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Understanding image scale and resolution

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Understanding image scale and resolution

The terms "scale" and "resolution" are often used in remote sensing discussions and it is important to know what they mean and how they differ. They both influence the detail that can be seen on an image but beyond that they are quite different.

Scale

The image scale or map scale as it is sometime called refers to the relative difference in size or distance between the image and the features represented on the ground. This difference is written as a ratio of image distance over ground distance. For example, a scale of 1:100,000 (one to one hundred thousand) means 1 centimeter on the map equals 100,000 centimeters (1km) on the ground. The following is a list of scales and equivalent ground distances for three distances measured on an image.

Image scale	1 mm on image	3 mm on image	5 mm on image
1:10,000	10 m	30 m	500 m
1:40,000	40 m	120 m	2,000 m
1:100,000	100 m	300 m	5,000 m
1:500,000	500 m	1,500 m	25,000 m

A similar table can be made for areas where the area on the ground (in hectares) is given for three square areas measured on an image.

Image scale	1 mm X 1 mm	3 mm X 3 mm	5 mm X 5 mm
1:10,000	0.01 ha	0.09 ha	25 ha
1:40,000	0.16 ha	1.44 ha	400 ha
1:100,000	1.00 ha	9.00 ha	2,500 ha
1:500,000	25.00 ha	225.00 ha	62,500 ha

One often refers to a scale as being larger or smaller than another scale. This can be confusing, especially since scales are often referred to solely by their denominator. For example a scale of 1:100,000 (one to one hundred thousand) may be called a scale of 100,000 when it is actually a ratio of 1/100,000. A scale of 1:100,000 is smaller than a scale of 1:40,000 because the number 1/100,000 is smaller than 1/40,000 (or as it is often stated, a scale of 100,000 is smaller than a scale of 40,000). Another way to look at this is to think of a lake on an image with a scale of 1:100,000 and another with a scale of 1:40,000. The lake will be larger on the 1:40,000 image because the scale is larger. One way to avoid the confusion between large and small scale is to use the terms “coarse scale” and “fine scale”.

Calculating image scale

To calculate the scale of a map or image it is necessary to compare the distance between two points on a reference and the same two points on the map or image of unknown scale. The reference can either be a map, another image with a known scale, or a distance measured in the field. The technique differs if the reference is a map or an image with a known scale or a measurement taken in the field. In either case, it is important to realize that the accuracy of the calculated scale depends on the accuracy of the measured distance between two points being used as a reference and the points on the map or image of unknown scale.

To calculate the scale, using a reference map or image with a known scale, locate two points on the reference and the same two points on the map or photo of unknown scale. Measure this distance for both media and use the following formula to calculate the new scale:

*S = UD / RD * RS*

S - Scale of the map or image which needs to be calculated RD - Distance between two points measured from the reference UD - Distance between the same two points measured from the map or image with unknown scale RS - Scale of the reference map or photo.

For example, a topographic map at a scale of 1:100,000 can be used to determine the scale of a satellite image. In this case, two points are found which can be located in both the map and the image. The distance between these two points on the topographic map is 12.7mm and the distance on the satellite image is 50.9mm. Entering this information in the formula, we have:

*Satellite image scale = 50.9 / 12.7 * 1/100,000 = 1/24,951*

To calculate scale using measurements in the field, measure the distance between two points in the field and measure the distance between the same two points in the map or image of unknown scale. Use the following formula to determine the scale of the map or image:

S = MD/RD

S - Scale of the map or photo which needs to be calculated RD - Distance between two points measured in the field MD - Distance between the same two points measured from the map or image with the same scale Note: The units of RD and MD must be the same.

For example, the scale of a satellite image can be determined using this technique by measuring the distance between two points on the satellite image and then measuring the distance between the same two points in the field. If, for example, the distance measured on the map was 50.9 mm and the distance in the field was 515 m (515000 mm) the scale can be calculated as follows:

Satellite image scale = 50.9 mm / 515,000 mm = 1/10,118

Resolution

When we mention resolution in this document we are referring to spatial resolution. The spatial resolution of an image is an indication of the size of a pixel in terms of ground dimensions. It is usually presented as a single value that represents the length of one side of a square. For example, a spatial resolution of 30 meters means that one pixel represents an area 30 meters by 30 meters on the ground. If the pixel is rectangular it will be represented by a height and width dimension (i.e., 56m x 79m).

The resolution of an image is an indication of the potential detail in an image. The actual detail involves a combination of image resolution and the scale at which the image is printed or viewed. If we have a high resolution image such as a satellite image with a 1 meter resolution printed at a scale of 1:500,000 we will not see much of the detail that is in the image because it is printed too small. The inverse is also true. If we have a low resolution image such as an image with a 500 meter resolution printed at a large scale we will see the individual pixels. Although we can keep increasing the scale at which an image is viewed there is a point when we begin to see individual pixels and increasing the scale beyond that point does not provide any increase in detail. At some point the image becomes so coarse that it is difficult to interpret.

Use the multiple scale interactive tool to compare the spatial resolution of different satellite images.