EXERCISE

Multiple Choice Questions

1. In which of the following aerial photographs the horizon appears?
   a. Vertical
   b. Near-vertical
   c. Low-oblique
   d. High-oblique

2. In which of the following aerial photographs the Nadir and the principle points coincide?
   a. Vertical
   b. Near-vertical
   c. Low-oblique
   d. High-oblique

3. Which type of the following projections is used in aerial photographs?
   a. Parallel
   b. Orthogonal
   c. Central
   d. None of the above.

Short Questions

1. State any three advantages that an aerial photograph offers over ground based observations.

2. How is an aerial photograph taken?

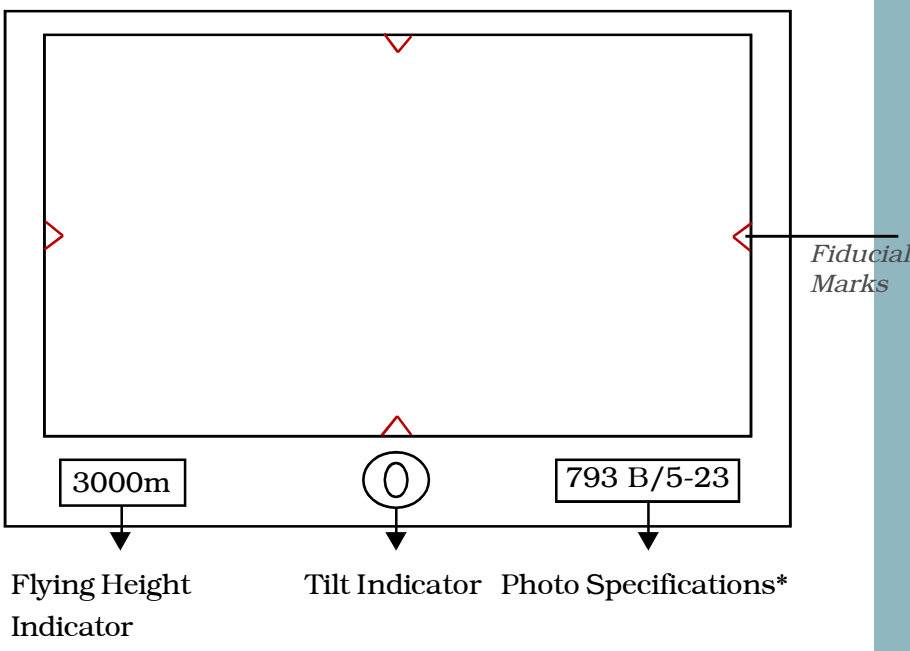
3. Present a concise account of aerial photography in India.

4. Answer the following questions in about 125 words :
   i) What are the two major uses of an aerial photograph? Elaborate.
   ii) What are the different methods of scale determination?

Method 2: By Establishing Relationship Between Photo Distance and Map Distance: As we know, the distances between different points on the ground are not always known. However, if a reliable map is available for the area shown on an aerial photograph, it can be

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Box 6.2



us to compute the scale of the aerial photograph (Sp). The relationship between the two distances may be expressed as under :

(Photo scale : Map scale) = (Photo distance : Map distance)

We can derive

Photo scale (S_p) = Photo distance (D_p) : Map distance (D_m) x Map

** 793 is a Photo Specification number maintained by the 73 APFPS Party of the Survey of India. B is the Flying Agency that carried out the present photography (in India three*

world. It can be expressed in unit equivalents like 1 cm= 1,000 km(or 12,000 inches) or as a representative fraction (1:100,000).

Scale determines what objects would be visible, the accuracy of estimates and how certain features will appear. When conducting an analysis that is based on air photos, it will sometimes be necessary to make estimates regarding the number of objects, the area covered by a certain amount of material or it may be possible to identify certain features based on their length. To determine this dimension during air photo interpretation, it will be necessary to make estimates of lengths and areas, which require knowledge of the photo scale. There are three methods to compute the scale of an aerial photograph using different sets of information.

Method 1: By Establishing Relationship Between Photo Distance and Ground Distance : If additional information like ground distances of two identifiable points in an aerial photograph is available, it is fairly simple to work out the scale of a vertical photograph. Provided that the corresponding ground distances (D_g) are known for which the distances on an aerial photograph (D_p) are measured. In such cases, the scale of an aerial photograph will be measured as a ratio of the two, i.e. D_p / D_g.

Problem 6.1 The distance between two points on an aerial photograph is measured as 2 centimetres. The known distance between the same two points on the ground is 1 km. Compute the scale of the aerial photograph (Sp).

Solution

Sp = D_p : Dg

= 2 cm : 1 km

= 2cm : 1 x 100,000 cm

= 1 : 100,000/2 = 50,000 cm

= 1 unit represents 50,000 units

Therefore, Sp = 1 : 50,000

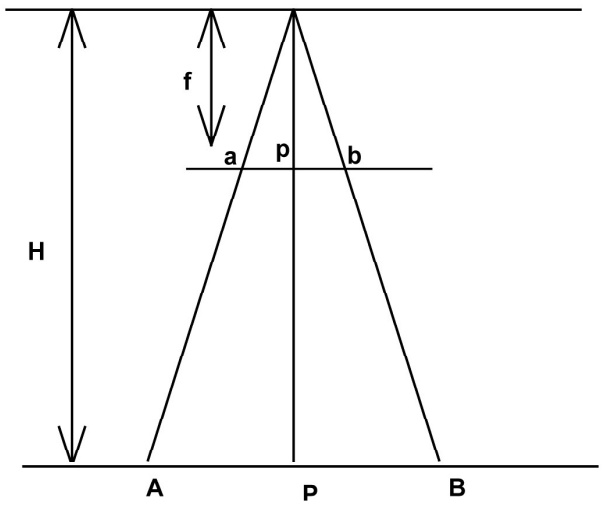


Figure 6.15 Focal Length of the Camera (f) and Flying Height of the Aircraft (H)

Scale of Aerial Photograph

You are already familiar with the concept of a map scale (See Chapter 2). The concept of scale for aerial photographs is much the same as that of a map. Scale is the ratio of a distance on an aerial photograph the distance between the same two places on the ground in the real

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Difference between a Map and an Aerial Photograph

A map cannot be directly traced out of an aerial photograph. The reason is that there is a basic difference in the planimetry (projection) and perspective of a map and an aerial photograph. The difference is given in Table 6.2.

Table 6.2: Difference between Maps and Aerial Photographs

Aerial Photograph	Map
It is a central Projection.	It is an orthogonal Projection.
An aerial photograph is geometrically incorrect. The distortion in the geometry is minimum at the centre and increases towards the edges of the photographs.	A map is a geometrically correct representation of the part of the earth projected.
The scale of the photograph is not uniform.	The scale of the map is uniform throughout the map extent.
Enlargement/reduction does not change the contents of the photographs and can easily be carried out.	Enlargement/reduction of the maps involves redrawing it afresh.
Aerial photography holds good for inaccessible and inhospitable areas.	The mapping of inaccessible and inhospitable areas is very difficult and sometimes it becomes impossible.

Even vertical aerial photographs do not have a consistent scale unless they have been taken of a flat terrain. Aerial photographs need to be transformed from perspective view to the planimetric view before they can be used as map substitute. Such transformed photographs are known as *orthophotos*.

Central Projection: Figure 6.13 shows an example of Central Projection. The projecting rays Aa, Bb and Cc pass through a common point O, which is called the perspective Centre. The image projected by a lens is treated like a central projection.

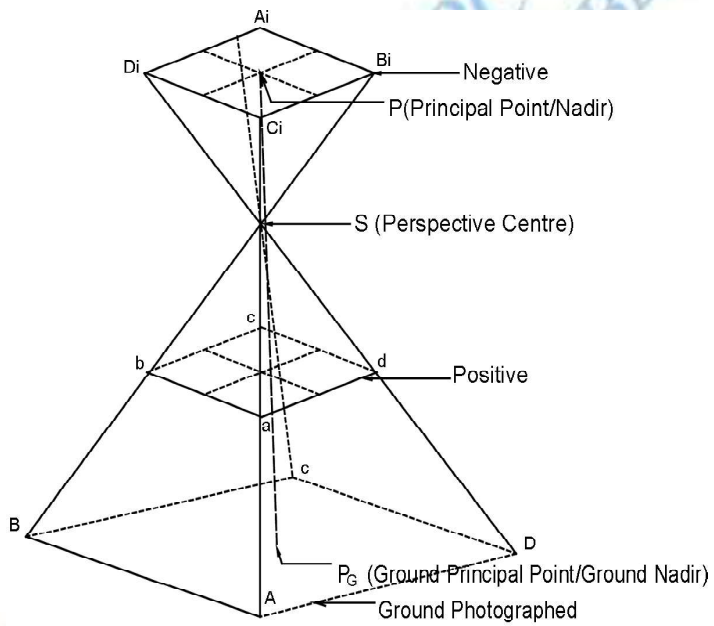


Figure 6.14 Geometry of Vertical Photograph

An aerial photograph, as discussed earlier is a central projection. In an absolutely vertical flat terrain the aerial photograph will be geometrically the same as the corresponding map of the area. However, because of the tilt of the photograph and relief variations of the ground photographed, an aerial photograph differs geometrically from the map of the corresponding area.

As shown in Figure 6.14, S is the camera lens centre. The bundle of light rays coming from the ground plane converge at this point and diverge

scale photographs (Fig. 6.10).

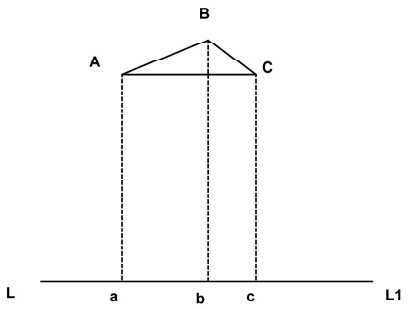


Figure 6.12 Orthogonal projection

Geometry of an Aerial Photograph

To understand the geometry of an aerial photograph, it is important to appreciate the orientation of the photograph with respect to the ground, i.e. the way the rays connect or 'project' onto the ground in relation to the ground representation (photograph or map). The following three examples of such projection would be useful in understanding the problem.

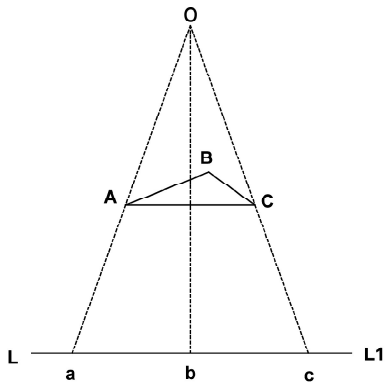


Figure 6.13 Central Projection

Parallel Projection: In this projection, the projecting rays are parallel but not necessarily perpendicular. The triangle ABC is projected on LL1 as triangle abc (Figure 6.11).

Orthogonal Projection: This is a special case of parallel projections. Maps are orthogonal projections of the ground. The advantage of this projection is that the distances, angles or areas on the plane are independent of the elevation differences of the objects. Figure 6.12 is an example of orthogonal projection where the projecting rays are perpendicular to the line LL1.

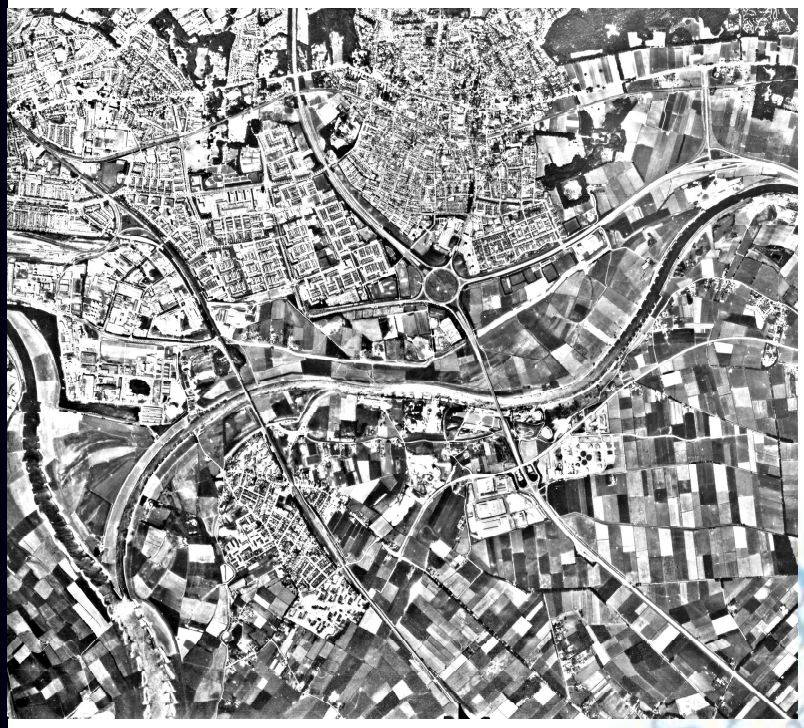


Figure 6.10 1 : 40,000 Photograph of Arnehem

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

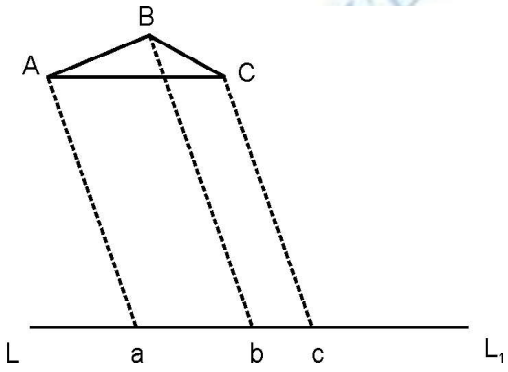


Figure 6.11 Parallel Projection

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(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 (Fig. 6.8).

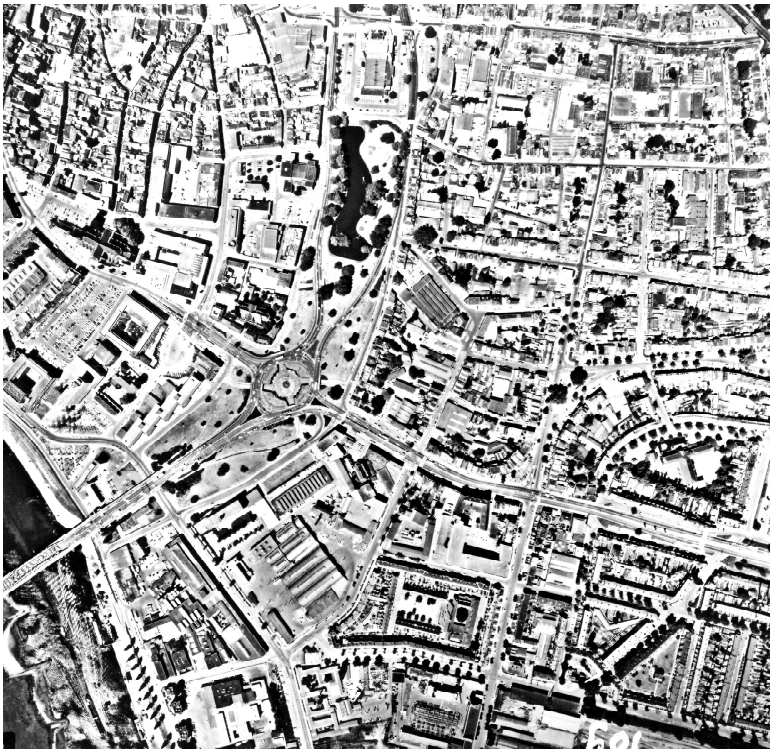


Figure 6.8 1 : 5000 Photograph of Arnehem



Figure 6.9 1 : 20,000 Photograph of Arnehem

(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 (Fig. 6.9).

(iii)High Oblique: The high oblique are photographs obtained when the camera axis is intentionally inclined about 60° from the vertical axis (Figure 6.7). Such photography is useful in reconnaissance surveys.

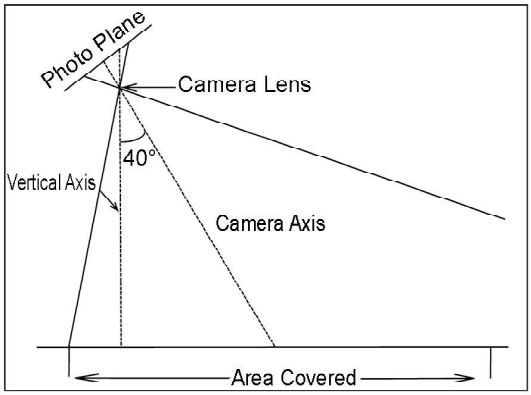


Figure 6.7 High Oblique Photograph

Table 6.1 provides a comparison between vertical and oblique photographs.

Table

Attributes	Vertical	Low Oblique	High Oblique
Optical Axis	Tilt < 3° i.e. exactly coincides with the vertical axis.	Deviation is <30° about 60° from the vertical axis.	Deviates by or nearly from the Vertical axis > 30° from vertical axis.
Characteristics	Horizon does not appear.	Horizon does appear.	Horizon appears
Coverage	Small area	Relatively larger area	Largest area
Shape of the area	Square	Trapezoidal	Trapezoidal

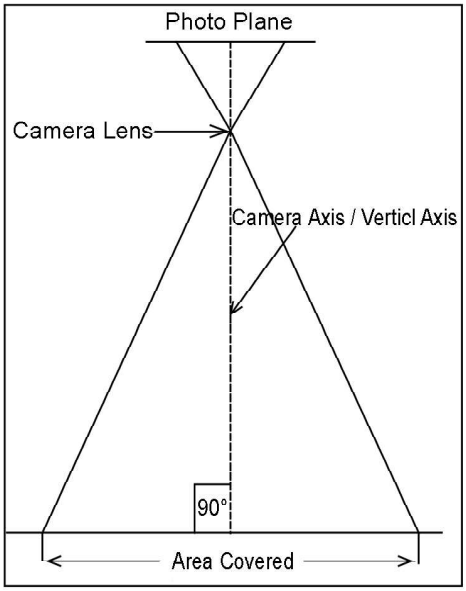


Figure 6.3 Vertical Aerial Photograph

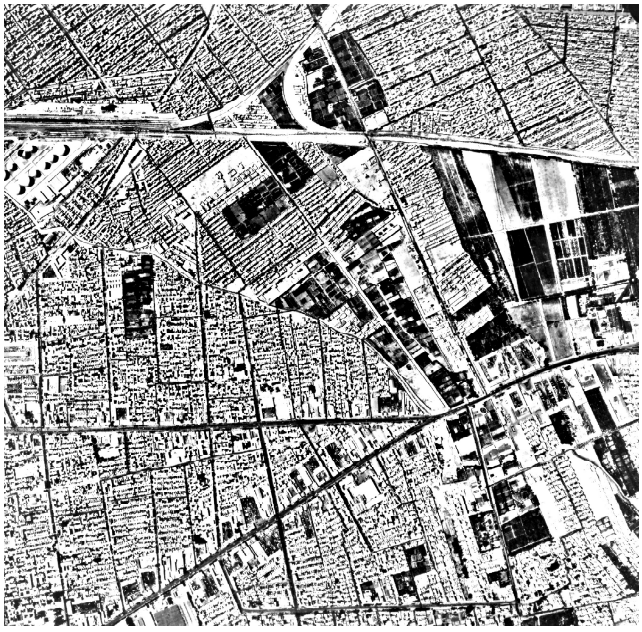


Figure 6.4 Vertical Aerial Photograph of Arneham, The Netherlands

(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 (Figures 6.5 and 6.6). This kind of photograph is often used in reconnaissance surveys.

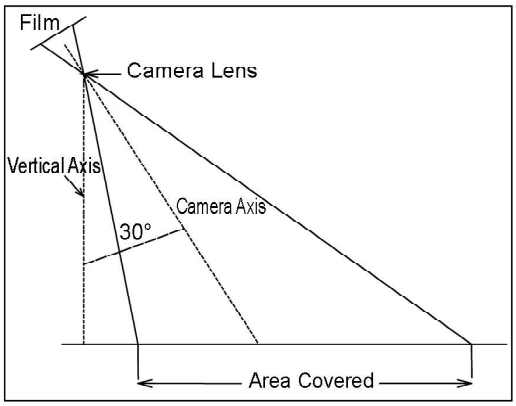


Figure 6.5 Low-Oblique Photograph



Figure 6.6 Low-Oblique Photograph of Arneham, The Netherlands

their spatial context.

b. 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.

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c. 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.

d. *Three Dimensional Perspective:* Aerial photographs are

These two different uses have led to the development of *photogrammetry* and *photo/image interpretation* as two independent but related sciences. The development of aerial photography in India is briefly given in Box 6.I.

Box 6.1 Aerial Photography in India

Aerial photography in India goes back to 1920 when large-scale aerial photographs of Agra city were obtained. Subsequently, Air Survey Party of the Survey of India took up aerial survey of Irrawaddy Delta forests, which was completed during 1923–24. Subsequently, several similar surveys were carried out and advanced methods of mapping from aerial photographs were used. Today, aerial photography in India is carried out for the entire country under the overall supervision of the Directorate of Air Survey (Survey of India) New Delhi. Three flying agencies, i.e. Indian Air Force, Air Survey Company, Kolkata and National Remote Sensing Agency, Hyderabad have been officially authorised to take aerial photographs in India.

The procedure for indenting aerial photographs for educational purposes could be made with APFPS Party No. 73, Directorate of Air Survey, Survey of India, West Block IV, R. K. Puram, New Delhi.

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.

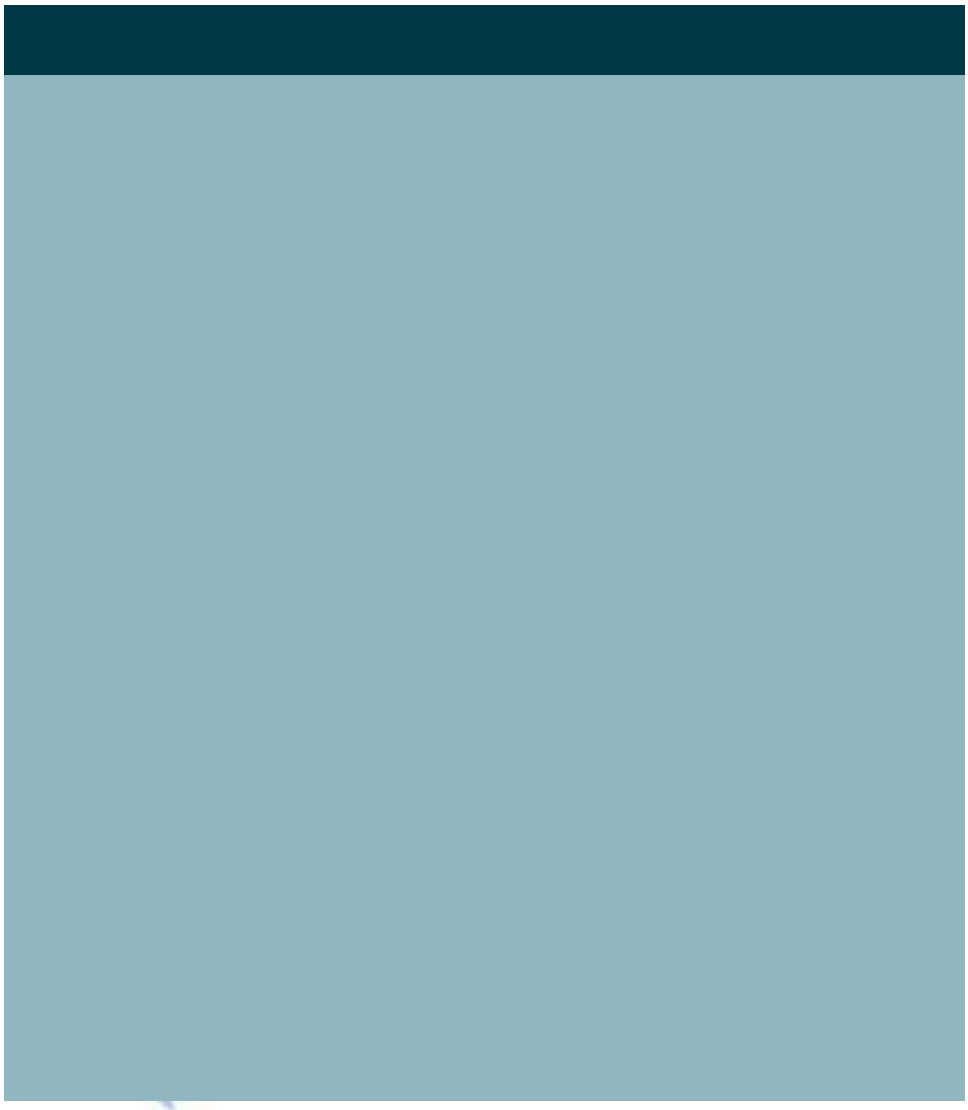
Image Interpretation: It is an art of identifying images of objects and judging their relative significance. The principles of image interpretation are applied to obtain qualitative information from the aerial photographs such as land use/land cover, topographical forms, soil types, etc. A trained interpreter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

Advantages of Aerial Photography

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

***a. Improved vantage point*:** Aerial photography provides a bird's eye view of large areas, enabling us to see features of the earth surface in

The photographs so obtained have been found to be indispensable tools in the topographical mapping and interpretation of the images of the objects.



Uses of Aerial Photographs

Aerial photographs are used in topographical mapping and interpretation.

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

Aerial Film : A roll film with high sensitivity, high intrinsic resolution power and dimensionally stable emulsion support.

Aerial Photography : Art, science and technology of taking aerial photographs from an air-borne platform.

Chapter 6

Introduction To Aerial Photographs



Figure 6.1 Terrestrial photograph of Mussorrie town

We are familiar with photographs taken with normal cameras. These 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. For example, a photograph of a part of settlement will provide us a perspective the way it appears to us when we look at it (Fig. 6.1). 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 (Fig. 6.2).

The photographs taken from an aircraft or helicopter using a precision camera are termed *aerial photographs.*

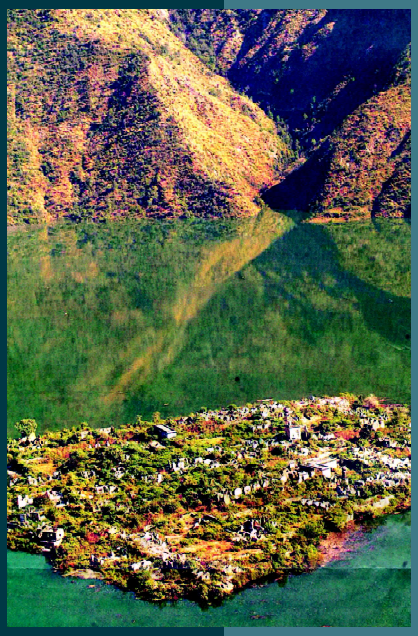


Figure 6.2 Bird's Eye View of Tehri Town, Uttarakhand