HYDROLOGY PROJECT
Technical Assistance

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Training module # SWDP - 28

How to carry out primary validation of stage-discharge data

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1. Module context

While designing a training course, the relationship between this module and the others, would be maintained by keeping them close together in the syllabus and place them in a logical sequence. The actual selection of the topics and the depth of training would, of course, depend on the training needs of the participants, i.e. their knowledge level and skills performance upon the start of the course.

2. Module profile

Title	:	How to carry out primary validation of stage-discharge data
Target group	:	Assistant Hydrologists, Hydrologists, Data Processing Centre Managers
Duration	:	One session of 60 minutes
Objectives	:	After training, the participants will be able to • carry out prescribed primary validation of stage-discharge data
Key concepts	:	• comparison of cross sectional & velocity profiles • velocity vectors & mean velocity profile • re-computation of summary data • scatter plot of stage-discharge data • scrutiny of stage-discharge data against rating curve
Training methods	:	Lecture, software
Training tools required	:	Board, OHS, Computer
Handouts	:	As provided in this module
Further reading and references	:	

3. Session plan

No	Activities	Time	Tools
1	***General*** • Important points	5 min	 OHS 1
2	***Inspection of field sheets and Field Record Book*** • Specimen of current meter record sheets	5 min	OHS 2
3	***Comparison of field and office computed discharge***	5 MIN	
4	***Comparison of computed discharge with existing rating curve*** • General • Graphical plot of stage-discharge data 4.1 Deviations due to reliability of individual gaugings 4.2 Deviations due to physical properties of the gauging station 4.3 Deviations due to actual changes in the stage-discharge relationship	15 min	 OHS 3 OHS 4 OHS 5 OHS 6 OHS 7
5	***Exercise*** • Compare the field and office computed discharge for two observations • Observe the deviations in stage-discharge data with respect to previous observations	30 min	

4. Overhead/flipchart master

5. Handout

Add copy of Main text in chapter 8, for all participants.

6. Additional handout

These handouts are distributed during delivery and contain test questions, answers to questions, special worksheets, optional information, and other matters you would not like to be seen in the regular handouts.

It is a good practice to pre-punch these additional handouts, so the participants can easily insert them in the main handout folder.

7. Main text

Contents

1.	General	1
2.	Inspection of field sheets and Field Record Book	1
3.	Comparison of field and office computed discharge	3
4.	Comparison of computed discharge with previous gaugings	3

How to carry out primary validation of stage-discharge data

1. General

- **Flow measurement in this module refers to individual measurements of discharge made by current meter which are used in the plotting and fitting of a stage discharge relationship or rating curve.**

- **Initial calculation is carried out in the field and the completed field sheets are returned monthly to the Sub-divisional office where they are entered to computer using Primary module of dedicated hydrological data processing system (SWDES) and the discharge recomputed.**

- **Primary validation consists of:**

  ❖ inspection of field sheets and Field Record Book
  ❖ comparison of field and office computed discharge
  ❖ comparison of computed discharge with existing rating curve
  ❖ comparisons of cross sectional and velocity profiles

2. Inspection of field sheets and Field Record Book

Each current meter measurement of discharge contains multiple observations or calculations of width, depth, velocities, slope, areas, flows, etc., and the information is entered to the standard "Discharge Measurement Sheet" (Fig. 2.1). Before checking the arithmetic calculations, it is necessary to check ancillary information on the form and in the Field Record Book to ensure that it is complete and that any change at the station which may have influenced the relationship between stage and discharge is available for interpretation of the computed discharge. Information which may be relevant includes:

- rates of rise and fall in level during measurement (possible unsteady flow effect)
- backwater due to very high stages (i.e. flooding) in receiving river or contributing tributary downstream of gauging station
- flood in deposition or scour of the channel at the gauge or at the downstream control, based on observer observations.
- gravel extraction at the station or downstream
- bunding or blockage in the downstream channel
- weed growth in the channel
- change in datum at the station, adjustment or replacement of staff gauges.

The stage recorded at the beginning and end and during the gauging must be compared with the hourly or other stage observation by recorder or manually. Any discrepancy must be investigated by reference to the field supervisor. The error may be in the continuous record or in the observation during current meter gauging; if the latter then the mean stage in the summary form for the current meter measurement must be amended.

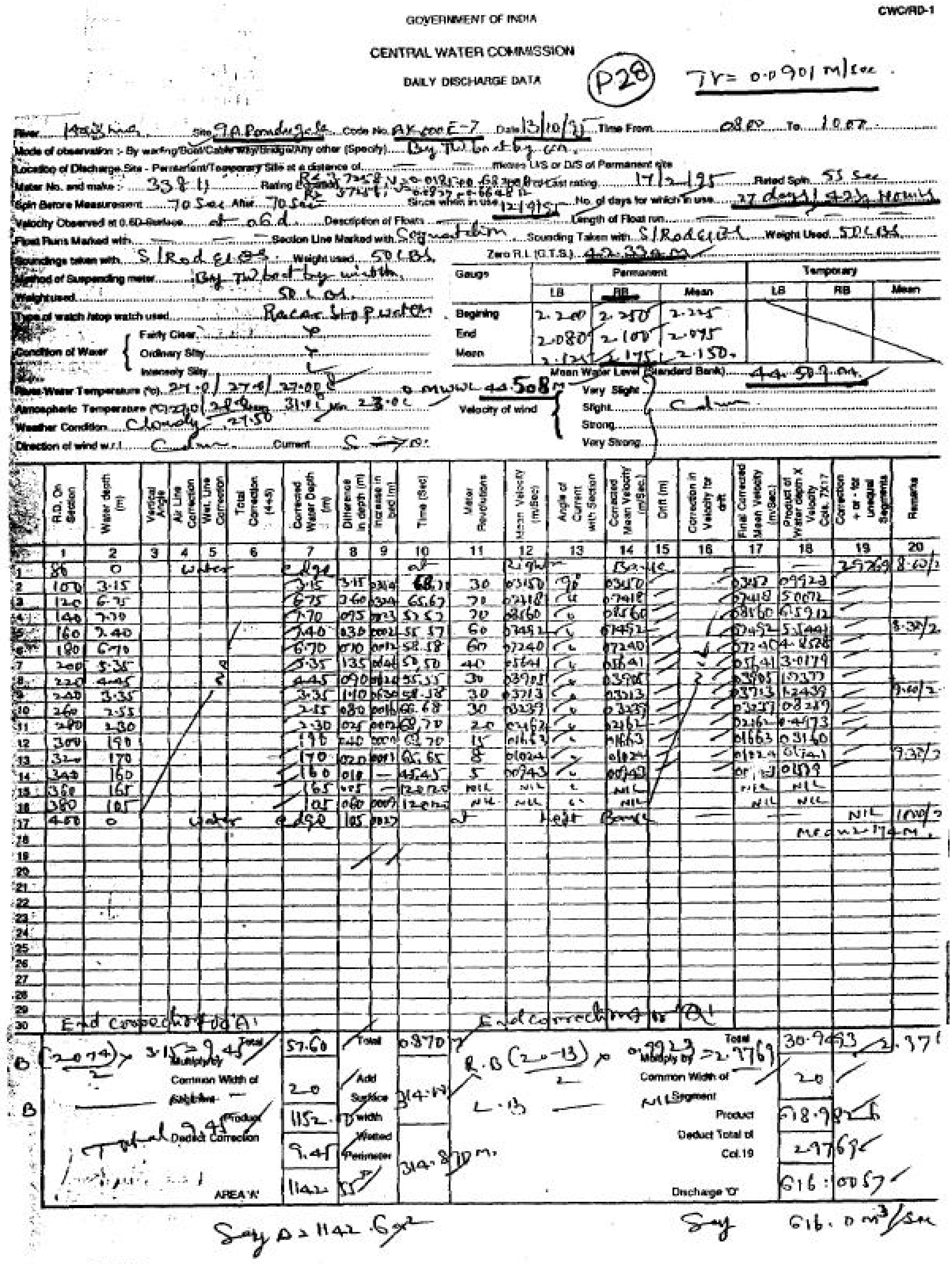

Fig. 2.1: Specimen "discharge measurement sheet"

3. Comparison of field and office computed discharge

The calculation of discharge from current meter measurements is initially carried out in the field by the gauging team. On receipt in the office, individual observations made during the measurement are entered to computer and the discharge is re-computed. If the total discharge determined from the two calculations differs, the source of the difference must be identified and correction made. In particular line by line comparisons of the two calculations should be made to identify data entry errors to computer. If none are found, arithmetic errors should be sought in the field calculation. Other potential sources of discrepancy are in the use of the wrong current meter rating in one of the calculations or incorrect entry of current meter rating parameters to the ratings datafile.

Any errors in the field computation should be notified to the field supervisor.

4. Comparison of computed discharge with existing rating curve

Validated gaugings are entered to the stage-discharge summary data file in a form suitable for graphical plotting and inspection. The new gauging can then be compared graphically with existing rating curve and the previous current meter gaugings (Fig. 4.1); a table can also be obtained of the actual and percentage deviation of the gauging from the previously established rating.

Deviations may be due to:

- the reliability of the individual gauging
- the general accuracy with which measurements can be made at a station
- actual changes in the stage discharge relationship

It is important to distinguish the difference. Early identification is necessary so that gauging practice can be adjusted or, in the case of rating changes, so that gauging can be intensified to establish a new relationship.

The percentage deviation of a gauging which requires further action will depend on the physical characteristics of the station and the assumed accuracy with which individual measurements can be made. For example in a station with sensitive control and a regular gauging section and error of ± 5% may be achieved but at irregular sections with erratic velocity distribution an error of ± 10% may be acceptable. In general the individual gauging should be investigated further if the deviation from the previous rating exceeds 10% or, if a sequence of gaugings shows persistent positive or negative deviations from the established rating.

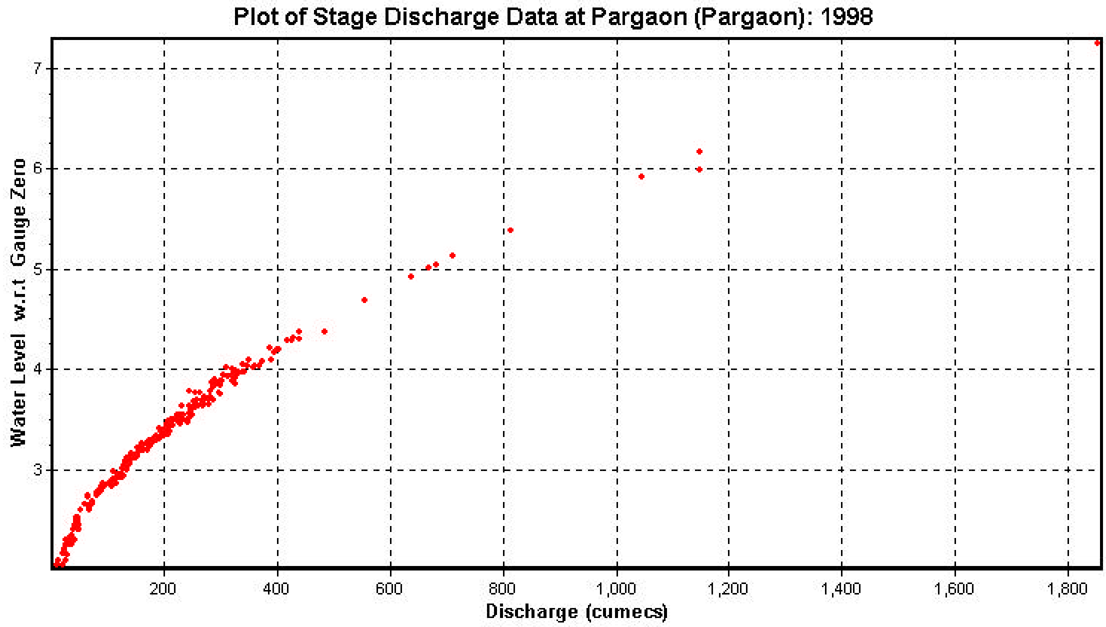

Fig. 4.1: Scatter plot of stage-discharge data

4.1 Deviations due to reliability of individual gaugings

The individual gauging may be unreliable due, for example, to:

(a) an inadequate number of verticals taken to define total area and mean velocity
(b) very low velocities in the section not measured accurately by available equipment
(c) no air/wet line corrections made to depth measurement in high flow
(d) no angle correction for gaugings taken oblique to the flow
(e) a faulty current meter

Items (a) to (d) can be identified from the tabulated gauging. The use of a faulty current meter (e) cannot be so identified but may be identified from field inspection or by persistent differences between the results from the specified meter and other meters at the same station. A plot of cross sectional velocity can be made for individual gaugings and a comparison made between gaugings at the same stage

4.2 Deviations due to physical properties of gauging section

The general accuracy with which gaugings can be made at a station depends to a large extent of the regularity of the bed and banks at the gauging cross section and approach conditions - both bed roughness and the existence of a bend - whether or not these are subject to change. These control the velocity distribution across the section and how it differs from a smooth trapezoidal channel. Irregularities may result in deviation from a typical logarithmic velocity profile in the vertical so that neither 0.6d nor (0.2d + 0.8d)/2 represent the mean flow. They may also cause rapid velocity variations across the section such that the number of verticals chosen may not be an adequate sample to represent the mean flow.

The velocity distribution in the cross section may be investigated by plotting velocity contours or velocity vectors across the cross section if sufficient observations have been made.

4.3 Deviations due to actual changes in the stage discharge relationship

Deviation from a simple power relationship at a gauging station may arise for a number of reasons including the following:

- **Unsteady flow causing hysteresis with rising and falling floods**. This can be identified by plotting the rate of rise (+) of fall (-) during gauging alongside the plotted point on the stage discharge graph. Higher flow for given level may be expected in rising flows when the energy slope is greater but is generally only evident in reaches with low channel slope. **In such cases an unsteady flow rating should be adopted** (module 29)**.**

- **Changes in cross section at the control section due to natural scour or deposition or gravel extraction**. Such changes may be identified by plotting sequential cross-sections for the control section where available but otherwise for the gauging section. It is changes in the control section which are critical, but these are often accompanied by changes in cross section at the station also and these can give an indication of the existence of scour or deposition At least two cross sections are conducted each year before and after the monsoon period. These may be compared. In addition, a cross sectional profile is available from each current meter gauging and these may also be compared and may indicate the presence of scour or deposition at the station. Reference should be made to gauging notes and to the Field Record Book for observations of field staff. **Introduction of a new rating or the use of the shift procedure should be considered.**

- **Discharge for given level may also be affected by downstream bed changes even if no change is found at the station itself**. In channels of low slope the control may extend to many kilometres downstream for which no cross sectional information exists. Comparison of mean velocity between sequential gaugings across the width of the channel at the gauging section will help to identify such changes (though backwater may exhibit the same effect - see below). Scour or gravel extraction downstream will result in increased velocity for given gauge level; bunding and blockage will result in a decrease. Reference should again be made to gauging notes. **Introduction of a new rating or the use of the shift procedure should be considered.**

- **Similarly discharge for given level may be affected by downstream backwater conditions caused for example by a confluence or by tidal effects**. The effect may also be illustrated by comparison of velocity profiles. Unlike the effects of downstream bed changes, the effect may not persist from one gauging to the next. For stations affected by backwater, rating curves with backwater corrections should be applied.

- **Weed growth at or downstream from the station may also be identified by changes in the mean velocity profile across the section**. Weed growth decreases the velocity for a given level. Reference should be made to gauging notes. If weed growth causes significant variation from the mean rating, **the introduction of the shift procedure should be considered.**

- **Where bed profile and mean velocity profiles remain sensibly constant from one gauging to another but the plotted point deviates from the previous rating, then a change in the datum or a shift in the staff gauges should be suspected.** Reference should be made to the Field Record Book and gauging notes. Field staff should be requested to carry out a check survey of the staff gauges. **If necessary a new rating can be introduced with a simple change in the 'a' parameter.**