Surface Water Data Processing Using SWDES

A.K. LOHANI
National Institute of Hydrology, Roorkee

GENERAL

Hydrometeorological data collected from various sources/instruments are generally raw in nature and as such can not be used for most of the hydrological analysis. The Hydrometeorological data collected from the field are required to be computerised. Furthermore, the primary validation of the computerised data is needed for its checking ensuring the quality. The secondary processing is required for bringing the data in the desired format for the hydrological studies. Therefore, primary as well as secondary processing of such data are essential requirements to make them usable for various studies.

Data processing is a broad term covering all activities from receiving records of observed raw data to making them available in a usable form. The raw data are in a variety of formats such as hand-written records, charts and digital records. Raw data as observed and recorded may contain many gaps and inconsistencies. These raw data are passed through a series of operations, typically: data entry, making necessary validation checks, filling missing values in a data series, processing of raw data to estimate required variables, compilation of data in different forms and analysis of data for commonly required statistics etc.

The rapid advance in computer technology, in hardware speed of operation and data storage capacity as well as the capability of hydrological software has greatly simplified the management of large quantities of hydrological data and has rendered obsolete those time-consuming manual methods which were formerly the norm. Computer-based hydrological information systems offer various advantages viz., to permit and promote the standardisation of processing, validation and reporting procedures; to handle very large amounts of data and users can be provided with data in the required tabular or graphical format

Surface Water Data Entry System (SWDES) was initially developed under Hydrology Project and introduced in 1999. The prime objective of this data entry software is to provide sufficient facilities for entering all types of meteorological and hydrological quality and quantity data. Primarily, the software provides suitable facilities for entry of rainfall, water level, stage-discharge, water quality, sediment and climatic data as observed by surface water agencies. The data so entered using this software is subjected to essential data entry checks so that the possibility of committing mistakes is minimized. The graphical interface so provided gives added advantage of visual means of validating the entered data. The software is primarily used for entering the historical and current data, available with various agencies in huge volumes. All the data thus available in databases, associated with this software, are finally exported to the databases of the dedicated Hydrological Surface Water Data Processing software for further necessary data validation and processing. In other words, this software provide a kind of front end for the data entry personnel for entering and preliminarily validating all types of meteorological and surface water quality and quantity data.

HYDROLOGICAL DATA PROCESSING

The term hydrological data processing refers to the recording and handling of hydrological data that are necessary to convert it into more refined or useful form of information.

The volume of data has grown to such proportions that data processing has become a major activity attracting a great deal of interest. The data processed should not be taken as an end in itself. It is rather the beginning step of achieving objectives which can vary as the nature of data. The objectives of data processing now extend for beyond the routine handling of transaction documents and records of other types, providing timely information to facilitate greater control and improved decisions.

The data processing activities which come in cyclic way is called data processing cycle. In the data processing cycle first the information are gathered for data processing work. This is known as origination and collection. Then the collected data is considered as input for the processing. Subsequently it is stored for further processing and retrieval. The result and information obtained, as the products of data processing are subjected to feed back, which can be either negative or positive. Depending upon the type of feed back, corrections or modification are incorporated to get the new system. The obtained new system may be run for the subsequent operations. The data processing life cycle activities are illustrated in Fig. 1.

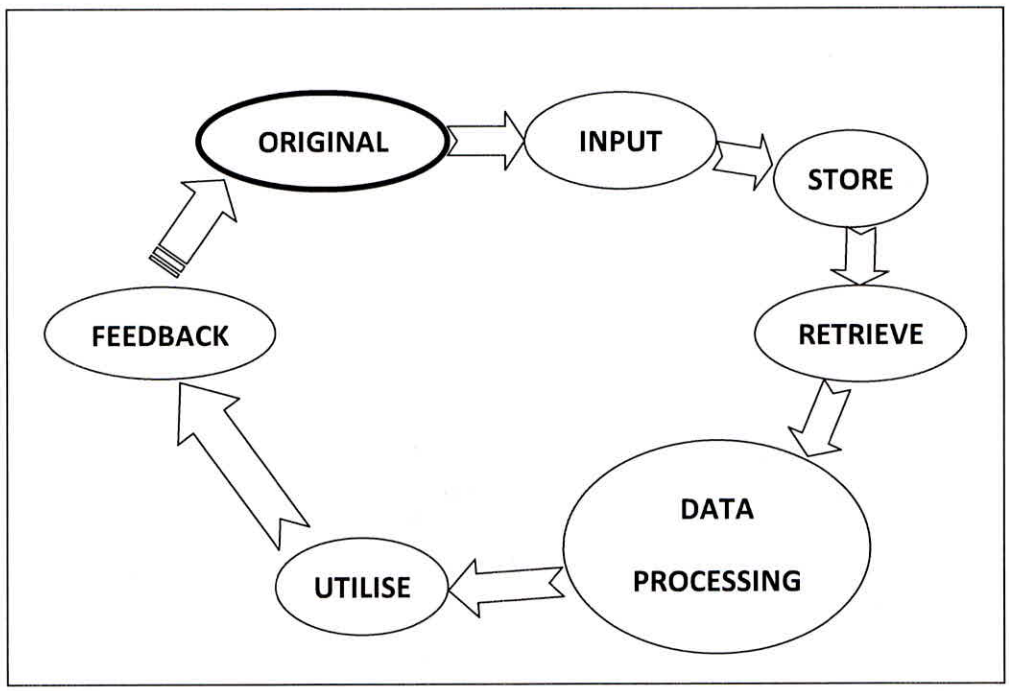

Fig. 1 An illustration of data processing life cycle activities

FEATURES OF SWDES SOFTWARE

The software is primarily oriented towards easy and reliable data entry options for various hydro-meteorological quality and quantity variables. It organizes the data into well-defined databases using concept of relational database systems. The main features of the software are highlighted as given below.

- **User Authorization** Adequate facility for user authorization and identification is available. Number of users can be authorized by the system manager for working with the software with varying level of authority.
- **Organized Databases** The data pertaining to different sub-basins or offices or periods can be organized in separate databases (referred as Work areas in the software) in a well-organized and methodical way.

- **Extended Data Types** A comprehensive set of variables is available in the program. The characteristics like description, unit and type of measurement of the variables are also maintained. Adequate flexibility is provided for adding new data types in the program.
- **Master Information** The software maintains a set of important hierarchical information on administrative and drainage boundaries and that on the offices controlling various observation stations. This master information helps in avoiding duplicate entries and wrong spellings for the same item in the database and at the same time the user is not required to waste time every time in keying-in the same information. The required item can be chosen simply by clicking it from the available list. Adequate facility is available in the system to extend or modify this type of information.
- **Static/semi-static Data** The software provides for the entry of necessary characteristics associated with the observation stations. The data pertaining to various variables is stored under well-defined data series, which also have useful characteristics, associated with them. The data on current meters and setting of the zero of the gauge for different validity periods, cross-sectional profiles etc. are also stored in an organized manner.
- **Data Entry Screens** A number of user-friendly data entry screen layouts are available that are appropriate for data pertaining to different types of variables and time intervals.
- **Data Entry Checks** Adequate facilities are built into the system for providing a number of data entry checks so that the amount of data entry errors can be reduced to a very low level. Sufficient flexibility is available in the system for making these data entry checks more effective.
- **Graphical Options** Facility is provided in most of the data entry options to make plots of the data being entered. This provides the users a very convenient way to graphically visualize the entered data, which thereby will help in reduction of errors in data entry.
- **User Friendliness** The software provides sufficient level of user friendliness while working with it. Most of the work is accomplished by choosing an item by clicking it from the available lists. Only the actual data to be entered are required to be keyed-in using the keyboard. Most of the actions are performed by choosing an option by clicking appropriate buttons. Suitable error and help messages are displayed for guiding the user to work with the software.
- **On-line Users' Manual** The software provides the contents of the user manual on-line. Appropriate portions of the manual are displayed on the basis of screens from which the help is invoked. Flexible and faster navigation facilities are provided, using hypertext, to browse through the manual conveniently.

Login for user authorization

After the start of the program the first screen displayed is the login window. The user has to enter the username and password to be able to work with the software. After installation, the user can use **"ADMIN"** and **"ADMIN"** as the username and password respectively for entering into the program. This initial user profile can be deleted by the administrator, if desired, and new profiles can be created for user authorization. The user is also required to select the desired database from the list of available databases. In the beginning, a sample database is available to the user. At this stage, the login can be accomplished by clicking the "O.K." button. The layout of the login window is as shown in Fig. 2.

Executing various options and entering data

After successful login into the program, various options have to be chosen, executed and data has to be entered. Any command or action is carried out by either choosing a menu item or

pressing a button. The data is entered from suitable data entry forms. A brief description about working with menu items, buttons and data entry forms is given below.

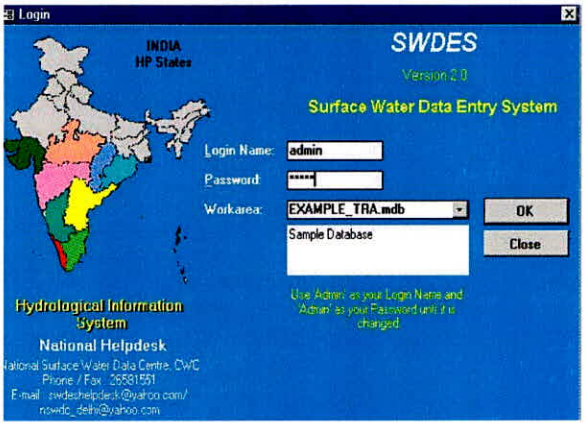

Fig. 2 Layout of the login screen of SWDES

Menu items

The main options available in the program are listed as different menu items in the program window (also called as **main switchboard**). Any menu item can be invoked by clicking on the button associated with it. The options on the main switchboard lead to another menu screen, called the **secondary switchboard**, for selection of the desired sub-option. The hierarchical layout of these menu items is as given in Table 1.

Table 1: Hierarchical layout of menu items on main and secondary switchboards

Main switchboard items	Corresponding items in secondary switchboards
1. Static/semi-static characteristics	1. Station characteristics
	2. Series characteristics
	3. Current meter characteristics
	4. R L of gauge zero
	5. X-section data
	6. Salient features of reservoir/diversion scheme
	7. Elevation-Area-Capacity data
2. Meteorological data	1. Rainfall – Daily
	2. Rainfall - Twice daily
	3. Rainfall - Hourly
	4. Climatic – Daily
	5. Climatic - Twice-daily
	6. Pressure/Temperature/Humidity – Hourly
	7. Sunshine duration - Hourly
3. Hydrological data	1. Water level - Multiple times a day
	2. Water level - Multiple times a day & temperatures
	3. Water level - Hourly
	4. Flow measurement data
	5. Summary stage-discharge data
	6. Reservoir/diversion scheme data
4. Sediment data	1. Summary suspended sediment data
5. Water quality data	1. Laboratory information
	2. Parameter information

Main switchboard items	Corresponding items in secondary switchboards
5. Water quality data	3. Sample collection information
	4. Sample data entry & validation register
	5. WQ reports
	6. WQ graphs
	7. WQ options
6. Data validation	1. SRG & ARG data
	2. SRG (Twice daily) & ARG data
	3. ARG & sunshine duration data
	4. SRG data – Multiple stations
	5. Water level (Multiple times-a-day) – Multiple stations
	6. Water level (Hourly) – Multiple stations
	7. Climate data (Daily) – Multiple stations
	8. Climate data (Twice daily) – Multiple stations
7. Utilities	1. Data availability
	2. Block deletion of data
	3. Report on remarks
	4. Export of data
	5. Import of data
	6. Change switchboard items
8. Change work area/ Exit SWDES	

The layout of the main menu screen (main switchboard) is as shown in Fig. 3. The screen displays a number of menu items. Fig. 4 displays the secondary menu screen (secondary switch board) corresponding to the main menu item "Entry of Meteorological Data". Similarly, other menu items also have secondary switch boards or menu screens.

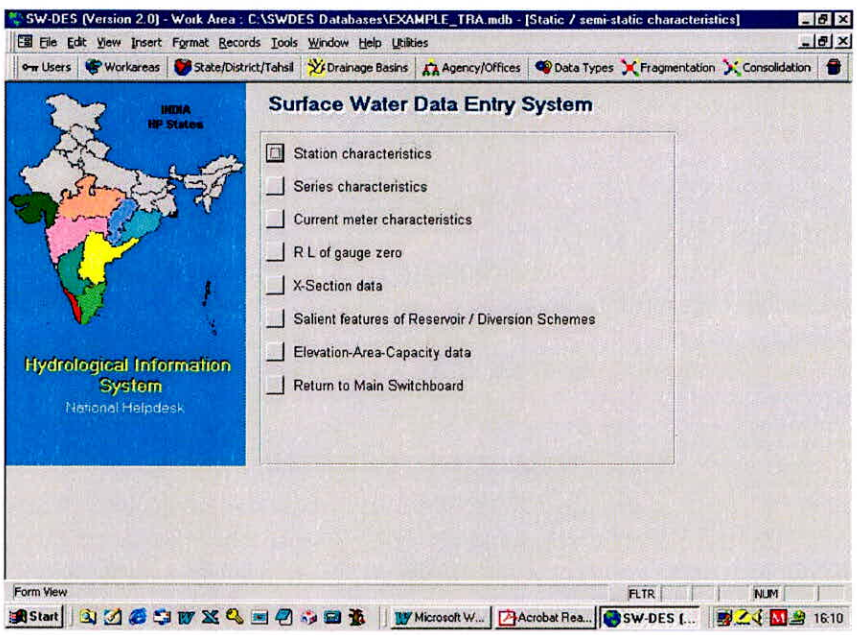

Fig. 3 Main switchboard displaying various menu items and buttons

The text of the menu items and their locations on these switchboards is changeable by choosing the option of **"Change switch board items"**. The last option on all secondary switchboards, **"Return to main switchboard"** brings the control to the main switchboard. The

option on main switchboard, **"Switch to another work area"**, closes the current database and brings the control to the login screen again. The user may choose another database from this screen and press "O.K" to work with the selected database.

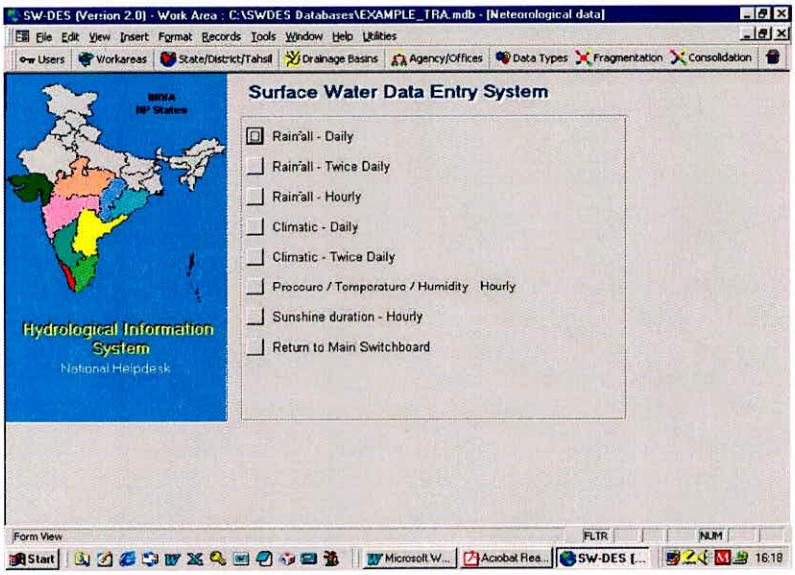

Fig. 4 Secondary switchboard displaying various menu items and buttons

Data entry forms

The data entry is made by invoking the desired data entry form by clicking on the relevant menu item or button. A number of dedicated data entry forms are available for the entry of various types of data. These forms can be categorised in two major groups: one for the entry of **master information and static/semi-static data** and other for all types of **meteorological hydrological, sediment and water quality data**. Typical example forms for both these categories are shown for the purpose of illustration in Fig. 5 and 6 respectively.

The layout of the forms for static/semi-static data typically has a list box in the left and the main area for entry of various fields. This list box displays all the records available in the database pertaining to that category. The current record being displayed is highlighted in this list box. The navigation buttons help in going to the desired record. The main area of the form comprises of several data entry fields pertaining to that form. Entry of data is accomplished using keyboard and navigation to different fields is done using "Tab" or "Enter" keys or with the help of the mouse.

Forms for entry of surface water data have three major functional parts. The first part is the portion of form showing the identification of the station and series and its associated series characteristics. Only the desired station and/or series is to be chosen from the available list and thereupon the associated characteristics are displayed. There is absolutely no necessity of making any data entry in this portion. The second part is the main area in which the appropriate tabular grid is displayed for making the required data entry. Suitable captions for all columns are displayed for easy identification and understanding. The dates, hours or timings are automatically filled up by the program wherever desirable. This avoids any error in the dates/hours and at the same time reduces the amount of data entry operations. The third portion of the form is for entry of certain averages or totals which are available in the manuscript. This allows data entry checks to see if these manuscript entries match with what has been entered in the form. Apart from this the form also has two fields for specifying the year and month for which the data has to be

entered or edited. Easy pull down list for the months and navigating buttons for years are available to specify the desired year and month conveniently and swiftly. These data entry forms also have several buttons on the toolbar as described earlier for adding records, making graphs and reports, checking data entry errors, navigation etc.

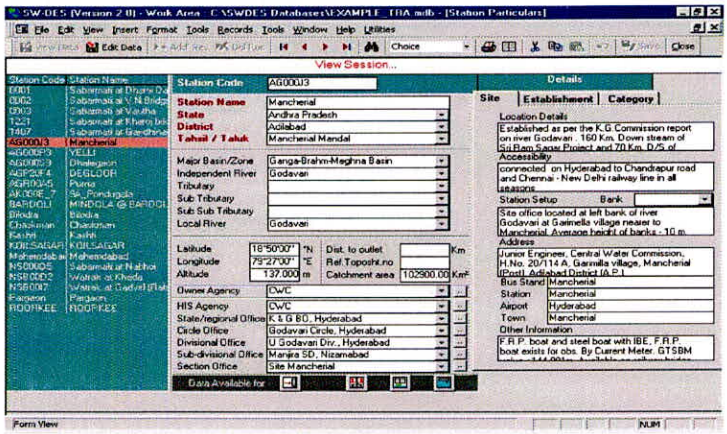

Fig. 5 Form for entering station characteristics alongwith various buttons on the toolbar

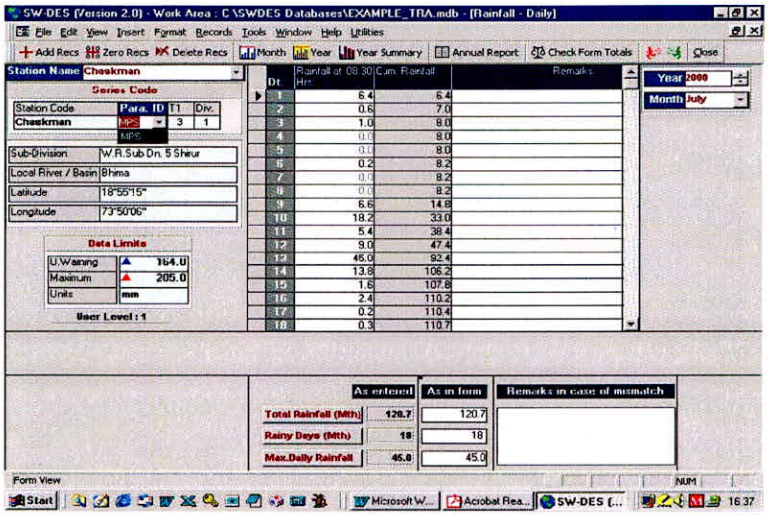

Fig. 6 Form for entering daily rainfall data alongwith various buttons on the toolbar

Creation of work areas

The data pertaining to different sub-basins or administrative set ups or periods can be organized in separate databases called **"Work Areas"**, in a well-organized way. For this, any number of work areas can be created and maintained. The option for defining, editing or deleting the work areas is given only to the database administrator, that is, to User Level 1. Defining and maintaining work areas is accomplished using **"Work Areas" button**. This button initiates the **"Work Area Definition" form** as shown in Fig. 7.

The available work area list is displayed at the left side of the form in the form of a list box. Definition of any work area can be viewed by using the navigating buttons. For creating a new work area, "Add Record" button is clicked after the form has been brought in the edit mode. There are three fields required for the defining the work areas as below.

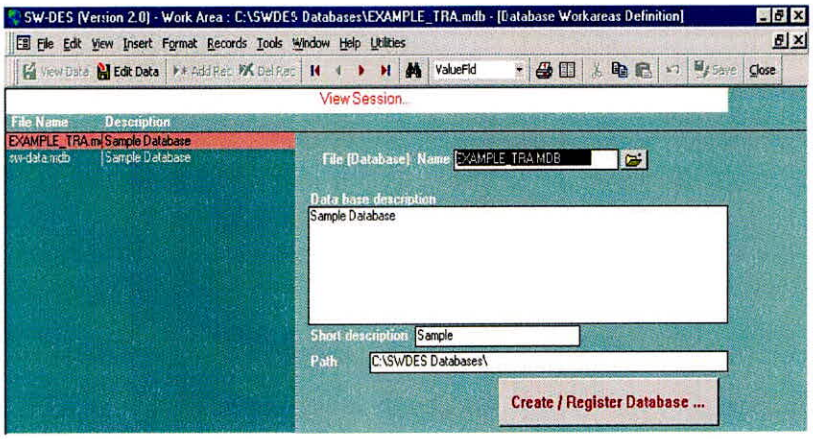

Fig. 7 Layout of Work Area Definition form

Filename This is the name of the file in which all the data pertaining to individual work area is stored. The structure of the file is that of a MS Access database file and therefore an extension ".mdb" is given at the end of the filename.

Description This field is for indicating the full name or description of the work areas and does not have any limitation of length of description. This description is given in a way that the work area is conveniently recognised.

Short Description This field is to indicate in short the identification of the work area. This short description will be always be displayed on the top of the program window to enable the user to know which work area is active.

Entry of data types

A number of variables are observed with the help of hydrological and meteorological network at several locations. It is also very important to note certain key characteristics of these variables. Characteristics like description, unit and type of measurement of the variables are also maintained. Defining and maintaining data types is accomplished using **"Data Type" button** available on the main switch board. This button initiates the **"Data Type Definition" form**. The available data types are listed on the form. Characteristics of any data type can be viewed by using the navigating buttons. For creating or deleting a data type, "Add Record" or "Delete Record" button is clicked respectively, after the form has been brought in the edit mode.
Four fields required for defining a data type are explained below:

Parameter ID Parameter identification code is a three character code used to uniquely define any parameter. No two parameters can have the same identification code and this integrity is maintained by the system automatically. This characteristic being the primary field is obviously mandatory to be supplied by the user.

Description Full description of the variable is given for explaining its exact meaning. Sometimes, a variable is observed by different methods/instruments and since it is required to keep these data separately, it is desired to codify them differently. In such cases, the codes themselves are a little obscure to understand, the description of the variable helps in knowing its meaning appropriately. A length of 30 characters is reserved for stating the description of the variable.

Units of measurement Every parameter is characterised with the units of measurement. This is a very important characteristic of the parameter since the quantitative interpretation of every data in a series depends on the units of measurement used. For a specific data type only one unit applies. A list of commonly used units is provided by the program. The desired units can be entered by clicking from the available list or entering it using keyboard, if not available in the list. A length of 15 characters is reserved for stating the units of measurement.

Type of measurement Measurements on various variables are either accumulative, instantaneous or constant in nature and is very important to know it. An **instantaneous type** of observation indicates the instantaneous value of the parameter at the time of measurement. On the other hand an **accumulative type** of observation gives the accumulated amount of the quantity being measured since the last measurement was made. **Constant type** of observation are made for those quantities which change only due to some artificial or man made interventions. In other words, it can be stated that the constant type of measurement remains constant till the next measurement is made. This distinction in the type of observation is of utmost important while compiling one data series into another data series with different time intervals. This field can be entered by clicking the appropriate choice of type of measurement out of all the three listed by the program.

A standard and **comprehensive list of data types** is included in the program. This list can not be modified by any user in any way so as to avoid ambiguity in interpreting the standard data types. Adequate flexibility is however provided for adding new data types, if required. The option for defining new data type or editing an existing one (except for the standard data types) is given only to the Level 1 users. Once a parameter is defined with the help of Parameter ID, its description, units or type of measurements is editable and thus can be changed later, if desired.

Entry of daily rainfall data

First of all, as stated earlier, the series in which the data is to be entered has to be initialized, in case it does not exist in the database. The initiation of series requires selection of the combination of station, parameter and time interval. The parameter for rainfall observed using a standard non-recording raingauge is **"MPS"**. The time interval code for daily data is **"3,1,0,0"** and the time label has to be the standard time of observation, i.e. 0800 hrs or 0830 hrs as per the case. The form functions for any parameter ID with the first two characters as **"MP"**. The layout of the daily rainfall form is as shown in Fig. 8. The form displays information regarding station code, station name, sub-division and local river/basin.

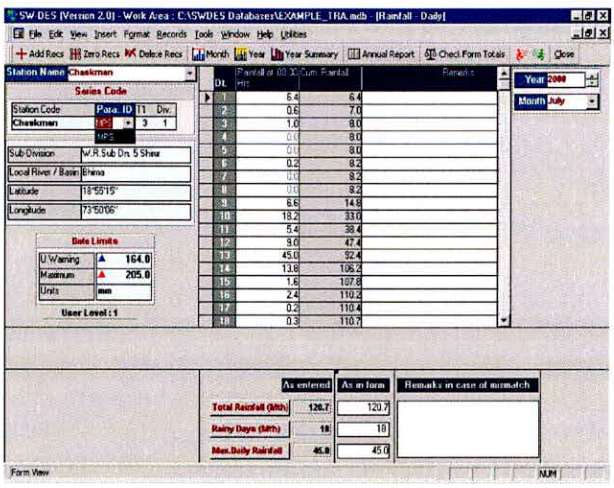

Fig. 8 Form for entry of daily rainfall data.

Two data limits: (a) Upper warning level and (b) Maximum value alongwith units of measurement are also displayed on the screen. The year and month of the data displayed on the screen at any point of time are also displayed for reference purpose.

There are four columns for the date, daily data, cumulative amount within the month and remarks respectively. The dates are filled automatically as per the month and year. The data corresponding to each day is to be entered by the user. The cursor goes in vertically downward direction by default after each data entry. As the entries are made the cumulative amount within the month is computed and filled automatically. If any remarks are to be entered the same can be done by going to the specific date by using mouse. At the bottom of the form, for each month, the number of rainy days, total and maximum rainfall for the month as available in the manuscript has to be entered. A rainy day is defined here as that day on which the rainfall is more than 0.0 mm. The computed values of these quantities as per the entries by the user are automatically filled.

Graph Options

During the process of making entries the user can draw the graph for the data being entered. There are three options: (a) to plot the data of the month for which the entries are being made and (b) to plot the data of the entire year for which the data is being entered and (c) to plot the yearly summary in the form of monthly totals. For the first two graphs facility is available for obtaining the plot with or without warning level using a convenient toggling option from within the graph. For the graph for the month, user can navigate through different months in the year to see the corresponding plots without leaving the graph. Similarly, for the graph for the year, user can navigate through different years to see the desired plots without leaving the graph.

Data Entry Checks

Two types of data entry checks are performed for this case of daily rainfall data. First, the entered daily data can be compared against upper warning level and/or maximum value. This allows the users to quickly know which data value has violated the prescribed limits. The user is prompted of such violations by simple flags that are indicated together with the respective data limits. Upon such prompting the user can once again refer back to the manuscript to see if there was some mistake in entering the data. If such values which violated the prescribed data limits are found to be actually reported in the manuscript then the user can put suitable remarks to indicate so. The second type of check is carried out to see if there is a proper match between the entered and computed values of no. of rainy days in the month, maximum and total rainfall in the month. This check is performed using the "Data Entry Checks" button. In case of any mismatch the user is prompted suitably so that the entries can be checked back. If cumulated values of daily series are also available in the manuscript then it becomes faster to pin down the mistake. Scrutinizing and checking the daily rainfall data month by month in this manner will leave little scope of any data being wrongly entered.

Entry of twice daily rainfall data

The parameter for rainfall observed using a standard non-recording raingauge is "MPS". The time interval code and time label for twice daily data for observations taken at 0800 hrs and 2000 hrs is "3,2,0,0" and 0800 and 2000 hrs respectively. For the series for which the observations are taken at 0830 hrs and 1730 hrs the time interval code and time labels will be "3,2,C,C" and 0830 hrs and 1730 hrs respectively. The form functions for any parameter ID with the first two characters as "MP". Entry of hourly rainfall data Hourly rainfall data is obtained either from the chart records of the autographic type recording rain gauge or by the digital data obtained from a tipping bucket raingauge (TBR). The parameter for rainfall observed using an

autographic raingauge is "MPA" and for the digital records from a TBR is "MPD". This hourly data is reported for each clock hour starting from the 0010 hrs and ending at 2400 (i.e. 0000 hrs). Each hourly data represents the amount of rainfall recorded during the hourly intervals ending at each of these clock hours. The time interval code for these hourly data series is "4, 1, 0, 0". The form functions for any parameter ID with the first two characters as "MP".

The data originating from data loggers, in digital form, can directly be imported into the database. However, the option of entering the digital data using this form can also be made use of, if required in certain circumstances. Moreover, after the data has been imported it can be inspected graphically and validated for certain limit checks using this form. The layout of the hourly rainfall form is as shown below in Fig. 9.

Data Entry Checks

Two types of data entry checks are performed for this case of twice daily rainfall data. First, the entered daily data can be compared against upper warning level and/or maximum value. This allows the users to quickly know which data value has violated the prescribed limits. The user is prompted of such violations by simple flags that are indicated together with the respective data limits. The second type of check is carried out to see if there is a proper match between the entered and computed values of totals for each column, no. of rainy days in the month, maximum and total rainfall in the month. This check is performed using the "Data Entry Checks" button. In case of any mismatch the user is prompted suitably so as to check back the entries. If cumulated values of daily series are also available in the manuscript then it becomes faster to pin down the mistake. The checks, both on columnar totals and number of rainy days, monthly maximum and totals, provide adequate data entry checks and enables faster tracking down the errors. Any mismatch remaining after a thorough checking with the manuscript must be suitably communicated to the observer by writing an appropriate remark in the space provided for it. As for the daily rainfall form this form also displays the information regarding station code, station name, sub-division and local river/basin. Two data limits: (a) Upper warning level and (b) Maximum value alongwith units of measurement are also displayed on the screen. The year and month of the data displayed on the screen at any point of time are also displayed for reference purpose.

The hourly rainfall data is entered in a form of a matrix in which the columns are the hourly rainfall values for a day and the rows represent different days of the month. The entries for the dates and hours are filled automatically. All the hourly values are entered by the user by navigating horizontally across the days. At the end of each day's entry the cursor moves to the column for entering the daily totals as available in the manuscript. At the end of the last entry for the last day of the month, the cursor moves to the cells for entering the columnar totals for each hourly observation for the month as available in the manuscript. In the last, the monthly total as available in the manuscript has to be entered. The computed totals for each day, each hour across the month and for the month are filled automatically in the respective cells. Similarly, the maximum hourly rainfall recorded in the month and numbers of rainy days in the month are entered as available in the manuscript. The corresponding totals are computed and filled automatically by the system. The remarks, if available in the manuscript, can be entered on the daily basis.

Graph Options

There are three options for the graphical display of data: (a) to plot the data of any day from 0100 to 2400 hrs. in the form of hourly bar chart form (only for cases when the tabulation is not for standard hours (i.e. 0830 hrs to 0830 hrs next day), (b) to plot the data from 0830 hrs on any day to 0830 hrs of the next day in hourly bar chart form and (c) to plot the tabulated rainfall

data back in the form of a continuous trace so as to replicate that obtained by the autographic chart recorder. The least count of the simulated trace, of course, remain 1 hour which is the interval of rainfall tabulation).

The latter option is very useful in comparing the entered data with the analogue chart records. The user can navigate through different days in the month to see the corresponding plots without leaving the graph.

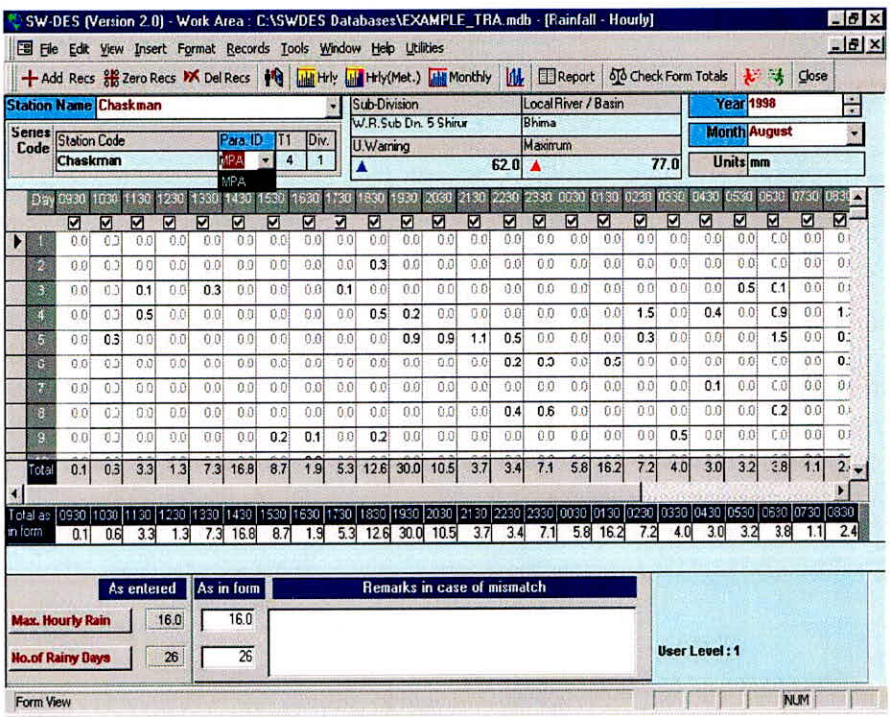

Fig. 9 Form for entry of hourly rainfall data.

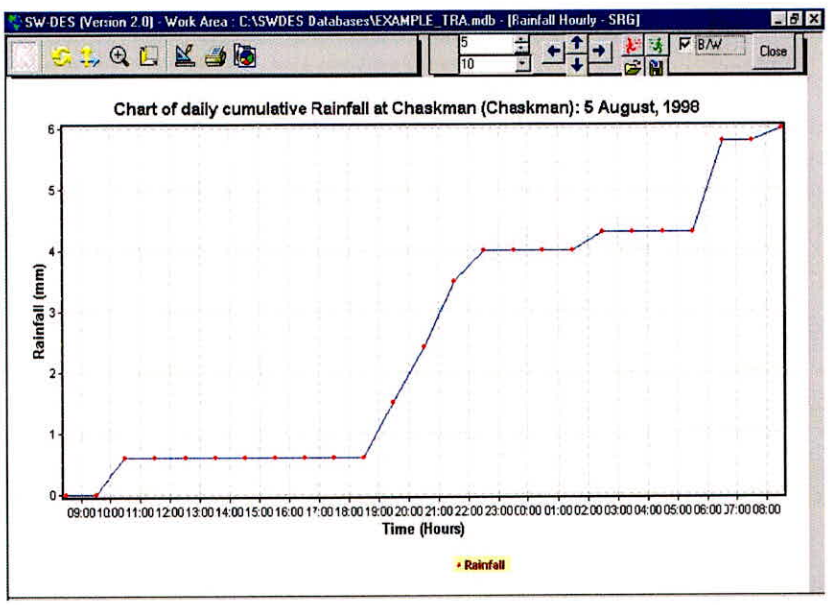

Fig. 10 Plot of hourly rainfall simulated as observed by the analogous chart recorder

Data Entry Checks

Four types of data entry checks are performed for this case of hourly rainfall data. First, the entered daily data can be compared against upper warning level and/or maximum value. This allows the users to quickly know which data value has violated the prescribed limits. The user is prompted of such violations by simple flags that are indicated together with the respective data limits. The second check is carried out to see if there is a proper match between the entered and computed values for daily total for each day. Next, the check is made to see if the entered and computed values for total for each hour across the month are in agreement. In the last, the monthly total rainfall, the no. of rainy days in the month and the maximum hourly rainfall in the month are checked. These checks are performed using the **"Data Entry Checks" button**. In case of any mismatch the user is prompted suitably so as to check back the entries.

Entry of daily climatic data

The station for which the data is to be entered is selected first. The parameter codes for climatic parameters observed using a standard non-recording equipment for rainfall, dry bulb temperature, wet bulb temperature, minimum temperature, maximum temperature, pressure, relative humidity, instantaneous wind speed, average wind speed, wind direction, pan evaporation and temperature of pan water are **MPS, MTD, MTW, MTN, MTX, MBS, MHS, MWI, MWS, MW1, MEP and MTW** respectively. These data types are also displayed in the form of **a pop-up message box** whenever the cursor is rested on the column title for a while. Units applicable for these data types are also mentioned with the title in each column. The time interval code for daily data is **"3,1,0,0"** and the time label has to be the standard time of observation, i.e. 0830 hrs. The layout of the daily climate data form is as shown in Fig. 11.

The form displays the information regarding station code, station name, sub-division and local river/basin. The year and month of the data displayed on the screen at any point of time are also displayed for reference purpose.

The first column is for the date and then there are as many columns as the parameters. There is facility available for switching off/on any column (using toggle buttons given above each column), if that type of data is not available at certain station. In such case the cursor will jump over this inactive column to go directly to the next active column. The data corresponding to each day is to be entered by the user. The cursor first goes horizontally to each column and then goes to the next day. If there is any remark to be entered the same can be done by going to the specific date by using the mouse. At the bottom of the form, the monthly total/average for each parameter, except wind direction, as available in the manuscript, has to be entered. The computed values of these quantities as per the entries made by the user are automatically filled.

Graph Options

During the process of making entries the user can draw the graph of the data being entered. Graphs are available for plotting (a) pressure, (b) minimum and maximum temperature (with dry bulb temp. superimposed), (c) relative humidity and difference of dry and wet bulb temperatures, (d) dry and wet bulb temperatures, (e) relative humidity, (f) rainfall, (g) instantaneous and average wind speed, (h) pan evaporation and (i) pan water temperature. These combinations also help in ensuring the consistency between different variables. Any individual variable can also be plotted if required using a separate option. Data for instantaneous variables (e.g. dry bulb temperature are plotted as line graphs; data for cumulative variables (e.g. pan evaporation) are plotted as bars. Fig. 12 illustrates graphs for wind rose diagram.

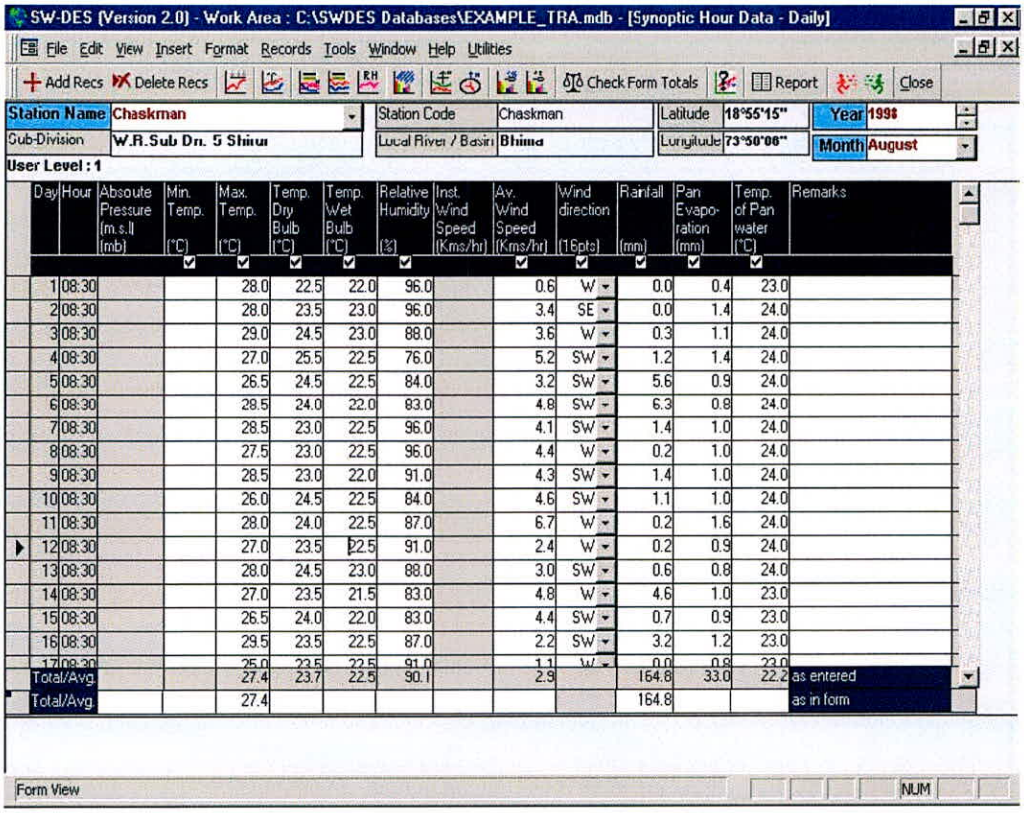

Fig. 11 Form for entry of daily climatic data.

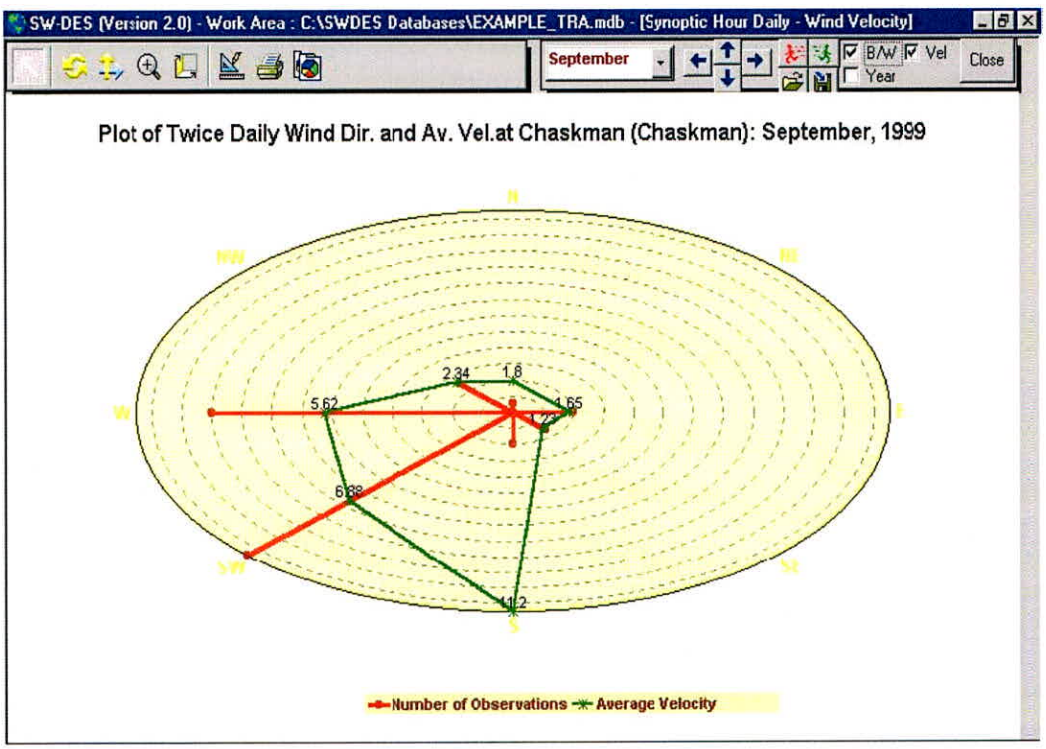

Fig. 12 Plot of wind rose diagramEntry of multiple times a day water level data

Water level at a few instants in a day is generally directly observed using staff gauge. First of all, the series has to be initialized, in case it is not existing in the database. The initiation of series requires selection of combination of station, parameter and time interval. The parameter code for water level with respect to gauge zero observed using a staff gauge is **"HZS"**. The time interval code for daily data is **"3,1,0,0"** and the time label has to be the standard time of observation, e.g., **0800 hrs** etc.. In most cases of multiple water level observations, the observations are taken in day hours only and thus results in a cyclic type of time series. For example, the time interval code for a series having three observations in the day at 0800, 1300 and 1800 hrs. will be **"3,3,C,C"** with three time labels **as 0800, 1300 and 1800 hrs**. Data for up to four observations a day can be entered using this form. The form functions for any parameter ID having first two characters as **"HH or HZ"**. The layout of the form for multiple water level observations is as shown below in Fig. 13.

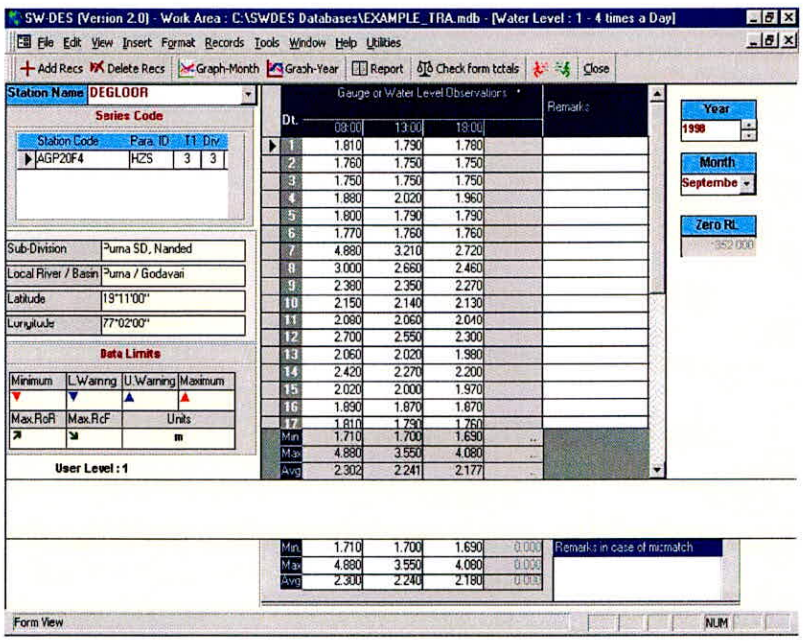

Fig. 13 Form for entry of water level data at multiple times a day.

The form displays the information regarding station code, station name, sub-division and local river/basin. All six data limits: (a) minimum value, (b) lower warning level, (c) upper warning level, (d) maximum value, (e) maximum rate of rise and (b) maximum rate of fall along with units of measurement are also displayed on the screen. The year and month of the data displayed on the screen at any point of time are also displayed for reference purpose. The reduced level (R.L.) of gauge zero, available in the database, is also brought on the screen.

The data for a complete month is entered in the tabular form. The rows represent the days in the month and number of column(s) corresponds to each observation in the day. The first column gives the dates of the month and is automatically filled up as per the month and the year. The data corresponding to each observation in the day is to be entered by the user. First the entries for each observation are made in succession and then the control moves to the next day. If any remarks are to be entered for any day it can be entered by going to the specific date by using mouse. At the bottom of the form, for each observation in the day, the average, maximum and minimum values as available in the manuscript have to be entered. The corresponding computed values as per the entries made by the user are automatically filled.

Entry of current metering observations

Discharge is indirectly estimated by observing the flow velocity at a number of locations in the flow cross section. Computing the flow for segmental portions on the basis of the observed velocities the total discharge is computed. For this, the observations on depths and locations along the section, distribution of velocity across depth in the sections, together with observations for making corrections in depth and velocities are required. The observer records all such raw observations and computes various quantities after making necessary corrections. While entering the data it is necessary to enter only the raw observations as recorded in the manuscript.

On the top of the sub form the entries for current meter is to be entered. The user has to choose the current meter used for making velocity observations from a list of meters. As soon as the meter is chosen, all the related details about current meters calibrated ratings are brought automatically from the database. The user is required to only enter the results of the spin test taken during the observations. The current meter rating coefficients will be used to automatically compute the velocity when the data for time taken and number of revolutions made by the meter during an observation is entered.

Next, the data related to velocity observations is made. General information like: (a) method of suspending meter, (b) weight used with the meter and (c) number of compartment is entered. The possible items in the list for the first two fields are:

Method of suspending meter

Wading rod; gauging reel

Weight used with meter

15 lb; 30 lb; 50 lb; 100 lb; 200 lb; 300 lb;10kg, 20kg, other (specify)

No. of Compartments

The flow of water at the gauging section can take place in more than one compartment. This is normally the case when the observations are taken from a bridge site. For other locations, though it is endeavored to have unbraided river sections but may sometimes be not easily possible. In this field, the total number of compartments in which the flow is divided is entered. This is obviously an integer field and the expected maximum number of compartment is kept 15 beyond which the user gets a prompt if the entry is correct.

The bulk of raw data is to be entered in a tabular manner. The Fig. 14 gives an illustration of a typical current meter observation exercise and computation of discharge using mid section method. The row wise entry in the tabular form is then made by filling all the necessary fields. A brief description of each of these fields is given here under:

Column 1: Compartment serial no.

As stated above, the flow may be divided in more than one distinct compartment. In this field, the serial no. of each compartment is filled automatically. In the beginning, serial no. 1 is filled in the first row and as soon as the number of rows required for each compartment is known, the next serial no. is filled automatically after leaving adequate no. of rows.

Column 2: No. of sections

In each compartment the velocity is observed at a number of sections. This field gives the total number of such sections for each compartment. Two more sections, the end sections of each compartment at which velocity and depth may or may not be zero, are always counted.

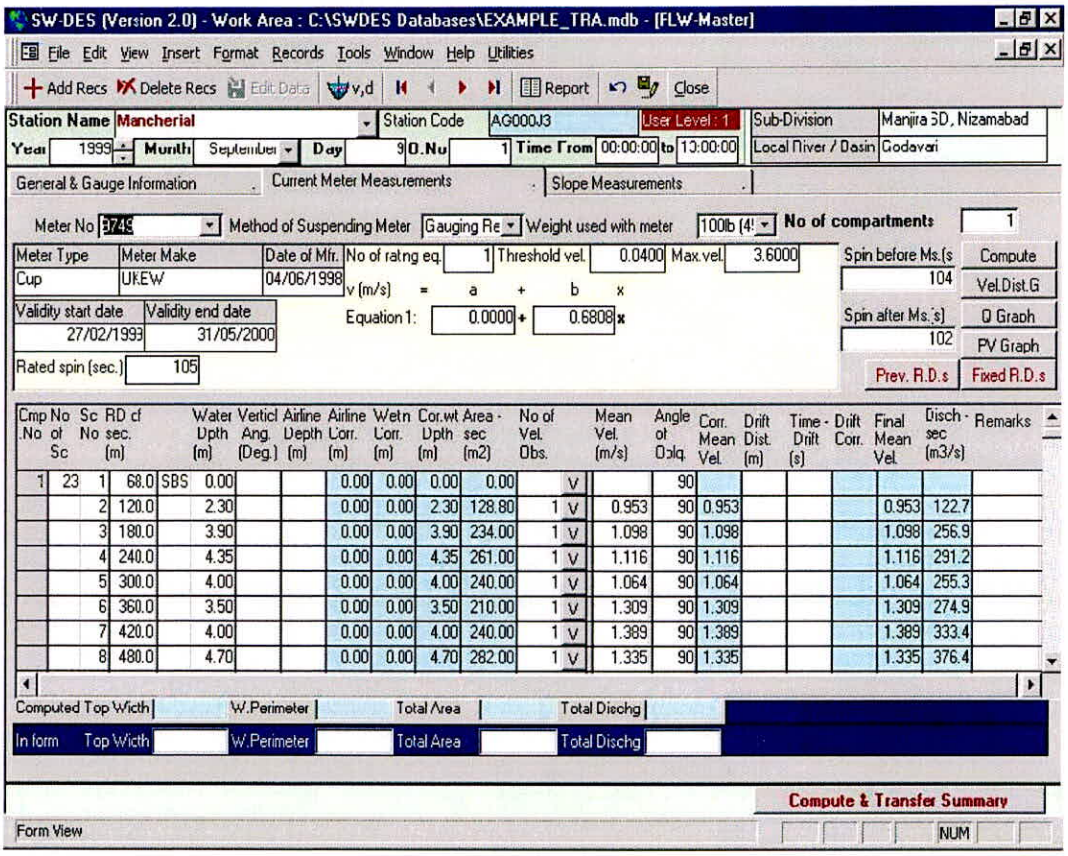

Fig. 14 Layout of form for entry of current metering observations.

Data validation options for meteorological data

Validation of data using graphical means is carried out simultaneously while data is entered in respective data entry forms. Few more data validation options are available to ensure consistency of data entered by making comparison of related data that are observed and entered independently. These options are listed under the "Data validation" option on the main switchboard. Various options are listed as shown in Fig. 15.

For meteorological data various data validation options available are on comparison of: (a) SRG and ARG data, (b) SRG (twice-daily) and ARG data, (c) ARG and sunshine duration data, (d) SRG data at multiple stations, (e) daily climate data at multiple stations and (f) twice-daily climate data at multiple stations. A brief explanation and objectives of these options is given as follows.

SRG and ARG data

This option is primarily to ensure that the daily values observed using the SRG are consistent with the sum of hourly rainfall for the same 24 hours period obtained by the ARG. Normally, these two are expected to be within 5% of each other (except when the magnitude of

rainfall is very small, say 10-15 mm). All those stations having both SRG and ARG data are listed on the input box.

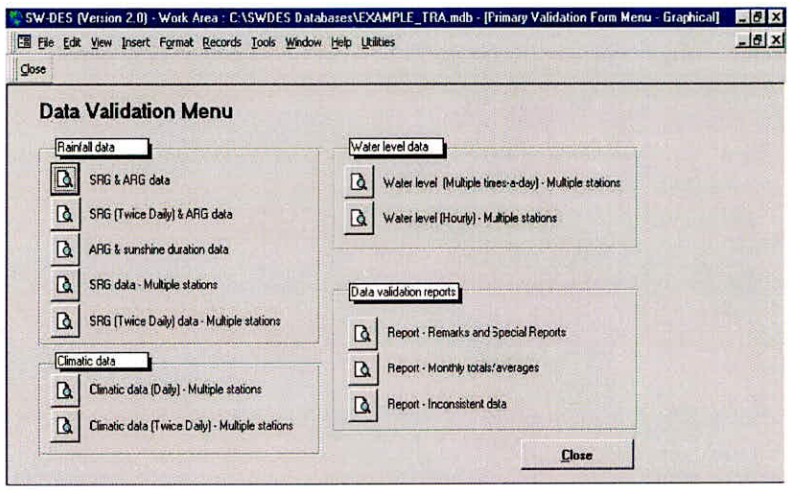

Fig. 15 List of additional data validation options

The station for which the comparison is to be made is selected from the list box and any day of the required month is specified on the calendar given at its side. The graph is then plotted by pressing the graph button. This comparison is graphically shown as given in Fig. 16. Easy navigation facility from within the graph is provided to get the plots for the adjoining month(s).

A quick view of the SRG and ARG values plotted adjacent to each other for any month gives the impression of their deviation from each other. The deviation is also plotted on the upper part of the graph in absolute or relative terms. Thus any significant deviation in the two can be quickly identified. Such instances are then followed up to know the causes of the deviations and to take suitable actions thereafter.

SRG (twice-daily) and ARG data

This option is exactly similar to the one on SRG and ARG data. The only difference is that in this case the sum of two SRG observations is taken instead of the single daily value of SRG. Rainfall for any day is computed as the sum of rainfall observed at 1730 hrs. on previous day and that observed at 0830 hrs. on the day in question. This is compared to the sum of 24 hourly rainfall values for the same period. The graph and its interpretations are exactly same as given for the case of SRG and ARG data above.

ARG and Sunshine duration data

This option is to facilitate the comparison of hourly rainfall and hourly sunshine duration. The basic objective is to help see the concurrent sunshine duration data for any doubtful rainfall values in the ARG data. After this option is chosen an input box appears on the screen that is similar to the one for SRG and ARG comparison. The station for which the graph is to be plotted is selected from the list box and the day is specified on the calendar given at its side.

The graph is then plotted by pressing the graph button. This comparison is graphically shown as given in Fig. 17. Easy navigation facility from within the graph is provided to get the plots for the adjoining day(s).

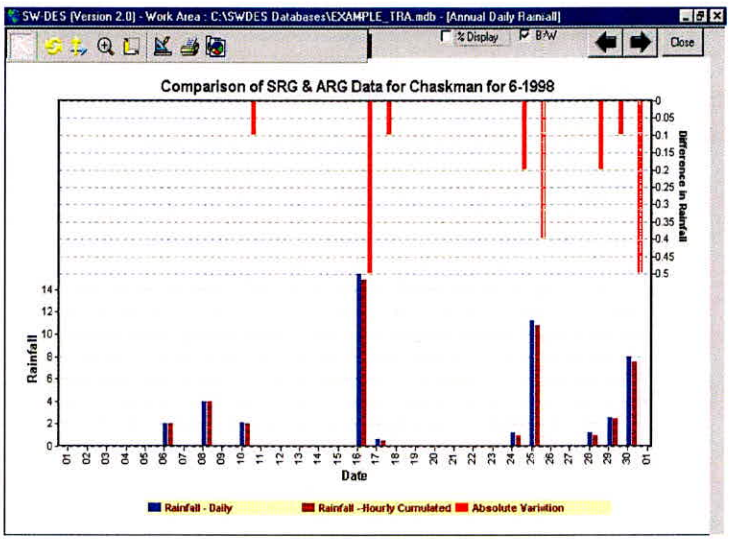

Fig. 16 Plot of SRG and ARG comparison

A quick view of the ARG and sunshine data values plotted one over another for any day gives the impression of sunshine duration during various hours for which there is significant rainfall. The sunshine duration for the hours in which significant rainfall is reported, is expected to be very small. Though it is expected that for a larger value of rainfall during the day the corresponding sunshine duration value will be small but the reverse analogy may not be true. That is, it is not expected that if the sunshine duration is very small there will be heavy rainfall.

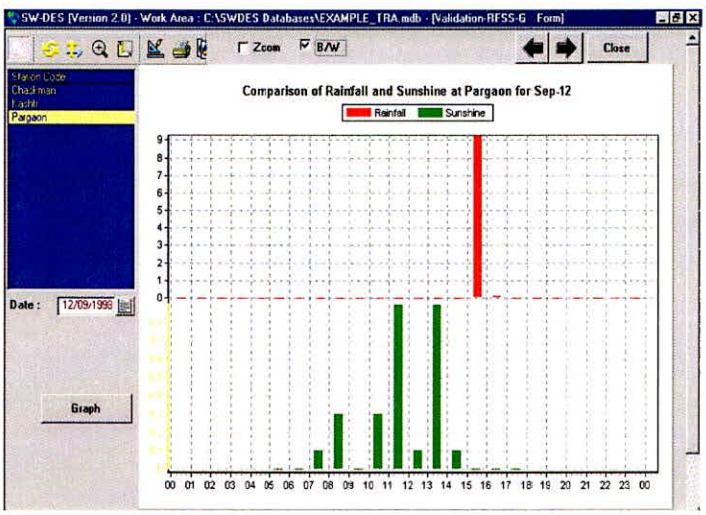

Fig. 17 Plot of ARG and sunshine duration comparison

Daily rainfall at multiple stations

Use of SWDES at Sub-divisional data processing centers envisages carrying out primary validation. Since primary validation pertains to validation using information obtained at a single station only, this type of multiple stations comparison, in fact, comes under the purview of Divisional data processing centers. However, to give opportunity for this type of multiple station comparison at an early stage, these options on (a) daily rainfall, (b) daily climate and (c) twice-daily climate on multiple stations have been included in SWDES.

The stations for which the graph is to be plotted are selected from the list box and the start and end date of the period to be plotted is specified on the calendars given at its side. The graph is then plotted by pressing the graph button. This option facilitates the comparison of daily rainfall values observed at two or more adjoining stations. The basic objective is to identify if there is significant difference in individual daily values or in its pattern. Since there are normally many zero values in daily rainfall data there are chances of mistakes in counting them while entering. This creates a shift in the rainfall event by a day or two. This type of comparison of daily rainfall data by simultaneously plotting them one over another is very useful in identifying the time shift in values at one or more of the stations. The plot is graphically shown as given in Fig. 18. Easy navigation facility from within the graph is provided to get the plots for the next period(s). Glaring differences between certain plots together with the common understanding of the rainfall variability in the region help indicate few mistakes, which are otherwise difficult to notice in the individual station records.

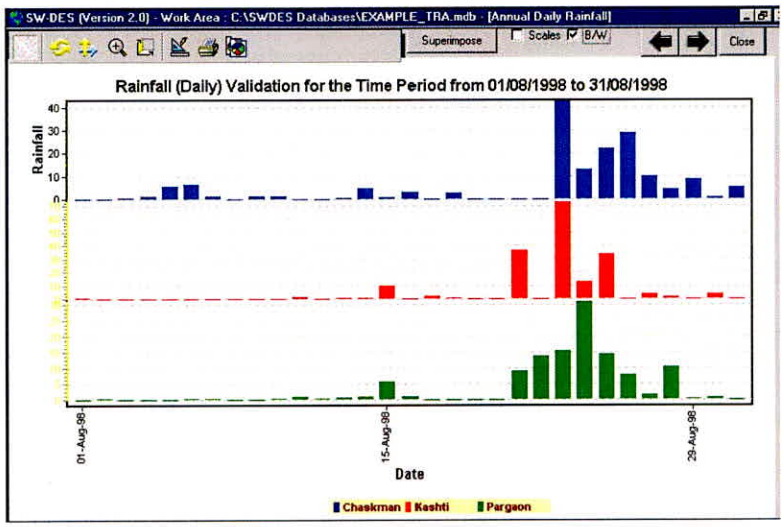

Fig. 18 Example of comparison of daily rainfall at multiple stations

Daily climate data at multiple stations

This option is to facilitate the comparison of daily climatic data observed at adjoining stations which are correlated to some extent. All available climate variables (except wind direction) that are entered using the climate forms are listed here. Upon selecting the required variable the list of stations is refreshed and given in the box on the left side. The stations for which the graph is to be plotted are selected from the list box and the start and end date of the period to be plotted is specified on the calendars given at its side. The graph is then plotted by pressing the graph button.

This option facilitates the comparison of any climate variable (on daily basis) observed at two or more adjoining stations. The basic objective is to help see if for a particular climate variable there is significant difference in individual daily values or in the pattern of it. This comparison is graphically shown as given in Fig. 19. Easy navigation facility from within the graph is provided to get the plots for the next period(s).

A quick view of these multiple plots one over another for any period gives the impression of variation between the two at different times. There are options to (a) superimpose these plots having a common scale or (b) to plot them separately one above another (on equal or unequal scales). The glaring differences between certain plots together with the common understanding of the weather in the region help indicate few mistakes that are otherwise difficult

to notice in the individual station records. Examples on other climate variables are not explicitly given here since the procedures are exactly similar to what is described for this case of minimum temperature.

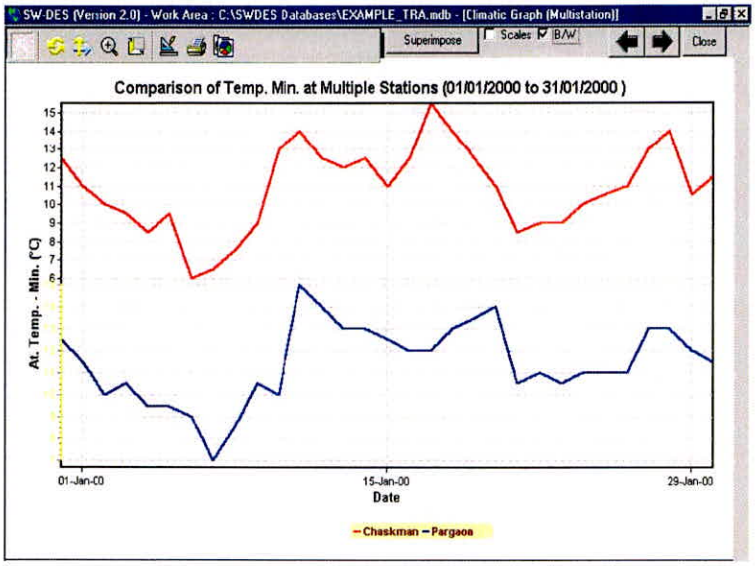

Fig. 19 Example of comparison of daily minimum temperature at multiple stations

REMARKS

SWDES has been designed keeping in mind the requirement of implementing the software using standard, inexpensive, commonly available database software. It was envisaged that in a front-end system like SWDES, the need for a countrywide installation would call for a fair amount of customization for different agencies. Therefore, since Access is available on all the computers being used by the Agencies, it was logical to use Access as the back-end with ***Visual Basic for Applications*** (a component of Microsoft Office) for the development application. The prime objective of this data entry software is to provide sufficient facilities for entering all types of meteorological and hydrological quality and quantity data. Primarily, the software provides suitable facilities for entry of rainfall, water level, stage-discharge, water quality, sediment and climatic data as observed by surface water agencies. The data so entered using this software is subjected to essential data entry checks so that the possibility of committing mistakes is minimized. The graphical interface so provided gives added advantage of visual means of validating the entered data. In other words, this software provide a kind of front end for the data entry personnel for entering and preliminarily validating all types of meteorological and surface water quality and quantity data.

REFERENCES

Chowdhary H. (1992) Training report on "Hydrological Data Processing", March 1992.

HYMOS (Version 4.01) Manual.(1999) Delft Hydraulics, P.O. Box 177, 2600 M.H. Delft.

Lohani A.K. (1993). *Hydrological data collection processing and analysis,* Report No. SR-27, National Institute of Hydrology, Roorkee.

Lohani A.K., Chowdhary H, Singh R.D. (2000) Use of GIS based HYMOS for surface watedata processing,, Spatial Information Technology-Remote Sensing and Geographical Information Systems, BS Publications, Hyderabad, India.