Texas A & M University and U.S. Bureau of Reclamation
Hydrologic Modeling Inventory
Model Description Form

JUNE 18, 1999

Name of Model:

MIKE 11

Model Type:

MIKE 11 is a professional engineering software package for the simulation of flows, water quality, and sediment transport in estuaries, rivers, irrigation systems, channels and other water bodies.

MIKE 11 is a fully dynamic, user-friendly, one-dimensional modelling tool for the detailed design, management and operation of both simple and complex river and channel systems. Due to its exceptional flexibility and speed, MIKE 11 provides a complete and effective design environment for engineering, water resources, water quality management and planning applications. MIKE 11 utilizes a fully Windows integrated Graphical User Interface.

Model Objective(s) :

The purpose of MIKE 11 is:
- simulation of hydraulic conditions (water levels and flow) for Flood risk and Flood Damage assessments, flood control measures and operation of irrigation and surface drainage systems,
- simulation of Advection-Dispersion of conservative and non-conservative materials. Typical applications comprise studies of saline intrusion and the behavior of cohesive sediment,
- simulation of river Water Quality (BOD-DO relations, Eutrophication and Heavy Metals) in areas influenced by human activities, e.g. oxygen depletion as a result of organic matter and/or ammonia loadings
- simulation of non-cohesive sediment transport and morphological changes. That is, to determine sediment budgets and to assess the morphological impacts of proposed river works such as dredging and sand extraction,
- real-time flood or storm surge forecasting of river flows and water levels,

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Model Structure or Mathematical Basis:

1. Type of basins: MIKE 11 is developed for simulating flows, water quality and sediment transport in estuaries, rivers, irrigation systems, channels and other water bodies .
2. Size of basin: MIKE 11 has No limitations what so ever on the size of model area or number of input elements to be included in the simulation. MIKE 11 is applicable to branched and looped networks and quasi two-dimensional flow simulation of flood plains
3. Nature of simulation: The simulation with MIKE 11 is continuous, in a user-defined time period. The time period defined by the user can comprise either single of multiple events.
4. Components represented in model formulation: Channel flow,
5. Type of equations: The complete non-linear equations of open channel flow (Saint Venant) are solved numerically between all grid points at specified time interval for given boundary conditions.
6. Mathematical formulation of model components: MIKE 11 is a deterministic mathematical modelling tool.
   In addition to the fully dynamic description (complete set of non-linear Saint Venant equations) a choice of simplified flow descriptions is available. These are; diffusive wave, kinematic wave and quasi-steady state.

Model Parameters:

- For the Hydro Dynamic model there is one parameter to estimate; that is the bed roughness.
- For the Advection Dispersion and Water Quality models, the parameters involved are: Concentrations, Temperature, Sun radiation, , dispersion coefficients, Oxygen processes, Algae growth and decay
- For the Sediment Transport model, the parameters comprise: Sediment grain size, Shear stress, porosity, Specific density of sediments, kinematic viscosity, transport rates, Bed levels

Spatial Scale employed in the Model:

In MIKE 11 the river system is decomposed into a network of single, branched or looped river branches, each having individual parameters and processes.

Temporal Scale employed in the Model:

MIKE 11 is a continuous model simulating single or multiple events in a user defined simulation period.

Input Data Requirements:

- Characteristics of the river system; topographical data (cross sections, channel lengths, storage areas),
- Man-made interventions; geometrical description and location of all man-made hydraulic structures etc.,
- Boundary conditions; measured series of water level and river flows or rating curves (Q-h relations),
- Channel roughness; Information on river vegetation. That is, the density and location of the different types of river vegetation for estimation of the channel roughness to apply in the river model.

Computer Requirements:

MIKE 11 is available for Windows 95, Windows 98 and Windows NT. Computer requirements for MIKE 11 are therefore similar to those recommended for Windows 95/98 or Windows NT. Recommended (minimum) configuration: Processor: Pentium, 120 MHz, Memory: 64 Mb RAM, Hard disk: 1 Gb, Monitor: SVGA, resolution 1024x768, 1Mb Ram on Graphic card and a CD-Rom drive.

Model Output:

MIKE 11 produces output for a large number of variables with a user defined time interval.
Default output from a MIKE 11 simulation comprise:
- water levels and river flows (Hydro Dynamic model),
- concentrations of each defined component (Advection Dispersion and Water Quality models),
- sediment transport and bed levels (Sediment Transport model)

In addition to the above, user-selected variables can be produced as output. Examples are:
Velocity, Water surface gradient, Flow Area, Flow Width, Hydraulic Radius, Bed Resistance, Conveyance, Froude number, Volume, Flooded (surface) area and Mass error.

Model output can be presented as user selected timeseries, longitudinal profiles, Q-h series and/or water level in cross sections. Results of one or more simulations can be presented for comparison and results can be presented synchronised. That is, viewing e.g. a plan view together with a longitudinal profile and one or more time series plots and Q-h relation plots – all from the same simulation and shown on the screen synchronised in time.

Parameter Estimation / Model Calibration:

In MIKE 11 the user can specify parameters both as global and as local values. That is, the spatial variation of e.g. bed roughness can easily be described by the user.
Additionally, a time varying bed roughness can be applied to describe the annual variation of vegetation in river systems.

Model Testing and Verification:

MIKE 11 has been extensively tested using data from laboratory tests as well as measurements from different watersheds. In addition to the test-procedures performed at the Danish Hydraulic Institute, MIKE 11 has participated in a number of tests worldwide. The latest is the 'Benchmarking and Scoping of Hydraulic models' where 12 computer models for simulation of river systems were tested. These tests were conducted by the University of Bradford, UK, in 1997.
An additional verification of the applicability of MIKE 11 is evidenced by the wide spread use of the model worldwide, and the fact, that several authorities worldwide has selected MIKE 11 as the one and only accepted modelling package to apply when carrying out investigations and simulations within their territory.

Model Sensitivity:

In MIKE 11 the spatial (and temporal) variation of bed roughness (Manning's M, Manning's n or Chezy) is the most important parameter to adjust when calibrating the river model.

Model Reliability:

MIKE 11 is one of the most common applied River modelling tools worldwide. MIKE 11 has been applied in all parts of the world for a significant diversity of projects. Continuity in development and reliability in output are keywords for MIKE 11 and some of the most important reasons for consultants and authorities worldwide to choose MIKE 11 as their preferred modelling tool.
It is through the large number of projects carried out by the Danish Hydraulic Institute, other consultants and regional as well as local authorities worldwide, that the reliability and applicability of MIKE 11 has been proven.

Model Application / Case Studies:

MIKE 11 has been applied worldwide in a large diversity of projects including design and planning of a wide range of civil works such as flood prediction, flood protection, urban drainage, dam safety and breach evaluation.

MIKE 11 is in the US applied by several US Army Corps Districts as well as other local municipalities. In Canada MIKE 11 has been selected as the hydrodynamic modeling tool by the Government for the past two years.

A few key international references for case studies with MIKE 11:
Flood Action Plans (FAP) in Bangladesh, Flood Forecasting in Yangtze River (China), Drainage Master Plans for all seven major drainage areas in Hongkong, Salt River Project (USA) involving control of irrigation systems, Flood Management in Czech Republic, Flood forecasting in Poland, Water Quality modelling in upper part of Yangtze River (China), Urban Pollution Management projects in UK etc.

Documentation:

User manual and Quick Guide to getting started is offered together with an extensive On-line Help system. Additionally, a Technical Reference is available.

In addition, DHI offers a comprehensive system of technical support through its dedicated Software Support Centre. 24 hour assistance from DHI's highly trained technical staff can be obtained through our Software Support Centre via telephone hotline, fax or the Internet (software@dhigroup.com). As a part of License Service Agreements DHI software users are updated regularly with software developments via newsletters and Internet broadcasts.

Other Comments:

- MIKE 11 offers the possibility of linkage with ESRI's ArcView GIS package for production of Flood Maps, Flood duration maps etc. Additionally, topographical information (cross sections, area-elevation curves etc) can be extracted from a DTM for usage in the river model
- Through linkage with the DHI's groundwater model; MIKESHE, it is possible to perform integrated modelling tasks where interaction of surface and sub-surface waters are dynamically simulated.
- Information about MIKE 11 is available on http://www.dhi.dk/mike11, which also describes current and planned developments, current installations etc. A demo version can be downloaded from the above web site.