LECTURE-12

Application of Mike Basin (DHI Software): A Hydrological Modelling Tool on Lake Sustainability

Ashok Tarai
Senior Engineer- Water Resources
DHI (India) Water & Env. Pvt. Ltd.
K-71, First Floor, Hauz Khas Enclave
New Delhi-110016

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Ashok Tarai
Senior Engineer- Water Resources
DHI (India) Water & Environment Pvt Ltd
K-71, FF, Hauz Khas Enclave
New Delhi-110016
e-mail: akt@dhi.co.in

INTRODUCTION

Lakes are being used for the purpose of drinking water and for tourist centre. The ecosystem of lake is loaded with pollutants from vicinity catchment. The catchment inflow is reducing day by day with rapid infrastructure development. So in this context to study the integrated catchment of Lake is essential.
This training course is designed to introduce and familiarise users with MIKE BASIN (Mathematical Modelling Tool for Water Optimization) and its application in the study of Hydrology of Lake catchment.

What is MIKE BASIN?

MIKE BASIN is a simulation model for water allocation representing the hydrology of the basin in space and time. Technically, it is a network model in which the rivers and their main tributaries are represented by a network of branches and nodes (Fig. 1). The branches represent individual stream sections while the nodes represent confluences, bifurcations, locations where certain water activities may occur, or important locations where model results are required.

The rationale of undertaking water resources studies on a basin scale instead of on a project by project basis is based on the recognition that the water and land resources of a basin forms a unity and hence must be treated as such if future conflicts over water utilization are to be avoided. River basin management and planning for a basin may broadly be conceived as an attempt to identify the best possible utilization of the available water resources given certain soil, land, agricultural, engineering, and social constraints. Due to the multitude of water resources development options which often exists, due to conflicts over the utilization of a particular source between individual schemes and finally due to the interdependency between water, soil and land use, river basin management is indeed a complex task. The planning for future water developments within a basin thus requires that conclusions originating from the study of individual aspects are gathered and brought together in a framework capable of undertaking an integrated analysis. A water resources management tool, such as MIKE BASIN centered on a basin wide representation of the water availability and potential users of water, offers a basis for such a framework.

MIKE BASIN operates on the basis of a digitized river network generated directly on the computer screen in the map view. All information regarding the configuration of the river branch network, location of water users, channels for intakes and outlets to and from water users, reservoirs are also defined by on-screen editing.

Basic input to the model consists of time series data of various types. Basically only time series of catchment run-off is required to have a model setup that runs. Additional input files define reservoir characteristics and operation rules of each reservoir, meteorological time series and data pertinent to each water supply or irrigation scheme such as bifurcation requirements and other information describing return flows. Additional data describes hydraulic conditions in river reaches and channels, hydropower characteristics, groundwater characteristics etc.

An important feature of the MIKE BASIN Model is the ability to handle users with multiple priorities from any number of different river sources as well and a source with priorities for any number of different users. Often, several users may want to receive water from the same resource (Figure 1.1). Within the MIKE BASIN network model concept this situation is represented by several user (off-take) nodes connected to a single supply node. Allocation algorithms determine how water is distributed among several users in case of conflicts. In general, a local priority relationship is applied between a supply node (upstream) and several user nodes (downstream). Dialog boxes for supply nodes (reservoirs, river off-take nodes) allow for the specification of the sequence in which connected user nodes' water demands are fulfilled. Alternative water sharing algorithms are available in MIKE BASIN that are based on fraction of flows or fraction of demands. All dialog boxes use a standard design for specifying these connections. Conversely, the dialog boxed for water users allow for the specification of the sequence in which extractions are requested from several upstream connected supply nodes. The first node in the list will supply the entire or partial demand before the second node is considered. This second node will supply the remaining demand (if any after the first node has supplied 'its' water), and so on for the subsequent supply nodes. For groundwater, all users have the same priority. They all receive the same proportion of their demand. A particular groundwater user can have only one supplying catchment at present.

The facility to handle priorities from a user perspective as well as from the resource perspective makes the model extremely flexible in its application. The model is also able to look at and use many different types of institutional arrangements such as fractional allocations and capacity sharing (Water banking) which make it even more useful in terms of different operating criteria which you can manage on a system.

MIKE BASIN is also able to handle a large array of different processes, such as rainfall runoff, water quality (non point source and point source for a large number of different WQ contingents), groundwater and channel routing on top of the water allocations priorities and water accounting dynamics. It has the ability to allow for flexible time stepping from seconds through to months and years enabling the user to run the model at the level of detail and with the processes they require. It can thus easily be used in real time and near real time operational river management, planning and licensing applications. A model with the flexible time stepping mechanisms allows for real time application and can reflect the operational time scale (be it daily, weekly or monthly) more accurately.

Another dynamic feature of the model is the customisability which enables users to add in their own processes or tailor their outputs specifically for a client's needs or requirements. Access to all the components of the time series and parameters enables the users to review individual users as well as aggregated components of the system making it possible to pinpoint problem areas and place in specific corrective remedial or planning actions. This allows for control of both users connected to specific large resources such as dams as well as upstream water users.

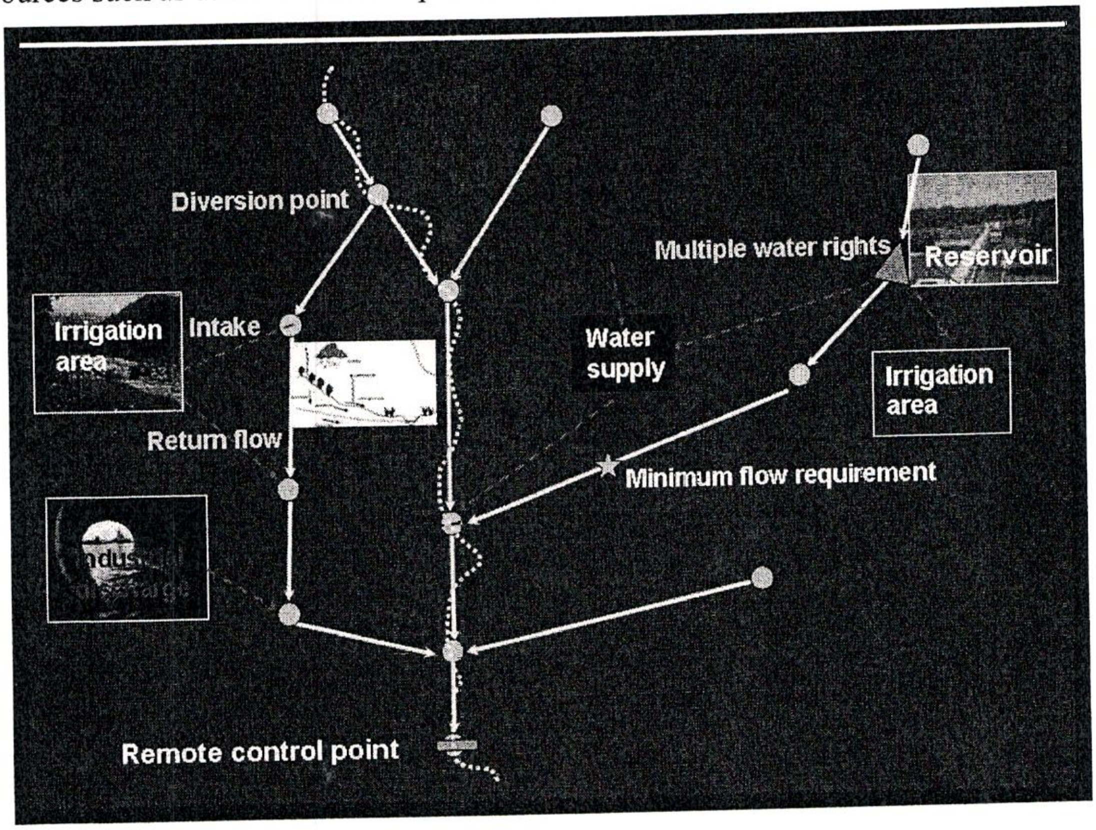

Fig. 1. Simplified schematization of the MIKE BASIN model network

Generic Modelling concepts

The methodology employed in the setting up of the MIKE BASIN model follows both local and international guidelines as to model formulation and setup. These guidelines ensure a scientifically rigorous approach is followed and that the models are set up at an appropriate level of detail for the project at hand. The process is also designed to ensure that model results can be replicated (with a reasonable degree of accuracy) in that the assumptions, chosen processes and associated temporal and spatial scales are made explicit.

The list below is a useful checklist describing the process to be followed in setting up and obtaining results from MIKE BASIN:

- Conceptual model formulation
- Project objectives
- Problem formulation
- Scale effects and dominant processes selection

- Model domain
- Conceptual configuration
- Scenario formulation
- Initial model setup
- Information collection
- Water requirements and return flows
- Climate information
- Hydrological information
- GIS information
- Infrastructure information
- Operating rules
- Information transformation and housing
- Database and data structure definition
- Automated data transformation development
- Information transformation and database data capturing
- Determining main infrastructural features
- Determining main water users
- Catchment delimitation
- Operational policy
- Current policy
- Future developments
- Model verification
- Hydrological information checking
- Verification against historical reservoir trajectories
- Verification against current operations
- Finalised historical and current model setup for verified information
- Refined scenario formulation
- Running of Stochastic information
- Run scenarios
- Formulate result requirements
- Examine results and key discussion points
- Finalise scenario results
- Report and presentation

The model application in the study of sustainable lake hydrology will be presented by representative from DHI Water and Environment, India.