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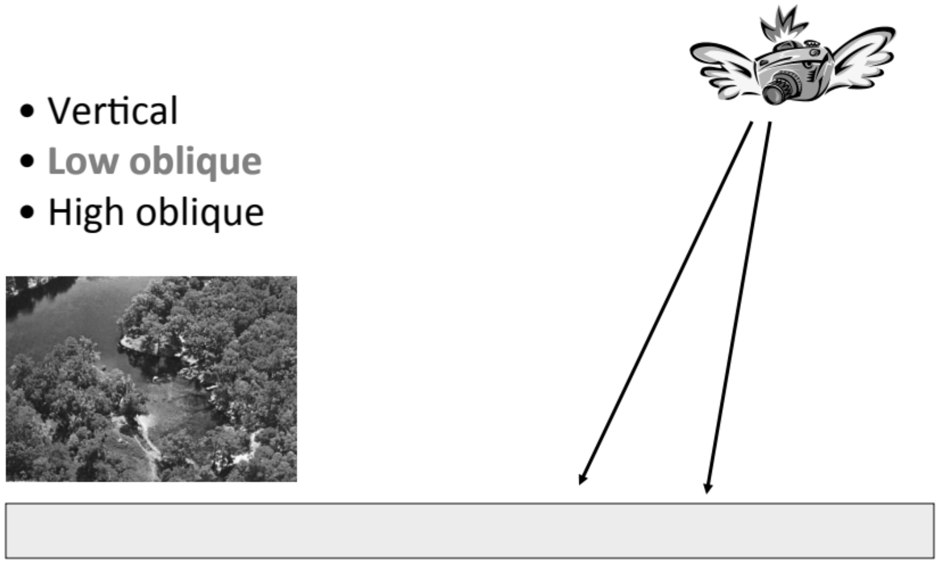
Aerial Photography

Aerial photography is to take **photographs** of the ground from an elevated/direct-down position.

Usually, in aerial photography, the camera is not supported by a ground-based structure.

Types of Aerial Photography



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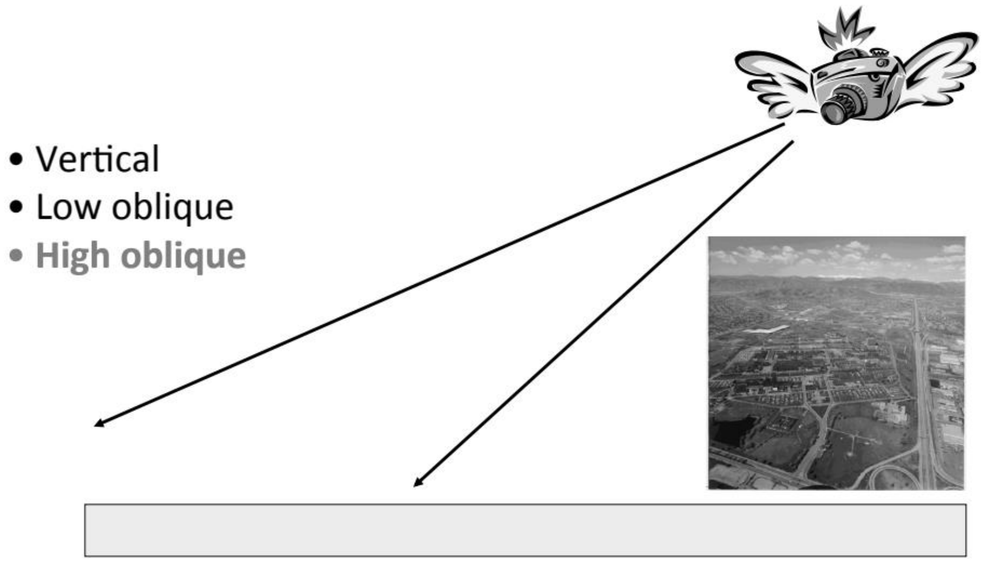


Terminology of Aerial Photography

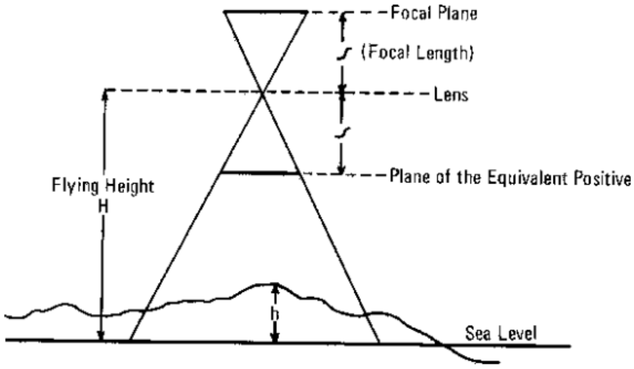
i) Format: the size of the photo

ii) Focal plane: the plane in which the film is held in the camera for photography

iii) Focal length (f): the distance from the lens along the optical axis to the focal point

iv) Plane of the equivalent positive: an imaginary plane at one focal length from the principal point, along the optical axis, on the opposite side of the lens from the focal plane

v) Flying height (H): height of the lens above sea level at the instant of exposure. The height of a specified feature above sea level is designated as “h”



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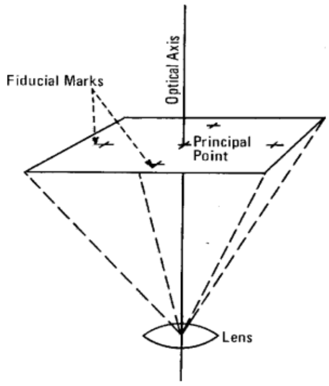
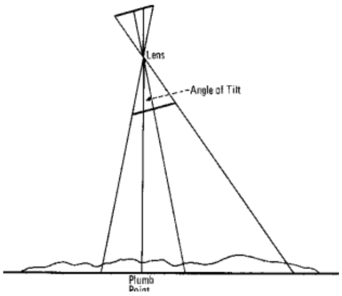
Principal point (PP): the exact centre of the photo or focal point through which the optical axis passes. This is found by joining the fiducial marks which appear on every photo;



Conjugate principal point: image of the principal point on the overlapping photograph of a stereo pair;

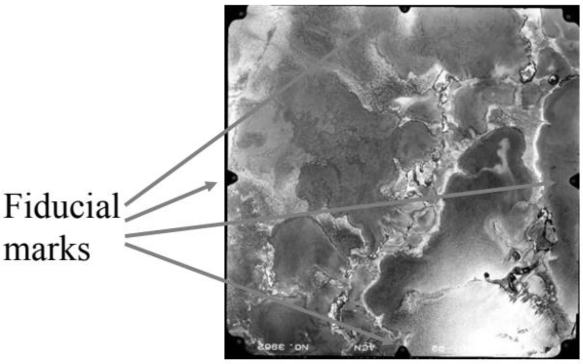
Optical axis: the line from the principal point through the centre of the lens. The optical axis is vertical to the focal plane;

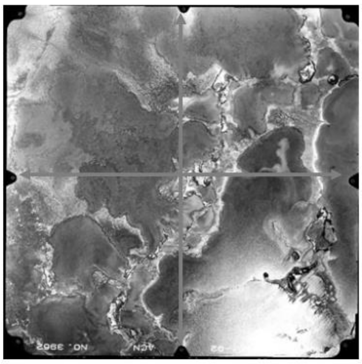
Plumb point (Nadir or vertical point): the point vertically beneath the lens at the instant of exposure;



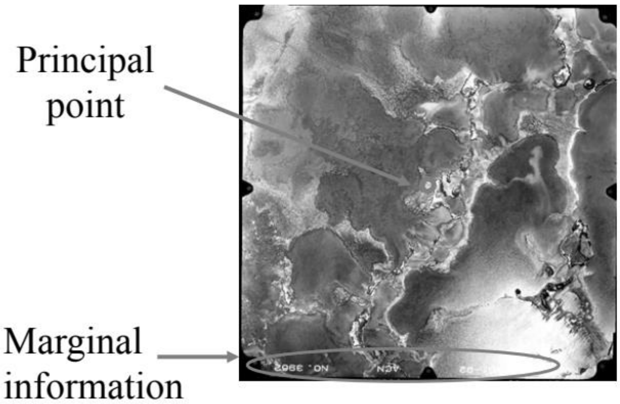
Angle of tilt: the angle subtended at the lens by rays to the principal point and the plumb point.

Aerial Photograph





Fiducial marks is a set of marks located in the corners or edge-centers, or both, of an aerial photographic image. These marks are exposed within the camera onto the original film and are used to define the frame of reference for spatial measurements on aerial photographs.



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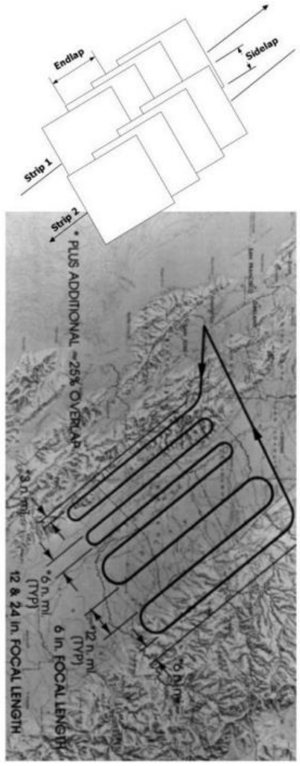
Aerial Photograph (contd.)



An aerial photograph mission needs to be flown in strips.

•Shutter timing set for 60% endlap (needed for parallax).

•Strips spaced for 30% sidelap (to avoid missing bits).

• Endlap (or forelap) is important that ensures every point on the ground appears in at least two photographs.

Elements/ Factors of interpretation

1. Shape
2. Pattern
3. Size
4. Tone/ Colour
5. Shadow
6. Texture
7. Association/ Site
8. Time
9. Stereo Perspective

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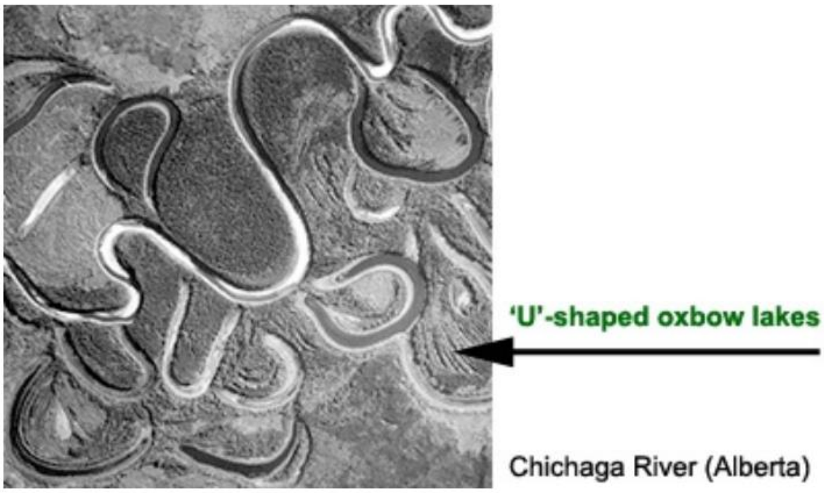
1. Shape

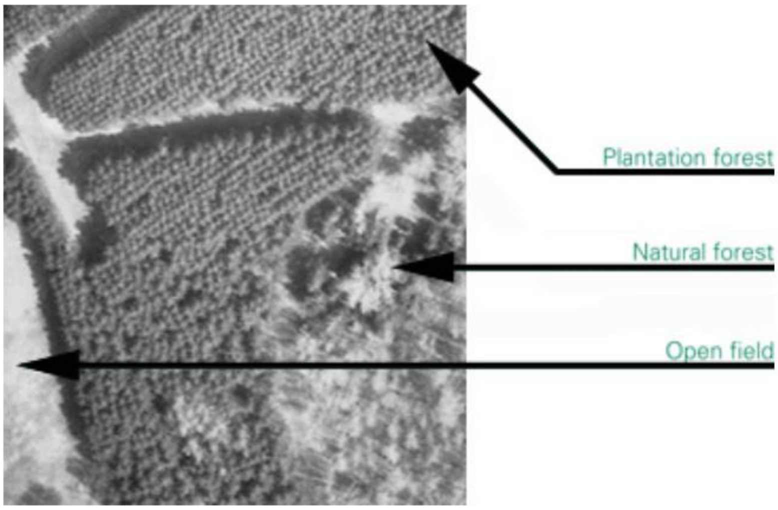
The form of an object on an air photo helps to identify the object. Regular uniform shapes often indicate a human involvement.



Chichaga River (Alberta)

2. Pattern

Similar to shape, the spatial arrangement of objects (e.g. row crops vs. pasture) is also useful to identify an object and its usage.



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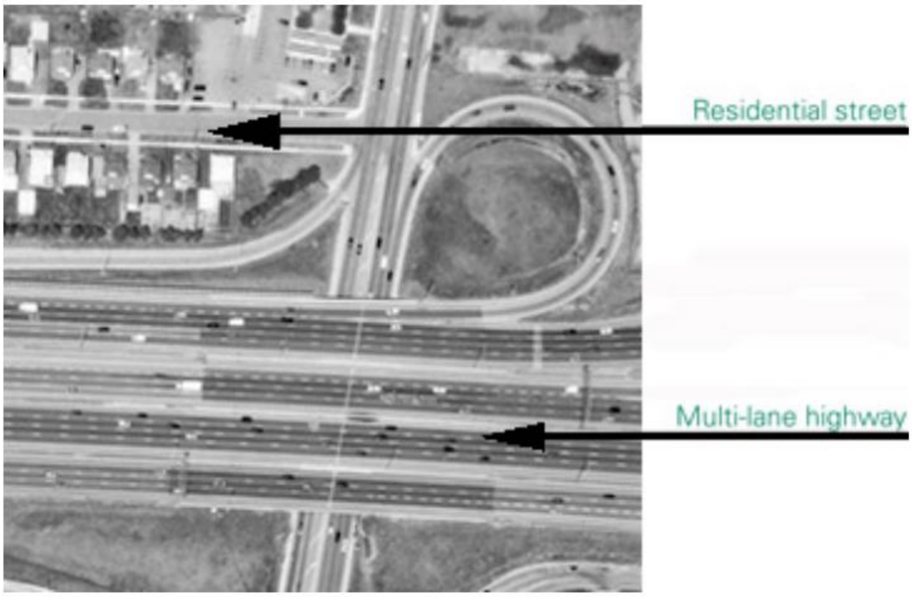
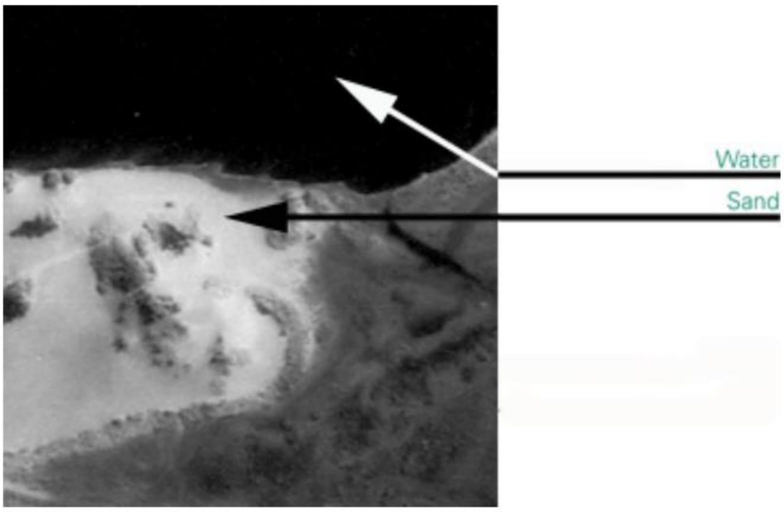
3. Size

A measure of the object's surface area (e.g. single-lane vs. multi-lane highways).



4. Tone / Colour

The colour characteristics of an object, relative to other objects in the photo, are used to identify the feature (e.g. sand has a bright tone, while water usually has a dark tone; tree species can be determined by the colour of their leaves at certain times of the year).



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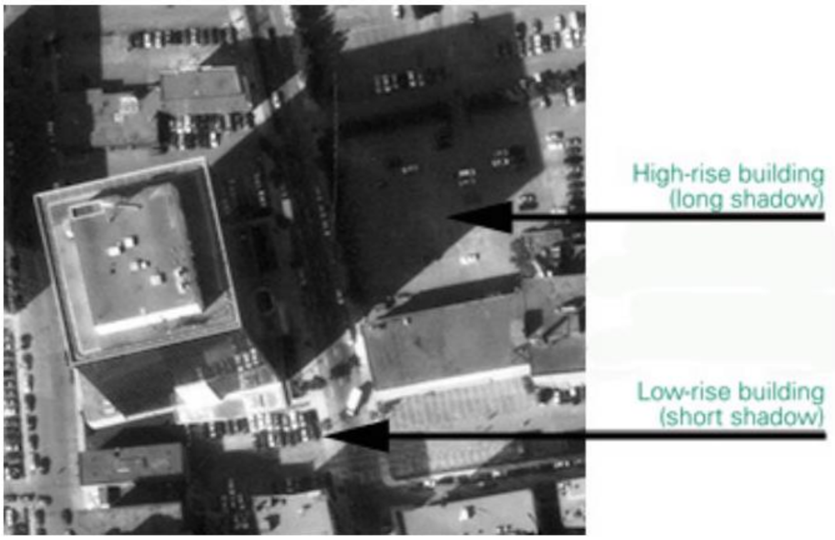
5. Shadow

A shadow provides information about the object's height, shape, and orientation (e.g. tree species).



6. Texture

The physical characteristics of an object will change the way they appear on a photo (e.g. calm water has a smooth texture; a forest canopy has a rough texture).

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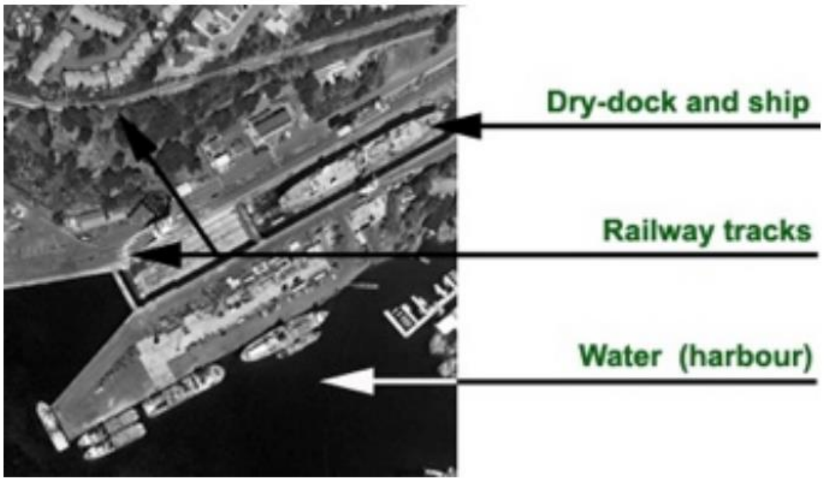
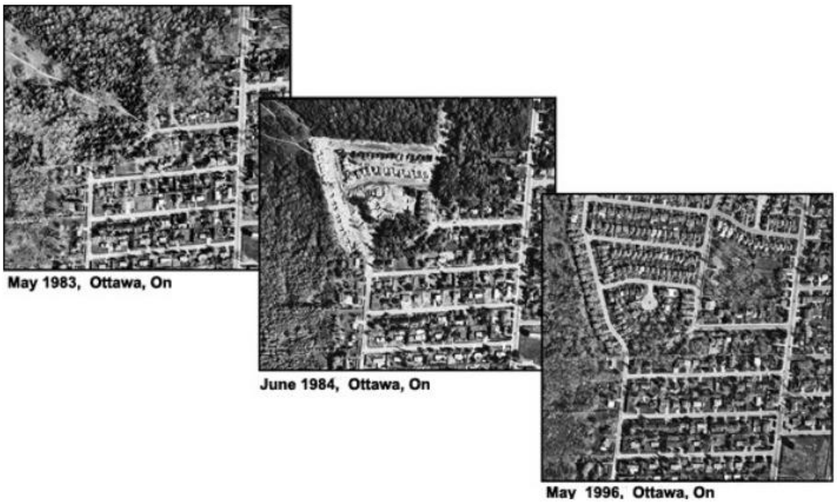
7. Association/ Site

Associating the presence of one object with another, or relating it to its environment, can help identify the object (e.g. industrial buildings often have access to railway sidings; nuclear power plants are often located beside large bodies of water).



8. Time

Temporal characteristics of a series of photographs can be helpful in determining the historical change of an area (e.g. looking at a series of photos of a city taken in different years can help determine the growth of suburban neighbourhoods.



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9. Stereo perspective

Seeing an area in stereo, or 3-D, is important for determining the topographical relief of an area, as well as the height of objects such as trees and building.

Photo Scale

The scale of a photo affects its use in the revision of line maps, i.e. a photo with a nominal scale of 1:50,000 should not be used to revise a map with a scale of 1:10,000. Photos at the same scale or larger should be used to ensure that the resolution of the photograph matches the degree of precision required for the revised information.

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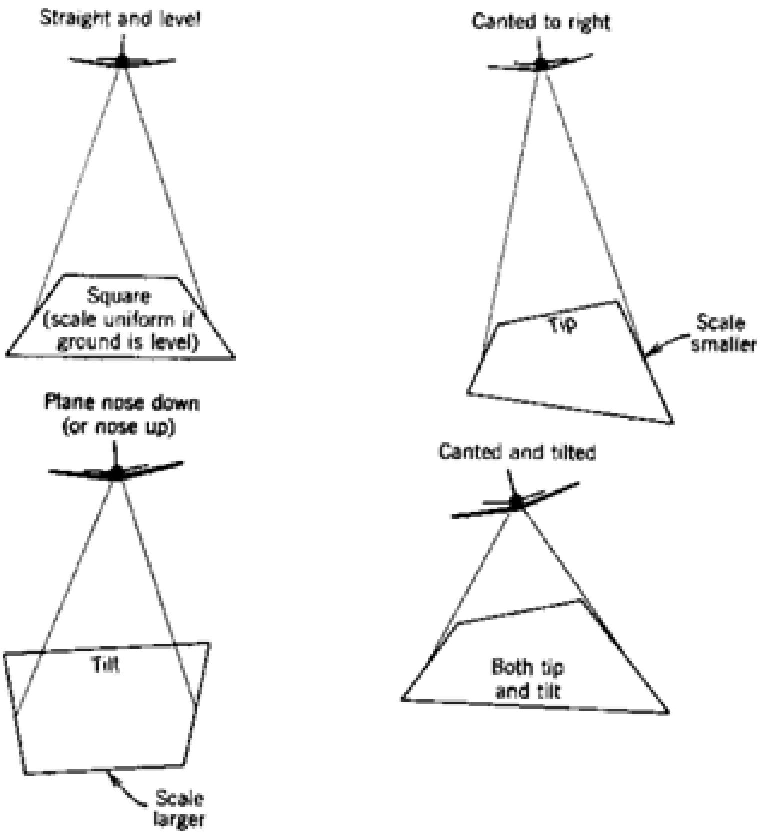
Variations in scale in relation to aircraft attitude.



Determining the scale

There are four basic methods of determining the scale of an aerial photograph which, in decreasing order of accuracy, are as follows:

1. the relationship between two points on the ground of known distance, and the same two points on the photo. (Note that the scale may vary for other locations on the same photograph if there is significant relief variation);

2. the relationship between two points on the map and the same two points on the photo;

3. the relationship between an object on the ground, whose dimensions are known and the same object on the photograph;

4. the relationship between the focal length of the camera lens and the altitude of the camera lens,

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e.g., focal length (f) = 15 cms, altitude (H) = 1,500 m;

$$\text{therefore scale} = \frac{15}{1500 \times 100} = 1:10,000.$$

The effect of tilt and height displacement on scale

The scale of an aerial photo changes from point to point due to tilt of the camera lens (i.e. aircraft attitude) and changes in height of the terrain unless the terrain is absolutely flat. The top of a high mountain, therefore, will be at a larger scale than a valley because it is nearer the camera lens when photographed (unless the photo has been rectified).

Methods of Determining Scale

Scale for aerial photos is generally expressed as a representative fraction (1 unit on the photo equals "x" units on the ground). If the scale is known distances on the photograph can easily be transformed into real-world ground distances.

$$\text{Scale} = \frac{\text{Photo Distance}}{\text{Ground Distance}}$$

Calculating Distance and Area

Distance and Length

If the scale of an aerial photograph is known distances lengths and areas of features can easily be calculated. You simply measure the distance on the photo (photo distance) and multiply the distance by the scale factor. Remember that scale is always equal to the ratio of the photo distance to the ground distance.

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Example: The scale of an aerial photograph is 1:15,000. In the photo you measure the length of a bridge to be 0.25 inches, what is the length of the bridge in feet in real life?

$$\frac{1}{15,000} = \frac{0.25 \text{ in}}{X}$$

$$X = (0.25)\cdot(15,000) = 3,750 \text{ in or } 312.5 \text{ ft}$$

Area

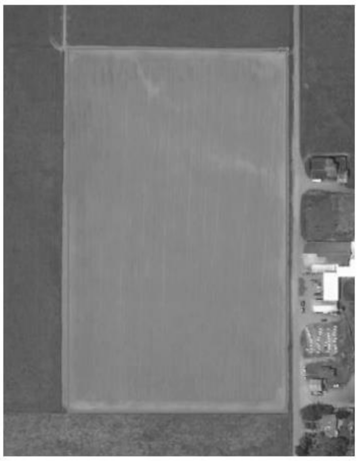
It is important to remember that area is measured in square units. To determine rectangular area, it is length multiplied by width, so if you measure both and convert these distances remember that if you are multiplying them together the resulting units are squared.

For example, if an area is 100 meters by 500 meters, it is 50,000 square meters.

Example: An aerial photograph has a scale of 1:10,000. On the photo, the length of a field is measured as 10 mm and the width 7mm. How big (in Hectares) is the field in real-life? Note that 10,000 square meters = 1 Hectare.

Length=10mm x 10,000 =100,000mm
Convert to m: 100,000/100=1,000m
Width=7mm x 10,000 =70,00mm
Convert to m: 70,000/100=700m

Area= 700m x 1000m=700,000 sq m
700,000 /10,000=**70 Hectares**



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Methods of Height Determination

As with calculating scale, there are multiple methods to determine the height of tall objects (e.g. trees or buildings) in aerial photos. In single aerial photos the two primary methods are the relief/radial displacement method and the shadow methods.

Relief/Radial Displacement Method

The magnitude of the displacement in the image between the top and the bottom of an object is known as its relief displacement and is related to the height of the object and the distance of the object from the principal point.

This method can only be used if the object that is being measured is be far enough from the principal point to measure the displacement and the top and bottom of the object are visible in the photo.

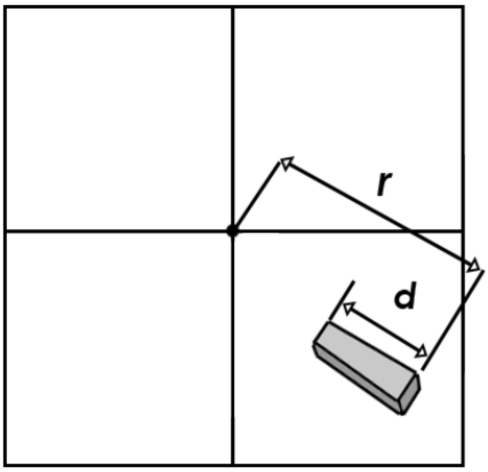
$$h^o = \frac{dH'}{r}$$

h^o = height of the object

d = length of displaced object on the photo

r = radial distance from principal point to displaced image point

H' = flying height above the surface (flying height above sea level – average elevation)



Example: The length of a displaced building is measured at 2.01 mm and the radial distance to the principal point is 56.43 mm. If the the flying height about the surface is 1220 m, what is the height of the building?

$$h^o = \frac{dH'}{r} = \frac{2.01\text{mm} \times 1220\text{ m}}{56.43\text{ mm}} = 43.4\text{ m}$$

Height = 43.4 m