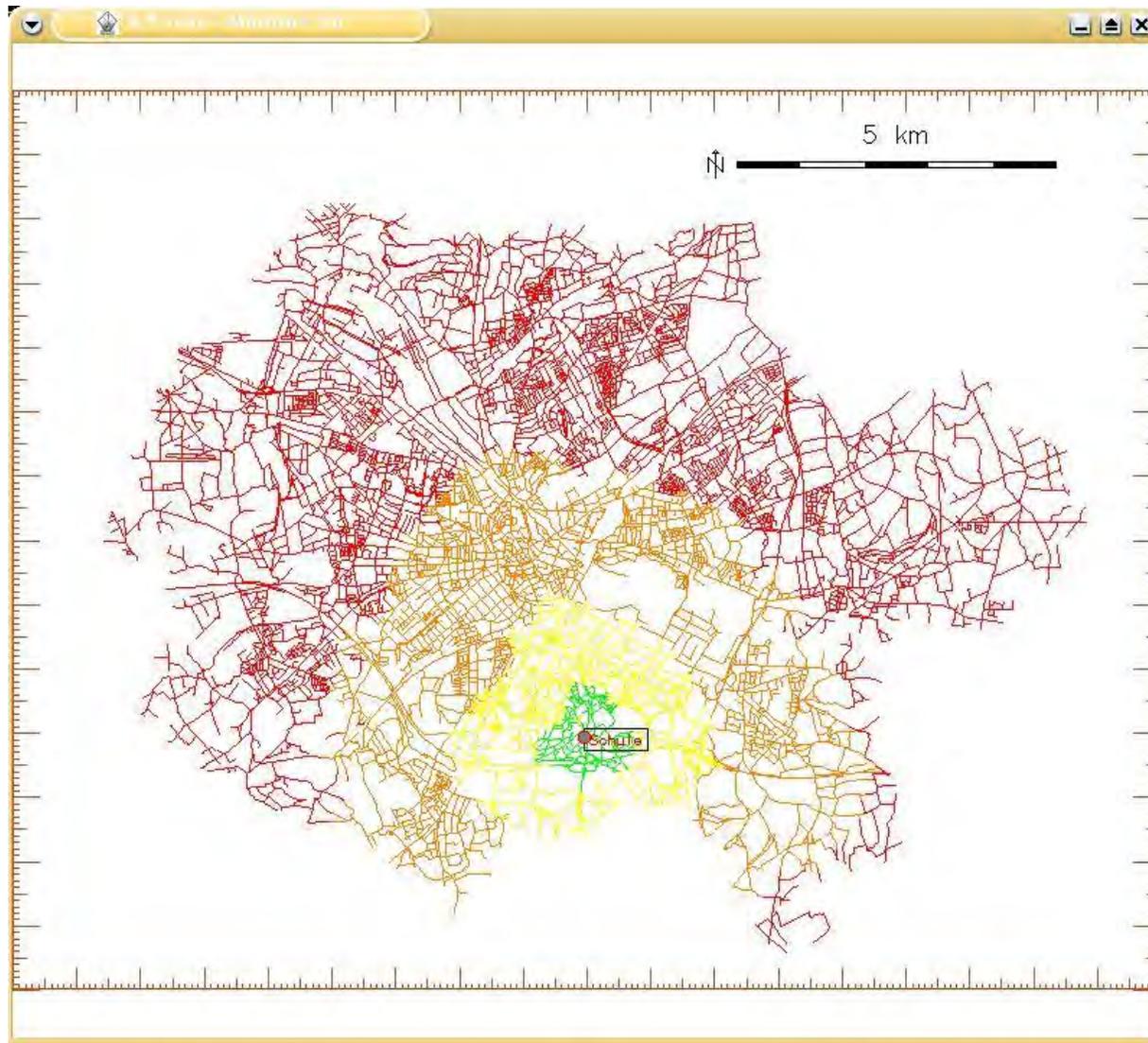
- maps
- elevations
- environment

mostly applied to:

- urbanistic
- hydrology
- geomorphology
- environmental sciences
- ...

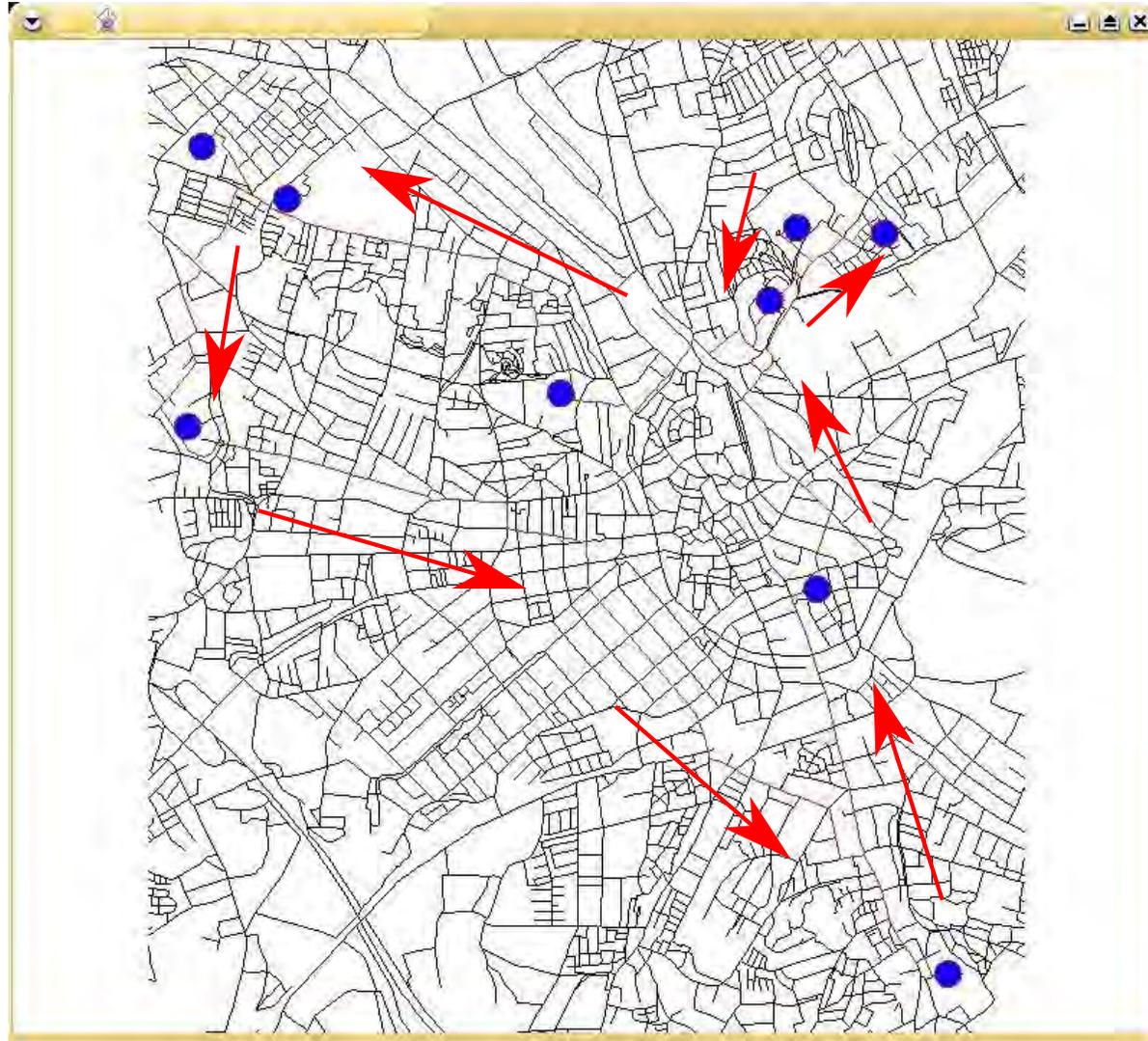
# Why a GIS?

## Calculation of iso-distances with weights



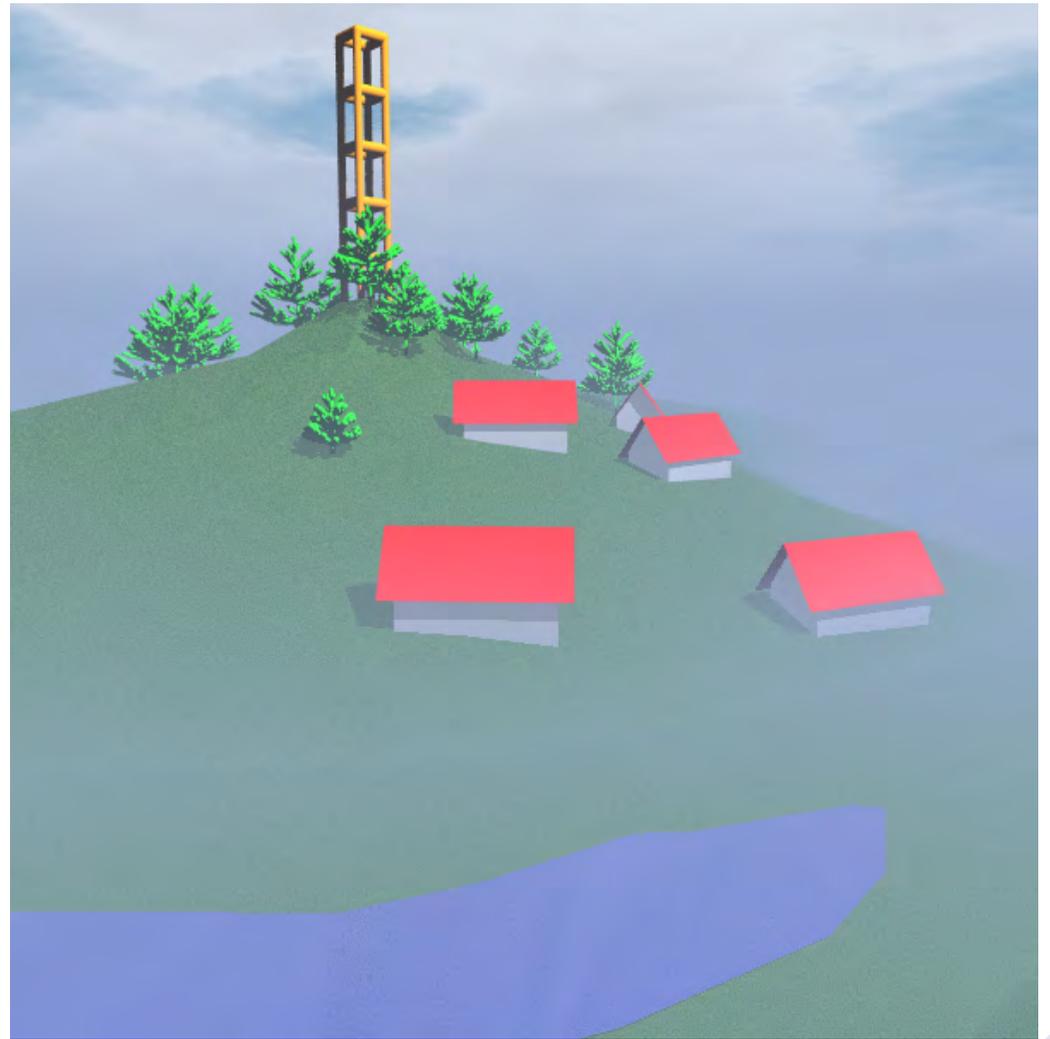
# Why a GIS?

## Calculation of salesman problem



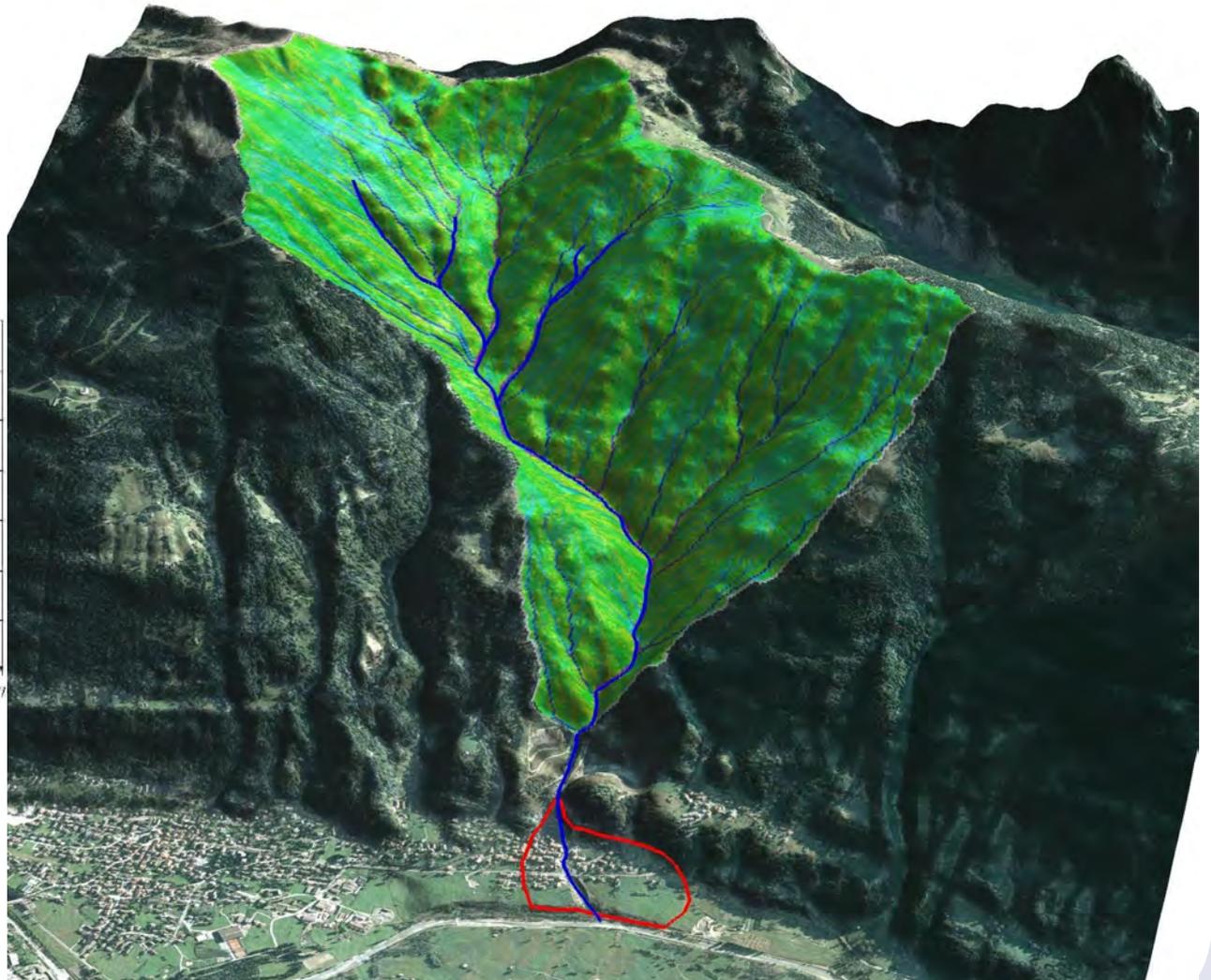
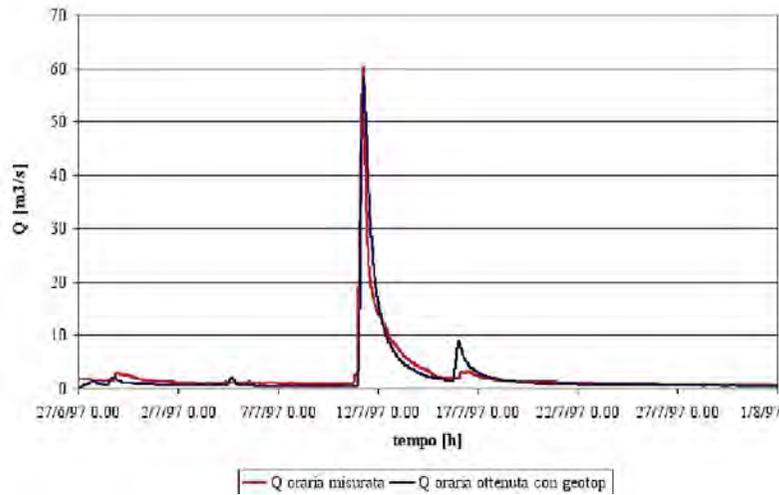
# Why a GIS?

Simulation of possible scenarios



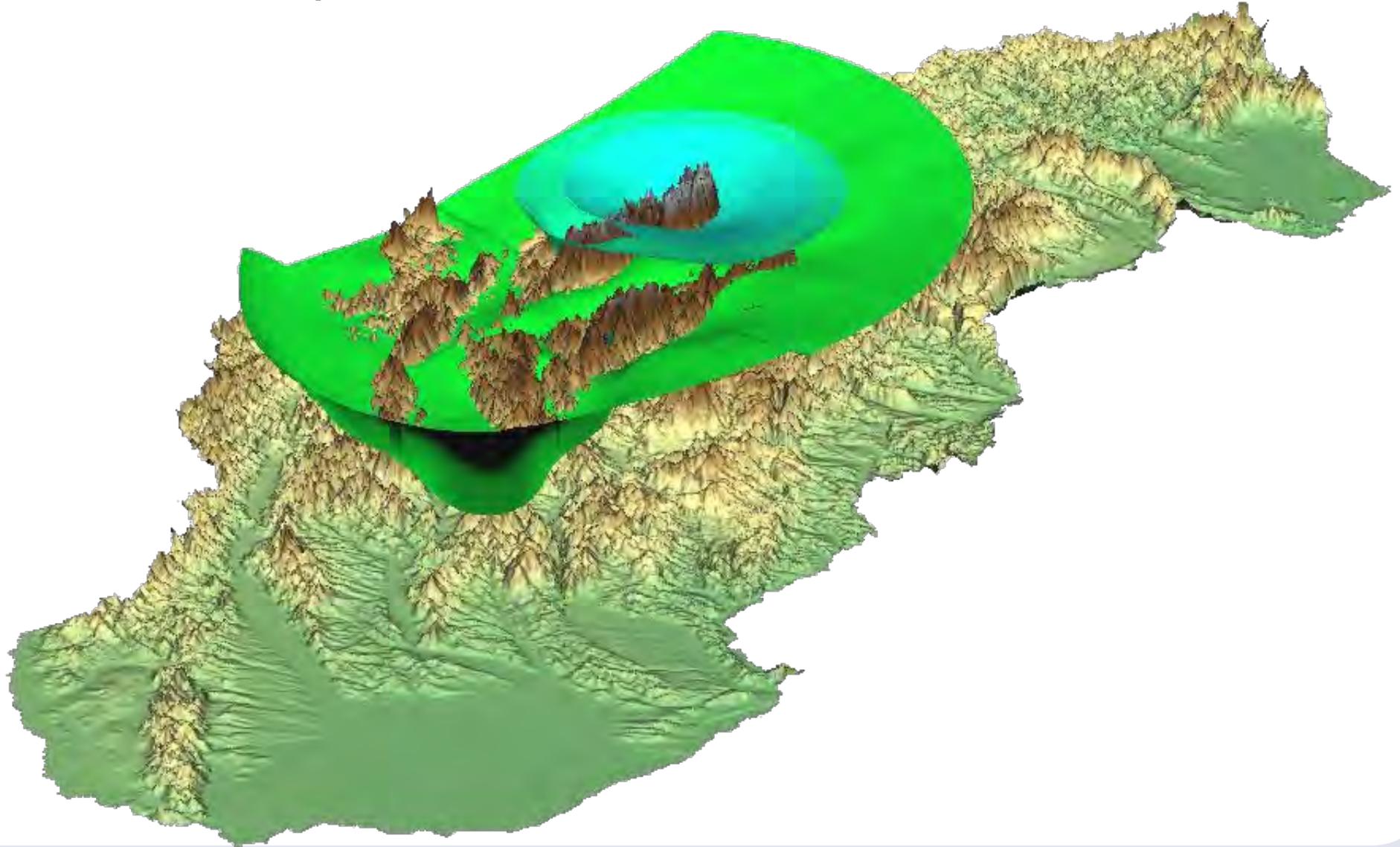
# Why a GIS?

## Hydro- geomorphology



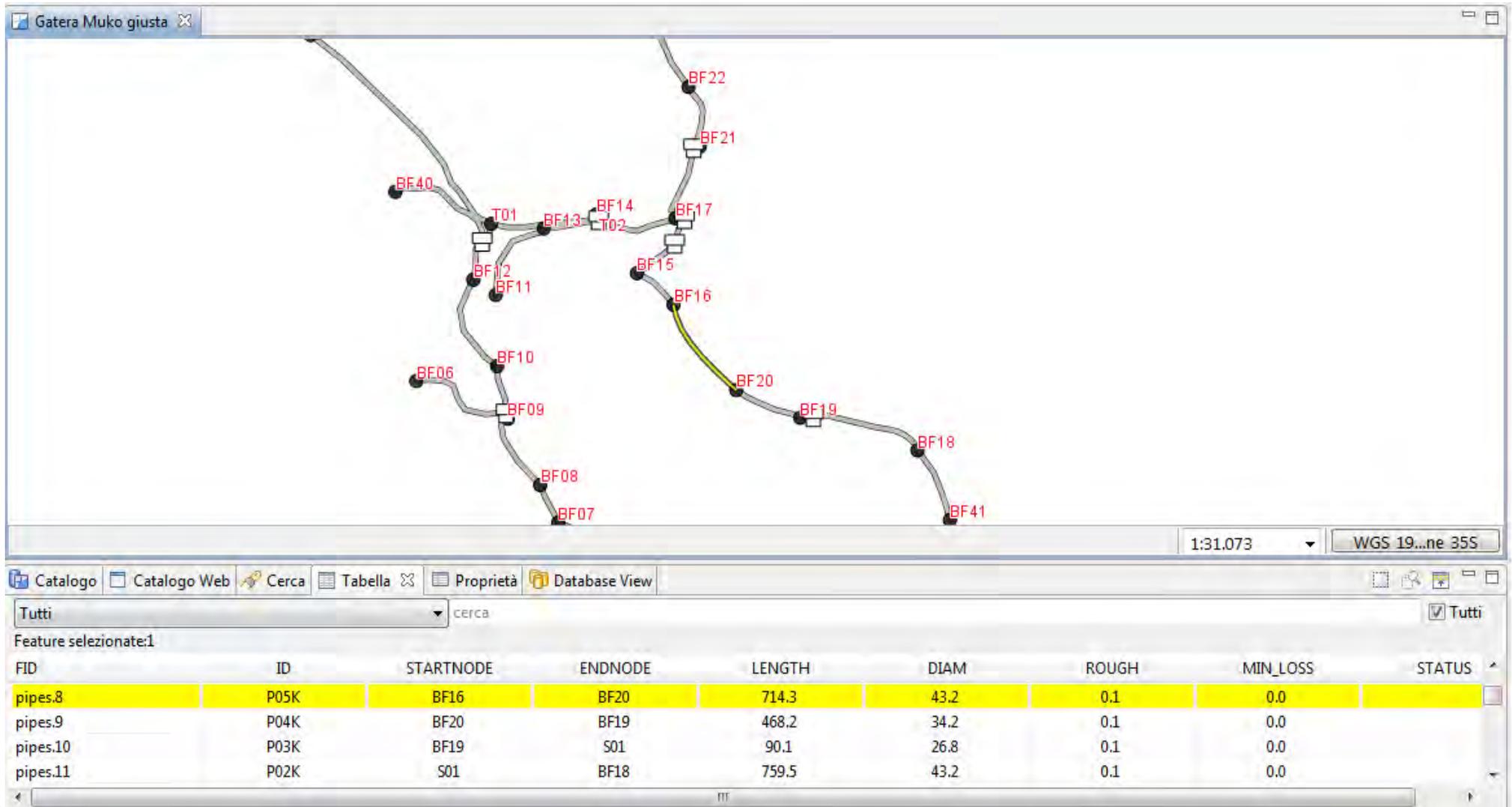
# Why a GIS?

Complex volumetric calculations



# Why a GIS?

## Water supply systems



# What a GIS is not!

## WebGIS - mostly publication of data

The screenshot shows a web browser window titled "Prototipo WebGIS INSULA s.p.a. - Mozilla Firefox" displaying a map of San Marco. The map is overlaid with various GIS layers, including canals, lagoons, and roads. A query results window is open, showing data for "isole laguna", "isole", "viabilita", and "zone".

**Query Results**

isole laguna					
ID	NOME	SW_MEMBER	SHAPE_INDEX	TILE_INDEX	LAYER_INDEX
337	Sant'Anzolo	337	335	-1	1

isole								
NR_ID	NOME	SUP	PERIMETRO	SW_MEMBER	SHAPE_INDEX	TILE_INDEX	LAYER_INDEX	
81	ANZO	Sant'Anzolo	41420.1000000000000000	1097.7300000000000000	81	80	-1	2

viabilita								
COD_VIA	SPECIE	PRENOME	TOPONIMO	PREN_TOP	SW_MEMBER	SHAPE_INDEX	TILE_INDEX	LAYER_INDEX
44620	CAMPO		SANT' ANGELO	SANT' ANGELO	3522	3521	-1	8

zone							
gid	id	codice	nome	sw_member	SHAPE_INDEX	TILE_INDEX	LAYER_INDEX
1	1	Sm	San Marco	1	1	-1	15

Map Information:

- Projection: Monte Mario / Italy zone 1
- Left: 2311026.7
- Right: 2311502.6
- Bottom: 5034551.1
- Top: 5034908.1
- Map Units: Metre
- Dist:
- Mouse X: 2311478.0
- Mouse Y: 5034889.8

# What a GIS is not!

## CAD - computer aided design

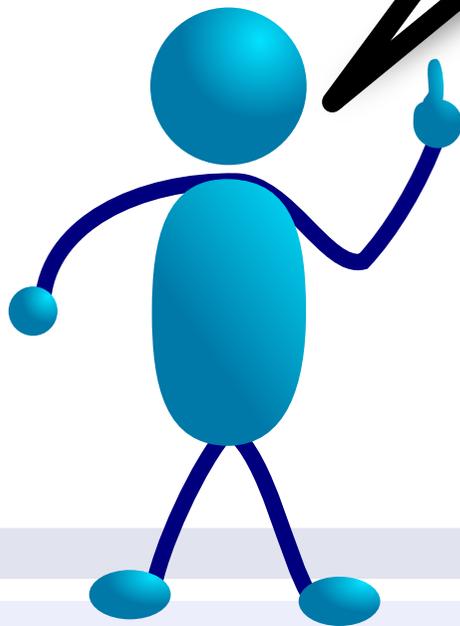
1	2	3	4	5	6
Pos.	Menge	Einheit	Benennung	Zeichener / Norm - Kurzbezeichnung	Bemerkung
1	1	Stück	Gehäuse		G - AlSi10Mg
2	1	Stück	Hohlwelle		34CrMo4
3	1	Stück	Schneckenrad		G - CuSn12Ni
4	1	Stück	Schneckenwelle		16MnCr5
5	1	Stück	Zahnrad		16MnCr5
6	2	Stück	Lagerdeckel groß		S235JR
7	1	Stück	Lagerdeckel klein		S235JR
8	1	Stück	Distanzring		S235JR
9	2	Stück	Rillenkugellager	DIN 625 - 6009	
10	2	Stück	Kegelrollenlager	DIN 720 - 30203	
11	1	Stück	Passfeder groß	DIN 6885 - B 12 x 8 x 22	
12	1	Stück	Passfeder klein	DIN 6885 - B 5 x 5 x 10	
13	2	Stück	Verschlusschraube	DIN 908 - M4 x 15 - S1	
14	2	Stück	Dichtung	DIN 7603 - A 14 x 18 V1	
15	15	Stück	Zylinderschraube mit Innensechskant	ISO 4762 - M6 x 20 - 8.8	
16	1	Stück	Zylinderschraube mit Innensechskant	ISO 4762 - M6 x 16 - 8.8	
17	1	Stück	Scheibe	DIN 9021 - B 6.4	
18	2	Stück	Radial-Wellendichtung	DIN 3760 - AS 4.5 x 60 x 8	
19	2	Stück	O-Ring	DIN 3771-85x355-N-NBR 70	
20	1	Stück	O-Ring	DIN 3771-40x355-N-NBR 70	
21	4	Stück	Stiftschraube	Kaufteil gemäß Zeichnung	S235JR

Technische Zeichnung		Blatt		Titel	
Zeichner	Gepr. / Rev.	Blatt	Blatt	Blatt	Blatt
Schneckengetriebe					
1					

# Building a soccer field

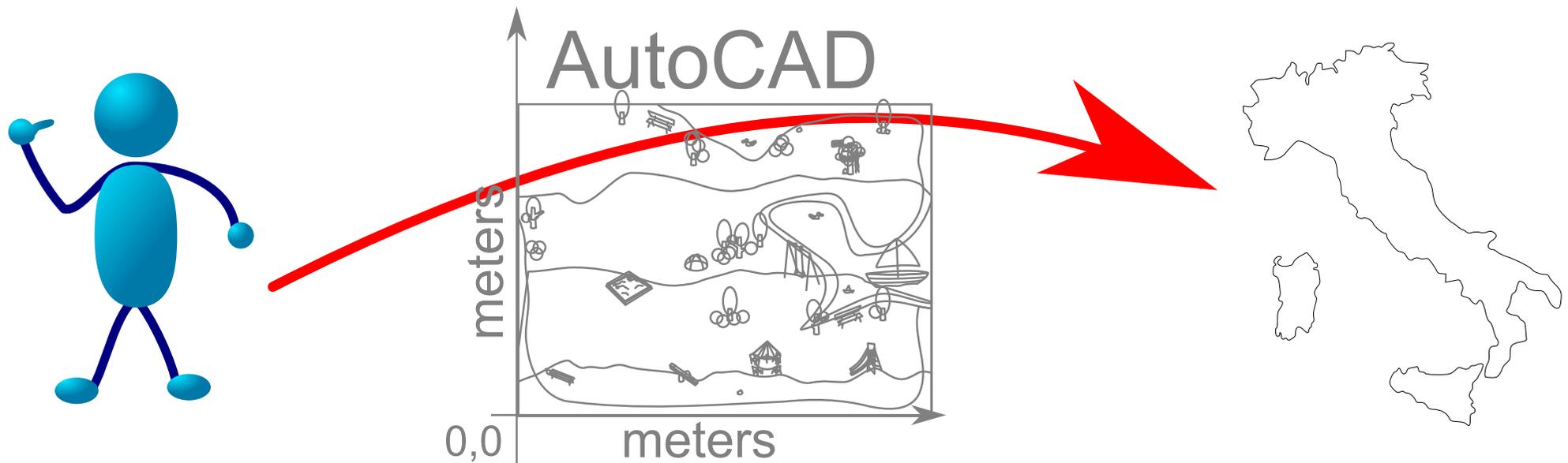


Danilo Pileggi: let's build a soccer field  
for kids in the park



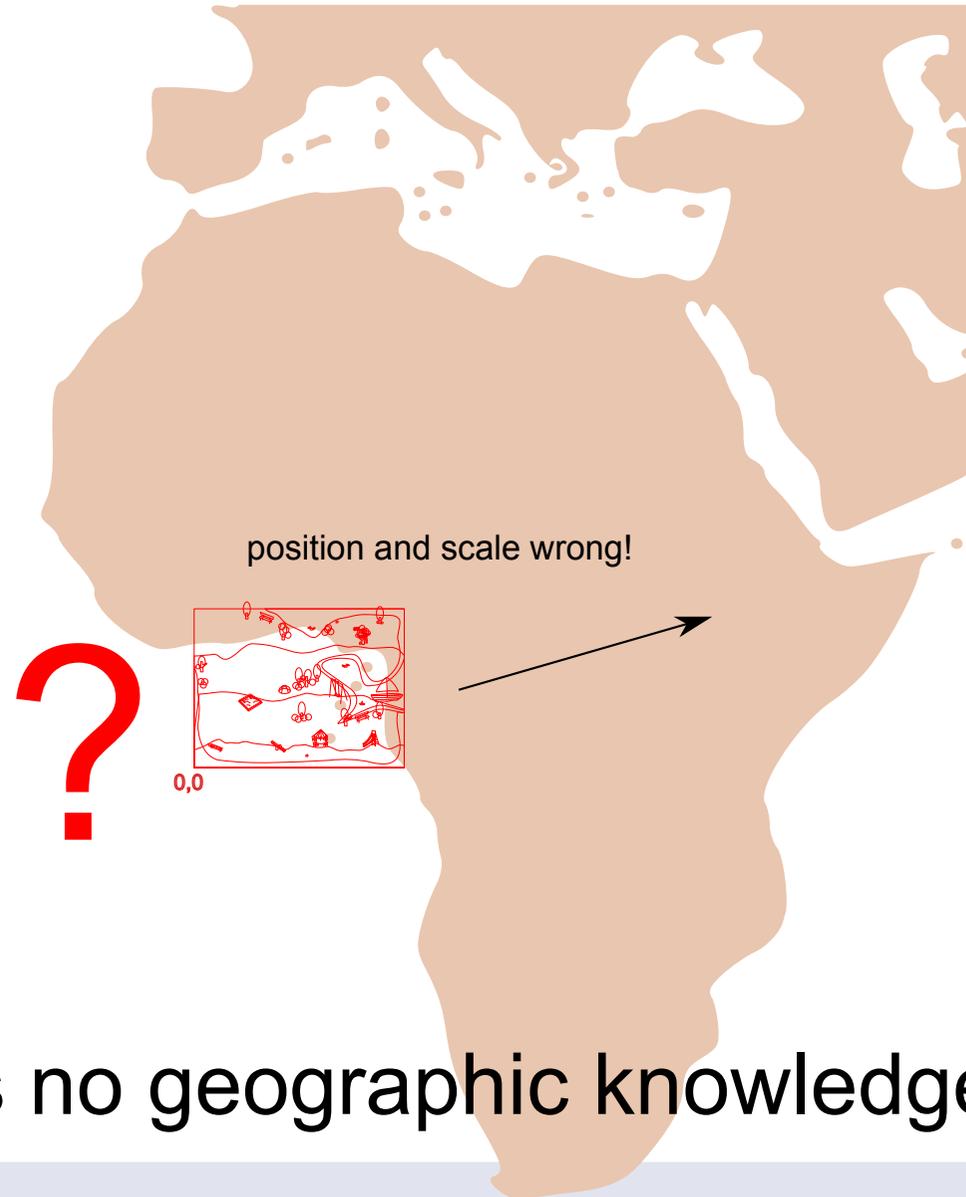
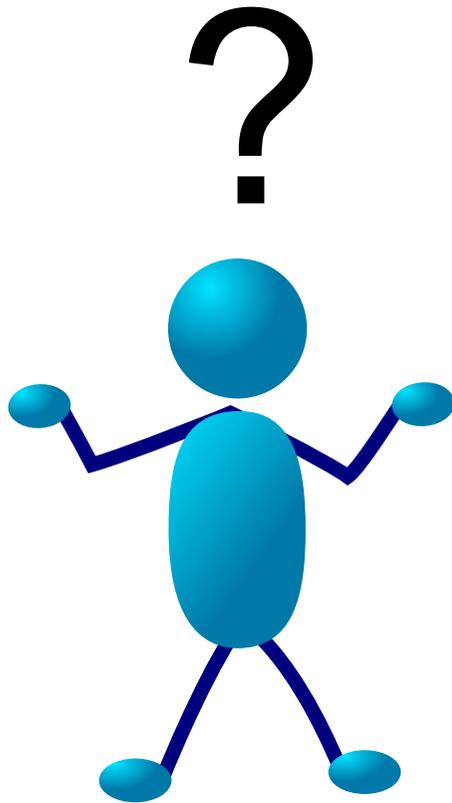
# Building a soccer field

- 1) DP asks an Italian engineer, which tells him to send him the map of the park, so he can design the field
- 2) DP asks his friend Adane Girma to create the plans for him
- 3) Adane draws the plans in AutoCAD and sends them to the Italian engineer



# Building a soccer field

4) the engineer imports the CAD drawing in the GIS, because it is the way to show territorial data

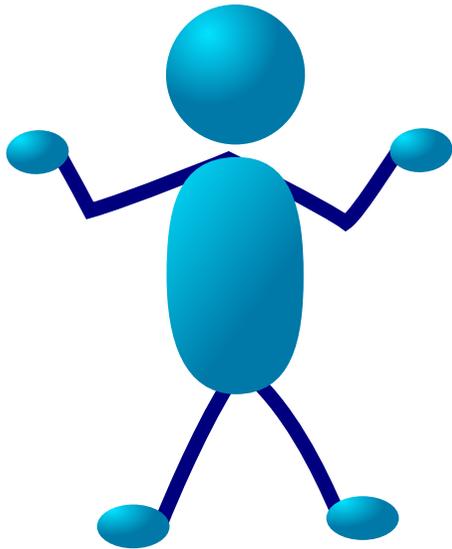


**A CAD has no geographic knowledge!**

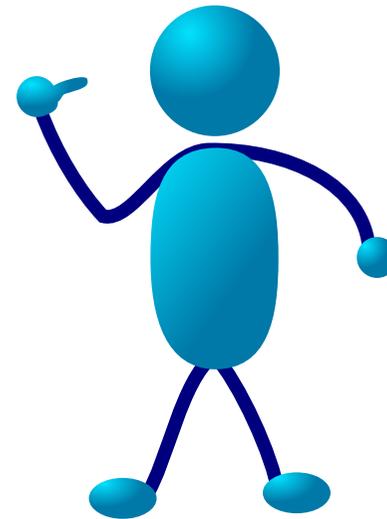
# Building a soccer field

5) the engineer asks explicitly for GIS data

?



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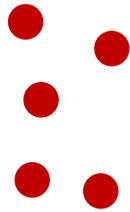


## Vector Geometry Types

Point



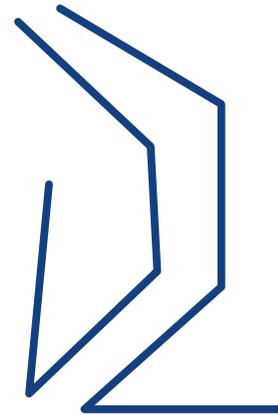
MultiPoint



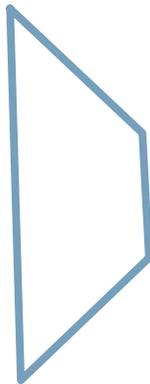
LineString



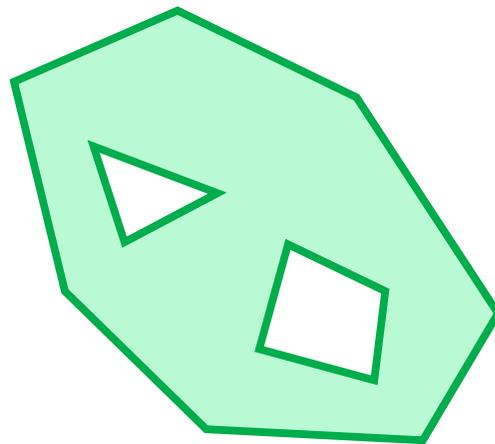
MultiLineString



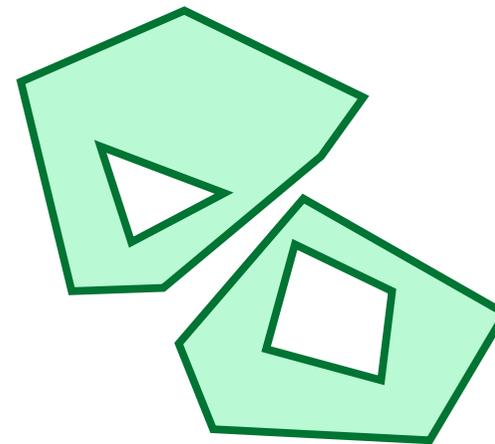
LinearRing



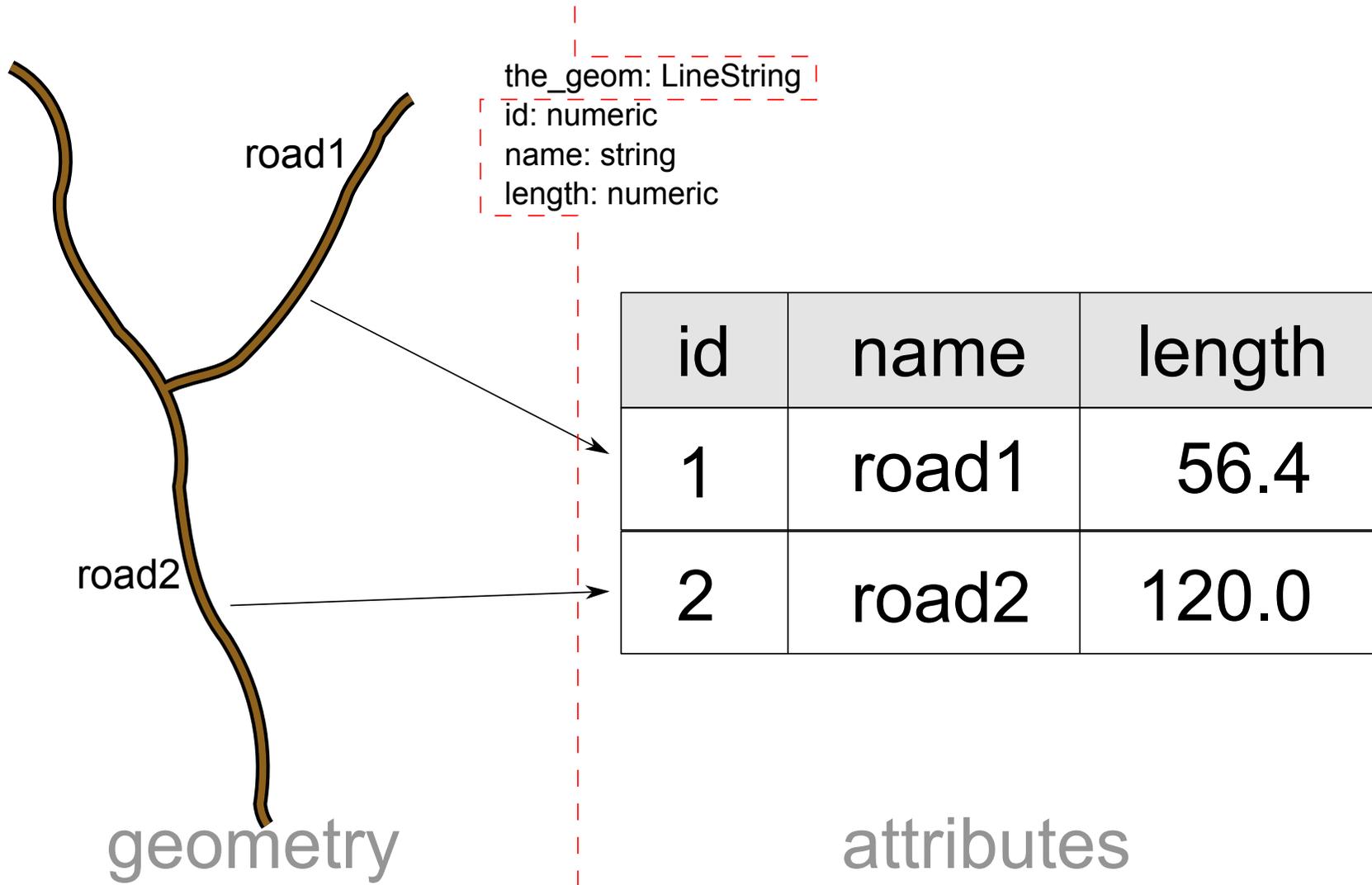
Polygon



MultiPolygon



## Vector Features



# GIS data types

The screenshot displays a GIS application window with a map showing a path of red lines and black points. A yellow circle highlights a specific point on the path with the timestamp '2013-03-09 06:17:07'. The interface includes a menu bar, toolbars, and several panels. On the left, the 'Projects' panel shows a tree view with 'project' containing 'arba', 'dtm', 'elevation\_parag', and 'gpspoints'. Below it, the 'Lay...' panel shows a legend with 'notes' (yellow circle), 'gpslines' (red line), 'gpspoints' (black square), and 'Mapnik'. On the right, the 'Info' panel shows 'Selection' options: 'Box Selection' (checked), 'Feature Selection', and 'Area of Interest Selection'. Below the map, a toolbar contains 'Catalog', 'Web', 'Search', 'Table', 'Information', 'Console', and 'Zoom Level Switcher'. A search bar contains 'Any' and 'search'. Below the search bar, a table shows 'Features Selected: 1' with the following data:

FID	DESCRIPTIO	TIMESTAMP	ALTIM
notes.3	s 3 wustermark nach charlotte	2013-03-03 20:40:36	0.0
notes.4	Markey	2013-03-06 17:53:20	74.9000244140625
notes.5	Strassenbahn 91	2013-03-09 06:17:07	0.0
notes.6	Farmacia	2013-03-09 06:35:54	0.0
notes.7	Rue 109	2013-03-09 07:17:46	0.0

At the bottom of the window, a status bar displays the coordinates '1449390, 6868043'.

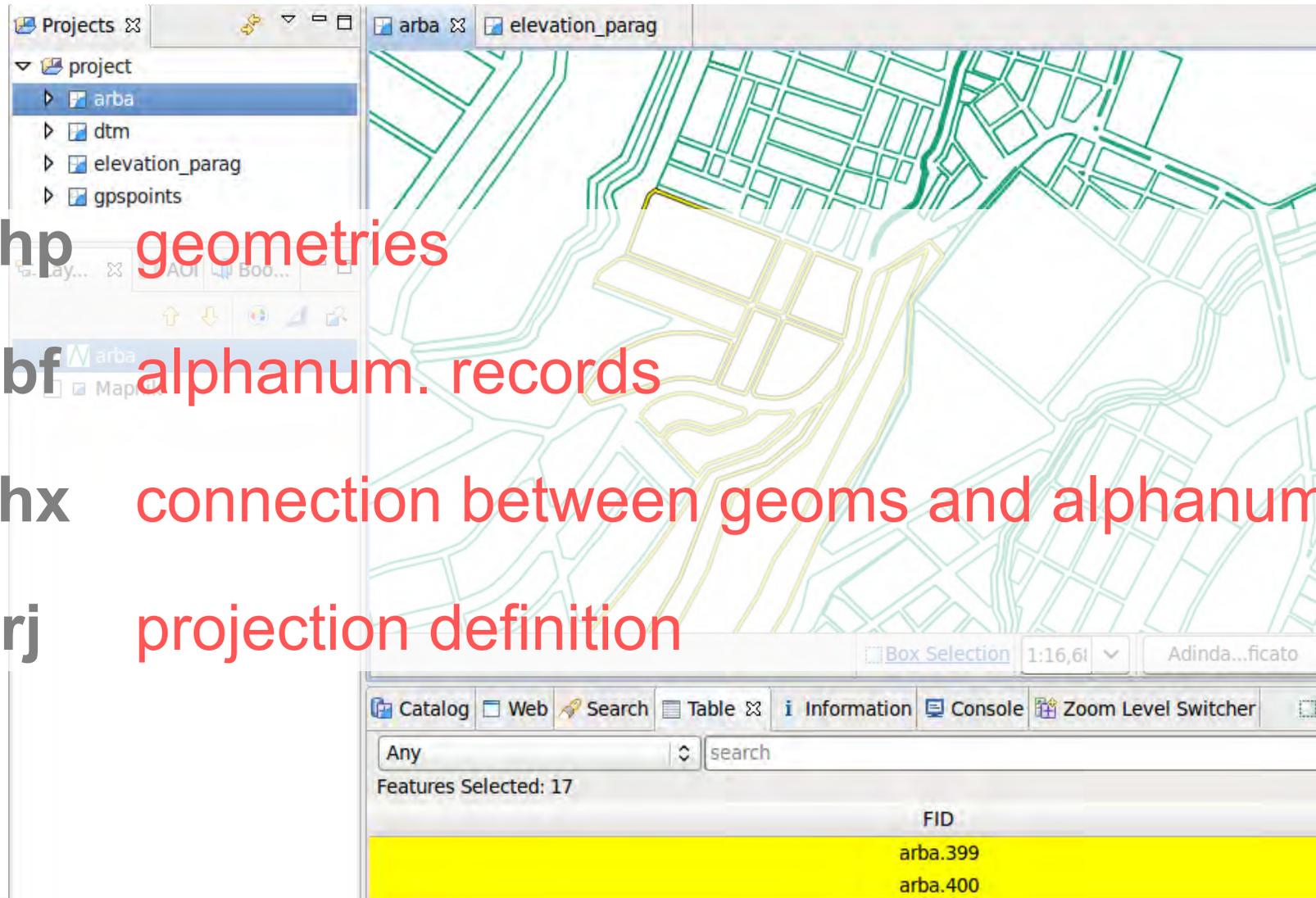
## Vector Files: the shapefile

**arba.shp** geometries

**arba.dbf** alphanumeric records

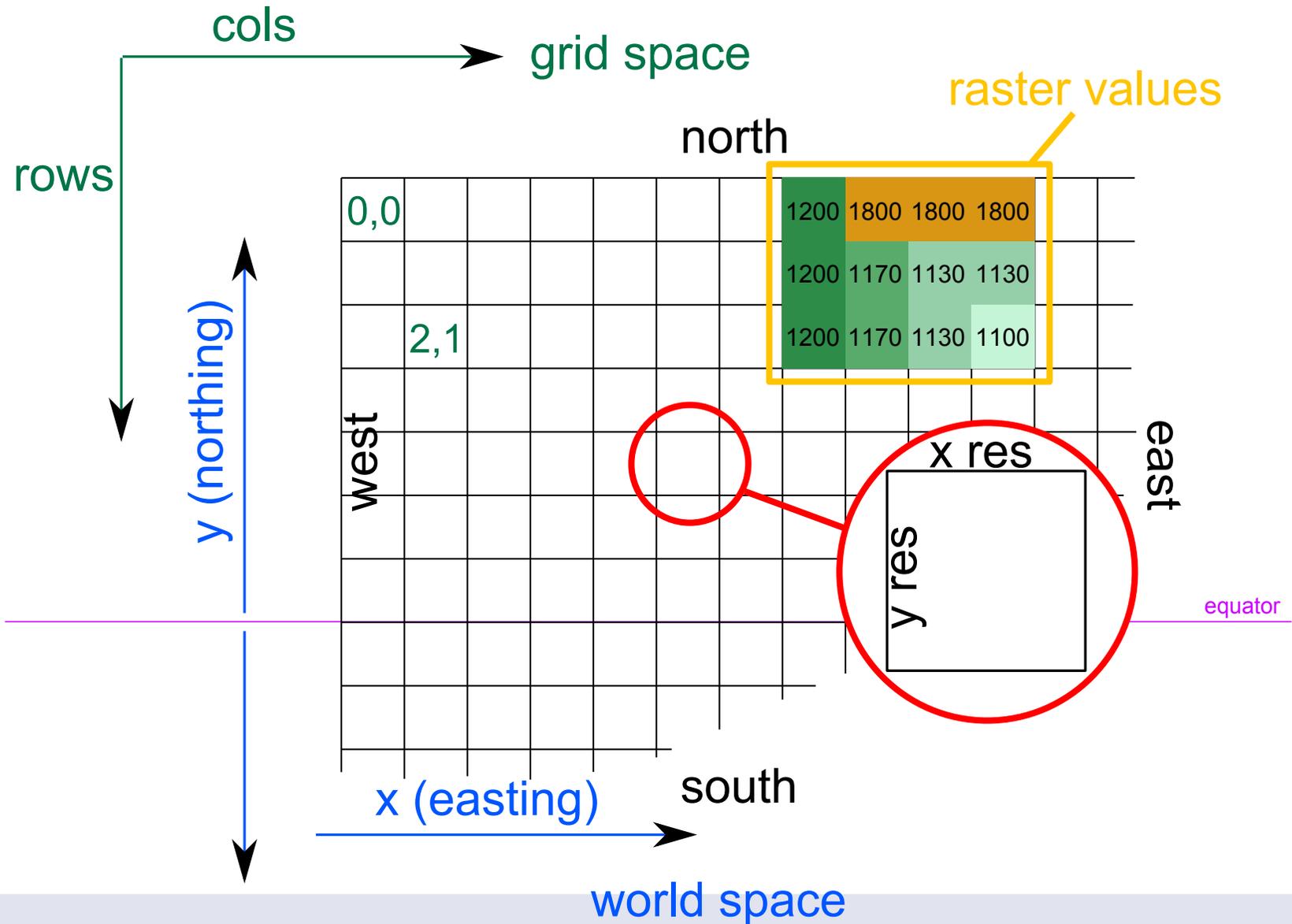
**arba.shx** connection between geoms and alphanumeric

**arba.prj** projection definition



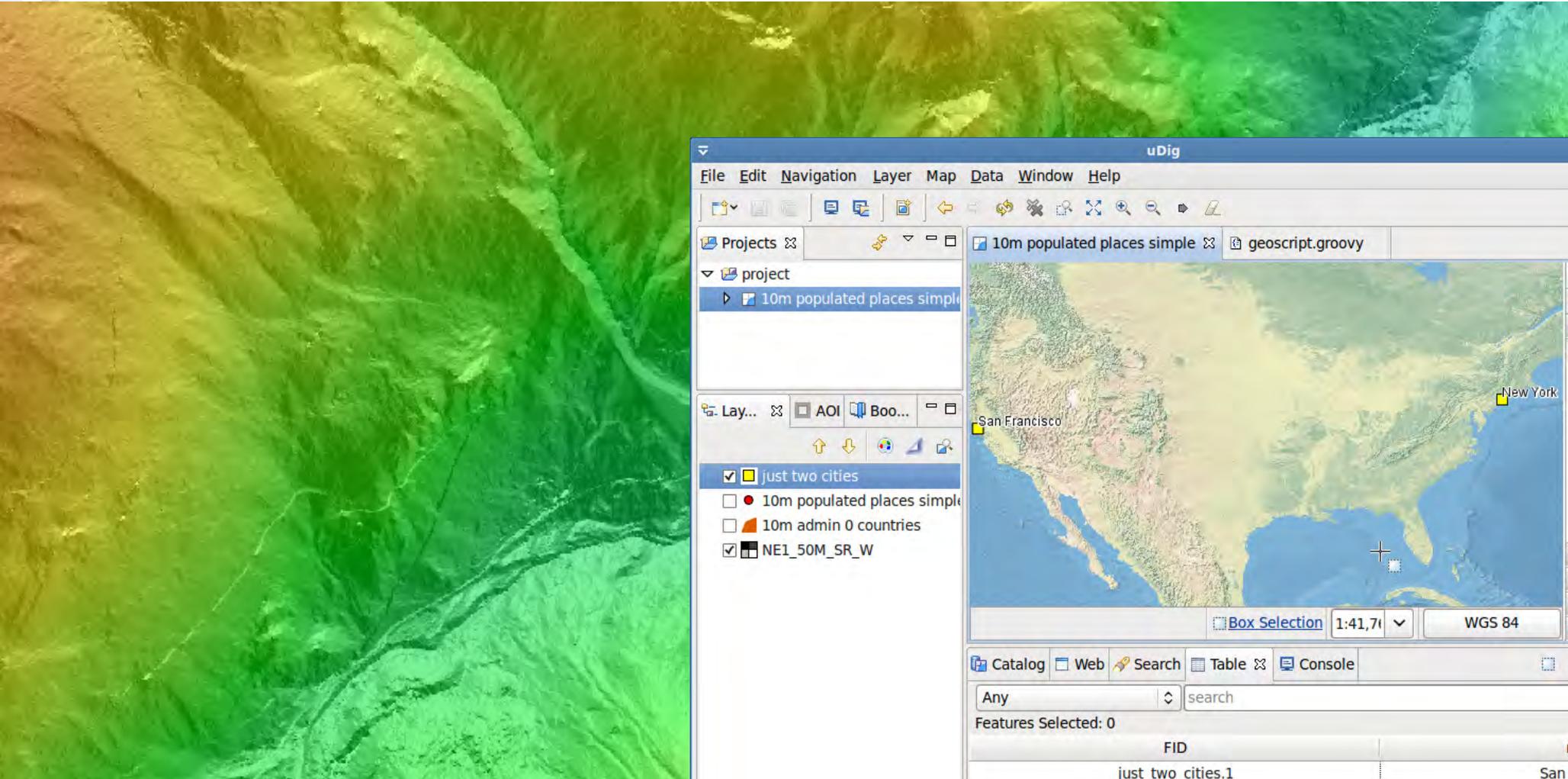
# GIS data types

## Raster data



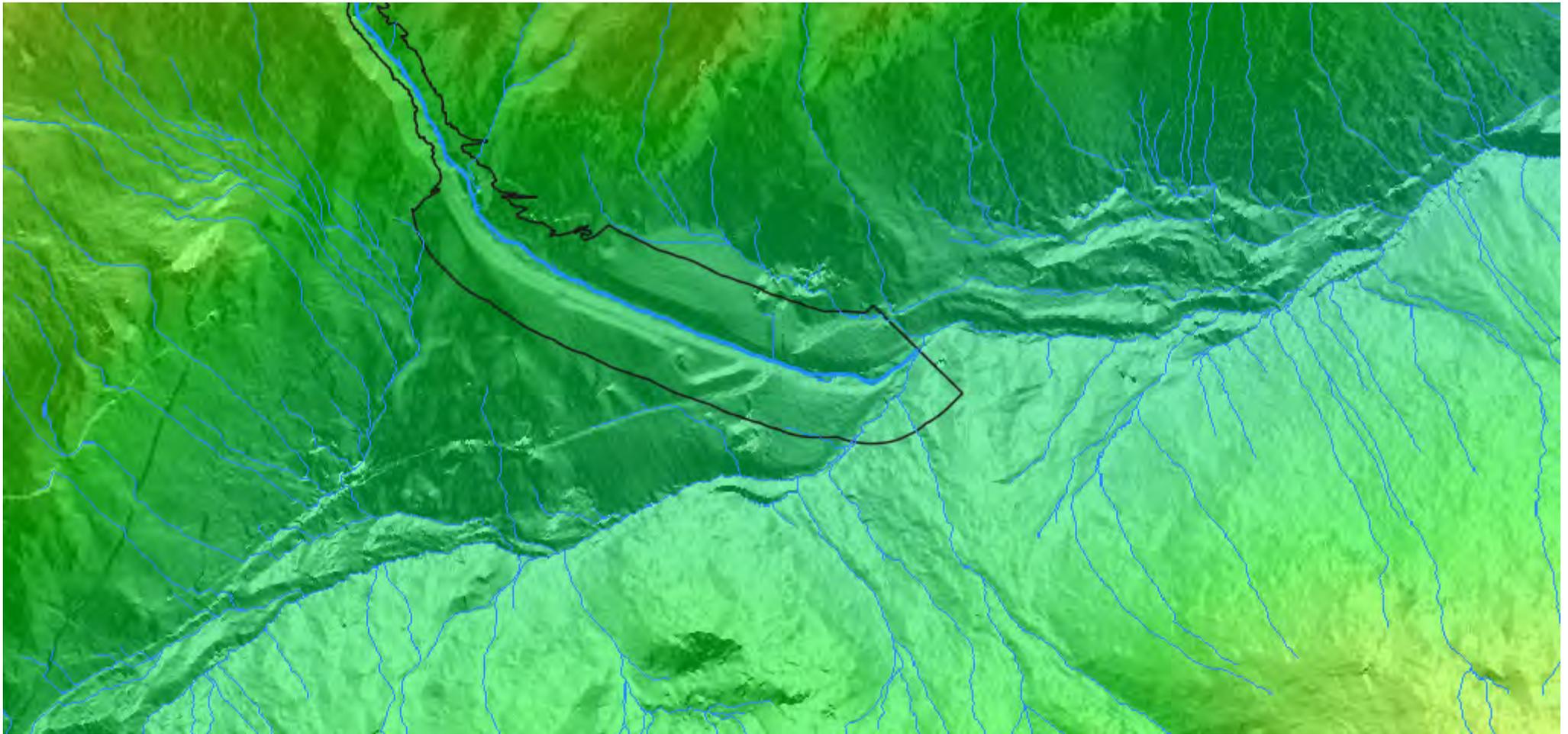
# GIS data types

## Raster data



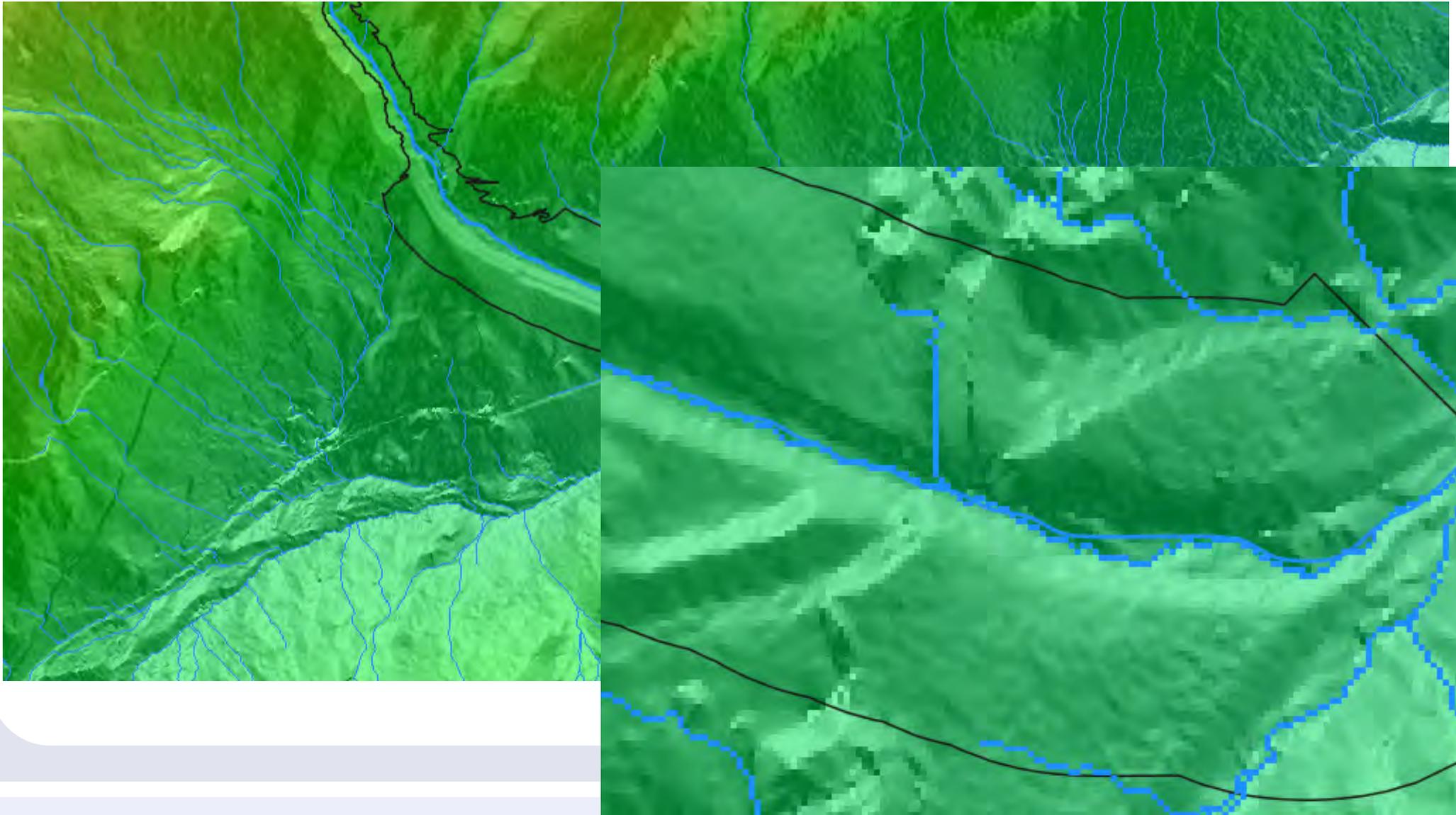
# GIS data types

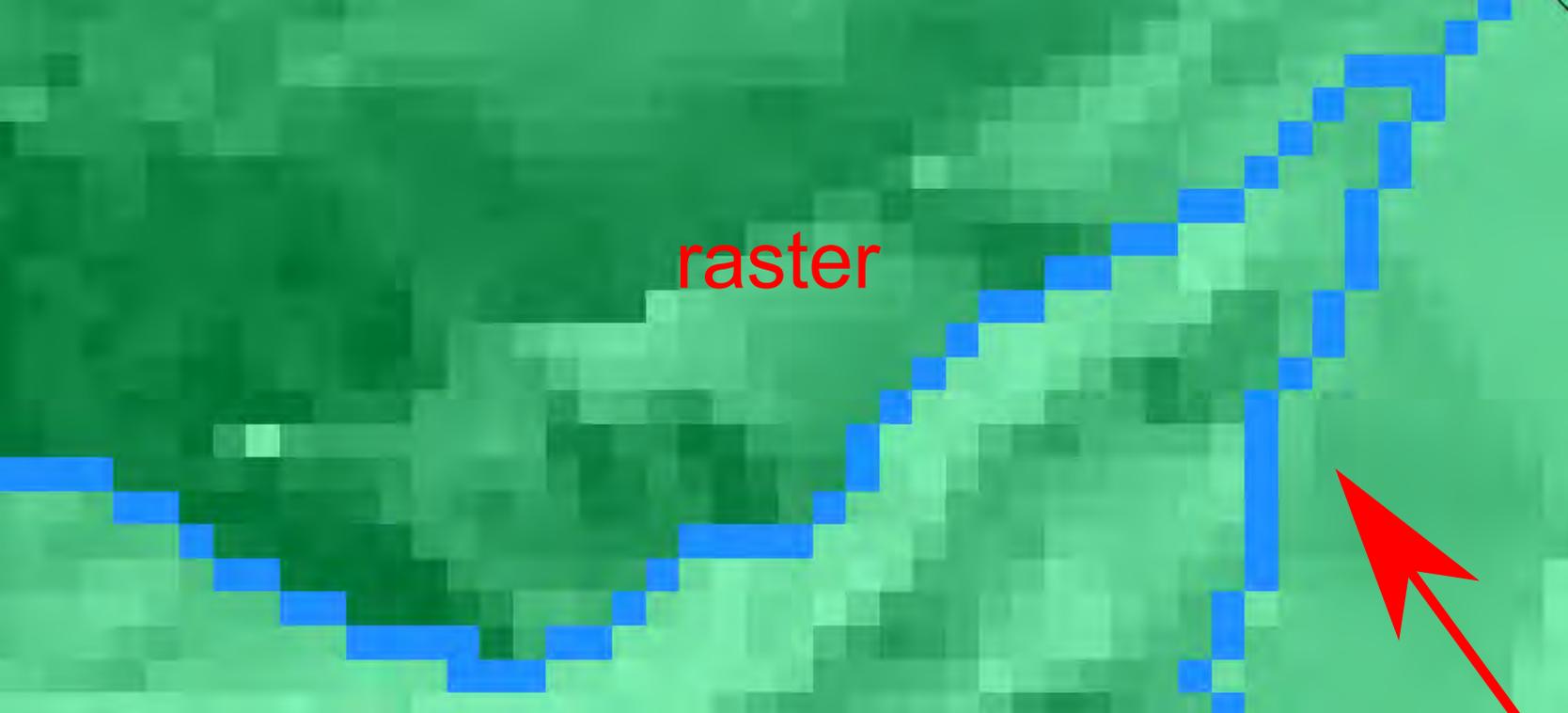
Difference between raster and vector



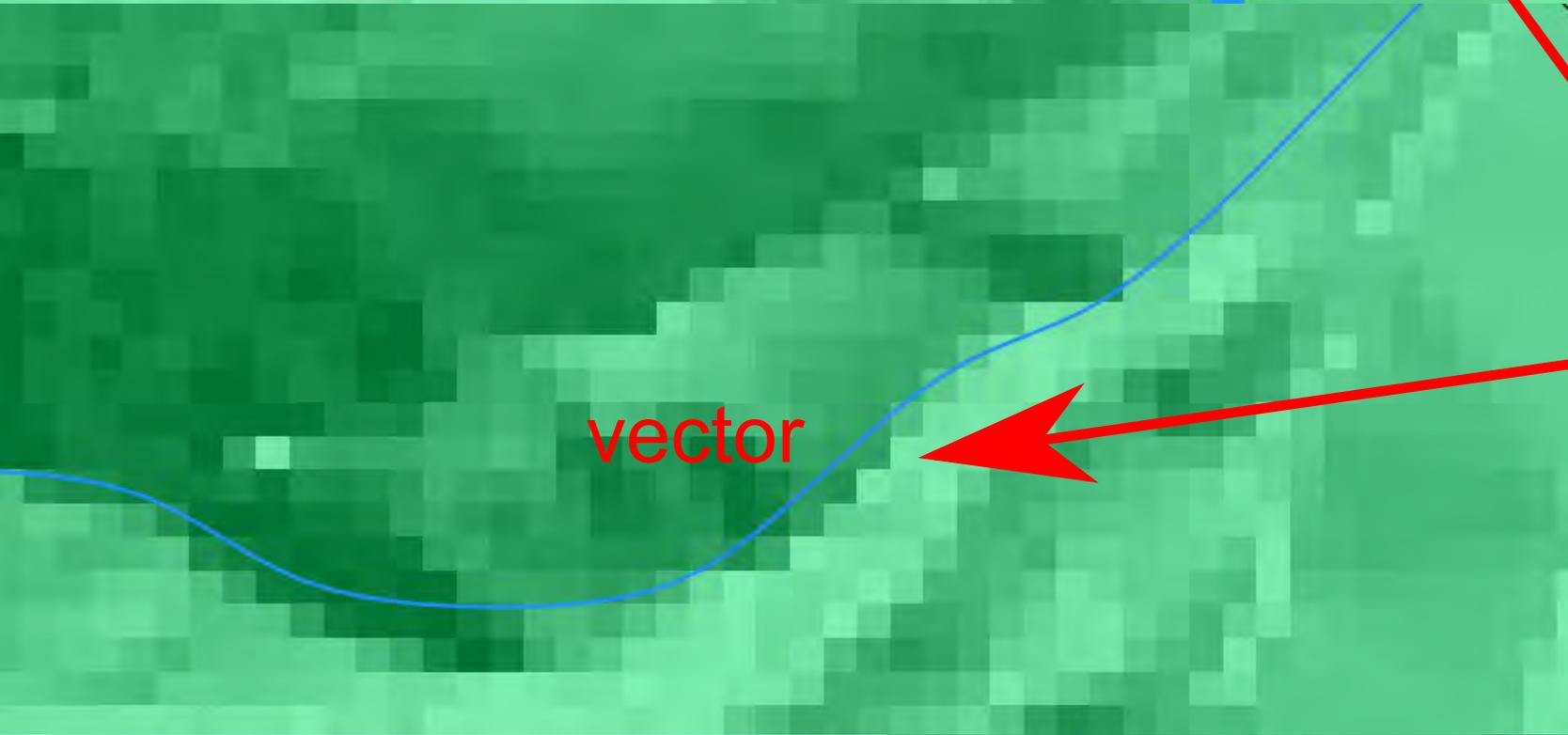
# GIS data types

Difference between raster and vector

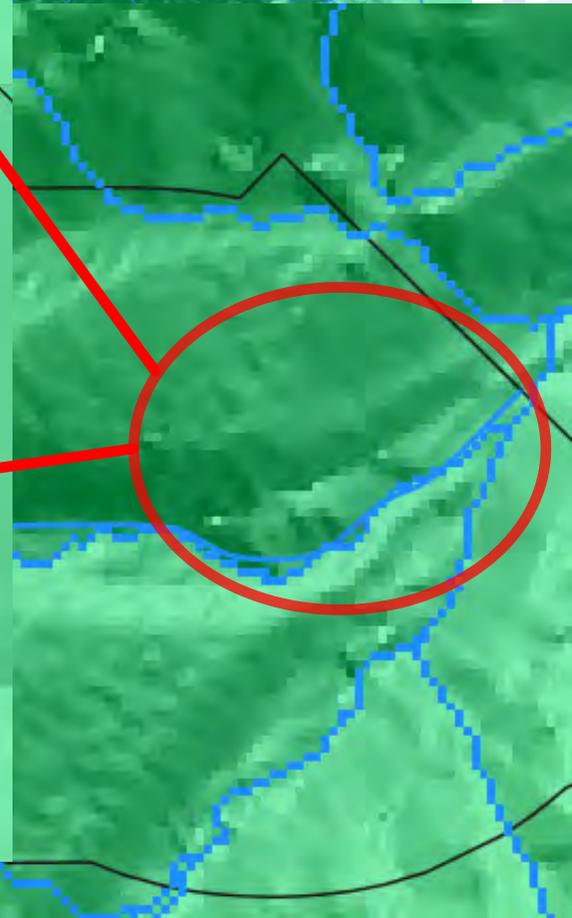




raster



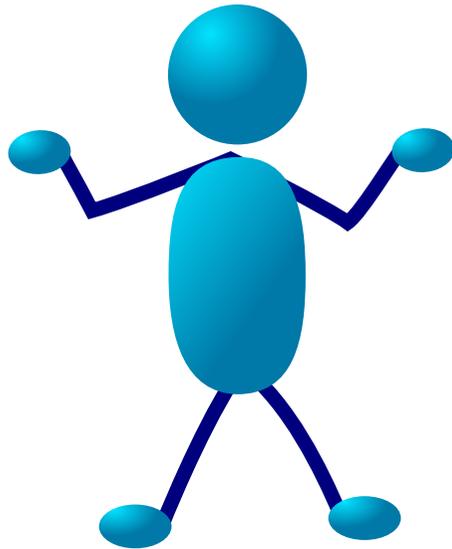
vector



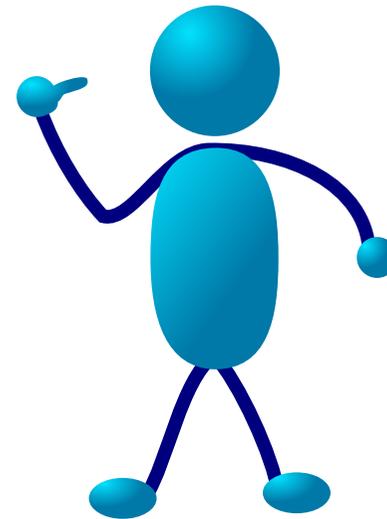
# Building a soccer field

5) the engineer asks explicitly for GIS data

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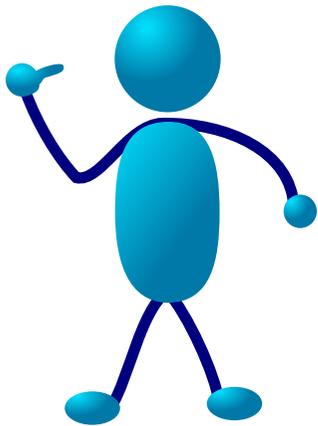
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# Building a soccer field

6) Mr. Watsam knows what to do. He

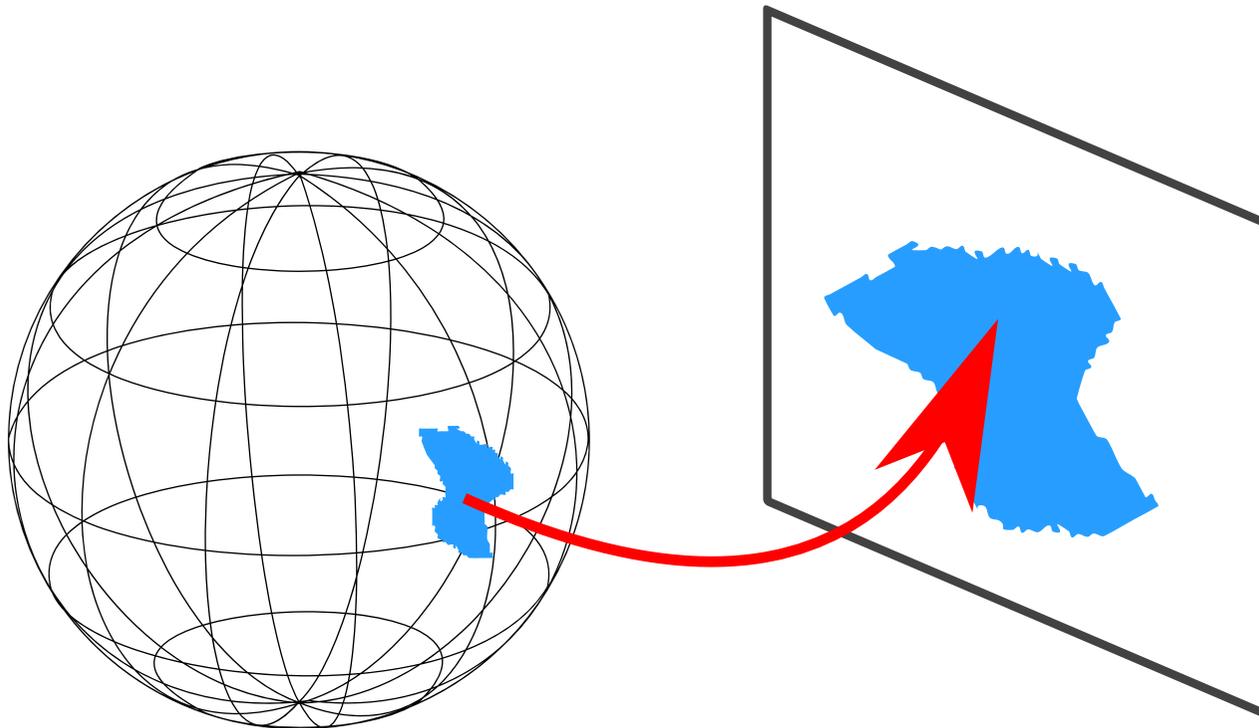
- draws the park in the GIS
- uses a known **projection**
- adds all needed information
- sends the **shapefile** to Italy



# Projections

Why do we need them?

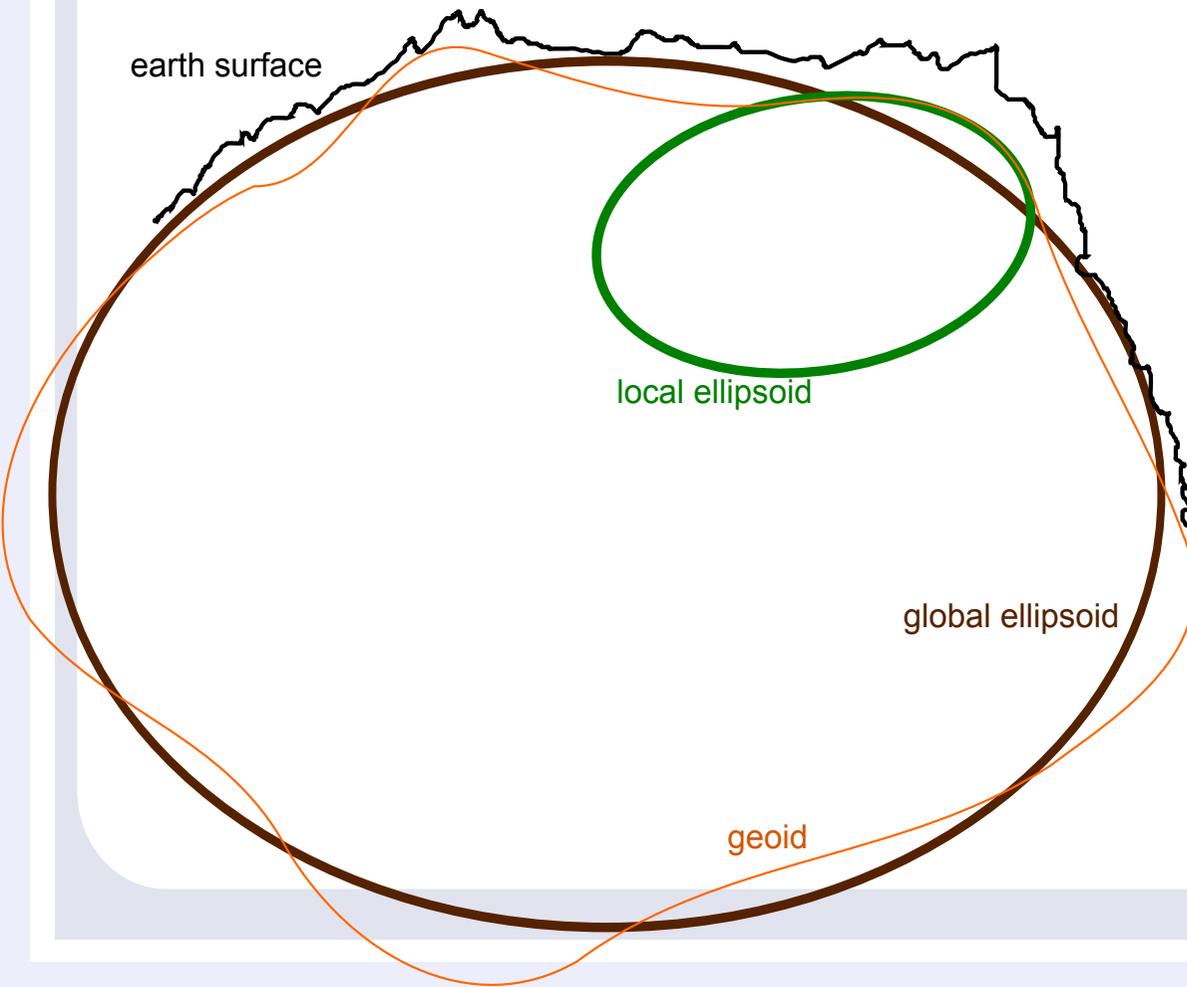
Basically we need to do measurements and to do so we need to transform a spherical shape to fix on paper without too many distortions



# Projections

The reference ellipsoid

The **datum** is a mathematically defined reference surface from which measurements are made.



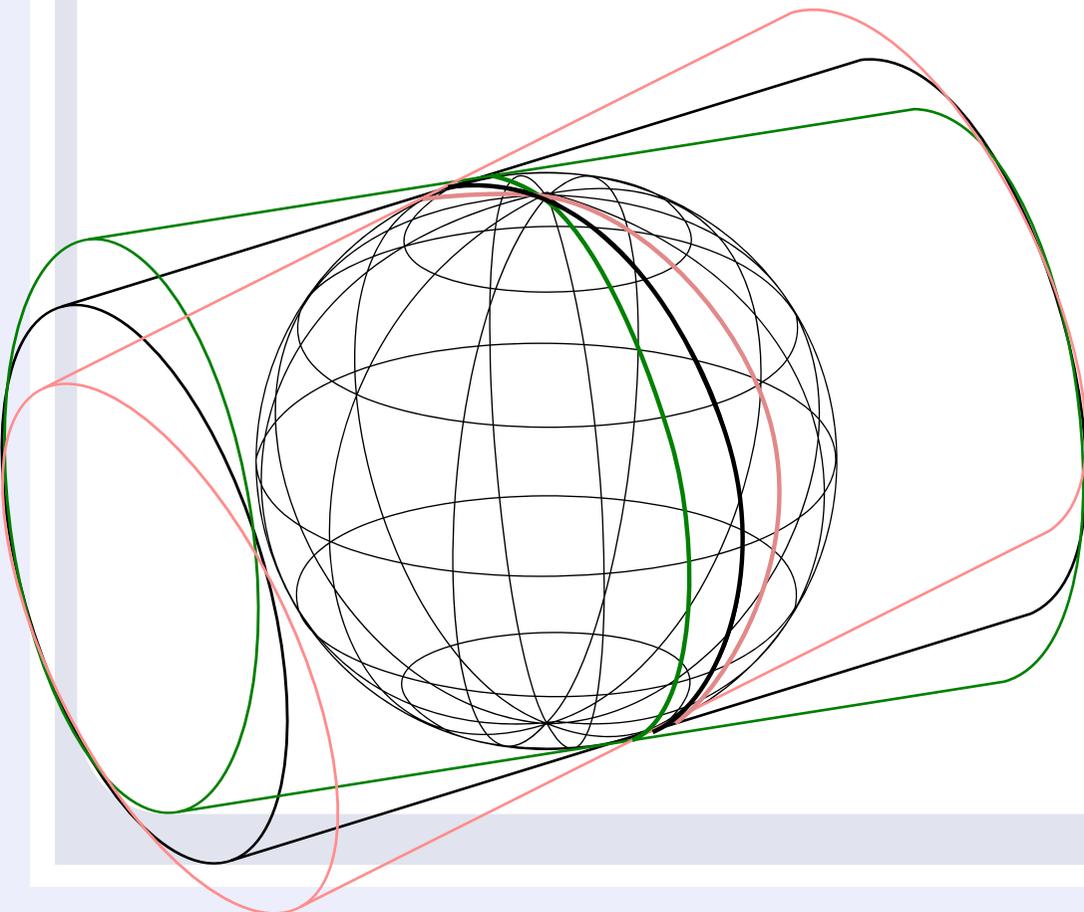
Datums can be **locally** orientated or cover the **whole globe** (designed to support satellitar measurements).

The GPS uses the WGS84 global datum, code **EPSG:4326** in uDig.

# Projections

The **projection** is the mathematical process to represent the earth on a flat piece of paper or screen

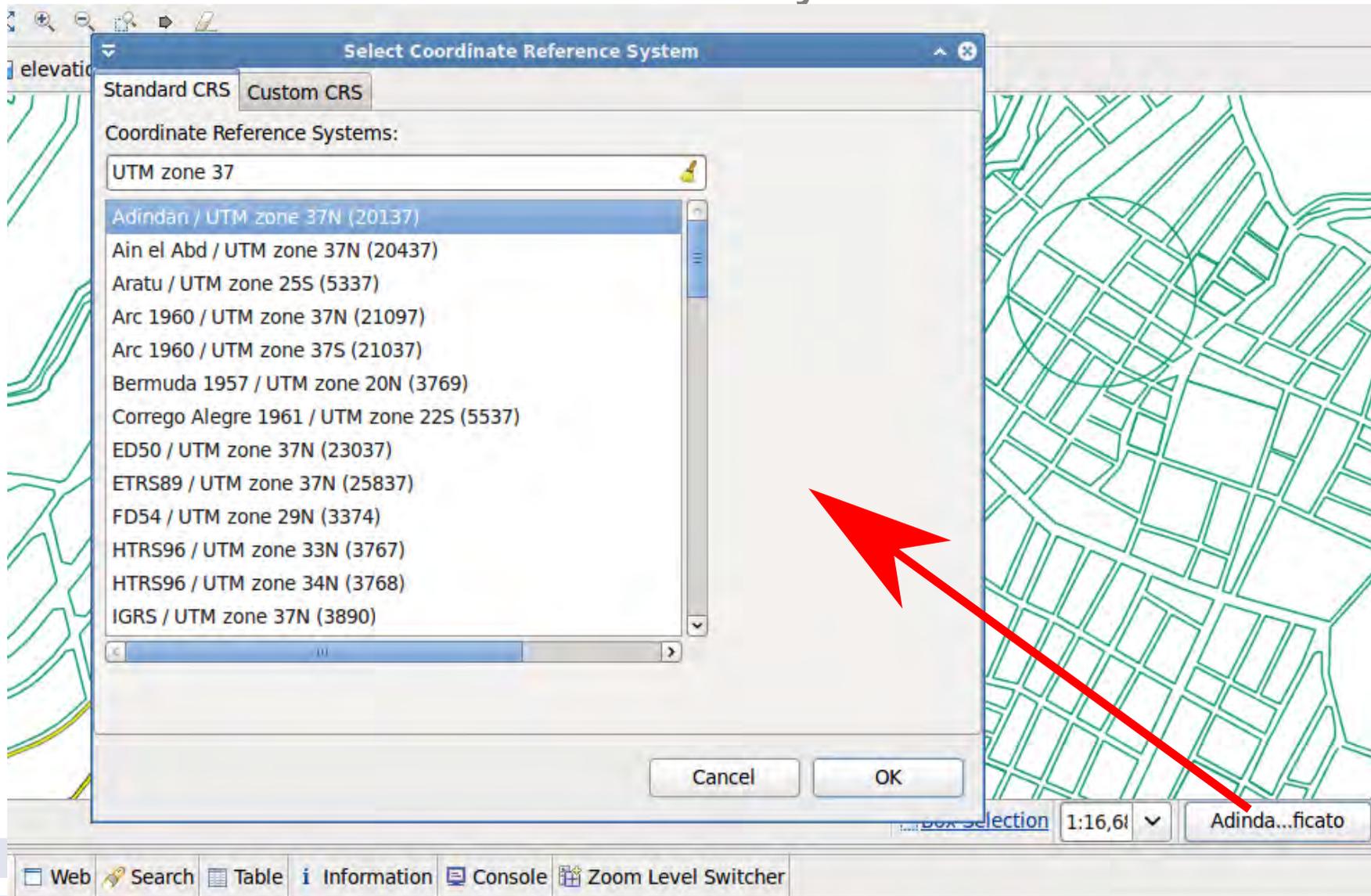
## UTM - Universal Transverse Mercator



UTM maps the Earth with a transverse cylinder projection using 60 different meridians, each of which is a standard "UTM Zone". By rotating the cylinder in 60 steps (six degrees per step, about 800Km) UTM assures that all spots on the globe will be within 3 degrees from the center of one of the 60 cylindrical projections.

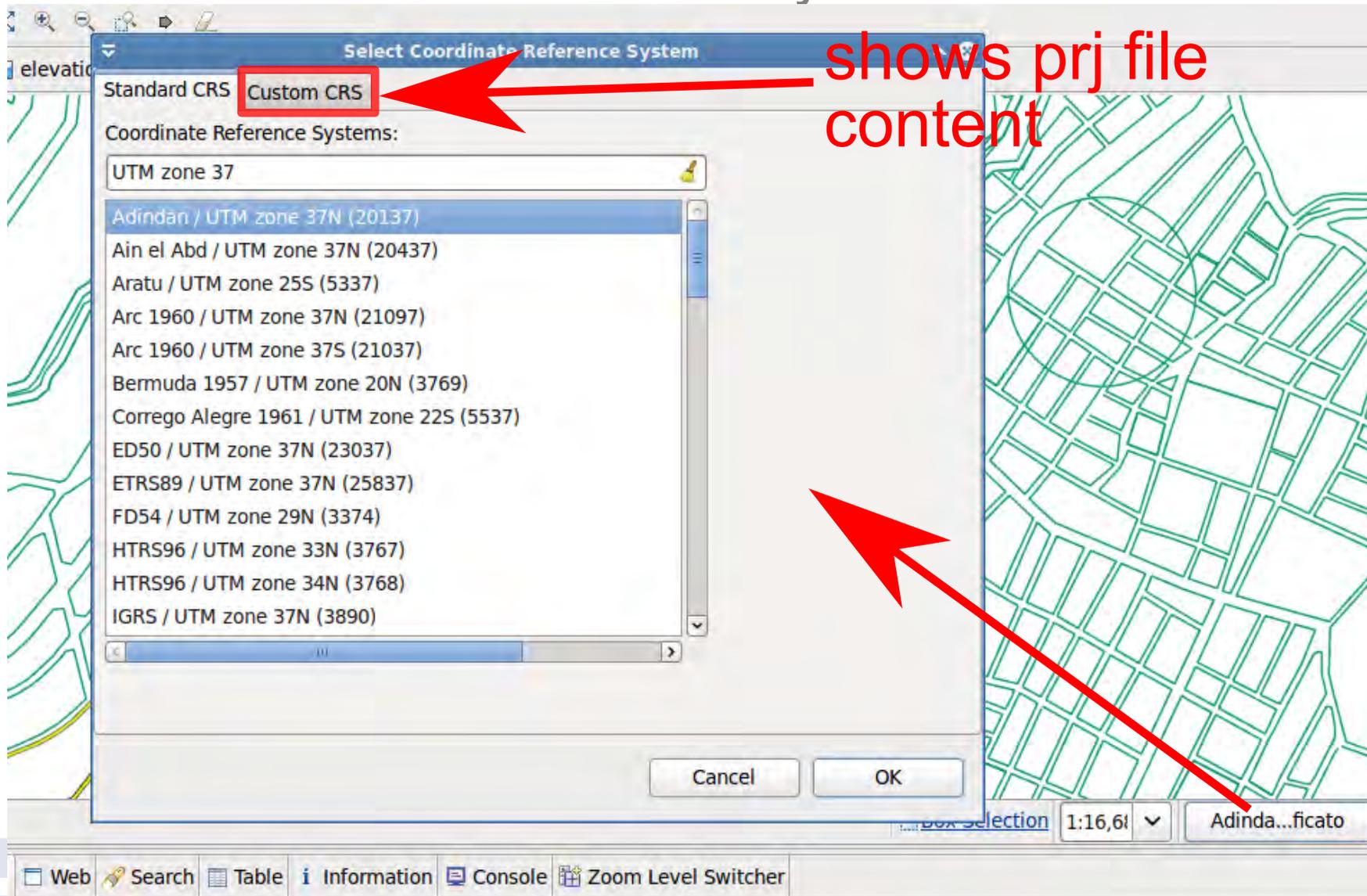
# Projections

uDig has a simple crs dialog to choose the projection if necessary



# Projections

uDig has a simple crs dialog to choose the projection if necessary



# Building a soccer field

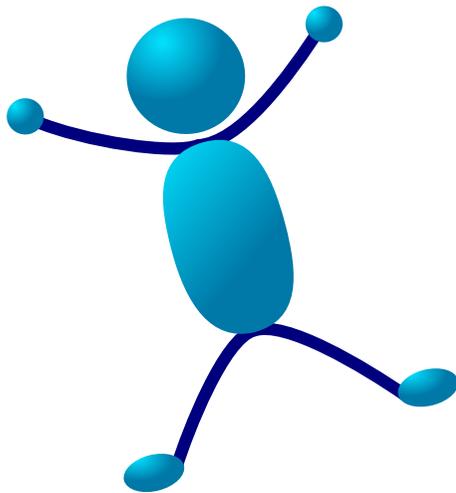
6) Mr. Watsam knows what to do. He

- draws the park in the GIS
- uses a known **projection**
- adds all needed information
- sends the **shapefile** to Italy



# Building a soccer field

7) Same as the first time the engineer imports the data in the GIS



8) The engineer .... the story goes on...

# Mapping water supply systems

- 1) **survey** data with the GPS (EPSG:4326)
- 2) **export** data from the GPS as CSV (text file)
- 3) **import** data into the GIS
- 4) modify/add info to the attributes table
- 5) save them as **shapefile**

If you can see the data in the GIS **properly positioned**, everyone will be able to work with them.