

Cartografia Urbana

Work tools – first step

5.1 main concepts

★

The *lecture* must go on...

and the number of acronyms will increase!!

How many of you are sure to be able to define:

DEM:

DTM:

DSM:

DEM, DTM and DSM

A **Digital Elevation Model (DEM)** is a raster that represents the elevation of the terrain over a specified area, usually at a regular grid interval, over the “Bare Earth”.

The intervals between each of the grid points will always be referenced to some geographical coordinate system.

(Elevation normally is the ellipsoidic but may also be the geodetic)

DEM, DTM and DSM

A **Digital Terrain Model (DTM)** is a 3D (three – dimensional) representation of a terrain surface, that includes not only heights and elevations but other geographical elements and natural features such as rivers, ridge lines, etc.

Difference between DEM, DTM and DSM

A **Digital Surface Model (DSM)** can be described as a 3D representation of a terrain surface, that includes all the elements presents on the terrain, such as roads, buildings, trees, etc.

Do you remember... *the lidar*



Immagine By Massimiliano Moraca

DTM DSM..

- Think to a Lidar as acquiring technology of the surface. You will have a first return and after, other returns and at the end the **last return**:

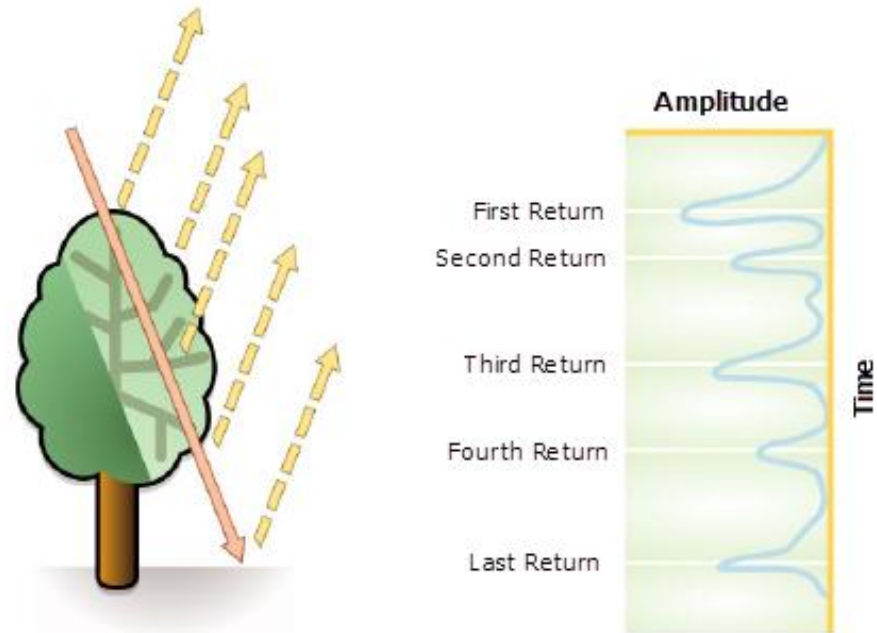


Immagine By ESRI

Sacrifice.....: DTM DSM

The first return is probably the edge of canopy. After the returns are given by the sub canopy and the last is probably the ground return.

- The DTM is elaborated starting from the last return and is the **Digital Terrain Model**
- The DSM is elaborated starting from the first return and is the **Digital Surface Model**

DEM (and DTM) VS DSM

- A **DSM** captures the **natural and built features** on the Earth's surface within the buildings and the canopy
- A **DEM** is a **bare-earth raster grid** referenced to a vertical datum. You filter out non-ground points such as bridges and roads, you get a smooth DEM. Aren't included in a DEM the atrophic buildings (powerlines, buildings and towers) and natural (trees and vegetation).
- In some countries, **DTM** is synonymous with **DEM**. This means that a DTM is simply an elevation surface, representing the bare earth referenced to a common vertical datum.

In USA? (*DEM vs DTM vs DSM*)

- In the USA and in the scientific literature it is completely different:
- A DTM is a **vector data** set. It is composed of regularly spaced points and natural features such as ridges and breaklines.
- Typical a DTM increase a DEM by including linear features of the bare-earth terrain.

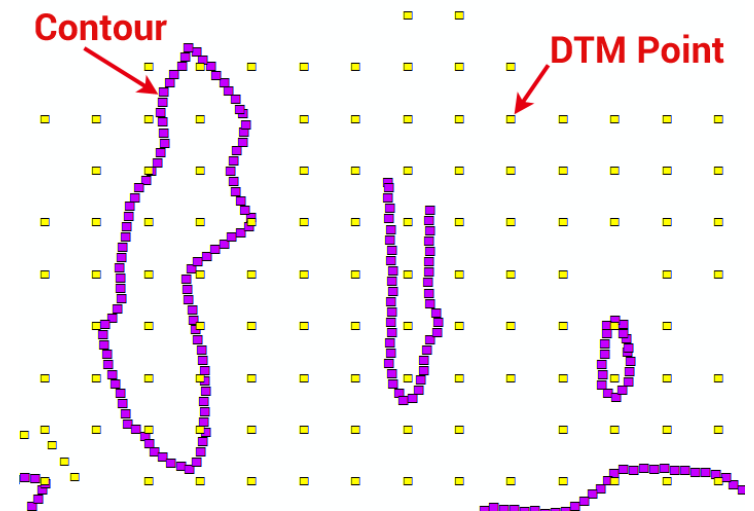


Image By GYSGeography

When

- A DSM is useful in 3D modeling for telecommunications, urban planning and aviation
- DEM (and his Italian synonymous DTM) is particularly useful in hydrology, soils and land use planning
- Normally DTM (according USA Definition) are typically created through photogrammetry. You can interpolate a DTM and its and contour lines into a DEM. A DTM represents distinctive terrain features much better

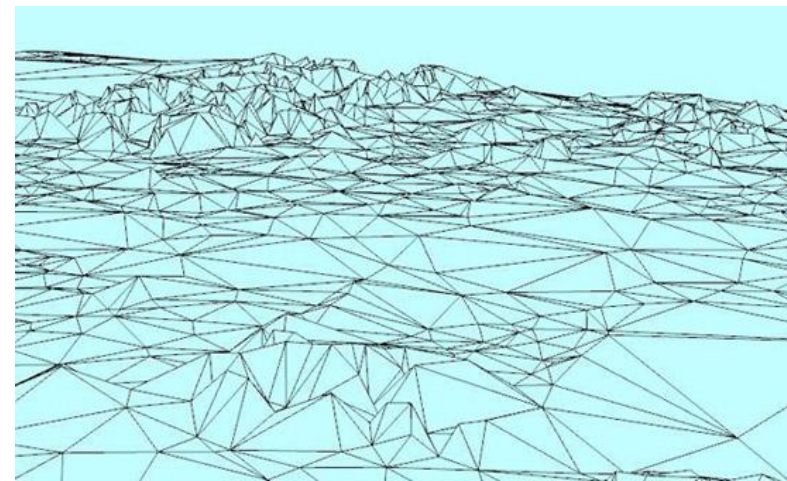
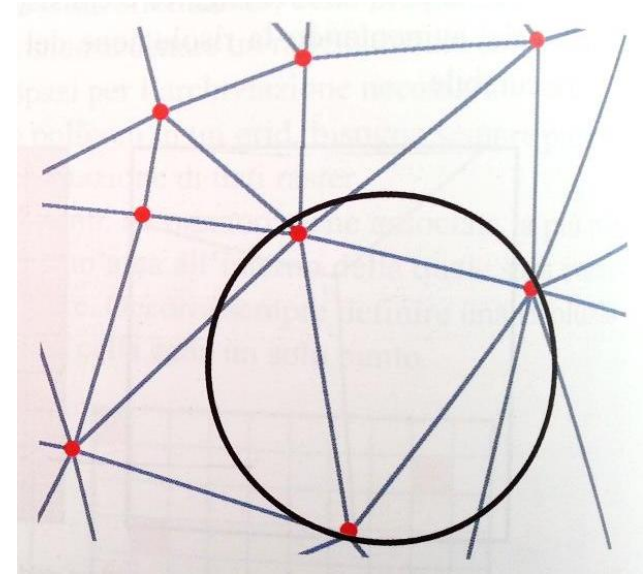
TIN = Triangulated Irregular Network

Una superficie è un insieme continuo di valori che possono variare su un numero infinito di punti.

I modelli di superficie consentono di memorizzare le informazioni di superficie in un GIS, prendendo un campione di valori in punti diversi sulla superficie e poi interpolando i valori tra questi punti.

I **TIN** rappresentano una superficie come un insieme irregolare di punti collegati per formare una rete di triangoli con valori z memorizzati nei nodi.

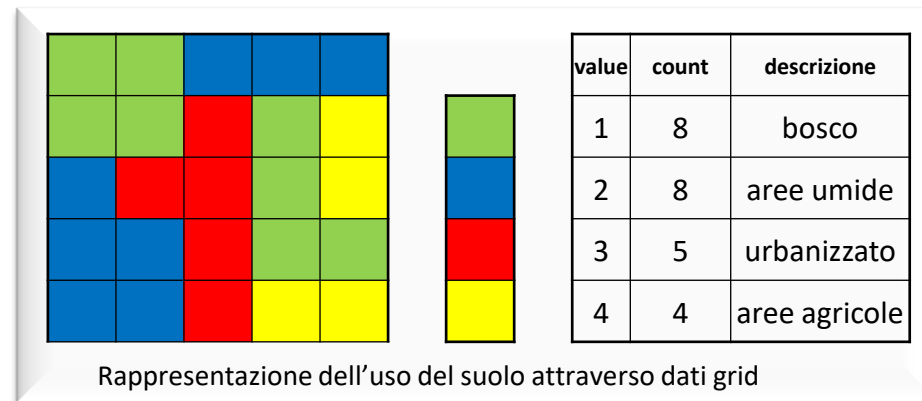
- Nota: queste slide sono richiami del corso di Territorio non urbanizzato e quindi sono in Italiano



The format GRID

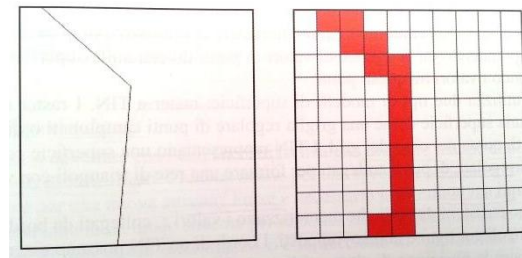
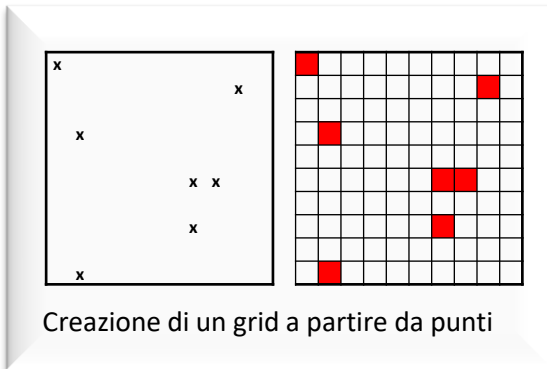
Il **formato GRID** costituisce un particolare formato raster in cui i dati spaziali vengono organizzati come una griglia di celle quadrate, con un valore associato a ciascuna cella.

Le celle sono organizzate secondo una matrice ortogonale che le raggruppa in righe e colonne.

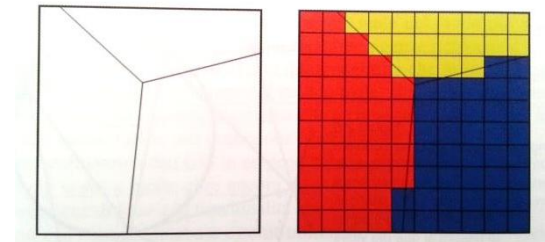


IL FORMATO GRID

La dimensione scelta per le celle di un grid di una determinata area di studio dipende dalla risoluzione dei dati e dal dettaglio richiesto dalle analisi.



Creazione di un grid a partire da linee



Creazione di un grid a partire da poligoni

GSD Ground Sample Distance

- In the digital images GSD is the linear dimension (typically in meters) of the area on the real soil, whose image, projected on the sensor covers a pixel

$$\text{GSD} = D * (L/f)$$

were:

f is the focal length of the camera

L is the dimension of the sensor's pixel

D is the shooting distance

Example

- A semi metric camera “35mm” full frame with a sensor 24*36 mm type CCD of 18 MPixel
- We assume that the pixels of the CCD are perfectly square
- In this hypothesis I can say that the number of rows multiplied by number of columns makes 18 millions and consequently (24 mm are $24 \cdot 10^3 \mu\text{m}$ and 36mm are $36 \cdot 10^3$):

$$24 \cdot 10^3 / L * 36 \cdot 10^3 / L = 18 \cdot 10^6$$

- From which $L=7 \mu\text{m}$ is the linear dimension of the pixel
- If the shooting distance of a generic area (greater than the fly altitude) is for example 2000m and the focus of the lens 50 mm:

$$\text{GSD} = D * (L/f) = 2000 * (0,007/50) = 0,28 \text{ m}$$

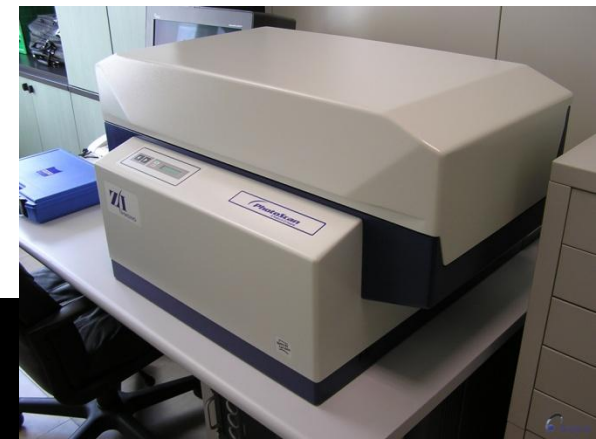
- Really the condition is worse because you have a color sensor and you have the sensor noise and a lot of other disturbance

GSD in analogic images

For the analogical images of big quality, you may assume that the resolution of the film is about 8-10 μm (0,008-0,01 mm). This value is of the same dimensional order of digital photos.

But you need of a digital scanning and this operation may be critical. There are not in Italy a lot of quality scanner (Photogrammetric scanner) with a resolution of 12 μm . You can understand that the scanning is a combination of the two resolution (The resolution of the photo and that of the scanner) and consequently is worse than the lowest resolution

The optic resolution of the scanner is measured in DPI Digit per Inches. As a inch is 25,4 mm, a resolution of 2200 DPI is equivalent to $25,4/2200 = 0,0115\text{mm} = 12 \mu\text{m}$



GSD in analogic aerial images

Typically the images are with a focal length of about 150mm and a film of dimension 230 mm *230 mm with a film grain of about 12 μm .

With the same division of the first example assuming the same shooting distance of a generic area, for example 2000m, and the focus of the lens 150 mm:

$$\text{GSD} = D * (L/f) = 2000 * (0,012 / 150) = 0,16 \text{ m}$$

N.B. in this case you have half GSD (2 times better than the example of the full frame camera) and at the same time the area in the frame is two time larger (about 3 km vs 1.4 km) and tree time higher (3 km vs 1 km)