Module 9

Lecture 4: MIKE models

MIKE Models

a) Flood Management

- **MIKE 11➔** For Analyzing Open Channel Flow
- **MIKE 21➔** For Analyzing surface complicated overflow

b) River Basin Management

- **MIKE BASIN**

c) Hydrological Cycle

- **MIKE SHE**

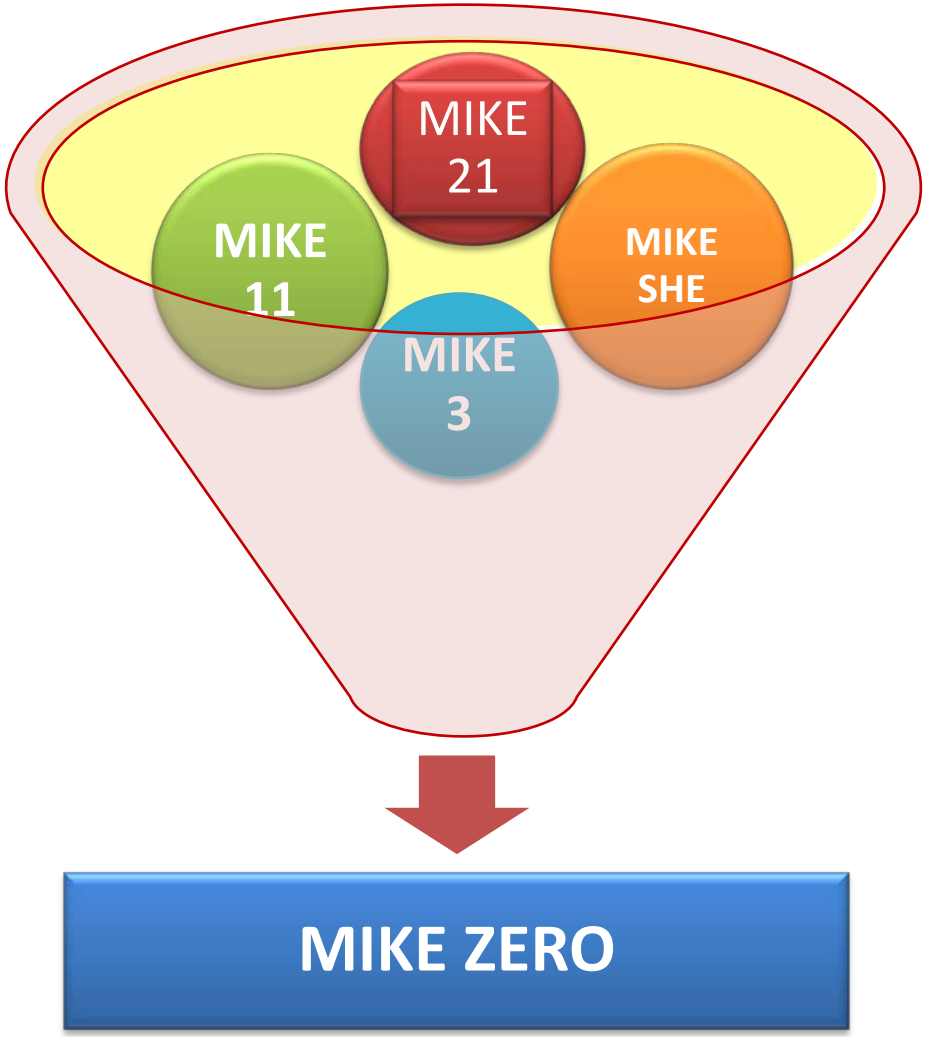
d) Urban Drainage

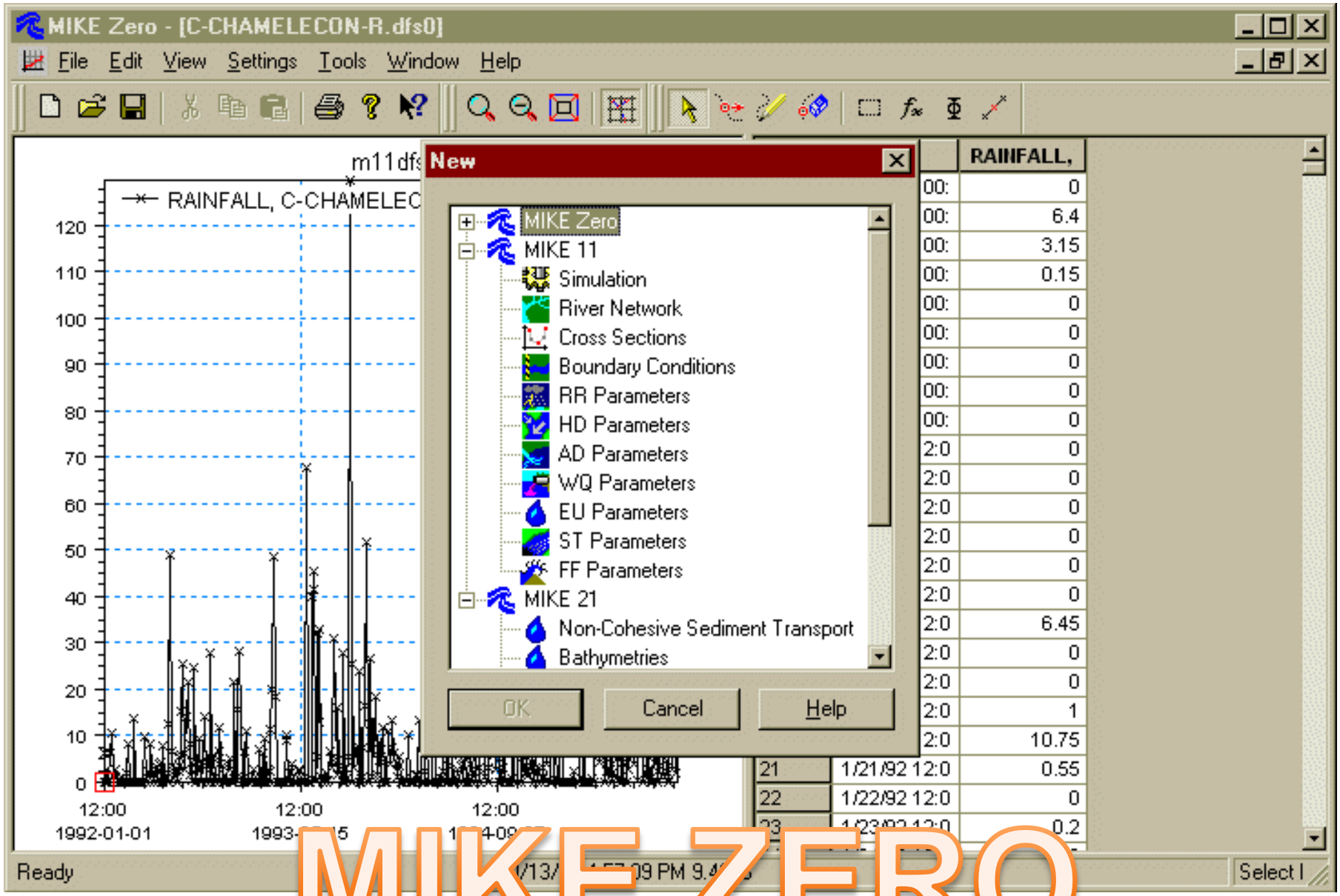
- **MOUSE➔** For Analyzing Urban Sewage

MIKE Hydrological and Hydrodynamic Models

- **1 Dimensional**
  - **MIKE 11**
- **2 Dimensional**
  - **MIKE 21**
- **3 Dimensional**
  - **MIKE SHE**
  - **MIKE 3**

MIKE Zero-fication!




MIKE Zero - [C-CHAMELECON-R.dfs0]
File Edit View Settings Tools Window Help
RAINFALL, C-CHAMELEC
120
110
100
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New
MIKE Zero
MIKE 11
Simulation
River Network
Cross Sections
Boundary Conditions
RR Parameters
HD Parameters
AD Parameters
WQ Parameters
EU Parameters
ST Parameters
FF Parameters
MIKE 21
Non-Cohesive Sediment Transport
Bathymetries
OK
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RAINFALL,
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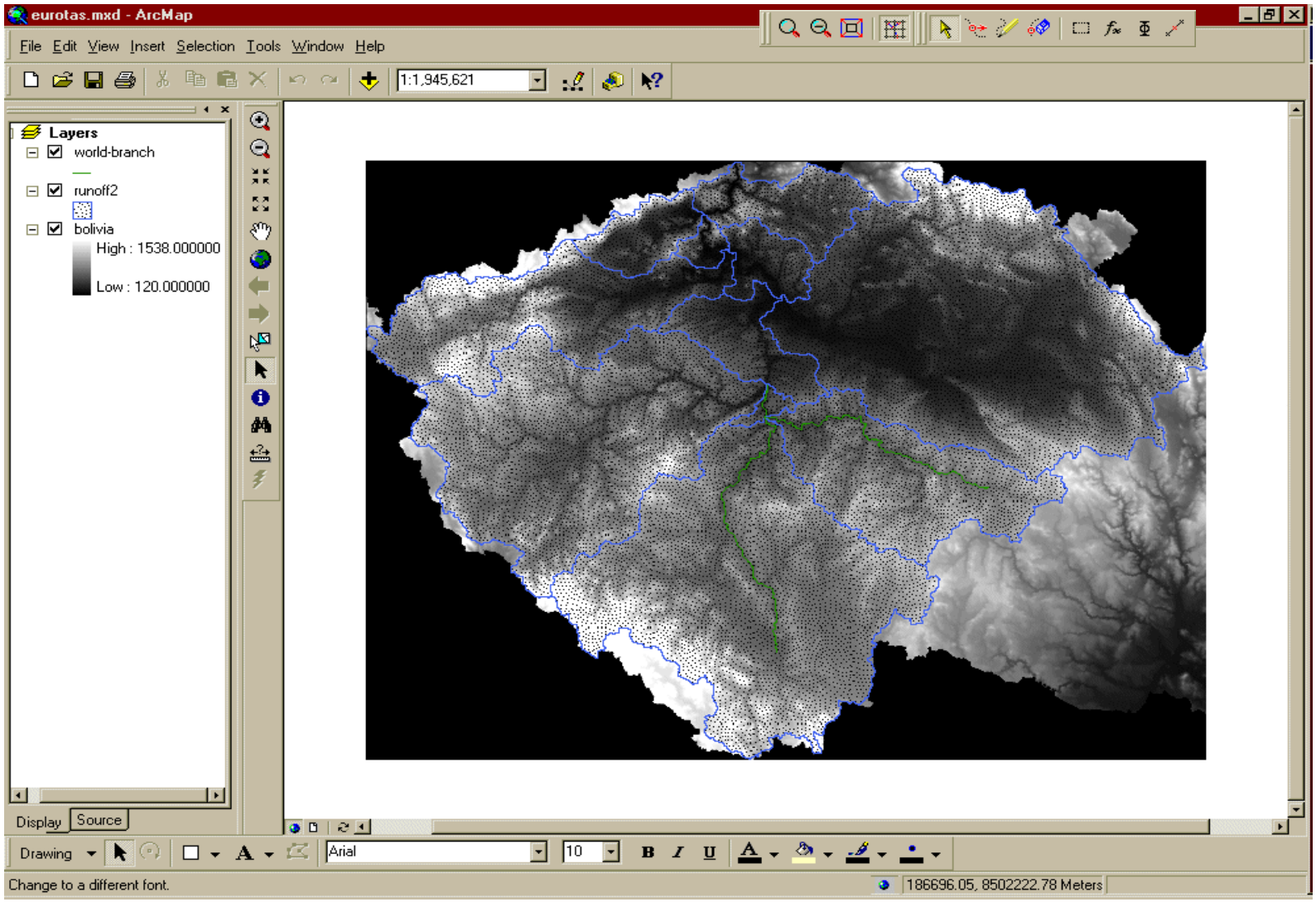
21 1/21/92 12:0 0.55
22 1/22/92 12:0 0
Ready
Select I

MIKE ZERO

ArcMap with MIKE ZERO



MIKE 11 GIS

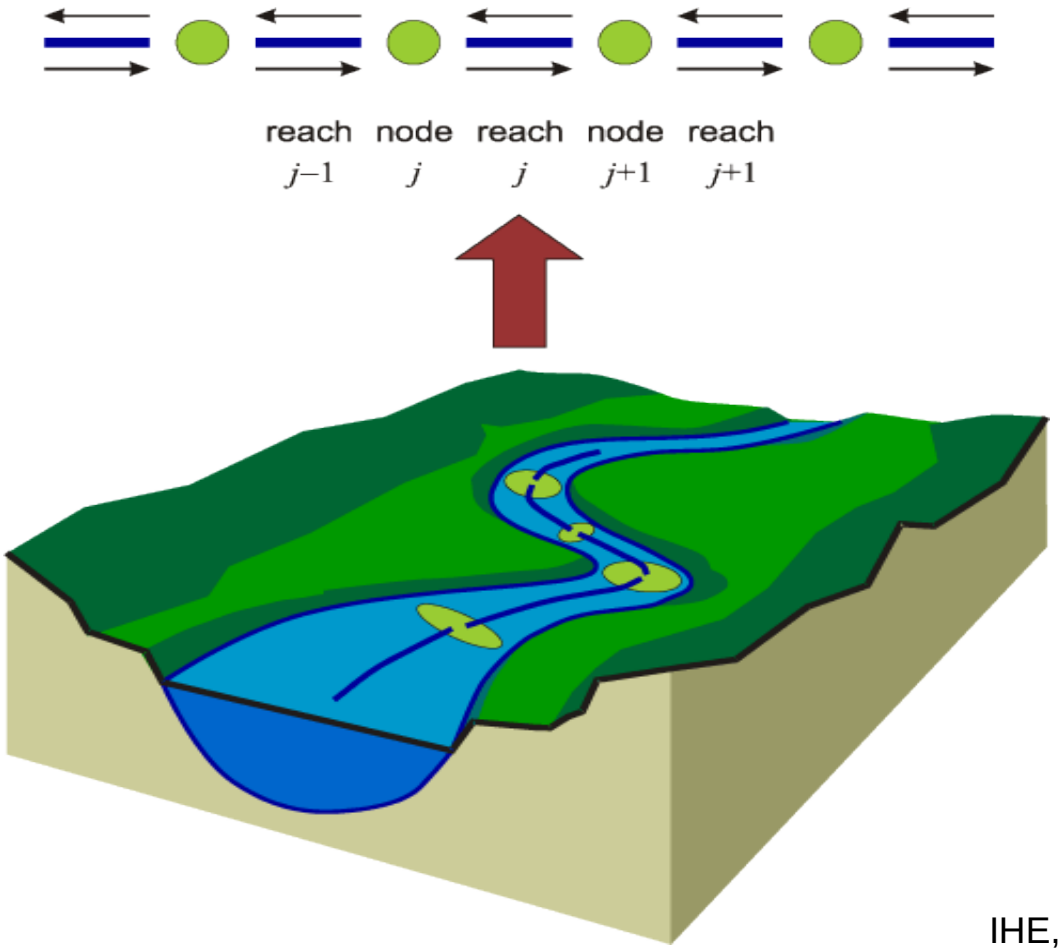
- Fully integrated GIS based flood modelling
- Developed in ArcView GIS
- Pre-processing:
  - Floodplain schematization
- Post-processing:
  - •Flood depth maps
  - •Comparison maps
  - •Duration maps
- Analysis with other GIS data

- **Mike 11 Modules**
  - HD : hydrodynamic - simulation of unsteady flow in a network of open channels. Result is time series of discharges and water levels;
  - AD : advection dispersion
  - WQ : water quality

Open channel flow

- Saint Venant equations (1D)
  - continuity equation (mass conservation)
  - momentum equation (fluid momentum conservation)
- Assumptions
  - water is incompresible and homogeneous
  - bottom slope is small
  - flow everywhere is paralel to the bottom (i.e. wave lengths are large compared with water depths)

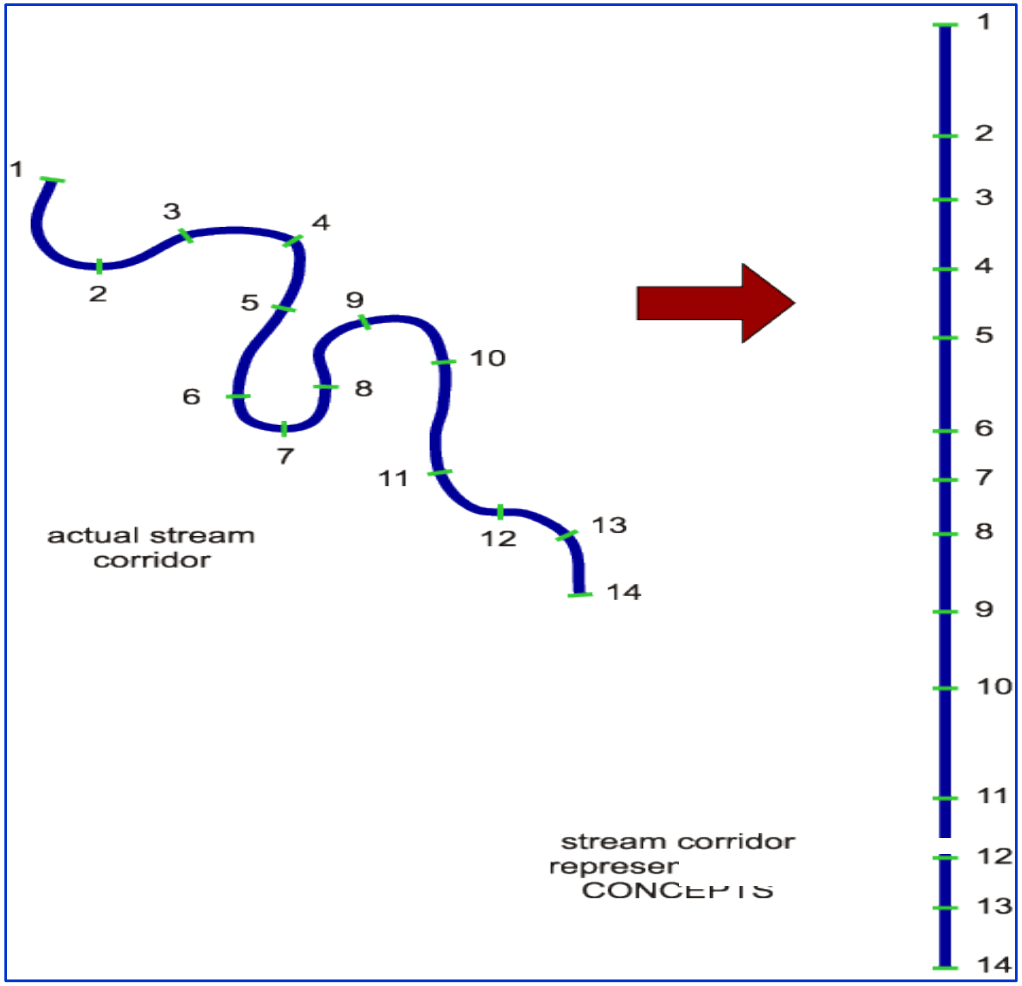
Discretization - branches



IHE, 2002

Discretization – branches

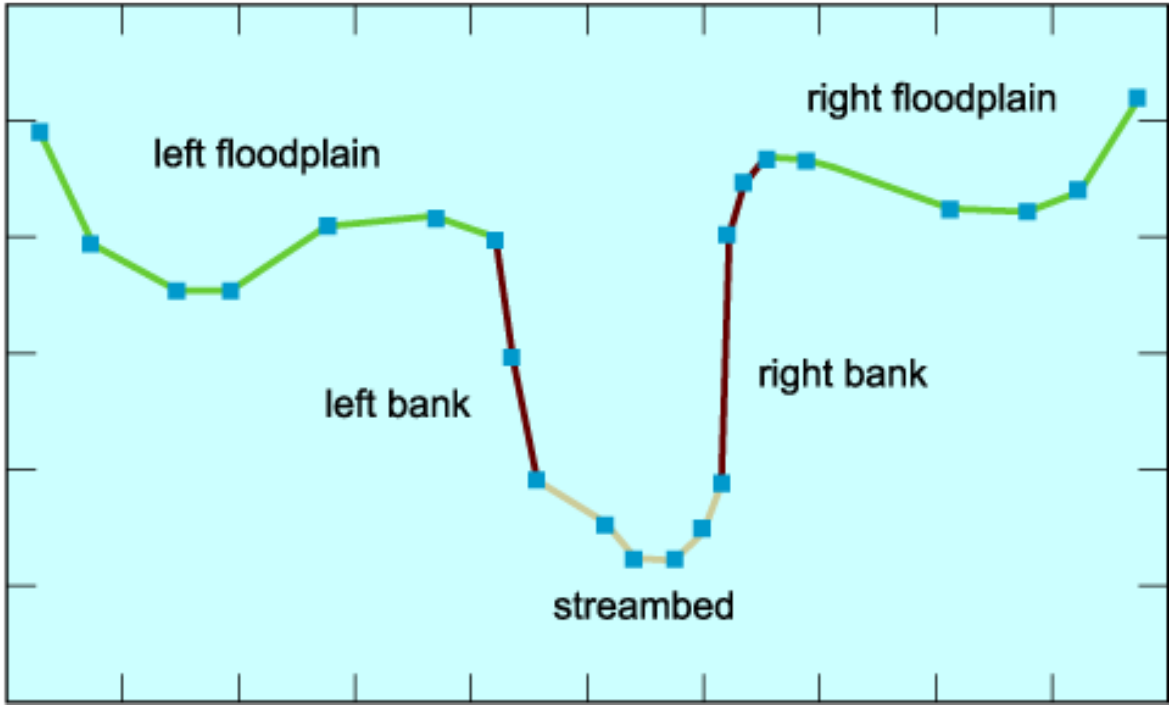
Contd...



IHE, 2002

Discretization - cross sections

- Required at representative locations throughout the branches of the river
- Must accurately represent the flow changes, bed slope, shape, flow resistance characteristics

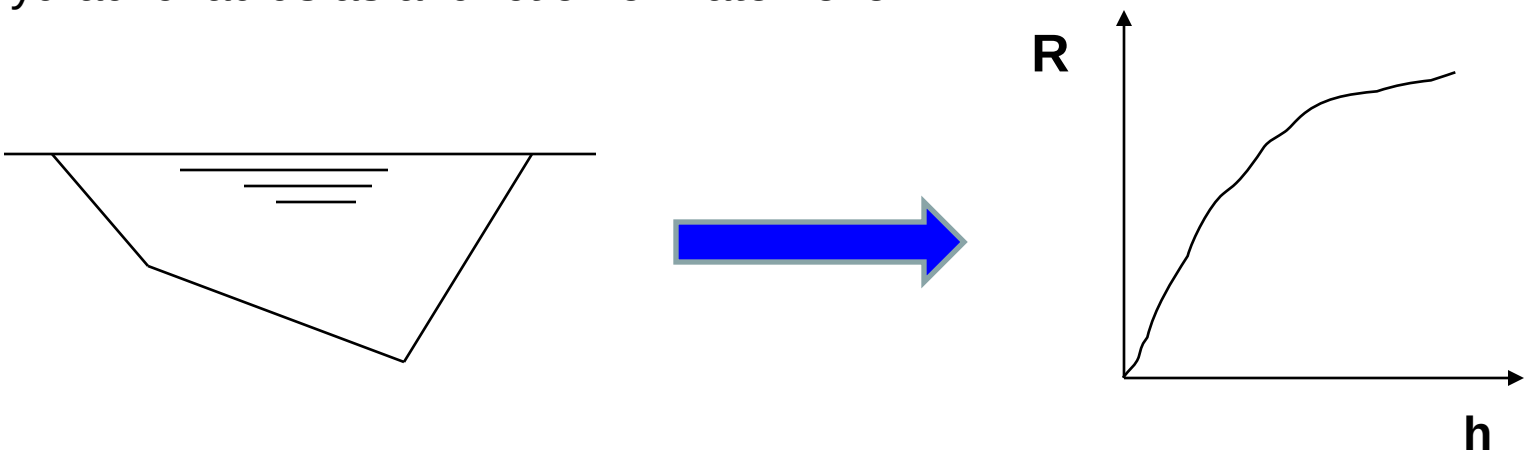


IHE, 2002

Discretization – cross sections

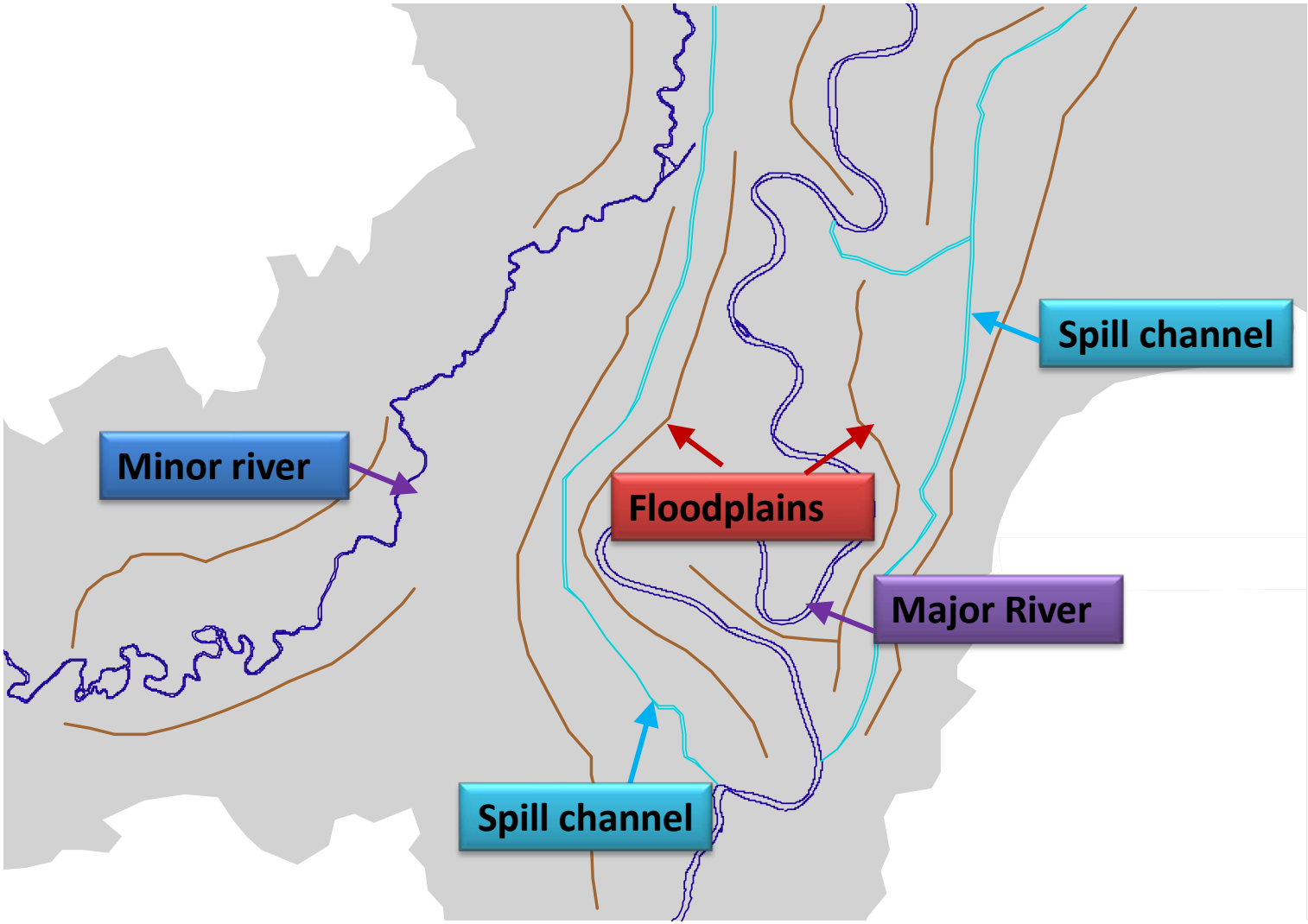
Contd...

- Friction formulas
  - Chezy
  - Manning
- For each section a curve is made with wetted area, conveyance factor, hydraulic radius as a function of water level



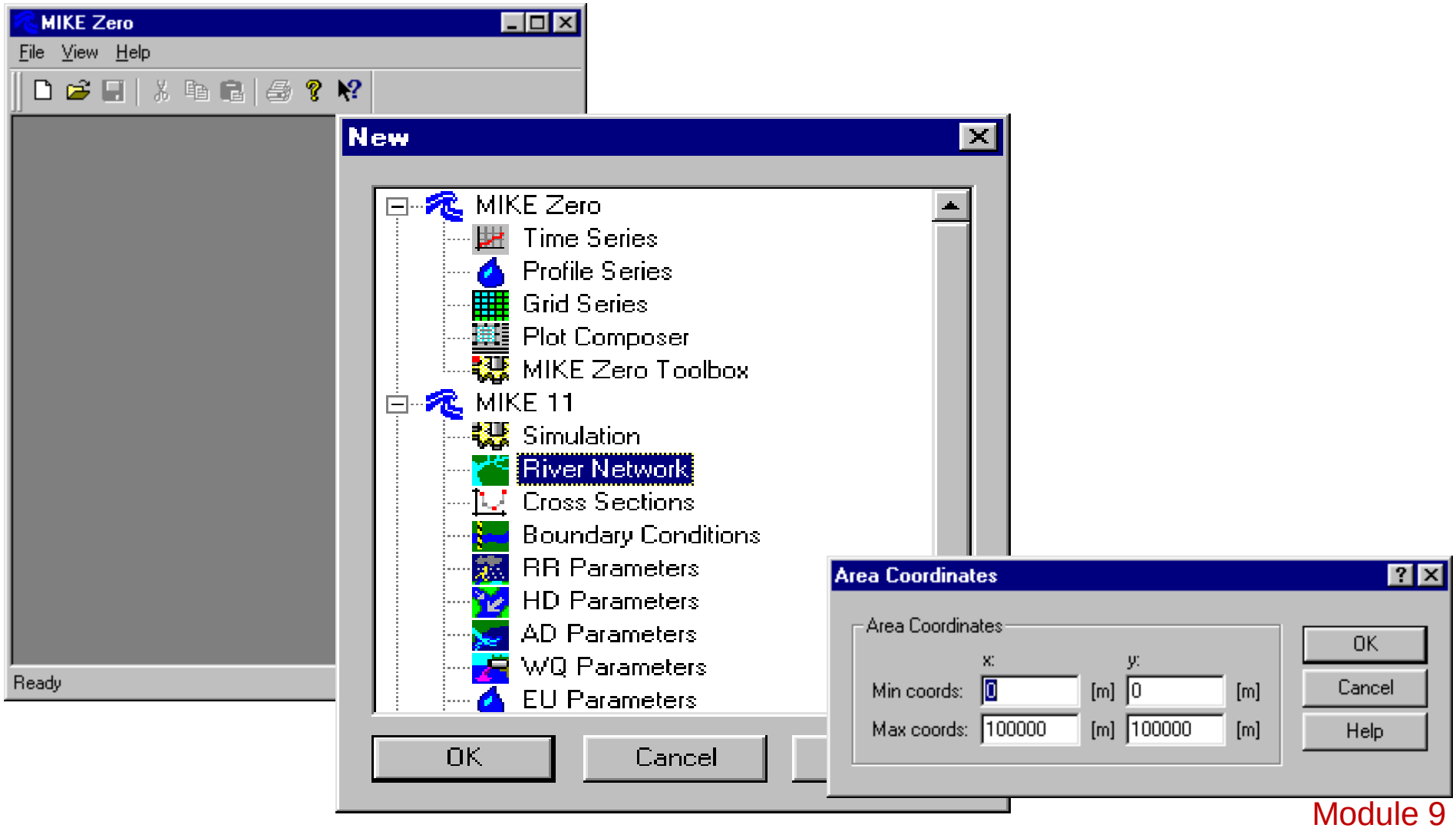
IHE, 2002

Typical Model Schematisation

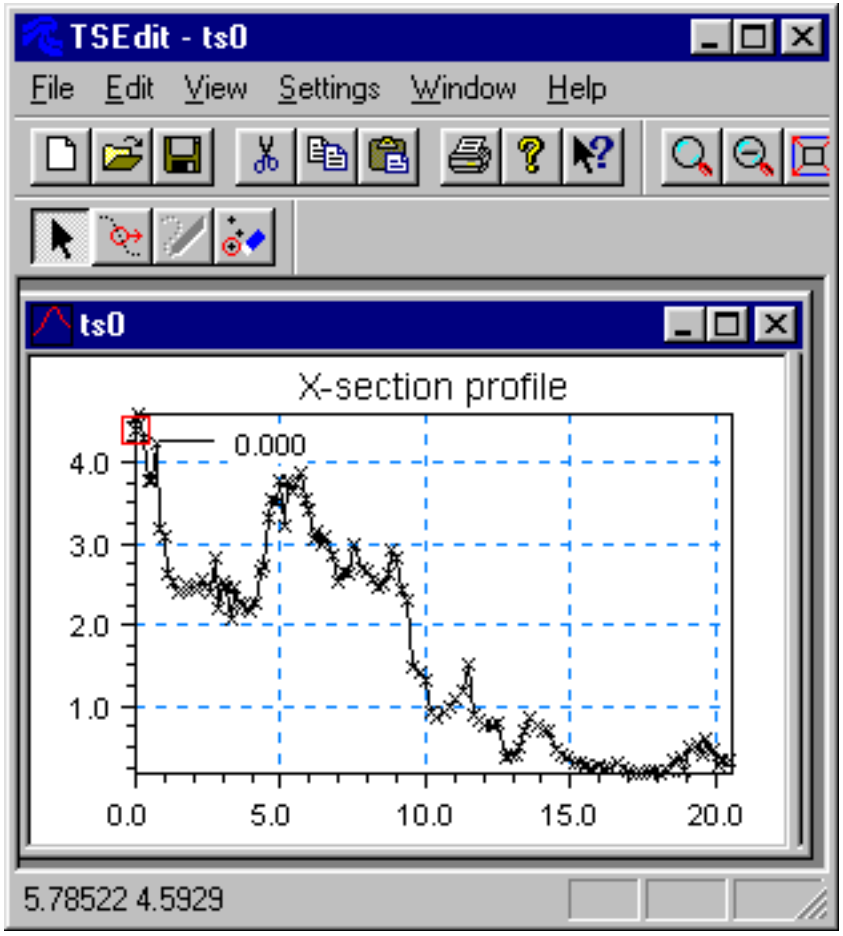


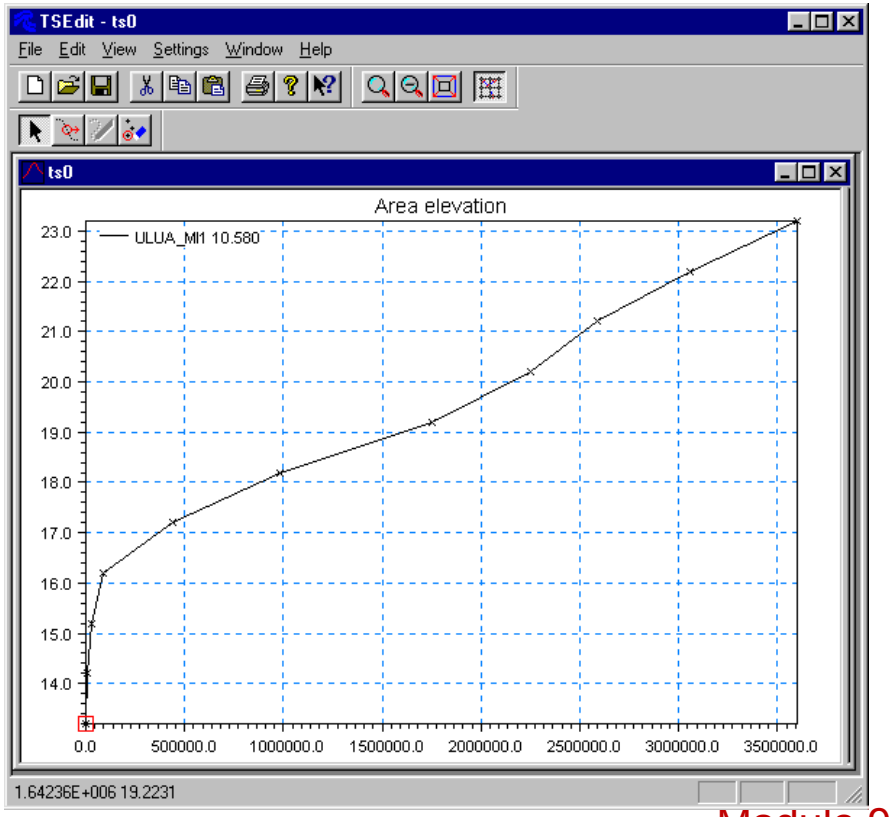
(Source: http://www.crwr.utexas.edu/gis/gishyd98/dhi/mike11/M11_main.htm)

Mike 11 main menu



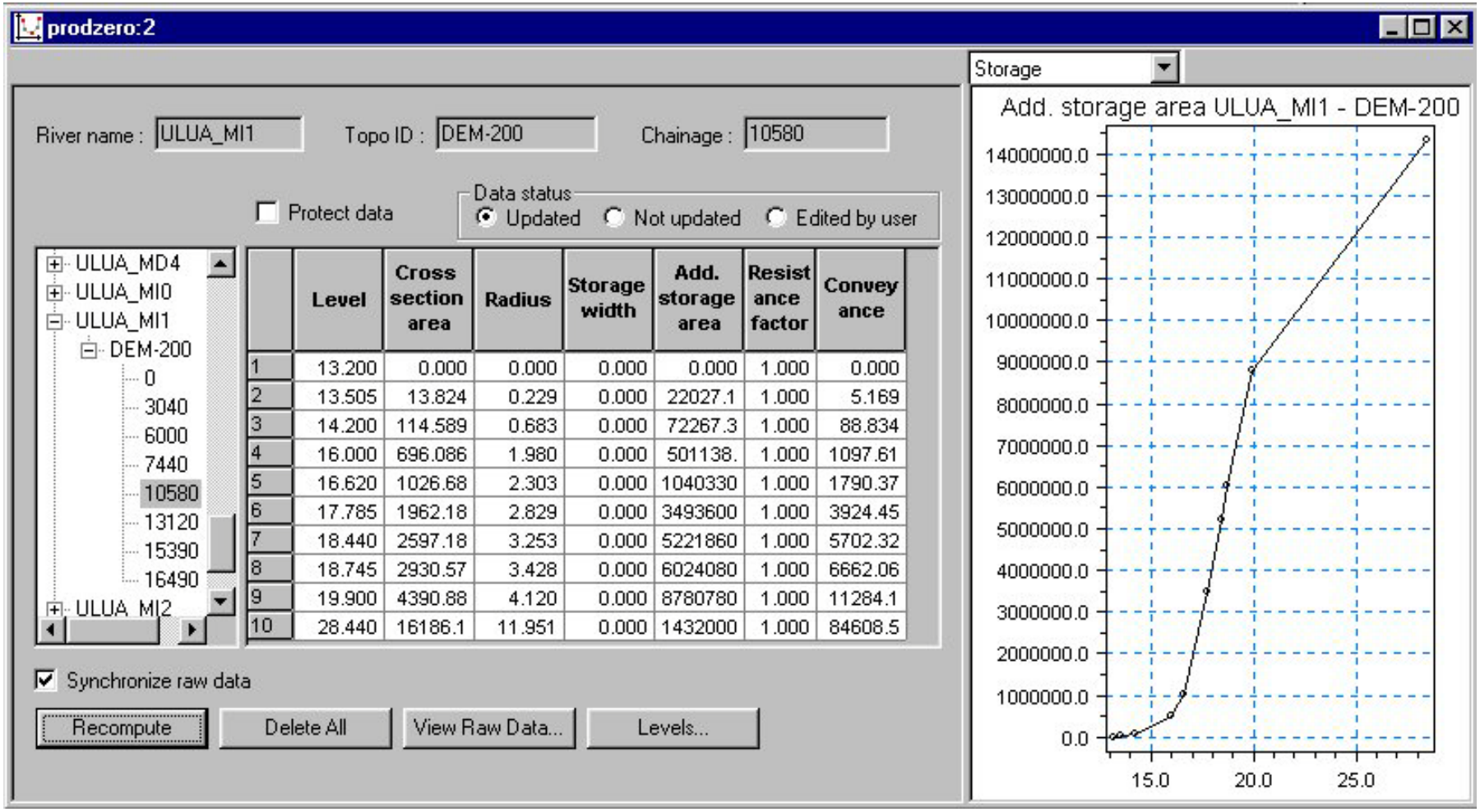
Extraction from DEM





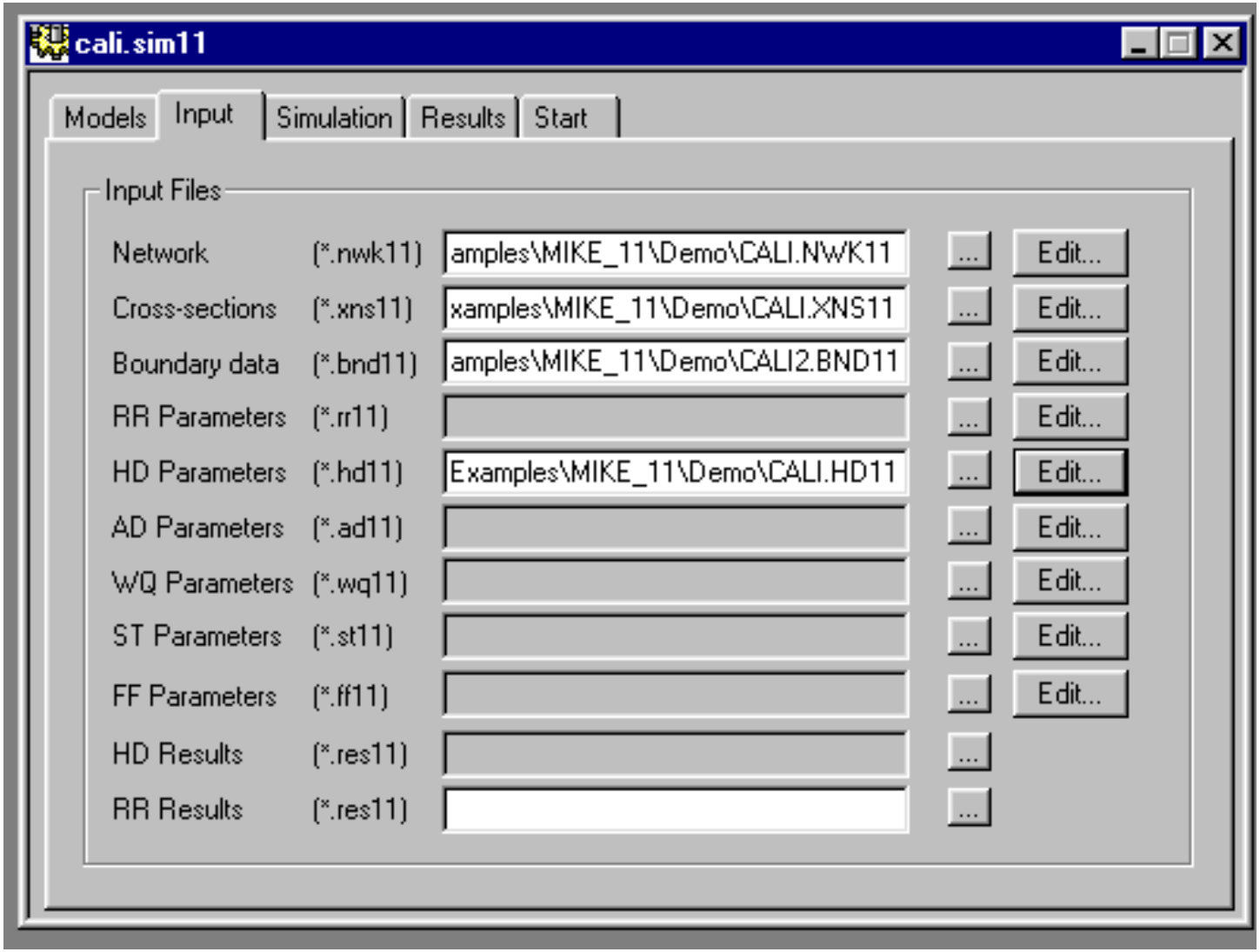
(Source: http://www.crwr.utexas.edu/gis/gishyd98/dhi/mike11/M11_main.htm)

Import to MIKE 11

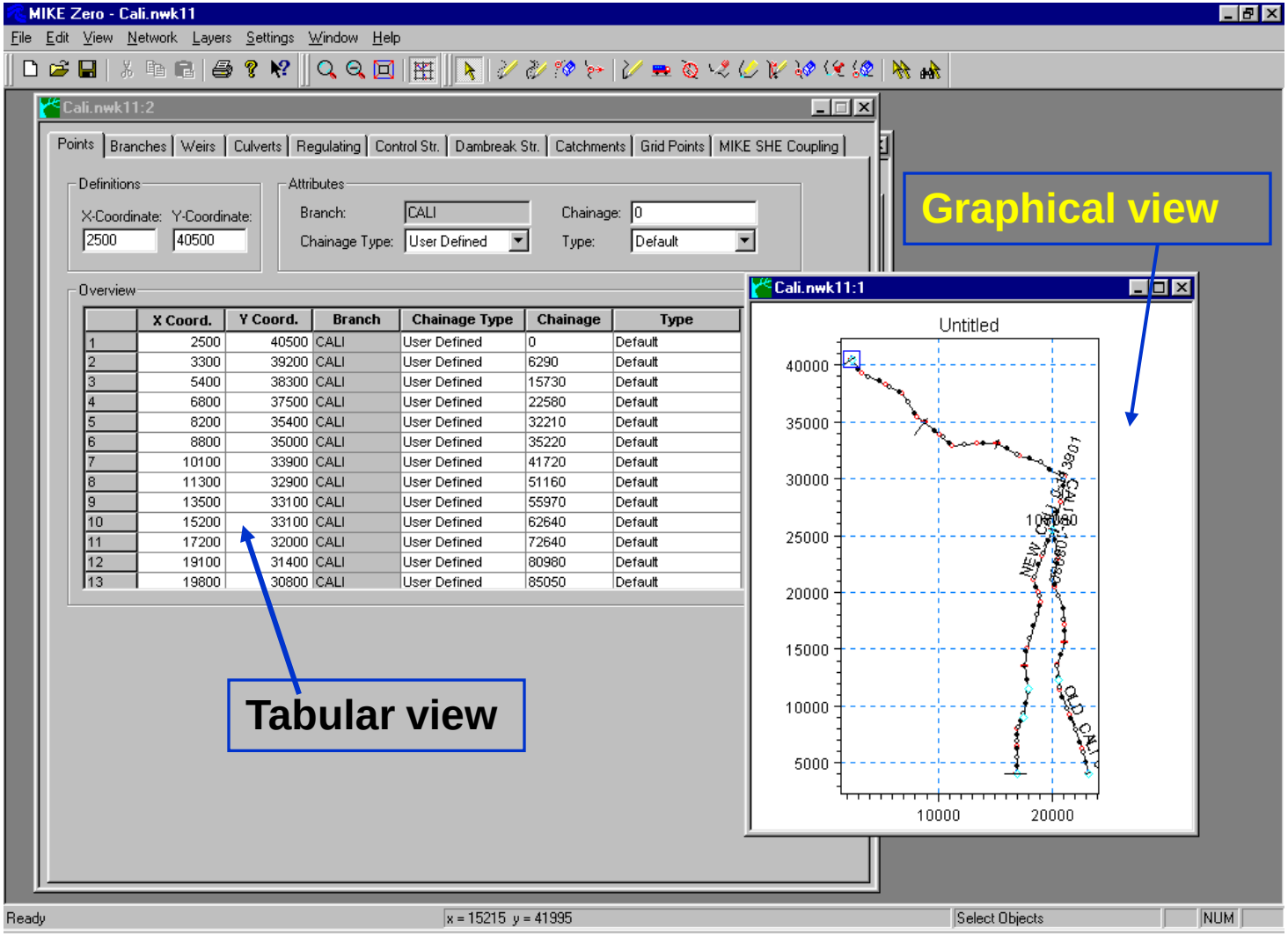


(Source: http://www.crwr.utexas.edu/gis/gishyd98/dhi/mike11/M11_main.htm)

Menus and input files editors



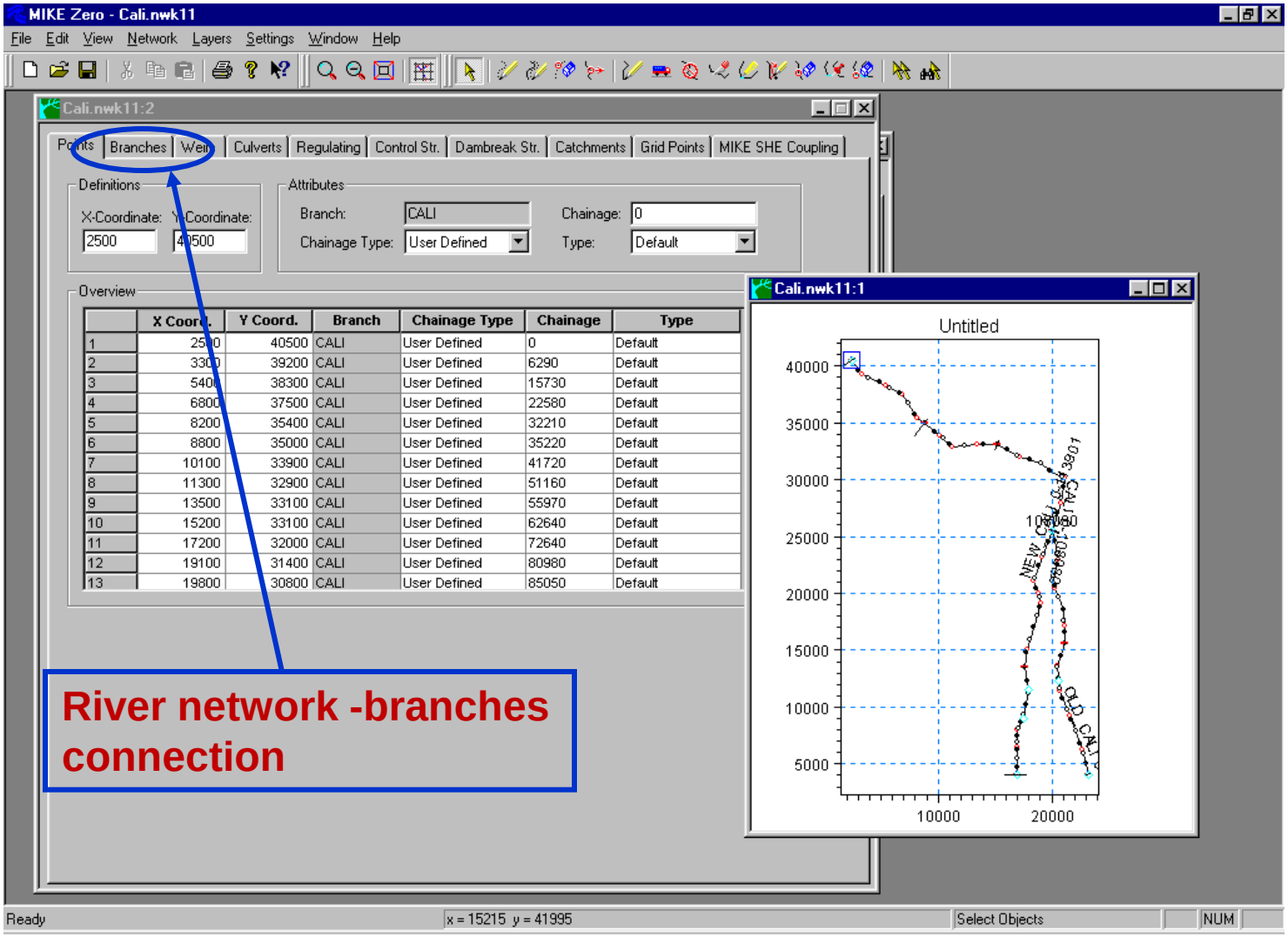
Network editor



	X Coord.	Y Coord.	Branch	Chainage Type	Chainage	Type
1	2500	40500	CALI	User Defined	0	Default
2	3300	39200	CALI	User Defined	6290	Default
3	5400	38300	CALI	User Defined	15730	Default
4	6800	37500	CALI	User Defined	22580	Default
5	8200	35400	CALI	User Defined	32210	Default
6	8800	35000	CALI	User Defined	35220	Default
7	10100	33900	CALI	User Defined	41720	Default
8	11300	32900	CALI	User Defined	51160	Default
9	13500	33100	CALI	User Defined	55970	Default
10	15200	33100	CALI	User Defined	62640	Default
11	17200	32000	CALI	User Defined	72640	Default
12	19100	31400	CALI	User Defined	80980	Default
13	19800	30800	CALI	User Defined	85050	Default

Network editor

Contd...



Network editor

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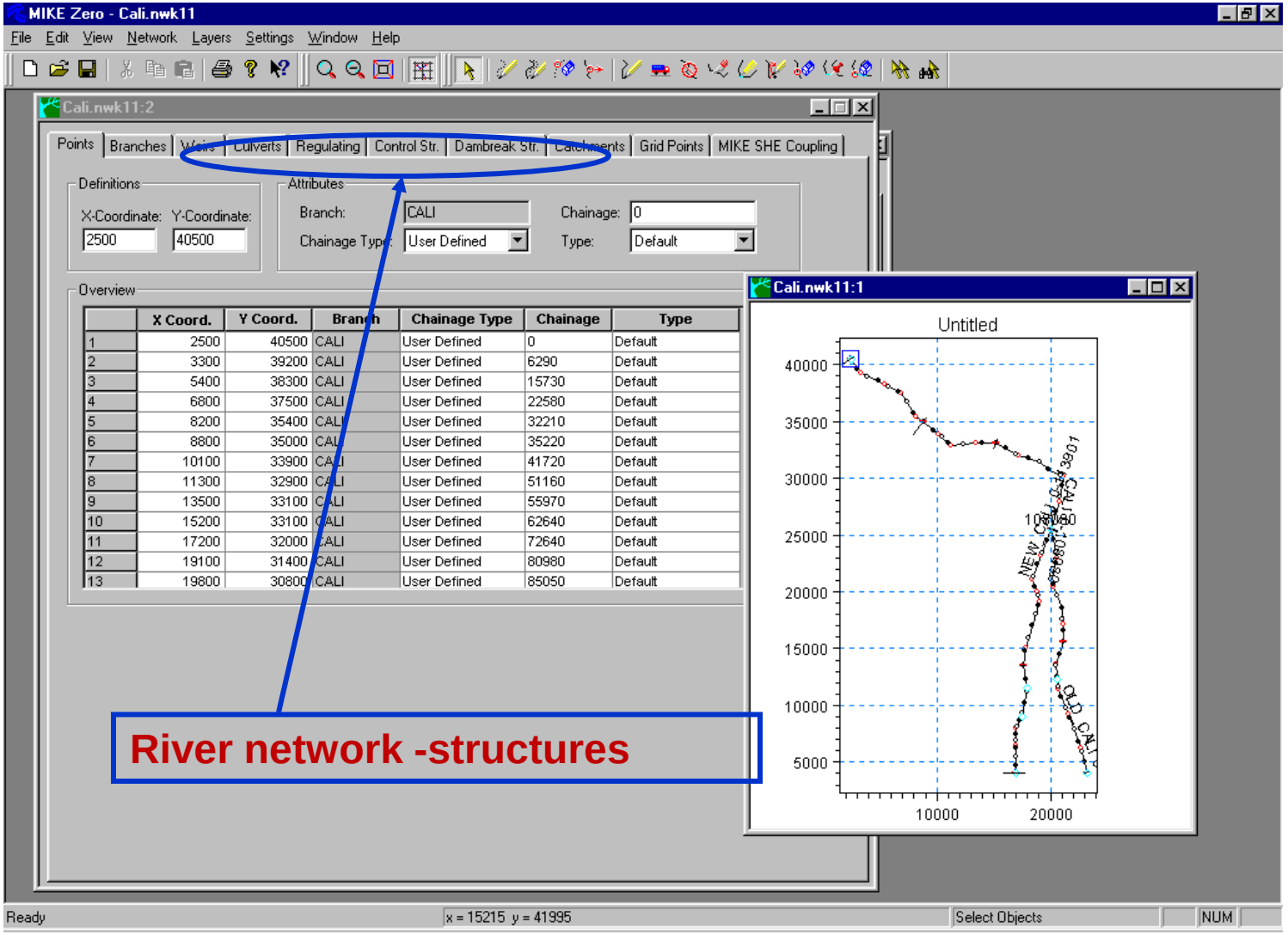
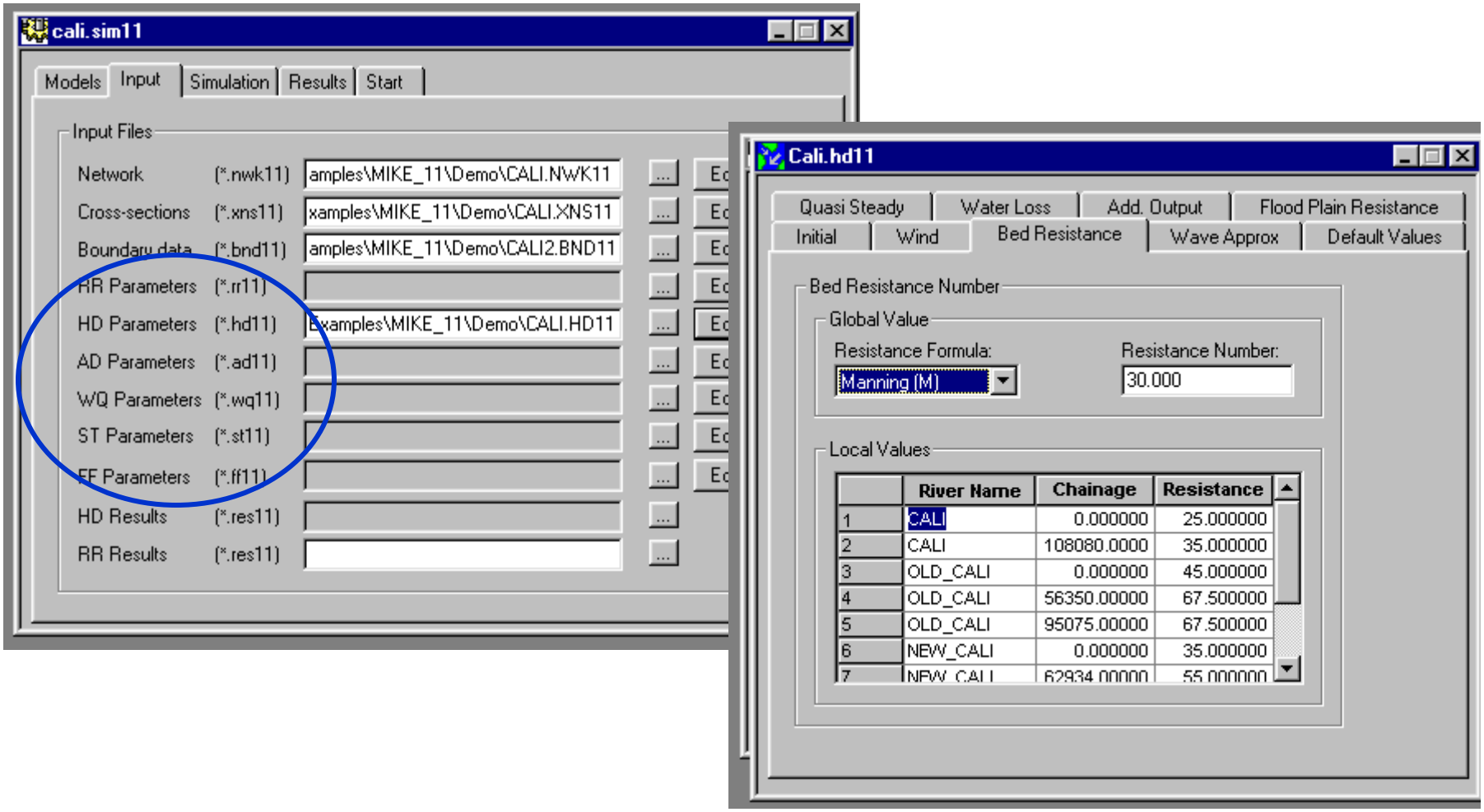
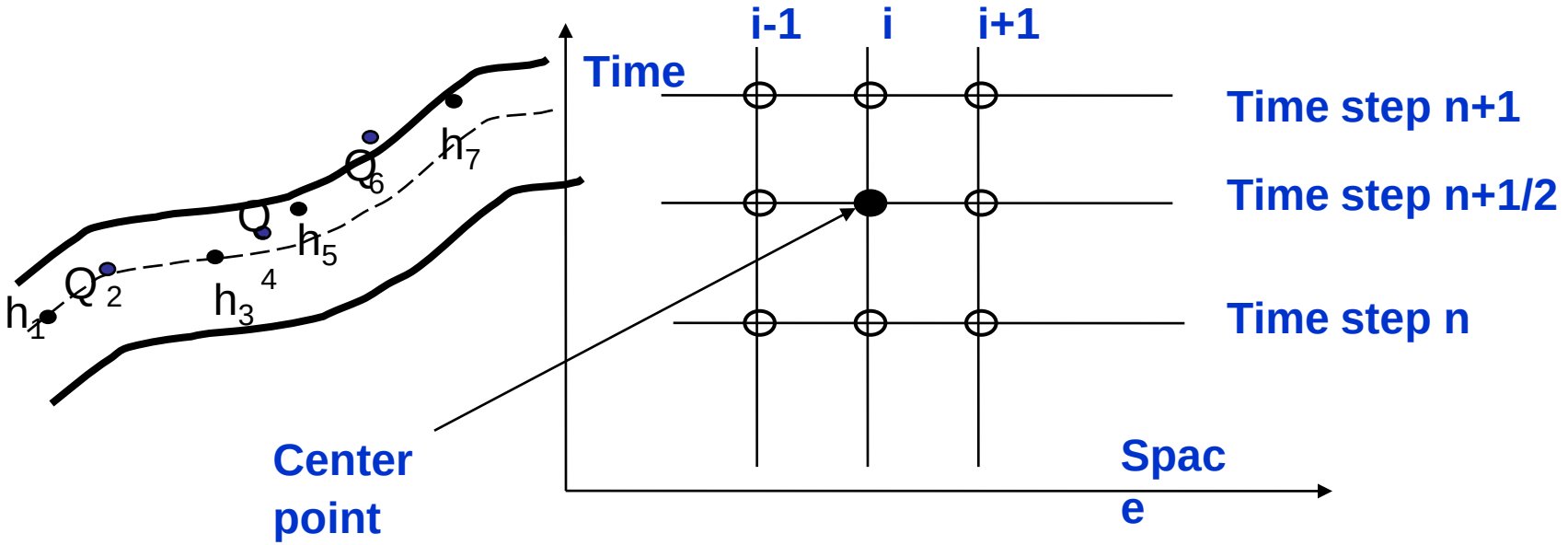


Parameter file editor



Parameter file - coefficients



$$\frac{\partial Q}{\partial x}+\frac{\partial A}{\partial t}=q \quad \Rightarrow \quad \alpha_i Q_{i-1}^{n+1}+\beta_i h_i^{n+1}+\gamma_i Q_{i+1}^{n+1}=\delta_i$$

$$\frac{\partial Q}{\partial t}+\frac{\partial\left(\alpha\frac{Q^2}{A}\right)}{\partial x}+gA\frac{\partial h}{\partial x}+\frac{gQ|Q|}{C^2AR}=0 \quad \alpha_i h_{i-1}^{n+1}+\beta_i Q_i^{n+1}+\gamma_i h_{i+1}^{n+1}=\delta_i$$

Limitations of MIKE 11

❖Because of its numerical limitations, MIKE 11 cannot model the supercritical flow downstream of the weir.

➢For the low-flow case, the downstream water level is over-estimated by a factor of 8 .This high tailwater, impacts on the flow conditions on the weir, causing a significant error in the upstream water level.

➢ The incorrect tailwater has less impact for the high-flow case. There is still significant error in the predictions across the weir, but the upstream water level is almost correct.

MIKE SHE

❖Advanced integrated hydrological modeling system

❖Simulates water flow in the entire land based phase of the hydrological cycle rainfall to river flow, via various flow processes such as,

✓overland flow,

✓infiltration into soils,

✓evapotranspiration from vegetation, and

✓groundwater flow

MIKE SHE Features

Integrated:

Fully dynamic exchange of water between all major hydrological components is included, e.g. surface water, soil water and groundwater

Physically based:

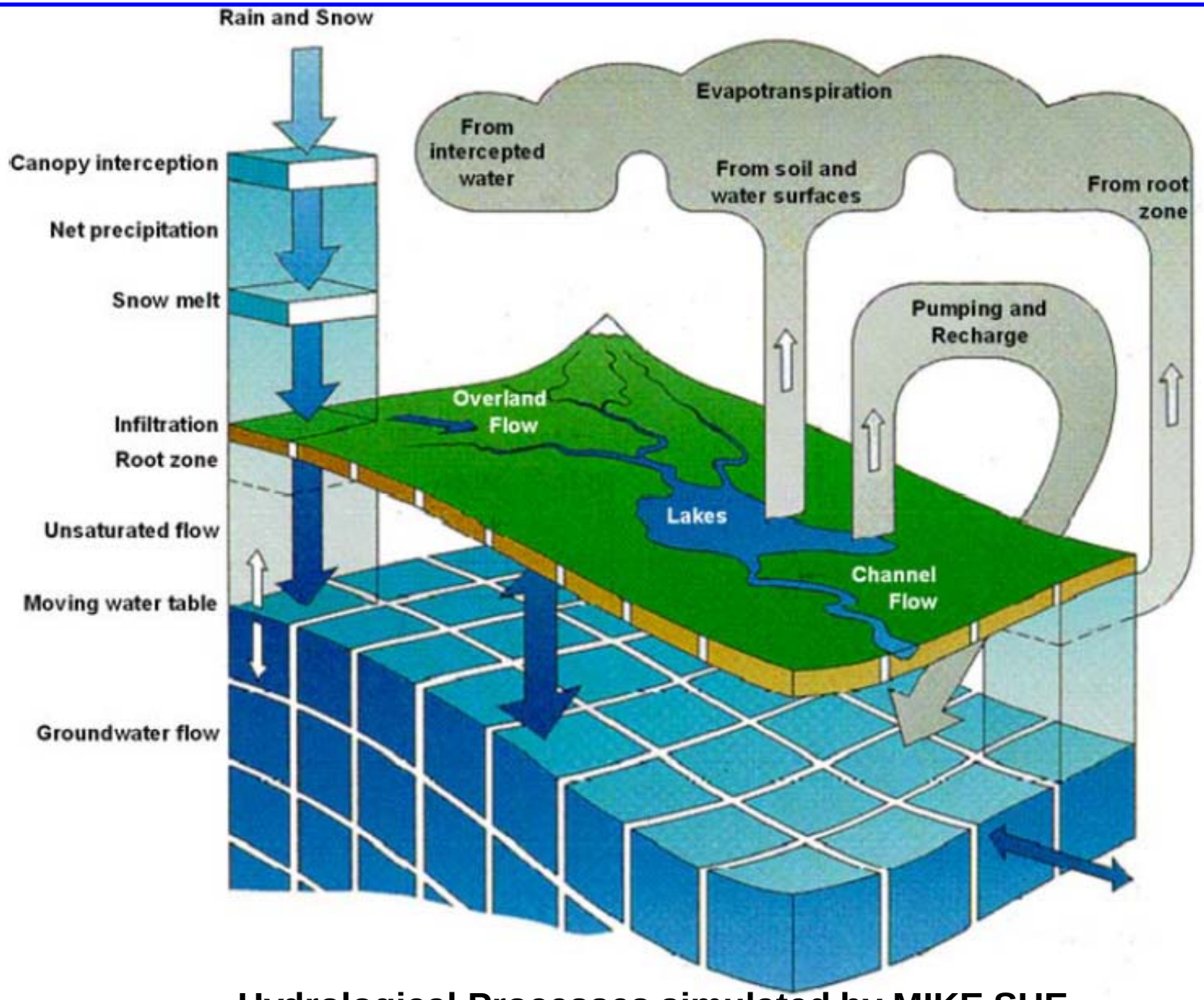
It solves basic equations governing the major flow processes within the study area

Fully distributed:

The spatial and temporal variation of meteorological, hydrological, geological and hydrogeological data

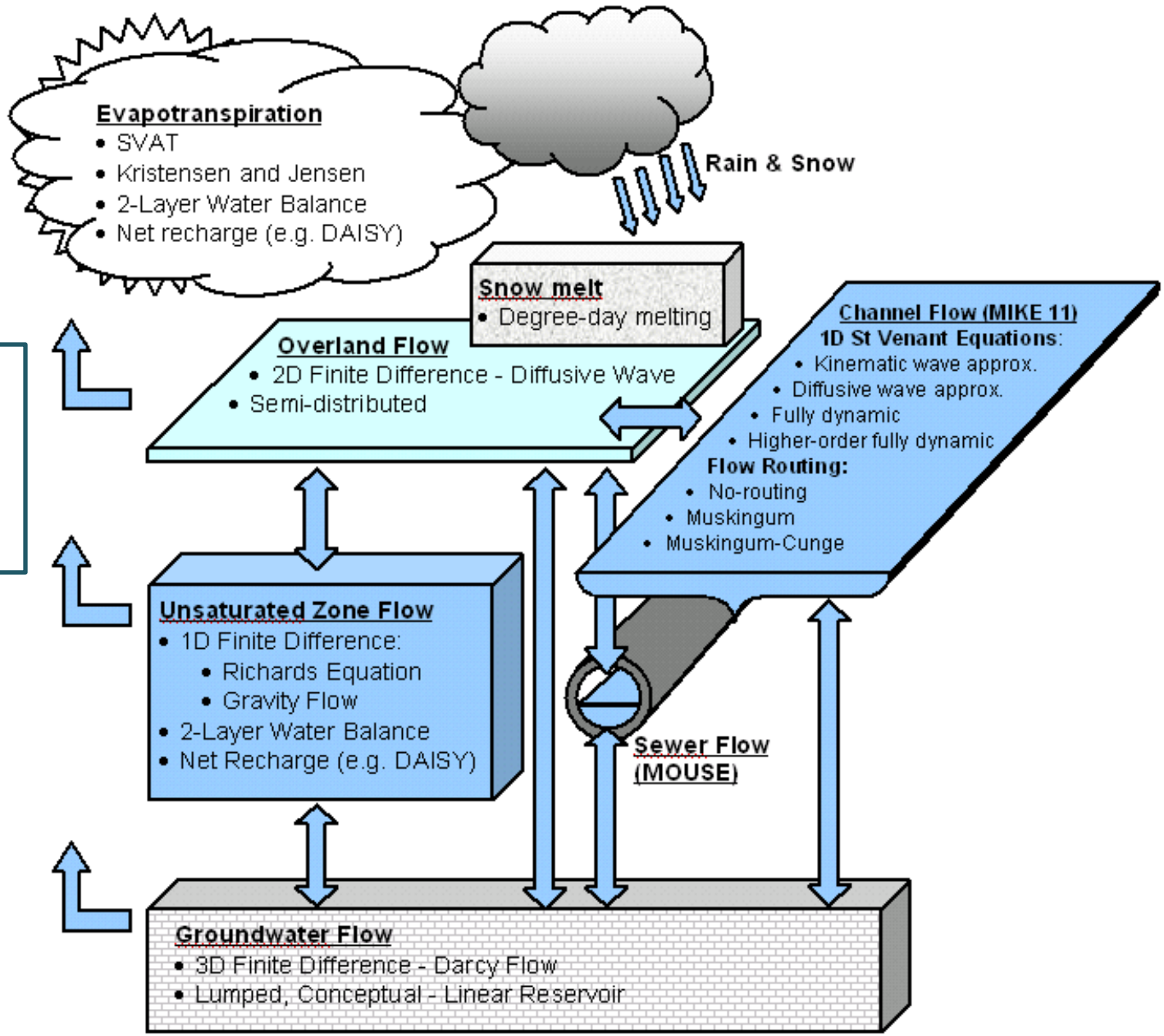
Modular:

The modular architecture allows user only to focus on the processes, which are important for the study



Hydrological Processes simulated by MIKE SHE

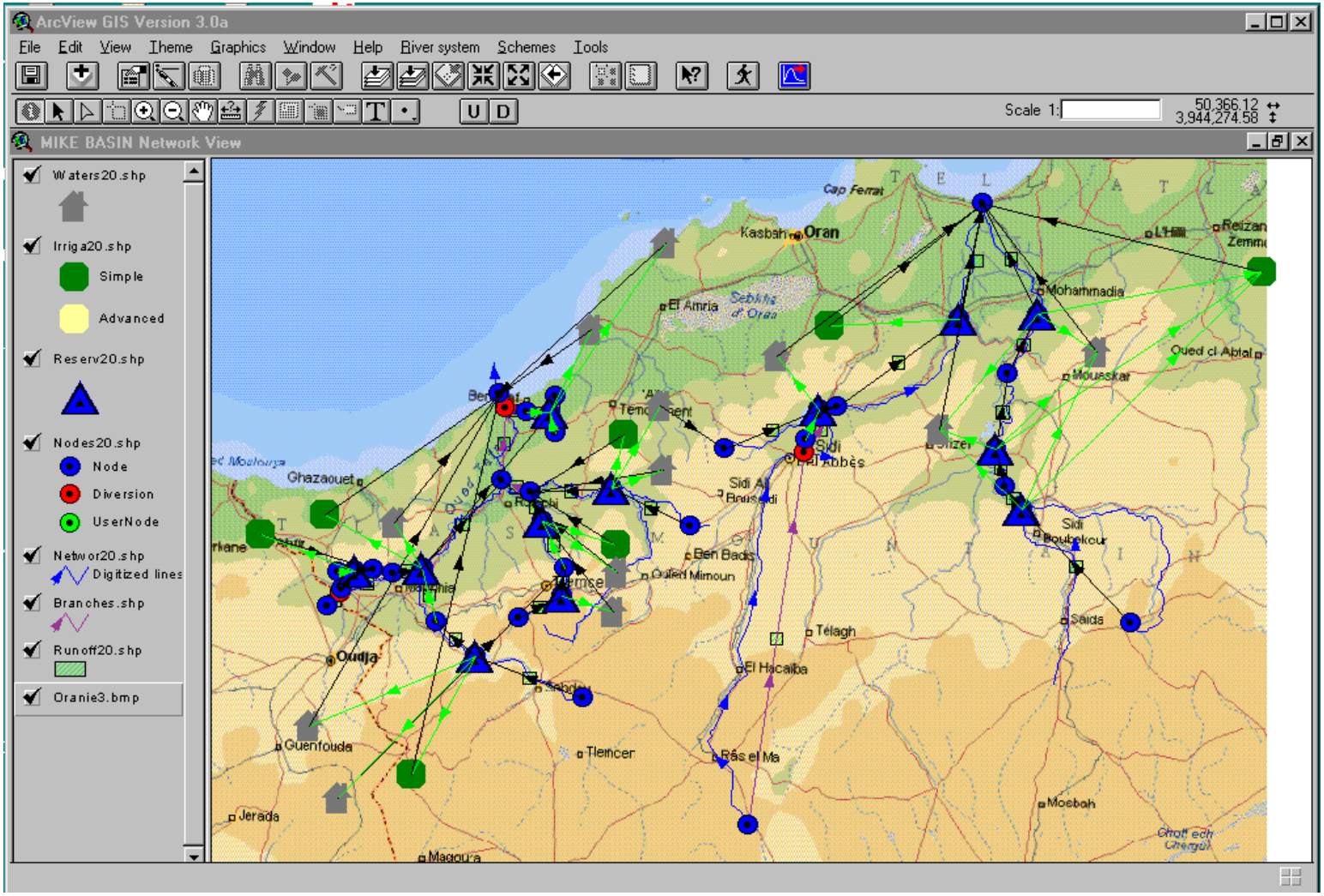
The arrows show the available exchange pathways for water between the process models.

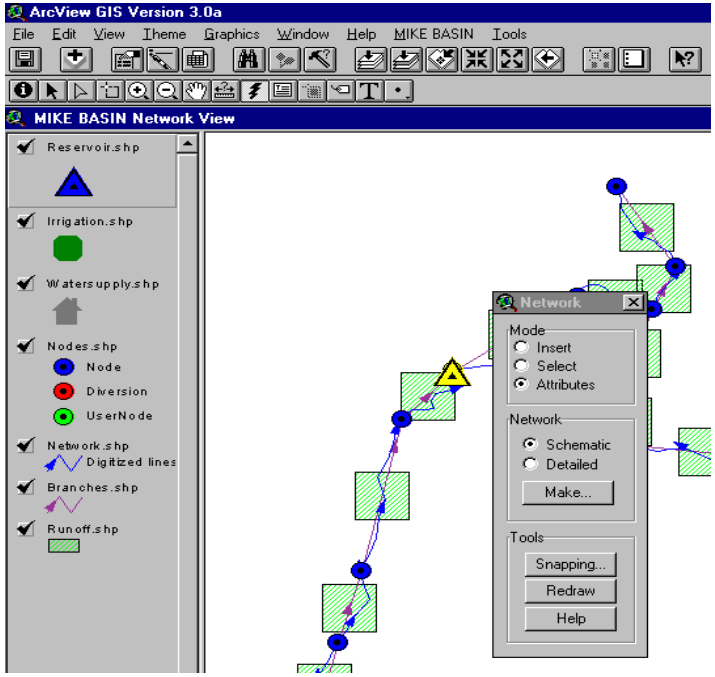


Schematic view of the process in MIKE SHE, including the available numeric engines for each process.

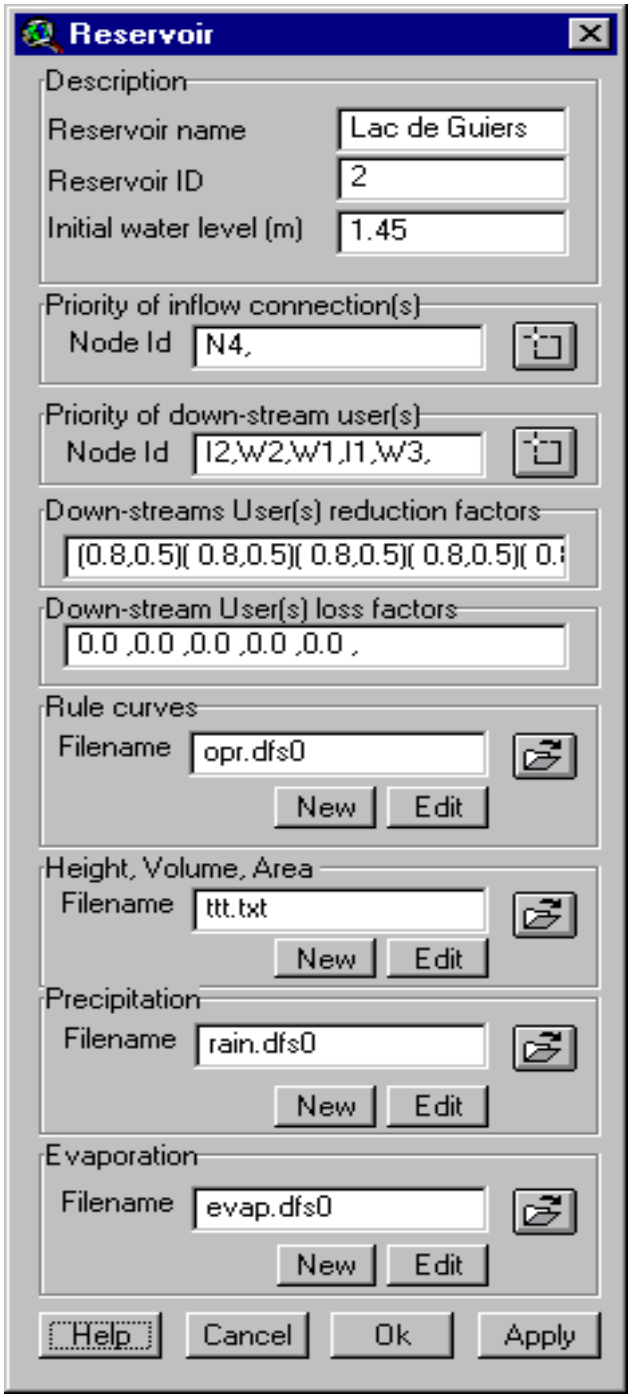
(V.P. Singh & D.K. Frevert, 19

Flow System Inputs and Outputs





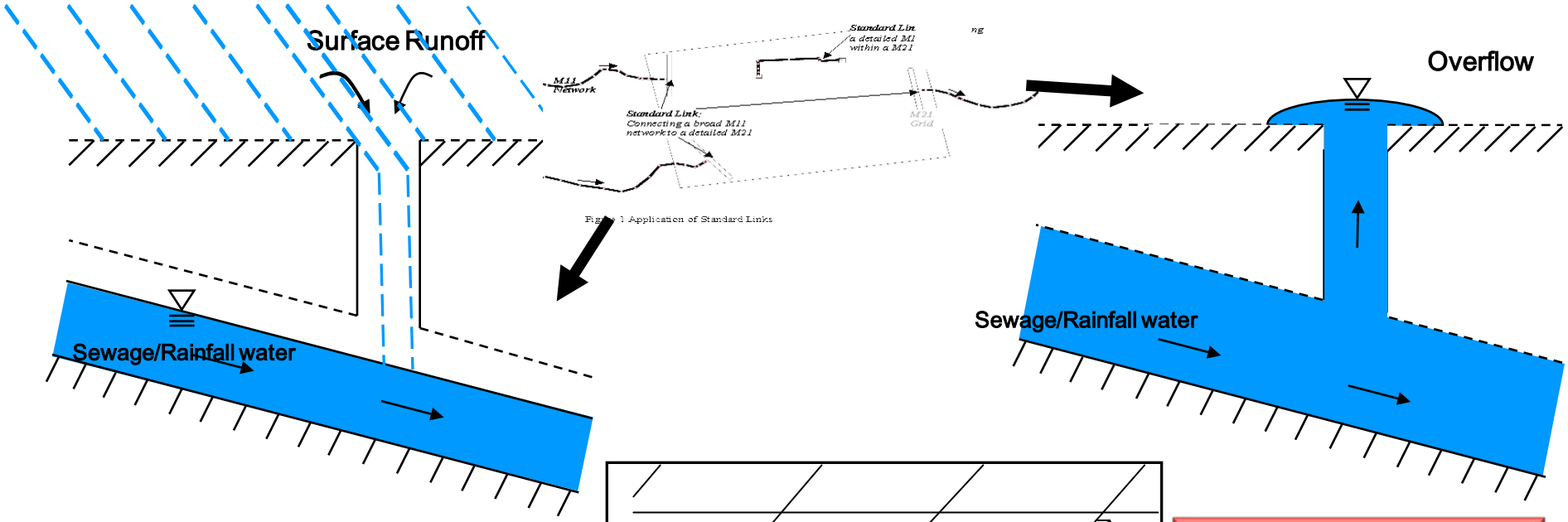
- Reservoir name
- Reservoir ID
- Initial water level
- Priority of inflow connections
- Priority of down-stream user(s)
- Down-streams user(s) reduction factor
- Down-stream user(s) loss factor
- Rule curves
- Height, Volume, Area
- Precipitation
- Evaporation



MIKE FLOOD

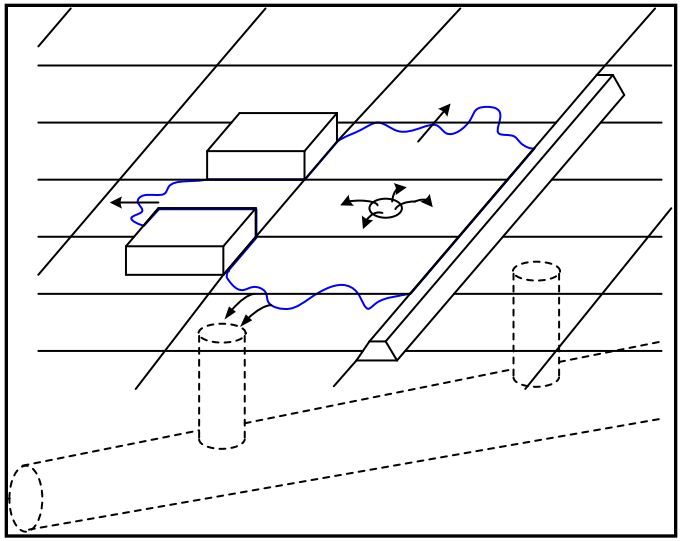
- Hydrodynamic Integrated model with 1D and 2D
- The result of either 1D or 2D model can be transferred as input of another model
- This model simulates simultaneously the flow in the sewer, the drainage system and the surface flow

Conceptual Representations



Rainfall Runoff

Flow-capacity excess



Re-inflow after flood