Stream Flow Measurement

The Water Cycle and Runoff

Precipitation that reaches the ground is subject to various losses. After these losses, the remaining water becomes runoff. This runoff travels over the land, through the subsurface, or as groundwater. Eventually, all water moving through a network of streams joins a main stream, becoming part of the stream flow.

Stream flow is measured in units of discharge (m^3/s) occurring at a specified time and constitutes historical hydrological data.

Stream Flow Measurement Techniques

Stream flow measurement techniques are generally categorized into two types:

1. Direct Determination

Area-Velocity Method: The most common method, using cross-sectional area and flow velocity.

Dilution Techniques: Using tracers or chemicals to determine flow.

Electromagnetic Method: Measuring the voltage induced by water flowing through a magnetic field.

Ultrasonic Method: Using sound waves to calculate velocity.

2. Indirect Determination

Hydraulic Structures: Using man-made structures such as weirs, flumes, and gated structures.

Slope-Area Method: Estimating discharge based on the water surface slope and channel characteristics.

Calculation of Discharge (Flow Rate)

Discharge describes the volume of water flowing through a stream per second. To analyze this using the Area-Velocity Method, two primary variables must be estimated:

The average velocity of the water.

The cross-sectional area of the stream.

Velocity Variation

In a natural river with an irregular shape, water moves at different speeds across the width and depth of the stream:

Horizontal Variation: Velocity is typically higher in the middle of the stream and lower near the banks due to friction.

Vertical Variation: If you plot a velocity profile, the velocity is higher near the surface and decreases toward the bottom.

Measuring Average Velocity

Since velocity cannot be measured at every single point, we use representative depths to calculate the mean:

Deep Streams: Average velocity is often taken as the mean of the velocities at 20% depth (0.2d) and 80% depth (0.8d) from the surface.

Shallow Streams: It is often sufficient to measure the velocity at 60% depth (0.6d) from the surface.

Current Meters

A Price Current Meter is a common instrument used in hydrometry to measure velocity at a specific point in the flow cross-section.

Mechanism

It consists of a rotating wheel with cone-shaped cups. When placed in flowing water, the cups fill and rotate the wheel. The angular velocity of the wheel is proportional to the stream velocity.

Calculation

When the meter is lowered into the water and faces the current, the rate of rotation is recorded. The velocity is then calculated using the following equation:

$V=sNs+b$

Where:

V: Stream velocity at the instrument location.

Ns: Number of revolutions per second.

a and b: Calibration constants specific to the meter.

Selecting a Gauging Site

The Area-Velocity method requires a carefully selected gauging site to ensure the "stage-discharge curve" remains constant over several years. A good site should meet these criteria:

Well-defined cross-section: The channel shape should not change significantly across different seasons.

Accessibility: The site must be easily accessible throughout the year.

Straight Reach: The site should be located on a straight, stable stretch of the river.

No Backwater Effects: The site should be free from obstructions or backwater effects that could distort flow readings.