Software

RIBASIM, River Basin Planning and Management

Introduction
An integrated approach to the water system and its surroundings is the basis for long-term, sustainable management of environment. Multi sector planning to allocate scarce resources at the river basin level is increasingly needed in the water sector, as water users and governmental agencies become more aware of the trade-offs occurring between quantity, quality, costs and reliability. The RIBASIM (RIver BAsin SIMulation) model package provides an effective tool to support the process of planning and resource analysis. Since 1985 RIBASIM has been applied in more than 20 countries world-wide and is used by a wide range of national and regional agencies.

RIBASIM is a generic model package for simulating the behaviour of river basins under various hydrological conditions. The model package is a comprehensive and flexible tool which links the hydrological water inputs at various locations with the specific water-users in the basin. RIBASIM enables the user to evaluate a variety of measures related to infrastructure, operational and demand management and to see the results in terms of water quantity, water quality and flow composition. RIBASIM can also generate flow patterns which provide a basis for detailed water quality and sedimentation analyses in river reaches and reservoirs.

RIBASIM is a WINDOWS-based software package and includes a range of DELFT Decision Support Systems Tools.

RIBASIM schematization of the Nile river basin upstream from the High Aswan Dam (Burundi, Congo, Egypt, Eritrea, Ethiopia, Kenya, Sudan, Tanzania and Uganda).

Keywords: surface water, groundwater, water demand, integrated resource planning & management, simulation, water allocation, irrigation, hydropower, reservoir operation, hydrologic flow routing
**Deltares-Delft tools, a new approach: open structure and flexibility**

The structure of RIBASIM is based on an integrated framework with a user-friendly, graphically oriented interface. This framework is built using the Deltares-Delft tools which are a set of general applicable, WINDOWS-oriented software modules required to set up Decision Support Systems. Functions provided by Deltares-Delft tools include the interactive design of the river basin network from a map of the basin, data entry and the set-up of an object-oriented river basin data base, presentation and animation of results on maps, simulation case management, and the analysis of results. Using Deltares-Delft tools opens options for links with other Deltares software.

**Typical Ribasim applications**

RIBASIM is designed for the following purposes:

- Evaluation of the options and potential for development of water resources in a river basin.
  - Given the available water resources and their natural variations, to what extent can a river basin be developed in terms of reservoirs, irrigation schemes and water supply systems, while avoiding unacceptable crop damage or harm to other water users?
  - When and where will conflicts between water users occur, such as between hydro-power production and agricultural development, or industrial development and the degree of water pollution in the basin?
  - What is the potential hydro-power production in the basin?
- Assessment of infrastructure, and operational and demand management measures.
  - What is the effect of potential measure(s) to improve water supply for various users taking into account water quantity and flow composition at selected critical points?
  - What are the agriculture production costs and yields for implementation of potential measures?

RIBASIM is designed for any analysis which requires the water balance of a basin to be simulated. The resulting water balance provides the basic information on the available quantity and quality of water as well as the composition of the flow at every location and any time in the river basin. RIBASIM provides the means to prepare such balances in required detail; taking into account drainage from agriculture, discharges from industry and the downstream re-use of water in the basin.

**Structure of the analysis**

The main RIBASIM user interface is presented as a flow diagram of blocks representing the tasks to be carried-out, and their order, to complete the simulation process. The interface guides the user through the analysis from data entry to the evaluation of results. The blocks change colour on the computer screen to show the user which tasks have already been finished, which are in progress, and which still have to be done. The results of various simulation cases can be analysed together. The user does not need to work with the underlying file and directory structures nor with file management. The Deltares-Delft tools provide an environment which organises these user functions. These tools have an open structure which makes it possible to add or remove blocks from the flow diagram and to adapt the interface to project requirements.

**Interactive schematization of the river basin**

RIBASIM enables a schematization of the river basin to be prepared interactively from a map. This schematization consists of a network of nodes connected by branches. The nodes represent reservoirs, dams, weirs, pumps, hydro-power stations, water users, inflows, man-made and natural bifurcations, intake structures, natural lakes, swamps, wetlands, etc. The branches transport water between the different nodes. Such a network represents all of the basin’s features which are significant for its water balance and it can be adjusted to provide the exact level of detail required. The river basin is presented as a map over which the network schematization is superimposed as a separate map layer. The background map can be produced by any Geographical Information System.

The attribute data of the network elements are entered interactively and linked to the map of the river basin and its network schematization. Data consistency tests are an integral part of this.
River basin simulation

Simulations are usually made over long (multiple years) time series to include the occurrence of dry and wet periods. The simulation time steps used are variable and are defined by the user. Within each time step, the water demand is determined, resulting in targets for water releases from reservoirs, aquifers, lakes, weirs and pumping stations. Then, the water is allocated to the users according to the release targets, water availability, operation rules and water allocation priorities.

Water allocation to users can be done in several ways: at its simplest, water is allocated on a “first come, first served” basis along the natural flow direction. This allocation can be amended by rules which, for example, allocate priority to particular users, or which result in an allocation proportional to demand.

Evaluation of results

Using a set of simulations, usually made for a range of alternative development or management strategies, the performance of the basin is evaluated in terms of water allocation, water shortages, firm and secondary hydropower production, overall river basin water balance, flow composition, crop production, flood control, water supply reliability, groundwater use, etc.

The user can select how the output data will be shown and in which format: graphs, thematic maps, tables or spreadsheet. A wide range of functions are available to provide insight into the behaviour of large and complex river basins. For instance, it is possible to make an animation of the basin in which flow is indicated with arrows and the size of the flow is shown in different colours and/or line thickness. In a similar way, other output parameters, can be shown. By clicking the item on the map and then selecting the desired output parameter, time diagrams can be presented. Moreover, all output data can be simply exported into other formats.

Interactive design of river basin network schematization for Jratseluna basin, Indonesia

Interactive graphical design tool of a crop plan for the North Tarum irrigation area (Indonesia).

Important features

- RIBASIM is a modelling instrument for river basin planning and management;
- RIBASIM supports a default and user-defined source analysis giving insight in the water’s origin and residence time at any location of the basin and at any time within the simulation period;
- RIBASIM has an integrated agriculture water demand, water allocation, crop yield and production costs model based on crop and soil characteristics, crop plan, irrigation and agriculture practise, expected and actual rainfall, reference evapotranspiration, seepage, actual field water balance, potential crop yield and production costs.
- RIBASIM has a fully graphical user interface for designing the river basin network but also for crop cultivation planning.

Interactive design of river basin network schematization for Jratseluna basin, Indonesia.

The flow in the Oum Er Rbia basin (Morocco) is visualised by blue coloured width of the links. The graph shows the water demand and allocation to a selected irrigation area.

Interactive graphical design tool of a crop plan for the North Tarum irrigation area (Indonesia).
For most basin planning purposes the RIBASIM straightforward water quality modelling is sufficient. If detailed simulation of chemical and biological processes is required then a link between RIBASIM and a detailed water quality simulation model like Deltares 1DWaq-model should be activated;

- Groundwater is modelled as separate source for various users with its own characteristics and water management.

- Large and complex river basins can be modelled and simulated with RIBASIM;

- RIBASIM offers various flow routing procedures like Manning, 2-layered multi-segmented Muskingum, time-delayed Puls method, Laurenson non-linear “lag and route” method, etc;

System requirements
RIBASIM does not require any software from third parties.

Hardware
The advised minimum requirements is a configuration consisting of:
- Pentium processor;
- 64 Mb RAM;
- 400 Mb free disk space;
- super VGA graphics card with monitor;
- mouse;
- CD-ROM drive

Software
MICROSOFT WINDOWS 95, 98, 2000, NT, XP AND VISTA.

The composition of the flow over 5 year period in term of the water’s origin at a downstream location in the Caroni Basin, Trinidad.