

LECTURE 6.

PHOTOGRAPHIC INTERPRETATION

In the previous section, it was shown that maps are very important tools to study the interrelationship between geographical phenomenon. In this section, photographs/photography is indicated as another way used in geography to study and analyze the interdependence between physical and human features.

Definition of key terms

Photograph: The word "photograph" was coined in 1839 by Sir John Herschel and is based on the Greek φῶς (*phos*), meaning "light", and γραφή (*graphê*), meaning "drawing, writing", together meaning "drawing with light"

A photograph or a photo may be defined as follow:

- An image created by light falling on a light-sensitive surface, usually photographic film or an electronic medium such as a CCD or a CMOS chip.
- A picture produced by using a camera or satellite or radar and then made visible and permanent by chemical treatment or stored digitally.
- A picture or an image made using a camera, in which an image is focused on a light sensitive material and then made visible and permanent by chemical treatment or stored digitally.

Most photographs are created using a camera, which uses a lens to focus the scene's visible wavelengths of light into a reproduction of what the human eye would see. **Photography:** Photography is the process and practice of creating photographs.

Photo-interpretation

According to the American Society of Photo-grammetry (1966), photograph interpretation is “the act of examining photographic images for the purpose of identifying objects and judging their significance.

The major purpose of interpreting photographs is to develop geographic skills. This aid into the recognition of landforms and landscapes and in the assessment of the effect s of mans impact on the environment.

Significance of photographs in geographic study and daily life

- It is used for reference and keeping records
- It is used for study purposes or visual aids to enable study of distant features/places
- Details about features of a place or surface are known
- It is used for comparison and study of interrelationships between geographic phenomena
- Photographs are easy to take. One does not require special skills to take a photograph. This makes photographs an easy way of storing information.
- They are easy to share because they are less bulky. Many copies can also be reproduced, making them an easy source to store and share information.
- Aerial photographs are used in map making (topographic maps)
- Investigation/research purpose – proof of occurrence of certain event/action
- It is a piece of work for photographers and cartography –career development

- Monitoring changes in the environment e.g. urban capturing in the 1960s and now (comparability). Fires like those in Indonesia, volcanicity, erosion, refugees, vegetation cover changes, climatic changes etc

Limitations in the Use of Photographs

1. Coloured photographs are generally expensive to produce.
2. Black and white photographs don't show the real colours of objects or scenery e.g. it's difficult to distinguish ripe coffee berries from green ones.
3. Some aerial photographs have objects which are far away and hence unclear which may lead to the wrong interpretation.
4. Vertical aerial photographs are difficult to interpret without special instruments like stereoscopes.
5. Photographs are difficult to interpret if they are blurred because it's difficult to distinguish objects which look similar e.g. wheat and barley.

Comparison between maps and photographs

- Both represents a three dimensional world on a flat sheet of paper which is a two dimension
- The map is far more conventional image with selection of facts and the interpretations which have been made by the map maker. In contrast, the camera doesn't select what image to show and what to omit from the photograph. The camera leaves greater task of interpreting this image to the user thus photos show greater details than a map
- Map extracts show clearly the features present in that area since the map maker will use various symbols for those features. E.g. if an area has scattered settlements, scrub, swamps will appear on the map with those symbols
- Distance on map extracts can be measured fairly accurately than on maps whose scales varies
- On photos many objects are hidden from the camera by other dominant features
- Photos have a fixed view point
- The scale on topographic map sheets is the same all over the surface. In contrast scale on photos isn't uniform throughout the map.
- Photos may be produced relatively quickly and cheaper than topographic maps
- Maps represent generalized information that has been synthesized over time while photos tend to represent instant state of a given condition on the earth's surface

TYPES OF PHOTOGRAPHS

There are generally two types of photographs i.e.,

1. Ground/terrestrial/close photographs
2. Aerial photographs

Ground photographs

These are photos taken by using ground based cameras from some strategic point. This may be a top of a tree, tall building, level surface etc to capture the basic view of the photo.

Ground photographs are photographs taken from the ground level. They record exactly what a person would see if he/she was standing on the ground level. A ground photograph gives a horizontal view, great details of the landscape and covers a small area.

Classification of ground photographs

There are three categories of ground photographs:



(i) **Ground general view:** These types of photographs are produced when the camera is held horizontally to the ground facing the area or landscape focused on. Objects in such photographs become smaller the further they are from the camera.



(ii) **Ground close-ups:** In such photographs, the camera is focused on one major object such as a person, an animal, a cliff or a house. The object may block out the other things behind it.



(iii) **Ground oblique:** The photographer in this type of photos stands on a higher or lower ground than the object. The camera is then tilted or slanted towards the object or area of focused an angle less than 90° .

Characteristics of ground photographs

- Certain features are clearer than the others. Those near to the cameraman are clearer.
- Usually show one dimension (one side) of the object
- Size and height of the object can be recognized quite easily
- Area coverage is small than in aerial photographs
- In terms of interpretation, there is a foreground, middle and background.

Advantages of ground photographs

- They show the ground in great details
- Ground photography is less expensive compared to types of photograph like aerial photograph also it is quick method of storing geographic information.
- It can replace a great deal of verbal description
- It can be used in field sketching
- It is used for geographical studies for example study of climate, land use

Interpreting ground photographs

1. Divide the photograph into three sections i.e. foreground, middle ground and background. Further can be subdivided into left, center and right ground

BACK - GROUND		
LHS	CENTER	RHS
MIDDLE - GROUND		
LHS	CENTER	RHS
FORE - GROUND		
LHS	CENTER	RHS

LHS=left hand side, RHS=Right hand side

- Identify/describe the physical and human features and state the section where the feature is found (see table below)
- Draw geographic conclusions using the information from the photographs, we can describe the interrelationships between physical and the human environment.

Basic clue on photo interpretation

<i>Determining the title/theme</i>	Photographs show human activities, physical features, natural catastrophes etc e.g. nomadic pastoralism, drought, flooding, etc. When determining the title examine the photograph carefully and apply the knowledge you have learnt in geography.
<i>Determination of time of the day</i>	In the tropics the shadows are short at noon and longest in the morning and afternoon. If the camera is facing south and the shadow is cast to the right it's in the morning and if cast to the left it's in the afternoon.
<i>Dry season</i>	Bright clear skies Dry vegetation harvesting Light clothes e.g. shirts and T-shirts since temperature is high (also an indication of high temperature)
<i>Rainy season</i>	Rain clouds, Luxuriant vegetation, Young crops, Flowering plants, Weeding, Heavy clothing e.g. pullovers or jackets since temps are low (also an indication of cool season)
<i>Hot temperature and low rainfall</i>	Grass Sisal Scrub and bush land vegetation Dense forests Light clothes
<i>Cool temperature high rainfall</i>	Tea, Coffee, Wheat, Dairy farming
<i>Compass direction ...take photos in the morning and evening and show own observations...</i>	If it's in the morning and the shadow is cast to the left the photographer is facing north and if cast to the right he was facing south. If it's in the morning and the shadow is facing towards you the photographer was facing east and it taken in the afternoon and the shadow is facing towards you the photographer was facing west.
<i>Flatland/plain</i>	Rice crop, Irrigation, Combine harvesters, Swamps, Meanders, Oxbow lakes, Inselbergs & plains
<i>Hilly/mountainous/highland</i>	Steep slopes, terraced landscape, tea, wheat crops, rapids and falls, interlocking spurs
<i>Natural vegetation</i>	Indigenous species Dense undergrowth Trees grow haphazardly
<i>Planted vegetation</i>	Different species of trees Not of the same height
<i>Discuss all possible socio-economic activities</i>	Exotic species, In rows, Little undergrowth, Same species, Same heights

LECTURE 7.

AERIAL PHOTOGRAPHS

Ground photographs provide us with a view of the object similar to the way we see them with our own eyes. In other words, we get a horizontal perspective of the objects photographed. Suppose we want to take a 'bird's eye view' of similar features, then we have to place ourselves somewhere in the air. When we do so and look down, we get a very different perspective. This perspective, which we get in aerial photographs, is termed as aerial perspective. The photographs taken from an aircraft or space-borne platforms using a precision camera are termed aerial photographs

Definition of terms and concepts

Aerial photographs: These are photographs taken using cameras mounted on aircrafts and other space borne platforms. Or it can be defined as a photograph taken from an air-borne platform using a precision camera.

Aerial Camera: A precision camera specifically designed for use in aircrafts

Aerial Photography: Art, science and technology of taking aerial photographs from an air-borne platform (aircrafts, air balloons, drones etc)

Aerial Image Interpretation: An act of identifying the images of the objects and judging their relative significance.

Principal Point: The foot of the perpendicular drawn from the camera lens centre on the photo plane.

Principal Distance: The perpendicular distance from the perspective centre to the plane of the photograph.

Photogrammetry: The science and technology of taking reliable measurements from aerial photographs.

Uses of aerial photographs

Aerial photographs are used in topographical mapping and interpretation. These two different uses have led to the development of photogrammetry and photo/image interpretation as two independent but related sciences.

Photogrammetry: It refers to the science and technology of making reliable measurements from aerial photographs. The principles used in photogrammetry facilitate precise measurements related to the length, breadth and height from such photographs. Hence, they are used as the data source for creating and updating topographic maps

Image Interpretation: It is an art of identifying images of objects and judging their relative significance. The principles of image interpretation are applied to obtain qualitative information from the aerial photographs such as land use/land cover, topographical forms, soil types, etc. A trained interpreter can thus utilize aerial photographs to analyze the land-use changes

Advantages of Aerial photographs

The basic advantages that aerial photographs offer over ground based observation are:

1. **Improved vantage point:** Aerial photography provides a bird's eye view of large areas, enabling us to see features of the earth surface in their spatial context.
2. **Time freezing ability:** An aerial photograph is a record of the surface features at an instance of exposure. It can, therefore, be used as a historical record

3. **Broadened Sensitivity:** The sensitivity of the film used in taking aerial photographs is relatively more than the sensitivity of the human eyes. Our eyes perceive only in the visible region of the electromagnetic spectrum, i.e. 0.4 to 0.7 μm whereas the sensitivity of the film ranges from 0.3 to 0.9 μm .
4. **Wide coverage:** They cover larger area hence providing broader view of the environment
5. **Arithmetic calibrations:** It has better spatial resolution and geometric fidelity than many ground-based photos.
6. **Three Dimensional Perspective:** Aerial photographs are normally taken with uniform exposure interval that enables us in obtaining stereo pair of photographs. Such a pair of photographs helps us in getting a three-dimensional view of the surface photographed.
7. They provide up to date information
8. Provide additional minor details such as building types, colour, vegetation types and land use patterns

Disadvantages of vertical aerial photographs

- Difficulty in interpretation
- Inconsistency of scale
- Limited height information

Types of aerial photographs

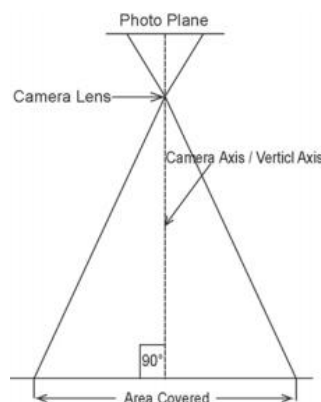
The aerial photographs are classified on the basis of

1. the position of the camera axis,
2. scale,
3. angular extent of coverage and
4. the film used.

For this course, the position of optical axis and the scale are given below:

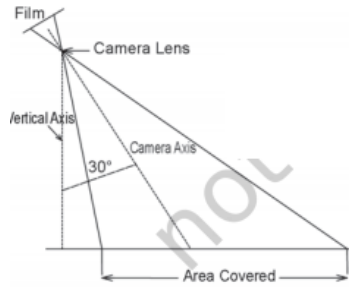
a) Types of Aerial Photographs Based on the Position of the Cameral Axis: On the basis of the position of the camera axis, aerial photographs are classified into the following types:

- (i) Vertical photographs
- (ii) Low oblique photographs
- (iii) High oblique photographs

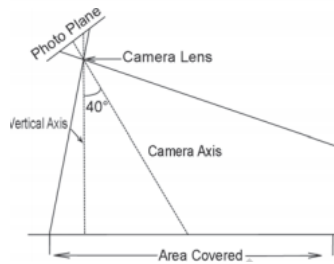


i) Vertical aerial photographs are taken from the air with the camera facing the earth surface at exactly 90° . These photographs are very important because they tend to cover all geographical aspects. These photographs are taken from an aircraft and the eye of the camera points vertically over a principal point on the ground.

In situations where the camera is unintentionally tilted slightly from the real vertical position, the resultant photograph is called a tilted photograph. Those unintentional tilts should not in any way exceed 3° to 5° .



(ii) Low Oblique: An aerial photograph taken with an intentional deviation of 15° to 30° in the camera axis from the vertical axis is referred to as the low oblique photograph. This kind of photograph is often used in reconnaissance surveys



(iii) High Oblique: The high oblique are photographs obtained when the camera axis is intentionally inclined about 60° from the vertical axis. Such photography is useful in reconnaissance surveys.



Characteristics of oblique photographs

- Objects near the view point appear larger than those in the background
- Objects heights may be recognized
- Part of the top and side of the objects displayed
- Area coverage is relatively larger than ground photos

To take a vertical aerial photograph, there are certain conditions one must address. They include;

- 1) Selection of the camera in terms of the focal length and the focal scale
- 2) The flying height in terms of altitude
- 3) Ground coverage – what region is to be covered
- 4) Weather conditions -clear day but not shiny is appropriate
- 5) Time of the day
- 6) Flight plan



Characteristics of vertical aerial photographs

- They display a rectangular area which is monotonously flat (featureless or dull)
- Have a specific scale
- Objects seen at their tops
- Cover relatively large area
- Size and height of the objects is very much reduced
- Skyline is completely out

(b) Types of Aerial Photographs Based on Scale: The aerial photographs may also be classified on the basis of the scale of photograph into three types.

(i) Large Scale Photographs: When the scale of an aerial photograph is 1:15,000 and larger, the photography is classified as large-scale photograph

(ii) Medium Scale Photographs: The aerial photographs with a scale ranging between 1:15,000 and 1:30,000 are usually treated as medium scale photographs

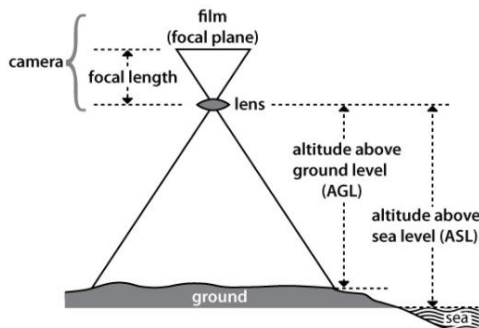
(iii) Small Scale Photographs: The photographs with the scale being smaller than 1:30,000, are referred to as small scale photographs

Photogrammetry

Photogrammetry, as already noted, is the science and technology of making reliable measurements from aerial photographs. It facilitates precise measurements related to the length, breadth and height from such photographs. It aids the determination of scale and other measurements. Hence, they are used as the data source for creating and updating topographic maps

Basic concepts in photogrammetry

1. Focal length: the distance from the middle of the camera lens to the focal plane (i.e. the film). As focal length increases, image distortion decreases. The focal length is precisely measured when the camera is calibrated.



Focal Length may be expressed as the product of the Ground distance and the Air craft altitude
 $\text{Focal length} = \text{Ground Scale} * \text{Air Craft Altitude}$
 NB: FL is usually given in millimeters (mm)
 $\text{Focal length} = \text{Ground scale} * \text{Air Craft Altitude}$

Example: Given the Ground scale is 1:40,000 and Air craft altitude is 8,000m, calculate the focal length

$$\begin{aligned} \text{FL} &= \text{GS} * \text{ACA} \\ &= 1:40,000 * 8,000\text{m} \\ &\text{(change to mm, and } 1\text{m}=1,000) \\ &= 8,000,000\text{mm} \\ \text{FL} &= 1/40,000 * 8,000,000\text{mm} \\ \text{FL} &= 200\text{mm} \end{aligned}$$

2. Photo Scale: the ratio of the distance between two points on a photo to the actual distance between the same two points on the ground (i.e. 1 unit on the photo equals "x" units on the ground). The scale of the photo is expressed as photo distance divided by ground distance.

Example: If a 1 km stretch of highway covers 4 cm on an air photo, the scale is calculated as follows:

$$\begin{aligned} \text{Scale} &= \text{Photo distance}/\text{ground distance} \\ &= 4\text{cm}/1\text{km} \end{aligned}$$

$$= 4\text{cm}/100,000\text{cm}$$

$$= 1/25,000$$

$$\text{Photo scale} = 1/25,000$$

Another method used to determine the scale of a photo is to find the ratio between the camera's Focal Length and the Air Craft Altitude above the ground being photographed. If a camera's focal length is 152 mm, and the plane's altitude is 7,600m, the scale would be:

$$\text{Photo scale} = FL/ACA$$

$$= 152\text{mm}/7600\text{m}$$

$$= 152\text{mm}/7600,000\text{mm}$$

$$= \text{Scale} = 1/50,000$$

Scale may be expressed three ways, i.e., Unit Equivalent, Representative Fraction and Ratio. A photographic scale of 1mm on the photograph represents 25m on the ground would be expressed as follows:

Unit Equivalent - 1 mm = 25 m
 Representative Fraction - 1/25 000
 Ratio - 1:25 000

3. Air Craft Altitude(ACA)/flying height: this is the elevation/height at which the airborne platform on which the camera is mounted is flying/positioned. ACA is given in meters or feet.

It is expressed as: Air Craft Altitude = Focal Length/Ground Scale

Example: Given the ground scale is 1:20,000 and Focal length is 400mm. calculate the Air Craft Altitude

$$\text{Air Craft Altitude} = \text{Focal Length}/\text{Ground Scale}$$

$$= 400\text{mm}/ 1:20,000$$

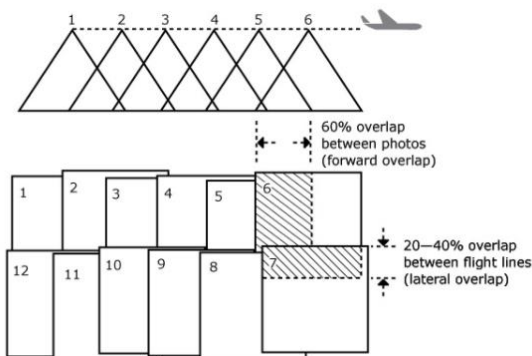
$$= 400\text{mm} * 20,000/1$$

$$= 8,000,000\text{mm (change to meters, and 1m=1000mm)}=8000\text{m}$$

$$\text{ACA} = 8000\text{m}$$

Activity

If ground scale is 1:30,000 and Focal Length is 300mm, calculate the air craft altitude



4. Overlap: is the amount by which one photograph includes the area covered by another photograph, and is expressed as a percentage. The photo survey is designed to acquire 60% forward overlap (between photos along the same flight line) and 30% lateral overlap (between photos on adjacent flight lines).

How to take vertical aerial photographs

They are taken along a series of parallel passes called flight strips. These photographs are taken in such a way that the area covered by each successive photograph along a given flight strip duplicates or overlaps part of the coverage of the previous photographs. See diag. above

The lapping along the flight strip is called the end lap, i.e. areas taken by two photographs. In addition to overlaps during the flight strip, all flight strips must in one way or another overlap each other (with adjacent flight strips). The overlapped are supposed to cover minimum of the 10° of the previous photograph.

From the above diagram, photograph must overlap photograph 1, 3 must overlap 2, 4 must overlap 3 etc as the flight continues. The same applies to the second flight strip and etc.

However, the second flight strip must overlap the first flight strip to create the stereoscopic overlap as shown in the diagram. These overlaps help especially when it comes to construction or generation of topographic maps.

Note: The position of a camera at any exposure is called **exposure station** and on maps, that center point of a photo is normally called/marked the **air photo principle focal point (+)**.

Air photo interpretation

To interpret vertical aerial photographs very well, one may require special instruments and the major ones are the **stereoscopes** because they give a 3 dimensional perspective of the photograph. Compared to other photographs, aerial photographs are very important in geography because of the fact that they can be used for quantitative analysis.

Basic Elements of Air Photo Interpretation

Novice photo interpreters often encounter difficulties when presented with their first aerial photograph. Aerial photographs are different from "regular" photos in at least three important ways:

- Objects are portrayed from an overhead (and unfamiliar) position.
- very often, infrared wavelengths are recorded, and
- photos are taken at scales most people are unaccustomed to seeing

These "basic elements" can aid in identifying objects on aerial photographs.

- **Tone** (also called Hue or Color) -- Tone refers to the relative brightness or color of elements on a photograph. It is, perhaps, the most basic of the interpretive elements because without tonal differences none of the other elements could be discerned. Different objects have different reflectance abilities and therefore appear differently on photographs. E.g water may appear darker, buildings may appear lighter
- **Size** -- The size of objects must be considered in the context of the scale of a photograph. The size will help you determine if e.g an object is a pond or Lake, residential or industrial structure.
- **Shape** -- refers to the general outline of objects. Regular geometric shapes are usually indicators of human presence and use. Some objects can be identified almost solely on the basis of their shapes.
 - the Pentagon Building
 - football fields
 - highways

- **Texture** -- The impression of "smoothness" or "roughness" of image features is caused by the frequency of change of tone in photographs. It is produced by a set of features too small to identify individually. Grass, cement, and water generally appear "smooth", while a forest canopy may appear "rough".
- **Pattern** (*spatial arrangement*) -- The patterns formed by objects in a photo can be diagnostic. Consider the difference between the random pattern formed by an unmanaged area of trees/woodlands/natural forests and the evenly spaced rows formed by plantations/planted forests.
- **Shadow** -- Shadows aid interpreters in determining the height of objects in aerial photographs. However, they also obscure objects lying within them.
- **Site** -- refers to topographic or geographic location. This characteristic of photographs is especially important in identifying vegetation types and landforms. For example, large circular depressions in the ground are readily identified as sinkholes in central Florida, where the bedrock consists of limestone. This identification would make little sense, however, if the site were underlain by granite.
- **Association** -- Some objects are always found *in association with* other objects. The context of an object can provide insight into what it is. For instance, along coasts there may found swamps, beaches, cliffs.

Importance of vertical aerial photographs in making of topographic maps

In topographic mapping, photographic interpretation is important for thematic information. Thematic information concerns the nature or identity of the objects. One can easily determine the number of photos that were used in the production of topographical map sheet by counting the number of Air photo principle points (+) indicated on the map.

Vertical aerial photos can be used as supplement to the map or when necessary as a substitute for a map.

Questions

1. *State any three advantages that an aerial photograph offers over ground based observations.*
2. *How is an aerial photograph taken?*
3. *What are the two major uses of an aerial photograph? Elaborate.*
4. *What are the different methods of scale determination?*