eSWIS software

During the HP-I project the Central Water Commission, Ministry of Water Resources developed dedicated Surface Water Software for the data entry, primary and secondary data validation, data processing, data storage in the Surface Water domain and dissemination of water related data in general using proprietary software. The application software was developed in a stand-alone environment, and in the client server environment, integrating GIS, database and various systems software to provide client applications, and a limited web service.

The eSWIS is focused on, using open source software, replacing the underlying database system used for central storage of hydro-meteorological data, replacing the existing system for validation and data processing, moving data entry from stand-alone systems to a web environment, and providing the web services required for data dissemination and the support of the Flood Warning functions currently hosted by the WISDOM web site. The new system, **e-SWIS**, (web and GIS based Surface Water Information System) implemented in participating Agencies in Hydrology Project II, and potentially in all States and UTs of India.

The Central Water Commission and other Implementing Agencies operate an extensive network of hydrometric and hydro-meteorological measurement stations, from which data are collected on climate, river flows and water quality. A suite of software packages (Surface Water Data Entry System (**SWDES**), Hydrological Modeling Software (**HYMOS**) and Water Information System Data Online Management (**WISDOM**)), collectively the Hydrological Information System (**HIS**) are used for entry, storage, analysis and dissemination of this data.

The online system architecture is represented by the following figure:

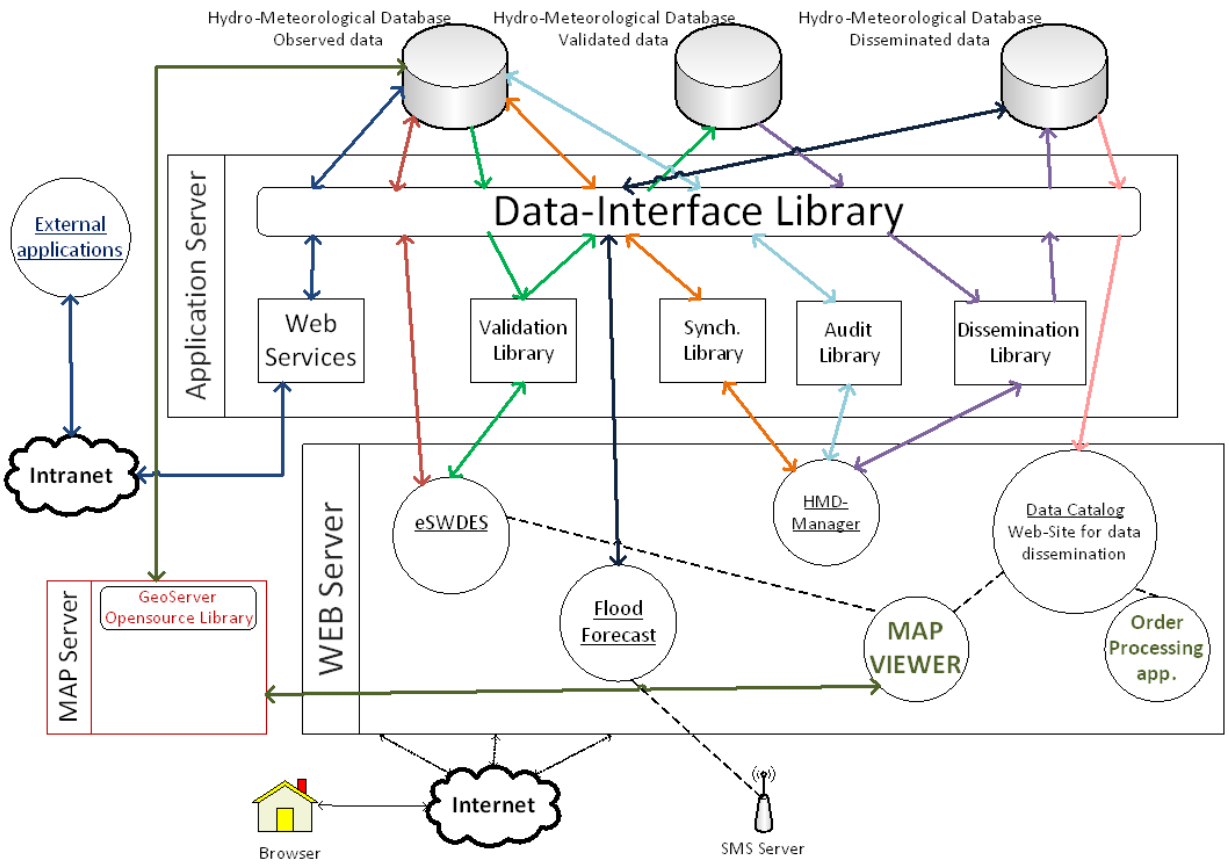


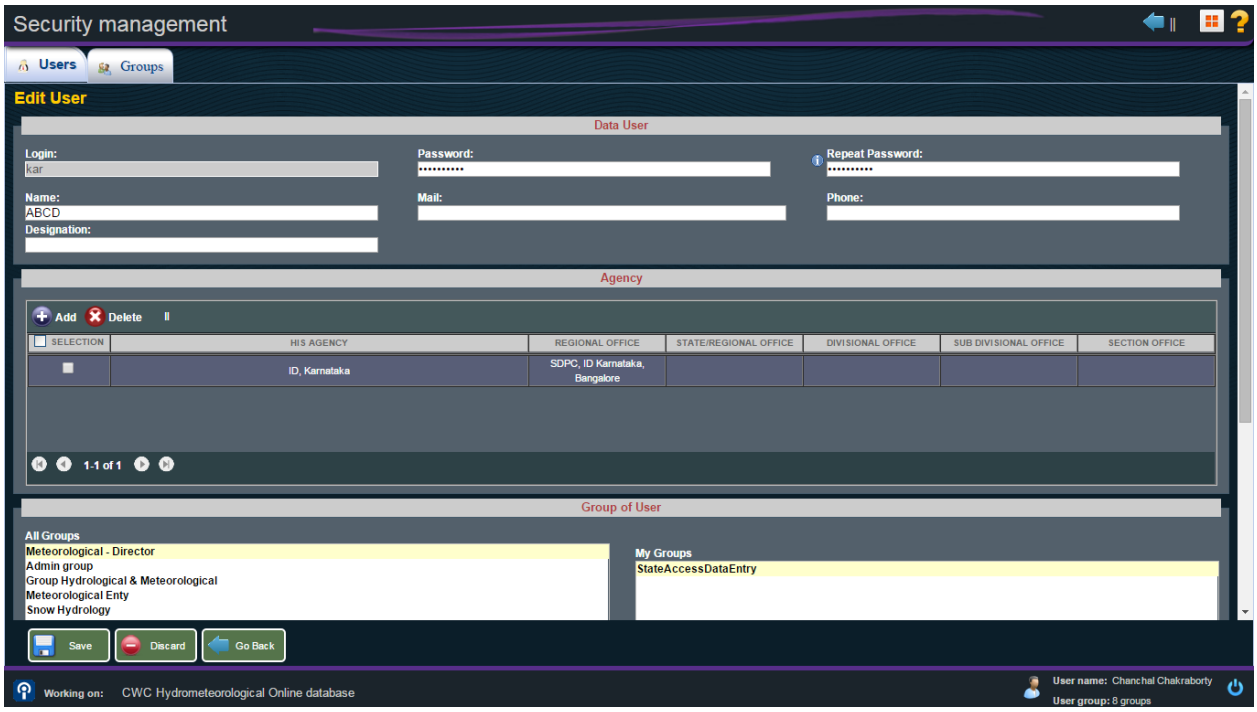
Figure 1 **- Online system architecture**

The online system architecture diagram consists of the following components:

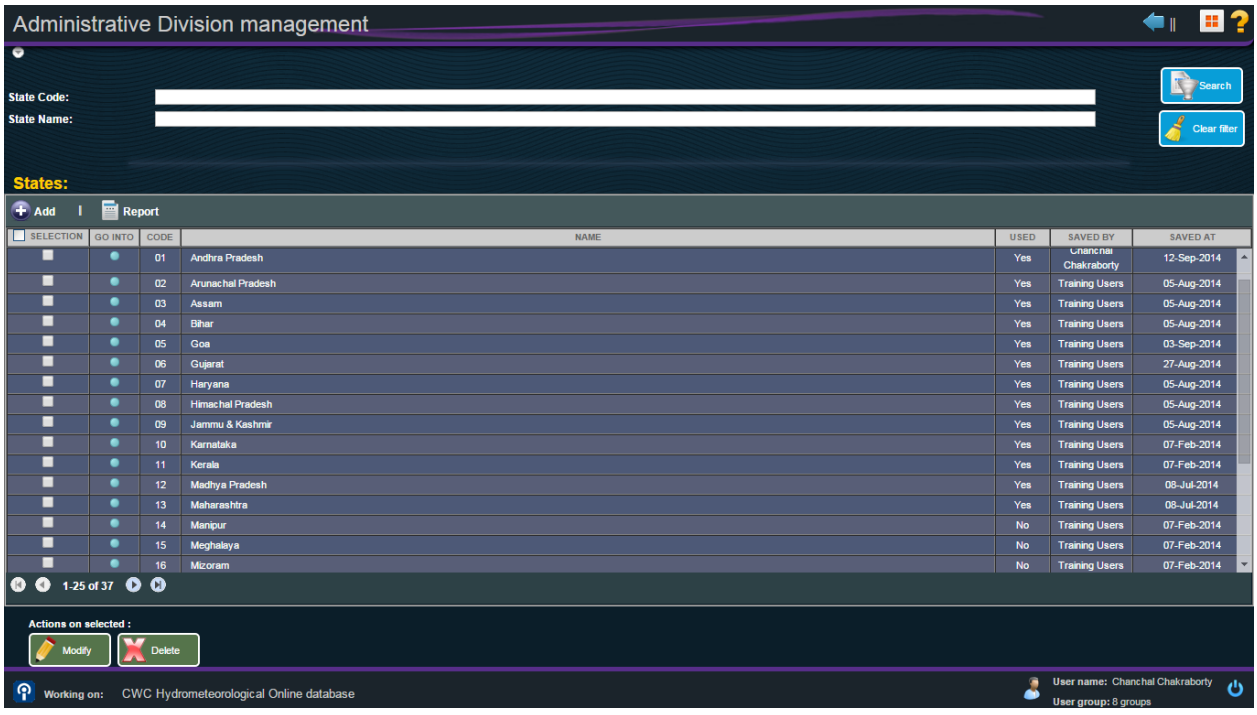
- **eSWDES:** A Web-application which users will use for data-entry and for performing secondary-data validation. It is the main application for data-entry and data in-charge users from different offices, agencies, etc. When data have been saved, they pass a primary-validation automatically. A secondary-data validation will require a manual process after data have been entered
- **Hydro-meteorological database manager:** A Web-application for performing high-level operations on entered data, such as Synchronization, Auditing and Dissemination data. Application for special users who will in charge of this kind of special operations over data
- **Web based data catalogue:** Web-site where disseminated-data can be consulted for everyone. This website is available for all people without login. It allows querying and searching all alphanumeric and geographical information available
- **Independent facility for the order processing of data requests:** Web application join to web based data catalogue where the user can order some data
- **Map viewer:** Web application which is able to locate geo-referenced data over a map.
- **Data interface library**: The only way to perform operations over data will be through this library. All other libraries or applications will need to call methods from this library to carry out operations over data
- **Validation library:** A library which contains all operations related to functionality of performing second-validation over data
- **Synchronization library:** A library which contains all operation related to functionality of performing data synchronization
- **Audition library:** A library which contains all operation related to functionality of performing audition of data
- **Dissemination library:** A library which contains all operation related to functionality for data dissemination
- **Hydro-meteorological database**: The data will be separated into 3 schemas depending on the kind of data which they will contain. That is, the structure of the database is the same in all three, and just data will change among them:
    - *Observed data:* Data recently entered that not have been approved
    - *Validated data*: Data which have been approved
    - *Disseminated data*: Data exposed publicly through Web based data catalogue
- **Web server:** Container for all web sites and web applications, known as front-end applications
- **Application server**: Container for all business-logic of applications. It contains different libraries which group common functionalities inside. The different front-end applications can access to them for performing actions sent by users
- **Map server:** Server used to publish all map services and provide some spatial functionality
- **Web services:** The way of exposing Data interface operations outside will be through Web services that allows to future third-party applications (external applications) to query and to manage data from Hydro-Meteorological database. In order to keep security of accessing, this web services will not be exposed on the internet, just they will be accessed from intranet
- **Flood-forecast web application:** Application for publishing reports of forecasts and analyses weekly data evolution where users are also able to send bulk SMS and emails for quickly informing.
- **Secondary validation:** After Primary validation user can validate the data using secondary validation tools.

Brief Descriptions of Modules and Sub modules of eSWIS

Main objective of this project is to translate the actual Surface Water Information System from desktop ownership architecture to open source web based architecture, keeping the current functionality and adding certain new functionalities.

- **Master Data**: Master Data is controlled by the administrator; those data will be used in throughout the application.
  - **Security**: Security management is basically to dealing with user's credentials. This module has been designed to create different level of users or groups depending upon their permissions. It can be local administrator, data entry operator & data in-charge etc. The data in the server is stored in the encrypted form and without proper authentication/permission no other user can edit/view the data. This feature also control the inter agency access of data without proper authorization**.**
  - 

  - **Administrative Division:** Administrative boundaries need to be identified so that observation stations can be associated with them and vice versa. In this module, three levels of administrative boundaries have been defined. These are: (a) State, (b) District, and (c) Tehsil/Taluka. The classification and identification of these boundaries has to be done by the competent administrative authorities and the same is to be followed**.**



- **Geographical Hierarchy:** This module has been developed to identify the drainage boundaries so that observation stations can be associated with them and vice versa.
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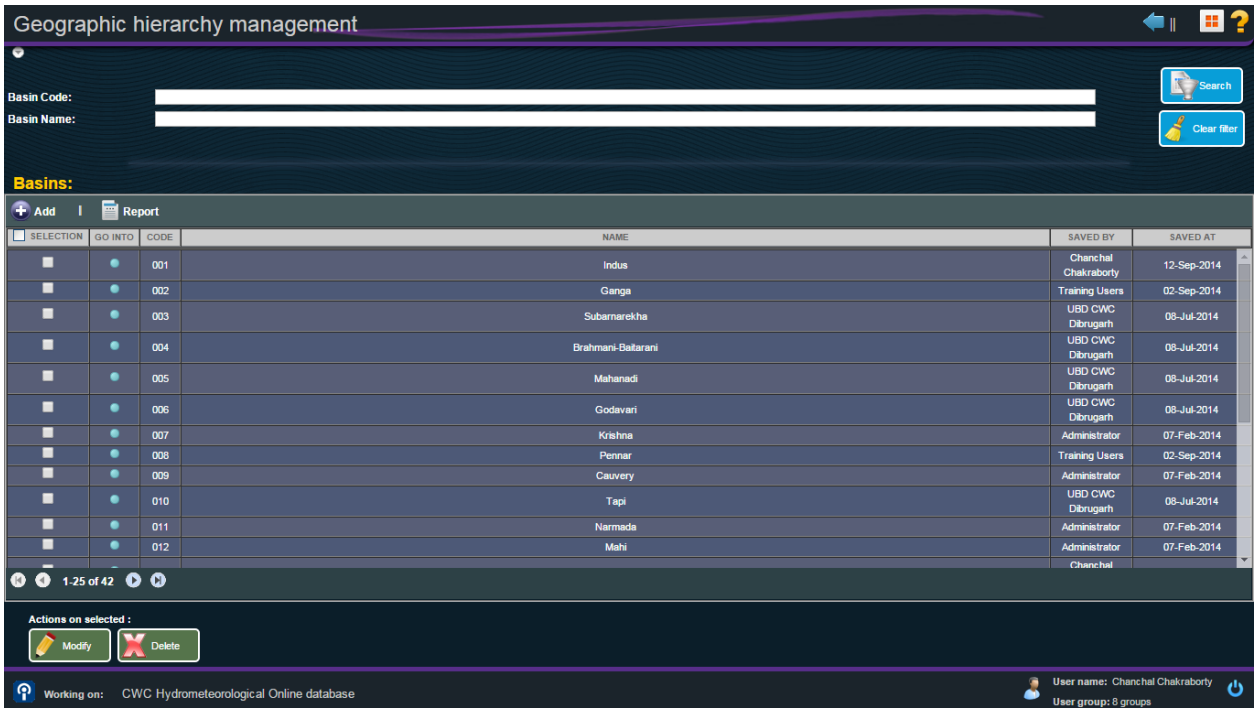
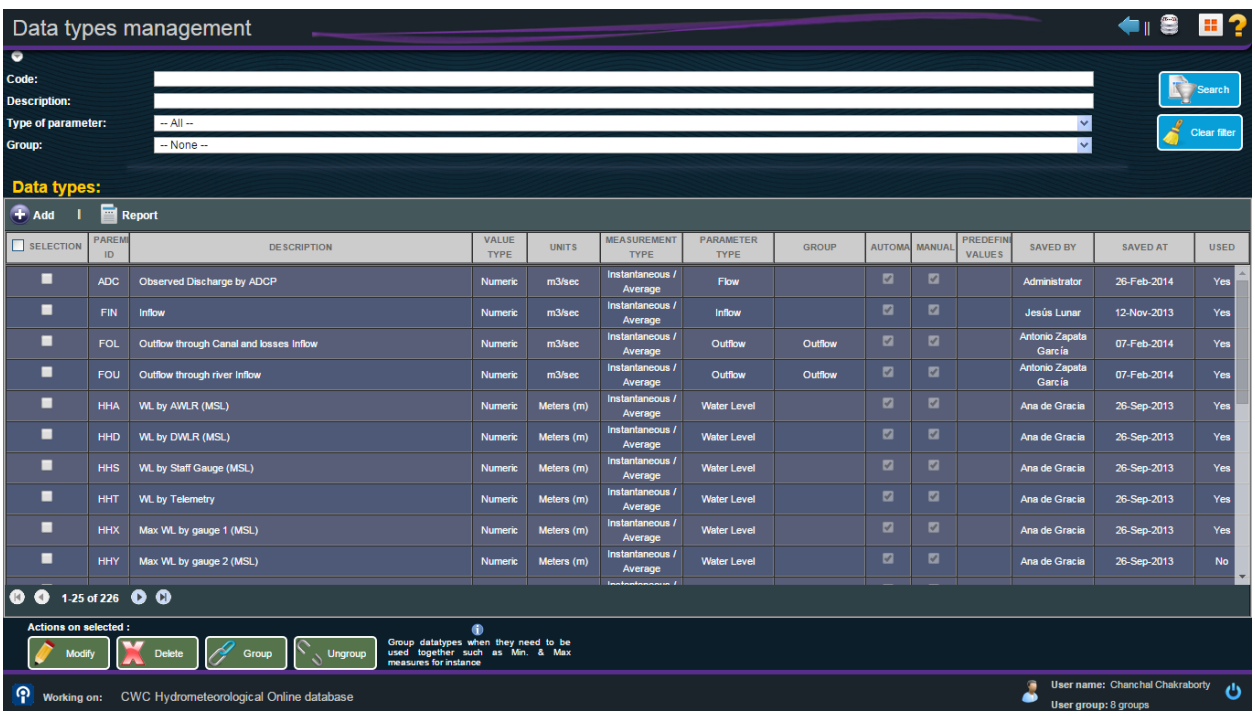


- **Administrative Hierarchy:** This Module is to Create/Delete/Modify Agencies, Regional Offices, Circle Office, Division and Sub-Division.

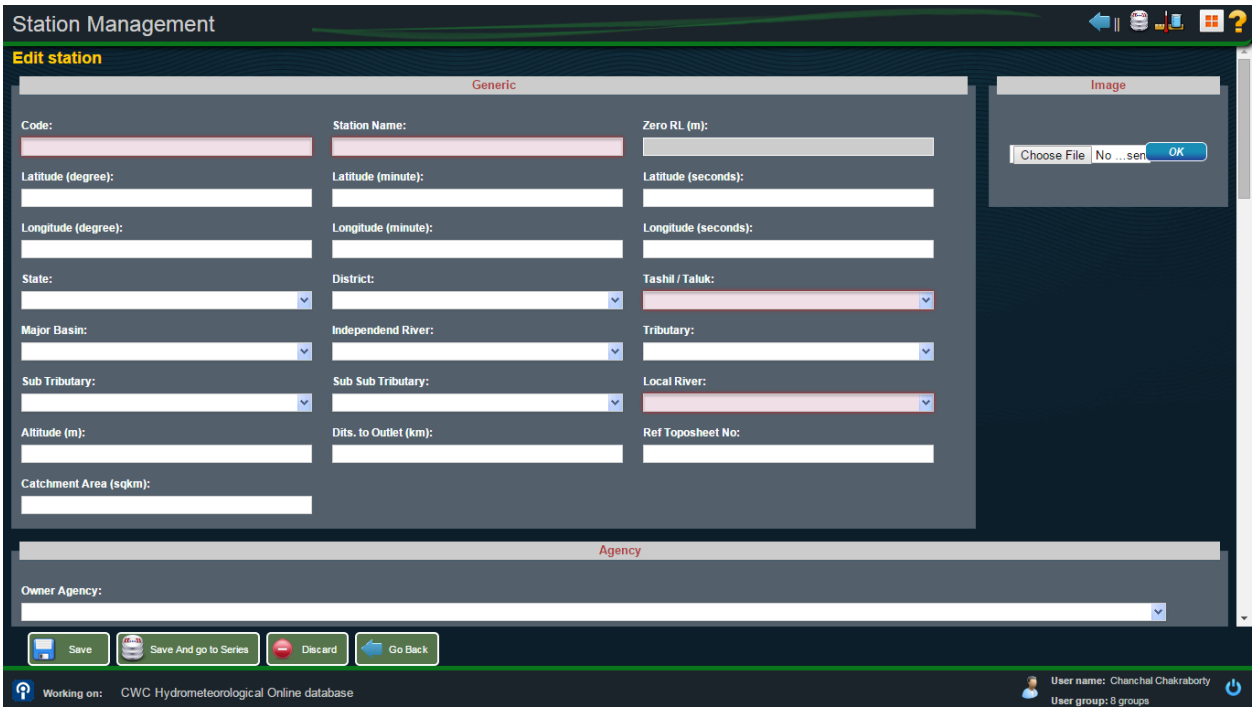
- **Data types**: A number of variables are observed with the help of hydrological and meteorological network at several locations. It is also very important to note certain key characteristics of these variables. Characteristics like description, unit and type of measurement of the variables are also maintained. This Module is to Create/Delete/Modify those variables.



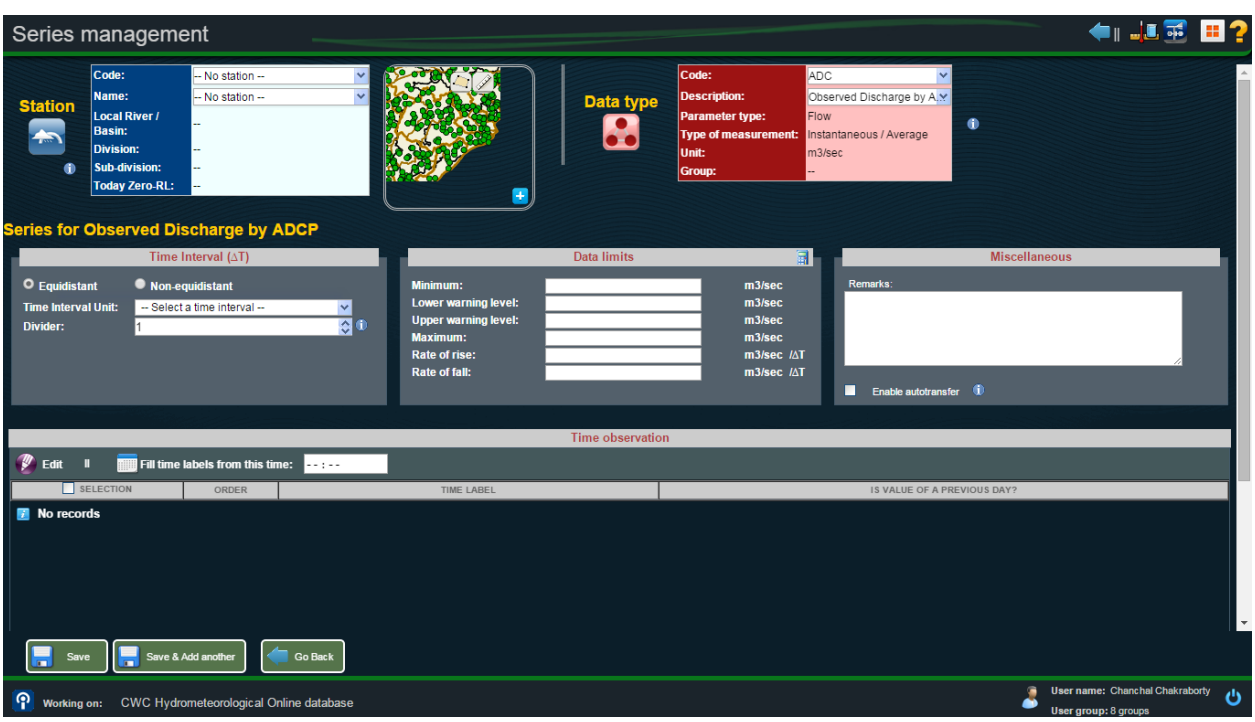
- **Static/Semistatic Characteristics**: Attributes associated with the observational stations or equipment, which do not change with time, are considered as static type of data. Some of these attributes change but very infrequently and are thus taken to be of semi-static nature.

  - **Station Management:** Many important attributes to each observational station can be assigned for defining its location in terms of geographical, administrative or drainage units and for indicating various offices which have control on its operations. Locational attributes are important for the purpose of finding inter station distances and difference in altitudes for the purpose of data

processing. These characteristics are also very important for the purpose of retrieval of data pertaining to particular range of these attribute(s).

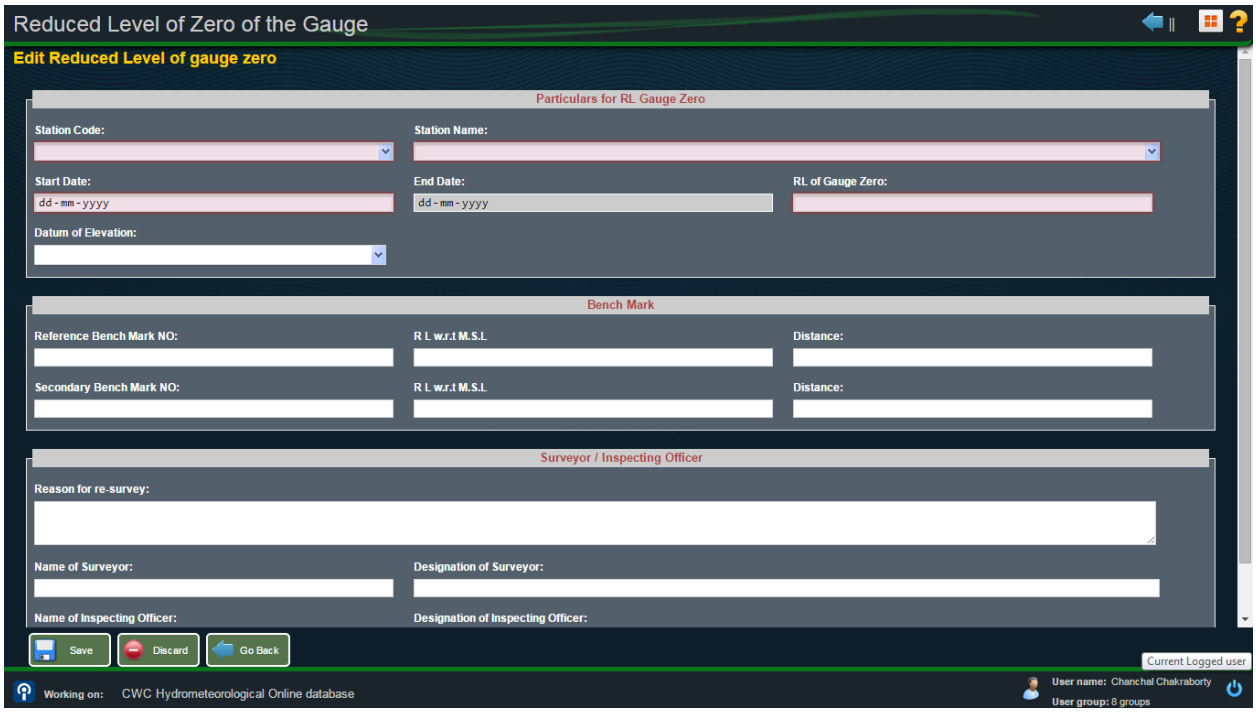


- **Series Management:** The bulk of hydrological and hydro-meteorological data is time series data. At every station a number of variables are observed and sometimes at varying time intervals. Thus, the time series data is required to be organised in different series at every station for each combination of the required variables and time intervals of observation. These series are attributed with certain key characteristics, which are useful for identification and providing necessary information about the series and in validation of the elements of the series. Any time series can be recognised by its series identification code. The identification code comprises of three parts: station code, data type and time interval code. The combination of these three entities is considered to be unique and thus defines a specific series.

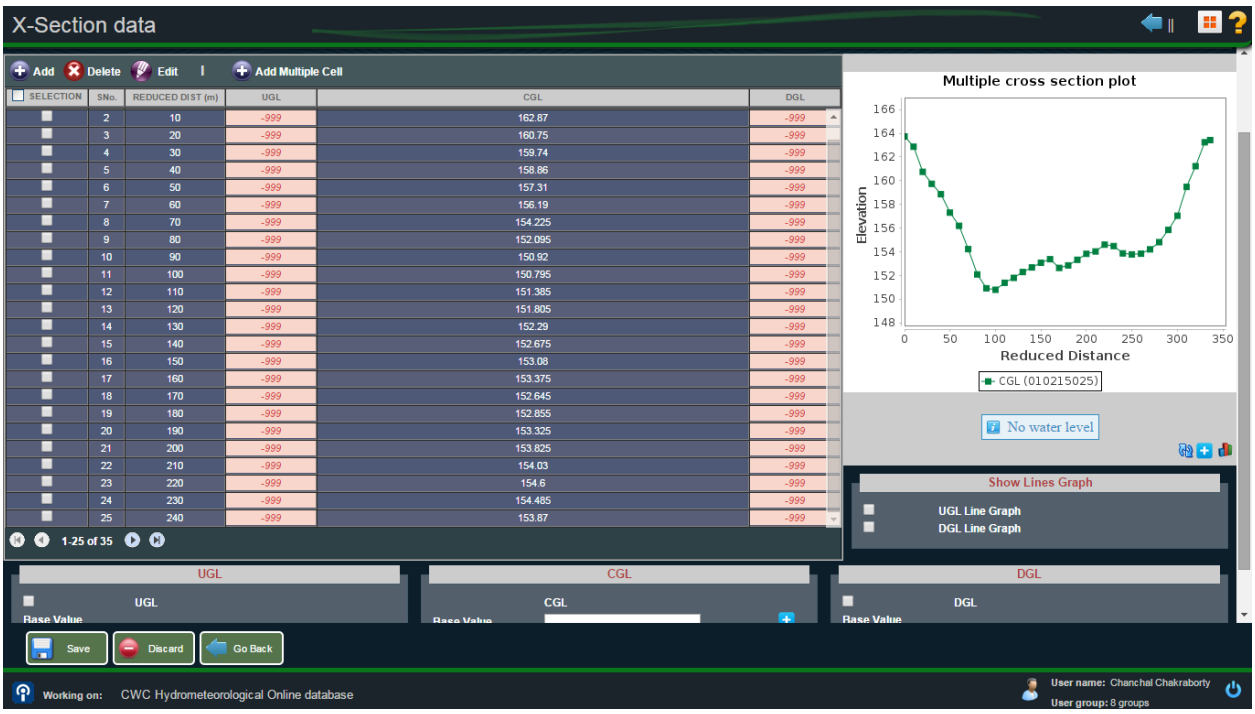


- **Current Meter Characteristic:** Current meters or flow meters are one of the important equipment employed for measurement of flow velocities. The relation between the speed of rotation of the current meter to the velocity of the water which, causes the rotation, is defined by the meter rating. The current meter should be rated from time to time whenever it is repaired or modified in any way and in any event after a prescribed period of use.

- **Reduced Level of Zero of the Gauge:** At the stream gauging stations, water level is always measured with respect to the zero of the gauge. The zero of the gauge is established as per the requirement and flow conditions prevailing at individual stations. Thus, zero of the gauges for different stations are obviously at unequal elevation with respect to a common datum. For making any comparison of water level at two or more gauging stations it is necessary to bring all the water level observations at all the gauging stations to a common datum. Also, with the passage of time, gauges may be displaced or destroyed or they may be changed in elevation as the result of erosion of beds. In order that the records of stage may assuredly refer to the same datum throughout the period of record, the datum of each gauge must be referred to and occasionally checked with at least one and preferably two or more bench marks that are entirely detached from the gauge, its support or shelter, and that are not liable to destruction or change in elevation.

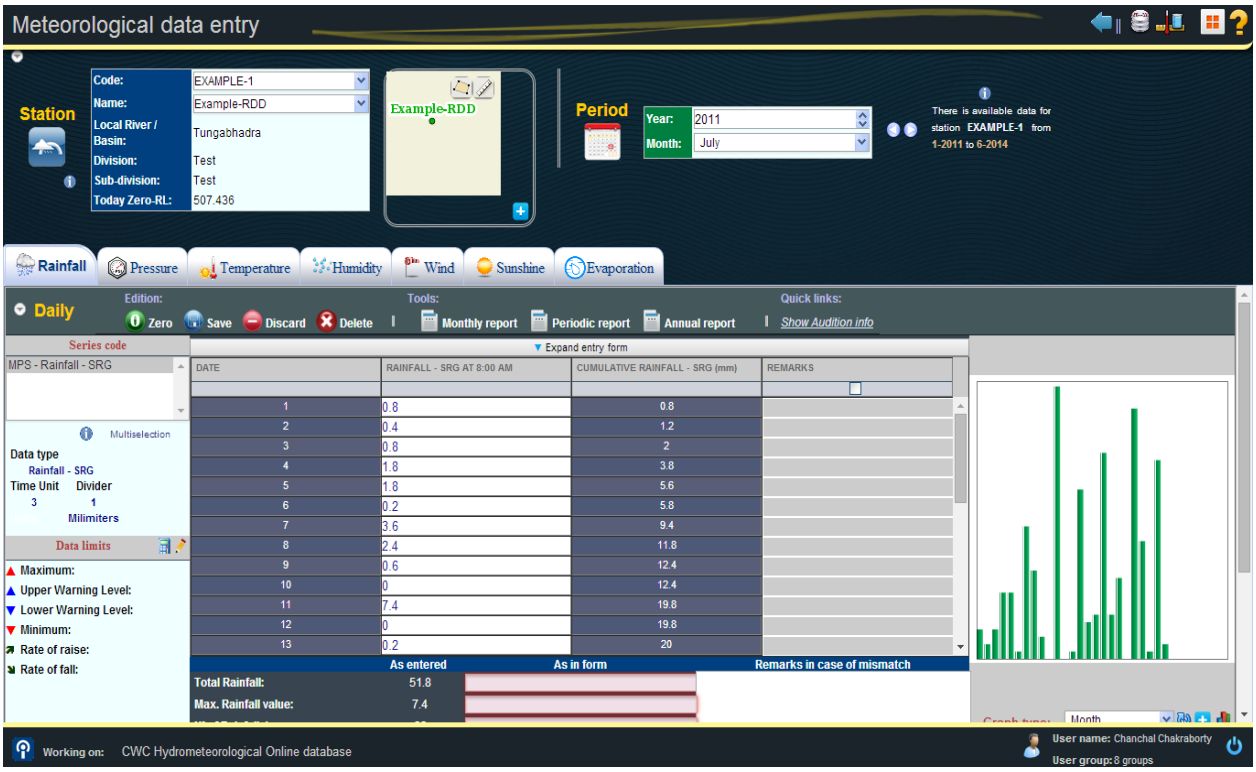


- **X-Section Data:** Cross-section data comprise of the pairs of distance and elevation of several points on the cross-sectional profile of the river gauging section. The distances are taken with respect to an origin on the gauging section and elevation is reported with respect to the mean sea level as the datum. The date of survey is always associated with the cross-sectional data.



- **Salient Features of the Reservoir/Diversion Schemes:** The purpose of this module is to store silent feature of reservoirs.

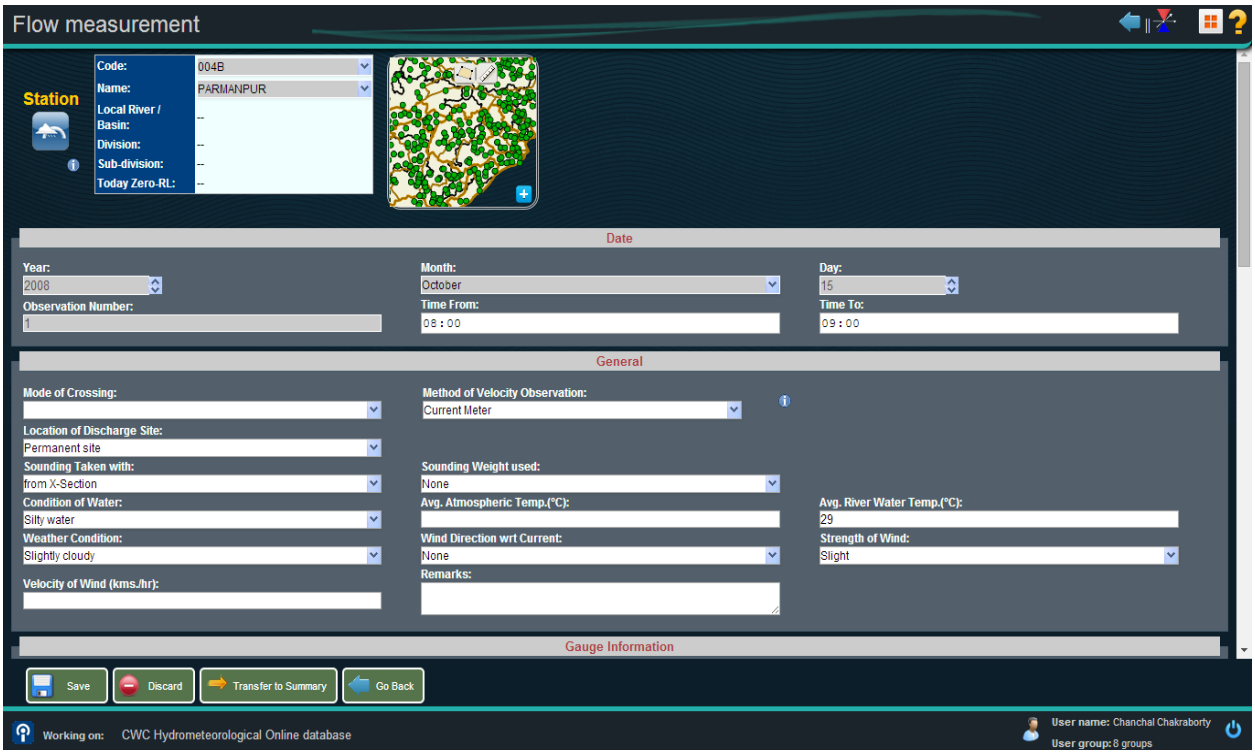
- **Meteorological Module**: There are a few hydro-meteorological data that are useful and available from the observational network.



- **Rainfall Data:** This is the data entry module for Rainfall data and reports for the same can be generated here.
- **Pressure Data:** This is the data entry module for Pressure data and reports for the same can be generated here.
- **Temperature Data:** This is the data entry module for Temperature Data and reports for the same can be generated here.
- **Humidity Data:** This is the data entry module for Humidity Data and reports for the same can be generated here.
- **Wind Data:** This is the data entry module for Wind Data and reports for the same can be generated here.
- **Sunshine Data:** This is the data entry module for Sunshine Data and reports for the same can be generated here.
- **Evaporation Data:** This is the data entry module for Evaporation Data and reports for the same can be generated here.

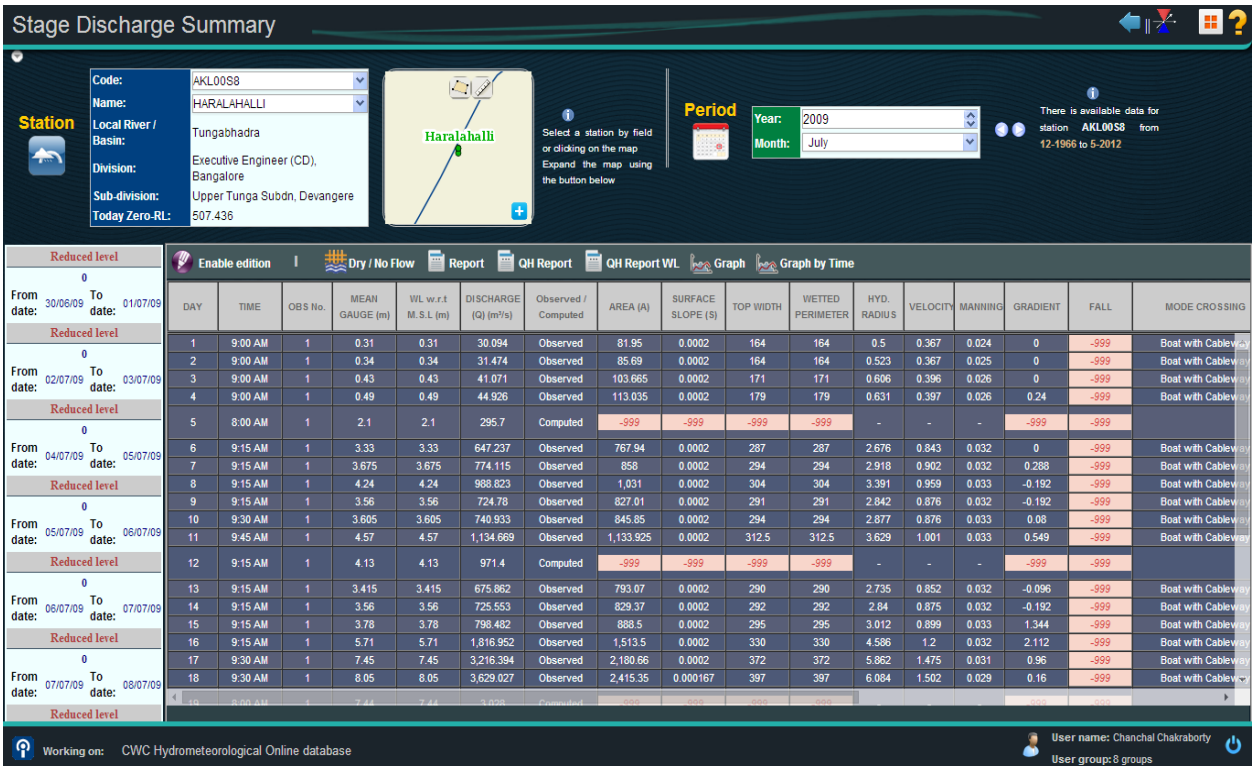
- **Hydrological Module**: Observations on water level, stage-discharge measurements and sediment concentration are the main raw hydrological data required to be entered.
  - **Water Level:** This is the data entry module for Water Level data and reports for the same can be generated here.

- **Flow Measurement:** The velocity observations normally results in a huge amount of data for each discharge observation. For the purpose of reference many other details such as mode of crossing, type of equipment used, condition of water and weather etc. are also recorded. After each stage-discharge observation the observer compiles the field notes in proper forms and then computes discharge and other characteristics of flow and reports for the same can be generated here.

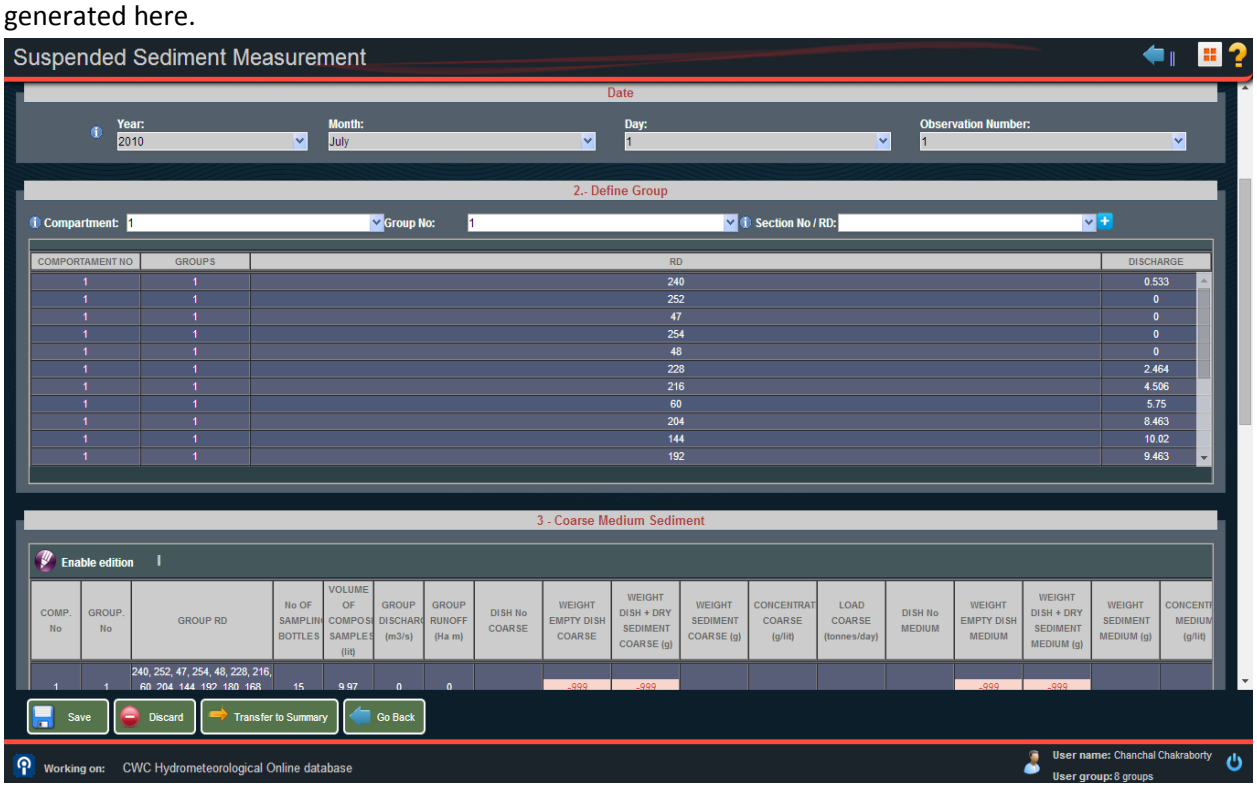


- **Summery Stage-Discharge:** The entry of primary stage-discharge is done mainly to re-compute and check the discharge computations carried out by the observer, to graphically observe the velocity and discharge profiles in the cross section. For further use, only a summary information is needed out of this detailed information. This summary information can either be automatically generated from the detailed data already entered or if the detailed data is not available then it can be directly entered using a separate form. The entry of summary stage-discharge data is made station wise and after the station is chosen other essential entries like its name, local river/ basin and subdivision are displayed automatically. The month and year are selected for making entries. As for the case of primary flow data the summary stage-discharge data is also identified by Station, date and

observation number. All these three entries can never be identical and this provides integrity of the data and reports for the same can be generated here.

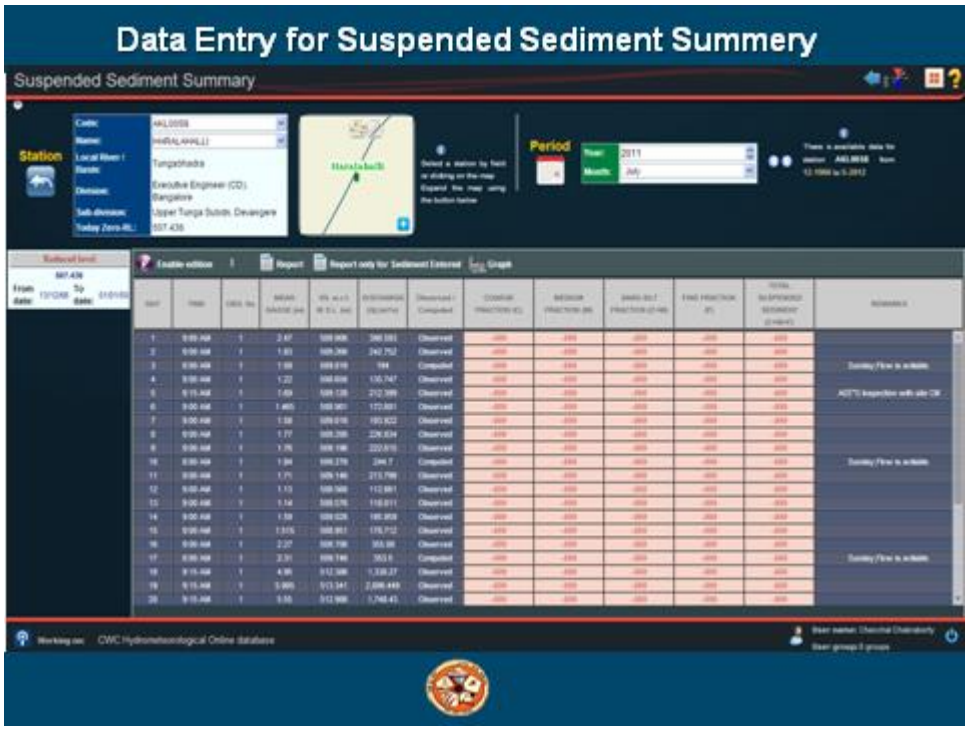


- **Sediment Module:**
  - **Suspended Sediment Summary:** Suspended sediment observations form the part of sediment data and is normally associated with the amount of flow at any section. The observations are normally taken along with stage-discharge observations. However, they may also be taken with only stage measurement and later computing the corresponding discharges by using rating curves. The form used for making entries for summary suspended sediment data and reports for the same can be generated here.



  - **Suspended Sediment Measurement:** Under normal conditions samples are collected from a Boat/Motor launch with the help of Punjab Type Bottle sampler. Under high velocity conditions, when sampling is not possible with the help of Boat/Motor launch, the samples are collected from

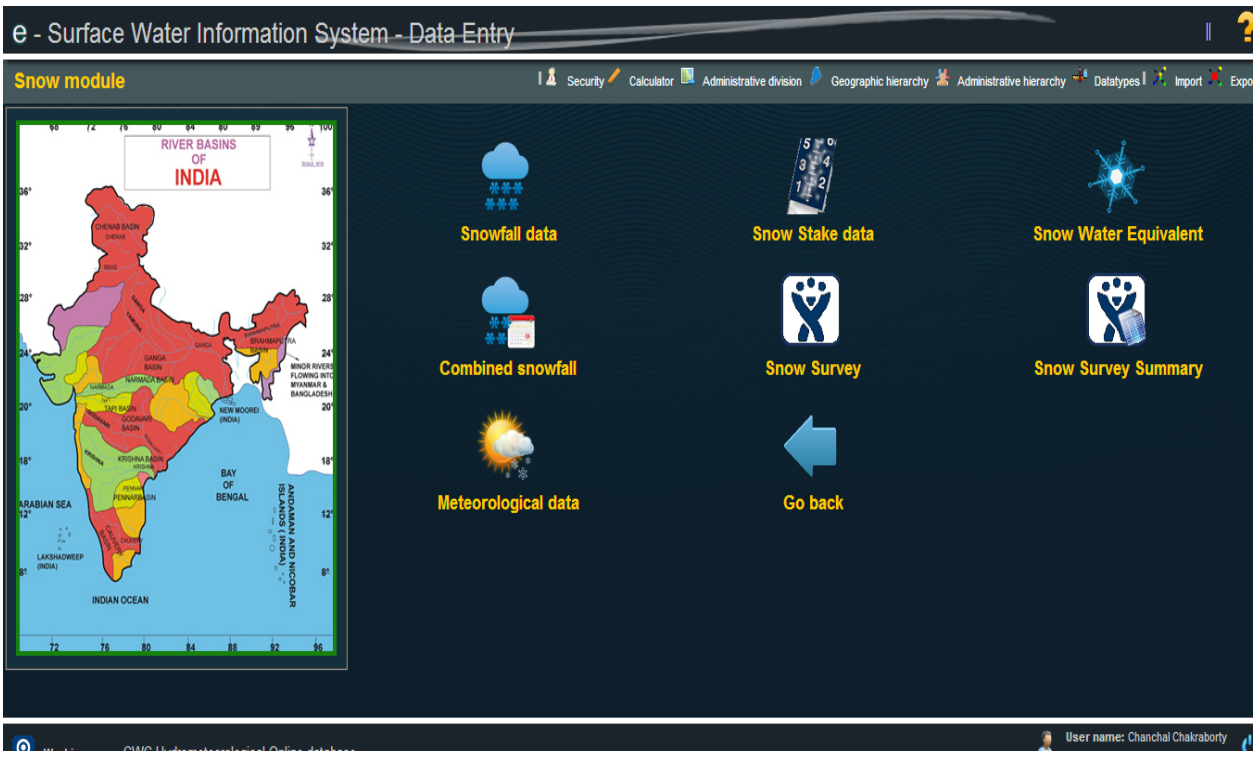
either a bridge or a cableway. The samples collected for each sampling vertical point are mixed to make groups having almost equal discharges. These groups divide the river hypothetically into almost equal compartments of flow. The suspended sediment samples are analysed by Gravimetric procedure. While entering the data it is necessary to enter only the raw observations as recorded in the manuscript. All the computed quantities are automatically filled in by the system. The form to enter daily suspended sediment measurement data is as shown in the following figure and reports for the same can be generated here.



- **Water Quality Module:** Observations of water quality mainly refer to concentrations of dissolved constituents in the water in terms of physical (like turbidity, conductivity etc.), chemical (like sodium, potassium, cadmium etc.) and biological parameters (like algae, bacteria etc.). Data on water quality requires collection of a water sample followed by analysis (measurement) for specific water quality parameters. Some of these water quality parameters can be measured at site, the so-called 'field parameters'. The other parameters are analysed in a laboratory. Laboratories of different levels are distinguished under HP. Level I laboratories are small laboratories located at or near the sampling location. These were originally established for determination of sediment load only, but now can also be used for determination of the water quality field parameters. Higher level laboratories (levels II and II+) are usually located in major cities and provide analytical capacity to a larger region covering more sampling locations.

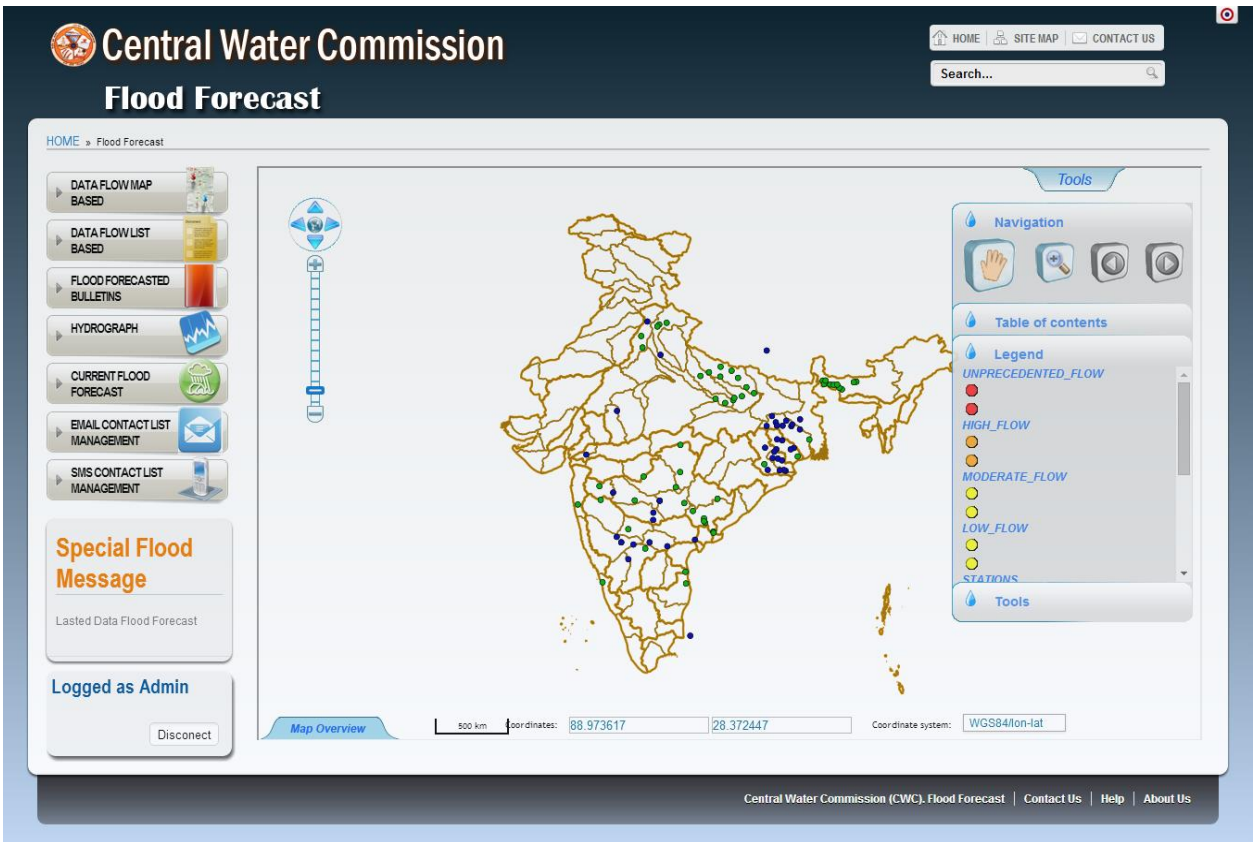
- **Laboratory Information:** In this data entry section, a laboratory can enter and edit all the relevant information necessary to describe the laboratory. An agency may enter information on multiple laboratories coming under its jurisdiction. This form also registers the number of parameters the laboratory can analyse along with the method of analysis. Parameter Information: In this form, all the important information about the water quality parameters and the analytical methods available for each parameter are shown.
- **Sample Data Entry:** In the data entry section, water quality analytical results as measured in the field and in the laboratory are entered into the database.
- **Reports:** To generate various reports on Water Quality.
- **Graphs:** To generate various graphs on Water Quality.
- **Analysis Quality Control:** In this form, all the important information about the analysis quality control can be filled.
- **Options:** This form allows for changing some of the options in the data entry system

- **Snow Module:** Snow data can be entered using one or more given bellow modules:

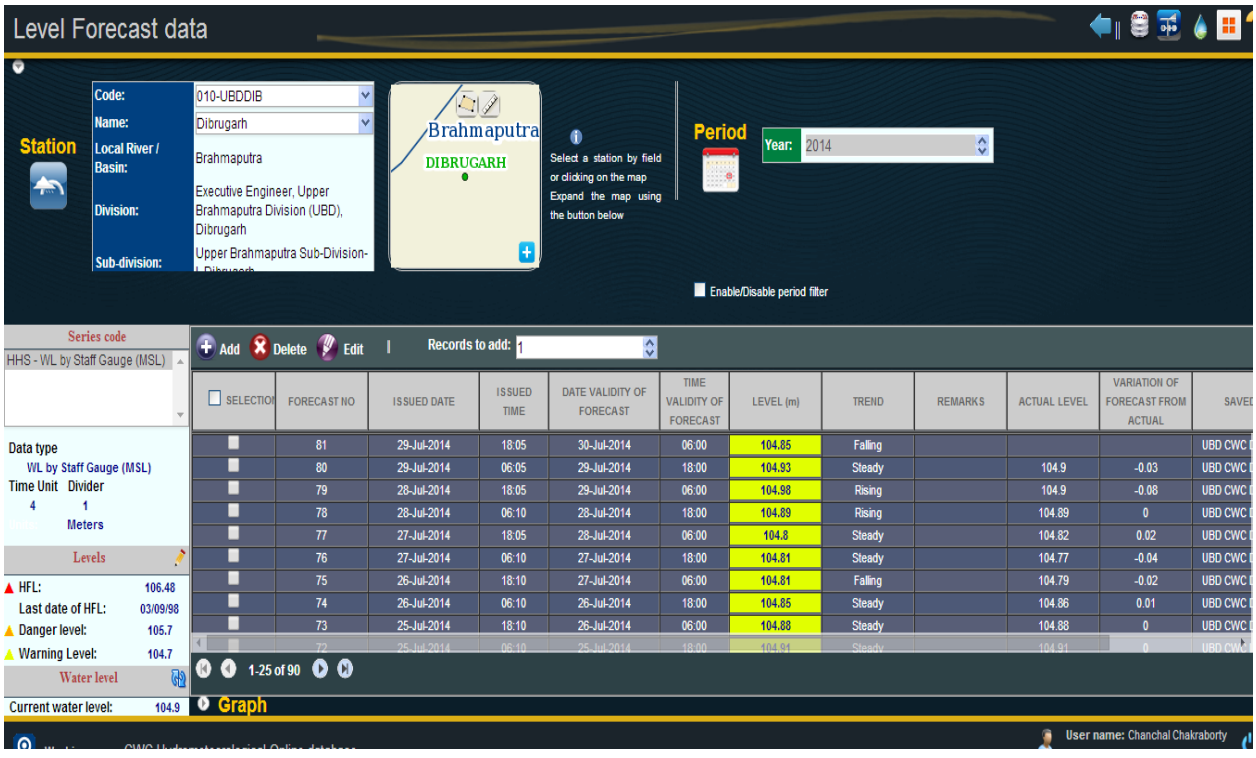


- **Snowfall Data**
- **Snow Stake Data**
- **Snow Water Equivalent**
- **Combined Snowfall**
- **Snow Survey**
- **Snow Survey Summery**
- **Meteorological Data**

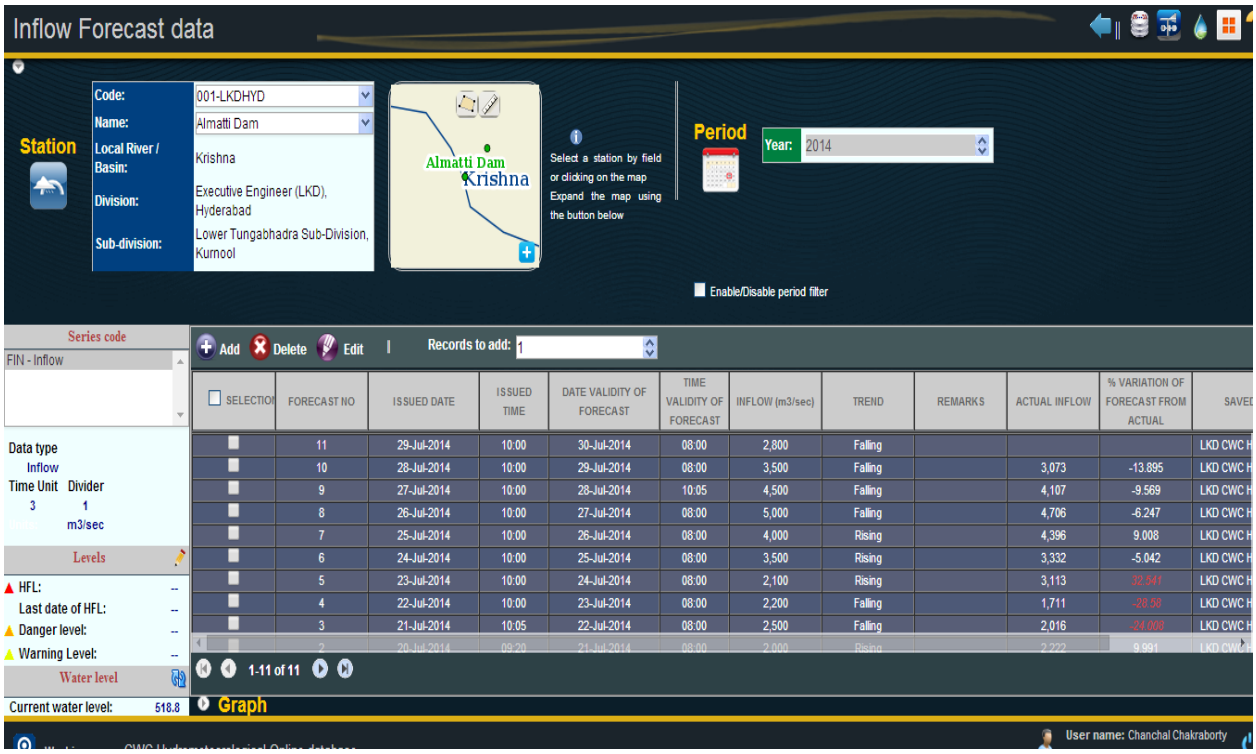
- **Flood Forecast Module:**



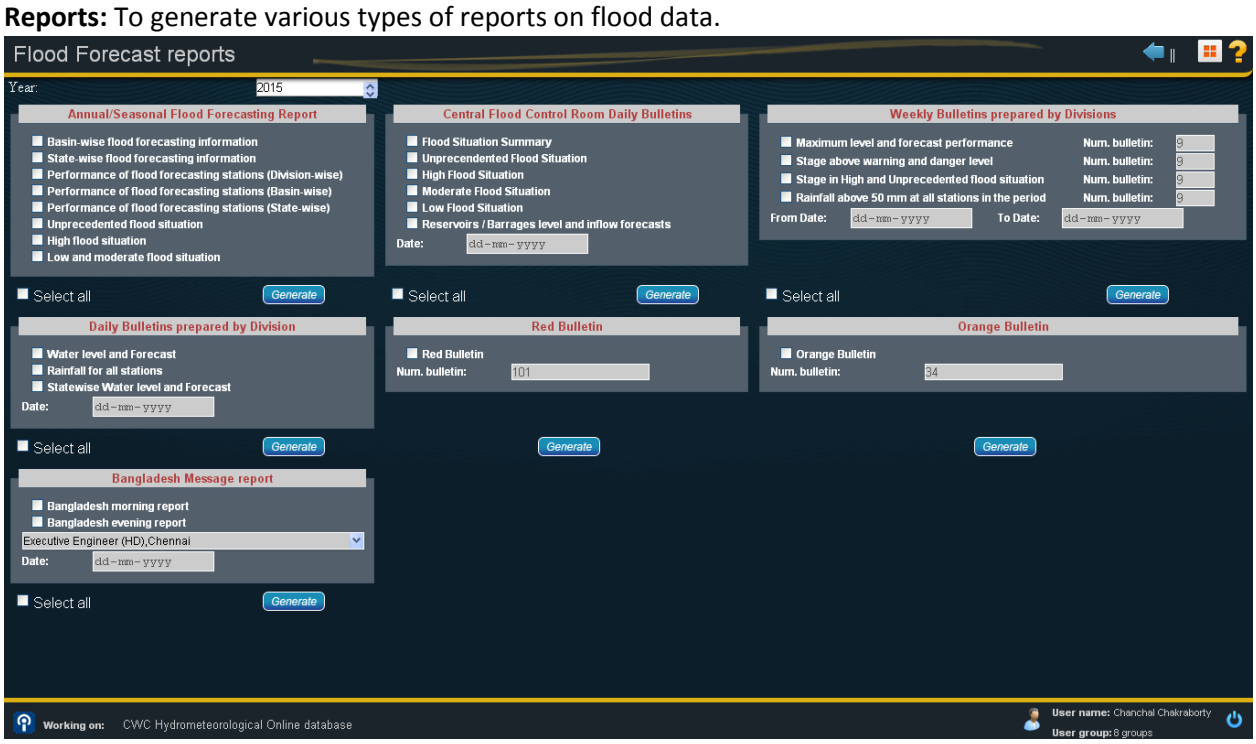
- **Level Forecast Data:** The purpose of this module is to forecast any level forecast station, after approved the data this data will be shown in flood-forecasting web-site.



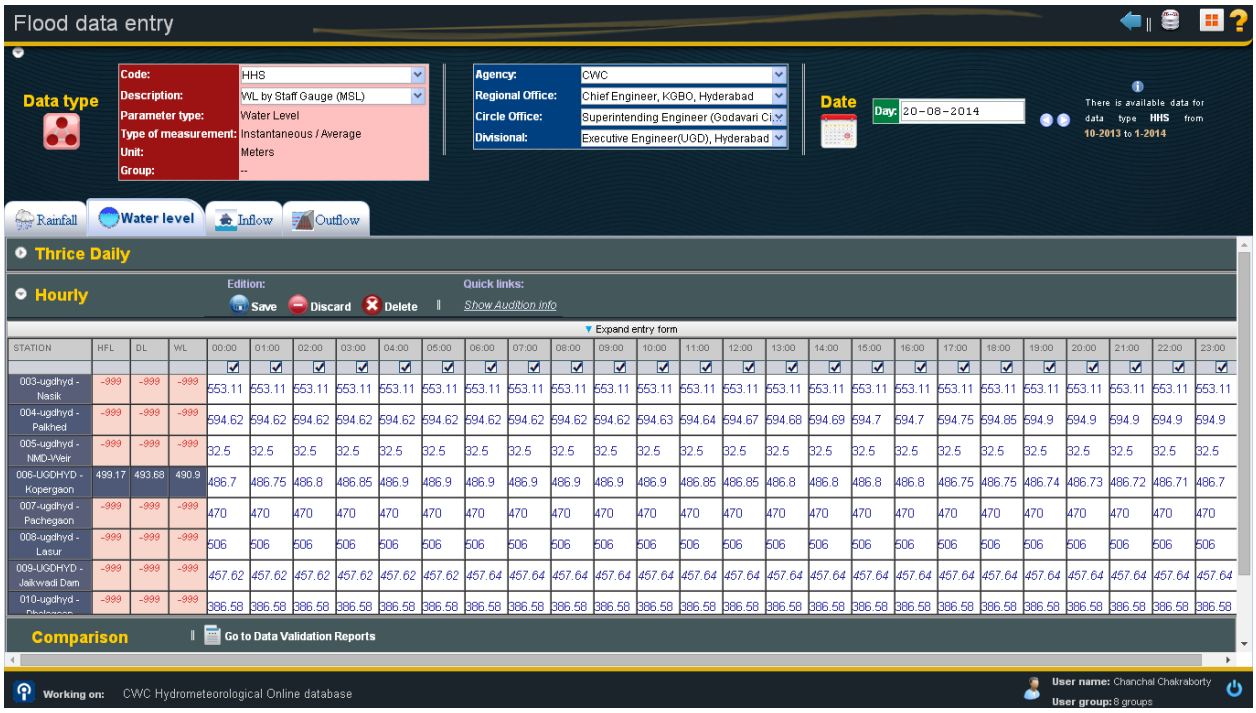
- **Inflow Forecast Data:** The purpose of this module is to forecast any Inflow forecast station, after approved the data this data will be shown in flood-forecasting web-site.



- **Reports:** To generate various types of reports on flood data.



- **Flood Data Entry:** This is the entry form for entering data for flood stations. There is a provision to enter data division wise.



- **Data Validation:** Primary Validation of data 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.
  - **Book Register:** validation options This Module allows user to enter Meta data of a station that can be approved or modify for dissemination purpose.
  - **Data Validation Reports:** To validation data by various reports
  - **Graph Comparison:** To validation data using graphs.
  - **Data Availability:** To query of availability of data.
- **Utilities:**
  - **Import Tool:** The purpose of this module is to Import the Hydro-Meteorological data from SWDES(Access data file), from excel format and from IMD(text format)
  - **Export Tool:** The purpose of this module is to Export the Hydro-Meteorological data in "IMD" format, "MIKE 11"format, "Excel" and "Water year book" format.
  - **Unit Conversion**: A handy tool to convert units.
  - **Compare Reduced Level of Zero Gauge:** The purpose of this module is to compare Reduced Level of Zero Gauge of different stations
- **Reservoir/Diversion Scheme Module:**
  - **Reservoir/Diversion Scheme Data:** The purpose of this module is to enter data for Reservoir.
  - **Elevation-Area Capacity Data :** The purpose of this module is to enter data for Elevation, area and Capacity. A plot of Elevation, Area and Capacity can be generated here
- **HMD Manager:**
  - **Data Synchronization:** The purpose of this module is to Synchronized data from one work area to another; It is mainly used to Synchronization from offline to online database.
  - **Data Audition:** Data Audition shows all operations over data made by the entire user with full description.
  - **Data Dissemination:** The purpose of this module is to Published the approved data in the web site.
- **External Links:** Some Important links which could be useful for the users:
  - **Central Water Commission**
  - **CWC Flood Forecasts**
  - **Water Resource Information**
  - **Ministry of Water Resources**
  - **The Hydrology Project**

- **Indian Meteorological Department**

• Secondary Validation Module

1. Tests on timing errors: Facility to display several stations side by side to detect timing errors.
2. Inspection of temporal variation :
    a. Graphical display of multiple station data in single graph, i.e. flow + rainfall
    b. Graphical display of residual series, residual mass curves
3. Inspection of longitudinal/spatial variation :
    a. Tabular and graphical display of data along a profile
    b. Graphical display of variables on a map
4. Test of relations :
    a. Scatter plots between variables
    b. Time series relations by regression, including time shifts, regression of multiple variables, including flow/discharge
5. Double mass analysis: Comparison of time series to aggregated or averaged groupings of other series.
6. Hydrological validation: Volume and time distribution comparisons between observed runoff and basin rainfall.
7. Data correction :
    a. Linear Interpolation of missing values
    b. Use of regression relations
    c. Constant correction across a range of values
    d. Drift correction across a range of values
    e. Time-shifting data
8. Fitting rating equations :
    a. Simple equations
    b. Complex equations, including backwater corrections, shifts due to scour and deposition, unsteady flow
    c. Calculations for standard weirs and flumes
9. Extrapolation of rating equations : Logarithmic extrapolation, stage-area stage-velocity, Chezy & Manning equations
10. Validation of rating equations : Test new data against existing ratings
11. Hydraulic computations : Calculation of backwater effects by observations of levels and cross sections at downstream points
12. Stage-Discharge Computations : Calculate discharge from stage by calculated ratings
13. Establishment of sediment rating equation : Calculation of sediment ratings in a similar manner to discharge
14. Aggregation and disaggregation : Transformation of data by aggregation or disaggregation to different time intervals
15. Creation of derived series : Minima, maxima, peak over threshold
16. Computation of areal rainfall : Basin rainfall by station weights, theissen polygons, kriging
17. Evapotranspiration : Calculation of PE from meteorological observations