GOVERNMENT OF INDIA
CENTRAL WATER COMMISSION
CENTRAL TRAINING UNIT

HYDROLOGY PROJECT

TRAINING OF TRAINERS
IN
HYDROMETRY

PROCESSING OF STREAM FLOW DATA

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1. MODULE CONTEXT

This module is categories under "Processing and Analysis of Hydrological Observation Data". This training module is intended for the Engineers involved in Review, Analysis and Processing of the Stream Flow Data

Module	**Code**	**Subject Contents**
1. Processing of Stream Flow Data, Sediment Data, Water Quality Data, Bed Material Data and Meteorological Data		– Describe the methods of Processing of these data for its correctness, consistency, reliability etc. before it is published

2. MODULE PROFILE

Title	:	Processing of Stream Flow Data
Target Group	:	Engineers/Trainees
Duration	:	One session of about 3 hours
Objectives	:	After the training the participants will be able to analyse and process ■ Gauge - Discharge data ■ Sediment data ■ Water Quality data ■ Bed Material data ■ Meteorological data
Key Concepts	:	– Correction and analyse of data entered in various forms, method of processing stream flow data, consistency checks, reliability aspects
Training methods	:	Display, Discussions & questioning
Training aids	:	Overhead Projector, Overhead Sheets, data forms
Handout	:	Copy of main text, Overhead sheets and Data forms

3. SESSION PLAN

Steps to follow	Training Aids
1. Introduction giving the importance and necessity of processing stream flow data	Listing key points on flip chart
2. Discuss with participants their experience and problems in processing data	Listing key points on flip chart
3. Describe the method of processing of • Stage-Discharge Data • Sediment Data • W.Q. Data • Bed Material Data	OHS & Data forms
4. Questionnaire and discussion with participants on the subject	Discussions

3. SUGGESTIONS FOR EVALUATION

1) To check whether the participants have got sufficient knowledge in checking processing and ananlysing various stream flow data collected at H.O. Stations.

2) Whether the participants can analyse and process the collected/available data independently.

3) To check the participants understanding the following questions are asked.

A) STAGE - DISCHARGE DATA

i) What are the basic points need to be checked in a RD-1 data form ?
ii) What are the precautions to be noted while changing a current meter for velocity measurements ?
iii) State the reason for error in Area and Velocity and how is it corrected ?
iv) Explain Back Water Effect ?

B) WATER QUALITY DATA

i) Explain importance of physical, chemical, Biological parameters in reference to various uses of water ?
ii) What is Tolerance limits ?

iii) What is the reason of $\sum$Cations = $\sum$ Anions

C) SEDIMENT DATA

i) What are the precautions required to be taken while collecting sediment samples?
ii) How is Coarse, Medium and Fine Sediment classified?
iii) Explain Q V/s Sediment load graph

D) BED MATERIAL DATA

i) Explain method of sample collection ?
ii) What is Silt Factor ?. What is its physical significance?

INTRUCTORS NOTE

PROCESSING OF STREAM FLOW DATA

1. INTRODUCTION

Hydrological data collected from each hydrological observation station are computed checked, reviewed and published annually. The 12 month period used which is known as Water Year, generally does not coincide with the calendar year. In India, water year runs from 1st June to 31st May. The 12 month record is essentially an inventory of water quantity, water quality and sediment transported at the particular observation station.

At any hydrological observation station generally following observations are conducted :-

(i) Stage-Discharge observation
(ii) Sediment observation
(iii) Water quality observation
(iv) Bed material analysis
(v) Hydro meteorological data

The site-wise data collected regarding all above aspects at various intervals is checked and finalised for publishing it in the relevant year books, i.e. Water Year Book, Water Quality Year Book or Sediment Year Book.

Verification

The reports received from manually observed stations by telephones or other communication channels like wireless need to be checked by a repeat back system.

Valid Status

The station reporting should form part of a standard network accompanied by proper identification with respect to its location, i.e. latitude, longitude, district and state to which it belongs.

Reasonable Report

Improper registering of data includes entering against wrong time and dates alteration of figures etc. Also transmission errors occur while sending the data either through telegram or wireless.

Quality of Data

Quality of data depends on

(i) Method measurement / observation of hydrological data, standards followed, instruments used, frequency of observation etc.

(ii) History of station, particularly shift in the location, causing shift in the rating -curves. Whether discharge data is observed or estimated from the rating curve ?

(iii)Stage discharge curves at discharge site. Extrapolations to be verified by other methods such as hydraulic calculations, etc.

Filling of short data gaps

The following are some of techniques which can be used for gap filling :

(i) Random choice from values observed for that period.
(ii) Interpolation from adjoining values by plotting a smooth hydrograph (for run-off alone)
(iii) Double mass curve techniques
(iv) Correlation with adjoining station either of the same hydrologic element or different hydrologic elements.
(v) Auto correlation with earlier period at the same station.

Consistency of data

(i) Internal consistency check :

The study of consistency of the observed data at specific control points and corrections, if any, made shall be checked and discussed. The check can be done by study of stage discharge relationship for different periods. Large variations, if any, should be investigated, corrected and explained suitably, if required.

Trend analysis should be performed :

- To detect a slow continuous variation of meteorological conditions or a long periodic variation of the climate
- To observe the modification of catchment physiography especially through human activity.

(ii) External Consistency Check :

The consistency of the observed stream flow data should be discussed with reference to the rainfall in the project catchment and observed data in adjacent location/basins.

Note: The consistency can be checked by :

⇒ Comparing monthly and annual rainfall with corresponding run-off.
⇒ Comparing average annual specific flow expressed in depth unit with corresponding figures at other sites of the same river or adjacent basis.

- ⇒ Comparing the hydrographor daily discharge at the control point with adjacent sites etc.
- ⇒ Use of double mass curve techniques
- ⇒ Trend analysis.

(iii) Quality control procedures:

Some of the methods for quality control are -

- ⇒ Testing the stage or discharge of a given day within a year against the highest and lowest value of the same date in all the previous years.
- ⇒ Apply the same test on the difference between the value on the day and the day before.
- ⇒ Comparing observed data with estimates based on data from adjacent stations.

The estimates may be based on regressions. By transforming the data it is possible to increase the weight on high or low values. By plotting the estimates possible errors are easily identified.

- ⇒ Comparing the observed data with estimates based on a precipitation run-off.

- ⇒ Checking for negative values during the computation of inflow to a reservoir when the stage storage relationship and the outflow are known.

- ⇒ Comparing the run-off at a station with run-off at upstream stations.
- ⇒
- ⇒ Applying double mass curve analysis to identify shift in control.

- ⇒ Applying time series analysis to detect changes in the homogeneity in time series. This is a valuable supplement to double mass analysis.

- ⇒ Plotting a graph of the points at which measurements are made and comparison with the original cross section.

- ⇒ Plotting the graph of the annual regime of specific discharges and regional comparison.

- ⇒ Regional comparisons of monthly and annual stream flow deficits.

<u>Adjustment of records</u>

The adjustment of flows to natural and virgin conditions for historical uses in the upper reaches and the manner in which this has been done should be discussed duly supported by the withdrawal data, reservoir operation data and irrigation statistics. Whether adjustments due to upstream storage are made, such storage changes and evaporation losses are to be properly accounted for. Apart from adding upstream withdrawals return flows have to be substracted.

Note:

1. The adjustment of the observed flow data may not be necessary, if

   – The utilisation by upstream projects has been same throughout the period of observation of flows.
   – If the pattern and quantum of usage has not changed appreciably or with a definite trend.

2. Adjustment with the flow records is required in those cases where appreciable changes in land use have taken place.
3. Adjustment of floods and low flows to remove the effect of upstream regulation may be required where this is appreciable.

Secondary processing

Specialisation in secondary data processing include

⇒ Calculation of mean velocity and discharge based on stream gauging.

⇒ Analytical fitting of stag* discharge relations.

⇒ Conversion of stages to discharge.

⇒ Preparation of regular time series containing monthly tables of hourly values with means and extremes annual tables of daily values with means and extremes and miscellaneous graphs showing variations with time.

⇒ Preparation of chronological tables with elementary statistical parameters daily data tables for special comparison, summary tables of monthly and annual value (mean, totals, extremes or frequencies of occurrence) with elementary statistical parameters discharge classified into ranges and probability envelope curves (table and graphs) and characteristic discharges and probability envelope curves, etc.

Analysis of Processed data

The following analysis are normally performed with the processed data:

⇒ Computation of flow duration curves
⇒ Computation of summation and regulation curves
⇒ Computation of the inflow to a reservoir
⇒ Routing of flood through reservoir or river channels
⇒ Unit hydrograph analysis
⇒ Flood forecasting
⇒ Computation of flow frequency curves
⇒ Flood frequency analysis
⇒ Low flow frequency analysis
⇒ Analysis of flood or low after volumes
⇒ Multiple linear regression analysis
⇒ Time series analysis

2. DATAPROCESSING

1. State Discharge Data

The raw stage-discharge data collected at various sites is 100% checked at Sub Division level technically as well as arithmetically. 25% checks are exercised at division level and 10% checks are carried out at Circle level before the data is finalised for publication.

Monsoon discharge data are finalised at Circle level, whereas non-monsoon data is finalised at Division level. The finalised review data is then ready for its publication in Water Year Books.

The accuracy of discharge record is governed by the accuracy with which stages have been recorded and thereafter converted into discharges. The reliability of conversion of stage record into discharge record is affected by:-

a) Stability of stage-discharge relationship
b) The extend to which station rating cure is well defined by discharge measurements.
c) Magnitude and duration of backwater effect, if any.
d) The sensitivity of the cross section to discharge variations.
e) The method and accuracy of the application of the station rating to the record of the stages.

The fundamental aim of processing and checking stage and 'discharge data is for obtaining a reliable stage-discharge relationship. This relationship at every site is generally developed by graphical analysis of discharges measured and corresponding stages records. For this, following points are to be checked in the raw data available in various forms.

1) All the entries in CWC/RD-1 forms are to be checked thoroughly and arithmetically.
2) The method of discharge observation i.e. by wading, by boat, from bridge etc. to be indicated on data sheet along with location of measurement section, i.e. at S.G.line or temporary section etc.
3) For reliability of depth measurements at various sections, if soundings are taken using cable, sufficient fishweight is to be added to keep the cable verticml. In case of echo-sounder depths, it should be compared with those taken by sounding and if necessary, correction to echosounder depths are to be applied. For bridge observations, soundings, taken daily to be compared with the latest available cross section to check he reliability.
4) For checking the velocity measurements, actual spin of current meter before and after use is to be checked (it should be nearly same). Current meter should not be used more than the stipulated number of working hours/days. Whenever new current meter is to be used* comparisons with old current meter for minimum 3 days should be made and the difference in discharge should not be more than $\pm$5%.

Correction of mean velocity is to be applied in case the surface velocity is observed. In case of float observations sufficient number of floats to cover the entire width of the river are to be checked. For unequal segments correction for area and velocity is to be applied.

Velocities observed by the current meter should be checked from the rating chart of the current meter. For float observations, the velocities are to be taken from velocity graphs plotting of velocity graphs is to be checked thoroughly.

All the gauge readings entered in CWC/RDD-1 data to be compared with those entered in CWC/RD-3 and CWC/RD-4 data forms to detect the error, if any, occurred during observation or recording.

The gauge height change during the time required for measurement is also listed, because a rapidly changing stage would adversely affect the accuracy of measurement.

The condition of control, along with zero of gauge is to be noted particularly at the time of low flow measurements.

The stability of rating depend upon the control conditions. The elevation of zero of gauge is highly important for extrapolating the low water end of the rating.

If the gauging station is on a non-perine stream, that goes dry for periods during the year, the list discharge measurements should include chronologically dates of no flow in the stream.

Stage-Discharge Relation :

The Stage-discharge relation is the complex interaction channel characteristics, i.e. cross-sectional area, shape, slope and roughness which is generally called as control. In natural channels, the control may change because of effects of changing channel scour and fill in an alluvial channel, back water rapidly changing stage, variable channel storage, aqua vegetation and the freezing and breaking of ice etc.

After checking and processing of the raw data, next step development of the rating curve using the observed stage discharge data.

The rating curve for a gauging station is the gauging depiction of relation between stage and discharge.

In India, rating curve for monsoon and non-monsoon plotted separately on suitable scale forgetting a good curve.

The points representing falling and rising stages are to indicated in different colours. For comparison, the curves the previous years for the season are to be superimposed.

If few points or group of points lie outside the mean Stage-discharge curve, the correctness of the value of the stage and discharge represented by these points are to be verified corrections made. The points can be either on the left (-ve side or right (+ve side*)* of the mean curve. As discharge is a function of area and velocity, the discarding and determining the scatter points and comparative study of stage-area and stage-velocity curve is to be made.

Error in Area :

One reason is wrong sounding. If the stage-discharge, stage-area and stage-velocity curves are plotted daily and kept up-to-date, this error can be detected on the same day and verified by conducting discharge observation. If it is detected later on then the only alternative is to estimate from the stage-discharge curve.

Area taken from old X-section may vary with the change in river bed. Error can be corrected by re-calculating the discharge using the latest X-section.

Silting at S/G line after floods will show scattered points to the -ve side and scouring to the + ve side. But here the shift will not happen in one day. It will be gradual and instead of one point a group of scattered points will be there.

Error in Velocity :

Reduction in velocity occurs due to rapid fall in stages and vice versa. it increases due to rise in stages. This can be checked from CWC/RD-4 data.

When floats are used it is likely that these did not cover the entire stream uniformly. Sometimes, section with higher velocities will be missed. If this mistake was not noted on the same day, the discharge will have to be discarded and value estimated from S-D curve.

Change in control also affects velocity - construction of bund downstream of S/G line increases the stage. Hence, the same discharge for higher stage given a -ve shift to S-D curve.

Back water effect

This can be easily detected from the study of water slope. Whenever, there is a back water effect, the slope will get reduced and for same stage velocity will be less. Stations located on tributaries close to confluence are always affected by the floods in monsoon. If it has been established that the shift is due to back water effect, the values can be retained with this specific remark.

If there has been no change in area and velocity then it should be seen whether there is a change in the musto bench mark level. Disturbances or sinking of musto bench mark can be determined by connecting with the G.T.S. Bench mark.

3.0 OTHER CORRECTIONS,

If the Stage-Area curve indicates a change, it should be checked up whether the change did occur and whether soundings had been taken or just assumed from pre-monsoon and post monsoon cross section. At sites with rocky bed possibility of change in area is almost NIL.

In case there is an increase or decrease in velocity then the corresponding increase or decrease in area also to be checked. When there is no corresponding increase or decrease in area then there are chances of cumulative errors due to the use of current meters. To avoid this the current meters are to be compared a minimum of three days with a rated one at the time of replacement and the percentage variation to be recorded.

4.0 CONCLUSION

After correction of all errors in the S-D data, the S-D curve can be finalised and drawn. if necessary, the curves can be split up into more than one - each curve valid for a particular period. This happens when the change in river bed after floods are substantial and reflects in the area curve.

In order to study the change in the stage discharge relation the stage discharge curves for the particular season for v&.EA-i1t-.i years are to be superimposed. They should be in different and marking. For studying the shift, the Stage-Area and Velocity curves of the particular periods are to be compared.

When compared with previous years, at some sites the S-D relation changes from year to year. Some places it may be steady. Wherever a stable stage-discharge relation is established, the future analysis of run-off / discharge can be done from the mere observation of stage at these places.

5.0 PROCESSING OF WATER QUALITY DATA

The river and ground water samples collected at water quality stations are packed in ice box and transported to water quality research laboratory (II) within 24 hours of collection for analysis. The analysed results are computed and entered in CWC/RD-14 form. The results of various parameters are checked before they are finalised to publish in a water quality year book.

Basically, the parameters are classified following in groups:-

(a) Physical Parameters : This is the data regarding temperature, pH, specific conductance etc.

(b) Chemical Parameters These include data regarding presence of all chemical compounds, cations as well as anions which are usually present in surface and ground water in the vicinity.

(c) Biological/Bacteriolomical Parameters, : This is the data regarding Dissolved Oxygen (DO), Biological Oxygen Demand (BOD), and Chemical Oxygen Demand (COD), Total coliform, Feacal Coliform, Phytoplankton etc.

(d) Chemical Indices : This include hardness number, S.A.R., R.S.C., as well as water classification indices.

CHART SHOWING THE METHODS AND PROCEDURE OF WATER QUALITY ANALYSIS

Sl. No.	Parameter	Method of Analysis	Brief Procedure of Analysis
1	2	3	4
I.	**Physical**		
1.	pH	By pH meter	Standardise the instrument using 4.0, 7.0 and 9.2 pHBuffer solution. Then take pH of samples
2.	Conductivity	By Conductivity meter	Standardise the instru-ment with standard solution. Take conductivity of the sample
II	CHEMICAL		
1.	Potassium (K+)	By Flame Photo meter	Standardise the instrument for 0 and 100 ppm of K and Na with standard solution ' Then take the reading of the sample. Find the concentration of the sample f rom the standard graph
2.	Sodium (Na+)	By Flame Photo meter	Standardise the instrument or 0 and 100 ppm of K and Na with standard solution. Then take the reading of the sample. Find the concentration of the sample f roe the standard graph.
3.	Calcium (Ca++)	Volumetric Titration	25 ml. Sample + 2 ml. KOH (10%)+ Muroxide Indicator. Titrate this against 0.02 NEDTA Sol. Pink changes to Violet blue.
4.	Magnesium (Mg++)	Volumetric Titration	25ml. Sample + 2. 5 ml. Ammonium Buffer Sol. +2 dropsof Erichrom black T dye (indicator). Titrate against 0.02 N EDTA Sol.Wine red colour charges to Blue or Greenish
5.	Aluminium (Al+++)	Spectrophotometer	25 mi. sample + I MI. Ammonium Acetate Buffer Sol. + 0.5 mi. Aluminon Sol. Take reading after 10 minutes.
6.	Iron (Fe+++)	Spectrophotometer	50ml. sample + 1. 0 ml. HCL (conc) ±1.0 mi. Hydroxyl Amine Hydrochloride – Heat and reduce to 20 ml cool and make the volume 25 ml .by adding distill water + 10ml Ammonium Buffer Sol. +2 ml Phenonthroline. Mix and wait 30 minutes then take reading.

7.	Ammo. Nitrogen	Spectrophotometer	100 mi. sample + 1.0 mi.+ (NH4+) Zinc Sulphate (10%) sol. + 0.5 mi. NaOH (6 N) Sol. Shake and filter 26 mi. Filtrate + 1 drop EDTA Sol.+ 2 mi. Nesslers reagent.Take the reading.
8.	Carbonate (C03--)	Volumetric Titration	25 ml sample + 5 drops Phenolpthalein (indicator). If colour changes to pink, C03--exists. Titrate Vs 0.02 N Hcl. Soc. Titrate till Pink colour disappears.
9.	Bicarnonate (HCO-3)	r Volumetric Titration	In above Sol. (S.No.8) add 2 drops of Methyl Orange (indicator) in the same flask. Titrate Vz 0.02 N HCI. Yellow colour charges to orange.
10.	Chloride (Cl-)	Spectrophotomete	20 mi. sample + 4 mi. Ferric. Alum Sol. + 2 mi. Hg (SCN)2 Sol. Take reading.
11.	Fluoride (F-1)	Spectrophotometer	100 mi. + 5.0 mi. Alizarin red m sol. +5.0mi. Zirconium Oxychloride Sol. After 1.0 hour take reading.
12	Sulphate (S04--)	Spectrophotometer	40 mi. sample + 10 mi. Buffer Sol. + 50 mi. ethanol (95%) make 100 mi. by distill water + 0.3 gm. Barium Chloranilate shake 10 minutes. Filter and take reading.
13.	Nitrite Nitrogen(N02-)	Spectrophotometer	50 mi. sample + 2.5 mi. Sulfanic Acid - wait for 10 minutes + 2.5 mi. N (Nepethel) Ethylene Di-amine Dihydrohlorine. After 20 minutes take reading.
14.	Nitrite Nitrogen (N03-)	Nesslers Tube	10 mi. sample + 16 drops Brucine Alkaloid + 10 mi. H2SO4 (conc) and make to 100 mi. by distil water. Compare the colour with standards.
15.	Phosphate(P04---),	Spectrophotometer	50 mi. sample + 4.0 mi. Ammonium Molybdate Sulpanic Acid Sol. + 0.2 gm. Ascorbic Acid(dry) heat and cool. Take reading.
16.	Silicate (Si03--)	Spectrophotometer	50 mi. sample + 1.0 mi. HC1 (6N! +

			2 mi. Ammonium Molybdate Sol. Wait 5 minutes + 2 mi. reducing agent. Take reading immediately.
III	BIOLOGICAL AND BACTERIOLOGICA L		
1	D.O.	Volumetr ic in Titration OR	Sample BOD Bottle +2.0 mi. MnS04 Sol. + 2.0 ml Alkali Iodide Azide D.O.Meter Sol. Shake + 2.0 mi. H2SO4 (Cone) Take 203 ml Solution from BOD bottle add 5-8 drops of 0.025 N Sodiumthio-sulphate Sol. (Blue colour to colourless)
2	B.O.D	Volumetric Titration OR D.O Meter	D.O. as above, after 5 days of water sample from the incubator at 20 C. The difference is the value.
IV.	TRACE AND TOXIC		
1.	Boron	pH meter	250 mi. sample + few drops of bromothymol indicator + 1.0 ml. H2SO4 (1N) boil and cool. Adjust pH of the Sol. by 0. 5 N NaOH Sol. at 7.0 pH. Add 5 .0 gm of mannitol dry. Add pH to original pH by 0.0231 (N) NaOH. No ml. consumed is equivalent to Boron.

6.0 LABORATORY ANALYSIS AND CONCLUSION

The samples of surface as well as ground water areanalysed stationwise. As per as the analysis and processing of data concerned, predominant cations in river waters are calcim, magnesium, sodium and potassium generally in that order. Chloride, sulphate and bicarbonate are generally the most concentrated anions in river water. River water temperature generally follows the long term average air temperature of the area. Generally, in non-polluted rivers, the dissolved oxygen concentration is near saturation. However, concentrations changing throughout the day. $C0_2$ is usually present in river water upto 10 ppm or more. B.O.D. is generally 1 to 2 ppm for unpolluted river. pH values are generally around 7. Turbidity very high in flood. Quality of ground water is superior to that of surface water in some respects like it is free f suspended solids and objectionable colour. On the other hand it generally contains higher dissolved solids.

During checking an processing of data, if results are found abnormal, the tests are repeated for the particular parameter.

Variations of parameters over a period of time are studied and trends are obtained for each parameter at various locations. The results of the tests carried out are **compared** with the trends obtained. The classification of the river waters of the station is carried out based on the results of various water quality parameters using the classification chart of U.S. Salinity diagram for classification of irrigation waters. The results are also compared with the various tolerance limits f each parameter prescribed by the BIS codes, before publishing Water Quality Books.

7.0 PROCESSING OF SEDIMENT DATA

The sediment data collected at each site is check thoroughly and processed for publication as mentioned below

1) Checking of suspended sediment daily data

The daily suspended sediment data from the sites collected in the form CWC/RD-7 (Daily suspended sediment and CWC/RD-8 (10 daily abstract of suspended sed i me concentration). This data is arithmetically and technically checked in full.

The daily suspended sediment data form contains ~x different grades of sediment i.e. coarse (above 0.2 mm) (0-2 mm to 0.075 mm) and fine (below 0.075 mm) diameter and all these sediments results are recorded in the prescribed form. -9 form contains reduced distance, depth, velocity and volume of -sample collected at that particular R.D. The composite groups for analysis of sediment samples depends upon the quantum discharge. On overleaf of the form, the dissolved mater, concentration, gauge and discharge data and abstract of sediment is entered.

The daily sediment analysis data is being technical checked such as sampling section, mode of sampling, temperature, weather and number of sampling bottles at each R.D. (The collected should be not less than 550 ml. and not more than ml) etc. The discrepancies if any noticed including in 1 arithmetical- calculations are regularly informed to the concerned site-in-charge.

The arithmetical checking of data is done an follows

a) The corrected discharge of each group is compared with RD data and corrections entered wherever needed.
b) The total volume of sediment samples of each group.
c) Group Run-off is checked formula 86.4 x Discharge of each group.
d) The sediment in the group stage is being checked upto 4 decimal places and converted into metric tonnes by the formula given below :

Discharge * Sediment concentration gm/lit x 86.4 = M.T.

On arrival of final figure of M.T. (Additional of each groups) the back calculations for mean concentration of each grade i.e.

M.T./ 86.4 * Discharge = Mean concentration of that grade.

The mean concentration is being rounded off to three decimal places.

The metric tonnes are being rounded off as

i) below 100 - two decimal places
ii) above 100 & upto 999 - one decimal place
iii) above 1000 - rounded off to whole number.

e) The abstract of Gauge Discharge data is compared wit form.
f) The calculations for fine sediment concentration and dissolved material is checked and corrected accordingly
g) The abstract of sediment is checked on the lines of 'd' above and corrected accordingly.
h) After entry of RD-7 forms, the value of each concentration is compared with RD-8 (10 daily abstract corrected wherever necessary)

2. Review of Sediment Data

1) The review of sediment data is completely dependent on review of gauge and discharge data.
2) The corrected discharge figures are taken as standard.
3) Wherever, the observed discharges were corrected, discharge are corrected in the form without changing sediment observations. The sediment load in Metric Tonnes reworked out.
4) On the non-observation days, estimated discharge considered.
5. From the above data, a graph of sediment load in MT/O V/s. Discharge in cumecs are plotted in log-log graph I for individual grade of sediment , for monsoon and non-monsoon period separately.
6) From the above graph, sub curves are plotted for estimating the concentration of sediment for non-observed days,
7) Then the ten daily total, mean, monthly total, monthly r: etc. wee calculated.
8) The sediment concentration is gm/lit. for the monsoon period, 10 daily and monthly total of sediment load in M.T for one year is prepared also the annuals monsoon, non-monsoon run off and sediment yields are calculated in review format along with history sheet etc. publication in the sediment year book.

8.0 PROCESSING OF BED MATERIAL DATA

8.1 Introduction

The importance of investigations pertaining to the material, its composition, movement and progressive variations along the river course cannot be underestimated. Studies mean diameter, type and grade of silt are helpful for correct appraisal of the behavior of rivers such as braiding, scouring, sedimentation etc. which depend on flow velocity, slope of river bed, type of catchment etc. as also quantum and type of bed material.

8.2 Collection

In flowing channel, samples are collected using scoop material sampler in shallow rivers and low velocities. Dredge type bed material samplers are useful for higher depths and velocites. In dry beds the samples are collected by scrappers after pit of about 1 foot depth in river bed. The samples collected dried and then reduced by coning and quartering method. thoroughly mixing, samples are packed in thick cloth bags. details of collection are neatly recorded on the cloth bags. The details of collection are neatly recorded on the cloth bag and the copy of the same is inserted in the bag. Maximum 3 to 5 collected during pre-monsoons monsoon and post-monsoon period. These samples are brought to divisional laboratory for analysis.

8.3 Analysis

The laboratory analysis consist of two parts viz. 1) dry sieving and2) wet sieving

8.3.1 Dry Sieving

The dry sieving analysis is done with the help of sieves different mesh for particle size greater than 0.6 mm dia. Larger sieve is kept on top (25 am) and smallest sieve is kept at the bottom (0.6 am) in descending order. The sample retained on each sieve is collected and weighted separately. The weight of sample passing through 0.6 mm, sieve is noted separately and grams of this is separated for wet sieving.

8.3.2 Wet Sieving

Purie's siltometer is used for wet sieving for particle size distribution below 0.6 mm dia. The horizontal column and trough of siltometer is filled with water and water in the column is held with the help of air tight cork on top. 10 gms of sample is released from the top by cup and cone device and cork is placed immediately on top end. The temperature of the water before inserting the sample is recorded. The bottom trough is rotated at regular interval of time. Thus, 20 different fractions of samples get deposited in 20 different dishes of trough. The samples fractions collected are then transferred into silt measurement tubes and compacted by taping on rubber pad. The volume of each sample is noted separately and all these fractions are collected in a porcelain dish. The sample is -dried and weighed in analytical balance.

CALCULATIONS

The total quantity sieved in grams = (A)
Quantity below 0.6 mm in grams = (B)
= quantity above 0.6 mm in grams = (C)
(A - B)
% Above 0.6 mm = (C) x 100/(A) = (D)
% Below 0.6 mm = (B) x 1.00/(A) = (E)

Sample taken for siltometer analysis 10 gms.

Final weight of sample after drying = (F)
Loss in weight (10 - (F)) = (G)

% Loss in weight in siltometer (G) x (E)/10 x = (H)

% Retained = (E) - (H) = I

Factor = (I)/(F) =(K)
This factor (K) is used for multiplying different values volume obtained in 20 siltometer dishes for obtaining percentage retained on them.

Two different curves are plotted both for dry sieving and siltometer analysis. The values of summation in regular intervals on the curves are read and noted.

The total of all the summation readings of curve = (T)

Highest diameter of the sample + 1/2 of two consecutive diameter intervals = (X)

1/2 of two consecutive diameter intervals/50 x (T) (Y)

Mean diameter of the sample (X) - (Y)

Silt factor = 1.76 x (SQRT(Mean diameter))

8.4 Processing and Publication of Bed Material Data

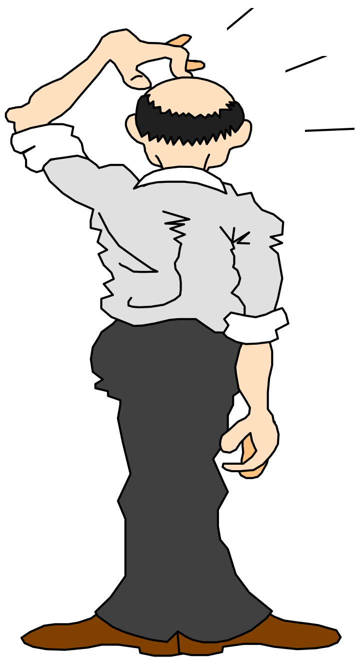
Calculations of each site samples analyzed in laboratory are done separately and total number of samples of a particular period are grouped together. Simultaneously the values of discharge, depth, surface water slope are noted in CWC/RD-12 proforma. Likewise values of all the mean diameters is taken for the calculation of silt factor.

This procedure is adopted for all the 3 season samples namely pre-monsoon, monsoon and post-monsoon. The value of all the 3 season samples are entered in one CWC/RD-12 Form of the year.

The CWC/RD-12 form of all the sites where bed materials are collected are sent together to Circle office for finalisation and publication. Circle office check all the CWC/RD-12 forms thoroughly and publish the same in book form as Bed Material Analysis Book of the year.

OVERHEAD SHEETS

PROCESSING OF HYDROLOGIC DATA



HYDROLOGIC DATA

- STREAM FLOW
- STREAM SEDIMENT CONCENTRATION
- STREAM FLOW WATER QUALITY
- STREAM FLOW WATER QUALITY
- RIVER BED MATERIAL
- METEOROLOGICAL DATA

DATA PROCESSING STEPS

- CHECKING
  - SITE |RD1
  - SUBDIVISION |RD3
  - DIVISION |RD 4
  - CIRCLE |
- ACCURACY
  - ACCURACY IN STAGE OBSERVATION
  - RATING CURVE
  - SENSITIVITY OF CONTROLS
  - OTHER LOCAL EFFECTS
  - METHODS OF OBSERVATION
  - INSTRUMENT NEEDS

DATA PROCESSING STEPS (CONTD..)

- SOURCES OF ERRORS
  - ERRORS IN AREA
  - ERRORS IN VELOCITY
  - BACK WATER EFFECT
  - HUMAN ERRORS
  - OTHERS

PROCESSING OF WATER QUALITY DATA

- PHYSICAL PARAMETERS
- CHEMICAL PARAMETERS
- BIOLOGICAL PARAMETERS
- TRACE ELEMENTS

CONSISTENCY CHECKS

$\bar{\text{C}}$ATIONS = ANIONS

- TOLERANCE LIMITS
- US SALINITY DIAGRAM -COMPARISON (CLASSIFICATION)

PROCESSING OF SEDIMENT DATA

- **DATA COLLECTED**
  - RD-7 FORMS
  - RD-8 FORMS
  - COARSE MEDIUM FINE
    >0.2MM 0.2-0.075 <0.075
  - DISCHARGE DATA
- **ARITHMETIC CHECKS/CALCULATIONS FOR CONCENTRATIONS**
  - COMPARISON OF Q WITH RD-1
- **RD-7 (DAILY) AND RD-8 (10 DAILY)**
- **REVIEW**
  - DEPENDS ON Q DATA
  - CORRECTED Qs ARE TAKEN
  - NON OBSERVATION DAYS -COMPUTED Q IS TAKEN
  - Q V/S SEDIMENT LOAD
  - 10 DAILY, MONTHLY AND MONTHLY MEAN SEDIMENT LOAD
- **PUBLICATION**

PROCESSING OF BED MATERIAL DATA

- SAMPLE COLLECTION
- GRAINSIZE ANALYSIS - SIEVE > 0.6 MM
  SILTOMER < 0.6 MM
- MEAN DIAMETER
- SILT FACTOR