Salahaddin University-Erbil
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Reservoir Planning, Design and Operation

Lec 02

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Multipurpose Reservoirs

- A ***multipurpose reservoir*** is designed and constructed to serve two or more purposes. Most of the reservoirs are designed as multipurpose reservoirs to store water for irrigation and hydropower, and also to effect flood control.

Distribution Reservoir

- A distribution reservoir is a small storage reservoir to tide over the peak demand of water for municipal water supply or irrigation. The distribution reservoir is helpful in permitting the pumps to work at a uniform rate. It stores water during the period of lean demand and supplies the same during the period of high demand. Water is pumped from a water source at a uniform rate throughout the day for 24 hours but the demand varies from time to time.

Distribution Reservoir … cont.

- During the period when the demand of water is less than the pumping rate, the water is stored in the distribution reservoir. On the other hand, when the demand of water is more than the pumping rate, the distribution reservoir is used for supplying water at rates greater than the pumping rate.
- Distribution reservoirs are rarely used for the supply of water for irrigation. These are mainly used for municipal water supply.

Balancing reservoir

A balancing reservoir is a small reservoir constructed D/S of the main reservoir for holding water released from the main reservoir.

Available Storage Capacity of a Reservoir

- Whatever may be the use of a reservoir, its most important function is to store water during floods and to release it later. The storage capacity of a reservoir is considered as the most important characteristics.
- The available storage capacity of a reservoir depends upon the *topography of the site and the height of dam*. To determine the available storage capacity of a reservoir up to a certain level of water, engineering surveys are usually conducted. These maps are available to a scale of 1 cm = 500 m (RF = 1/50000) and 1 cm = 2500 m (RF = 1/250000), with contours marked on it.

RF= Representative fraction

Available Storage Capacity of a Reservoir

- For accurate determination of the capacity, a topographic survey of the reservoir area is usually conducted, and a contour map of the area is prepared.

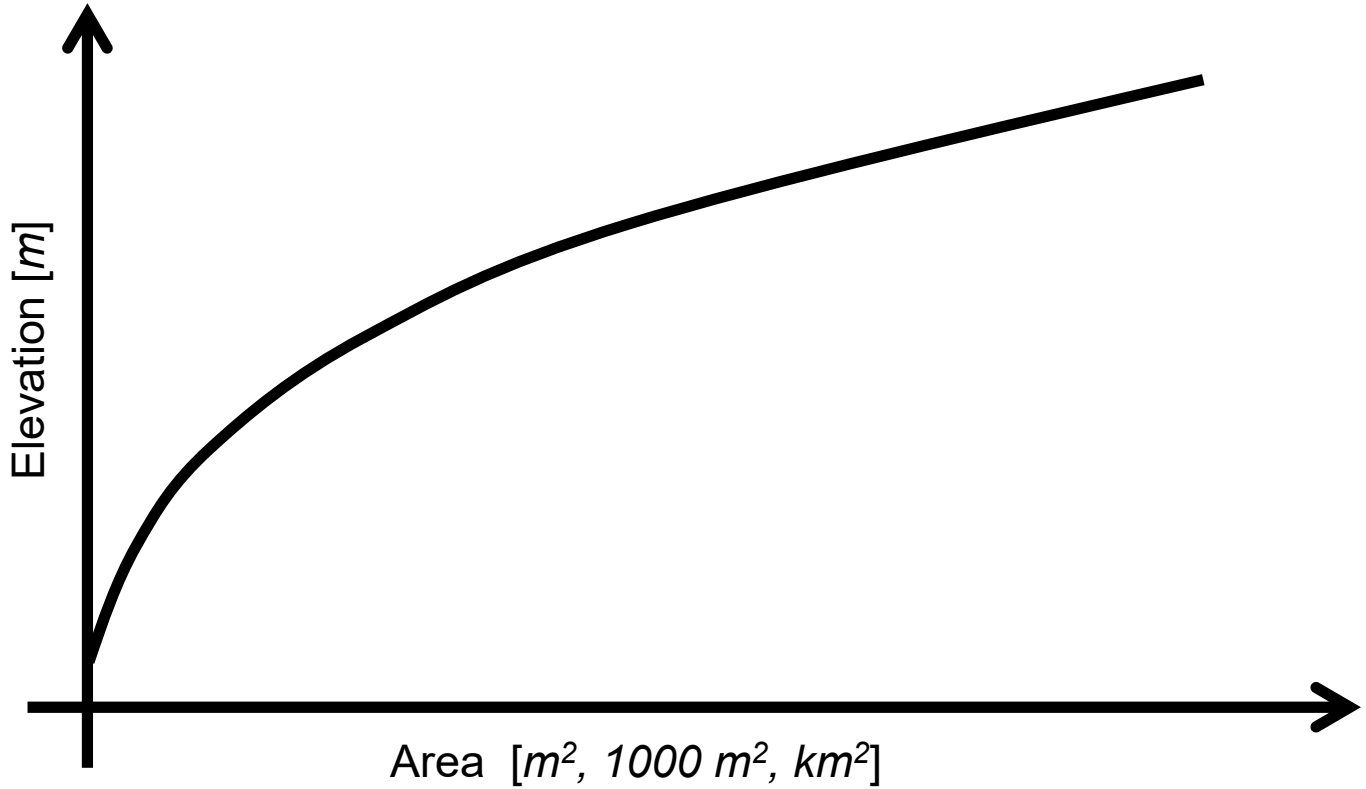
- A contour plan of the area is prepared to a scale of 1 cm = 100 m or 150 m (RF = 1/10,000 or 1/50000) with a contour interval of 1 to 3 m, depending upon the size of the reservoir.

- The storage capacity and the water spread area at different elevations can be determined from the contour map.

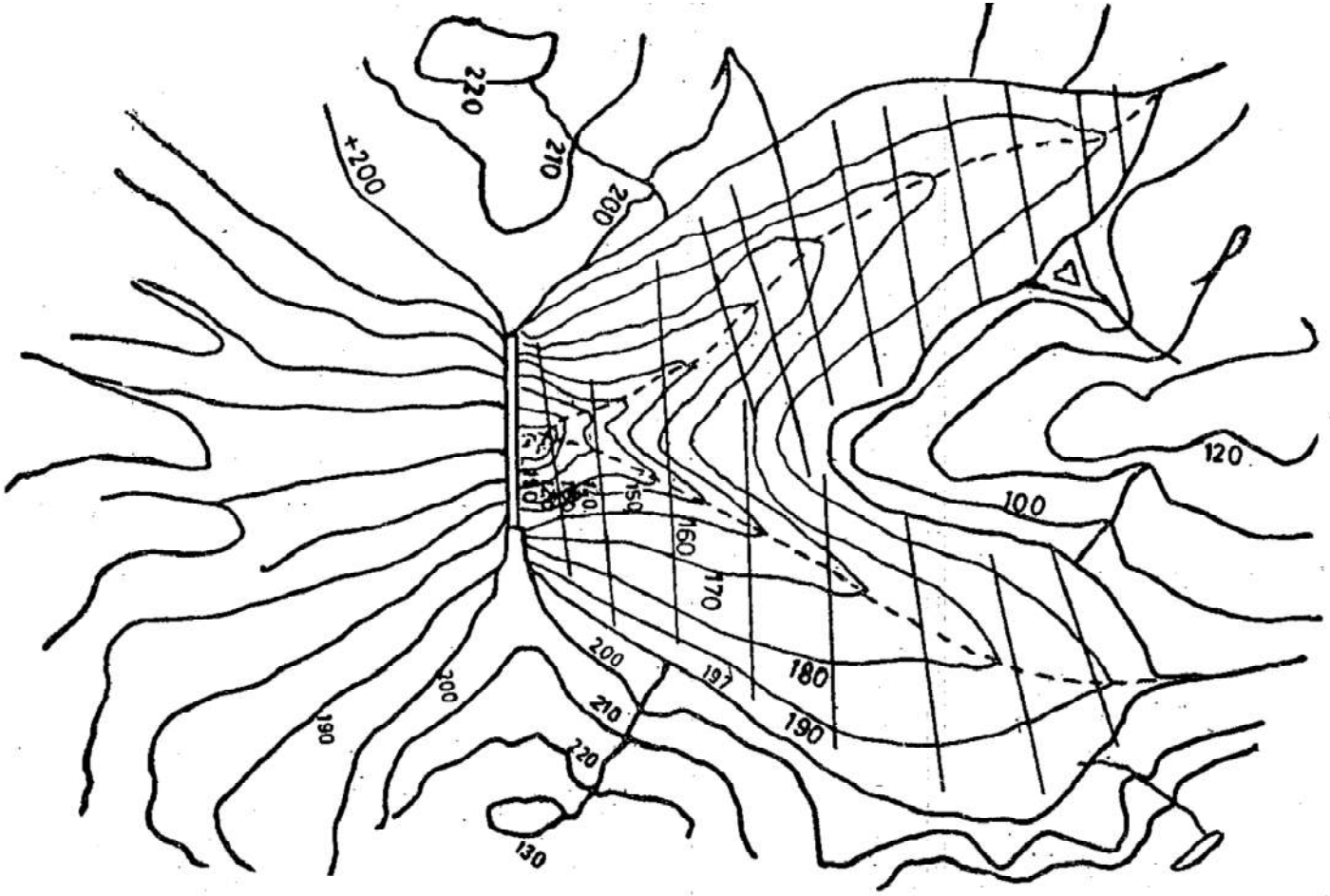
Area-Elevation Curve

- From the contour plan, the water spread area of the reservoir at any elevation is determined by measuring the area enclosed by the corresponding contour.
- Generally, a planimeter is used for measuring the area.
- Nowadays, CAD and GIS technique mostly used to determine the enclosed area of each contour.
- When water collected behind the dam, it spreads over an area.
- The water level at different elevation will submerge different area that can be determined by enclosed corresponding contour.
- An elevation-area curve is then drawn between the surface area as abscissa and the elevation as ordinate.

Area-Elevation Curve



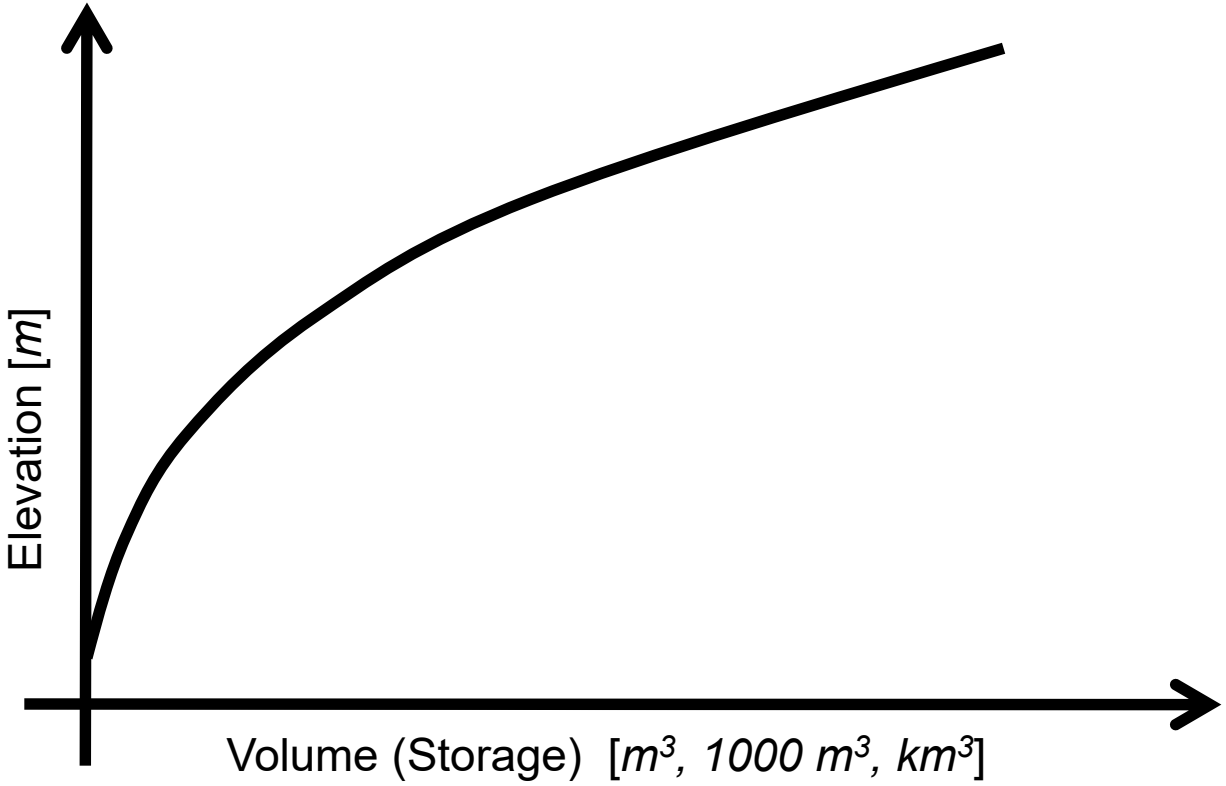
Contour Map of a Reservoir Area



Capacity (Volume or Storage)-Elevation Curve

- water storage behind the dam at any elevation has different storage capacity.
- When the submerged area increased with increasing elevation of water in the reservoir, the volume of stored water increased as well.
- The storage-elevation curve can be plotted by volume of stored water versus elevation.
- The storage capacity of the reservoir at any elevation is determined from the water spread area at various elevations. The following formulae are commonly used to determine the storage capacity (i.e. storage volumes)

Capacity (Volume or Storage)-Elevation Curve



Capacity (Volume or Storage)-Elevation Curve

1. *Trapezoidal formula*

According to the trapezoidal formula, the storage volume between two successive contours of areas A1, and A2 is given by:

$$\Delta V1 = \frac{h}{2}(A1 + A2)$$

Where h is the contour interval.

Therefore, the total volume V of the storage is given by :

$$V = \Delta V1 + \Delta V2 + \Delta V3 + ..$$
$$V = \sum \Delta V$$

or

$$V = \frac{h}{2}[A1 + 2A2 + 2A3 + \cdots ... + 2An - 1 + An]$$

Capacity (Volume or Storage)-Elevation Curve

2. Cone formula

According to the cone formula, the storage volume between two successive contours of areas A1 and A2 is given by:

$$\Delta V1 = \frac{h}{3}\left(A1 + A2 + \sqrt{(A1A2)}\right)$$

The total volume V is given by:

$$V = \Delta V1 + \Delta V2 + \Delta V3 + \cdots \ldots \ldots \ldots + \Delta Vn$$

$$V = \sum \Delta V$$

Capacity (Volume or Storage)-Elevation Curve

3. Prismoidal formula

According to the prismoidal formula, the storage volume between three successive contours is given by:

$$\Delta V = \frac{h}{3}(A1 + 4A2 + A3)$$

The total volume is given by:

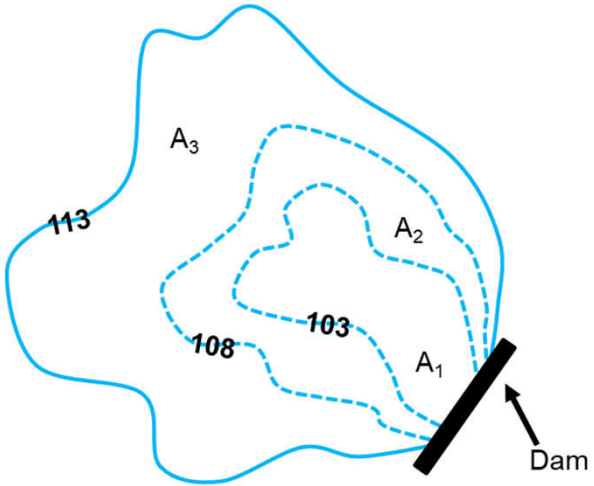
$$V = \frac{h}{3}[(A1 + An) + 4(A2 + A4 + A6 + \cdots) + 2(A3 + A5 + \cdots)]$$

where A3, A5, etc. are the areas with odd numbers : A2, A4, A6, etc. are the areas with even numbers A1 and An are respectively, the first and the last area.

Capacity (Volume or Storage)-Elevation Curve

3. Prismoidal formula

The prismoidal formula is applicable only when there are odd numbers of areas (i.e. n should be an odd number). In the case of even number of areas, the volume up to the last but one area is determined by the prismoidal formula, and that of the last segment is determined by the trapezoidal formula.



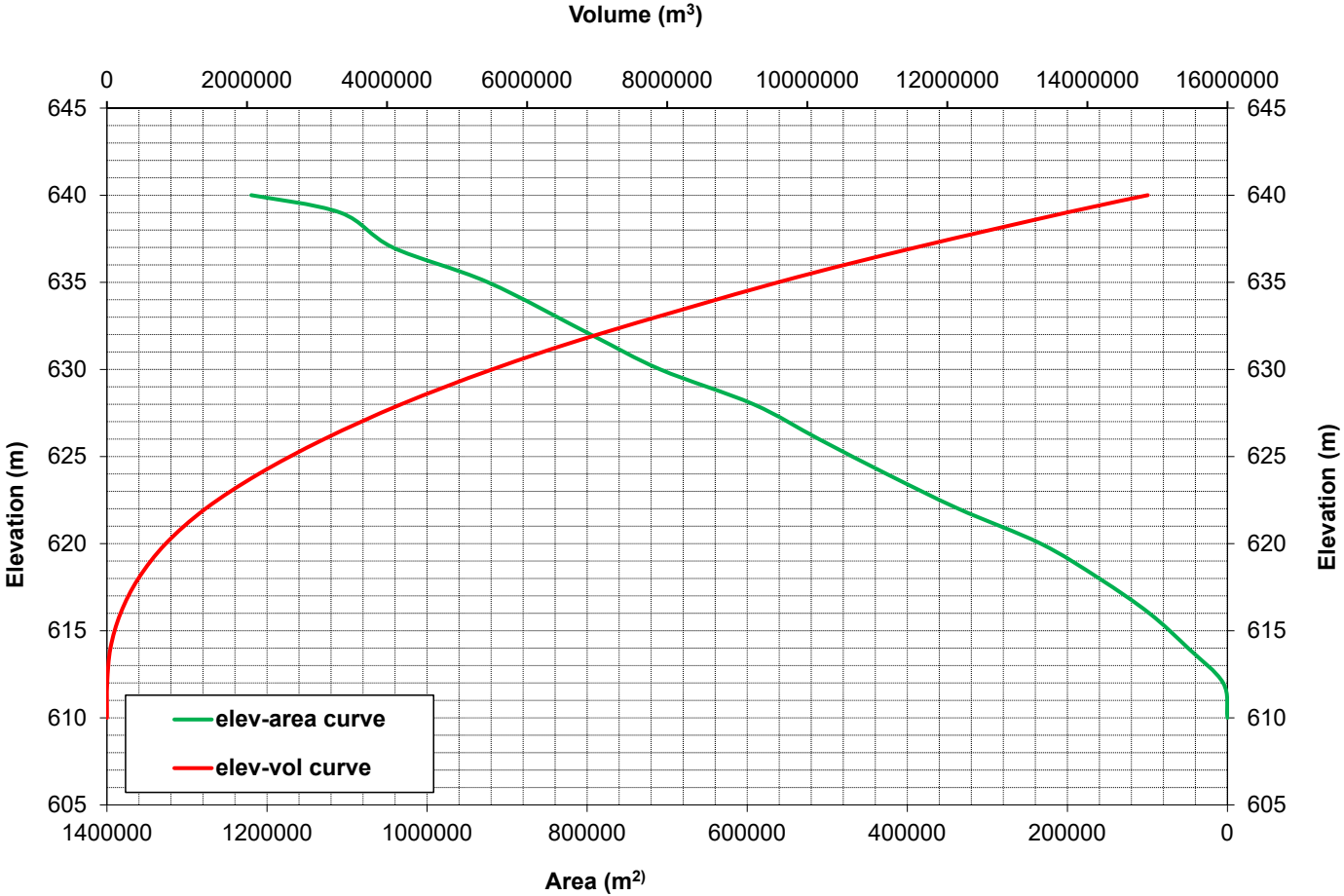
Combined Diagram (Area-Elevation Capacity-Elevation) curve

- It is the usual practice to plot both the elevation-area curve and the elevation-storage curve on the same paper . The reader should carefully note the abscissa marking as the areas and volumes increase in the opposite directions.

Submerged area

- In addition to finding out the capacity of a reservoir, the contour map of the reservoir can also be used to determine the land and property which would be submerged when the reservoir is filled up to various elevations.
- It would enable one to estimate the compensation to be paid to the owners of the submerged property and land. The time schedule according to which the areas should be evacuated, as the reservoir is gradually filled, can also be drawn

Combined Diagram (Area-Elevation Capacity-Elevation) curve



Combined Diagram (Area-Elevation Capacity-Elevation) curve