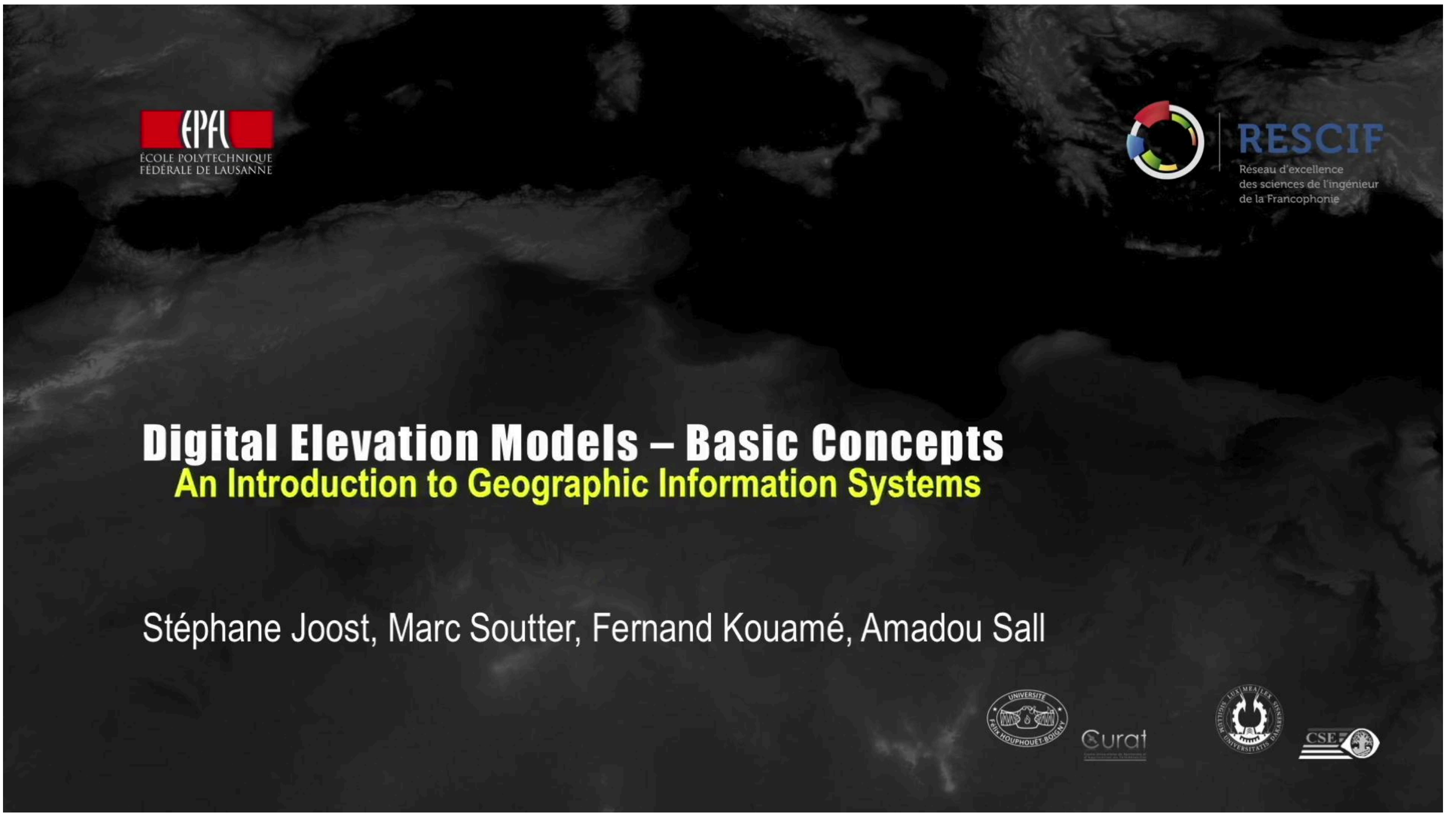

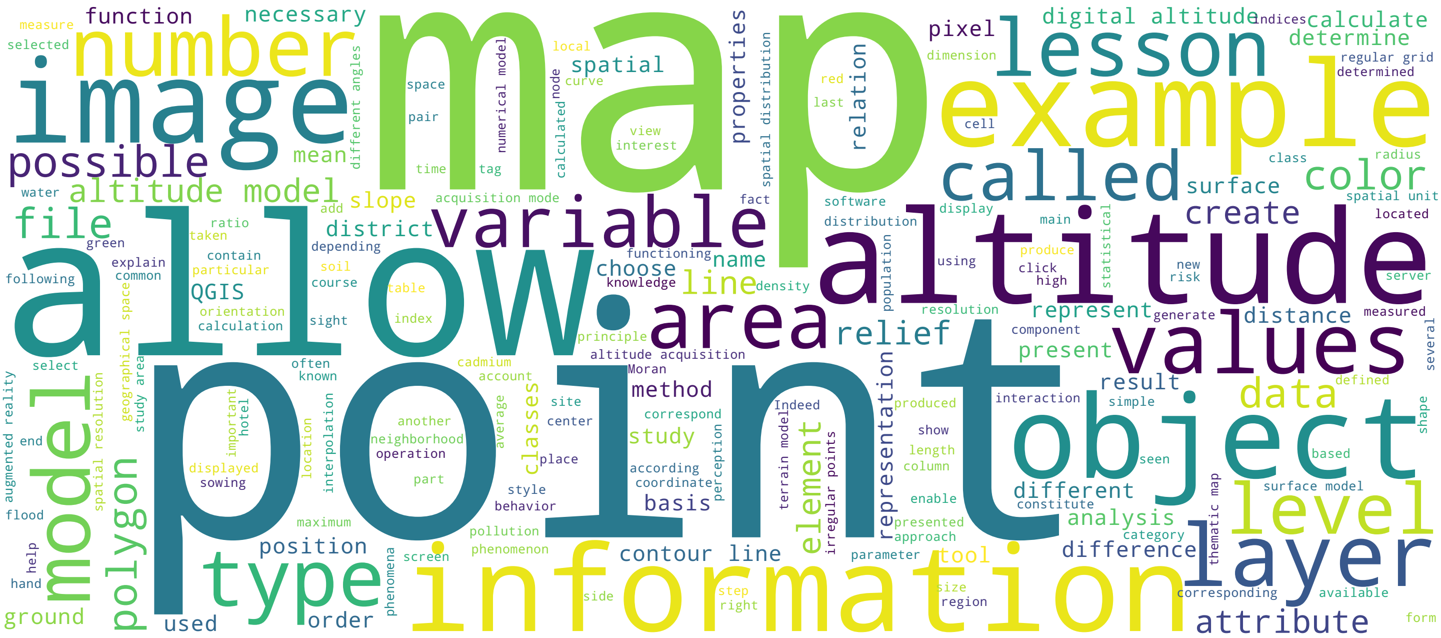

Search MOOC

Video

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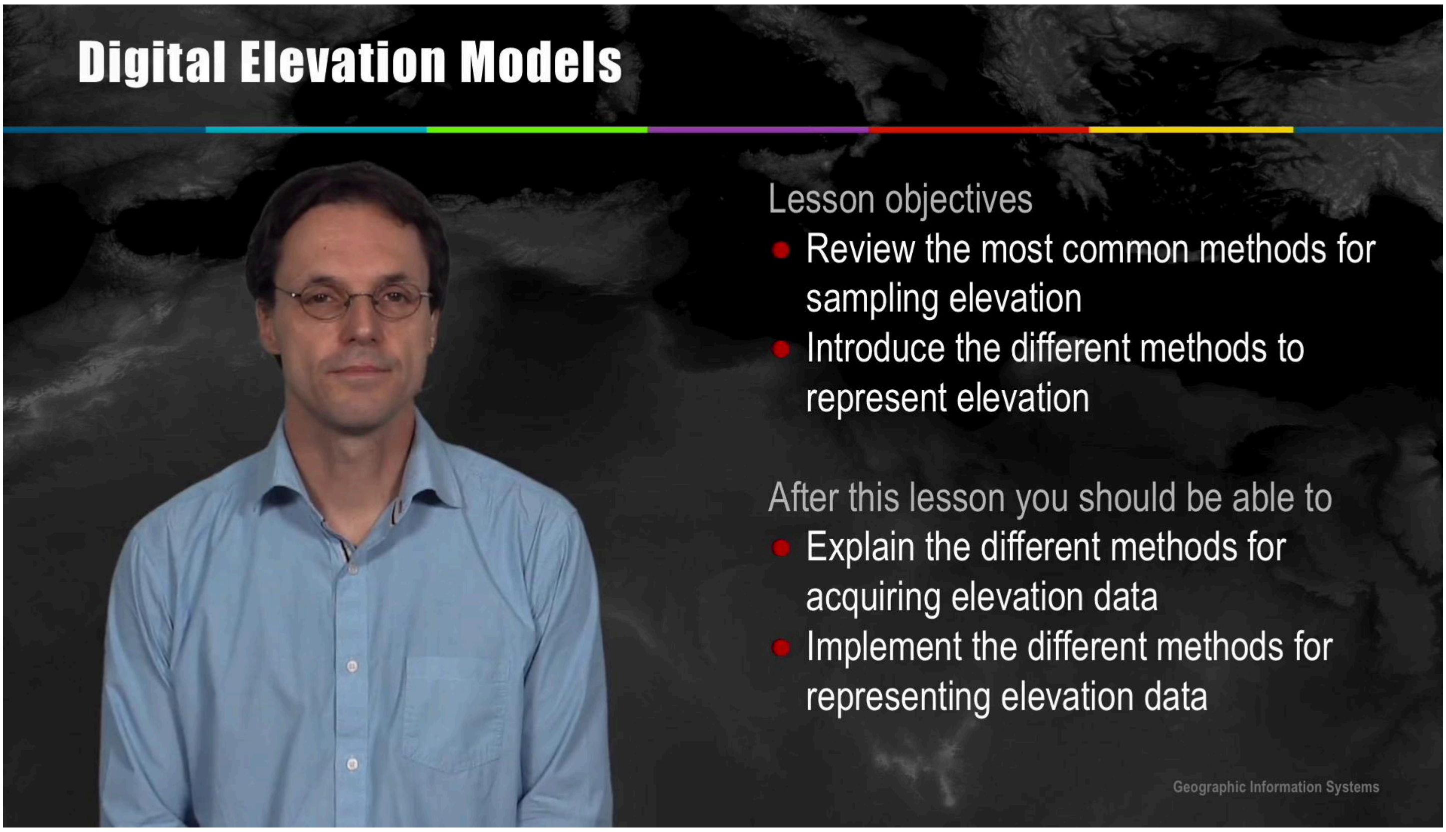
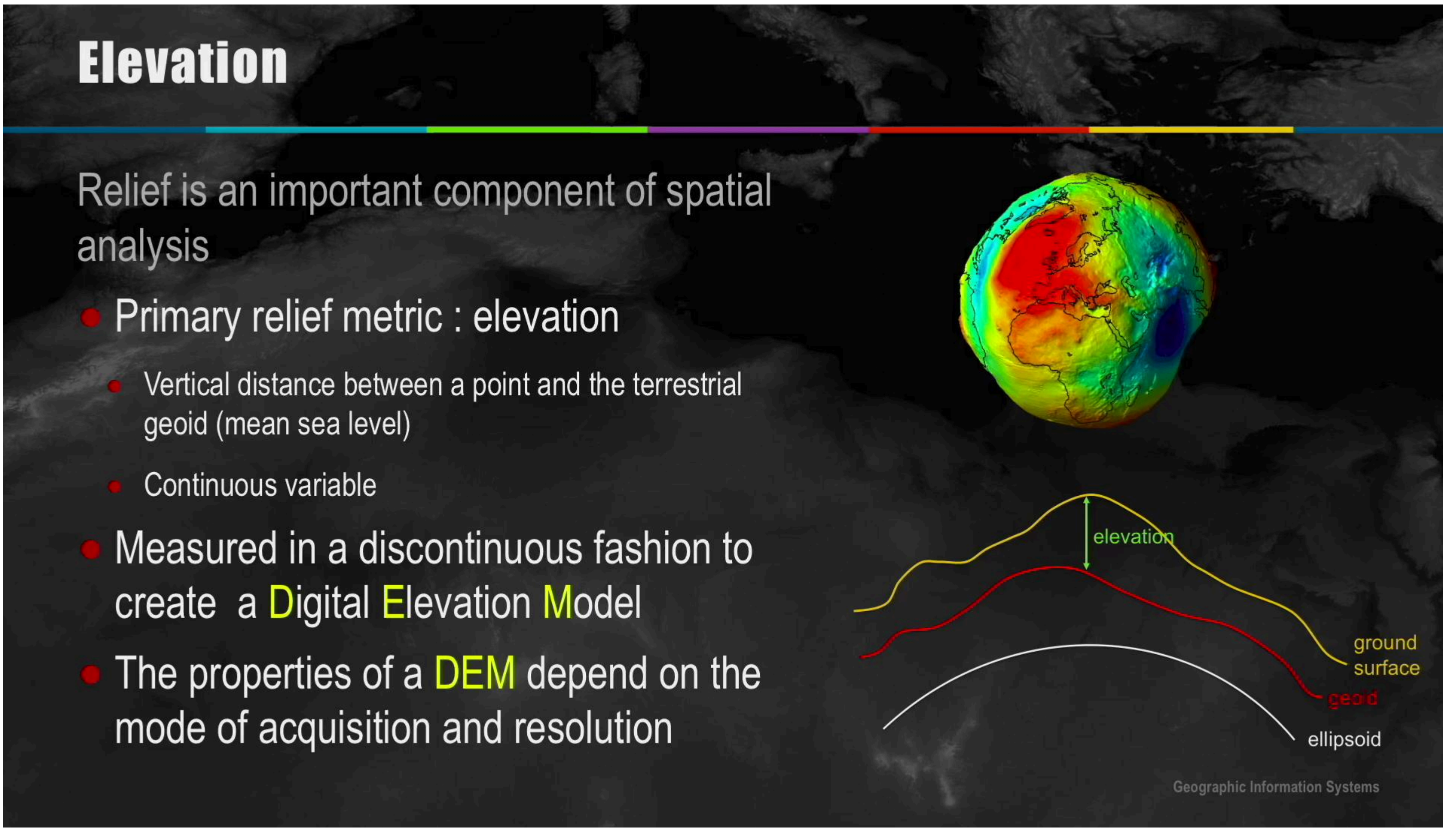


Welcome to this basic lesson on digital altitude models which allow us to model the topography. The relief represents by definition the shape and the inequalities of the earth's surface. It stems from geological and climatological movements that occurred over the course of thousands of years. According to these properties, the animal and vegetable kingdoms find favorable conditions to their evolution. They also condition the appropriation of the geographical space by human beings. The primary measure of the relief is the altitude on sea. And a digital file which contains the altitude measurements at the node of a regular grid constitutes what is called a numerical model of altitude. In this lesson, we will study some modes of altitude acquisition as well as the different representation techniques of the digital altitude models. The goals of this lesson are to explain the functioning of the various altitude acquisition techniques of representation of the relief. At the end of this lesson, you should be able to explain the functioning 27 00:01:38,212 --> 00:01:40,624 of the various altitude acquisition techniques in order to assess their accuracy and reliability but also to master the various topography representation techniques.

Notes

Summary

0m 30s

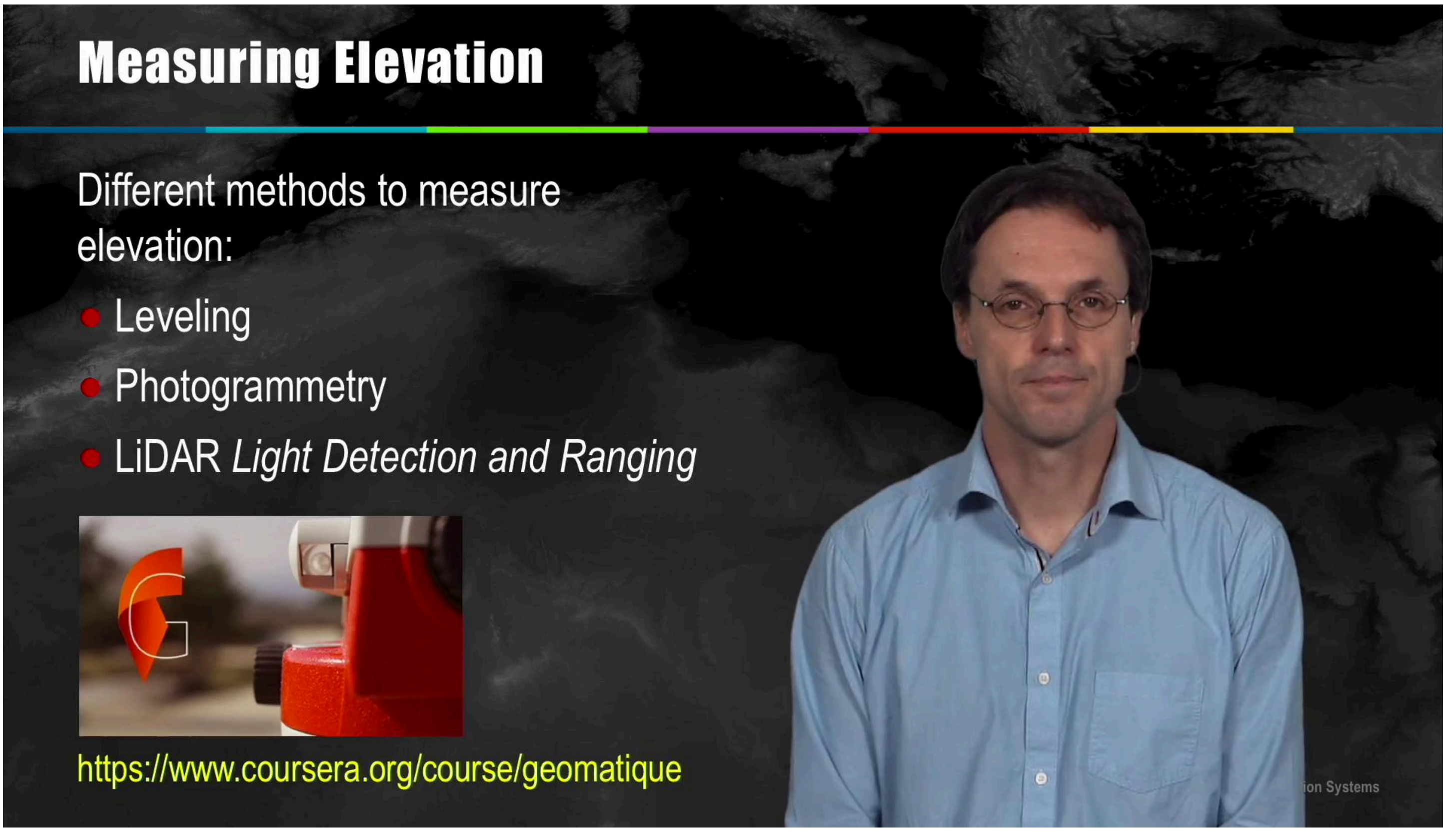


The relief shapes the landscape and creates more or less favorable conditions for human activities, for the exploitation of the resources contained in the soil and also to determine the habitat of plant or animal species. The knowledge of these properties is therefore essential for many disciplines and is an important element in spatial analysis. The primary relief measure is the altitude. The definition of altitude is the vertical distance which separates a point from the relief of the surface of the terrestrial geoid. The geoid is defined as the equipotential surface in gravity adjusted on an average level of the surface of the sea. The altitude is a continuous variable since it is possible to determine its value in any point in the geographical space However, as the exhaustive consideration of this information is not feasible, we create a model in which the altitudes are acquired in a discontinuous way according to a regular or irregular sampling mode. This is called a digital altitude model or digital ground model. The properties of a digital altitude model are determined by its acquisition mode and by its accuracy as we will see in the next section.

Notes

Summary

2m 03s

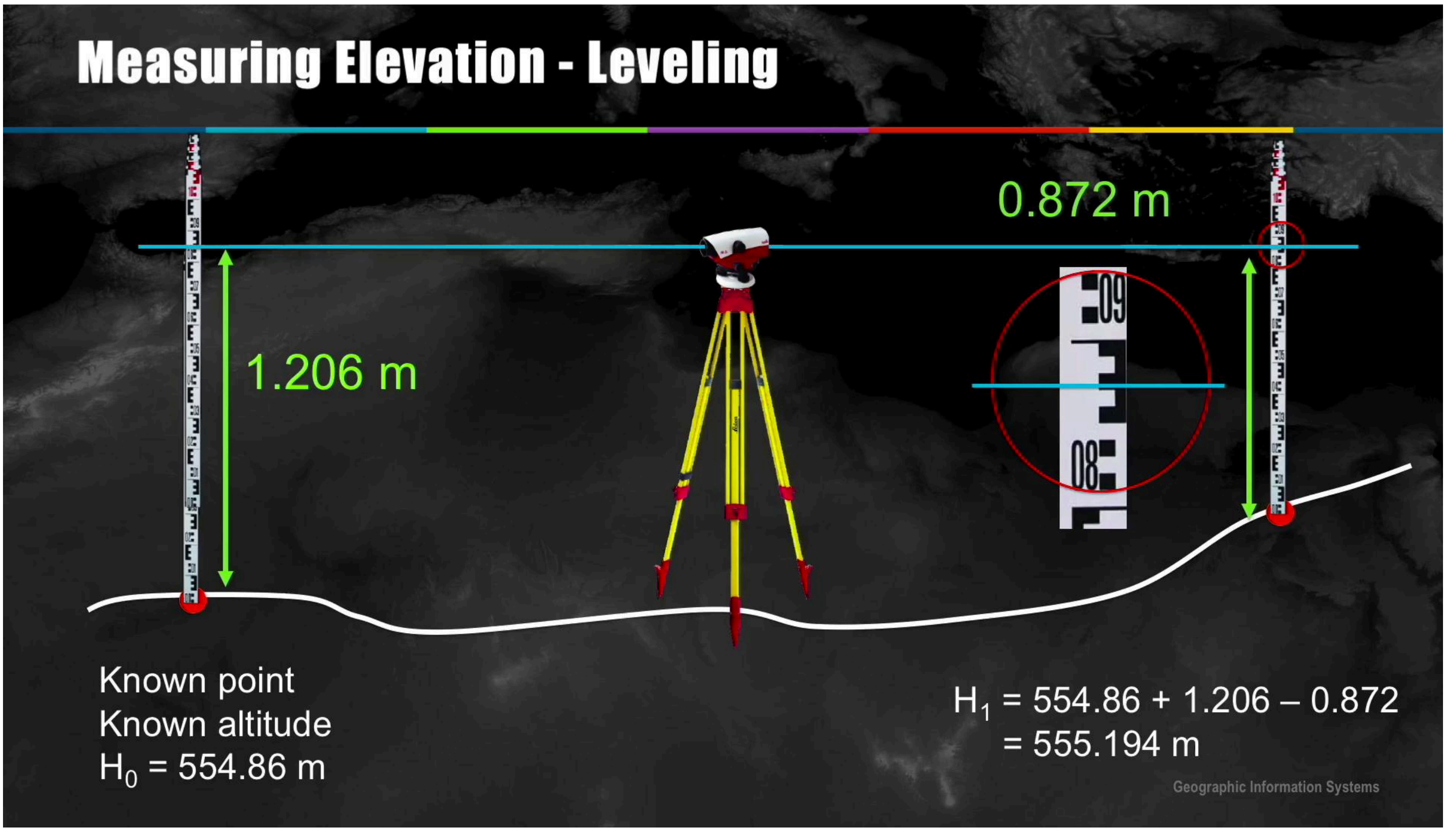


There are different altitude acquisition modes and we have chosen to present here the most common, that is the leveling, the photogrammetry and the scanning laser altimetry. Further information about them can be found in the "element of geomatics" MOOC whose internet address is displayed here.

Notes

Summary

3m 31s

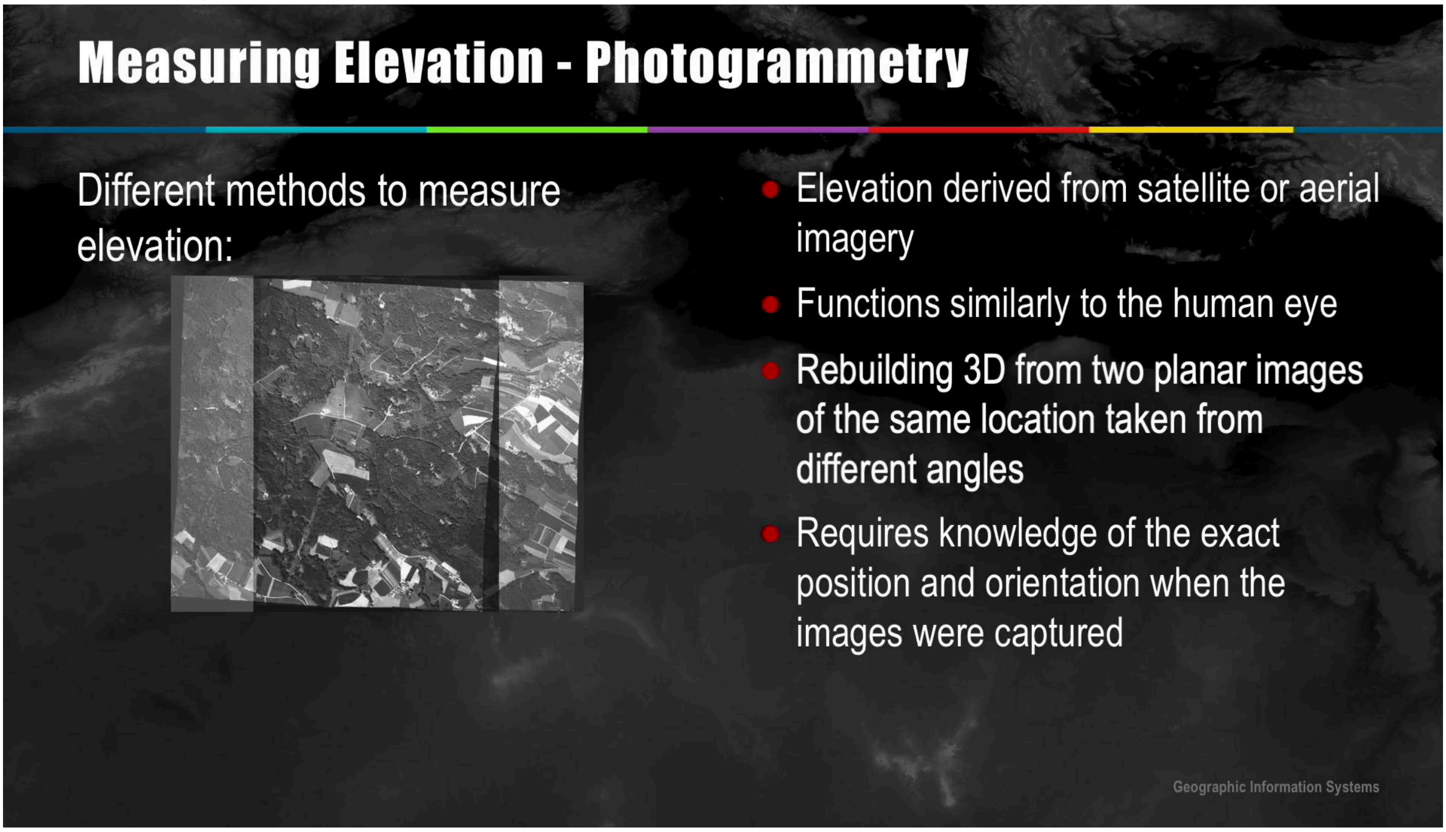


The geometric leveling consists in measuring an altitude difference in relation to a known altitude point which is called a leveling landmark. This type of leveling is also called leveling by horizontal sight or direct leveling. The operation consists in measuring the difference of height or difference in level between the point whose altitude is known and the point whose altitude is not known. This allows by simple subtraction to determine the altitude of the points. To do so, we use a level which is a device allowing to materialize a horizontal line of sight. This level is placed on a tripod halfway of 2 sights which are held vertically at the 2 points. We will then be able to successively read in the bezel of the level a value for each of the points. The steepness which is the difference between the 2 values read added to the altitude of the known point gives the altitude of the second point. To minimize the errors, the length of a grade does not exceed 80 m.

Notes

Summary

3m 52s

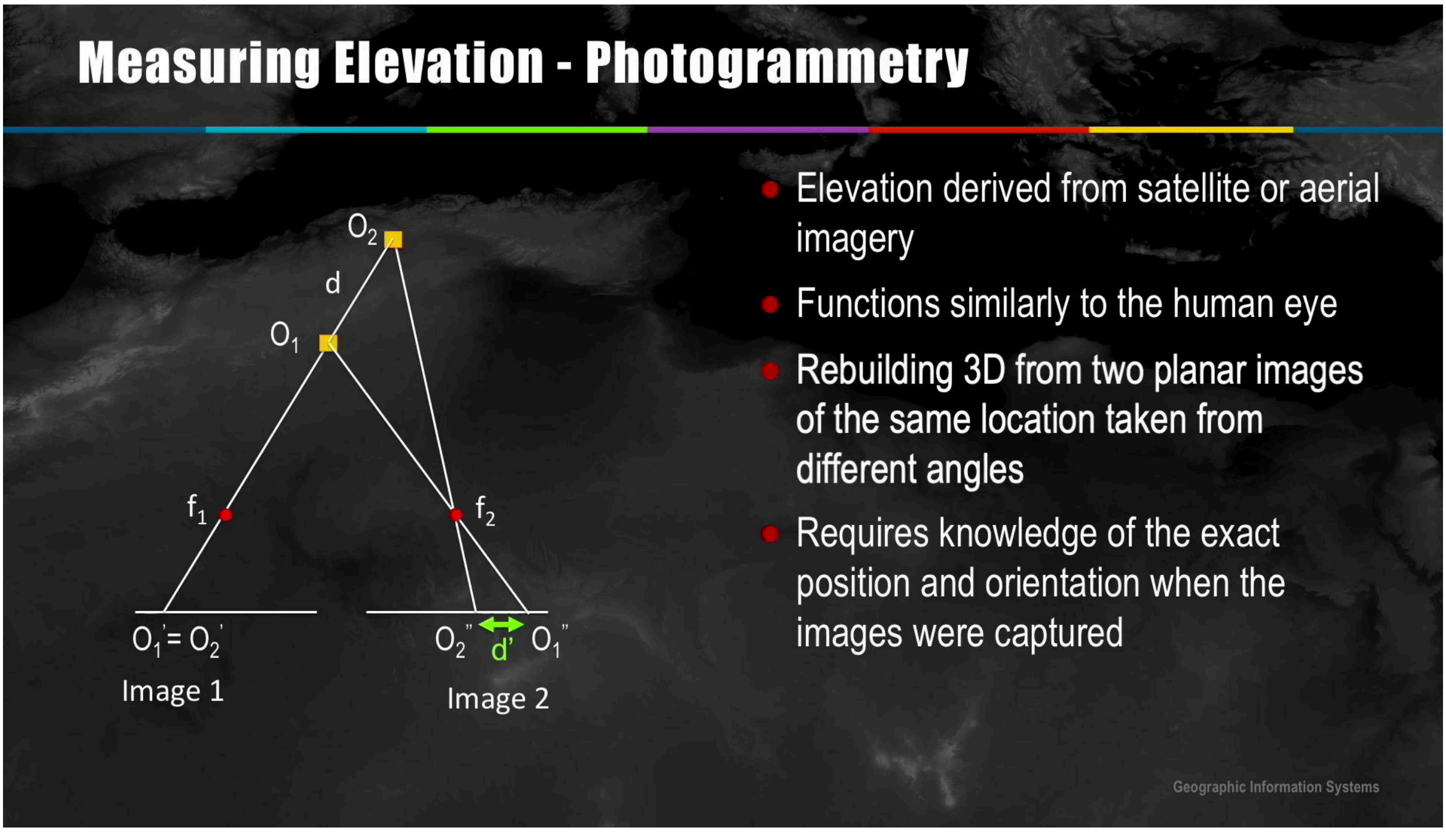


As soon as aerial images were available from the end of the 19th century, photogrammetric techniques have been implemented to make topographical maps and perform altimetry measurements. From a geometric point of view, the photogrammetry proceeds in a similar way as the human visual system which is able to perceive objects from 2 different angles. As a single image is formed in our brain, the relation differences between objects translate into the perception of depth. Instead of our 2 retinas, the photogrammetry uses 2 flat images of the same place and taken at 2 different angles. The 2 images form a stereoscopic pair from which, thanks to markers identifiable on the ground, we calculate the position of any object on the ground in the three dimensions X, Y and Z.

Notes

Summary

4m 52s



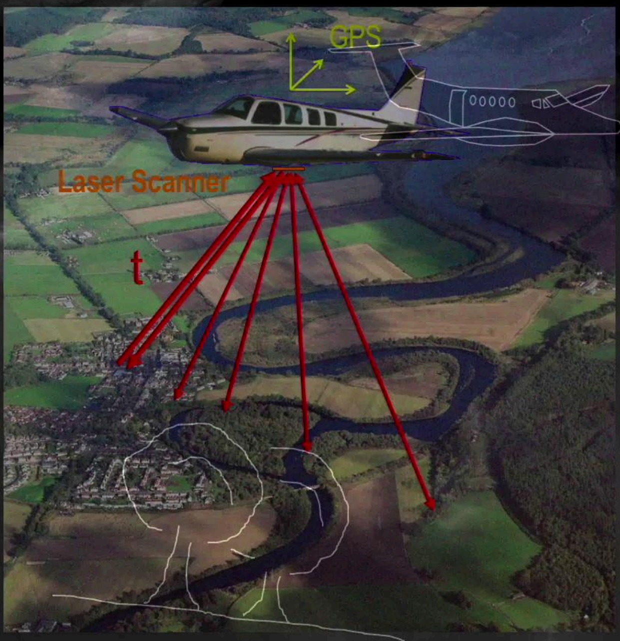
The principle is to exploit the paralax, so the apparent shift on the images of an object which is seen from 2 different angles. O1 and O2, are 2 objects in real space. These two objects are perceived on the same line of sight. As the position of the images 1 and 2 is known, we can deduce angular relations. Here, f1 and f2 are the photographic focus of image 1 and 2. The points O1' O2' and O1'' O2'' in the image space are said to be homologues of the objects O1 and O2. This identification of a pair of homologous points is called a stereoscopic pairing. Now, knowing the angular relations of the triangles whose vertices is f2 and the distance D' on the image 2, we can deduce the distance D. To ensure the photogrammetric restitution we have to have ground landmarks which are easily identifiable on the images. This is necessary because the geometry of the restitution of the 3 dimensions requires to know perfectly the relative position of the images when shooting.

Notes

Summary

5m 46s

Measuring Elevation - LiDAR



- LiDAR = *Light Detection And Ranging*
- Airborne LiDAR
- Position of the airplane is precisely measured with differential GPS
- Measures the time it takes for a laser to reach the surface and return as well as the intensity upon arrival
- Calculates the elevation of the terrain
- Multiple returns are measured (e.g. ground and vegetation)

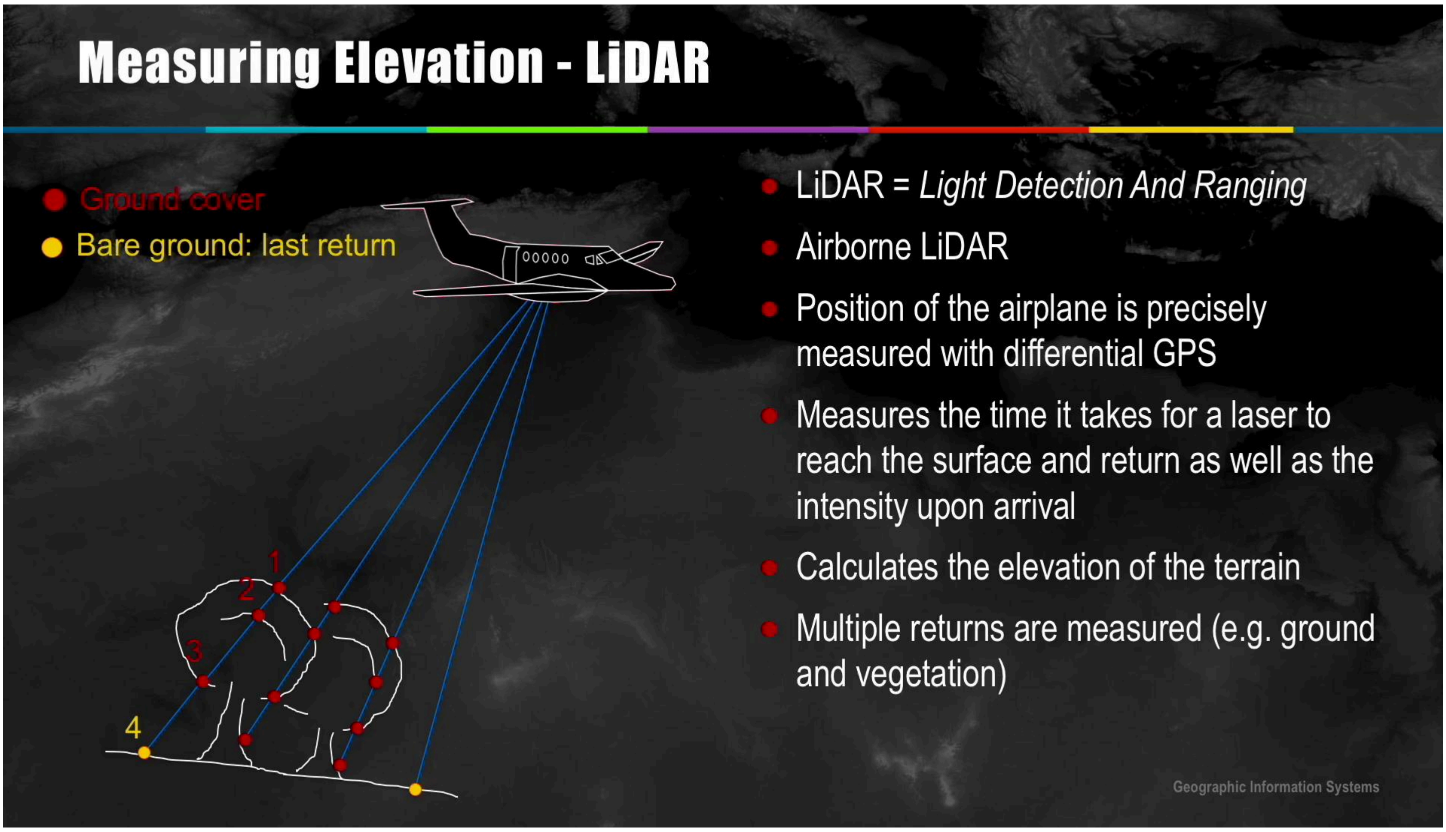
Geographic Information Systems

The third altitude acquisition mode presented here is the scanning laser altimetry. It is an electronic system called LIDAR which measures the return time and the intensity of a laser beam which is transmitted from an airborne platform. The ground altitude of the aircraft or the helicopter and its position are measured with very high accuracy by a differential GPS system. The knowledge of the precise position of the platform and the measure of the roundtrip times of the laser pulses allow to calculate the position of the surface elements who reflected the signal. Several echoes of the transmitted signal can be measured depending on the nature of the soil cover.

Notes

Summary

7m 00s

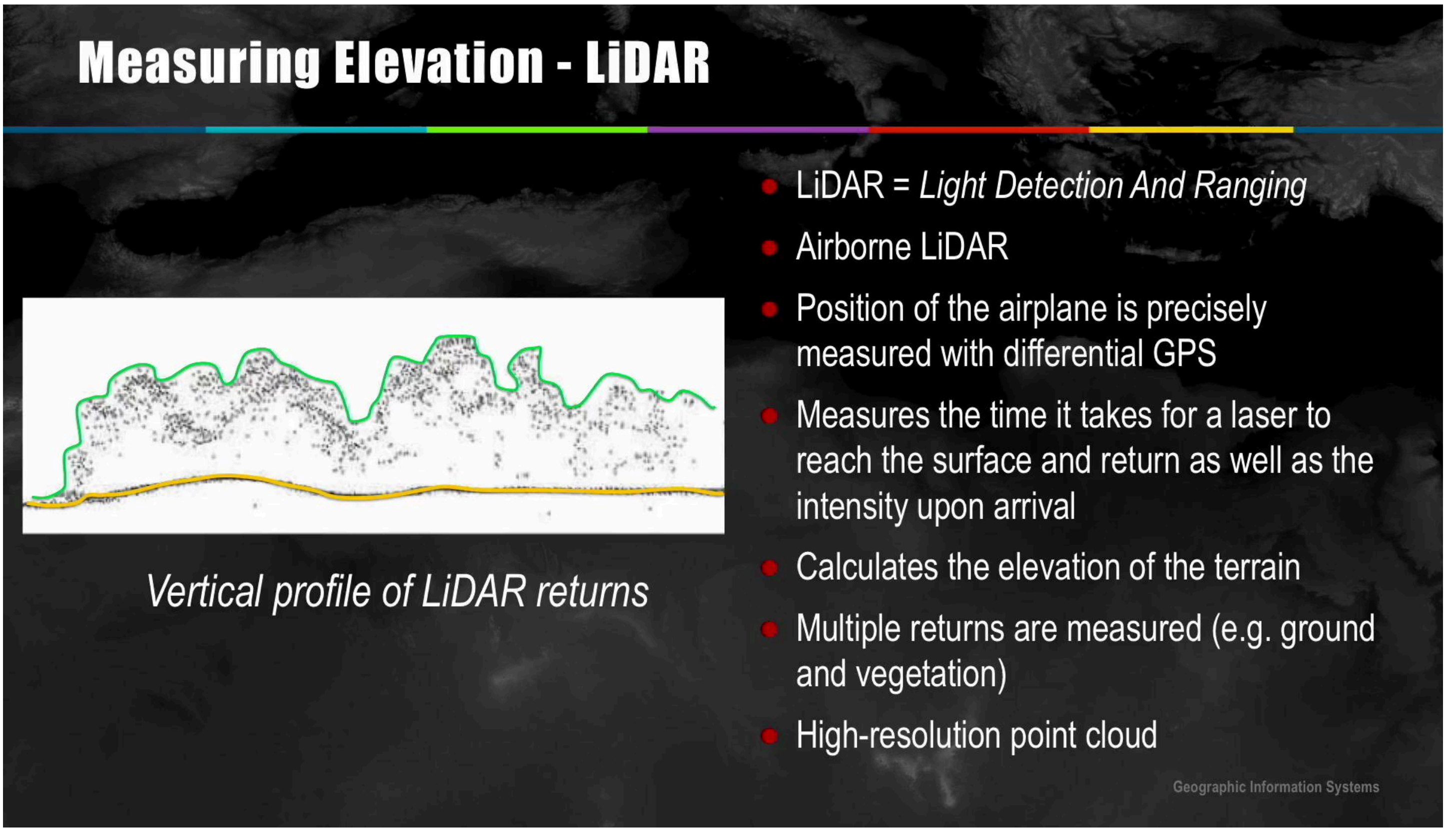


Indeed, if a first reflection is produced by the upper parts of a tree, a part of the signal will be able to reach lower layers or even the ground before being reflected in turn. The laser of a rangefinder emits from about ten to several hundreds of thousands of pulses every second. It is thus possible to record several echoes per radius.

Notes

Summary

7m 48s

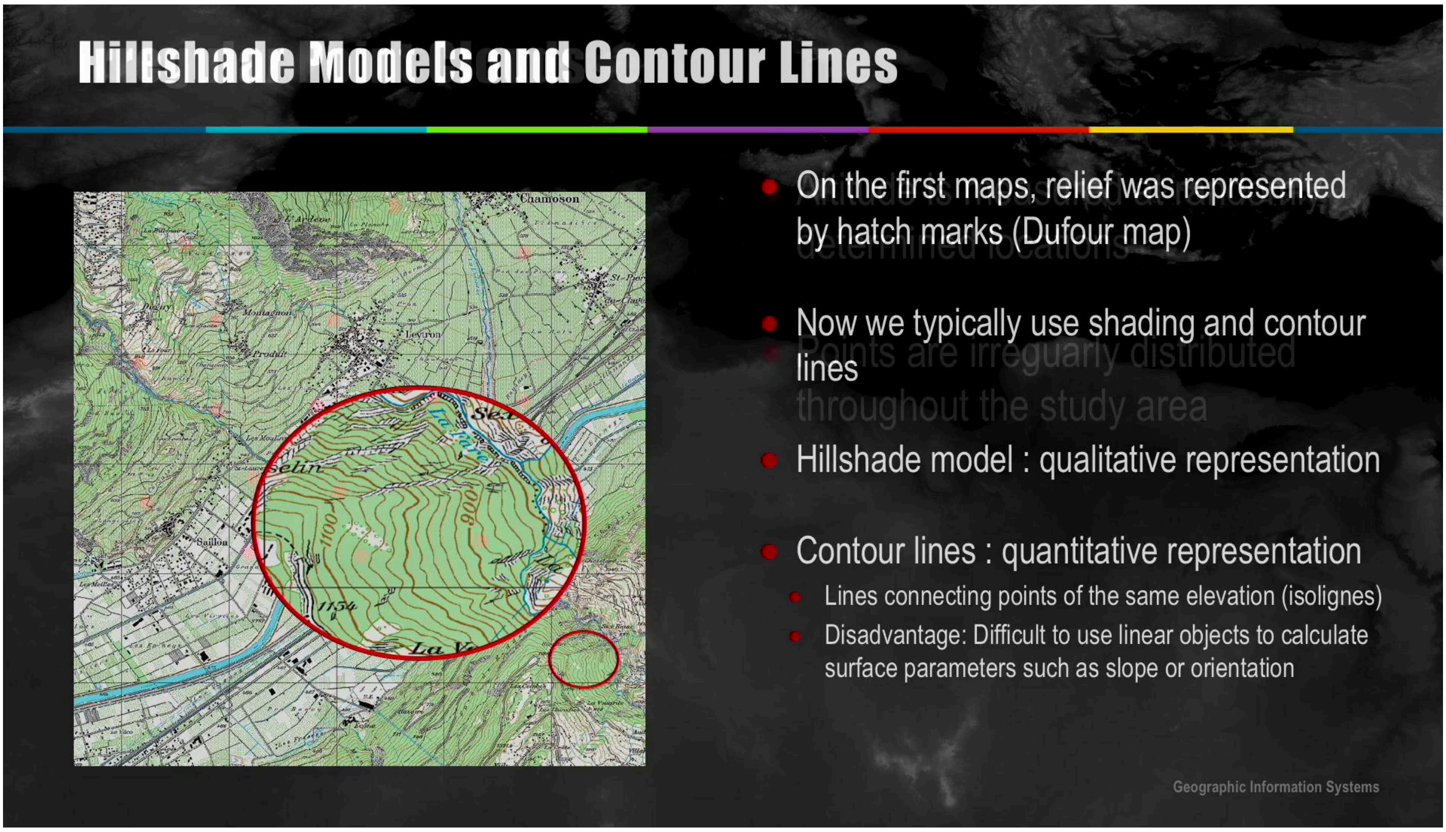


The wavelength of the beam is generally between 08 and 1 micrometer that is to say in the near infrared. The intensity of the return signal is a carrier of information on the properties of the surfaces, mainly the vegetation cover because it reflects well its wavelengths. The upper envelope of the reflections here represented in green takes the name of digital surface model. or MNS whereas the lower envelope represented in yellow corresponds in the vast majority to the echoes from the ground and retains the digital terrain model name.

Notes

Summary

8m 11s

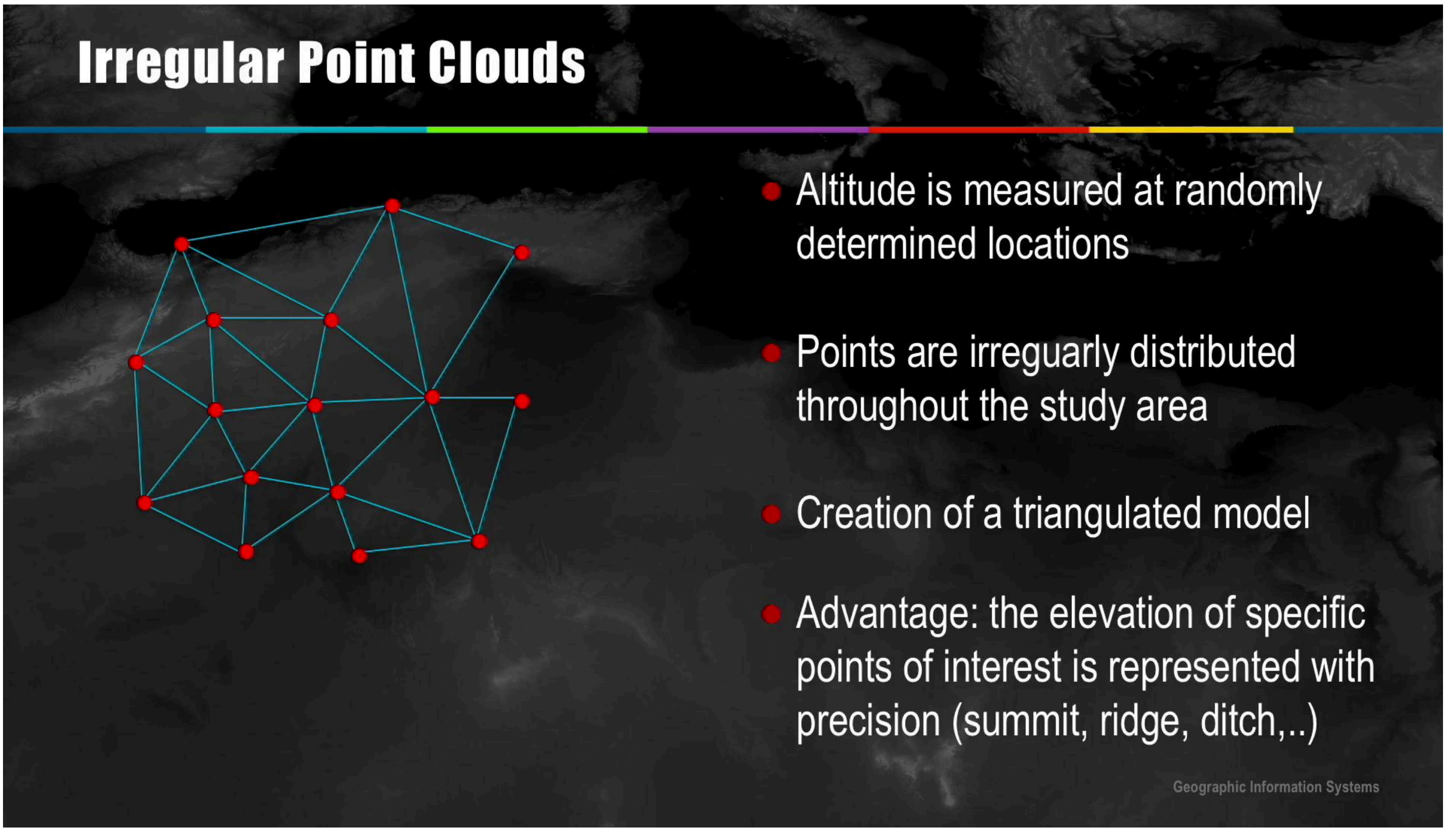


a surveying of altitude by sowing of regular or irregular points, and acquired by one of the methods which we have just presented allows to create a numerical model of altitude. We will now present different types of models beginning with a technique of representation of the relief used in the first maps. We will then see the shadow technique and the contour line model then the irregular sowing of points before concluding with the model in regular grids. The cartography has from the beginning granted some importance to the representation of the relief. This is in fact an essential information to locate the objects in their geographical context. We were simply representing the reliefs with hatchings on old maps like here on the Dufour map which represents an area of the central Valais in Switzerland in 1885. We now use shadows and contour lines to suggest the relief. On topographic maps, shadowing is a qualitative representation which suggests a relief illumination and a shadow projected towards the South-East. The contour lines are linear objects whose quantitative attribute is the altitude. This type of model is unsatisfactory because on its basis, any derived variable calculation such as the slope or the orientation is tedious.

Notes

Summary

8m 57s

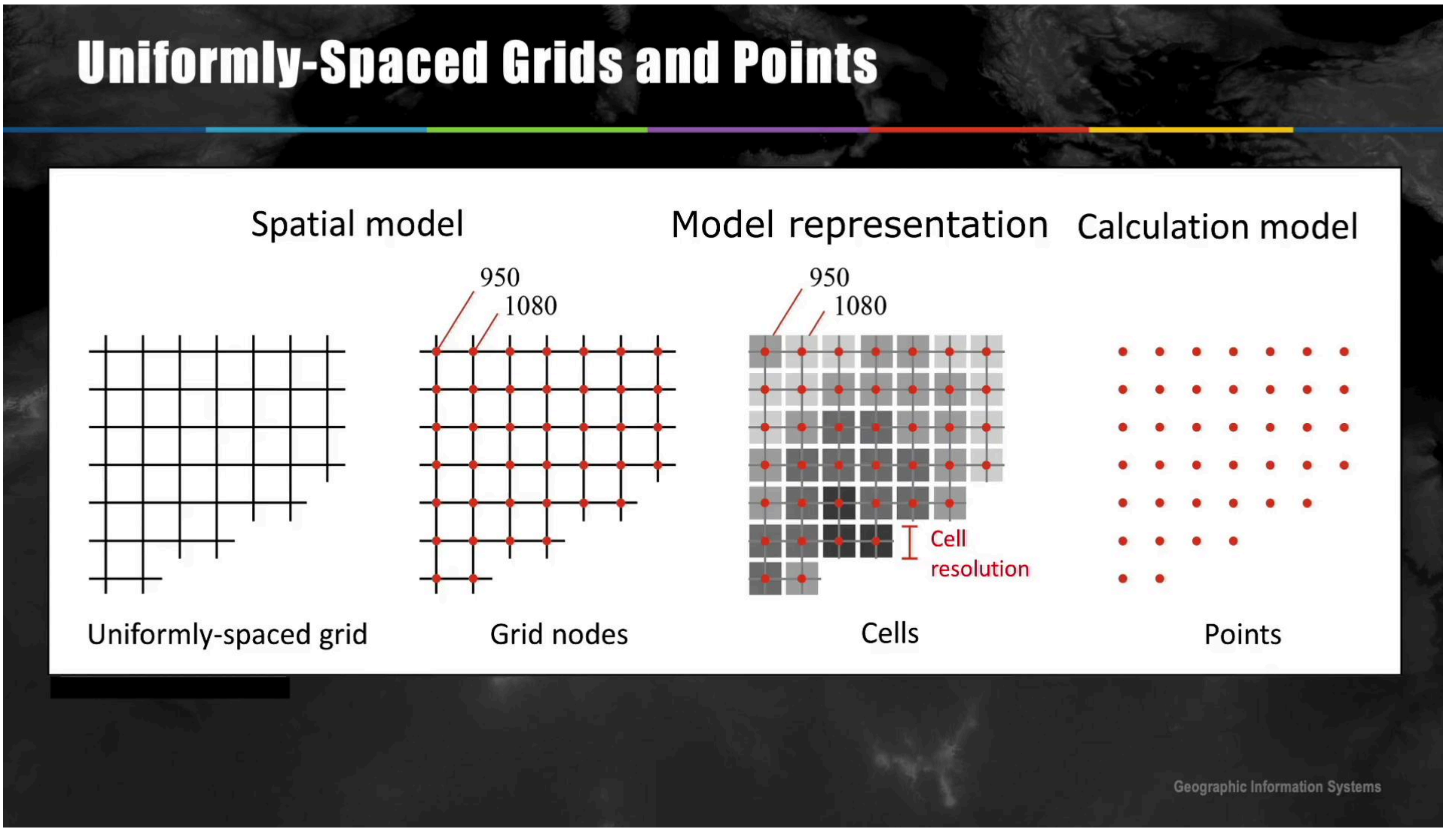


A sowing of irregular points appears when the altitude is measured punctually in a random way or by following relief structure lines. The altitude in each point is a measured value and its precision depends on the procedure and the equipments used. This altitude description model is similar to that of the triangulated irregular network frequently used in engineering to represent objects in their volume. Its main advantage is that it allows to represent precisely particular points of the relief. Its precision depends on the density of the measured points.

Notes

Summary

10m 24s

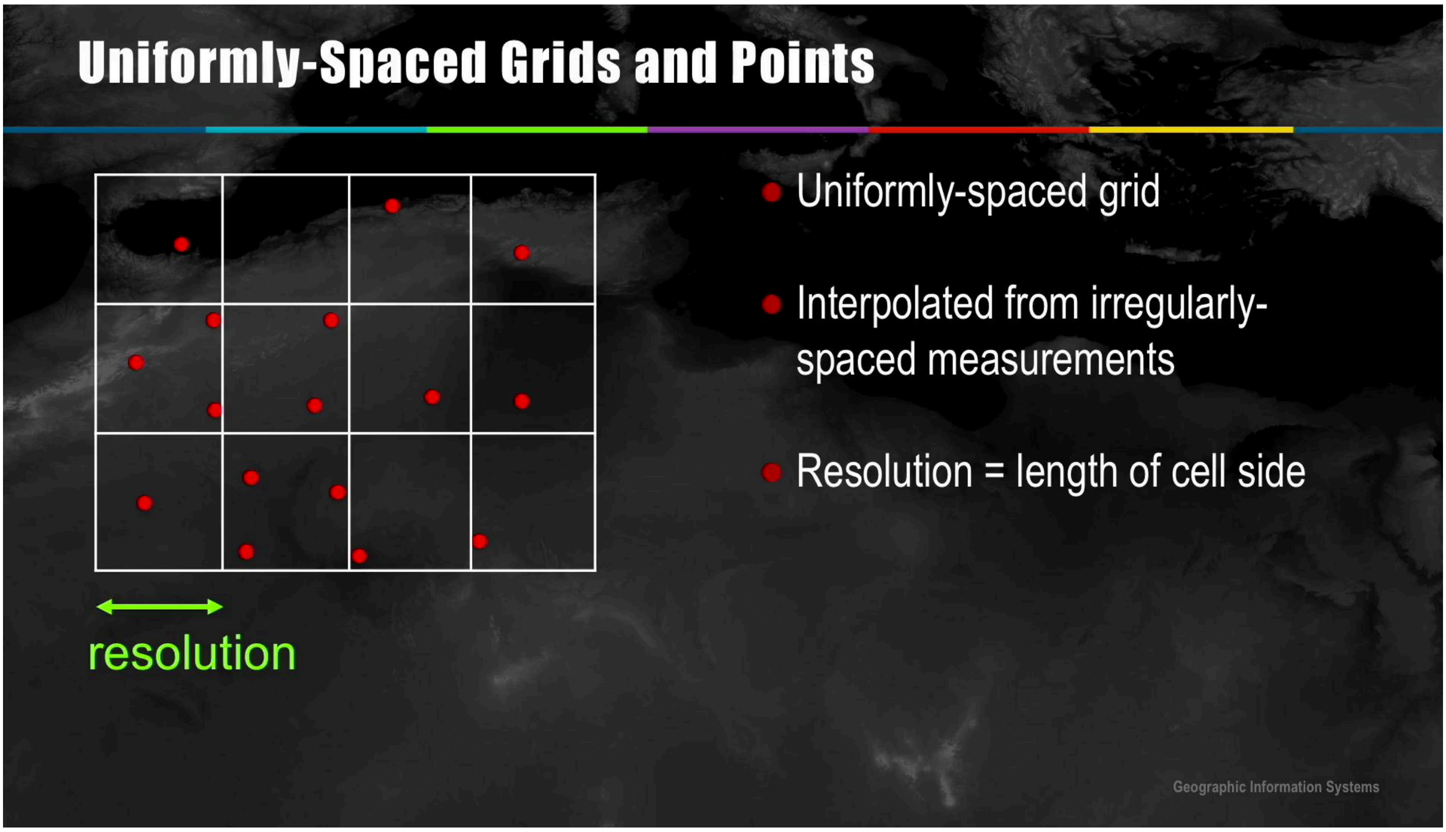


In the grid model, the altitude points are arranged according to a regular structure. The resolution or precision of the model is then the side of the mesh. The coordinates of each point locate either the nodes of the grid or most frequently the center of the mesh. It is rare that such a model consists of measured points Usually, it is produced by interpolation of a sowing of irregular points so that the accuracy depends on the acquisition mode and the interpolation procedure.

Notes

Summary

11m 05s

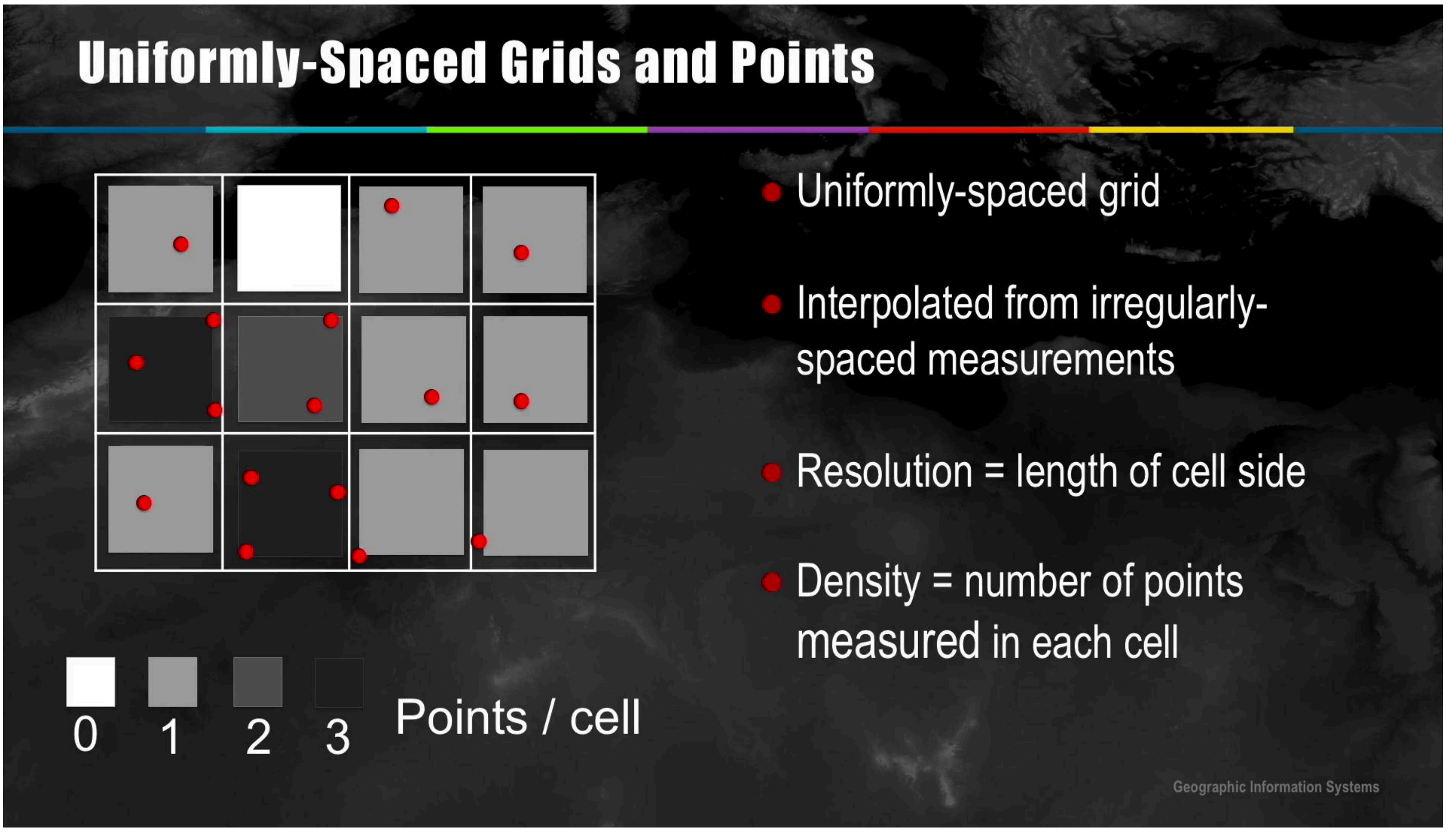


But the precision of this type of model will also depend on the density of points measured per cell. Typically, in the case of altitude data acquired by laser scanning altimetry, the number of points per cell can vary considerably depending on the spatial resolution of the cells which form the regular grid.

Notes

Summary

11m 36s

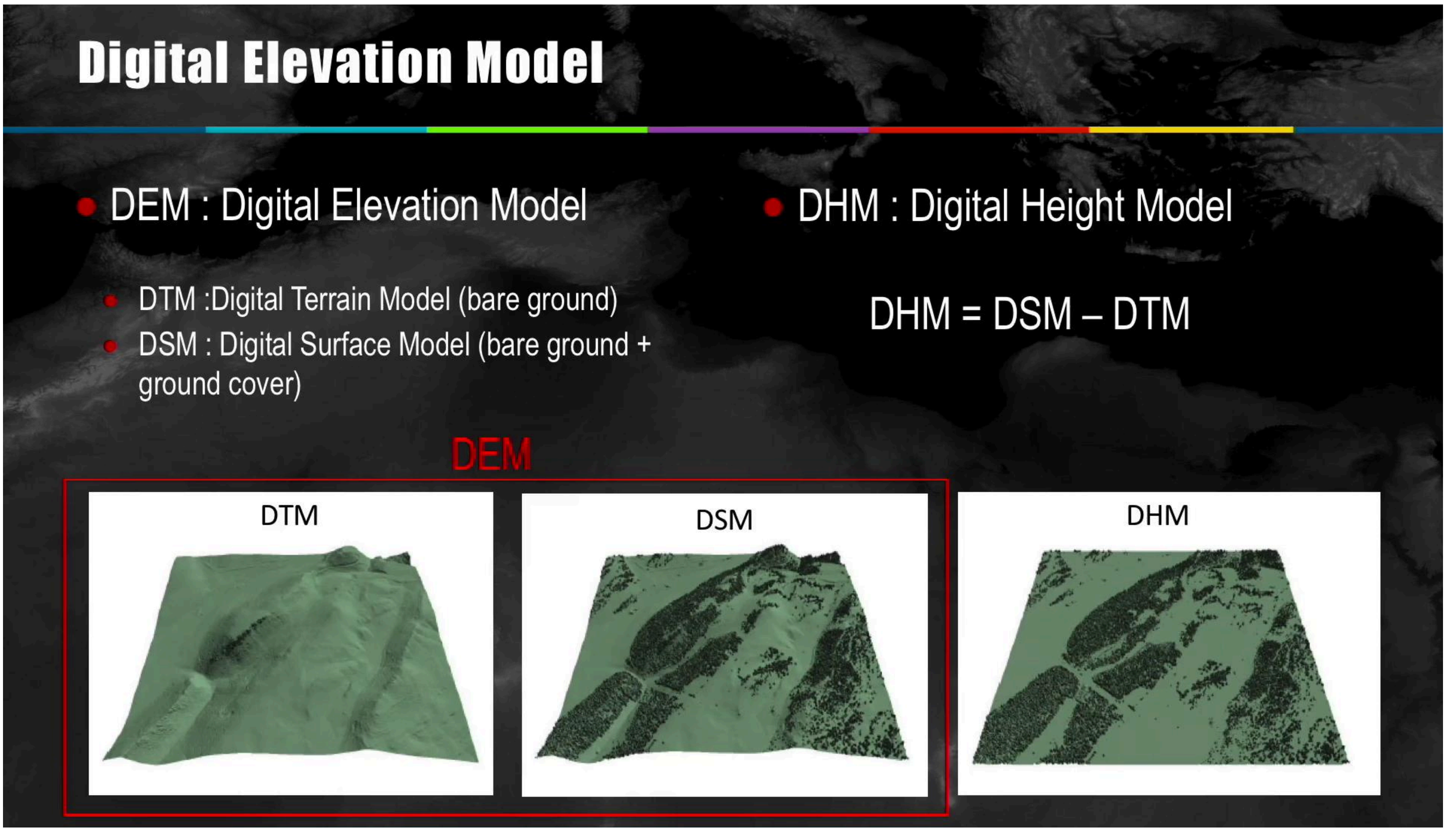


In a relatively standard way nowadays we generate digital altitude models with a spatial resolution of 1 m or even less and this on the basis of a ground point density which varies between 5 and 30 m per m² according to the laser rangefinder models. This has the effect to open many perspectives in the study of micro-relief.

Notes

Summary

12m 01s



We have seen that the LIDAR technology allowed to generate two distinct types of models either the digital terrain model which gives the altitude of he bare ground and the digital surface model which indicates the altitude of the first surface capable of reflecting the laser beam like the vegetation cover for example. These two models are part of the category of digital altitude models. But their respective quality enable to generate a third type of model which is the digital height model and which is obtained by subtracting the height of the surface model to the altitude of the terrain model.

Notes

Summary

12m 17s