REMOTE SENSING: AERIAL PHOTOGRAPHY, MEASUREMENTS.

Remote Sensing: collection of data about the object without direct contact, using reflected or emitted electromagnetic energy.

Examples of Remote Sensing Data:

Earth Resources Observation and Science (EROS) Center: https://eros.usgs.gov/remote-sensing

Passive and Active Remote Sensing: https://www.slideshare.net/VivekSrivastava22/passive-and-active-sensors

Aerial Photography: collection of images taken by camera attached to the aircraft (airplane, drone, balloon, etc.)

Examples of Aerial Photography:

Terra Server: https://www.terraserver.com/

History of Aerial Photography

History of photography: https://en.wikipedia.org/wiki/Photography#History

One of the first aerial photography: 18 century, Felix Nadar:
https://en.wikipedia.org/wiki/Nadar_(photographer)

Cuban Crisis (1962) Aerial Photos: http://nsarchive.gwu.edu/nsa/cuba_mis_cri/photos.htm

Historical Aerial Photo Viewer by NETRonline: https://www.historicaerials.com/

Use in modern archaeology: https://www.nytimes.com/2015/11/09/arts/international/ted-grant-goes-to-archaeologist-who-combats-looting-with-satellite-technology.html?partner=rss&emc=rss&_r=2

NATIONAL AERIAL PHOTOGRAPHY PROGRAM

Abstract: The National Aerial Photography Program (NAPP) is an interagency Federal effort coordinated by the USGS, which uses NAPP products to revise maps. The NAPP program encompasses each of the lower 48 states and Hawaii. The photos are acquired from airplanes flying at an altitude of 20,000 feet using a 6 inch focal length camera resulting in a scale of 1:40,000. Each 9-by 9-inch photo (without enlargement) covers an area of slightly more than 5 miles on each side. Flightlines for the NAPP program are flown in a north-to-south direction through the east and west halves of 7.5-minute quadrangles.

Purpose: The original purpose of the NAPP program which was established in 1987, was to provide the USGS with accurate and cloud-free photographs that would assist them in the creation and revision of

Source: https://gcmd.nasa.gov/records/EROS_NAPP.html

NATIONAL AERIAL PHOTOGRAPHY PROGRAM

National Wide Data: http://earthexplorer.usgs.gov/

New York State: http://gis.ny.gov/gateway/mg/

TYPES OF AERIAL PHOTOGRAPHY

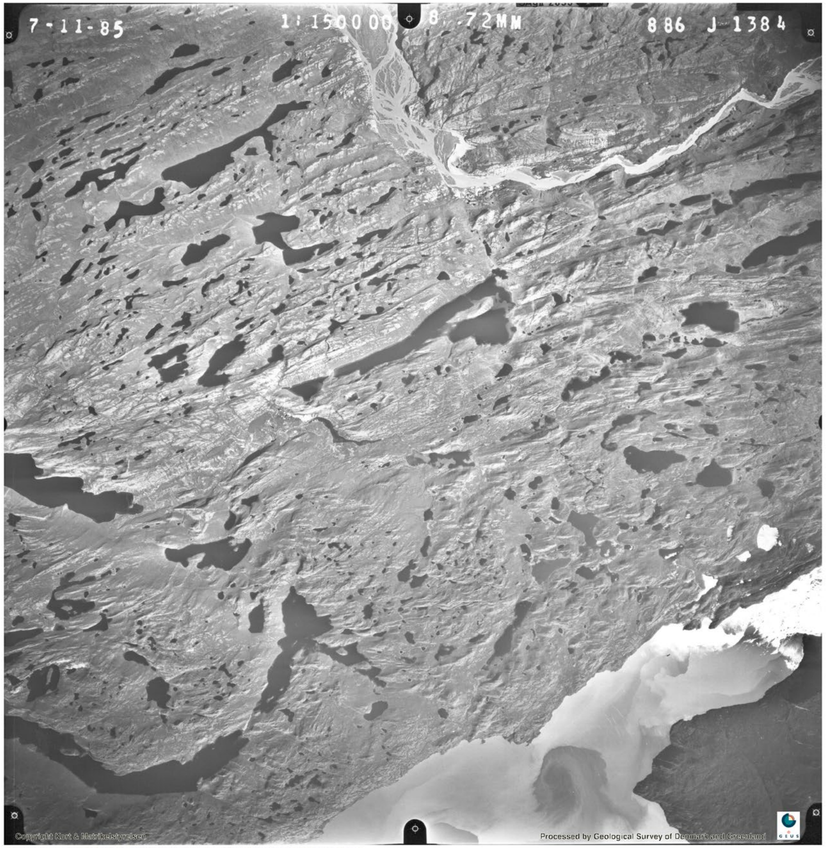
1. Vertical

Advantage: measurements and directions (azimuth) are more accurate and easy; scale is almost uniform on the photo; tall objects do not obscure short objects; easy to use for stereopair processing.

Lehman College, 2017

Approximate scale 0 2 4 6 8 10 km

Contents Airphoto Keymap



2. Oblique (high and low)

Advantage: cover larger area; better show texture (i.e. high/low objects) on the ground because of shadows and perspective; this also helps to assess relative height of the objects; does not require aircraft to fly directly over the object.

City of Halifax, ca 1965

ELEMENTS OF AERIAL PHOTOGRAPHY

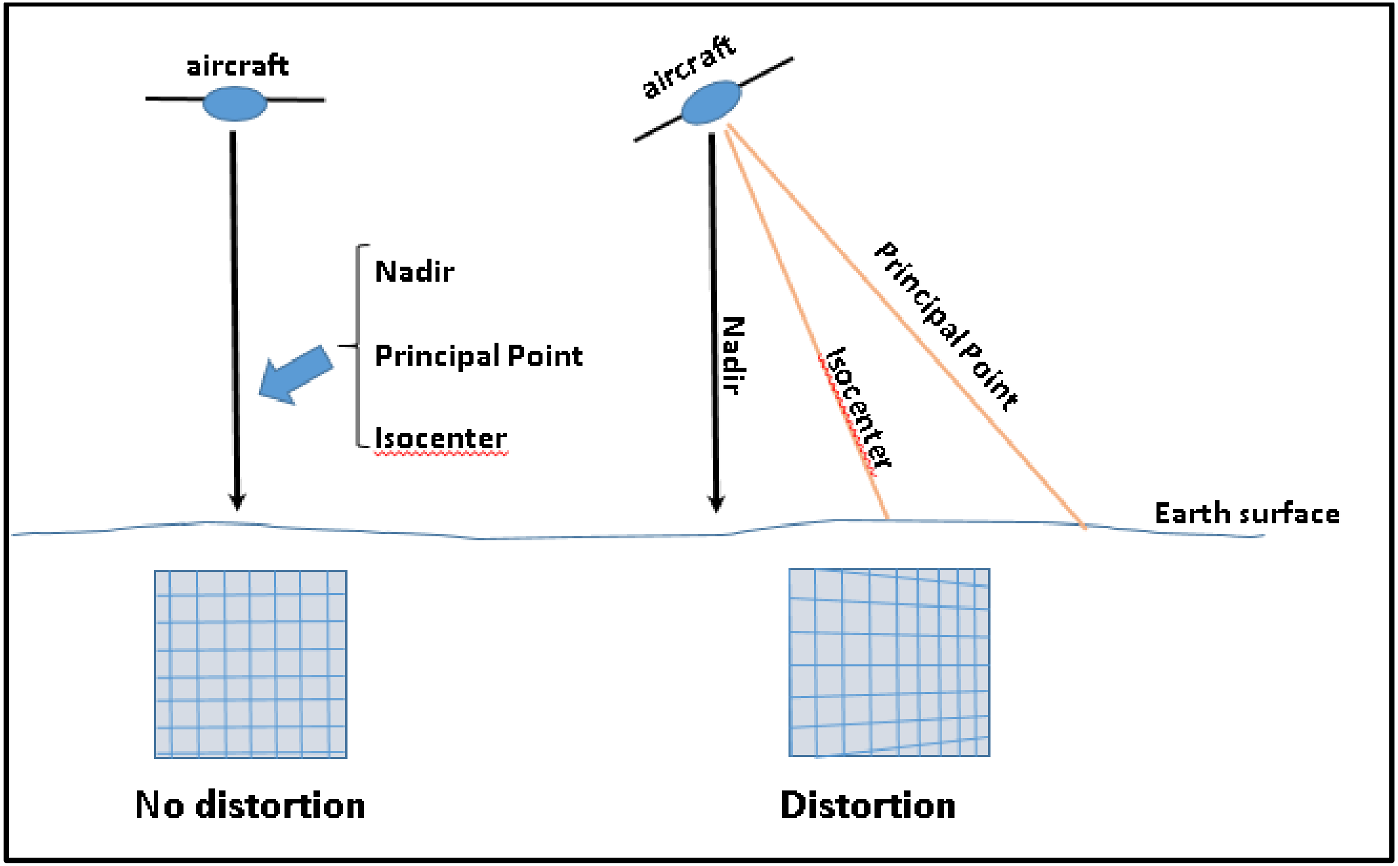
Nadir: point below aircraft, direction orthogonal to the earth surface

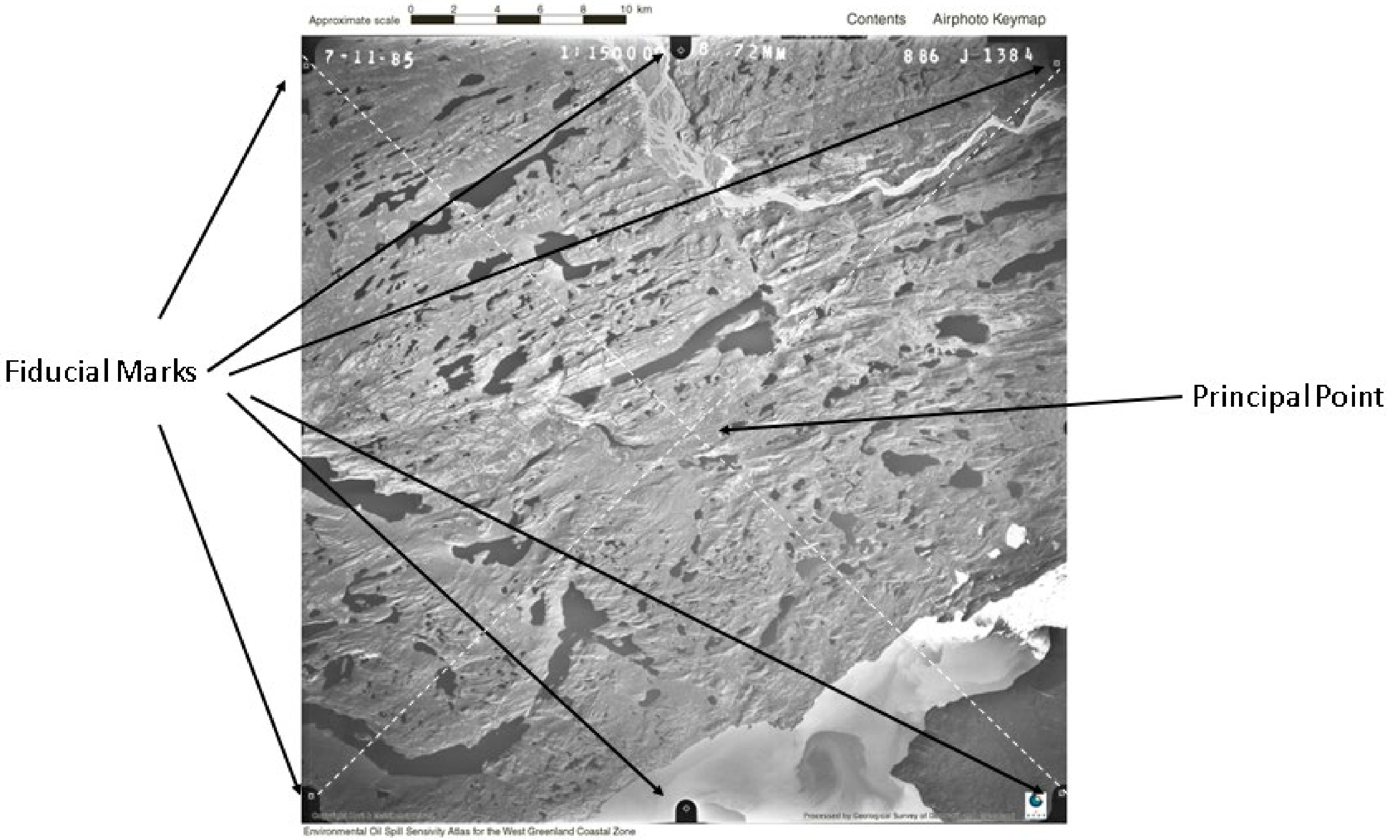
Principal Point: geometric center determined by fiducial marks on the image, location of least distortion.

Isocenter: point between nadir and principal point.

Relief displacement: visual distortion when tall objects tend to be displaced from the center of the image

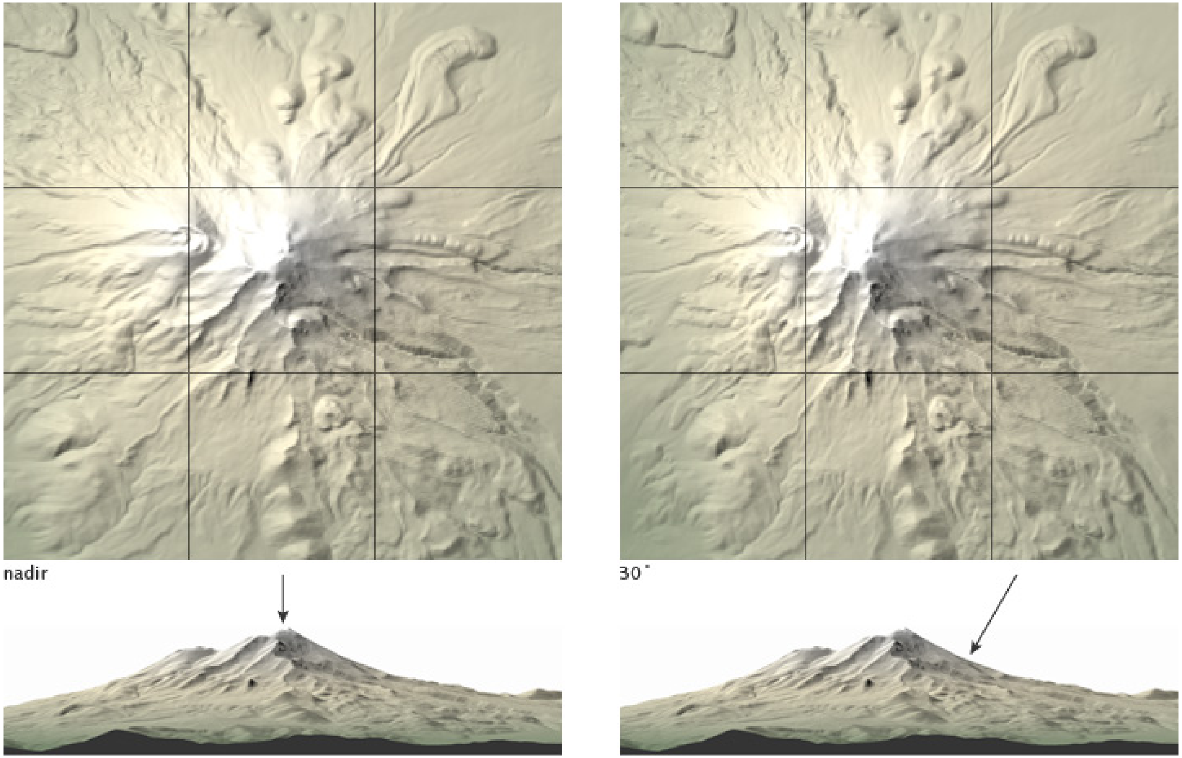
Fiducial marks: reference points on the aerial photo for use as a measure or fixed coordinate pairs.


aircraft
Nadir
Principal Point
Isocenter
aircraft
Nadir
Isocenter
Principal point
Earth surface
No distortion
Distortion

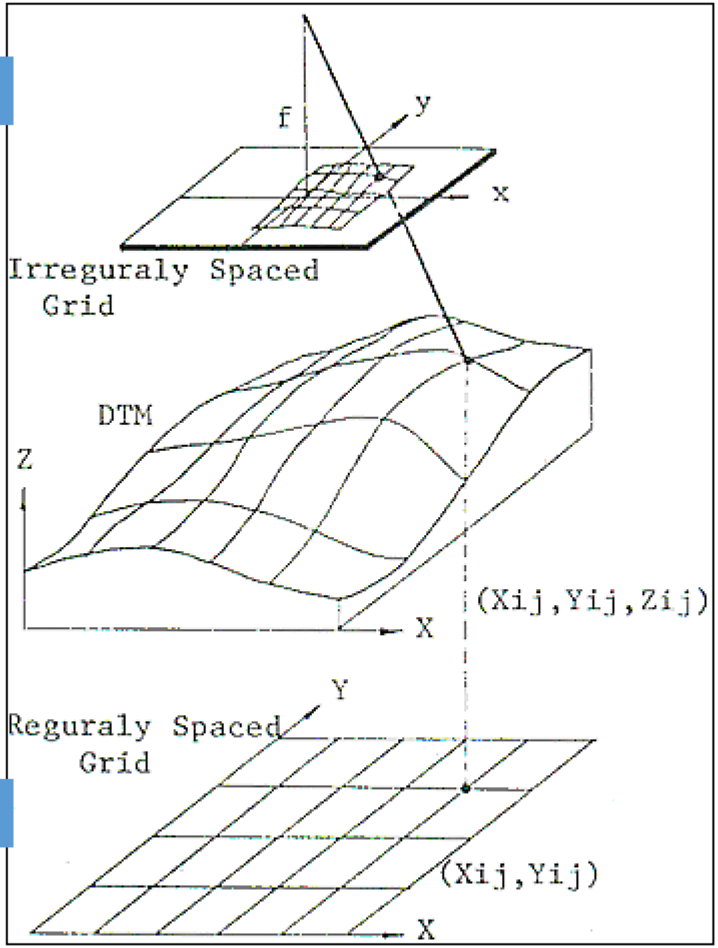

Approximate scale
0 2 4 6 8 10 km
Contents
Airphoto Keymap
7-11-85
1:15000
886 J 1384
Fiducial Marks
Principal Point
Environmental Oil Spill Sensivity Atlas for the West Greenland Coastal Zone


Relief Displacement

ORTHOPHOTO: corrected image with uniform scale. The process of correcting is called **orthorectification**; it removes distortion effects caused by terrain relief and camera tilting.



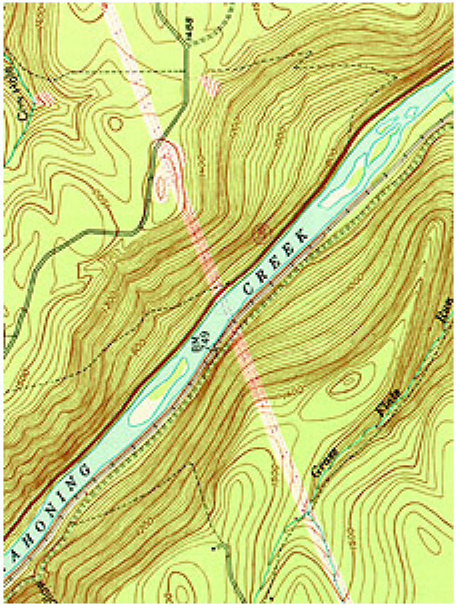
Source: https://earthobservatory.nasa.gov/Features/GlobalLandSurvey/page3.php aerial photo



orthophoto

Orthorectification example: power line crossing Sinnemahoning Creek in Central Pennsylvania.

Aerial Photo



USGS quadrangle

Orthorectification example: power line crossing Sinnemahoning Creek in Central Pennsylvania.

Aerial Photo

Orthorectified Aerial Photo

INTERPRETATION OF AERIAL IMAGES

Application of image interpretation in relation to population density estimates:

http://www.nature.com/news/satellite-images-reveal-gaps-in-global-population-data-1.21957

Introduction to Air Photo Interpretation (CANADA)

http://www.nrcan.gc.ca/earth-sciences/geomatics/satellite-imagery-air-photos/air-photos/about-aerial-photography/9689

Pattern: arrangement of details and elements

Size, Location, Attributes

Summary:

Size: the information about length and width of objects

Shadow: provide information on the height of objects

Shape: the form of objects

Texture: repeating tones in image. Can be “coarse” or “rough”, “fine” or “smooth”

Tone: the grayscale levels (from black to white) or ranges of color.

Examples: Earth from above: http://yannarthusbertrand2.org/

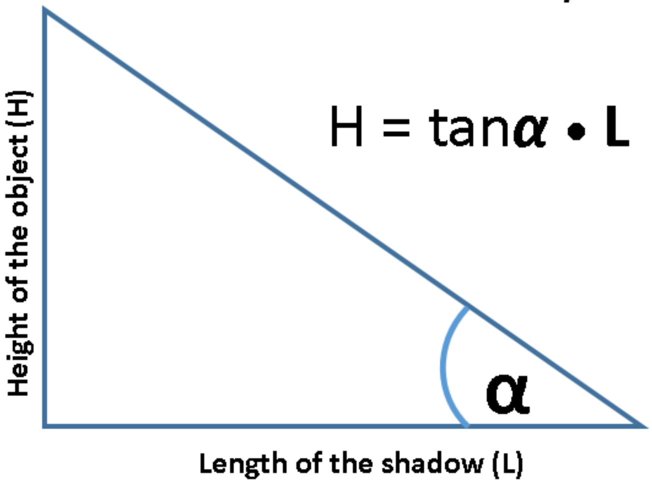
MEASUREMENTS ON AERIAL PHOTOGRAPHY

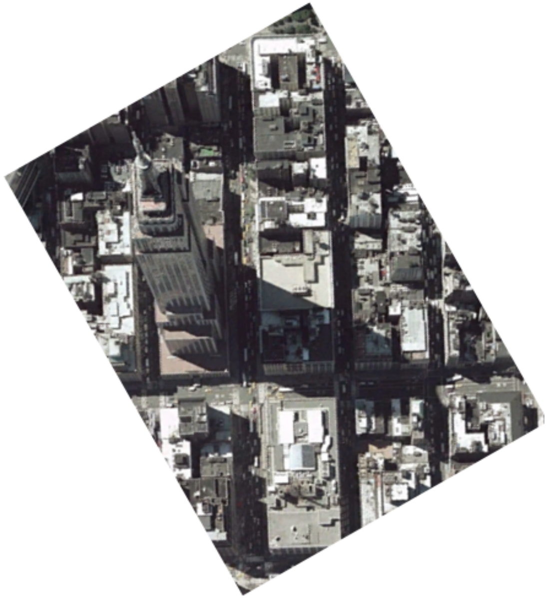
Height of objects can be calculated using Pythagoras Law:

Pythagoras Law:

$$\tan\alpha = H / L$$

$$H = \tan\alpha \bullet L$$





tan**α** is a constant for the image, i.e. by knowing at least one height of any object on the image we can identify heights (H) of other objects as: **H** = tan**α** • **L**

To make linear measurements (e.g. L) on the image we need to know image scale that shows relationship between units of measurement on the image and on the terrain. In cartographic tradition scale is usually represented as a fraction, e.g. 1:2,000 or 1:300,000. This also can be written as 2K or 300K scales. Therefore, in scale calculations we always need to keep nominator as 1.

Image scale is calculated as: Focal Length (f) / Aircraft altitude (H)

Equation specifics:

1. The units of nominator and denominator should be the same. Because focal lens is usually expressed in mm we need to convert aircraft height into mm as well. This is easy since 1 m = 100 cm and 1 cm = 10 mm. Therefore 1 m = 1000 mm.
2. The aircraft altitude is the height above ground, not the absolute altitude above mean sea level

Example: if you use lenses with focal length 135 mm and the height of the flight is 700 m (conversion to mm makes it 700,000) then the image scale will be = 135 / 700000 = 1/ 5185 or 1:5185.

Photogrammetry basics: http://www.blm.gov/nstc/library/pdf/TN428.pdf

For a full aerial photo with well-defined Principal Point building height can be calculated using this equation:

$$H = m / r * h,$$

where:

m – relief displacement

r – distance from the Principal Point to the top of the object

h – Aircraft height

Example of calculations:

Input information:

building height (h) is 10 meters;

the length of its shadow (L) on the aerial photo is 0.5 cm

the scale of the aerial photo is 1: 4000 (i.e. 1 unit on the map = 4000 units on terrain)

Question 1. what is the value of tan a?

Question 2. what is the height of building with shadow = 0.1 cm on the map?

Solutions:

Question 1:

Scale 1:4000 means (1 unit of the map = 4000 units on terrain)

0.5 cm on the 1:4000 map equal 2000 cm or 20 m.

Therefore **tan** *a* = 10 / 20 = 0.5

Question 2:

0.1 cm on the map = 400 cm = 4 m

Considering height (h) = **tan** *a x* L,

h = 0.5 x 4 m = 2 m