Data A6

Training Text : Explanation Note on Inundation Analysis Model (MIKE FLOOD) for the Mejerda River Basin (Presentation materials for the training are also attached here)

Republic of Tunisia

Ministry of Agriculture and Hydraulic Resources
Department of Dams and Large Hydraulic Works

Japan International
Cooperation Agency

The Study
on
Integrated Basin Management
Focused on Flood Control in Mejerda River
in
The Republic of Tunisia

TRAINING TEXT

Explanation Note
on
Inundation Analysis Model
for the Mejerda River Basin

June 2008

Nippon Koei Co., Ltd.

THE STUDY
ON
INTEGRATED BASIN MANAGEMENT FOCUSED ON FLOOD CONTROL
IN
MEJERDA RIVER
IN
THE REPUBLIC OF TUNISIA

TRAINING TEXT

Explanation Note on Inundation Analysis Model for the Mejerda River Basin

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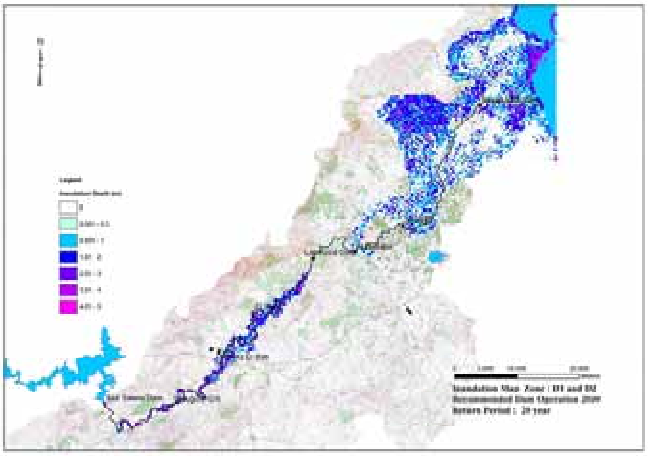
PART I : EXPLANATION NOTE ON OVERALL MEJERDA MODEL

I.1 Introduction

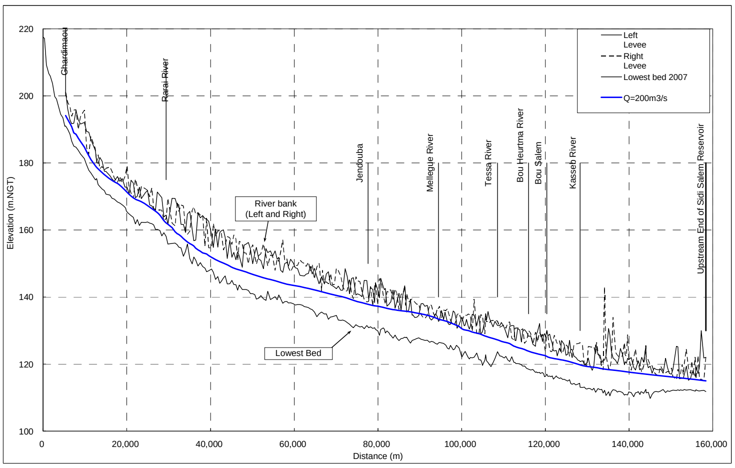
I.1.1 Purposes of this explanation note

This explanation note was prepared under the Study on Integrated Basin Management Focused on Flood Control in Mejerda River (the Study) aiming at maximized use of the inundation analysis model for the Mejerda River basin built under the Study.

Results of the inundation analysis provided important information for flood management planning for the Study. The inundation analysis itself can give discharges, water levels, velocity and other hydraulic conditions in channels and on flood plains. Then, with post-processing, inundation maps, water surface profiles and other useful information can be obtained. (See examples below)



(1) Inundation Map (Using 2-D Result)



(2) Water Surface Profile (Using 1-D Result)

Source : Study Team

Figure I.1.1: Examples of Outcomes of Inundation Analysis

The inundation analysis model for this Study was constructed using the commercial software MIKE FLOOD (ver.2008) produced by DHI, which enables to employ unsteady one and two dimensional analyses. The software's function which was used for the inundation analysis for the study was hydrodynamic computation. It should be noted that the MIKE software has possibilities of having other functions (and the inputting windows look as if all of those functions are available for all users). However, many of those analyses are not relevant to the Mejerda Model. Functions or modules other than the hydrodynamic analysis are not available to a MIKE FLOOD license for the inundation analysis.

This explanation note is targeted particularly at users of the inundation analysis model for the Mejerda River basin (the Mejerda Model), focusing on the MIKE FLOOD's functions relevant to the Mejerda Model.

Besides, this explanation note avoided to provide too much details on "how to use software itself" which are described in the software manuals provided by DHI unless the necessity rise for explaining the Mejerda Model. Rather, it aimed at expressing the information which is essential for modelling of the Mejerda River basin but not available or not clear in the manuals provided with the software, such as:

- Structure of the Mejerda Model,
- Simple explanations on how to build, operate and modify the Mejerda Model targeting on the functions of the software which should be required for the Mejerda Model), and
- Issues (or cautions), which were noticed by the Study Team during the inundation analysis, to be shared among the Mejerda Model users.

Hence, explanations on the operation of the software including scientific backgrounds need to be referred to the manuals and scientific notes provided by the software company.

The table below lists the selected manuals which would be necessary for the users of the Mejerda Model (hydrodynamic analysis). This explanation note refers these manuals (version 2008) with the ID No. mentioned in the table. The software company also provides manuals for a wide range of functions and modules other than the ones in the following table. However, such manuals are not relevant to the Mejerda Model users.

Table I.1.1: List of Manuals of MIKE Software Useful for Operating the Mejerda Model

No *	Title
MIKE11	
M11-1**	MIKE11 -a Modelling System for River and Channels, Short Introduction Tutorial
M11-2	MIKE11 - a Modelling System for River and Channels, User Guide
M11-3	MIKE11 - a Modelling System for River and Channels, Reference Manual
M11-4	MIKE VIEW, User Guide and Tutorial
MIKE21	
M21-1**	MIKE21 Model, Hydrodynamic Module, Step-by-step training guide
M21-2	MIKE21 Flow Model, Hydrodynamic Module, User Guide

No *	Title
M21-3	MIKE21 Flow Model, Hydrodynamic Module, Scientific Documentation
M21-4	MIKE21 Toolbox, User Guide
MIKE FLOOD	
MF-1**	MIKE FLOOD, Modelling of River Flooding, Step-by-step training guide
MF-2	MIKE FLOOD, 1D-2D Modelling User Manual
Pre- and Post-Processing (MIKE ZERO+)	
MZ-1	MIKE ZERO – Project Oriented Water Modelling, Step-by-step training guide
MZ-2	MIKE ZERO – The Common DHI User Interface for Project Oriented Water Modelling, User guide
MZ-3	MIKE ZERO Preprocessing & Postprocessing, User Guide, Generic Editors and Viewers
MZ-4	MIKE ZERO TOOLBOX, User Guide
MZ-5	MIKE ZERO Plot Composer, User Guide
MZ-6	Geodesy in MIKE ZERO, Map Projection and Datum Conversion, User Guide

Note : *: ID of the manual used in this text
** : Major tutorial materials
Version 2008
Source : Study Team

I.1.2 Notes on start learning how to use software applied the Mejerda Model

As a first step of learning how to use/operate and modify the Mejerda Model, users need to start from learning how to operate MIKE software applied to the Mejerda Model (MIKE11, MIKE21 and MIKE FLOOD). Besides, functions of each of MIKE11, MIKE21 and MIKE FLOOD and their relations should also be understood at the first stage.

Materials suggested as a “starter” are:

- This explanation note, **Part I**: Explanation Note on Overall Mejerda Model
- This explanation note, **Annex 1**: MIKE11 Tutorial for the Mejerda Model Users
- Tutorial manuals attached to the software (See the table below)

Table I.1.2: Tutorial Manuals Useful for the Mejerda Model Users

No	Title
M11-1	MIKE11- a Modelling System for River and Channels, Short Introduction Tutorial
M21-1	MIKE21 Model, Hydrodynamic Module, Step-by-step training guide
MF-1	MIKE FLOOD, Modelling of River Flooding, Step-by-step training guide

Note : Extracted from Table I.1.1 Source : Study Team

- Example files attached to the software

Table I.1.3: Demo Models of MIKE Software Useful for the Mejerda Model Users

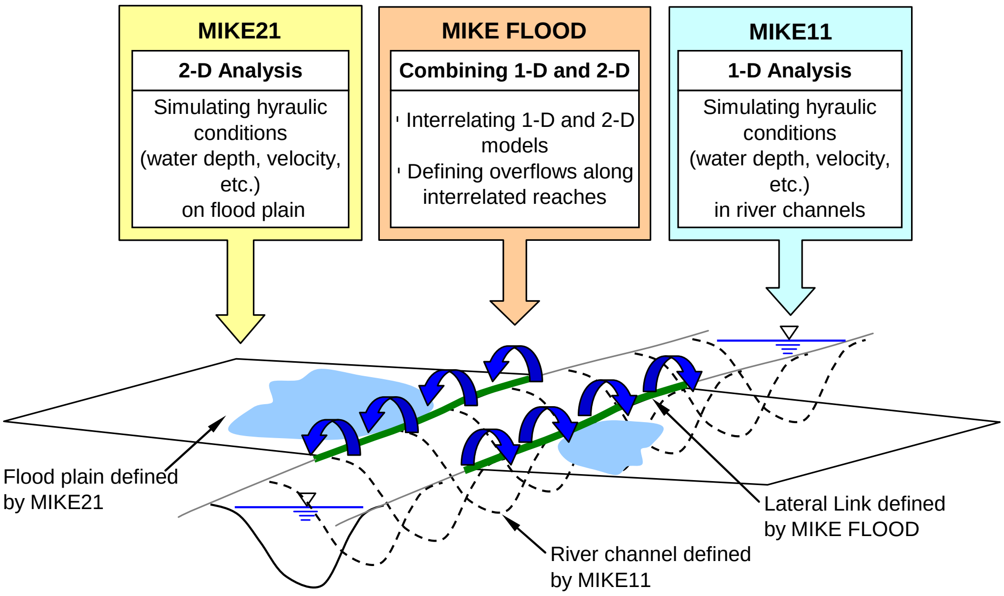
	Example Name
MIKE11	[MIKE 11 Examples] – [Demo] (Click “cali.sim11” to start)
MIKE21	[MIKE 21 Examples] – [Flow Model] – [HD] – [Lake] and [Sound] (Click a file “**.m21” in these folders to start)

MIKE FLOOD	[MIKE FLOOD Examples] – [FloodplainDemonstration] (Click "mfbig.couple" to start) ("MIKE_FLOOD_FM.couple" in the same folder is not applicable to Mejerda Model Users))

Note : [ ] : Folder name
Example cases attached to the software other than above cases might not be applicable to the Mejerda Model. (e.g. Functions or modules in those examples were not used in the Mejerda Model, or require additional licenses for such particular functions which were not available to a MIKE FLOOD license for an inundation analysis (hydrodynamic analysis).
Source : Study Team

I.2 Relations among MIKE11, MIEK21 and MIKE FLOOD

The Inundation analysis software called MIKE FLOOD is actually the combination of three applications, namely MIKE11, MIKE21 and MIKE FLOOD. MIKE11 and MIKE21 originally are independent software for one-dimensional (1-D) and two-dimensional (2-D) analysis, respectively. MIKE FLOOD has the function of interrelating the two applications. The following figure illustrates a basic concept of their relations.



Note : This figure illustrates the basic concept of "Lateral Link" which are applied in the Mejerda Model. Though they are not applicable to the Mejerda Model, other interlinking methods are available in the software. See the software manual MF-2 in Table I.1.1.)
Source : Study Team

Figure I.2.1: Relations among MIKE11, MIKE21 and MIKE FLOOD

The inundation analysis simulation by MIKE FLOODS conceptually proceeds the following steps. (See the software manual MF-2 in **Table I.1.1** for details.)

(i) The 1-D model (MIKE11) computes hydraulic conditions in river channels.

(ii) If computed water level in the channel exceeds river bank elevations, water overflows to a flood plain determined by the 2-D model (MIKE21).

(iii) Hydraulic conditions of overflowed flood flows on the flood plain are computed by the 2-D model (MIKE21).

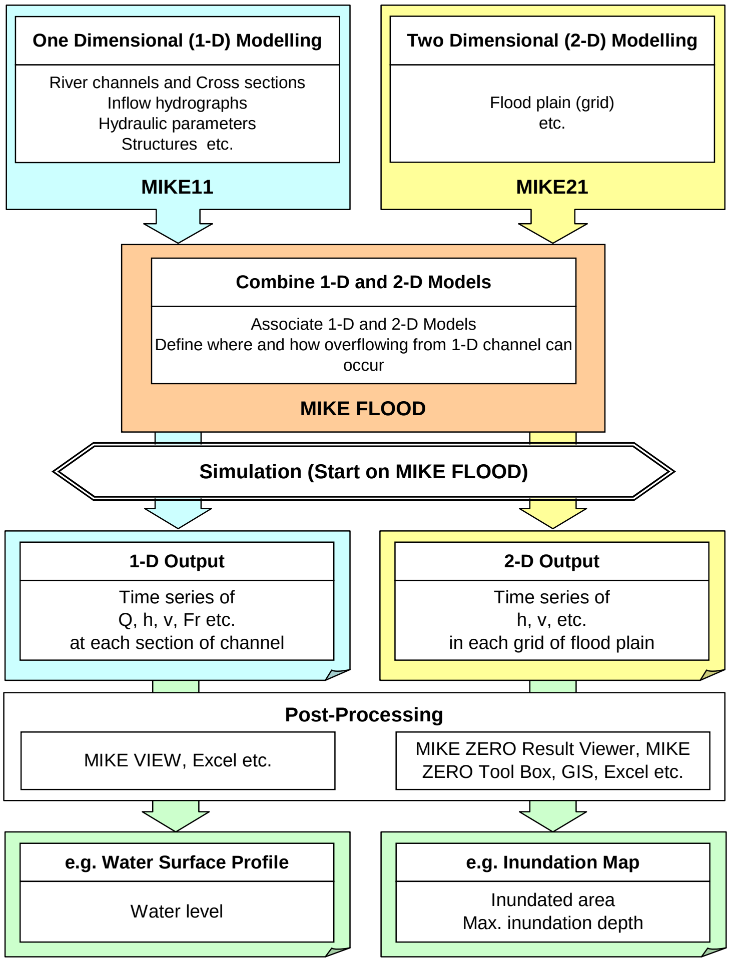
The name of the software MIKE ZERO appears whenever the MIKE software opened. MIKE ZERO is an application commonly used for the MIKE series software. For instance, making time series files of inflow discharge at model boundaries can be prepared by one of functions of MIKE ZERO. Creating new data or simulation files for MIKE11, MIKE21 and MIKE FLOOD also relies on MIKE ZERO.

I.3 Overall Procedure of Inundation Analysis

1.3.1 Overall procedure of inundation analysis (MIKE FLOOD) modelling and simulation

Building the inundation analysis model using MIKE FLOOD requires the following five major steps, as schematically shown in **Figure I.3.1**. Prior to building a MIKE FLOOD model, MIKW11 and MIKE21 models should be completed.

(i) 1-D modelling (MIKE11 modelling) : Build river channel model including structures and inflow / boundary conditions
(ii) 2-D modelling (MIKE21 modelling) : Build flood plain model
(iii) Combine two models using MIKE FLOOD
(iv) Simulation on MIKE FLOOD
(v) Post-processing of results to show and evaluate results. (e.g. inundation maps)



Source: Study Team

Figure I.3.1: Overall Procedure of Inundation Analysis Modelling of Mejerda Model

Modelling procedures in each application (MIKE11, MIKE21, and MIKE FLOOD) are described in the subsequent parts. Pre- and post- processing procedures, mainly by GIS and MIKE software, are also important steps of the inundation analysis, and described in **Part V**.

1.3.2 Result files produced

The followings are explanations regarding simulation results produced by the Mejerda Model:

- MIKE FLOOD controls the start of simulation only. Simulation result files are actually created by MIKE11 and MIKE21 (See **Figure I.3.1**) as summarised in the table below.

Table I.3.1: Types of Result Files Generated by the Mejerda Model

Appli-cation	File Extension	Explanation of Simulation Results	Examples of output parameters
MIKE11	*.res11	1-D Results • Hydraulic conditions in channels. • Time series data • Data at each (cross section) point	Water level Velocity Discharge
MIKE21	*.dfs2	2-D Results • Hydraulic conditions on flood plains • Data at each grid and each time step	Water level Velocity

Source: Study Team

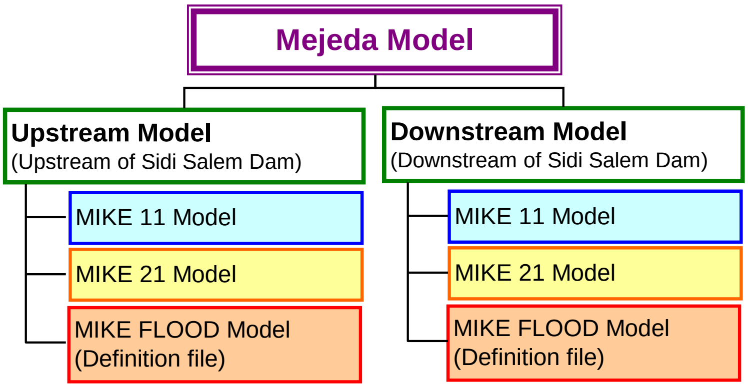
- Because of unsteady analysis, both 1-D and 2-D results can be obtained at each time step as time series data.
- Post-processing using other applications attached to MIKE FLOOD and independent software like ArcGIS is necessary to develop required outcomes of the inundation analysis, such as inundation maps and water surface profile charts.

Details on post-processing are described in **Part V** of this explanation note.

I.4 Overview of the Mejerda Model

1.4.1 Overall structure of the Mejerda Model

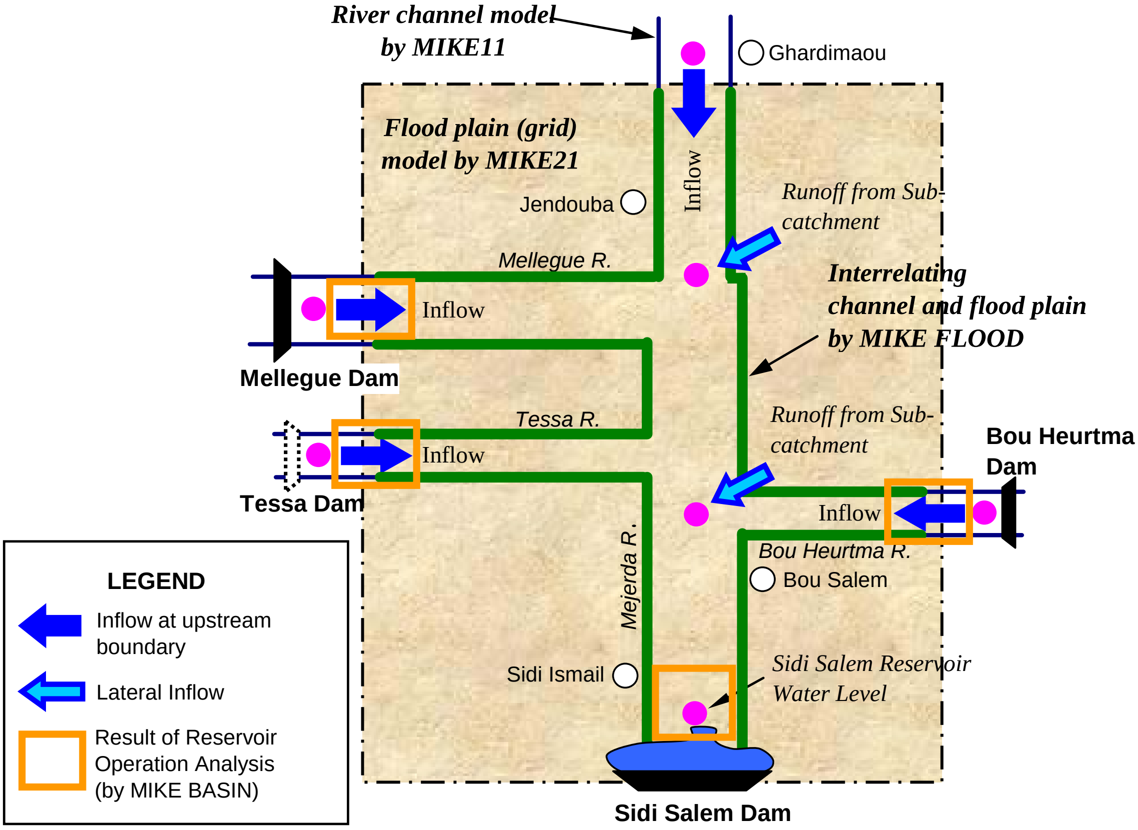
Two separate models were prepared for the upstream and downstream zones of the Sidi Salem Dam, because hydraulic conditions of two zones are made discrete by the dam. The model for each zone consists of the MIKE11, MIKE21 and MIKE FLOOD parts as shown in the following chart.



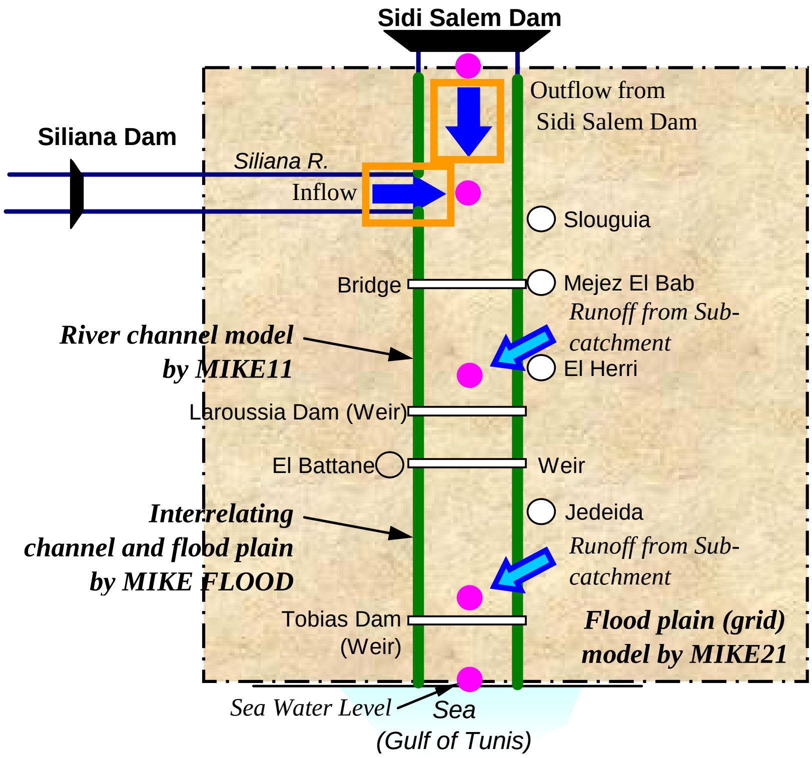
Source : Study Team

Figure I.4.1: Overall Structure of Inundation Analysis Model for the Mejerda River Basin

Overall model for each zone is schematically shown below. Details on the MIKE11, MIKE21 and MIKE FLOOD parts of the model are described in the subsequent parts of this explanation note titled each application.



(1) Upstream Model



(2) Downstream Model

Source : Study Team

Figure I.4.2: Overview of Inundation Analysis Model for the Mejerda River Basin

1.4.2 Major inputs and boundary conditions of the Mejerda Model

The following table summarizes the major input data required for each part (MIKE11, MIKE21 and MIKE FLOOD) of the Mejerda Model. Further details are described in the subsequent sections for each application.

Table I.4.1: Allocation of Input Data to Applications (for Upstream Model)

Major Input Data	Data Source	Model to be inputted
Topographies of River Channel • Coordinates of cross section position • Cross section shape (X, Y) • Structures (Bridges, etc.) on river channels (Location, dimention, definition, etc.), etc	• Results of topographic survey conducted under the Study in 2007	MIKE11
Designed River Channel Sections (River improvement design) • Designed cross section shape • Designed/planned embankments **Other Channel Conditions** • Roughness coefficient of riverbed	• Results of the Study • Existing documents	MIKE11
Topographies of Flood Plain • Elevation on flood plain (Grid data) • Roughness coefficient on flood plains	• Topographic maps • Existing materials	MIKE21

Major Input Data	Data Source	Model to be inputted
Inflow to the Model (from Dams) • Inflow to river channels connected to dams (outflow discharges from dams)	• Result of reservoir operation analysis conducted under the Study	MIKE11
Inflow to the Model (other than dam catchment areas) • Runoff from sub-catchments • Inflow at Ghardimaou	• Runoff analysis results by the Study • Hydrological analysis results by the Study	MIKE11
Water Level at Downstream End • Sidi Salem reservoir water level)	• Result of reservoir operation analysis condicted under the Study	MIKE11
Definition on overflowing from MIKE11 to MIKE21 Models • Reaches where overflow occurs • Definition of overflowing		MIKE FLOOD
Simulation Condition • Simulation time step • Simulation period		MIKE11 and MIKE21

Source: Study Team

Table I.4.2: Allocation of Input Data to Applications (for Downstream Model)

Major Input Data	Data Source	Model to be inputted
Topographies of River Channel • Coordinates of cross section position • Cross section shape (X, Y) • Structures (Bridges, etc.) on river channels (Location, dimention, definition, etc.), etc	• Results of topographic survey conducted by MARH in 2007	MIKE11
Designed River Channel Sections (River improvement design) • Designed cross section shape • Designed/planned embankments **Other Channel Conditions** • Roughness coefficient of riverbed	• Results of the Study • Existing documents	MIKE11
Topographies of Flood Plain • Elevation on flood plain (Grid data) • Roughness coefficient on flood plains	• Topographic maps • Existing materials	MIKE21
Inflow to the Model (from Dams) • Inflow to river channels connected to dams (outflow discharges from dams)	• Result of reservoir operation analysis conducted under the Study	MIKE11
Inflow to the Model (other than dam catchment areas) • Runoff from sub-catchments	• Runoff analysis results by the Study • Hydrological analysis results by the Study	MIKE11
Water Level at Downstream End • Sea water levels	• Hydrological analysis results by the Study • Results of topographic survey conducted by MARH in 2007	MIKE11

Definition on overflowing from MIKE11 to MIKE21 Models • Reaches where overflow occurs • Definition of overflowing		MIKE FLOOD
Simulation Condition • Simulation time step • Simulation period		MIKE11 and MIKE21

Source: Study Team

As in the above table, the hydraulic boundary conditions (inflow discharges at upstream ends and downstream water levels) and other inflow discharge data (lateral inflow discharges) are inputted to and controlled by the 1-D model (MIKE11). (See **Section II.2.4** for further details)

Those inflow data are consequences of the reservoir operation (by MIKE BASIN, another commercial software by DHI) and runoff analyses, which were conducted also as a part of the Study. The inflow discharges and water levels were computed for various cases with different probabilities and reservoir operations. Further, various river channel conditions (the present and the future with different design) were analysed under the Study. The inundation analysis models were prepared for different combinations of reservoir operation, probable floods and river channel conditions (alternative designs). Among numerous cases prepared under the Study, the following cases were applied to the formulation to the master plan for the Mejerda River basin and selected to be included in a package of the "Mejerda Model" files transferred to MARH.

Table I.4.3: Cases of the Mejerda Model

Case	Zone	Probability	Flood Control Option *
U1 -Present	U1	10- year flood	Present Condition (before Project)
U1 -Dam Operation			Improved Reservoir Operation
U1 - Dam Operation + River Improvement			Improved Reservoir Operation + River Improvement
U2 -Present	U2	20- year flood	Present Condition (before Project)
U2 -Dam Operation			Improved Reservoir Operation
U2 - Dam Operation + River Improvement			Improved Reservoir Operation + River Improvement
D1&D2 -Present	D1 + D2	10- year flood	Present Condition (before Project)
D1&D2 - Dam Operation			Improved Reservoir Operation
D1&D2 - Dam Operation + River Improvement			Improved Reservoir Operation + River Improvement

Zone : U1 : Ghardimaou – Mejerda & Mellegue Confluence
U2 : Mejerda & Mellegue Confluence – Sidi Salem Dam
D1 : Sidi Salem Dam – Larrousia Dam
D2 : Larrousia Dam – Estuary
Note : * : See next table
Source: Study Team

Table I.4.4: Flood Control Options (Combination of Reservoir Operation and River Channel Conditions)

Flood Control Option	Reservoir Operation Type	River Channel Shape
Present Condition (before Project)	Present standard operation	Present condition
Improved Reservoir Operation	Improved operation (Recommended by the reservoir operation analysis under the Study)	Present condition
Improved Reservoir Operation + River Improvement	Improved operation (Recommended by the reservoir operation analysis under the Study)	Planned (Master plan design by the Study)

Source: Study Team

1.4.3 Tree diagram of folders

Files required for the Mejerda Model are stored in a folder, and are distributed to sub-folders according to their types. **Figure I.4.2** shows a tree diagram of folders for the Mejerda Model.

Folders	Related Application	Input or output	Extention	File Type
MIKE_Mejerda				
19_MFloodDn-design				
(folders for each simulation case)	MIKE FLOOD	Input	*.couple	MIKE FLOOD coupling file
19_MFloodUp-design				
(folders for each simulation case)	MIKE FLOOD	Input	*.couple	MIKE FLOOD coupling file
20_M21Dn-design	MIKE21	Input	*.m21	Definition file
****_Res	MIKE21	output	*.dfs2	Simulation result file
****_HotS	MIKE21	output	*.dfs2	Hot start file
20_M21Up-design	MIKE21	Input	*.m21	Definition file
****_Res	MIKE21	output	*.dfs2	Simulation result file
****_HotS	MIKE21	output	*.dfs2	Hot start file
30_M11dn-design				
HD	MIKE11	Input	*.hd11	Hydraulic parameter file
Sim_Bound_**** (folders for each simulation case)	MIKE11	Input	*.bnd11	Boundary file
	MIKE11	Input	*.sim11	Simulation file
Sim_Bound_****				
****_Res	MIKE11	output	*.res11	Result file
50_M11up-design				
HD	MIKE11	Input	*.hd11	Hydraulic parameters
Sim_Bound_**** (folders for each simulation case)	MIKE11	Input	*.bnd11	Boundary file
	MIKE11	Input	*.sim11	Simulation file
Sim_Bound_****				
****_Res	MIKE11	output	*.res11	Result file
River2007				
CSec2007	MIKE11	Input	*.nxs11	Cross section file
Network2007	MIKE11	Input	*.nwk11	Network file
River2007_2Dim	MIKE21	Input	*.dfs2	Flood plain grid data file
TS-DamWLDesign	MIKE11	Input	*.dfs0	Time series file (Reservoir WL computed by Study Team)
TS-QDesign	MIKE11	Input	*.dfs0	Time series file (Discharges computed by Study Team)
TS-SeaWL	MIKE11	Input	*.dfs0	Time series file (Sea water level)

Source : Study Team

Figure I.4.3 : Tree Diagram of Folders for Mejerda Model Files

1.4.4 Summary of how to modify/ up date the Mejerda Model

Because the inundation analysis model consists of the three application parts (MIKE11, MIKE21 and MIKE FLOOD), users need to access to different application parts of the model according to an item wanted to be modified / updated. The following table summarizes the relations between items to be modified/ updated and applications. More details, such as methods of modification, are described in the subsequent parts titled each application. Combined MIKE11 and MIKE21 models can be accessed from the MIKE FLOOD window. (See **PartIV**).

It should be noted that if users want to change inflow discharges to the river channels connected to the dams, the reservoir operation analysis need to be conducted with MIKE BASIN, separate software particularly for the reservoir operation analysis. (See the MIKE BASIN training materials prepared under the Study.) Then, its result need be input to the MIKE 11 part of the inundation analysis model.

Table I.4.5: Items to be Modified/ Updated and Relevant Applications

Items to be Modified/ Updated	Application
• River channel (Add new tributaries, Change reach name etc.) • Cross section shape (including design section) • Positions of designed/planned embankments • Roughness coefficient of riverbed • Inflow hydrographs • Water level at downstream end • Structures on river channels (Location, dimention, definition, etc.)	MIKE11
• Elevation on flood plain • Roughness coefficient on flood plains • Data at each grid and each time step • Other information in each cell of flood plain grid	MIKE21
• Definition of MIKE11 and MIKE21 models to be connected • Reaches where overflow occurs • Definition of overflowing reaches	MIKE FLOOD
• Simulation time step • Simulation period	MIKE11 and MIKE21
• Flood plain grid size • Coordinate of flood plain grid data	ArcGIS, then MIKE21

Source: Study Team

Box I.4.1: NOTE for French Operating System (Windows) Users

If unknown strange errors are observed, changing the numbering system might improve the situation.

A point [.], not a comma [,], is suggested to be used as a decimal point in the operating system. (For instance, one thousand five hundred should be expressed like 1500.0, not like 1500,0.)

How to change or confirm the numbering system;
[Control Panel] – [Region and Language] – Change setting only of the numbering system or Change language selection to “English (UK)”
(“English (UK)” is more convenient than “English (US)”, because it applies a 24 hour system for showing hours, while “English (US)” employs a 12 hour system with a.m./p.m..)

PART II : EXPLANATION NOTE ON MIKE11 MEJERDA MODEL

II.1 Notes on Building 1-D Analysis (MIKE11) Model as a Part of MIKE FLOOD Model

The important notes are extracted and listed below for helping a quick check of the Mejerda Model during modelling and simulation. The contents of the following items are described in the subsequent sections.

Box II.1.1: Notes on MIKE11 Mejerda Model as a Part of MIKE FLOOD Model

- Inflow discharges and downstream water level (boundary conditions) of MIKE FLOOD Model can basically be controlled by settings in 1-D model (MIKE11)
- River channel models of MIKE 11 is normally designed to be larger than the extent of MIKE 21 bathymetry (except "land value" areas) because the MIKE 11 model controls boundary conditions of the MIKE FLOOD Model.
- Geographical area coordinates (in Network File) should be consistent with the ones in MIKE21 and GIS data which will be overlaid. (See **Section II.3.3**)
- Positions of Mark 1 and 3 in Cross Section File should carefully be selected, because MIKE FLOOD judges overflowing to flood plains (the MIKE21 model) based on the marks. (See **Section II.3.4**)
- Simulation time step and period in MIKE11 and MIKE21 should be consistent.

Box II.1.2: Other notes on MIKE11 Mejerda Model

- Cross section data can be linked with the Network data only after two data files are specified and opened through a simulation "sim11" file.
- Branch Name (River Name), Topo ID and Chainage in Cross Section and Network Editors should be exactly the same.
- When simulation shows unstable (e.g. Simulated water levels show divergence.), most probably a simulation time step is too long. An appropriate time step is often significantly small (e.g., 10 sec).
- When structures, such as bridges and weirs, need to be contained in a model, structures are suggested to be added after confirming that a river channel model without structures runs without errors.

It should be noted that the MIKE software has possibilities of having other functions and the inputting windows looks as if all of those functions are available for all users. However, many of those functions, such as water quality simulation (ECO-Lab), are not relevant to the Mejerda Model and unlicensed. (Often, users can input parameters and build a model, but users eventually find their work cannot be saved and cannot be simulated due to the license restriction!!)

Box II.1.3: NOTE for French Operating System (Windows) Users

If unknown strange errors are observed, changing the numbering system might improve the situation.

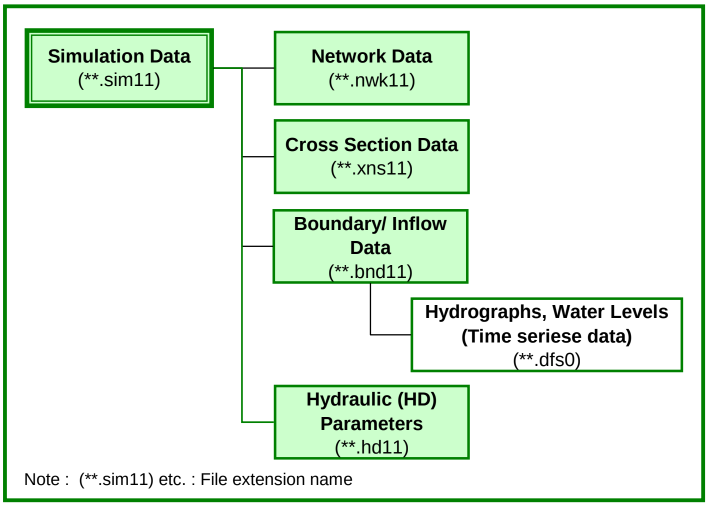
A point [.], not a comma [,], is suggested to be used as a decimal point in the operating system. (For instance, one thousand five hundred should be expressed like 1500.0 not like 1500,0 .)

How to change or confirm the numbering system:
[Control Panel] – [Region and Language] – Change setting only of the numbering system or Change language selection to "English (UK)"
("English (UK)" is more convenient than "English (US)", because it applies a 24 hour system for showing hours, while "English (US)" employs a 12 hour system with a.m./p.m..)

II.2 Structure of the 1-D (MIKE11) Mejerda Model

II.2.1 Relations among Editors of MIKE11 for the Mejerda Model

The MIKE11 part of the Mejerda Model, which serves a function of 1-D unsteady hydraulic analysis, is constituted by the data set (editors) of Cross Section, Boundary, Hydraulic Parameters, and Simulation. The simulation editor plays a role to integrate other input files as expressed in the following diagram.



Source : Study Team

Figure II.2.1: Overall Structure of MIKE11 Model for Mejerda Model

Data and information to be input or contained in each editor is summarized below.

Table II.2.1: Allocation of Data to Editors in the MIKE11 Mejerda Model

Editor Name	File Extension	Type of Major Data to be Input
Simulation	*.sim11	• Model definition (Hydrodynamic, Unsteady) • Simulation time step • Simulation period

Editor Name	File Extension	Type of Major Data to be Input
		• Name (and directories) of input files (Network, Cross section, Boundary data and Hydraulic parameter files) • Name (and directories) of result file (**.res11) • Result storing frequency
Network	**.nwk11	• Names of rivers and tributaries (“Branches”) • Cross section location (coordinates and longitudinal distance (“Chainage”)) • Structure position • Structure definition and dimension • Boundary position
Cross Section	**.xns11	• Name of rivers • Cross section ID No. • Cross section location (longitudinal distance (“Chainage”) • Cross section shape (X and Y) • Bed resistance of each cross section (Resistance type, roughness coefficient)
Boundary data	**.bnd11	• (Boundary position) (This can be input on Network editor.) • Name (and directories) of inflow/water level time series data file (**.dfs0)
	**.dfs0	• Time series data of boundary conditions or inflow (inflow discharge hydrograph and water level data)
Hydraulic parameters	**.hd11	• Initial condition (water level or discharge)

Source : Study Team

The Mejerda Model necessitates a function of the hydrodynamic analysis of MIKE11 only, while the software itself has a possibility of adding licenses of other functions like water quality analysis. Hence, among eleven chapters of users’ manual of MIKE11 provided by DHI (M11-2 in **TableI.1.1**), only the following parts of the manual are basically relevant to the users of the Mejerda Model.

Table II.2.2: MIKE11 Manual’s Chapters and Sections Requiring for Mejerda Model Users

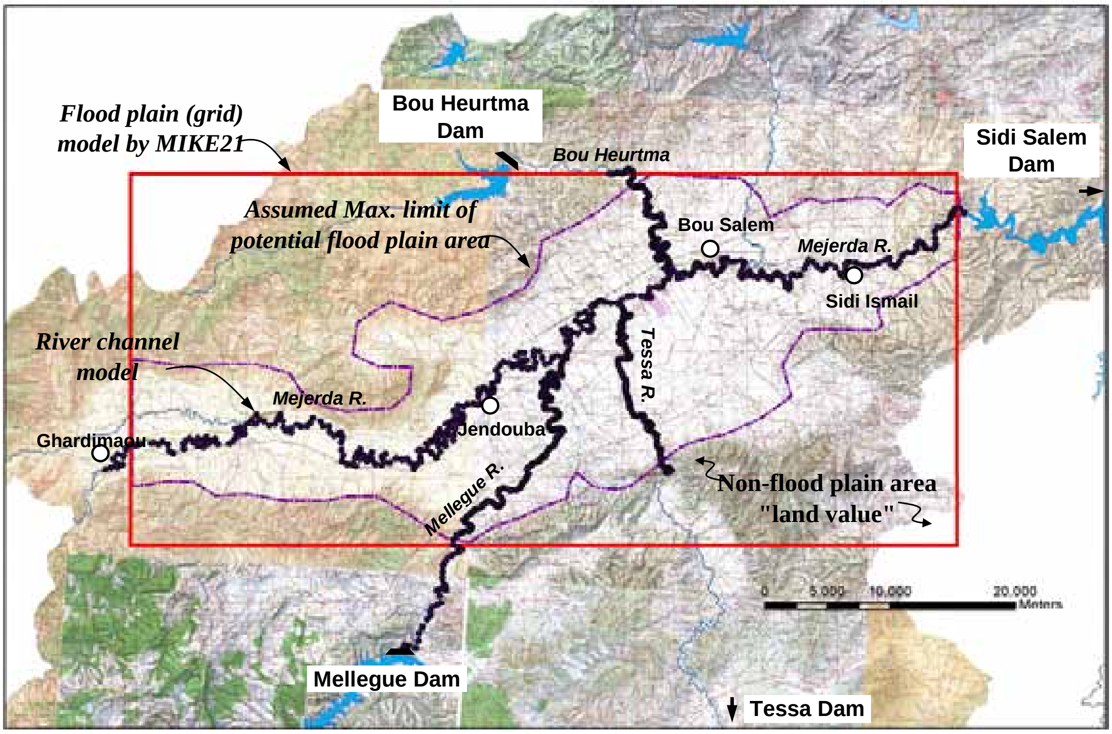
Chapter	**Title**
MIKE11 - a Modelling System for River and Channels, User Guide	
1.	Simulation Editor
2.	River Network Editor
3.	Cross Section Editor
4.	Boundary Editor (4.3.1 and 4.3.2 are not applicable for the Mejerda Model.)
6	Hydrodynamic Editor (Out of 20 sections from 6.1 to 6.20, only 6.3, 6.5, 6.10 are applicable to the Mejerda Model users.)

Source : based on DHI software manuals
Study Team

II.2.2 Basic concept of building MIKE11 Mejerda Model

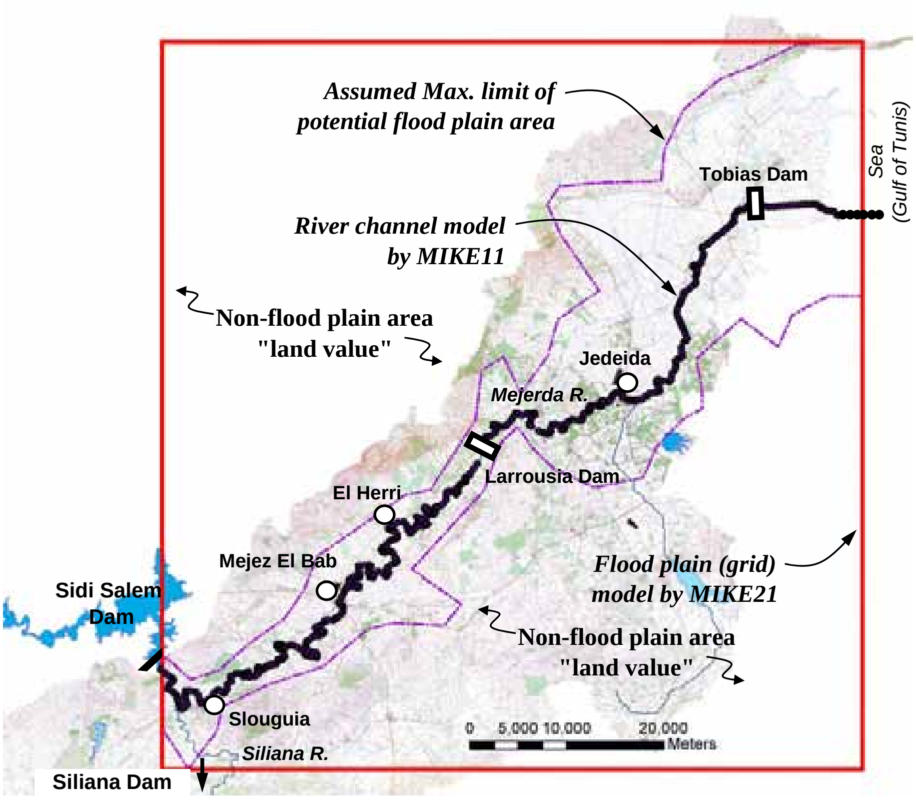
The MIKE 11 Model for the Mejerda was designed to fulfil the following requirements.

- The MIKE 11 Model for the Mejerda was designed to cover river reaches located on the potential flood plains (MIKE21 bathymetry except the "land value", see **Part III** of this explanation note.)
- Upstream and downstream ends of river channels of MIKE 11 should be located outside of MIKE21 (potential flood plains (MIKE21 bathymetry except the "land value")
- The mainstream and tributaries which are connected to the selected seven target dams (Sidi Salem, Mellegue (along with Mellegue 2 and Sattath), Tessa, Bou Heurtma, Siliana) were designed to be included in the MIKE 11 (1-D) model. This enables the model to evaluate impacts of reservoir operation improvement on inundation conditions along the downstream reaches.



Source : Study Team

Figure II.2.2: The Area Covered by Mejerda Upstream Model



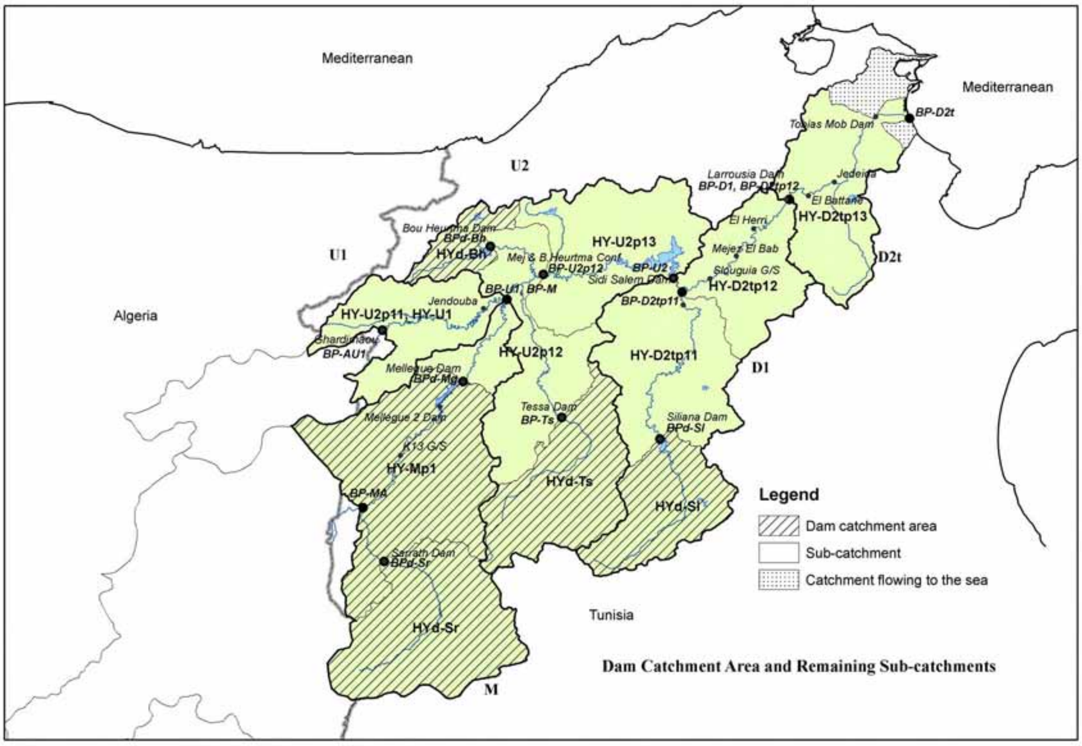
Source : Study Team

Figure II.2.3: The Area Covered by Mejerda Downstream Model

II.2.3 Discharges used for the Model

Inflow data for the MIKE11 Mejerda Model, which are used as boundary files, were resulted from the reservoir operation and runoff analyses conducted under the Study. Outflow discharges of the selected targeted dams (Sidi Salem, Mellegue, Mellegue 2 Sarrath, Bou Heurtma, Tessa and Siliana dams) were simulated by the reservoir operation analysis with MIKE BASIN, another software by DHI. Runoff from dam catchments can be regulated by the dams, while runoff from remaining sub-catchments is natural. The two different types of inflow data are distinguished in the model diagrams in **Section II.2.2**.

The following map shows river reaches, dam catchments and remaining subcatchments in the basin.



Source : Study Team

Figure II.2.4: Sub-catchments of the Mejerda River Basin

II.2.4 Cases of MIKE11 Mejerda Model

For the MIKE11 Mejerda Model Different cases necessitate different combination of "Boundary" and "Cross Section" files according to the inflow and river channel shape conditions as in the table below.

Table II.2.3: Flood Control Options (Combination of Reservoir Operation and River Channel Conditions)

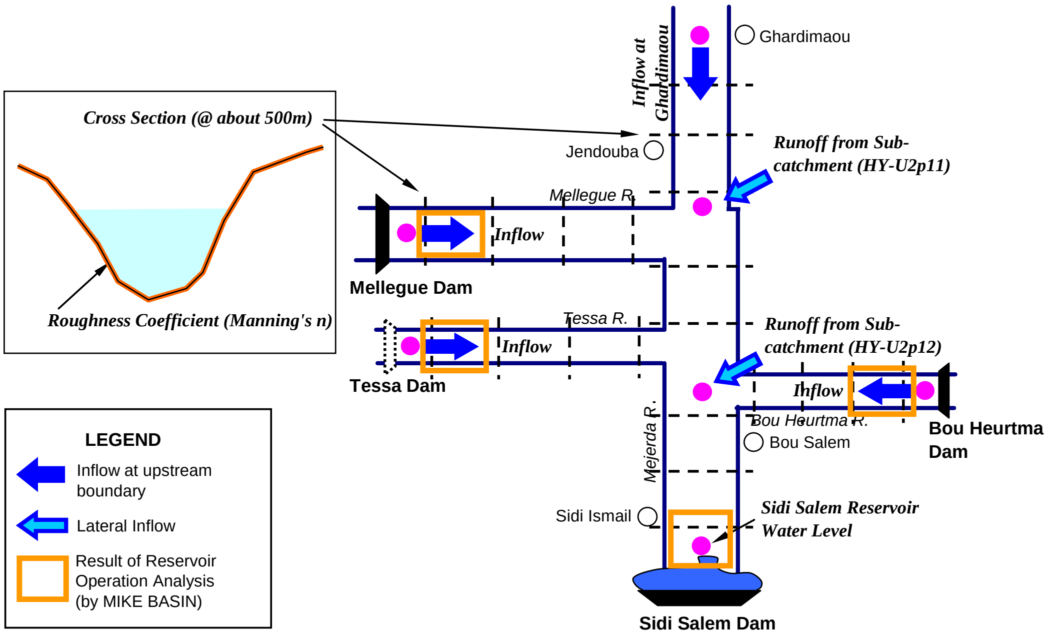
Flood Control Option	Reservoir Operation Type*	River Channel Shape
Present Condition (before Project)	Present standard operation	Present condition
Improved Reservoir Operation	Improved operation (Recommended by the reservoir operation analysis under the Study)	Present condition
Improved Reservoir Operation + River Improvement	Improved operation (Recommended by the reservoir operation analysis under the Study)	Planned (Master plan design by the Study)

Source: Study Team
Note: *: Different "Boundary" files required for cases with different probable floods.

II.2.5 MIKE11 Mejerda Model for Upstream of Sidi Salem Dam

(1) Model structure and required input

The structure and major required inputs of the upstream MIKE11 Mejerda Model is schematically presented in the following figure.



Source : Study Team

Figure II.2.5: MIKE11 Mejerda Model for Upstream of Sidi Salem Dam

The required inputs are summarized below along with their data sources. As mentioned in **Part I** of this explanation note, the boundary conditions of the MIKE11 Model determine the hydraulic boundary conditions of the inundation analysis model for the Mejerda basin by MIKE FLOOD.

Table II.2.4: Required Input for MIKE11 Upstream Mejerda Model

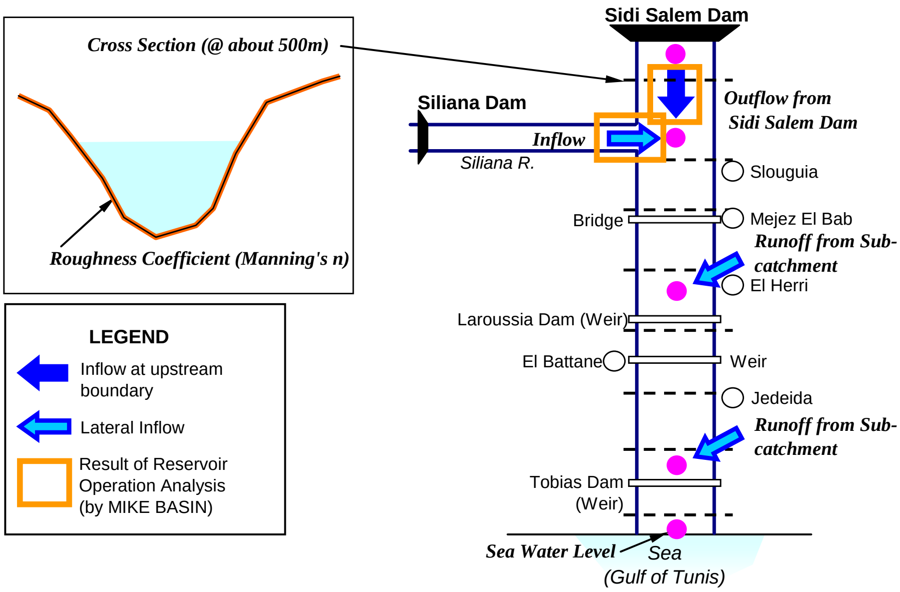
Input	Data source	Editor
Cross section location (coordinates and longitudinal distances)	Results of topographic survey conducted under the Study in 2007	Network Cross section
Cross section shape (X, Z)	• Results of topographic survey conducted under the Study in 2007 • Designed cross section by the Study (for "After project, with river improvement case only)	Cross section
Upstream boundary conditions (Inflow to river channels at upstream ends)	• Results of the reservoir operation analysis by the Study (by MIKE BASIN) • Hydrological analysis results conducted under the Study	Boundary
Downstream boundary condition (Sidi Salem reservoir water level)	Results of the reservoir operation analysis conducted under the Study (by MIKE BASIN)	Boundary
Runoff inflow (lateral inflow) from sub-catchment	Runoff analysis results conducted under the Study	Boundary

Source : Study Team

II.2.6 MIKE11 Mejerda Model for Downstream of Sidi Salem Dam

(1) Model structure and required input

The model structure and major required inputs of the downstream Mejerda Model are schematically presented in the following figure, and are summarized in the subsequent table along with their data sources.



Source : Study Team

Figure II.2.6: MIKE11 Mejerda Model for Downstream of Sidi Salem Dam

Table II.2.5: Required Input for MIKE11 Downstream Mejerda Model

Input	Data source	Editor
Cross section location (coordinates and longitudinal distances)	Results of topographic survey conducted by MARH in 2007	Network Cross section
Cross section shape (X, Z)	• Results of topographic survey conducted by MARH in 2007 • Designed cross section by the Study (for "After project, with river improvement case only)	Cross section
Structures (weir and bridge)	• Results of topographic survey conducted by MARH in 2007 • Existing drawings and reports	Network
Upstream boundary condition (Outflow from Sidi Salem Dam)	Results of the reservoir operation analysis conducted under the Study (by MIKE BASIN)	Boundary
Downstream boundary condition (Sea water level)	• Existing studies • Results of topographic survey conducted by MARH in 2007	Boundary
Runoff inflow (lateral inflow) from sub-catchment	Runoff analysis results conducted under the Study	Boundary

Source : Study Team

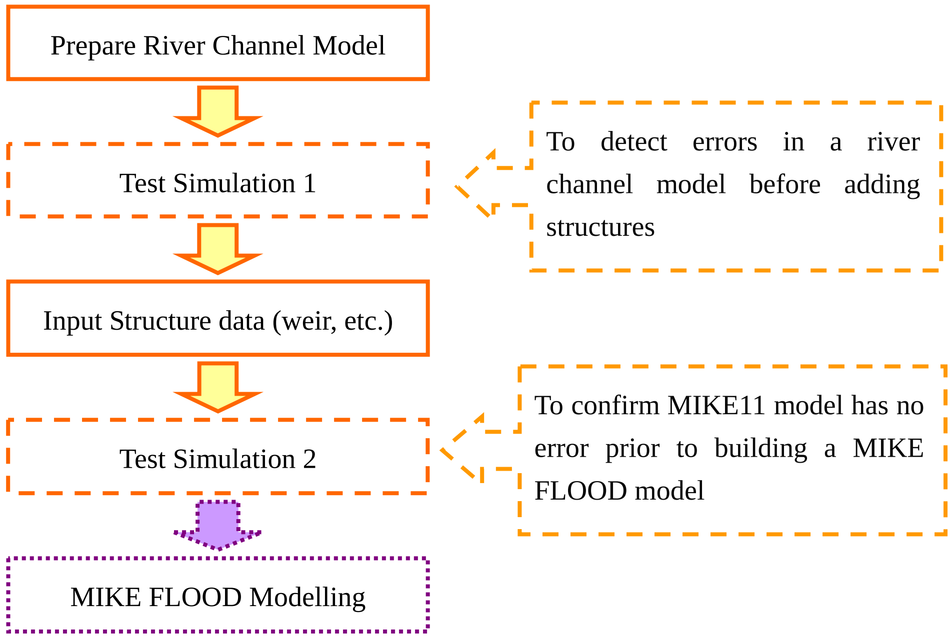
II.3 Procedures of MIKE11 Modelling for the Mejerda Model

II.3.1 Overall procedure of MIKE11 Mejerda Modelling

The input and simulation files in **Figure II.2.1** should be prepared for building one 1-D unsteady hydraulic analysis model by MIKE11 for the Mejerda basin. The modelling and simulation of the MIKE11 Mejerda Model as a part of a MIKE FLOOD model basically proceeds in the following order. The extensions of related data files are also listed below.

1. Preparing time series file (**.dfs0)
2. Preparing network file (**.nwk11)
3. Preparing cross section file (**.xns11)
4. Preparing HD (hydrodynamic) file (**.hd11)
5. Preparing boundary file (Empty file) (**.bnd11)
6. Preparing simulation file (**.sim11)
7. Inputting boundary data (**.bnd11)
8. Test simulation 1 (**.sim11)
9. Inputting structure data (**.nwk11)
10. Test simulation 2 (**.sim11)
11. Viewing result file (**.res11, MIKE VIEW)

These procedures can be summarized as below.



Source : Study Team

Figure II.3.1: Overall Modelling Procedure of MIKE11 Mejerda Model

Final simulation of a MIKE FLOOD model combining MIKE11 and MIKE21 parts of the model is started on MIKE FLOOD.

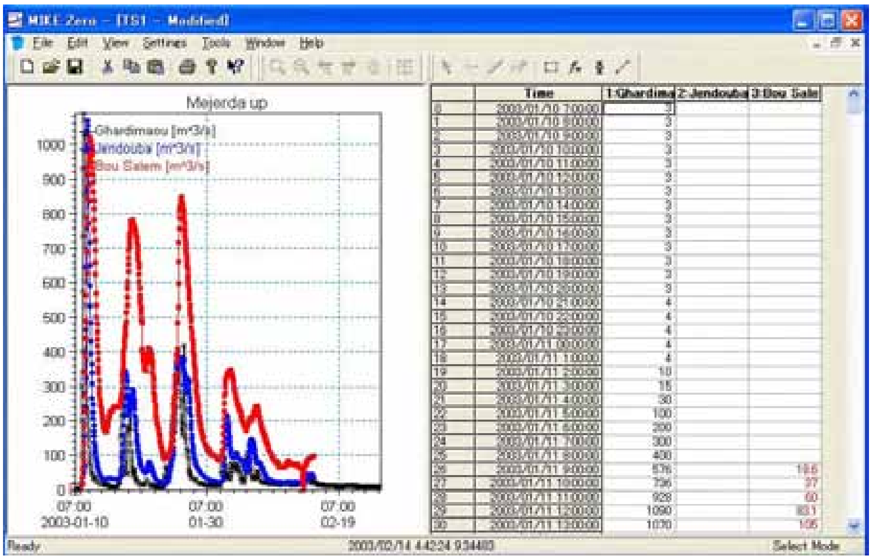
Step-by-step methodologies of each step, except for Step 9 above, are described in **Annex**

1 (MIKE11 Tutorial for the Mejerda Model Users) of this explanation note, and therefore, are not repeated in this Section in principle. Rather, this section aims at introducing additional information and issues to be considered in modelling for the Mejera basin. Besides, as mentioned in **Part I**, this explanation note avoids to state detailed methodologies of software operation which have been described in the software manuals by DHI. Further details on the modelling methodologies and definitions of the parameters are to be referred to the software manuals (M11-2, M11-3, and M11-4 in **Table I.1.1**)

II.3.2 Step 1: Preparing time series file

Inflow at upstream ends , lateral inflows and downstream water levels of the models in **Figures II.2.5 and II.2.6** are time series data.

File extension	*.dfs0
MIKE application to be accessed	Open MIKE 11 – [New] – [MIKE ZERO] – [Time series file (*.dfs0)]
Related software Manual	MIKE ZERO Preprocessing & Postprocessing, User Guide, Generic Editors and Viewers (MZ-2 in **Table I.1.1**), **Chapter 1**
Procedure	Prepare an excel file → Make a dfs0 file → Copy data in excel file to dfs0 file (See **Chapter AN1.1** in **Annex 1** of this explanation note)



Source : MIKE input file prepared by the Study Team

Example of Time Series File

(4) Data requirement and other notes

As described in **Chapter AN1.1** in **Annex 1**, raw time series data prepared by Excel can easily be transferred to the MIKE time series file (**.dfs0). For the preparation of time series data for the Mejerda model, users are suggested to keep the following matters in mind since the beginning of preparation of raw excel data files.

- Hourly or hourly level of simultaneous data are required.

- Time series data should cover a simulation period, and
- Required input data for the MIKE 11 model, such as reservoir operation and runoff analyses results, are suggested to be organized in one column in Excel (see below) which corresponds to the MIKE dfs0 file format.

	A	B	C	D
1				
2		Discharge (m3/s)		
3	Time	Ghadimaou	Jendouba	Bou Salem
4	2003/1/10 7:00	3.0		
5	2003/1/10 8:00	3.0		
6	2003/1/10 9:00	3.0		
7	2003/1/10 10:00	3.0		
29	2003/1/11 8:00	400.0		
30	2003/1/11 9:00	576.0		18.6
31	2003/1/11 10:00	736.0		37
32	2003/1/11 11:00	928.0		60
33	2003/1/11 12:00	1090.0		83.1
34	2003/1/11 13:00	1070.0		105
35	2003/1/11 14:00	1030.0	48.1	139
[illegible]	2003/1/11 15:00	1090.0	[illegible]	[illegible]

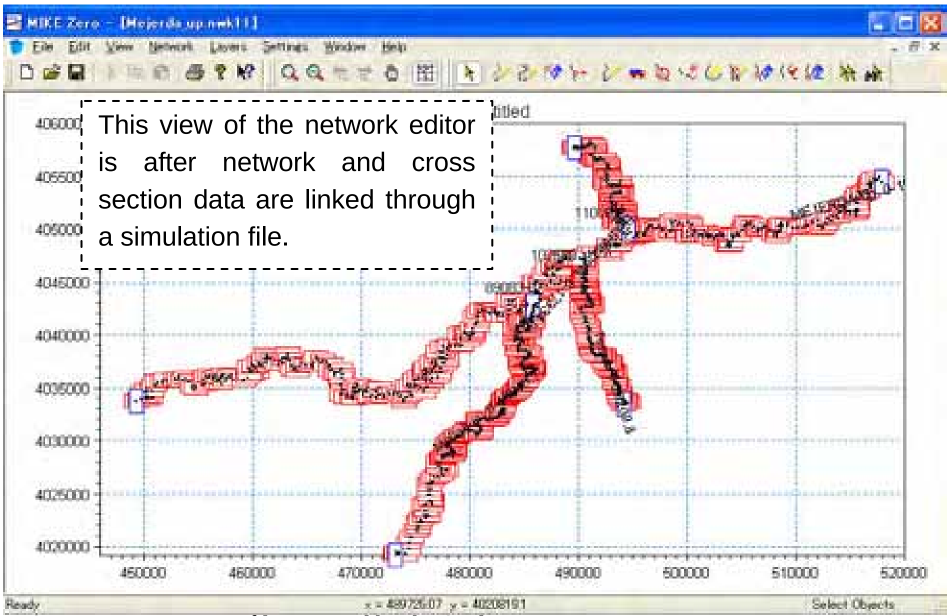
1st column : Time (hourly)
2nd column : Hourly data (data 1)
3rd column : Hourly data (data 2)
4th column : ....

II.3.3 Step 2: Preparing network file

File extension	*.nwk11
MIKE application to be accessed	Open MIKE 11 – [New] – [MIKE 11] – [Network file (*.nwk11)]
Related software Manual	MIKE11 - a Modelling System for River and Channels, User Guide (M11-2 in **Table I.1.1**), **Chapter 2**
Major information to be input	• River name • Topo ID • Coordinates of cross section locations • Chainage (Cumulated distances of cross section positions from the upstream end) • Structures (This will be explained in **Section II.3.8**)
Procedure	Prepare an excel file and text file → Make a nwk11 file → Import text file data to nwk11 file and input other necessary data on nwk11 file (See **Chapter AN1.2** in **Annex 1** of this explanation note)

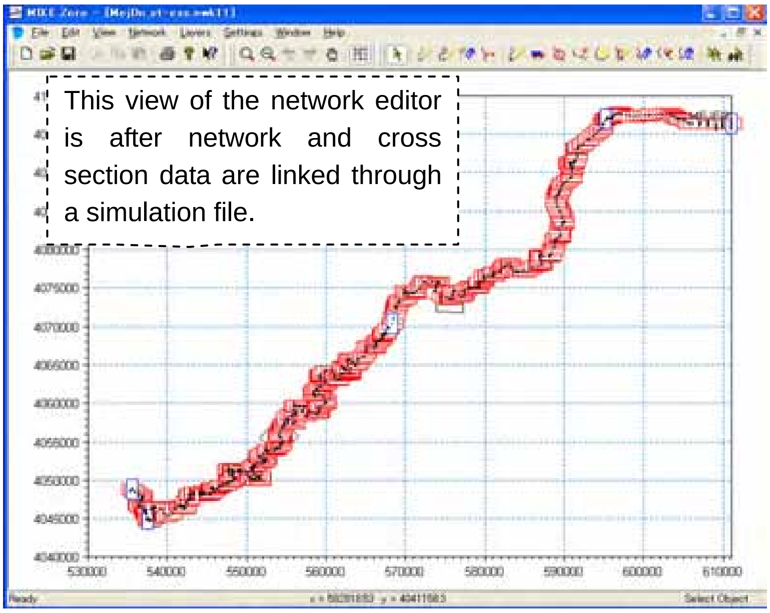
"Chainage" in MIKE 11 means a cumulated distance from the upstream end of a river channel. Chainage of a cross section at the upstream end should be 0 (zero).

Data on structures, such as bridges and weirs, should be input on the network editor. Nevertheless, structures are suggested to be added after completing a river channel model without structures and confirming the absence of errors through test simulation. Hence, users are suggested to proceed to Step 3, without adding structures at this stage. See **Section II.3.8** (Step 9) for methods of adding structure data.



Source : MIKE input file prepared by the Study Team

Figure II.3.2: Example of Network Editor (Graphical View) (Upstream Mejerda Model)



Source : MIKE input file prepared by the Study Team

Figure II.3.3: Example of Network Editor (Graphical View) (Downstream Mejerda Model)

(1) Geographical Coordinates

(i) Geographical coordinate system applied to the Mejerda Model

Because the MIKE 11 model for the Mejerda basin should be prepared as a part of the MIKE FLOOD model and, therefore, it should be combined with the 2-D MIKE 21 model, the geographical coordinate system in the MIKE 11 should be;

- the same to the one applied to the MIKE 21 model.
- consistent with the one applied to GIS data, such as geo-referenced topographical maps, because results of MIKE 21 which will be coupled with MIKE 11 are overlaid with such information.

- consistent with cross section locations (survey mark coordinates) in topographic survey results which should be inputted in the Network editor. Coordinates in survey results should be converted, if necessary.

The following table explains the geographical coordinate system applied to the Mejerda Model. The following system was selected because it has been used in geographical information data prepared by MARH, such as GIS data, aerial photographs, and topographic survey results.

Table II.3.1: Geographical Area Coordinates Applied to the Mejerda Model (Common to both upstream and downstream models)

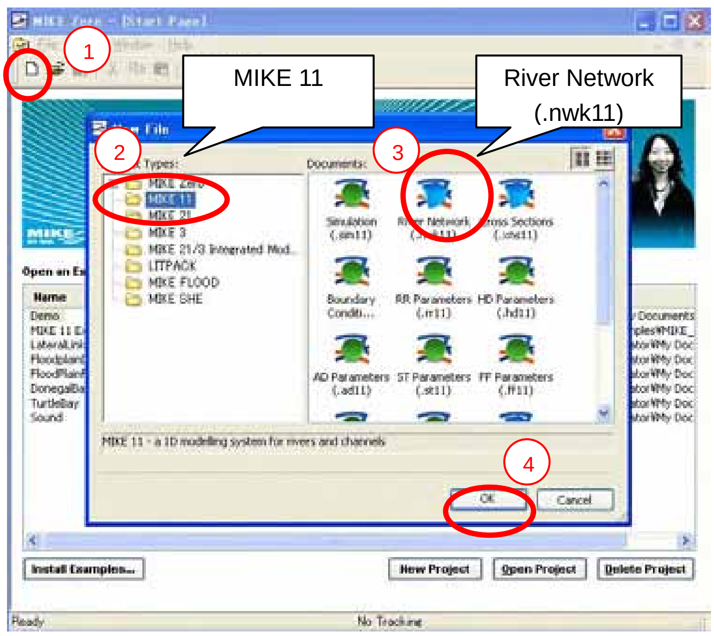
Parameter	Selection / Value	
Name	Carthage_UTM_Zone_32N (under D_Carthage) UTM_Carthage (These two have the same settings.)	Originally in MIKE by JICA Study Team
Projection Type	Transverse Mercator	
Prime meridian	0 - Greenwich	
Scale	0.9996	
Central Meridian	9 degree	
Latitude Origin	0 degree	
False Easting	500000 meter	
False Northing	0 meter	
Ellipsoid	Clarke_1880_IGN	

(ii) How to set geographical coordinate system in MIKE 11 model

A selection of the geographical coordinate system can be altered in the “Geographical Area Coordinates” window of the Network Editor.

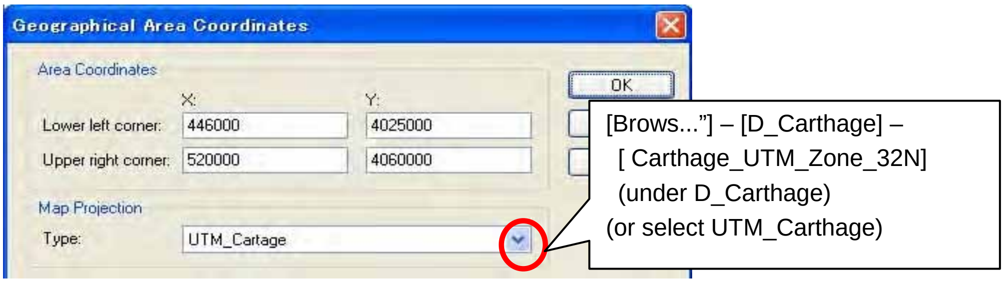
<u>Method 1: “Geographical Area Coordinates” window when a new network file is created</u>

Windows [All Program] – [MIKE BY DHI] – [MIKE11] – [MIKE11]



Method 2: Open "Geographical Area Coordinates" window of an existing Network File

Command bar [Network] – [Resize Area...] – select "Map Projection" type



(iii) "Area Coordinates" of the Network Editor

"Area Coordinates" determine the range of the graphical view of the Network Editor. (See **Figures II.3.2 and II.3.3**)

"Geographical Area" Coordinates Applied to the Mejerda Model

(Upstream Model)

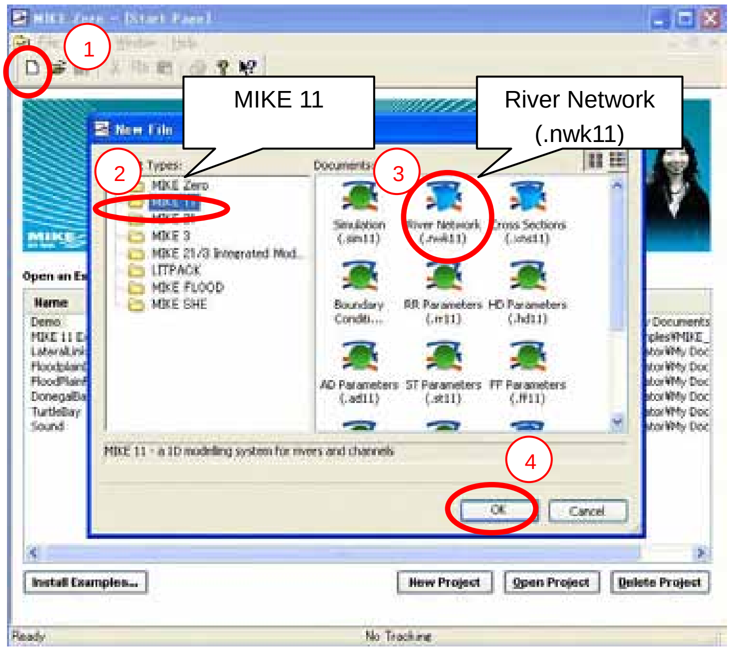
	X	Y
Lower left corner	446000	4025000
Upper right corner	520000	4060000

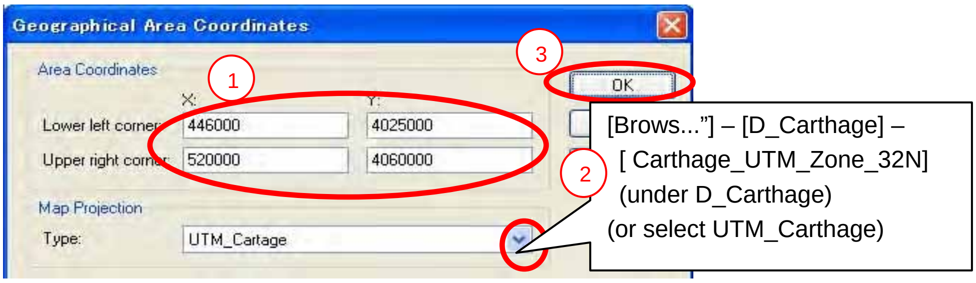
(Downstream Model)

	X	Y
Lower left corner	530000	4040000
Upper right corner	611096.1	4100000

Method 1: Specify when a new network file is created

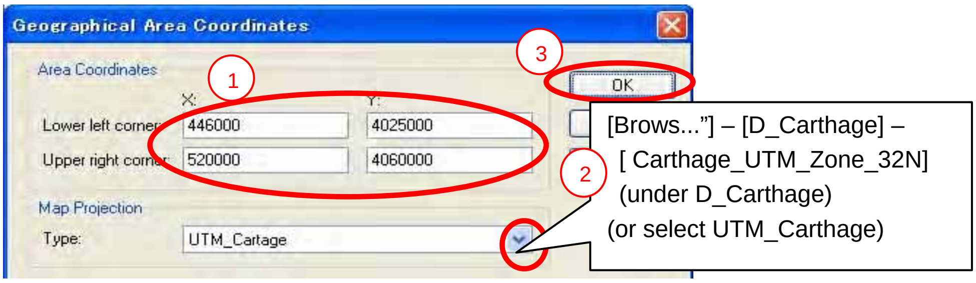
Windows [All Program] – [MIKE BY DHI] – [MIKE11] – [MIKE11]





<u>Method 2: Change ”Area Coordinates” in an existing Network File</u>

Command bar [Network] – [Resize Area...]



(2) Parameters in the Tabular View

(i) Parameters applied

Some parameters automatically are input when a text file of coordinates is imported. (See **Chapter AN-1.2** in **ANNEX 1**) Other parameters necessitate manual inputs on the tabular view of the Network Editor. The parameters and settings applied to the network files of the Mejerda Model are summarized below. The parameters belonging to the structures (bridges, etc.) can also be input on the tabular view of the Network File, and are described in **Section II.3.8**.

Parameter Settings in Network File Applied to the Mejerda Model, Manual Input ([Network] – [Branches])

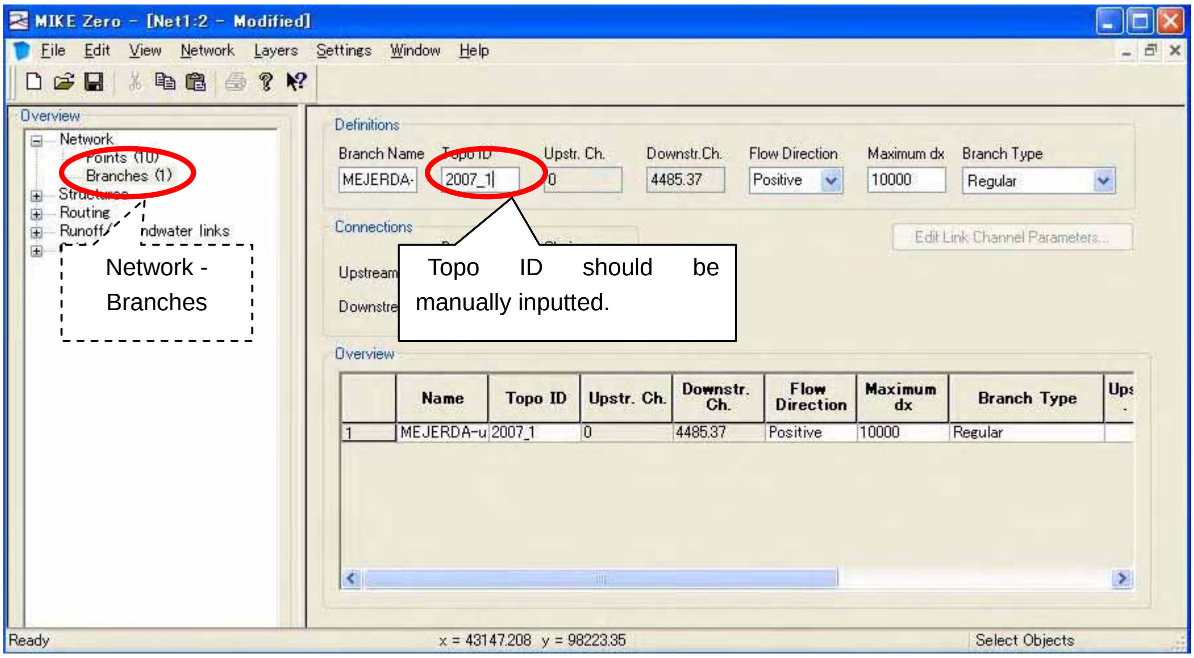
Branch Name	Topo ID	Flow Direction	Branch Type
Upstream Model			
MEJERDA-up	2007_1	Positive	Regular
Mellegue	2007_2	Positive	Regular
BouHeurtma	2007_2	Positive	Regular
Tessa	2007_2	Positive	Regular
Downstream Model			
MEJERDA-down	2007-EGET	Positive	Regular

Parameter Settings in Network File Applied to the Mejerda Model, Automatically Filled when a Coordinate Text File is Imported ([Network] – [Points])

Branch	Chainage Type	Type
Upstream Model		
MEJERDA-up	User Defined	Default
Mellegue	User Defined	Default
BouHeurtma	User Defined	Default
Tessa	User Defined	Default
Downstream Model		
MEJERDA-down	User Defined	Default

(ii) Procedure

Command bar [View] – [Tabular View...] – [Network] – [Branches] (or [Points]) – Input required parameters



(3) Other notes on the Network File

- Branch Name (River Name), Topo ID and Chainage in Cross Section and Network Editors should be exactly the same. Otherwise, the Simulation File cannot link the two editors appropriately.
- For the Mejerda Model, "Flow Direction" should always be "Positive". "Positive" means chainage zero is situated at the upstream end. Chanaiges in the network and cross section data in the Mejerda model were determined so that all the river channels can have "Positive" flow direction.
- For the Mejerda Model, "Branch Type" should always be "Regular". "Regular" means that river channels have cross section data. (See Section 2.2.2 of DHI MIKE 11 user guide (M11-2 in **Table I.1.1**) for further detail)

II.3.4 Step 3: Preparing cross section file

File extension	*.xns11
MIKE application to be accessed	Open MIKE 11 – [New] – [MIKE 11] – [Cross Sections (*.xns11)]
Related software Manual	MIKE11 - a Modelling System for River and Channels, User Guide (M11-2 in **Table I.1.1**), **Chapter 3**
Major information to be input	• River Name • Topo ID • Cross section ID • Chainage (Cumulated distances of cross section positions from the upstream end) • Cross section shapes (X, Z) • Roughness coefficient
Procedure	Prepare an excel file → Make an xns11 file → Input data on the xns11 file including copying data in the excel file to the xns11 file (See **Chapter AN1.3** in **Annex 1** of this explanation note)

Source : Study Team

(1) Bed resistance

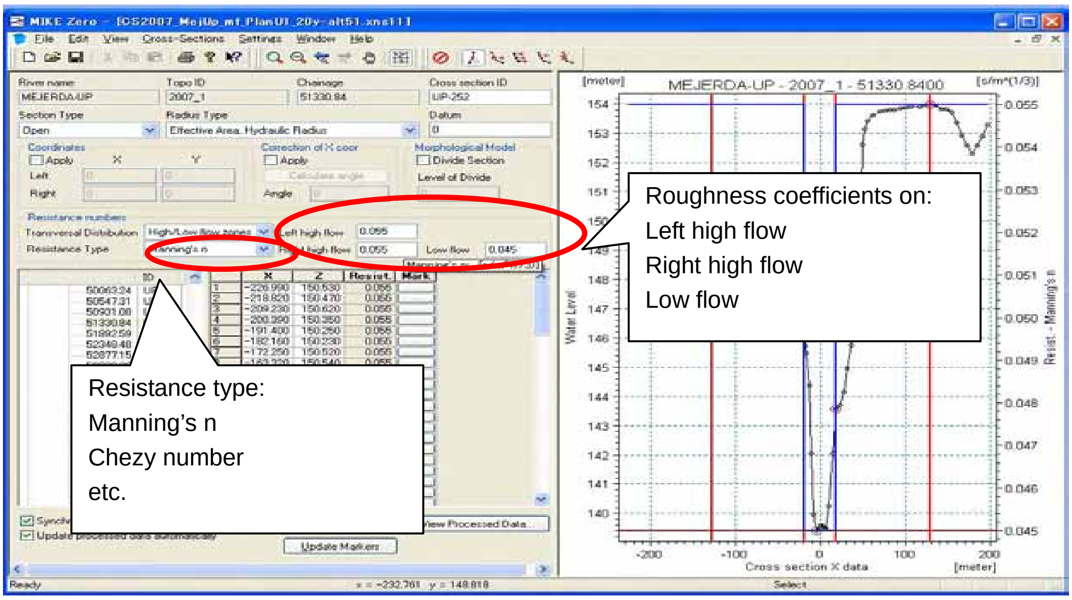
Bed Resistance and Radius Definition Applied to the Mejerda Model

Parameter	Selection / Value
Upstream Model, Downstream Model	
Section Type	Open
Radius Type	Effective Area, Hydraulic Radius
Datum	0
Transversal distribution	High/Low flow zones
Resistance Type	Manning's n
Left high flow	0.055
Right high flow	0.055
Low flow	0.045

(i) Roughness coefficients

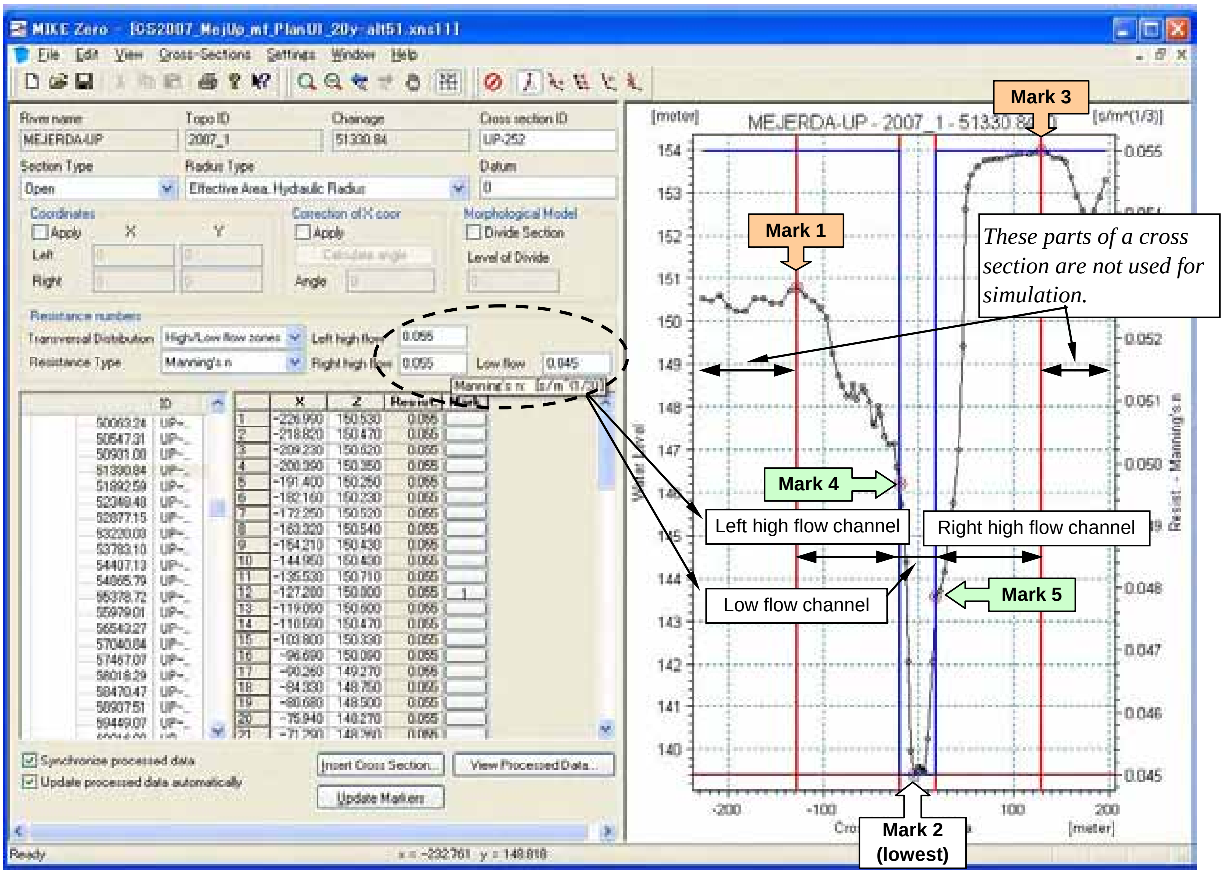
The above Manning's n were determined based on the calibration result using H-Q data, discharge records at the major cross sections obtained from MARH. Different coefficients are employed to express thick vegetations on high flow channels as described below.

The Manning's n was used for the Mejerda Model. The Chezy number can also be applied, if the resistance type and coefficients are changed on the Cross Section Editor.



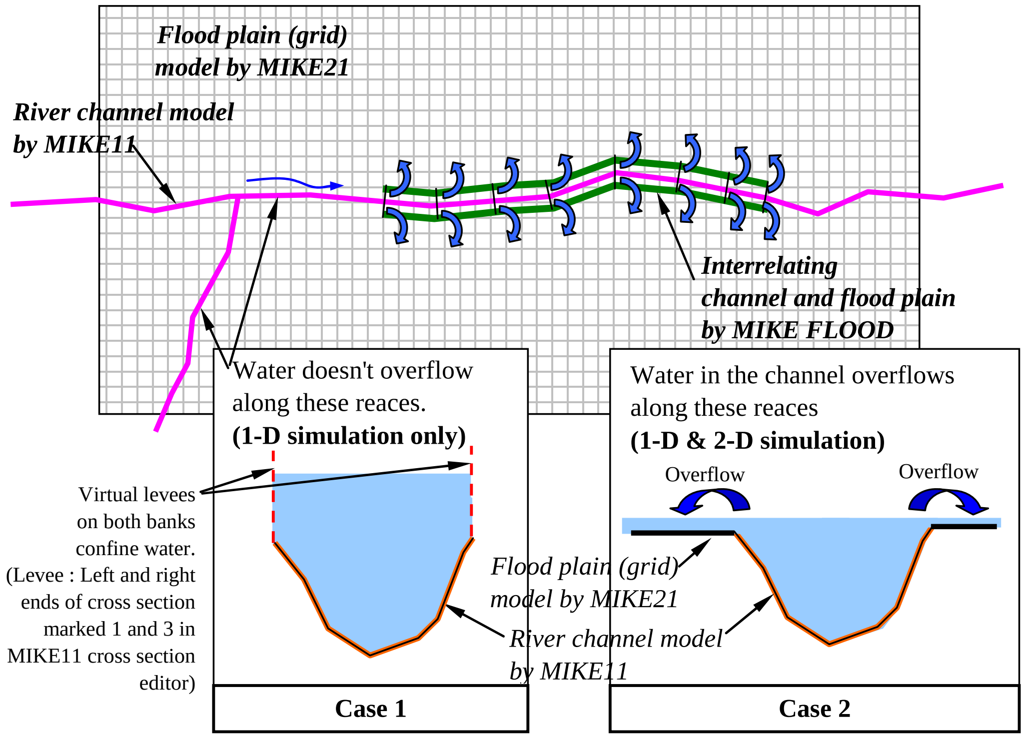
(ii) Transversal distribution : High / low flow zones

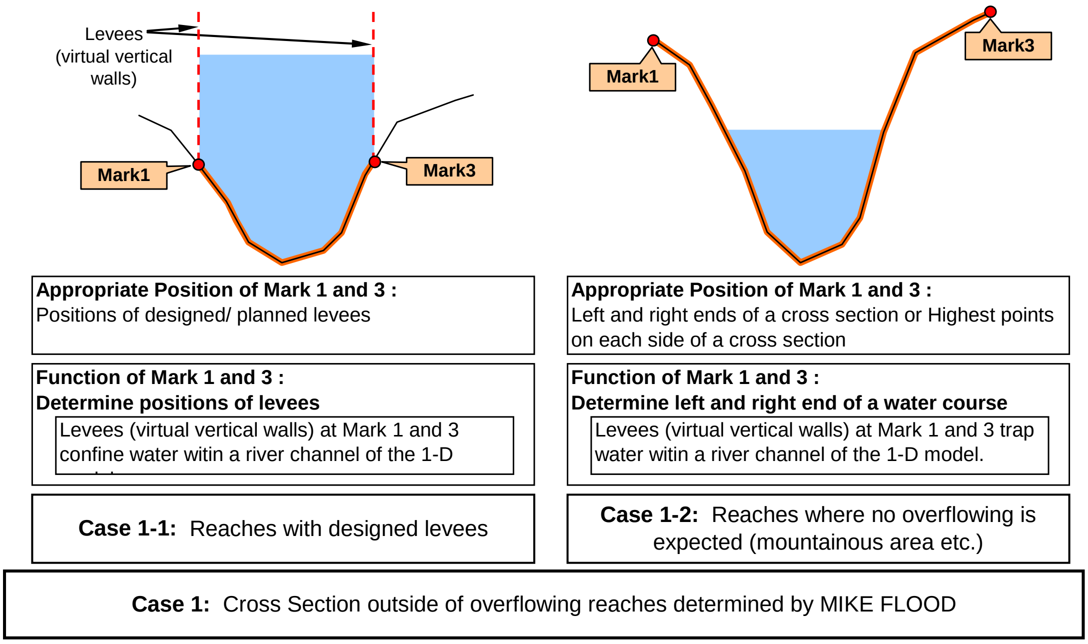
In consideration of thick vegetation on the high flow channels of the Mejerda River, "High/Low flow zones" of the transversal distribution was selected. It enables to employ different roughness coefficients on high and low flow zones. Marks 4 and 5 divide a cross section into zones as shown in the following figure. Thicker vegetation on high flow channels in the Mejerda was presented by this zone division and higher roughness coefficients on high/low flow zones.

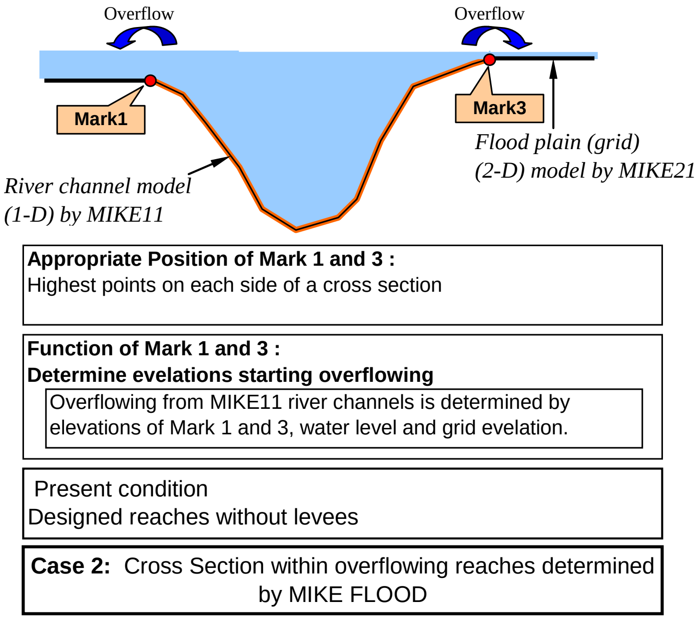


(2) Function of Marks 1 and 3 as a levee

Mark 1 and Mark 3 determine ends of cross section, and inputted cross section data (X, Z) outside of these marks are not used for the simulation as shown in the above figure. These marks are utilized as a basis of the occurrence of overflowing from the 1-D (MIKE11) model to 2-D (MIKE21) model, when the MIKE11 model is combined with the MIKE21 model by MILE FLOOD. The functions of the marks show slight differences according to the case whether the sections have levees or not, as the following figures explain. Hence, positions of Marks 1 and 3 need to be determined according to the case, and should be altered even for the same cross section but for different cases.







Source : Study Team

Figure II.3.4: Appropriate Positions of Mark 1 and Mark 3 on Cross Sections of MIKE11 as a Part of MIKE FLOOD

II.3.5 Step 4: Preparing HD (hydrodynamic) file

File extension	*.hd11
MIKE application to be accessed to create a new file	Open MIKE 11 – [New] – [MIKE 11] – [HD Parameters (*.hd11)]
Related software Manual	MIKE11 - a Modelling System for River and Channels, User Guide (M11-2 in **Table I.1.1**), **Chapter 6**
Major information to be input	• Initial conditions • Additional output files
Procedure	Make an hd11 file → Input necessary information (See **Chapter AN1.4** in **Annex 1** of this explanation note)

Source : Study Team

HD Parameters Applied to the Mejerda Model

Page	Parameter	Selection / Value
Initial	Global values	Water Depth : 1.5 Discharge : 0 Water Depth
Add. Output	-	(example) Velocity Froude Number (Not limited to. According to users' selection)

(1) Note on bed resistance in HD parameter file

In the HD parameter file, there is the "Bed Resit." page, and the bed resistance type and resistance number, such as Manning's n, can be input. However, in the case of the

Mejerda Model, the bed resistance definitions on this page are not used. Instead, the resistance type and values specified for each cross section on the Cross Section Editor are applied to the simulation. (see **Chapter 6** of the software manual **M11-2**)

II.3.6 Step 5: Preparing boundary file (empty file)

File extension	*.bnd11
MIKE application to be accessed	Open MIKE 11 – [New] – [MIKE 11] – [HD Parameters (*.hd11)]
Procedure	Make an empty bnd11 file → (Further procedures should be conducted after preparing a simulation file. (See **Section II.3.8: Step 7**.) (See **Chapter AN1.5** in **Annex 1** of this explanation note)

Source : Study Team

II.3.7 Step 6: Preparing simulation file

File extension	*.sim11
MIKE application to be accessed	Open MIKE 11 – [New] – [MIKE 11] – [Network file (*.nwk11)]
Related software Manual	MIKE11 - a Modelling System for River and Channels, User Guide (M11-2 in **Table I.1.1**), **Chapter 1**
Major information to be input	• Directories and names of input files • Simulation time step and period • Directories and names of a result fileRiver name
Procedure	Make a sim11 file → Specify directories and names of input files →Input simulation and result information (See **Chapter AN1.6** in **Annex 1** of this explanation note)

Source : Study Team

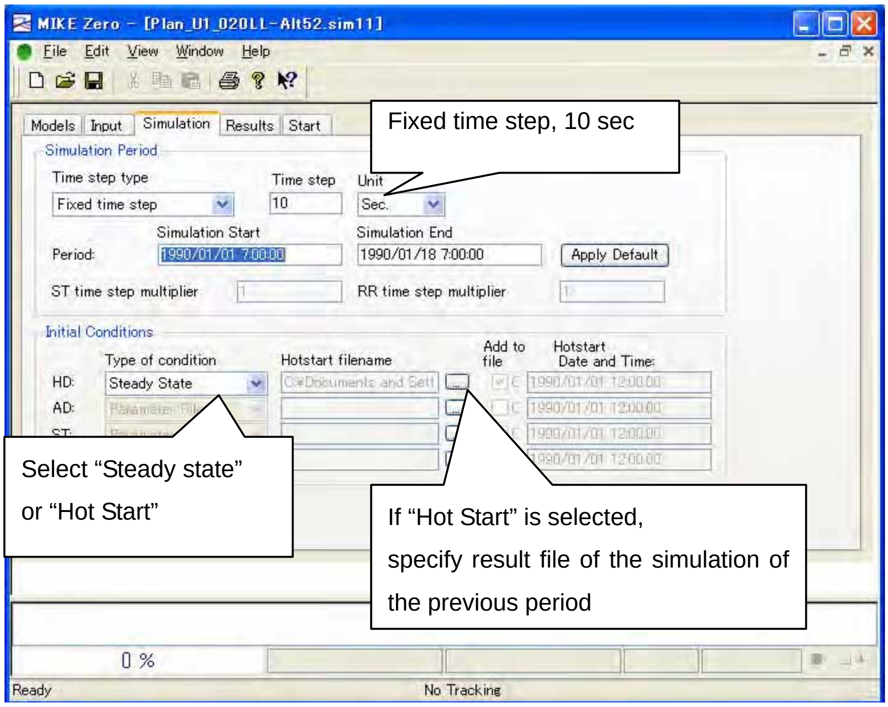
Parameters in the Simulation File Applied to the Mejerda Model
("Model" Page)

Parameter	Selection / Value
Upstream Model, Downstream Model	
Models	Hydrodynamic
Simulation Mode	Unsteady

Parameters in Simulation File Applied to the Mejerda Model
("Simulation" Page)

Parameter		Selection / Value
Upstream Model		
Simulation Period	Time step type	Fixed time step
	Time step	10
	Unit	Sec

Parameter		**Selection / Value**
	Simulation Start	01/01/1990 7:00:00
	Simulation End	18/01/1990 7:00:00
Initial Condition	Type of condition	Steady State
Downstream Model		
Simulation Period	Time step type	Fixed time step
	Time step	10
	Unit	Sec
	Simulation Start	02/01/1990 7:00:00
	Simulation End	19/01/1990 7:00:00
Initial Condition	Type of condition	Steady State or Hot Start (see below



The simulation period (17 days) were determined to cover a peak of flood which is prolonged as a result of dam operation, especially by the Sidi Salem Dam, in the Mejerda River basin.

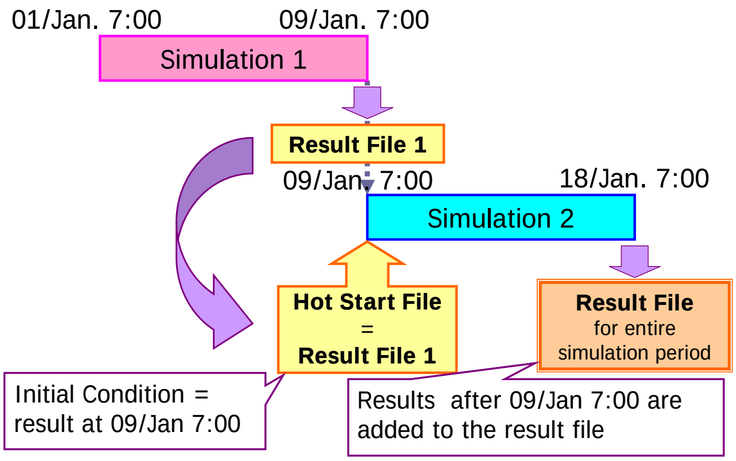
(1) Note on required time for simulation and "Hot Start"

Simulation of a MIKE FLOOD model requires surprisingly long time, for instance half day or more, especially for the cases of large floods with the extensive inundated area. This is resulted from the required simulation time for a MIKE21 model, but a MIKE11 model also incidentally requires the same time of simulation.

"Hot Start" allows dividing one case of simulation in to two or more periods, and the basic concept of the modelling of "Hot Start" is as in the following figure. Dividing the simulation period employing "Hot Start" could bring the following advantages.

- It could save a half of results, even if unexpected termination of the simulation occurs near the end of the required simulation period.
- It could bring a chance to check results at the middle of simulation.

In the case of a MIKE 11 model built as a part of a MIKE FLOOD model, "Hot Start" should be applied to a MIKE11 model, if a coupled MIKE21 model uses it.



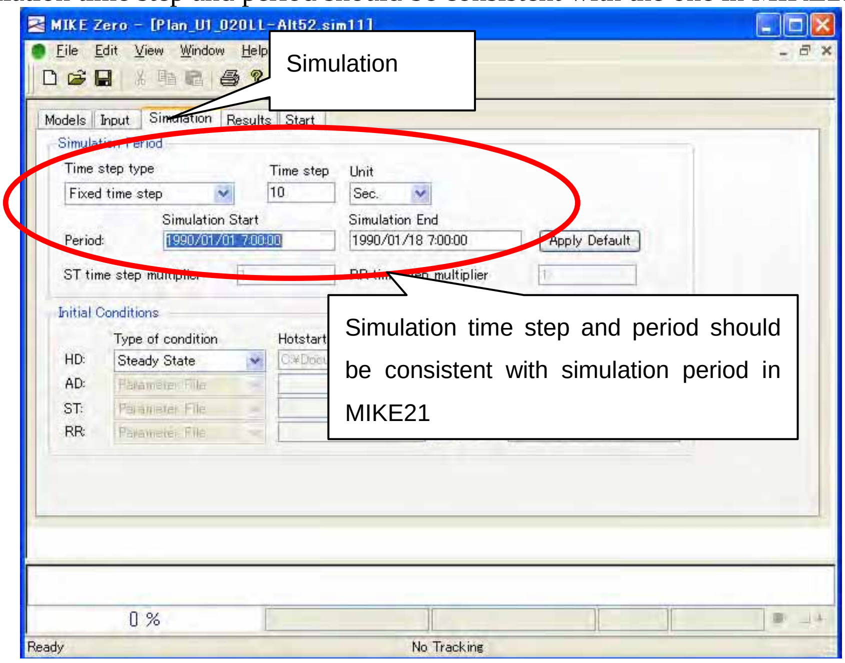
Source : Study Team

Figure II.3.5: Basic Concept of Modelling of "Hot Start"

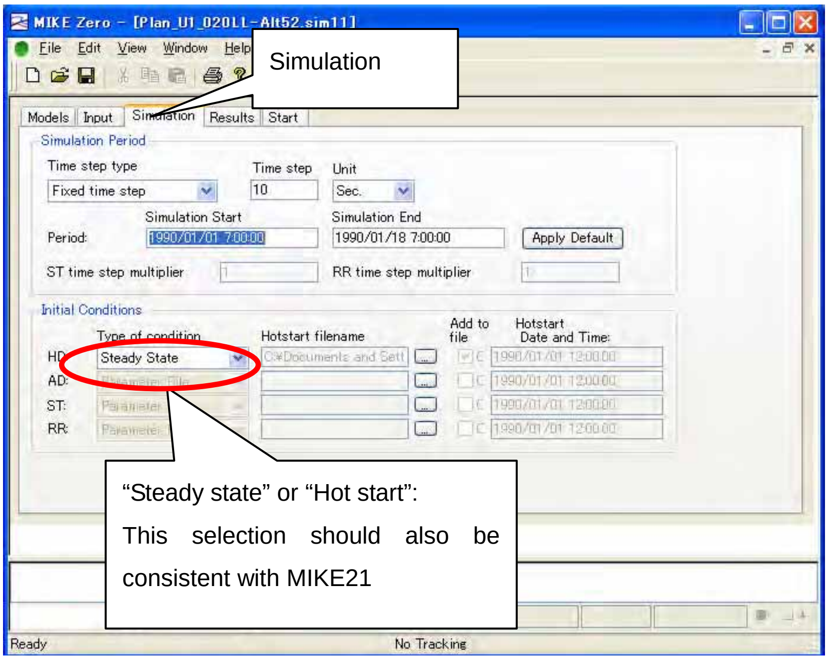
(2) Note on Simulation file as a part of a MIKE FLOOD model

Because the MIKE 11 model for the Mejerda basin should be coupled with the MIKE 21 model as a part of the MIKE FLOOD model, the following issues need to be considered in preparing the Simulation File.

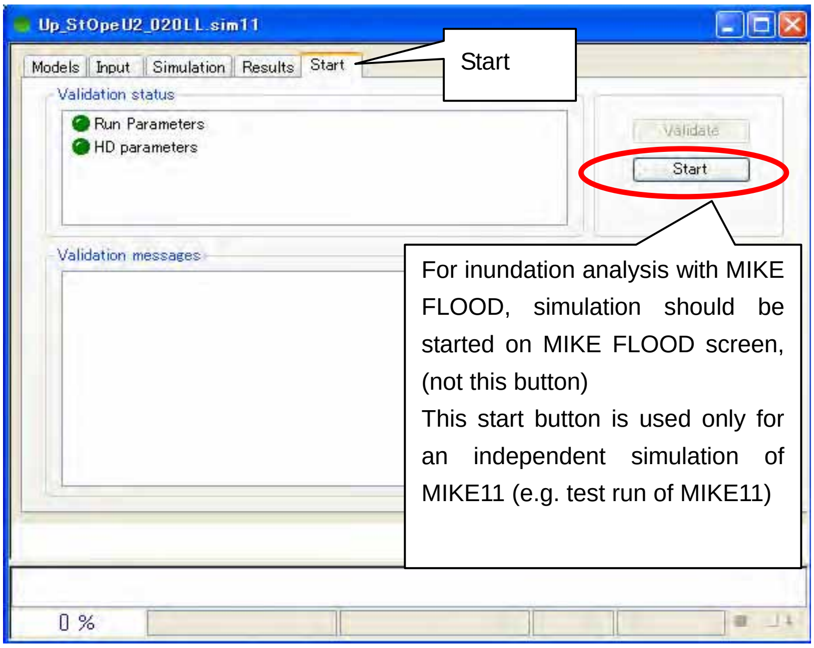
- Simulation time step and period should be consistent with the one in MIKE21.



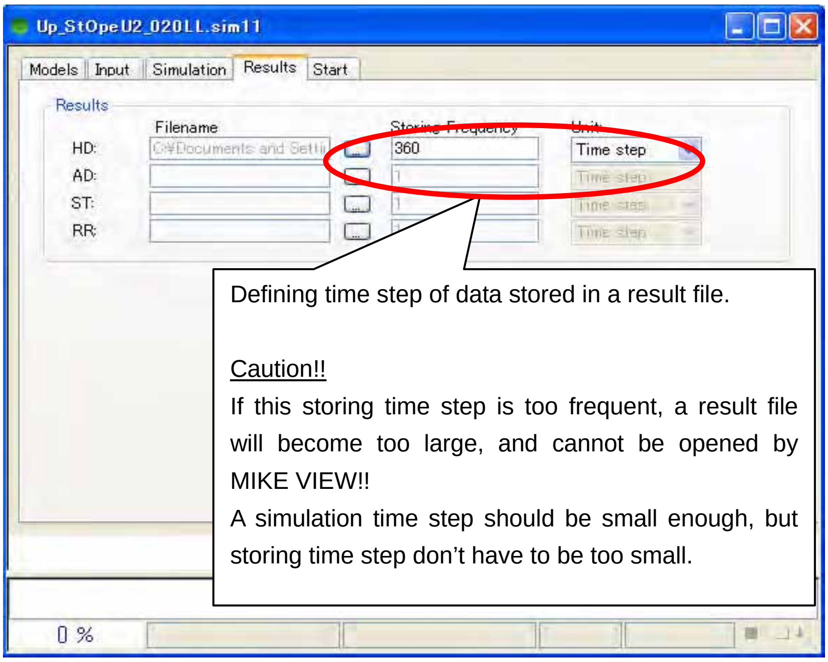
- "Steady State" or "Hot Start" of simulation should be selected according to the time required for the simulation of MIKE FLOOD (MIKE 21) Model.



- Starting simulation is controlled by the MIKE FLOOD editor ("**.couple" file) when a MIKE11 model is simulated as a part of MIKE FLOOD model



(3) Note on result files



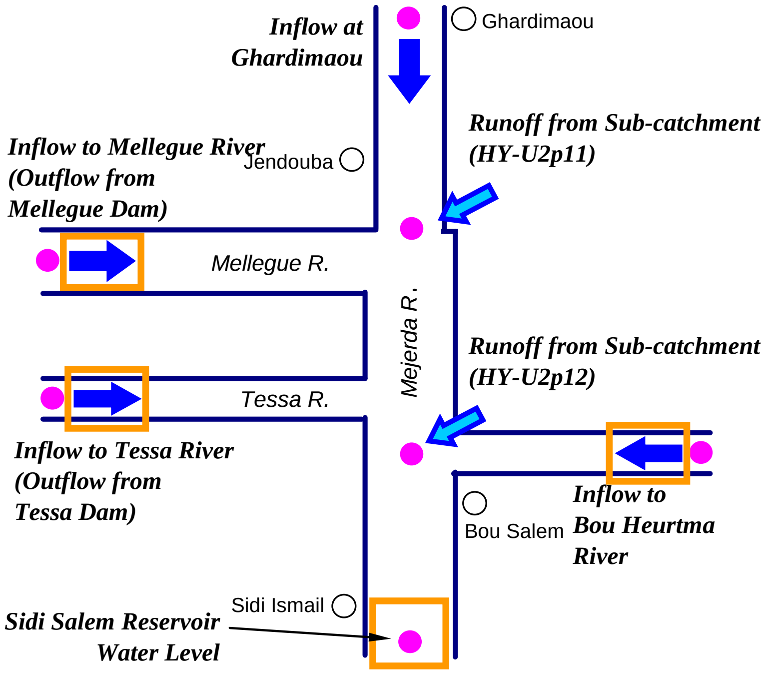
II.3.8 Step 7: Inputting boundary data

File extension	*.bnd11
Related software Manual	MIKE11 - a Modelling System for River and Channels, User Guide (M11-2 in **Table I.1.1**), **Chapter 4**
Major to be input	• Chainage (location) and time series of boundary inflow/ water level • Upstream boundary of the demo model: Hourly inflow discharge • Downstream boundary of the demo model: Hourly water level River name
Procedure	Open network editor through sim11 file →Input boundary data (See **Chapter AN1.7** in **Annex 1** of this explanation note)

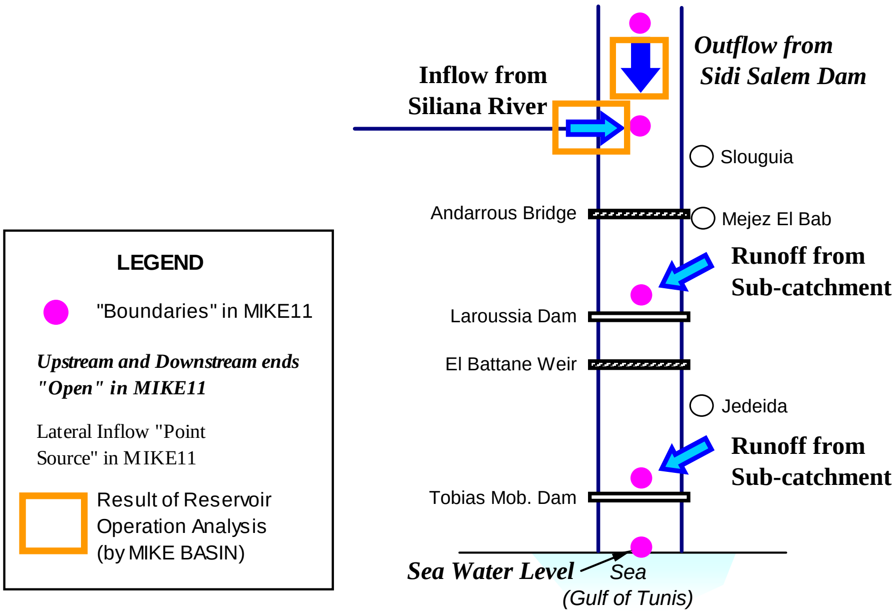
Source : Study Team

(1) "Boundary" of the Mejerda Model

"Boundaries" in MIKE11 mean inflow from the upstream ends of river reaches, water levels at the downstream end of the river reaches and lateral inflow at the middle of river reaches. The following figures schematically show the "boundaries" in the MIKE11 Mejerda Model.



(1) Upstream Model



(2) Downstream Model

Source : Study Team

Figure II.3.6: Boundary Inputs for the Mejerda Model

Parameters applied to the Mejerda Model and corresponding time series files are summarized in the following tables. Definitions of parameters are described in **Section 4.2** of the software manual, MIKE 11 user guide. (**M11-2**)

Table II.3.2: Boundary Conditions for Upstream Model

Location	Item	Parameter Selection in MIKE11		
		Boundary Description	Boundary Type	Branch Name
Boundary Inflow / Water Level				
Upstream end (Ghardimaou)	Probable inflow hydrograph from Algeria	Open	Inflow	MEJERDA-up
Downstream end (Sidi Salem Reservoir)	Sidi Salem reservoir water level (adjusted taking the distance from the dam site into account)	Open	Water Level	MEJERDA-up
Upstream end of Mellegue River	Out flow from Mellegue Dam	Open	Inflow	Mellegue
Upstream end of Bou Heurtma River (about 17 km upstream from the Mejerda confluence)	Outflow from Bou Heurtma Dam, transformed	Open	Inflow	BouHeurtma
Upstream end of Tessa River (about 20 km upstream from the Mejerda confluence)	Tessa dam outflow, transformed (without dam operation for the before Project Cases)	Open	Inflow	Tessa
Lateral Inflow				
BP-U2p11(=BP-U1): Mejerda & Mellegue Confluence	Runoff from sub-catchment (HY-U2p11)	Point Source	Inflow	MEJERDA-up
BP-U2p12: Mejerda & B.Heurtma Confluence	Runoff from sub-catchment (HY-U2p12)	Point Source	Inflow	MEJERDA-up

Note: [double-framed box] Derived from reservoir operation simulation result
"Open" in Boundary Description is the conditions at upstream or downstream ends of river channels, while "Point Source" should be applied to lateral inflow at some point of a channel.

Table II.3.3: Time Series File Name for Boundary Conditions for Upstream Model

Location	Chainage	Folder Name	File Name+	TS Info. (Item)
Boundary Inflow / Water Level				
Upstream end (Ghardimaou)	0	TS-QDesign	Qin-BPAU1_Ghardi.dfs0	**-y
Downstream end (Upstream end of Sidi Salem Reservoir)	152972.97	TS-DamWL Design	• SSWLd-D2t-OptOpe2030-MIKEBasin.dfs0 • SSWLd-D2t-4damStOpe-MIKEBasin.dfs0	**-y
Upstream end of Mellegue River (Mellegue Dam)	0	TS-QDesign	• Qd-D2t-OptOp2030_**y.dfs0 • Qd-D2t-4damStOpe_**y.dfs0	MelDam_out
Upstream end of Bou Heurtma River (about 17 km upstream from the confluence)	0	TS-QDesign	• Qdb-D2t-OptOp2030_BouHeurtma.dfs0 • Qdb-D2t-4damStOpe_BouHeurtma.dfs0	**-y
Upstream end of Tessa River (about 20 km upstream from the confluence)	0	TS-QDesign	• Qdb-D2t-OptOp2030_Tessa.dfs0 • Qdb-D2t-4damStOpe_Tessa.dfs0	**-y

Location	Chainage	Folder Name	File Name+	TS Info. (Item)
Lateral Inflow				
BP-U2p11 (=BP-U1): Mejerda & Mellegue Confluence,	88834.33(U2) 35563.28(U1)	TS-QDesign	• Qd-U2tp11.dfs0	**-y
BP-U2p12: Mejerda & B.Heurtma Confluence	110641.48	TS-QDesign	• Qd-U2tp12.dfs0	**-y

Note: [box] Derived from reservoir operation simulation result
** : Return period
+: ....-4damStOpe_... : Standard dam operation (before project case)
....-OptOpe2030_.... : Improved dam operation (after project case)

Table II.3.4: Time Series File Name for Boundary Conditions for Downstream Model

Location	Item	Parameter selection in MIKE11		
		Boundary Description	Boundary Type	Branch Name
Boundary Inflow /	**Water Level**			
Upstream end (Sidi Salem Dam)	Outflow from Sidi Salem River	Open	Inflow	MEJERDA-down
Downstream end (Estuary)	Sea water level (Average high tide, 0.5 mNGT)	Open	Water Level	MEJERDA-down
Lateral Inflow				
Siliana River (Mejerda & Siliana Confluence)	Out flow from Siliana Dam, transformed	Point Source	Inflow	MEJERDA-down
BP-D2tp11: Siliana conf.	Runoff from sub-catchment (HY-D2tp11)	Point Source	Inflow	MEJERDA-down
BP-D2tp12: Larrousia Dam	Runoff from sub-catchment (HY-D2tp12)	Point Source	Inflow	MEJERDA-down
BP-D2tp13: Estuary	Runoff from sub-catchment (HY-D2tp13)	Point Source	Inflow	MEJERDA-down

Note: [box] Derived from reservoir operation simulation result
"Open" in Boundary Description is the conditions at upstream or downstream ends of river channes, while "Point Source" should be applied to lateral inflow at some point of a channel.

Table II.3.5: Time Series File Name for Boundary Conditions for Downstream Model

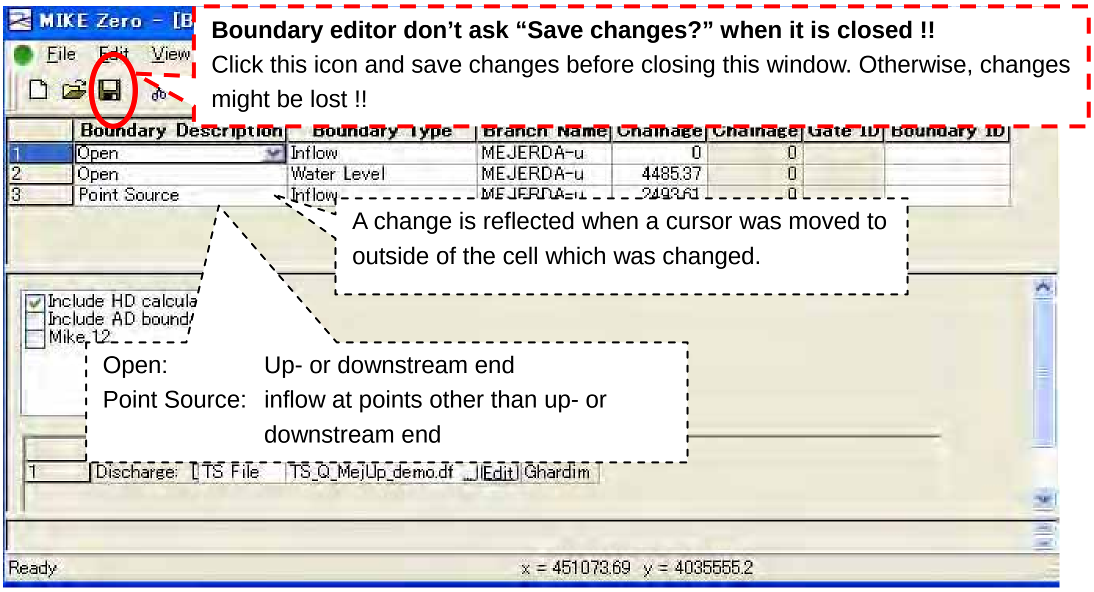
Location	Chainage	Folder Name	File Name	TS Info. (Item)
Boundary Inflow	**/Water Level**			
Upstream end (Sidi Salem Dam)	0	TS-QDesign	• Qd-D2t-OptOp2030_**y.dfs0 • Qd-D2t-4damStOp2030_**y.dfs0	S.SalemDam_out
Downstream end (Estuary)	154037	TS-DamWLDesign	• SeaWLdesign-05.dfs0	Sea WL
Lateral Inflow			•	
Siliana River (Mejerda & Siliana Conf.)	5255.27	TS-QDesign	• Qd-D2t-OptOp2030_**y.dfs0 • Qd-D2t-4damStOp2030_**y.dfs0	Siliana Estuary

Location	Chainage	Folder Name	File Name	TS Info. (Item)
BP-D2tp11: Siliana conf.	81224.43	TS-QDesign	• Qd-D2tp11.dfs0	**-y
BP-D2tp12: Larrousia Dam	137356.77	TS-QDesign	• Qd-D2tp12.dfs0	**-y
BP-D2tp13: Estuary	5255.27	TS-QDesign	• Qd-D2tp13.dfs0	**-y

Note: ▭ Derived from reservoir operation simulation result
** : Return period

(1) Note on saving changes

Before closing the boundary file window, users should be sure changes have been saved. The boundary editor don't ask "Save changes?", when it is closed.



II.3.9 Step 8: Test Simulation 1

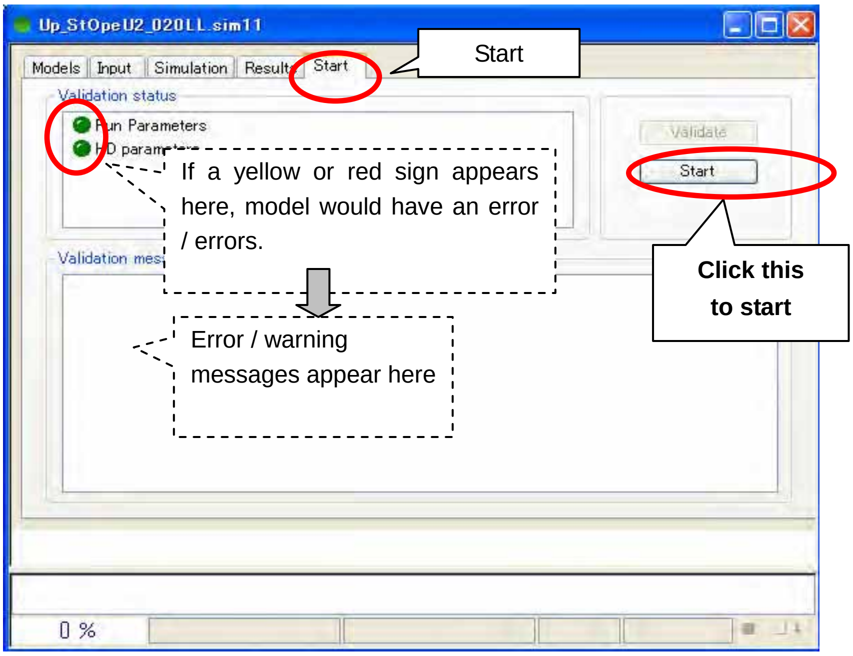
(1) Purpose

This is a test simulation of an independent MIKE11 river channel model before adding structures (bridges and weirs), in order to find errors of the river channel model before adding structure data.

(2) Procedure :

See **Section II.3.11**.

Open "Start" page of the Simulation (*.sim11) File, then start.



When the model is confirmed to have no error, then, modelling can be proceeded to the next step.

II.3.10 Step 9: Inputting structure data

File extension	*.nwk11
Related software Manual	MIKE11 - a Modelling System for River and Channels, User Guide (M11-2 in **Table I.1.1**), **Section 2.3**
Major information to be input	• Structure type • Dimension of structures • Locations of structures (chainage)
Procedure	Open network editor through sim11 file → Input structure location → Input structure parameters

Source : Study Team

(1) Structures considered in the Mejerda Model

Based on the prior non-uniform analysis of flow conditions at all bridge and other structure sites, the unsteady inundation analysis model was decided to consider the following bridges and structures which demonstrated rather significant impacts.

Upstream of Sidi Salem Dam	• A bridge over Bou Heurtma River at about 280m upstream of the confluence with the Mejerda
Downstream of Sidi Salem Dam	• Andalous Bridge at Mejez El Bab • Larrousia Dam • El Battane weir • Old Bridge at Jedeida • Tobias Mobile Dam • Other weirs crossing riverbed, such as a weir at the El Herri pumping station

The gates of the Larrousia and Tobias Mobile dams are assumed to be fully opened throughout flood periods of the major floods following the present operation.

Among the structures in the above table, the following four structures were selected as the priority structures which could affect on the river flow significantly, and were inputted as a "structure" in the Mejerda Model. Other structures were considered in the cross section shape.

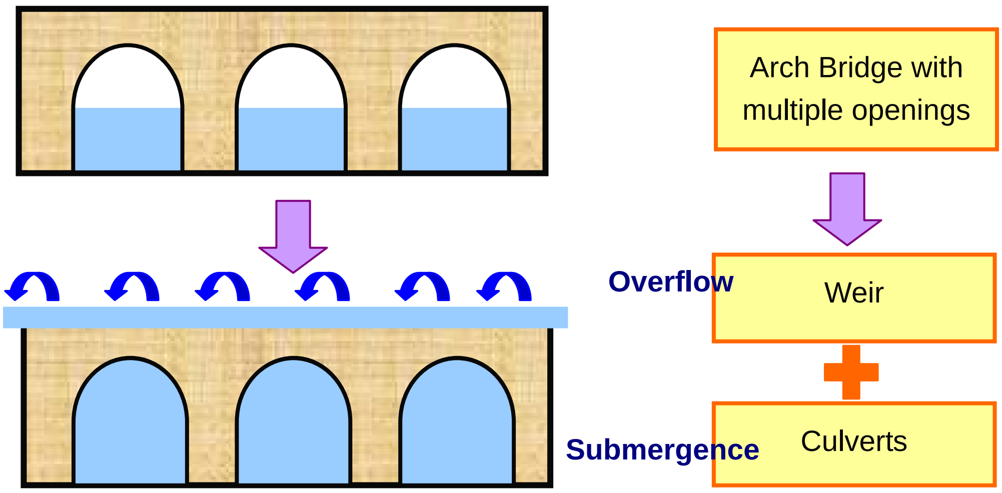
Table II.3.6: Structures in the Mejerda Model

Model	Name of Actual Structure	Structure Type in MIKE11
Upstream Model	none	-
Downstream Model	Andalous Bridge (at Mejez El Bab)	Bridge (+ Weir and Culvert)
	El Battan Weir	Bridge (+ Weir and Culvert)
	Larrousia Dam	Weir
	Tobias Mobile Dam	Weir

(2) Function of Bridges

Andalous Bridge and El Battan Weir have experienced overflowing during the major floods. "Bridges" in the MIKE 11 model for the Mejerda basin were designed so as to demonstrate this overflowing phenomina. "Bridges" in the MIKE11 Mejerda Model (Andalous Bridge and El Battan Weir) were designed so as to act as flows.

1. When a water level is not as high as the top of the bridge, water flows under the bridge. The arch bridge, one of the "Bridge" types in MIKE11, was applied.
2. Once a water level exceeds the top of the bridge, water starts overflowing and at the same time, water passes though under the bridge. The structure functions like the combination of culverts and a weir. Hydraulic conditions are simulated for a combination structure of a weir and culverts in MIKE11



Source : Study Team

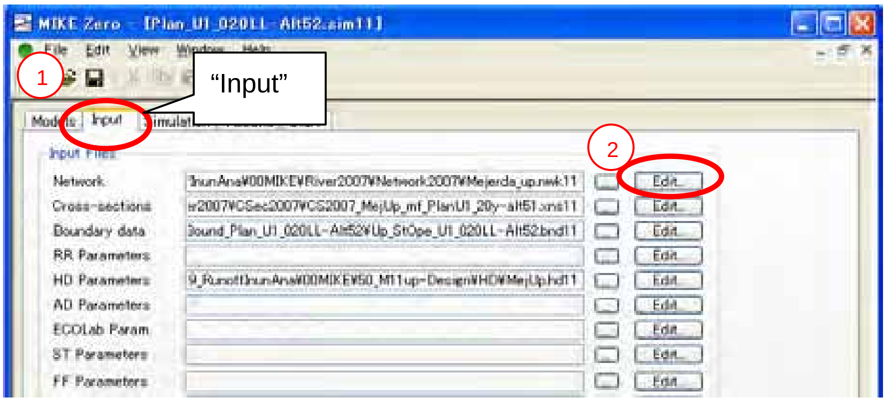
Figure II.3.7: Function of "Bridges" in the MIKE11 Mejerda Model

In order to enable the function of the combined strcuture, "Bridge", "Weir" and "Culvert" should be installed at the same position for the modelling of Andalous Bridge and El Battan Weir.

(3) Procedure :

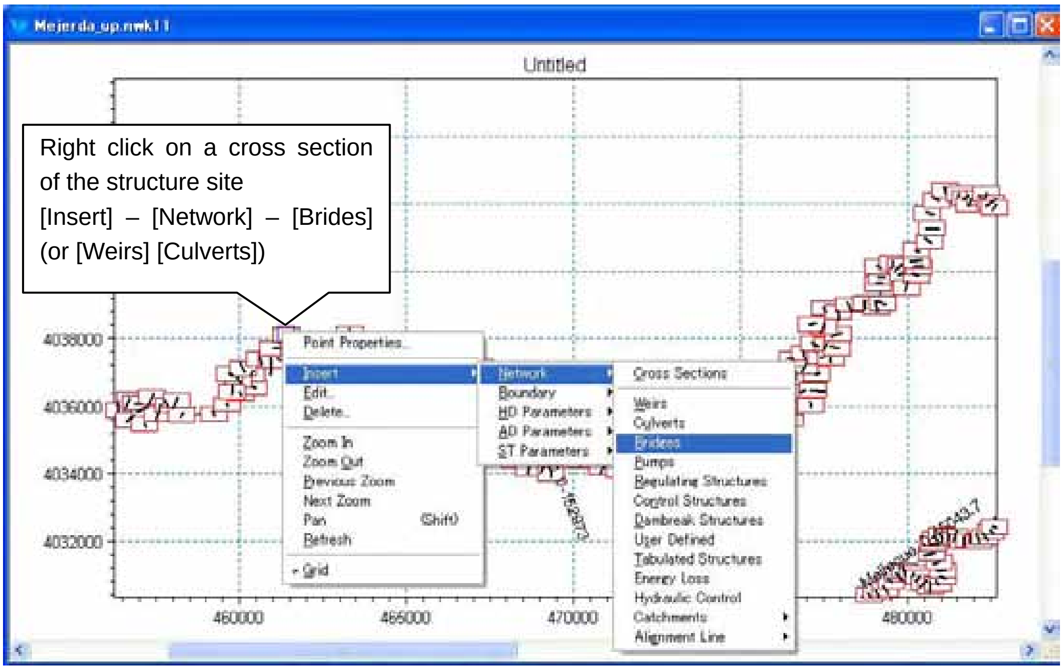
Open network editor through sim11 file → Input positions of structures → Input structure parameters

(i) Open network editor through sim11 file



(ii) Input positions of structures

Name of Actual Structure	Chainage	Structure Type in MIKE11
Andalous Bridge (at Mejez El Bab)	41044.52	Bridge (+ Weir and Culvert)
El Battan Weir	95426.71	Bridge (+ Weir and Culvert)
Larrousia Dam	83403.00	Weir
Tobias Mobile Dam	137753.20	Weir



The window of the tabular view opens automatically, when it has not been opened yet.

At the site of Pont Andarrous Bridge and El Battan Weir, the following three structures should be installed at exactly the same place repeating the following procedures, so that the “bridge” structure in MIKE 11 can simulate a overflowing phenomena.

- Bridge
- Weir
- Culvert

All types of structures in the model are placed at Q-points, which is for the computation of discharges in the unsteady analysis simulation, located between two cross sections (H-points, which is for the computation of water levels in the unsteady analysis simulation). Hence, cross sections should be added on the upstream and downstream sides of the structures if necessary. (See **Section 2.3** of the user guide, M11-2 in **Table I.1.1**) Structures can be inserted on this graphical view of the Network File only at the cross section locations (H-points). In order to add structures at “Q-points”, structures should be inserted at a cross section (“H-point”) near the targeted structure location, and then, chainage should be changed altered in the tabular view (see (4) and (5) below) later.

(iii) Input structure parameters

The parameters described in (4) and (5) below should be input in the window of the tabular view.

(4) Parameters for weirs

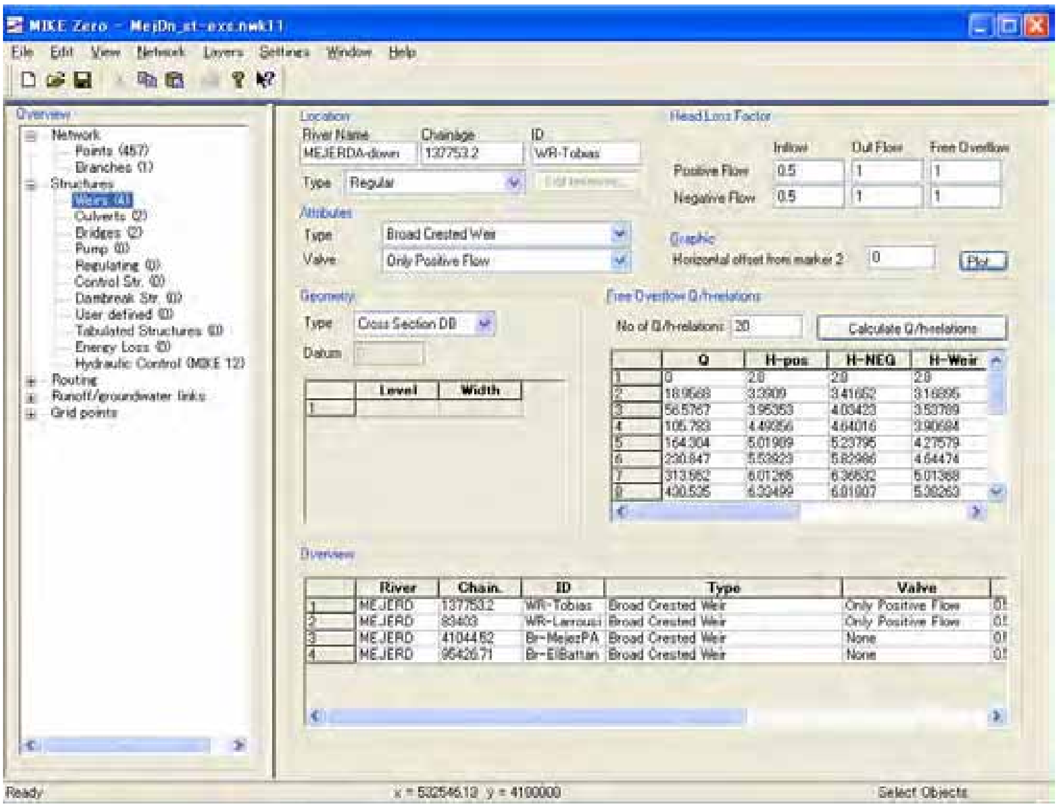
If the parameter input page in the tabular view is not opened, it can be opened from;

Command bar [View] – [Tabular View...] – [Structures] – [Weirs]

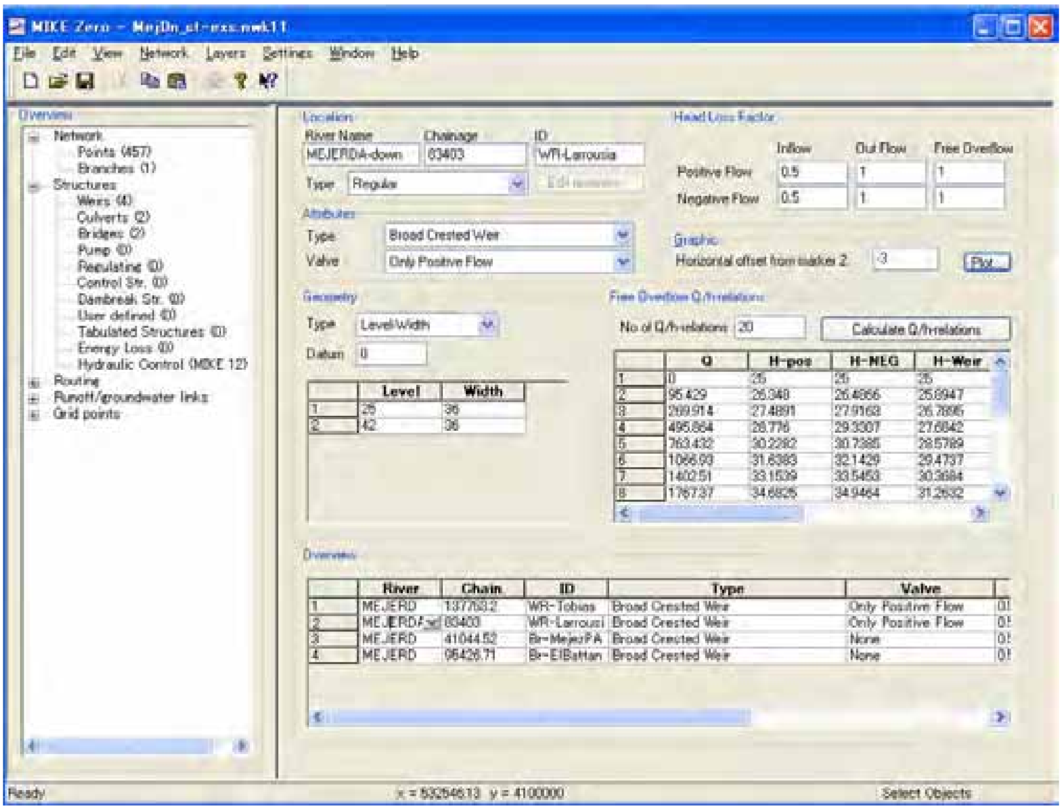
Parameters		**Tobias Mobile Dam**	**Larrousia Dam**
Location	**River Name**	MEJERDA-down	MEJERDA-down
	Chainage	137753.2	83403
	ID	WR-Tobias	WR-Larrousia
	Type	Regular	Regular
Attributes	**Type**	Broad Crested Weir	Broad Crested Weir
	Valve	Only positive flow	Only positive flow
Geometry	**Type**	Cross Section DB	Level-Width
	Datum	-	0
	Level / Width	-	25 36 24 36
Geographic	**Horizontal offset from maker 2**	0	-3

Details on each parameter are described in **Section 2.3** of the user guide (M11-2 in **Table I.1.1)**

(i) Tobias Mobile Dam



(ii) Larrousia Dam



(5) Parameters for bridges

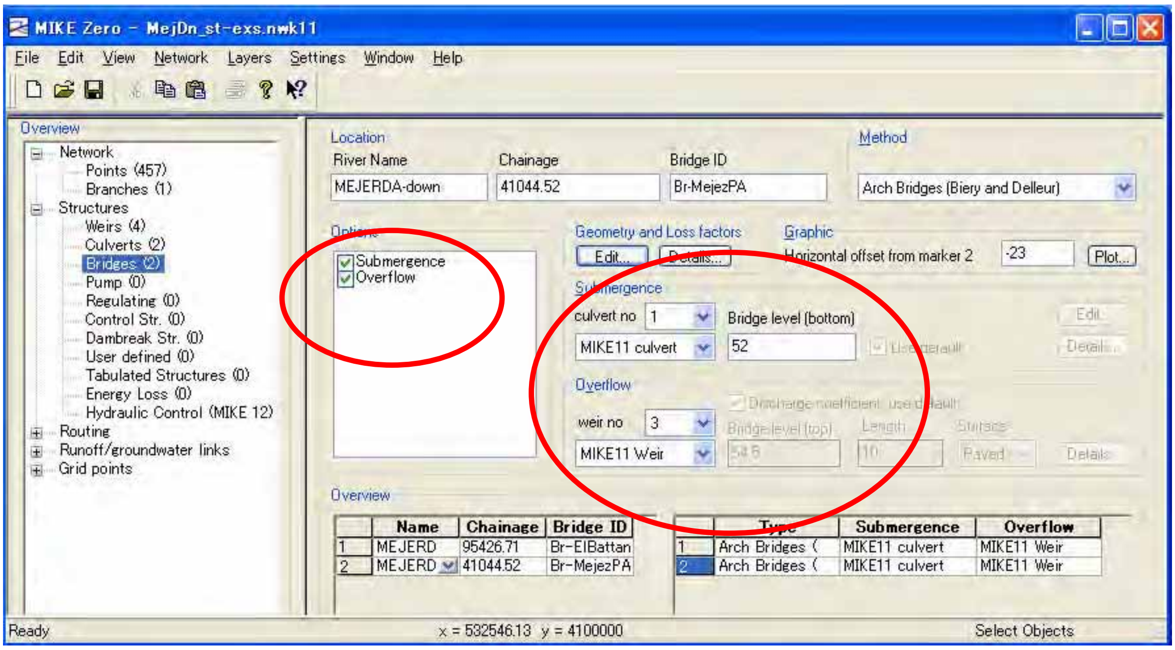
The number of arch openings counted effective openings. Openings near the both banks where flood flow become slow were considered ineffective and were not considered for the modelling.

If the parameter input page in the tabular view is not opened, it can be opened from;

Command bar [View] – [Tabular View...] – [Structures] – [Weirs]

(i) Andalous Bridge

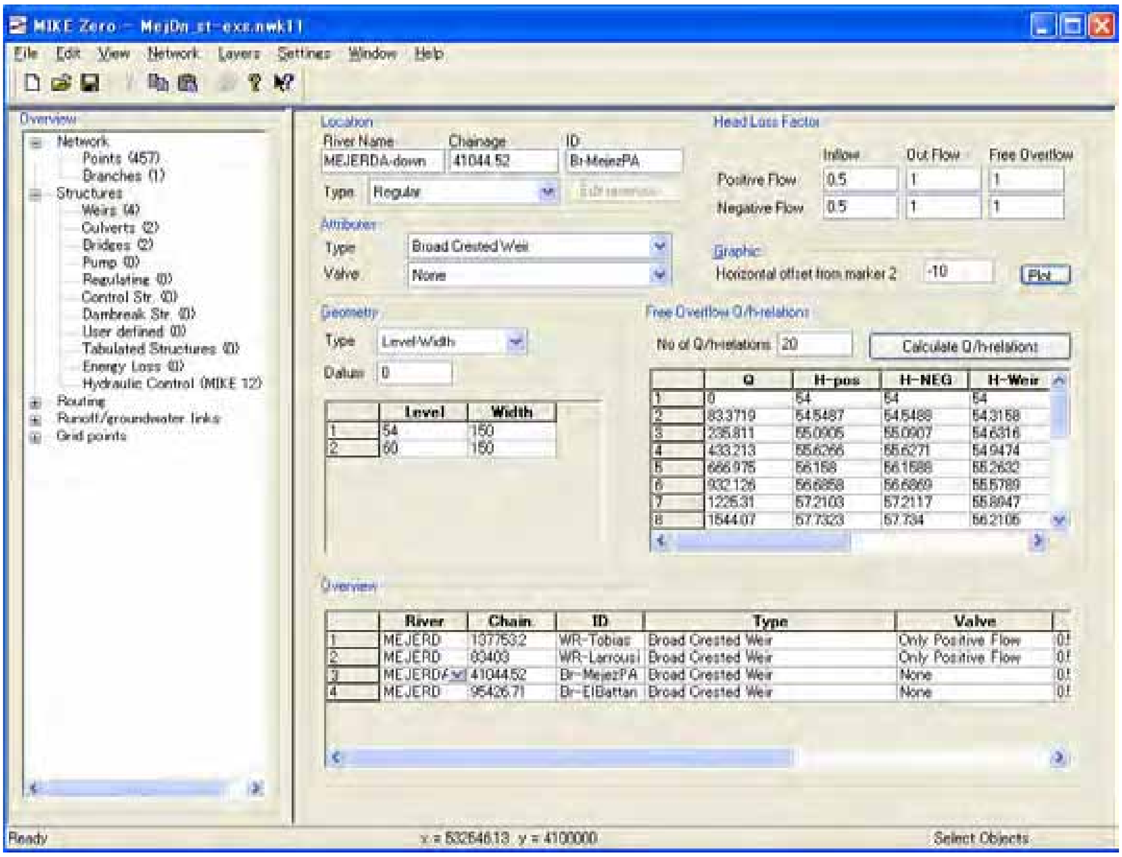
Parameters for Andalous Bridge in MIKE11 ("Bridges Window")



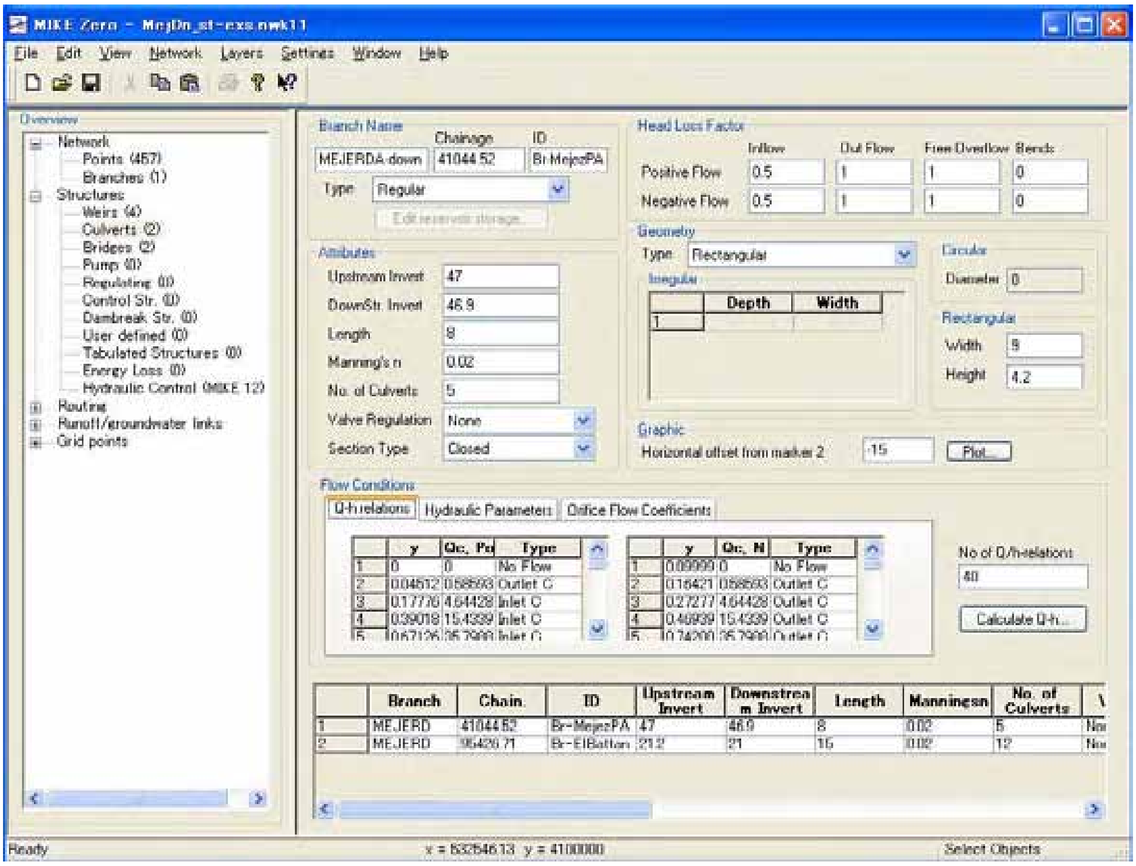
Geometry Parameters for Andalous Bridge

Parameters	Values
Opening width, b	9
Number of arches	5
Level for bottom of arch curvature	48.5
Level for top of each curvature	53
Radius of arch curvature, r	4.5

Parameters for Andalous Bridge in MIKE11 ("Weirs Window")

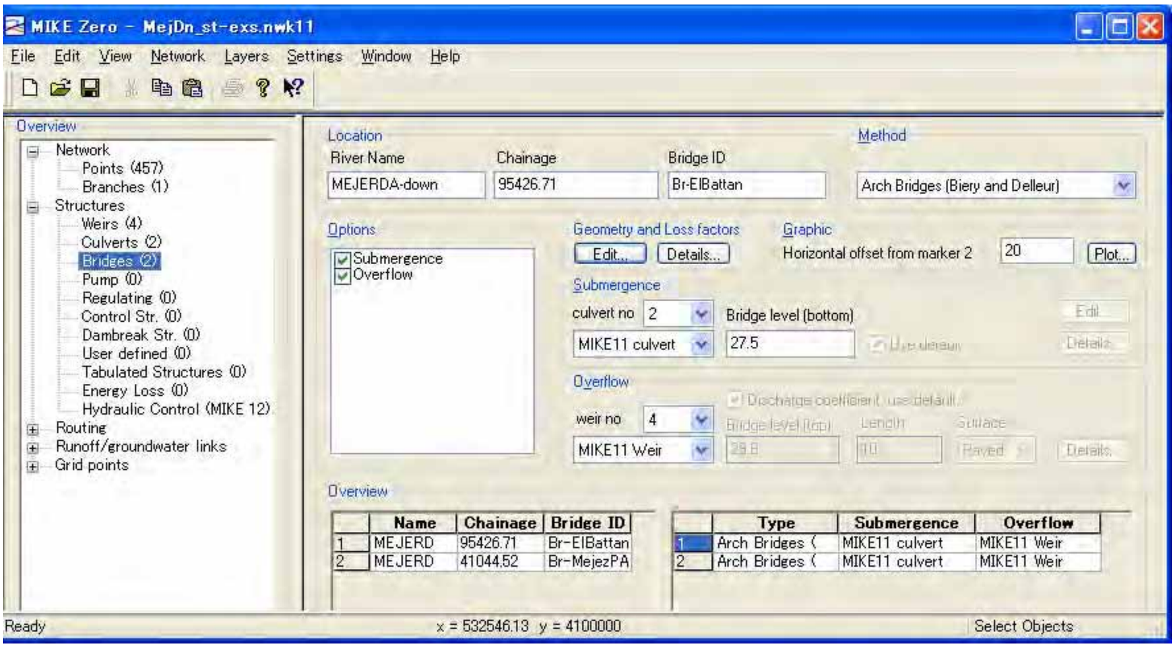


Parameters for Andalous Bridge in MIKE11 ("Culverts Window")



(ii) El Battane Weir

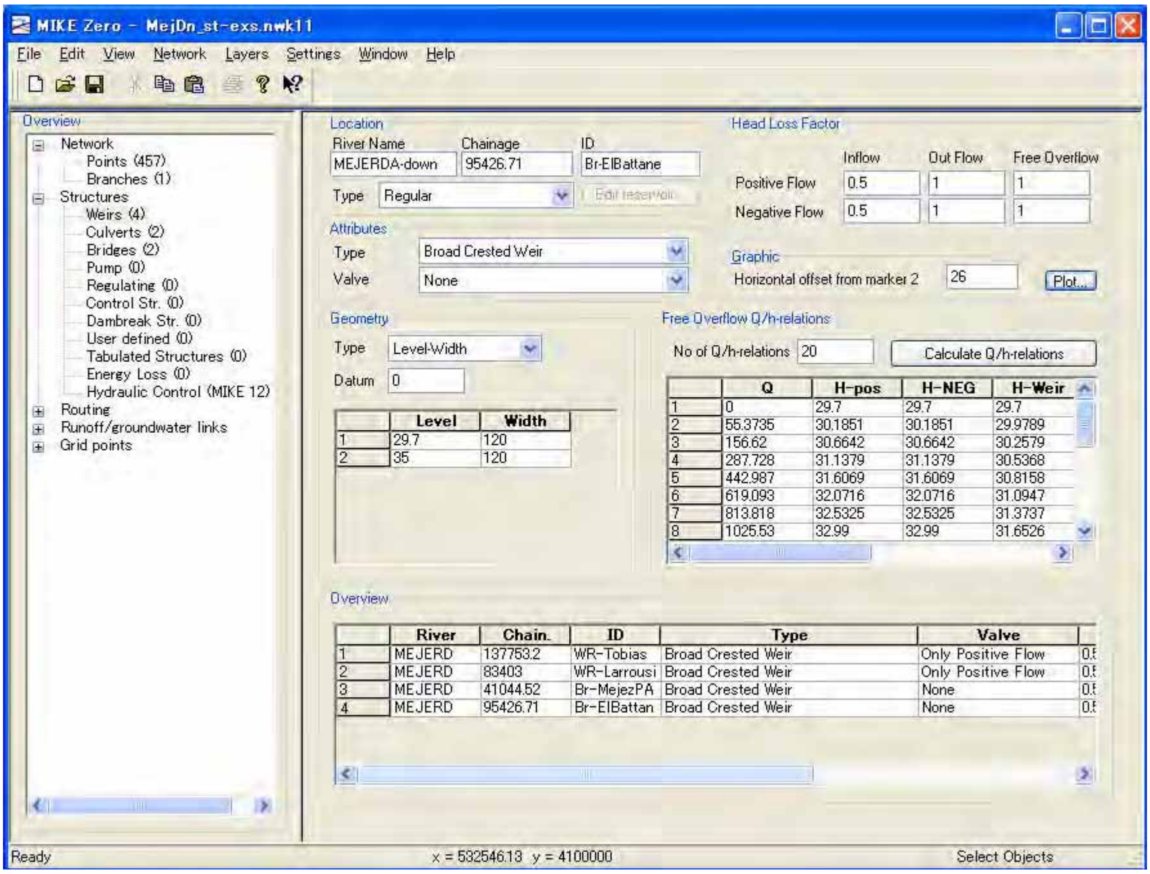
Parameters for El Battan Weir in MIKE11 ("Bridges Window")



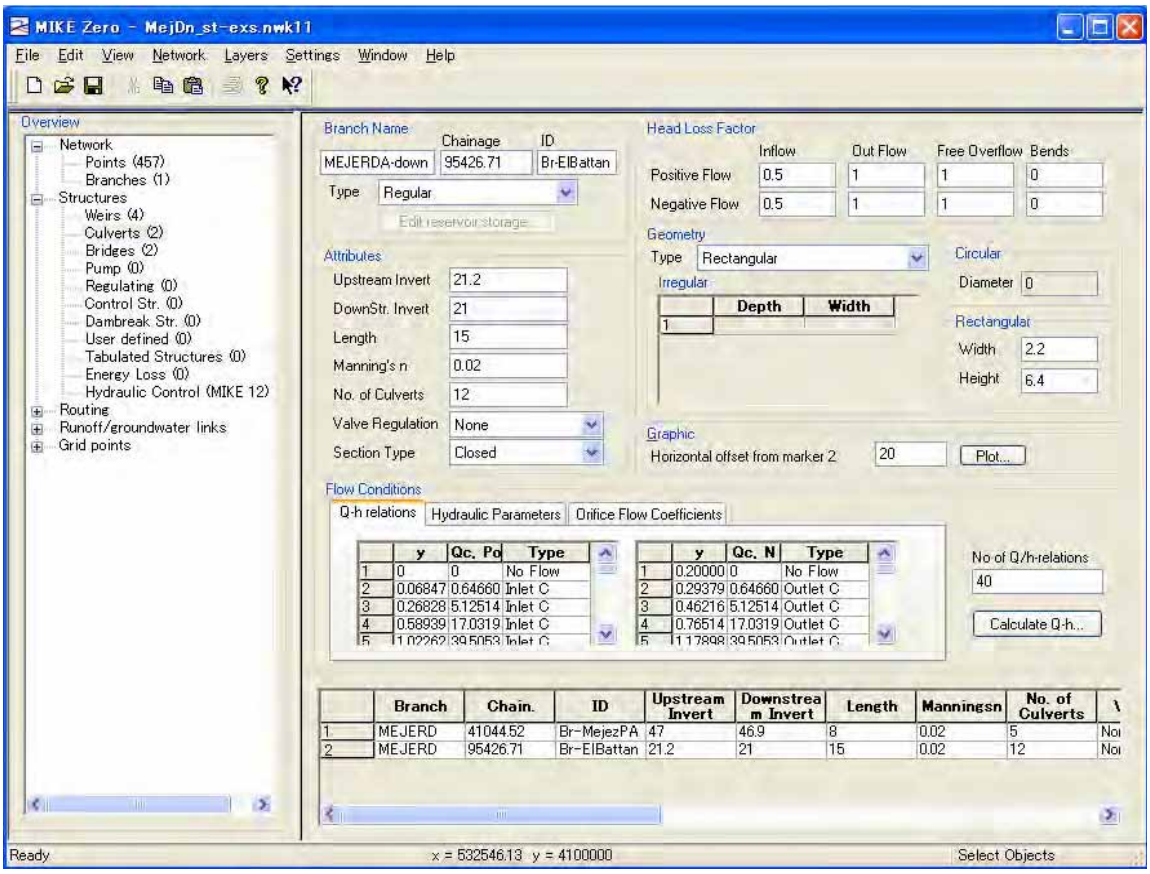
Geometry Parameters for Andalous Bridge

Parameters	Values
Opening width, b	2.3
Number of arches	18
Level for bottom of arch curvature	26.85
Level for top of each curvature	27.99
Radius of arch curvature, r	1.15

Parameters for El Battan Weir in MIKE11 ("Weirs Window")



Parameters for El Battan Weir in MIKE11 ("Culverts Window")



II.3.11 Step 10: Simulation 2

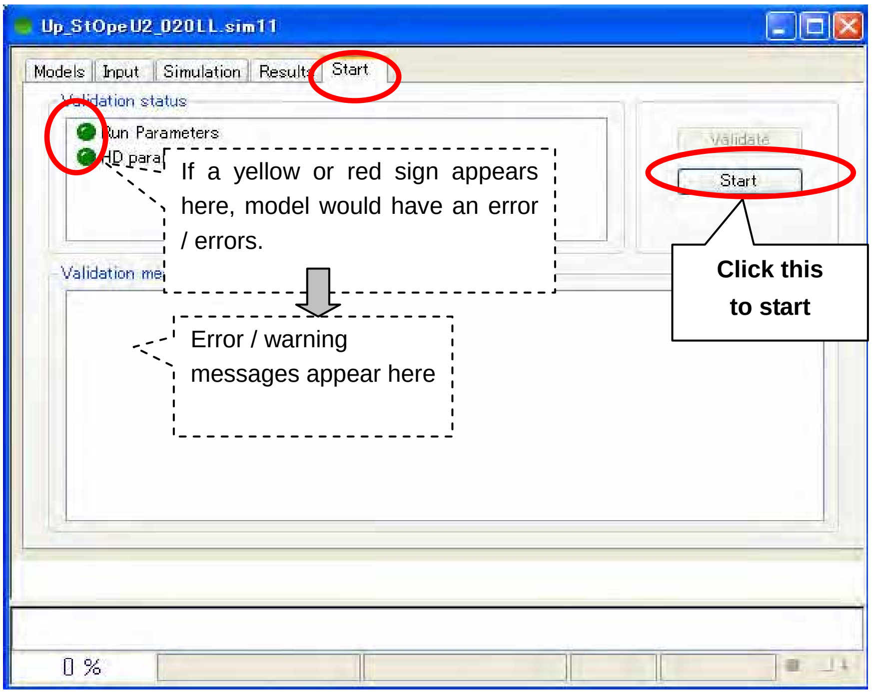
(1) Purpose

This is to confirm that there is no error in the MIKE11 model including structures. A MIKE11 model should be completed before building a MIKE FLOOD model.

It should be noted that the presence of structures tends to require shorter simulation time step than the one for a river channel model (without structures).

(2) Procedure :

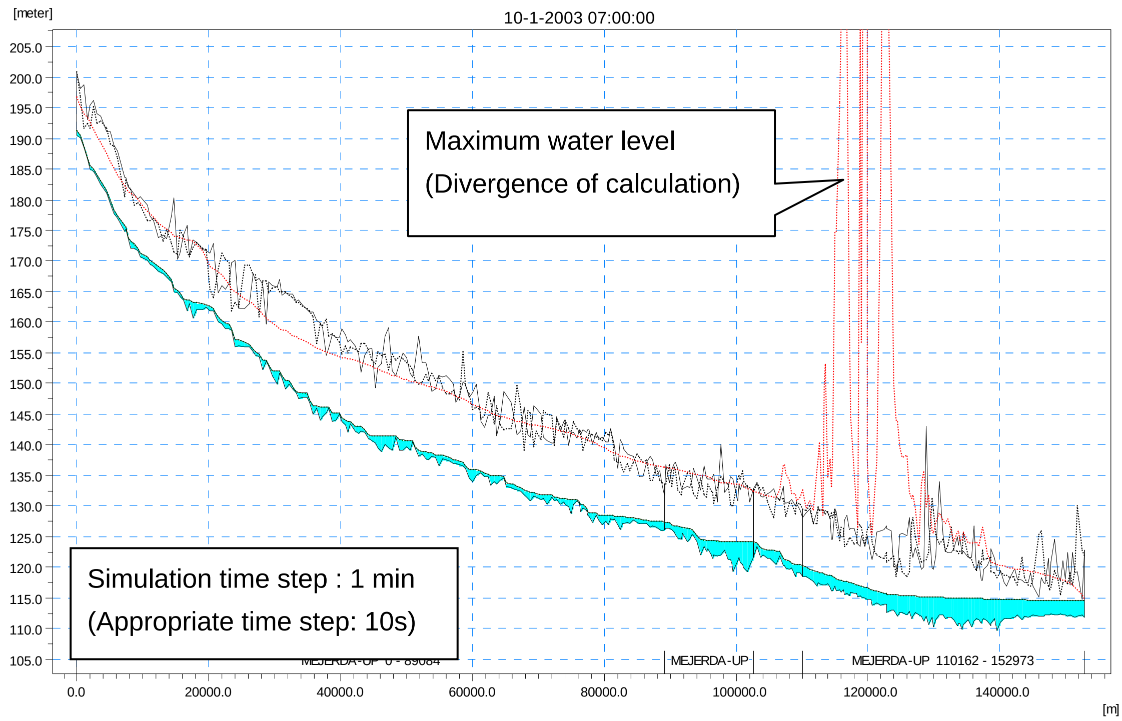
Open “Start” page of the sim11 file.



Error messages are stored in log (text) files, which are created in the same folder where the Simulation file (**.sim) is placed.

(3) Note on simulation time step

A simulation time step of ten seconds was applied to the Mejerda Model. Longer time step tends to be selected before finding an appropriate one. If a simulation result is as in the following figure (divergence of calculation), a simulation time step would be too long



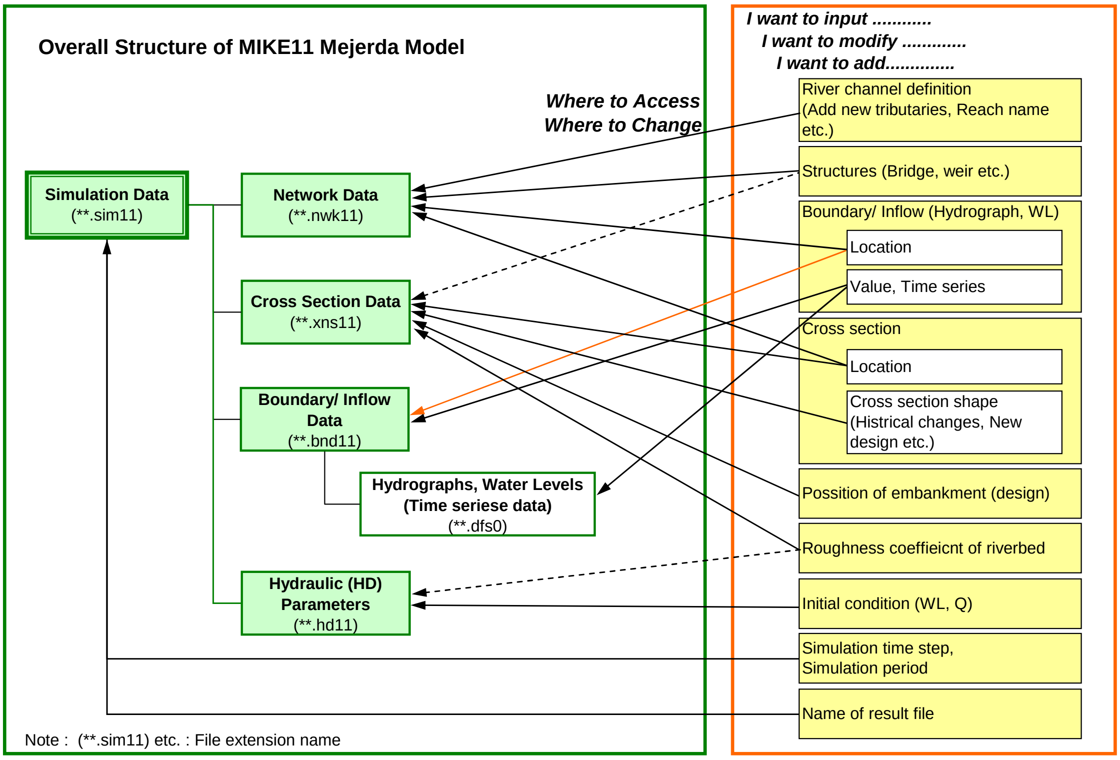
Source : Study Team

Figure II.3.8: Example of MIKE11 Simulation Result (Inappropriate Simulation Time Step)

II.4 How to Modify/Update the MIKE11 Mejerda Model

In order to modify or update input data, users have to access to an appropriate input (or simulation) files, which constitute a MIKE11 model. The following figure illustrates where to access.

All input files (**.nwk11, **.xns11, etc.) can be opened through the network file.



Source : Study Team

Figure II.4.1: Relation of Editors and Data Types of MIKE11

The subsequent subsections introduce some examples of methodologies how to update / modify parameters in MIKE11.

(1) How to change cross section shape

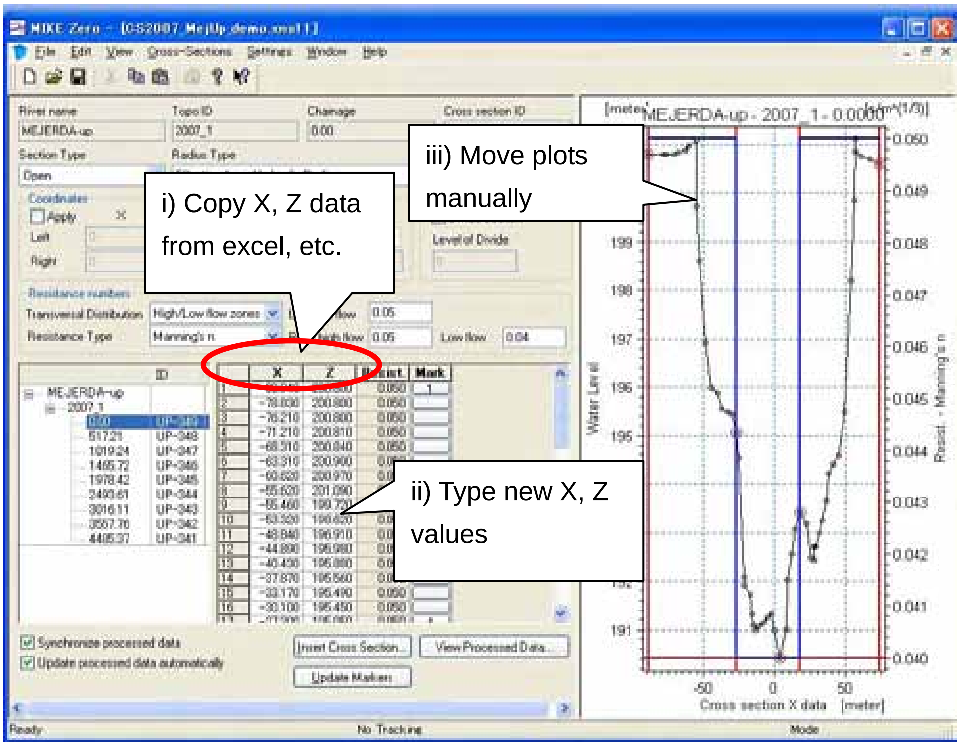
MIKE Editor	Cross Section Editor
File extension	*.xns11
Related software Manual	MIKE11 - a Modelling System for River and Channels, User Guide (**Chapter 3** of M11-2 in **Table I.1.1**)

Cross section shapes can be changed by the following methods.

i) Prepare new cross section data (X, Z) in excel, etc, and then, copy (X, Z) data to the MIKE11 Cross Section Editor (See **Chapter AN1.3** in **Annex 1**)

ii) Change some of X, Z values on the Cross Section Editor manually

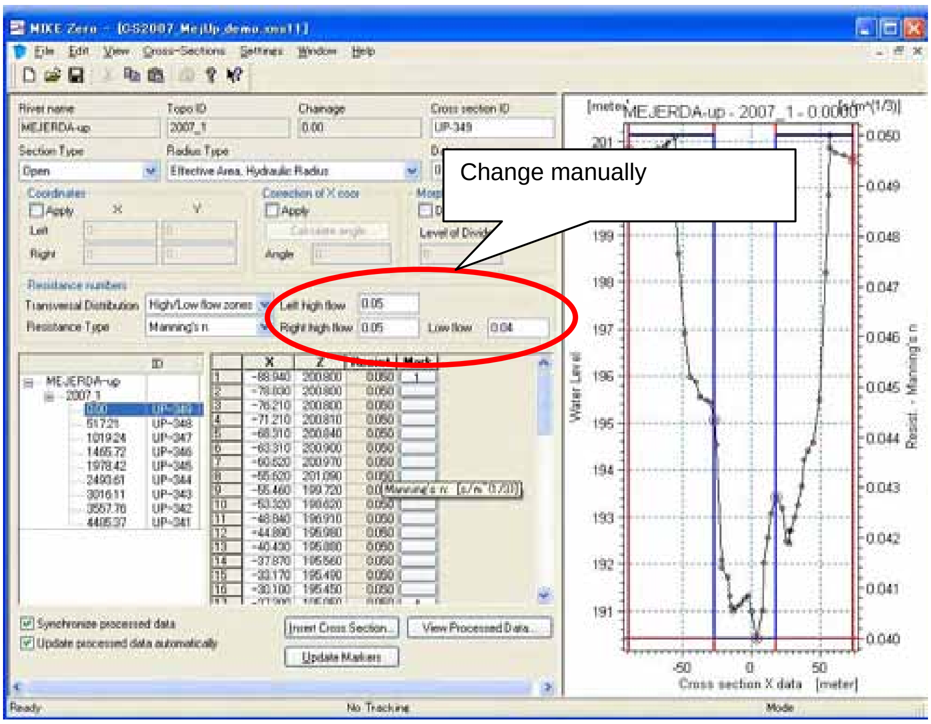
iii) Move plots manually on the cross section window of the Cross Section Editor



(2) How to change bed resistance

(i) Changing bed resistance in each cross section

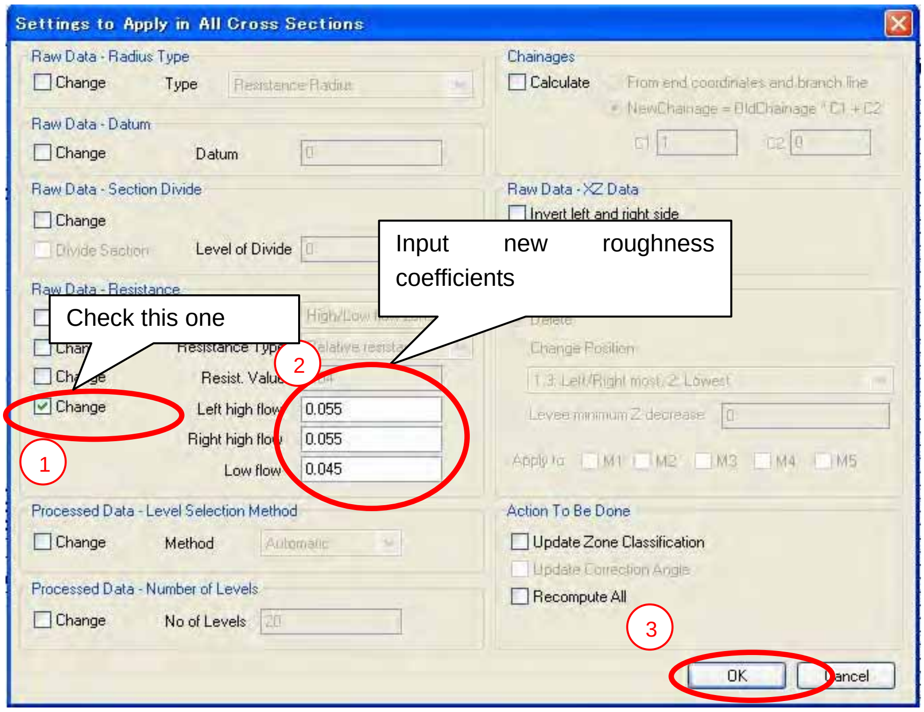
MIKE Editor	Cross Section Editor
File extension	*.xns11
Related software Manual	MIKE11 - a Modelling System for River and Channels, User Guide (**Chapter 3 of** M11-2 in **Table I.1.1**)



(ii) Changing inputted data in all cross sections at the same time

MIKE Editor	Cross Section Editor
File extension	*.xns11
Related software Manual	MIKE11 - a Modelling System for River and Channels, User Guide (**Chapter 3** of M11-2 in **Table I.1.1**)

Tool bar [Cross-Sections] – [Apply to all Sections...]

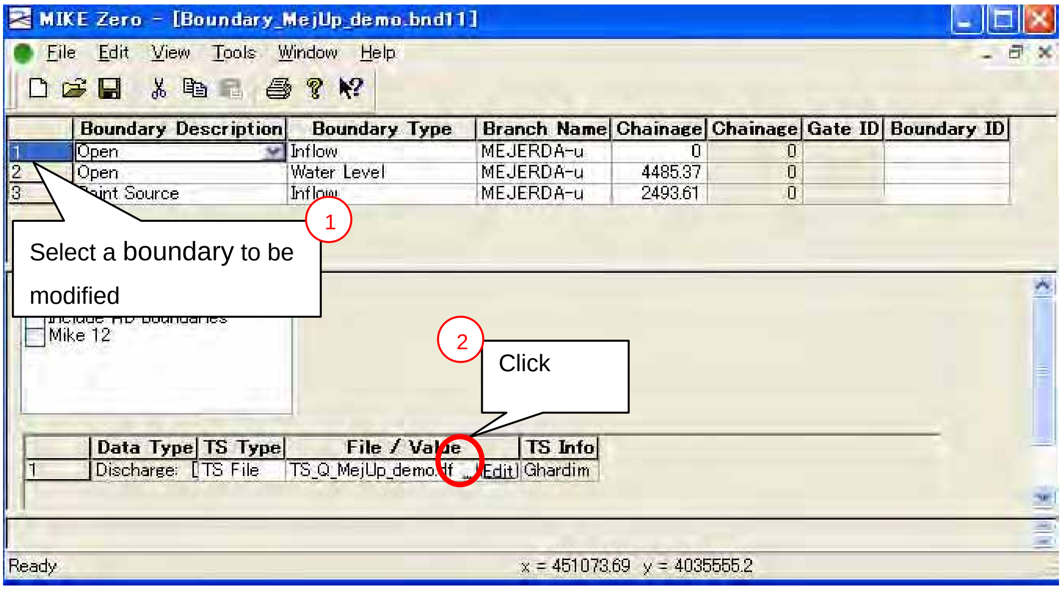


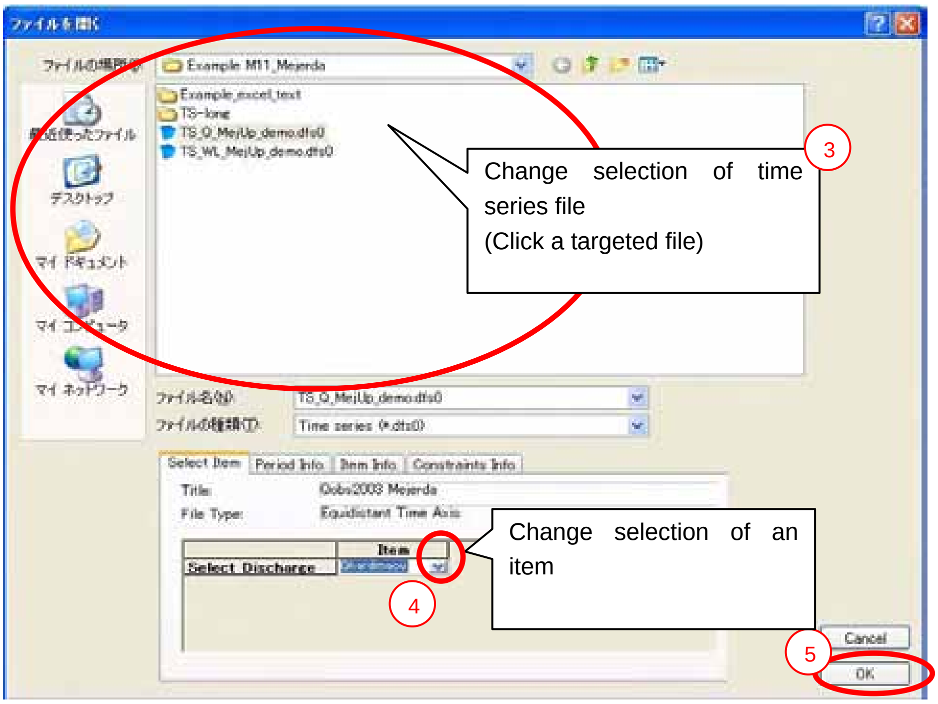
(3) How to change inflow discharges (boundary position remain unchanged, but discharges are changed) (in general)

MIKE Editor	Boundary Editor
File extension	*.bnd
Related software Manual	MIKE11 - a Modelling System for River and Channels, User Guide (**Chapter 4** of M11-2 in **Table I.1.1**)

(i) Procedure

Open boundary editor → Input boundary data





(4) How to change inflow discharges when different dam outflow with different reservoir operation data want to be applied.

MIKE Editor	Boundary Editor
File extension	*.bnd11
Related software Manual	MIKE11 - a Modelling System for River and Channels, User Guide (**Chapter 4** of M11-2 in **Table I.1.1**)

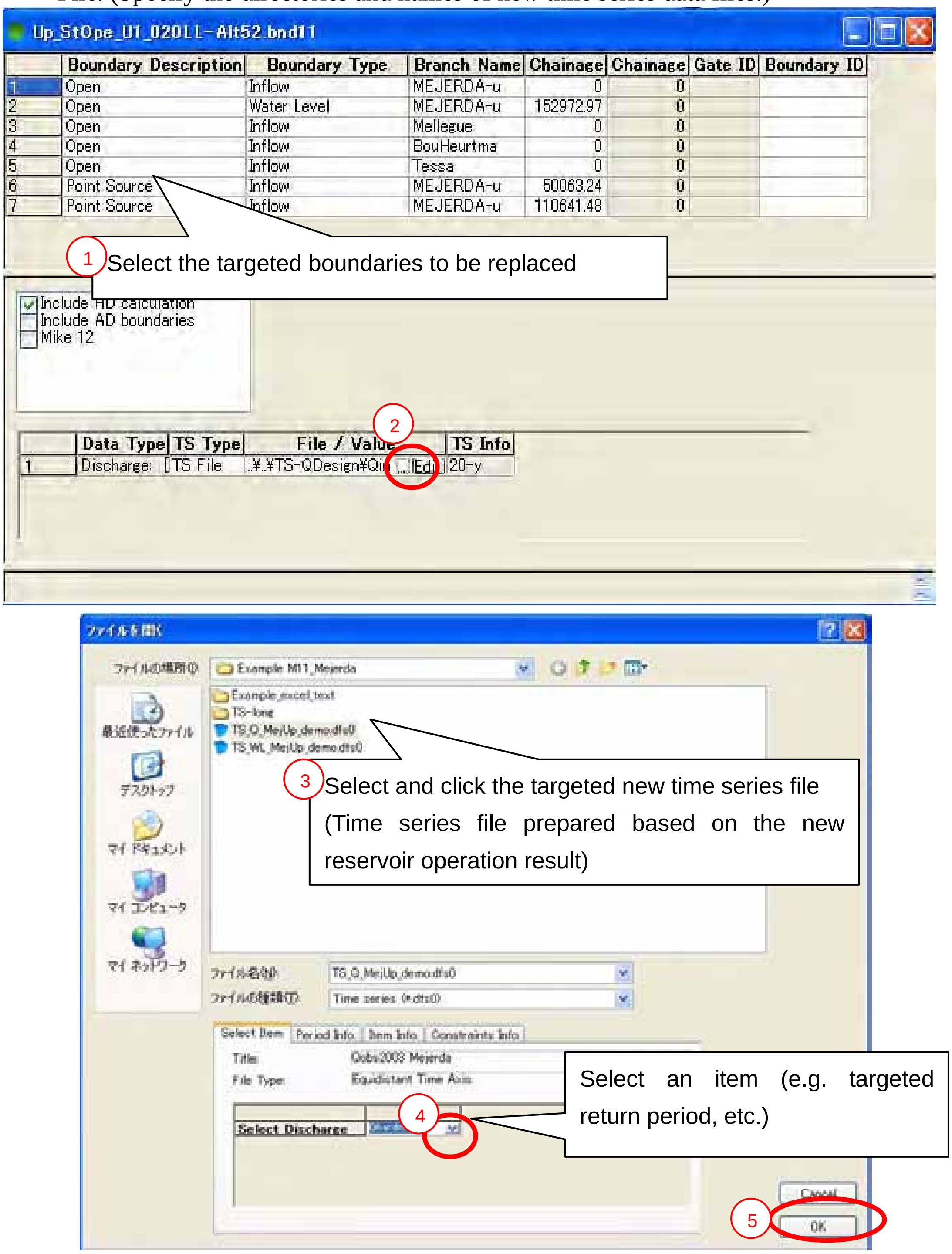
This is for the case if a new reservoir operation analysis by MIKE BASIN were to be made in the future, only related inflow and water level data for the existing MIKE11 model part of the inundation analysis model would have to be changed.

Among the inflow and water level data determined in the Boundary Editor, items derived from the reservoir operation analysis should be replaced, in this case. **Figure II.3.6** and **Tables II.3.2 to 5** distinguish discharge and water level data originated from the reservoir operation analysis results.

Modification procedures of the MIKE11 model are as follows.

i) Prepare new time series (dfs0) files based on new reservoir operation simulation results derived by MIKE BASIN. (See **Section II.3.2** how to prepare time series files)

ii) Change the directories and names of time series data files specified in the Boundary File. (Specify the directories and names of new time series data files.)



Repeat the above procedures for all targeted boundaries to be replaced.

Save the changes of the Boundary File.

(5) How to change cross section data, from the present condition or design cross sections to new design or new cross section shapes (due to erosion or sedimentation, etc.)

MIKE Editor	Cross Section Editor, Simulation Editor
File extension	*.xns11, :.sim11
Related software Manual	MIKE11 - a Modelling System for River and Channels, User Guide (**Chapters 1 and 3** of M11-2 in **Table I.1.1**)

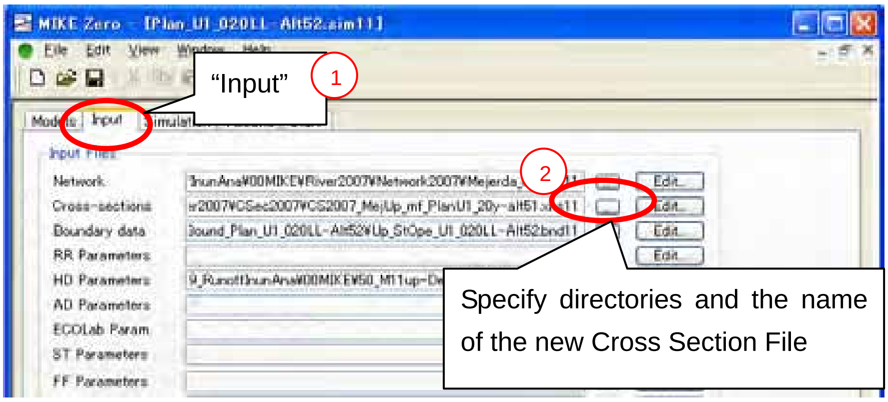
This is for the case that the only Cross Section File of the existing Mejerda Model is replaced to the new one for the new cross section shapes (caused by erosion or sedimentation, etc.), whilst other data, such as the Network and Boundary Files remain unchanged.

Modification procedures of the MIKE11 model are as follows.

i) Prepare a new cross section file based on new river channel conditions (new design, new cross section shapes, etc.). (See **Section II.3.4** how to prepare cross section files)

ii) Copy the Simulation file of existing "*.sim11" file.

iii) Change the directories and names of the Cross Section File (Specify the directories and names of the new Cross Section File) from the "Input" page of the Simulation File



PART III : EXPLANATION NOTE ON MIKE21 MEJERDA MODEL

III.1 Note on MIKE 21 Mejerda Model as a Part of a MIKE FLOOD model

The important notes are extracted and listed below for helping a quick check of the Mejerda Model during modelling and simulation. The contents of the following items are described in the subsequent sections.

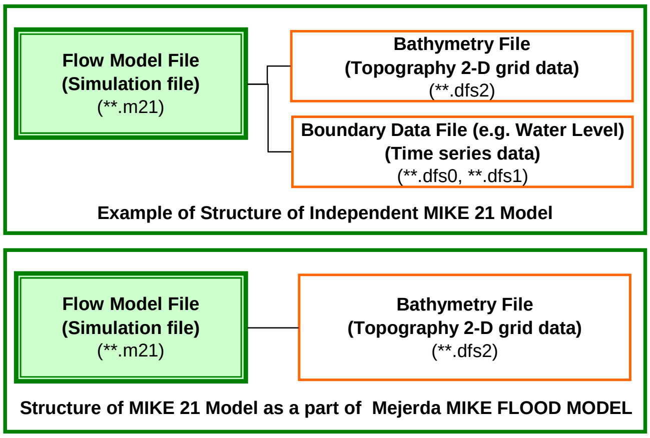
Box III.1.1: Notes on MIKE21 Mejerda Model as a Part of MIKE FLOOD Model

- Geographical area coordinates in MIKE21 should be consistent with the ones in MIKE11 (in Network File) and GIS data which will be overlaid.
- The bathymetry (except the area with "land value") should be designed to be within the extent of a MIKE11 river channel model.
- Simulation time step and period in MIKE11 and MIKE21 should be consistent.
- Inflow discharges and downstream water level (boundary conditions) of MIKE FLOOD Model can basically be controlled by settings in 1-D model (MIKE11)

III.2 Model Structure

III.2.1 Overall Structure of MIKE 21 Model

Typical structures of the MIKE21 models are shown below. A MIKE21 model prepared as a part of a MIKE FLOOD model normally do not require boundary files unlike an independent MIKE21 model, because boundary conditions, such as inflow discharge hydrographs and downstream water levels, are controlled by a MIKE 11 model, so the case of the Mejerda Model. For the MIKE21 Mejerda Model, 2-D grid topography data (called "Bathymetry" file in MIKE21) is only the required input file file for modelling.



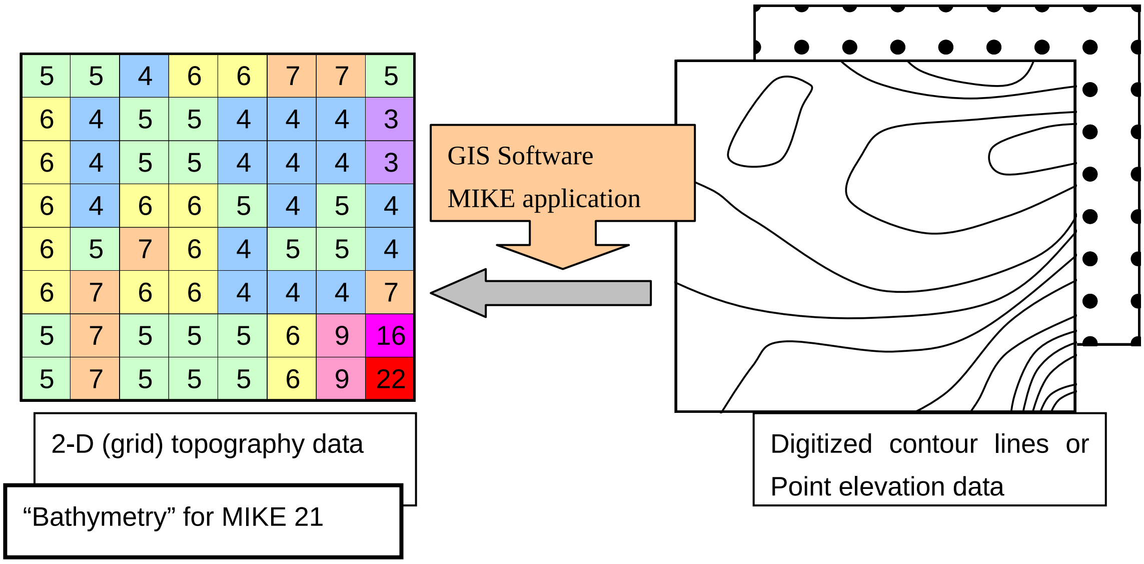
Source : Study Team

Figure III.2.1: Overall Structure of MIKE21 Model

III.2.2 Bathymetry File

(1) Basic concept

2-D topography grid data, called "Bathymetry" in MIKE 21, bring flood plain topography conditions to the inundation analysis, and should be prepared prior to building a MIKE21 model. The "bathymetry" file stores elevation data in each cell, which can be developed from digitized contours, point elevation data or existing grid elevation data sets. GIS and MIKE software could be tools for the pre-processing work. (See the software manuals of M21-1, M21-2 and MZ-3 in **Table I.1.1** for further details)



Source : Study Team

Figure III.2.2: Basic Concept of a bathymetry fi

(2) Notes on elevation data

An elevation in each cell is an average value of the area covered by the cell (basically, 228.13m x 228.13m for the Mejerda model). Hence, local topography, such as local depressions, might not be reflected on the bathymetry data. Elevation data in some cells may have to be modified manually, according to the site conditions, if necessary. (See (4) below)

(3) Coordinate system applied

Coordinate system should be match to the one applied to MIKE 11 and GIS data which will be overlaid with the MIKE21 data and result files. The following table summarizes the geographical coordinate system applied to the Mejerda Model. The following system was selected because it is used for GIS data prepared by MARH and topographic survey results.

Table III.2.1: Geographical Area Coordinates Applied to the Mejerda Model (Common to both upstream and downstream models)

Parameter	Selection / Value	
Name	Carthage_UTM_Zone_32N (under D_Carthage) UTM_Carthage (The above two have the same settings.)	Originally in MIKE by JICA Study Team
Projection Type	Transverse Mercator	
Prime meridian	0 - Greenwich	
Scale	0.9996	
Central Meridian	9 degree	
Latitude Origin	0 degree	
False Easting	500000 meter	
False Northing	0 meter	
Ellipsoid	Clarke_1880_IGN	

(4) Bathymetry files for the Mejerda Model

The following tables summarises features of the bathymetry files used for the Mejerda Model.

Item	Condition
Grid Data	Upstream Model : 228.13 m x 228.13 m (76.0432 m x 76.0432 m)* Downstream Model : 228.13 m x 228.13 m
Land Value	500 (m)
Data source	• SRTM3 (76.0432 m x 76.0432 m, grid elevation data issued by NASA) • Digitized 1/25,000 map • Topographic survey results conducted under the Study or by MARH in 2007.

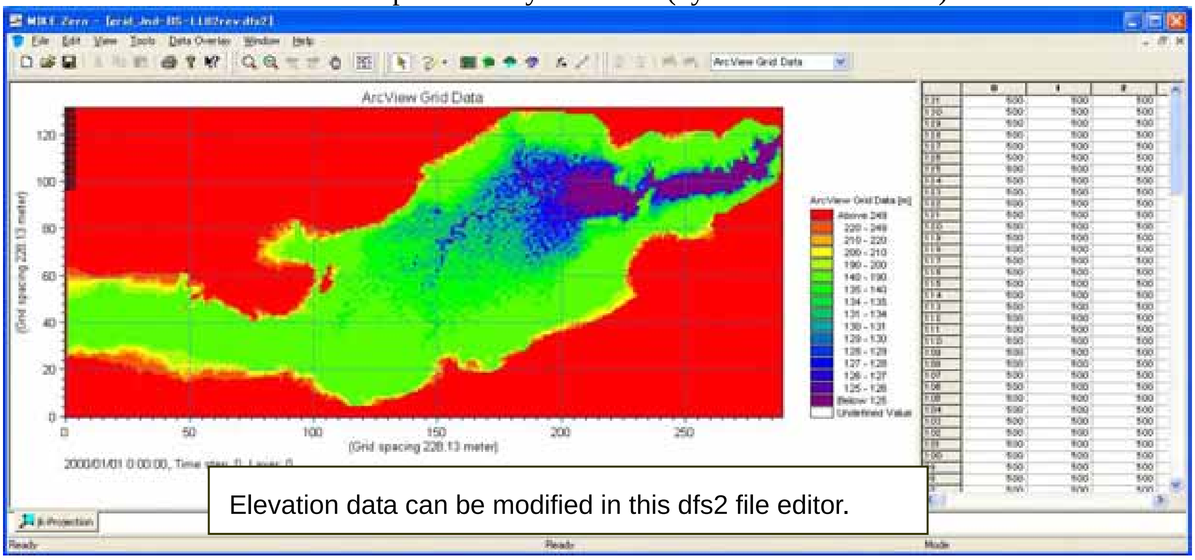
Note : * : For supplemental model in Bou Salem Area (See **Section II.2.3**)
Source : Study Team

For the Mejerda Model, all cells for bathymetry have a square shape with the same size. Hence, a bathymetry always becomes a square shape.

The grid size (228.13m x 228.13m, in principle) was selected in consideration of the required accuracy of results for the master plan study which covers the entire Mejerda basin and intervals of cross sections (approximately 500m). An independent model with smaller size of grid (76.0432m x 76.0432m) was prepared for the Bou Salem city area to reproduce actual inundation conditions attributes to locally low banks of the Bou Hertma River.

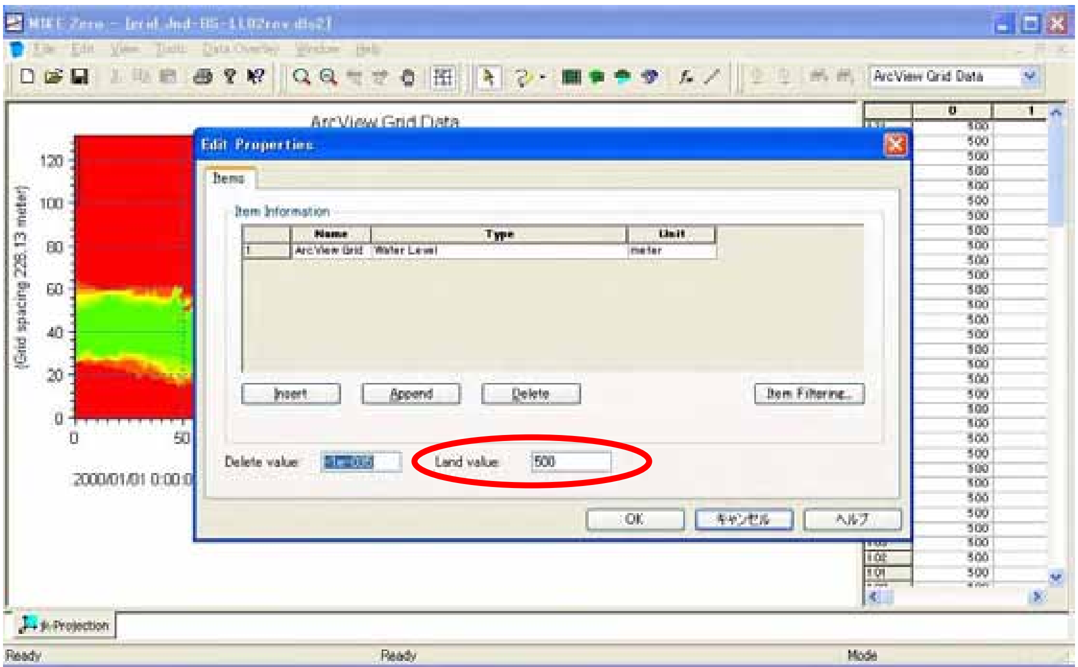
The primary source of the bathymetry files for the Mejerda Model is the SRTM3 grid elevation data (76.0432 m x 76.0432 m) downloaded from the NASA's web site. Then, the following modifications were made to the SRTM3 grid based on digitized 1/25,000 maps (prepared from 1/25,000 maps issued by the Tunisia issued by the Office of Topography and Mapping (Office de la Topographie et de la Cartographie)), topographic survey results conducted under the Study in 2007 and actual site conditions.

- Changing the grid size to 228.13 m x 228.13 m (by ArcGIS ver. 9 with the extension Spatial Analyst)
- Shifting coordinates (by ArcGIS ver. 9 with the extension Spatial Analyst)
- Modifying elevation data in some cells to determine "land value" areas,to finalize boundaries and to express locally low areas (by the dfs2 data editor)



The "land value" was applied to the cells in the areas which were expected to have no inundation, such as mountainous areas. The "land value" can be defined in the dfs2 file editor as below

[Edit] – [Items...]



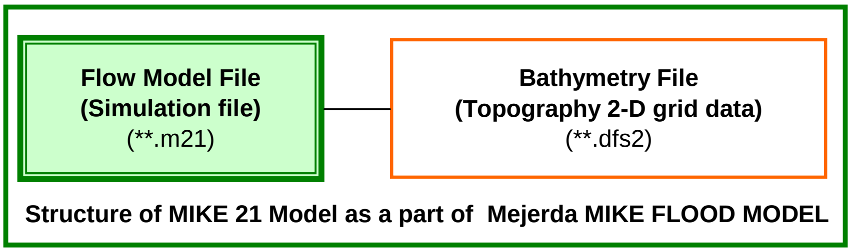
The "land value" was also used to close boundaries. The bathymetry files for the MIKE21 model which will be used as a part of a MIKE FLOOD model need to be closed, in principle, because the hydraulic boundary conditions of the MIKE FLOOD Model are controlled by the MIKE11 model. This concept was also applied to the Mejerda Model.

III.2.3 Model structure of MIKE 21 Mejerda Model

The MIKE 21 Model for the Mejerda basin was prepared;

- To cover the maximum potential flood plains, and
- To extend within the extent of upstream and downstream ends of the MIKE11 model

As mentioned in Section III.2.1, the MIKE21 Model for the Mejerda River basin consists of the two files, the Flow Model File (Simulation file, **.m21) and the Bathymetry File (**.dfs2) as in the following chart.

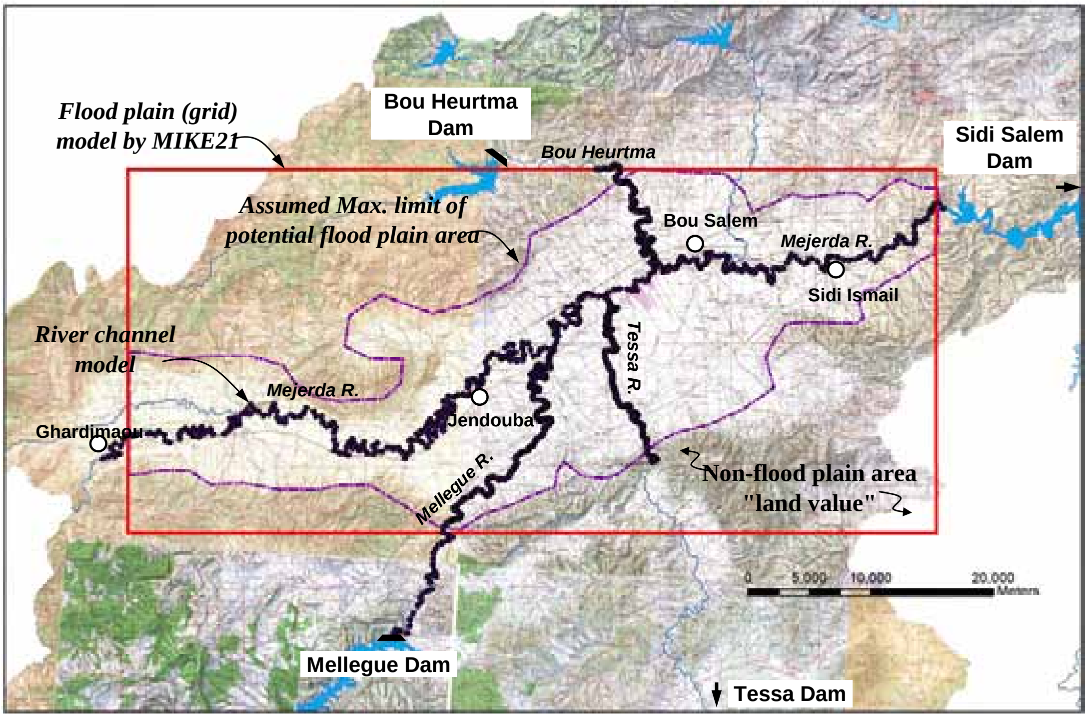


Source : Study Team

Figure III.2.3: Structure of MIKE21 Model for Mejerda Model

(1) Upstream Model

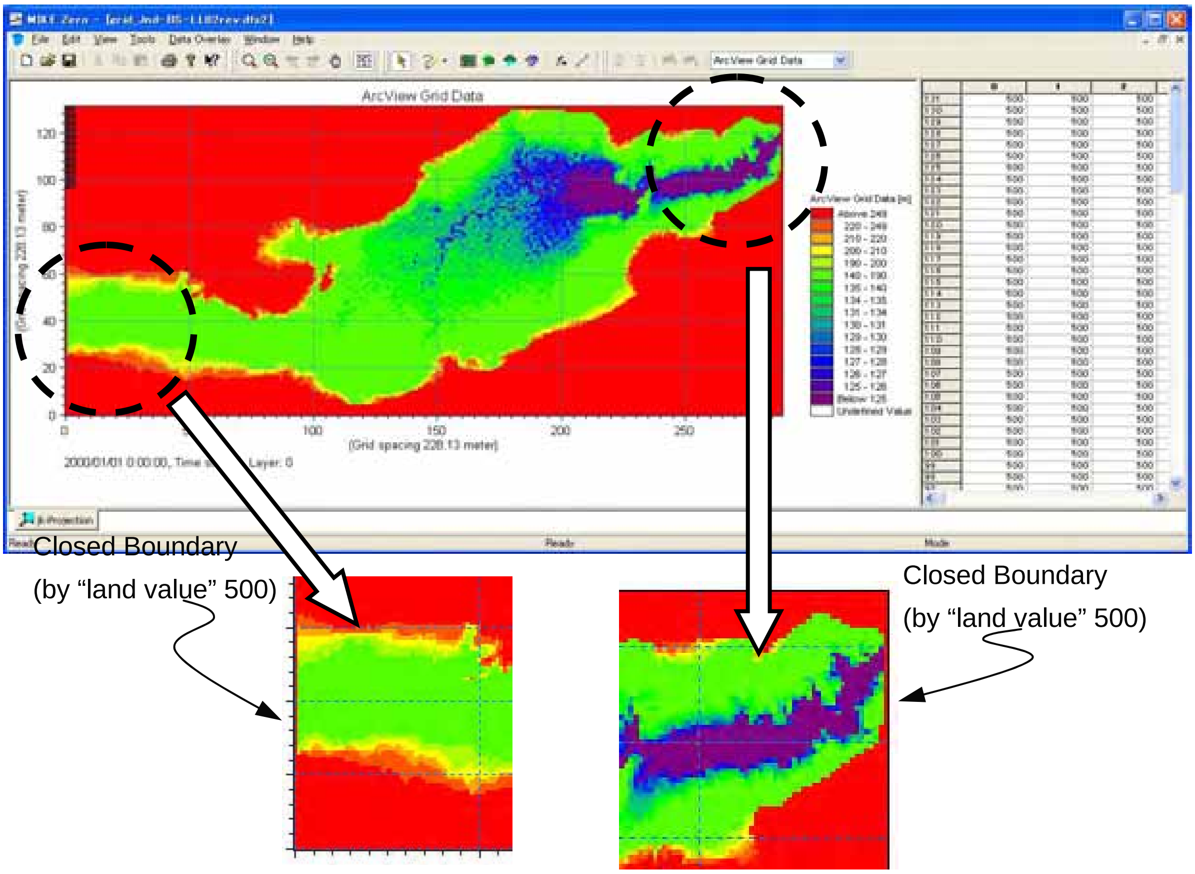
The model was built to cover the area in the following map.



Source : Study Team

Figure III.2.4: The Area Covered by Mejerda Upstream Model

The boundaries of bathymetry file for the upstream model was closed by the "land value" as below.

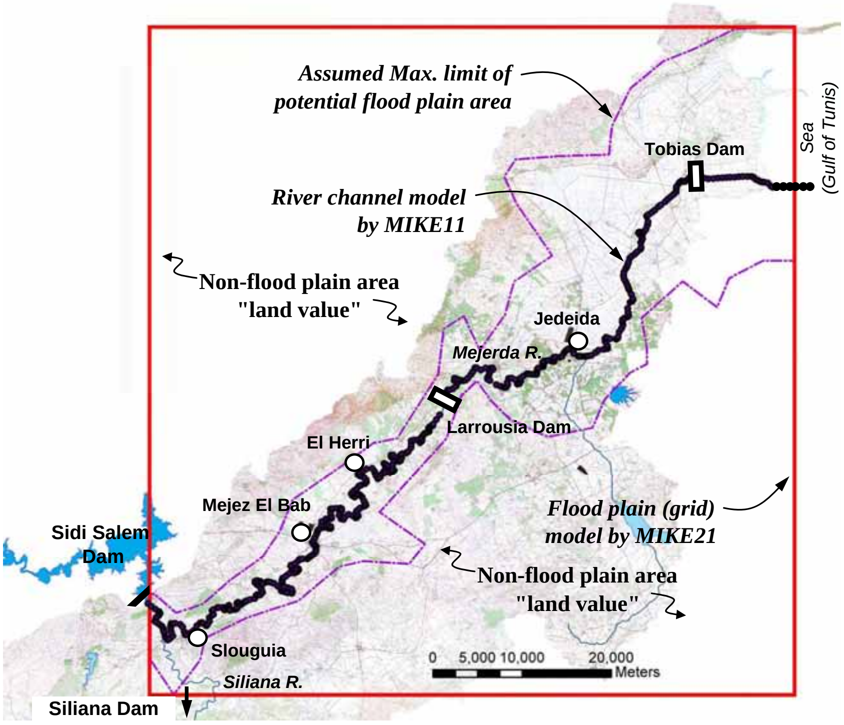


Source : Editor of dfs2 file prepared by the Study Team

Figure III.2.5: Bathymetry File for Mejerda Upstream Model

(2) Downstream Model

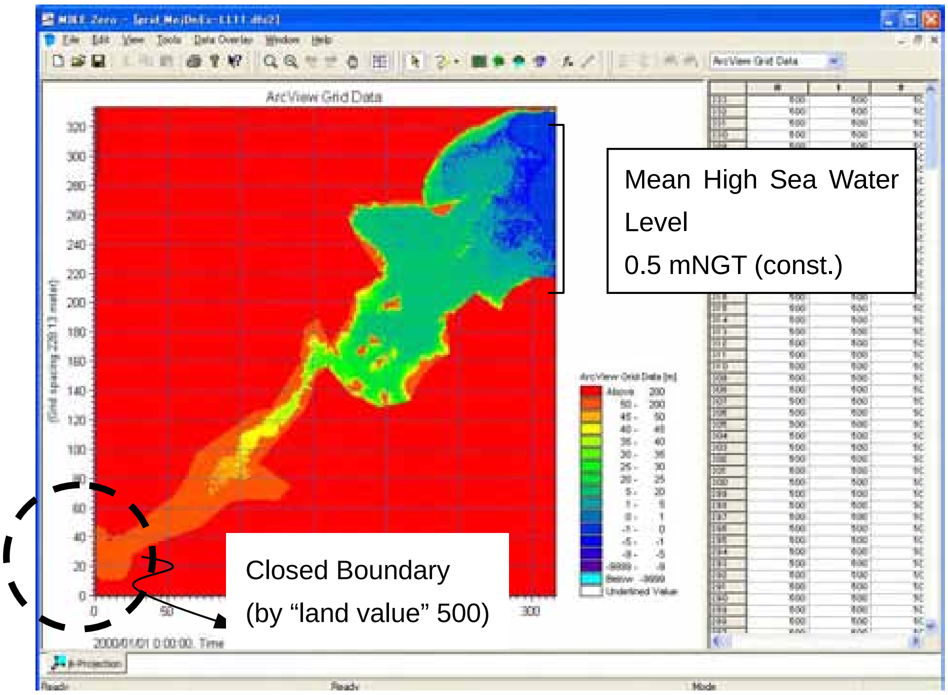
The model was built to cover the area in the following map from Sidi Salem Dam to the estuary.



Source : Study Team

Figure III.2.6: The Area Covered by Mejerda Downstream Model

The upstream end of the model was closed by the "land value", while the downstream end boundary which faces to the sea was determined to have the average high sea water level (0.5 mNGT) based on data in existing studies and recorded water levels during the topographic survey.



Source : Editor of dfs2 file prepared by the Study Team

Figure III.2.7: Bathymetry File for Mejerda Downstream Model

III.3 Procedures of Modelling of MIKE 21 Mejerda Model

III.3.1 MIKE 21 modelling procedure

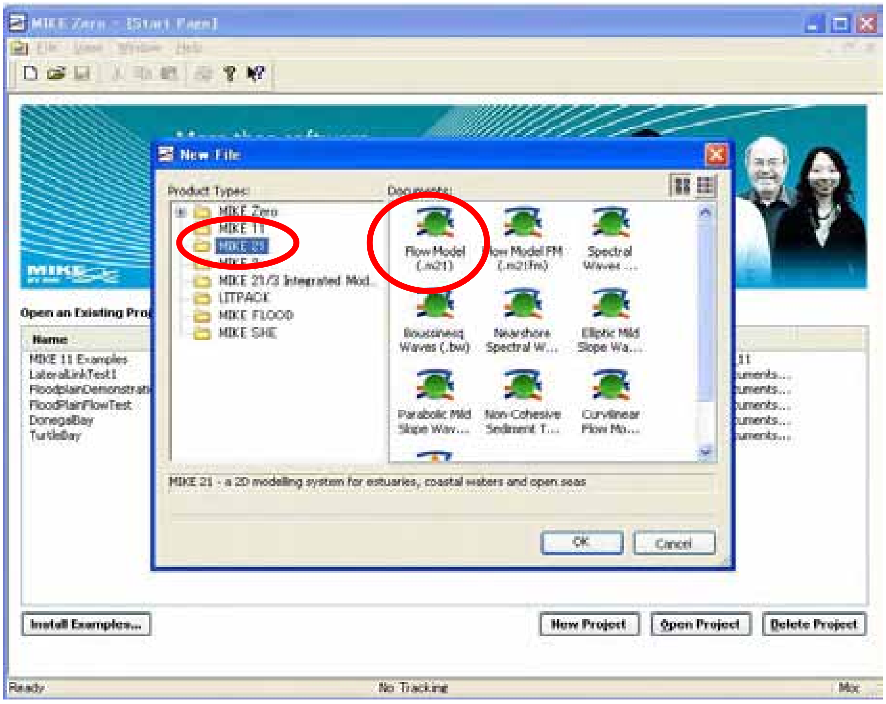
(1) Modelling procedure

1. Prepare bathymetry file (See **Section III.2.2**)
2. Make a new **.m21 file (Flow Model File, equivalent to a MIKE 21 simulation file)
3. Input parameters including the directories and name of the bathymetry file
5. Simulation
6. Post-processing (See **Section IV.2.2**)

This section summarizes the inputs from Step 2 to Step 5. See the software manuals M21-2 and M21-3 in **Table I.1.1** for details on the software operation methodologies and definitions of the parameters.

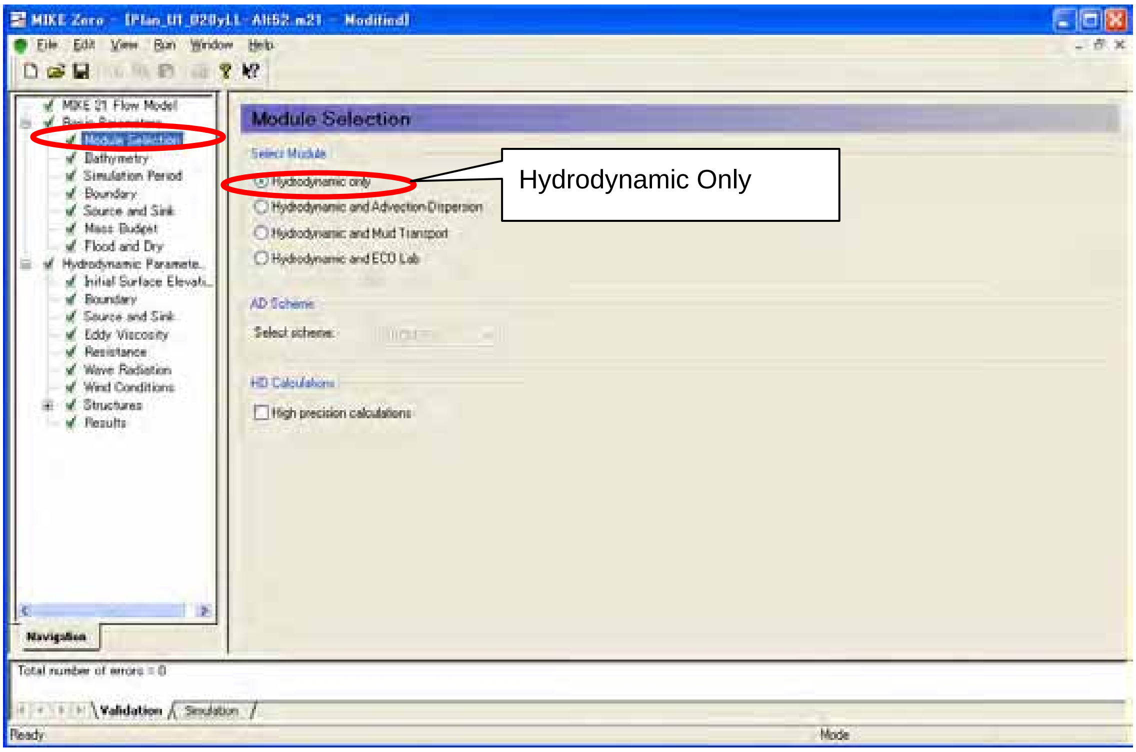
(2) Step 2: Make a new **.m21 file (Flow Model File, equivalent to a MIKE 21 simulation file)

Windows[Start]- [All Program] – [MIKE BY DHI] – [MIKE21] – [MIKE21] – Select "Flow Model (.m21)

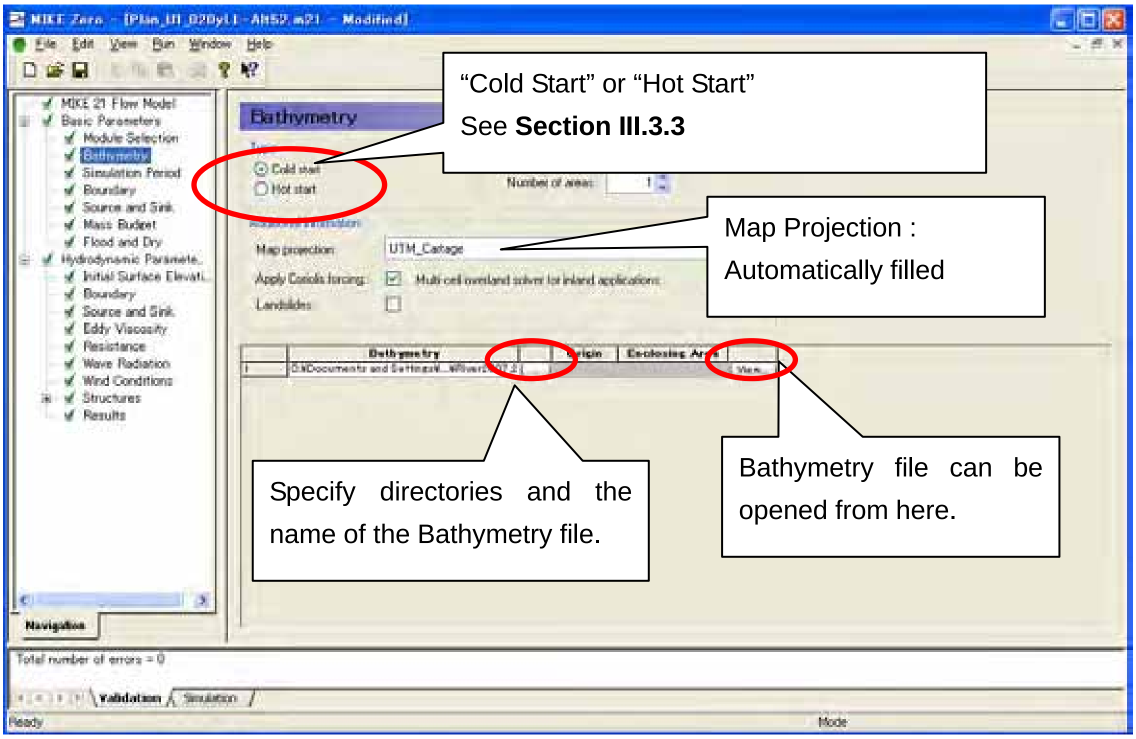


(3) Step 3: Input parameters including the directories and name of the bathymetry file

[Basic Parameters] – [Module Selection]

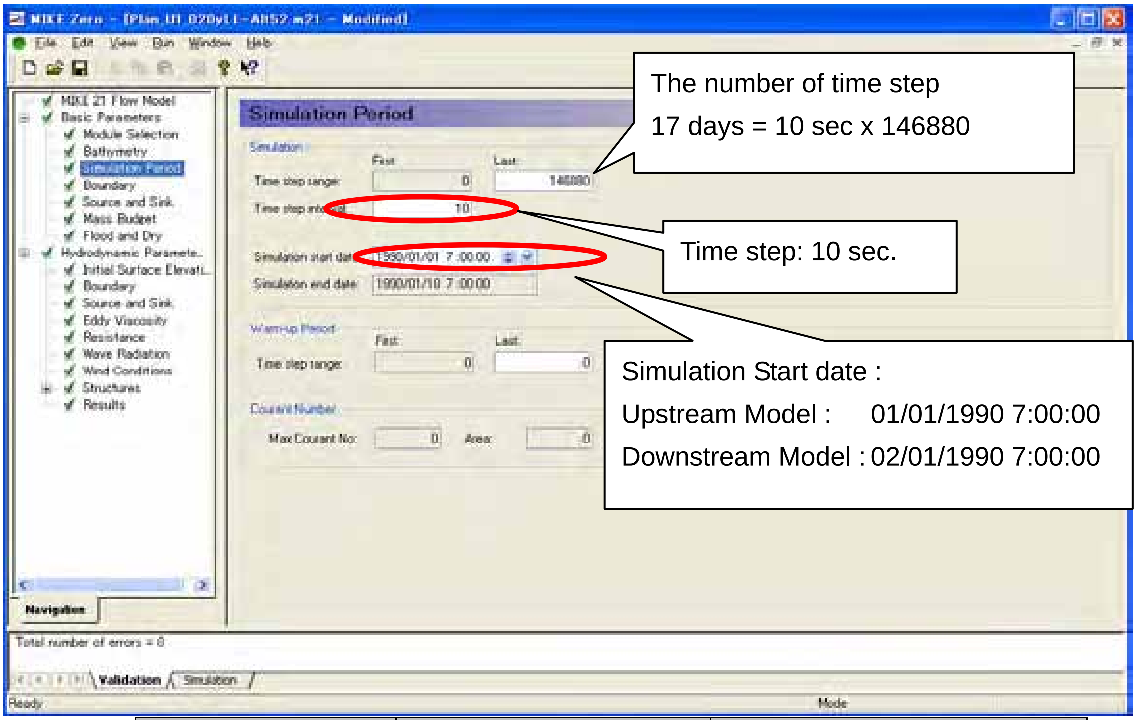


[Basic Parameters] – [Bathymetry]



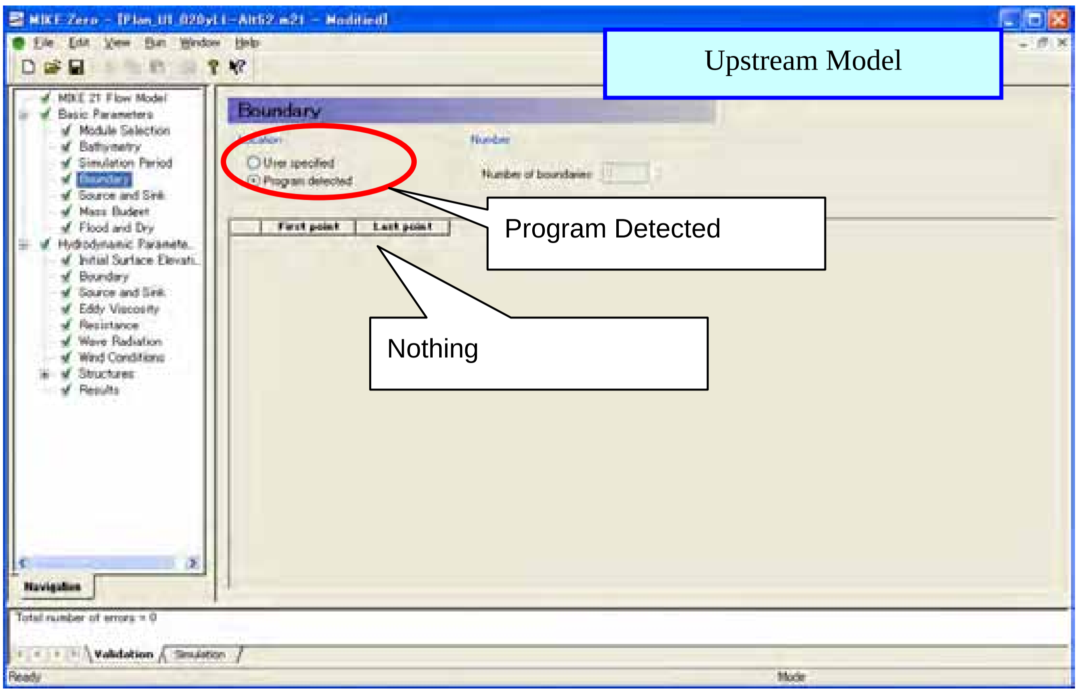
[Basic Parameters] – [Simulation Period]

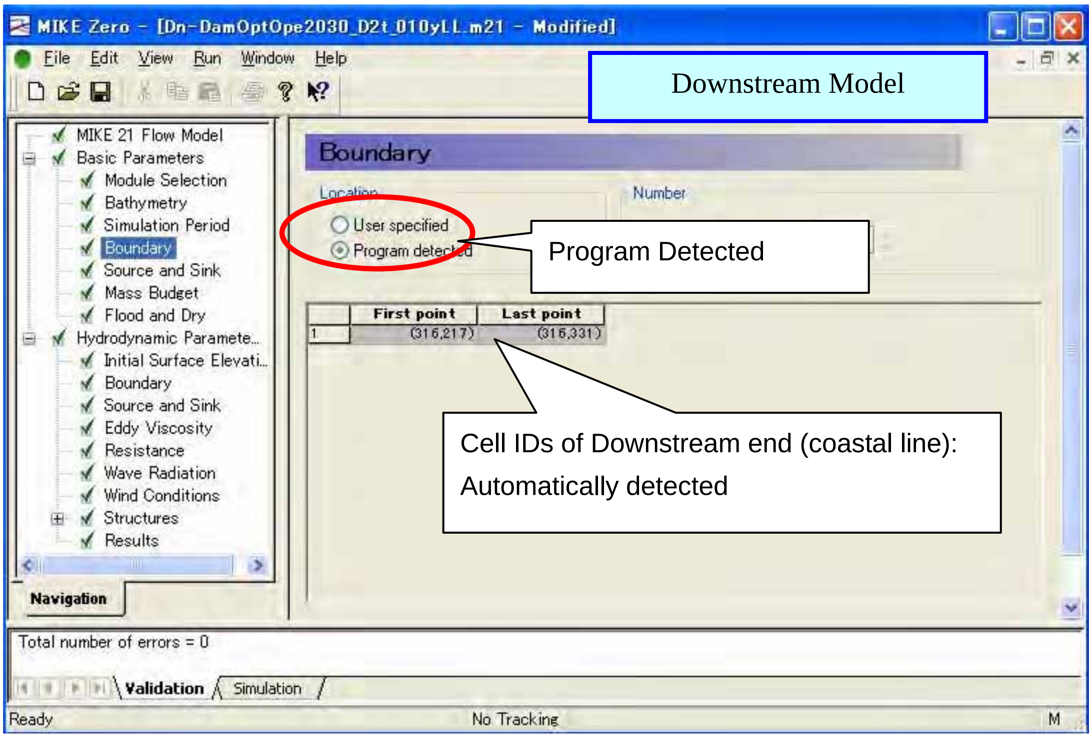
The simulation time step and period should be consistent with the one in MIKE11.



	Parameter	Selection / Value
Upstream Model	Time step interval	10 (sec)
	Simulation Start date	01/01/1990 7:00:00
	Simulation End date	18/01/1990 7:00:00
Downstream Model	Time step interval	10 (sec)
	Simulation Start date	02/01/1990 7:00:00
	Simulation End date	19/01/1990 7:00:00

[Basic Parameters] – [Boundary]



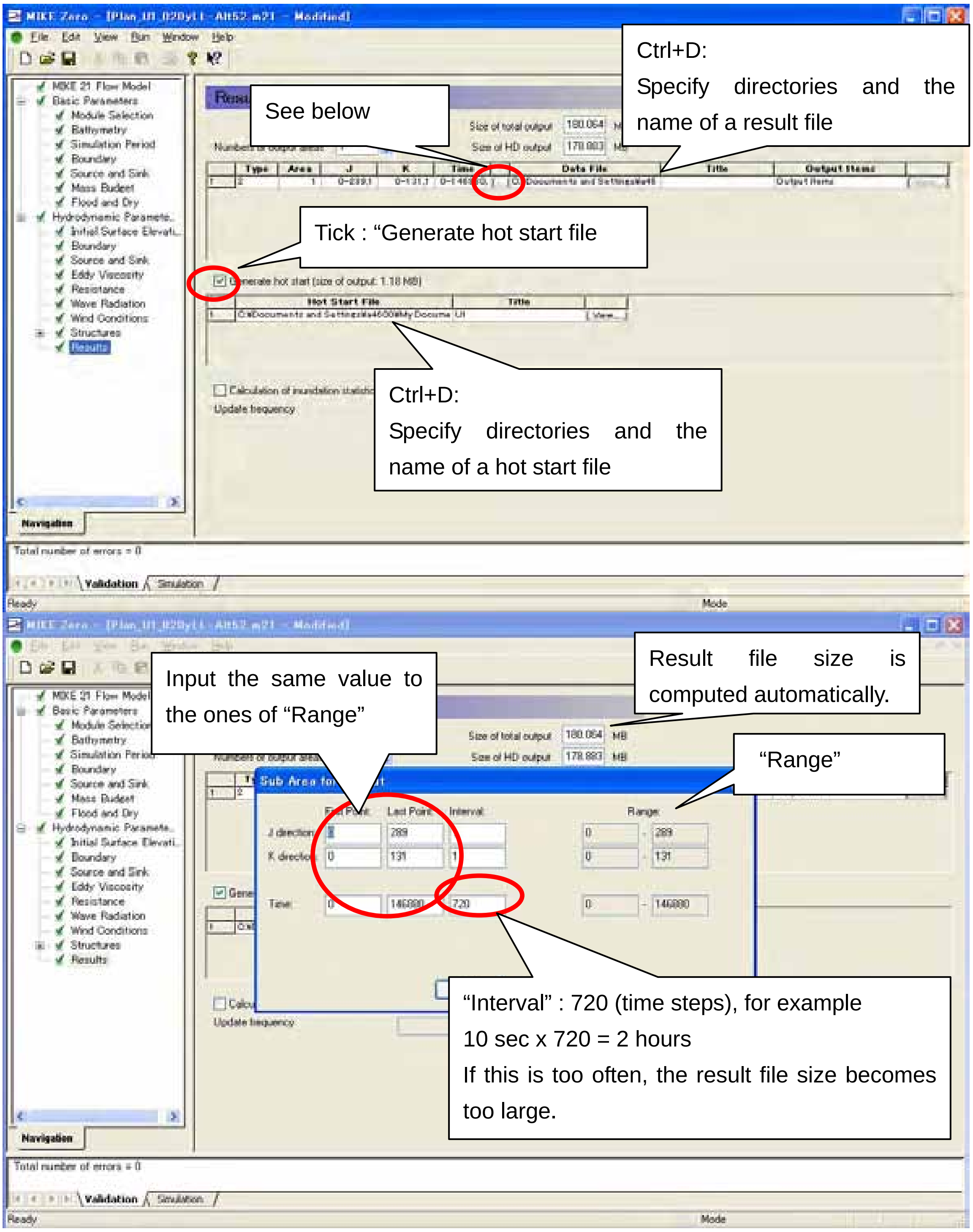


[Hydraulic Parameters]

The following table summarizes hydraulic parameters applied to the Mejerda Model. (See the software manual M21-2 and M21-3 in **Table I.1.1** for definitions of the parameters)

Parameters		**Upstream Model**	**Downstream Model**
Initial Surface Elevation	Given as	Constant value	Constant value
	Value	100.0	0.5
Boundary		-	Constant
		-	0.5
	FAB Type	-	0
Resistance	Value given as	Manning number	Manning number
	Format	Constant	Constant
	Value	18.18	18.18

[Hydraulic Parameters] – [Results]



(iii) Simulation

Command bar [Run] – [Start Simulation]

III.3.3 Notes on time required for the simulation and "Hot Start"

(1) Required time for one simulation

Generally, simulation of a 2-D model requires surprisingly long time. In the case of the Mejerda Model, it requires from a couple of hours to half days or more, according to the case. The following conditions prolong the simulation time

- Larger inundation area (the larger number of cells in the bathymetry with inundation)
- Longer simulation period
- Smaller cell size (the larger number of cells in the bathymetry with inundation)

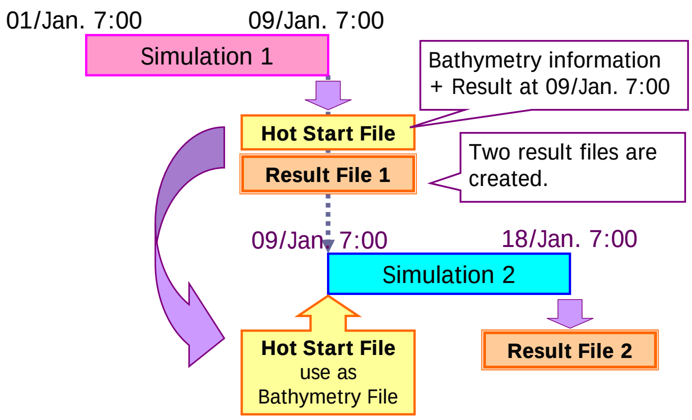
(2) Cold Start and Hot Start

Simulation of a MIKE FLOOD model requires surprisingly long time, for instance half day or more, especially for the cases of large floods with the extensive inundated area. This is resulted from the required simulation time for a MIKE21 model as mentioned above.

"Hot Start" allows dividing one case of simulation in to two or more periods, and dividing the simulation period could bring the following advantages, and therefore, "Hot Start" was applied to the cases with extensive inundation area.

- It could save a half of results, even if unexpected termination of the simulation occurs near the end of the required simulation period.
- It could bring a chance to check results at the middle of simulation.

The basic concept of "Hot Start" in MIKE21 modelling is illustrated in the following chart.



Source : Study Team

Figure III.3.1: Basic Concept of "Hot Start" (MIKE21)

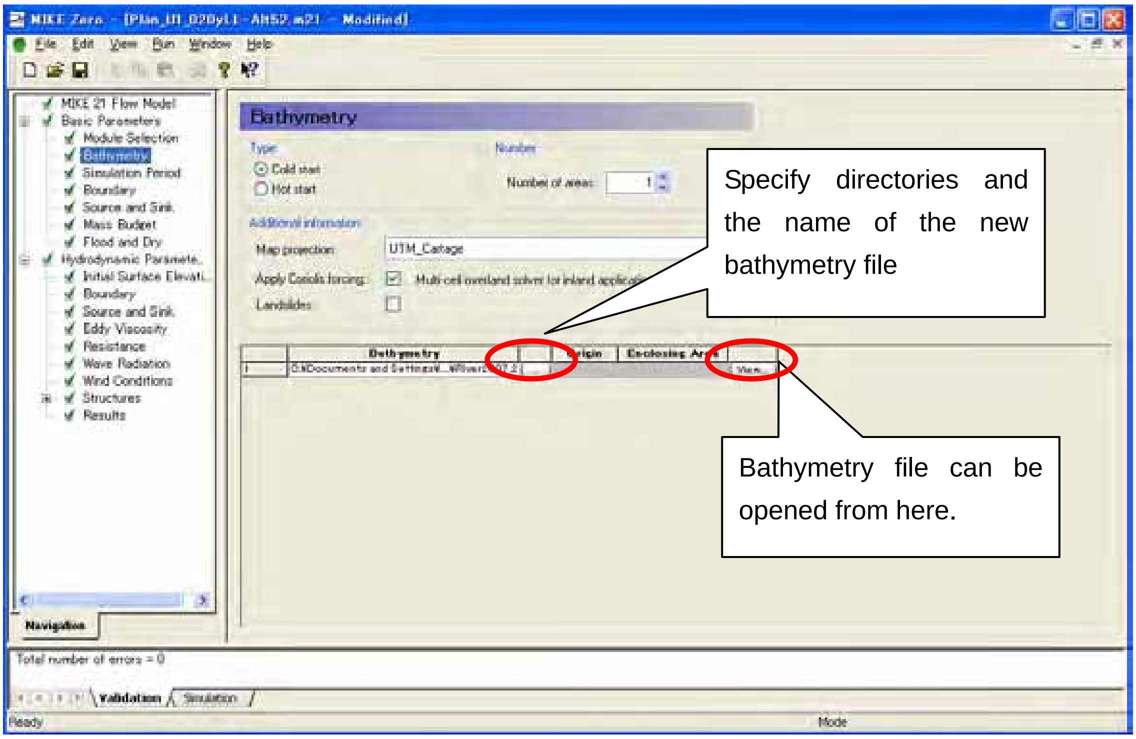
It should be noted that more than two result files for each simulation period are created if "Hot Start" is selected in MIKE21, whilst MIKE11 stores the simulation results for the entire simulation period in the sole result file.

Because the simulation period in MIKE11 and MIKE21 should be consistent, MIKE11 should incidentally apply "Hot Start" when it is selected in MIKE21.

III.4 How to modify/update the MIKE21 Mejerda Model

(1) Change the bathymetry file applied to the model

**.m21 file [Basic Parameters] – [Bathymetry]


Bathymetry
Specify directories and the name of the new bathymetry file
Bathymetry file can be opened from here.

PART IV : EXPLANATION NOTE ON MIKE FLOOD MEJERDA MODEL

IV.1 Notes on Building and Operating MIKE FLOOD Mejerda Model

The important notes are extracted and listed below for helping a quick check of the Mejerda Model during modelling and simulation. The contents of the following items are described in the subsequent sections.

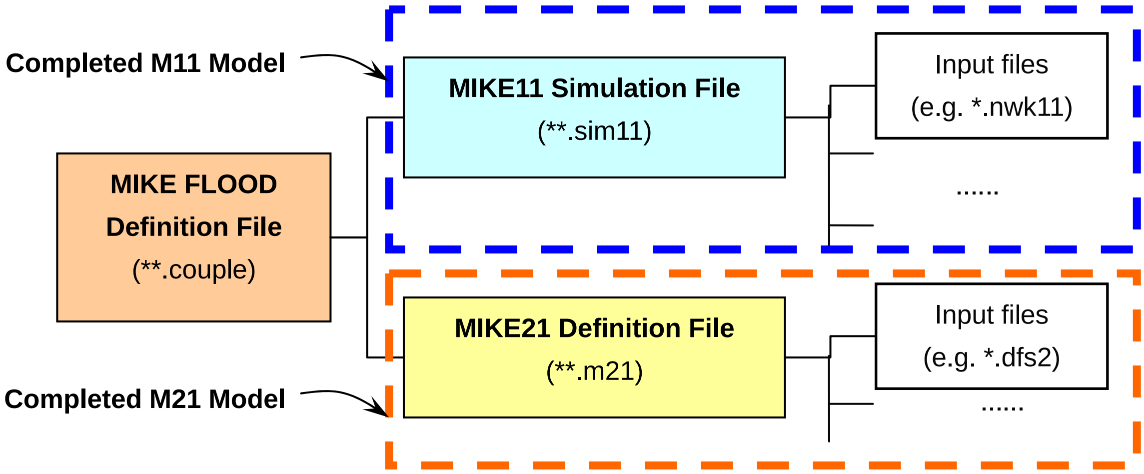
Box IV.1.1: Notes on MIKE FLOOD Mejerda Model as a Part of MIKE FLOOD Model

- One run of simulation of the model often requires surprisingly long time (e.g. half day or more) due to the required time for 2-D simulation.
- To avoid loosing computation results, dividing models into more than one simulation could be a useful way. (Hot Start)
- Geographical area coordinates in MIKE11, MIKE21 and GIS data should be consistent.
- Positions of Mark 1 and 3 on a MIKE11 cross section should carefully be determined. Positions could be different for overflowing and non-overflowing (e.g. planned levees) cases Hence, positions might have to be changed, if chainages of overflowing reaches are changed, even applying the same cross section shapes.
- Simulation time step and period in MIKE11 and MIKE21 should be consistent.

IV.2 Procedures of MIKE FLOOD Modelling for the Mejerda Model

IV.2.1 Model Structure of MIKE FLOOD Mejerda Model

Separate models are built for upstream and downstream of Sidi Salem Dam in the Mejerda River basin. Each model consists of a MIKE11 model for the 1-D analysis in river channels, MIKE21 Model for the 2-D analysis on flood plains and MIKE FLOOD as described in **Part I**. MIKE FLOOD interrelates the completed MIKE11 and MIKE21 models as below.

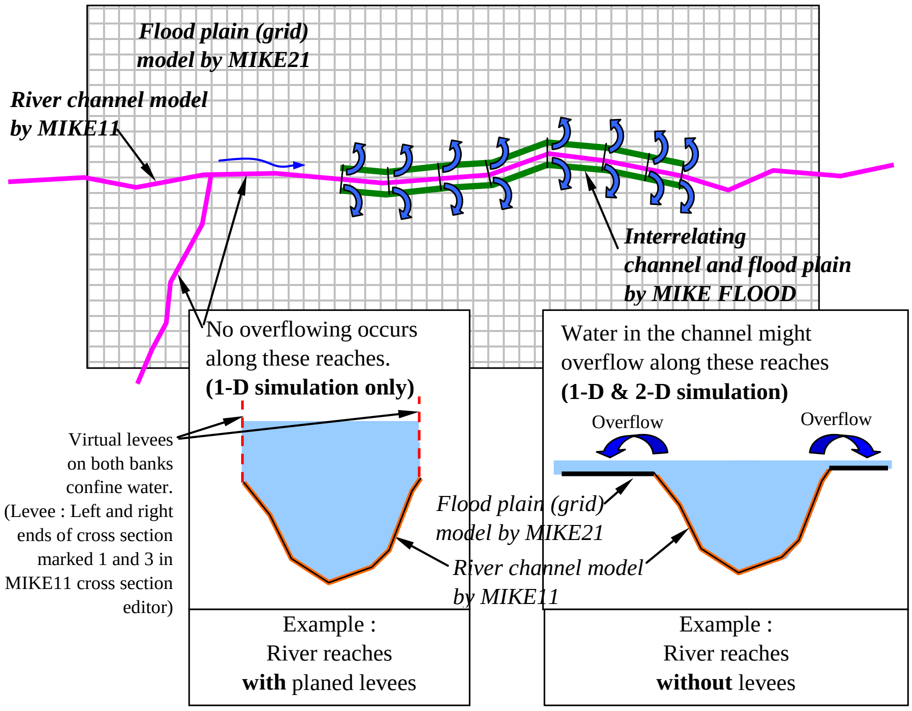


Source : Study Team

Figure IV.2.1: Overall Structure of MIKE FLOOD Model for Mejerda Model

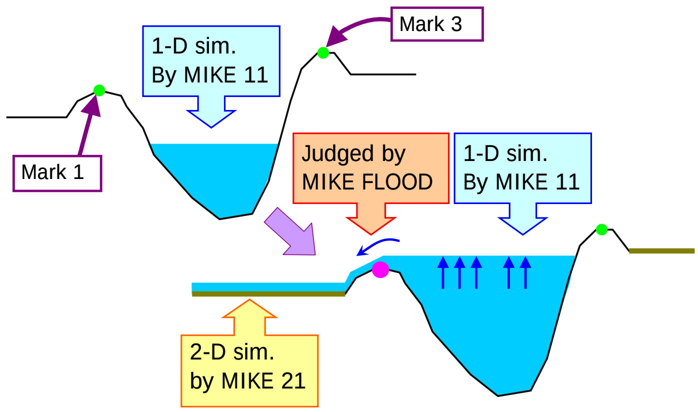
IV.2.2 Basic concept of definition of overflowing

MIKE FLOOD combines some river reaches in a 1-D (MIKE11) river channel model with grid topography data of a 2-D (MIKE21) model. Among the selection of the link types in MIKE FLOOD, the Lateral Link was applied to the Mejerda Model. The following chart describes the basic concept of overflowing by the Lateral Link in MIKE FLOOD.



Source : Study Team

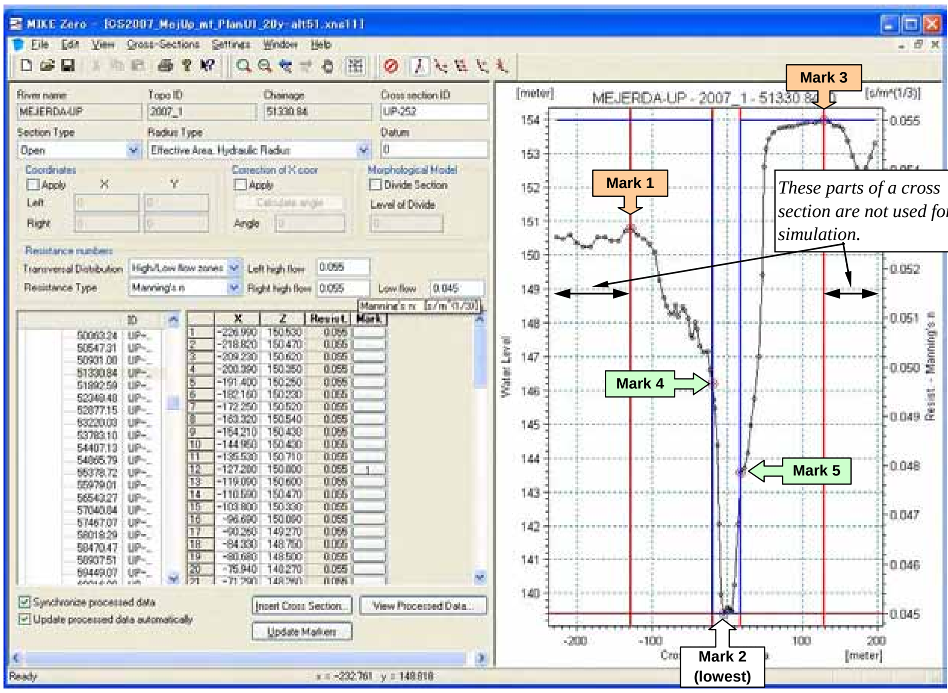
Figure IV.2.2: Basic Concept of Linked "Overflowing" Reaches in MIKE FLOOD



Source : Study Team

Figure IV.2.3: Basic Concept of Overflow in MIKE FLOOD

Marks 1 and 3 at the left and right ends of a cross section are defined in the MIKE11 Model as in the following figure, and details are described in **Section II.3.4** of **Part II**.

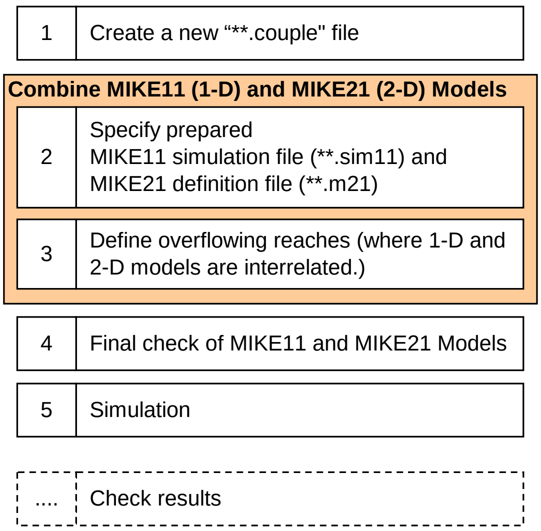


Source : Study Team

Figure IV.2.4: Example of Cross Section Defined in MIKE11

IV.2.3 Procedures of MIKE FLOOD Modelling

After completing MIKE11 and MIKE21 modelling, a MIKE FLOOD Model can build with the following steps. Modelling work at each step is described subsequently.



Source : Study Team

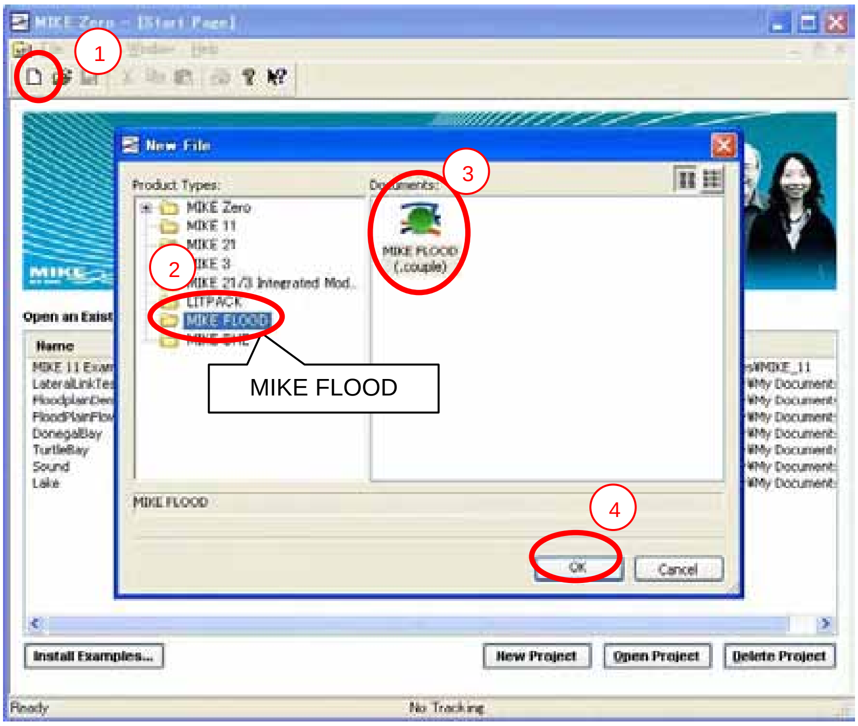
Figure IV.2.5: Overall Procedures of MIKE FLOOD Modelling

(1) Step 1: Create a new "**.couple" file

(i) Open MIKE ZERO Start Page

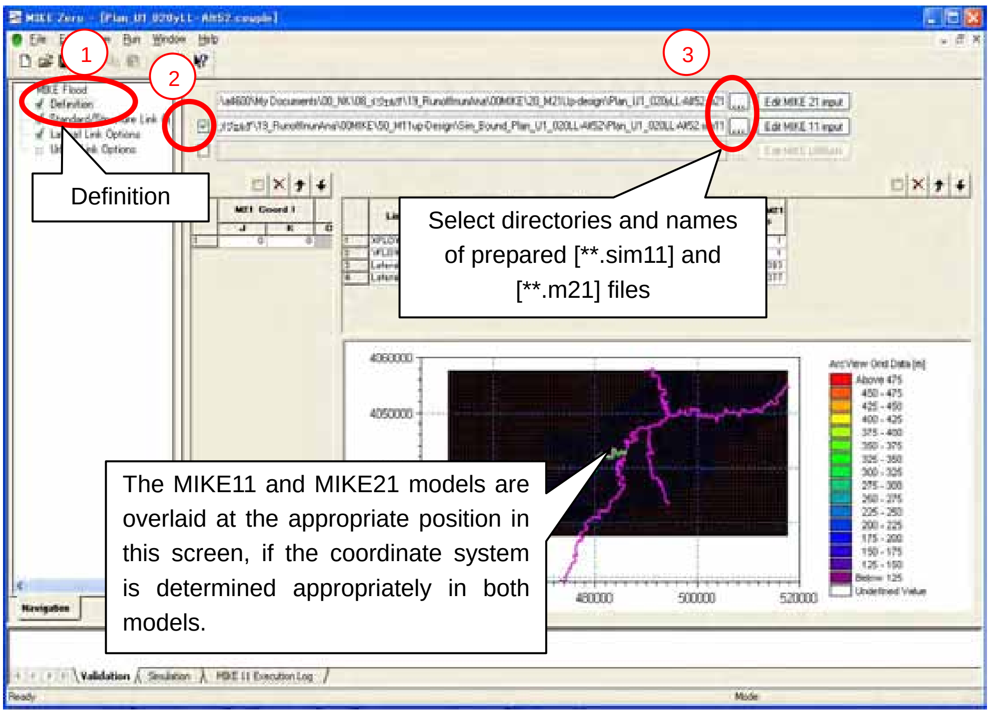
Windows[Start] – [All Program] – [MIKE BY DHI] – [MIKE FLOOD] – [MIKE FLOOD]

(ii) Open new "**.couple" file window



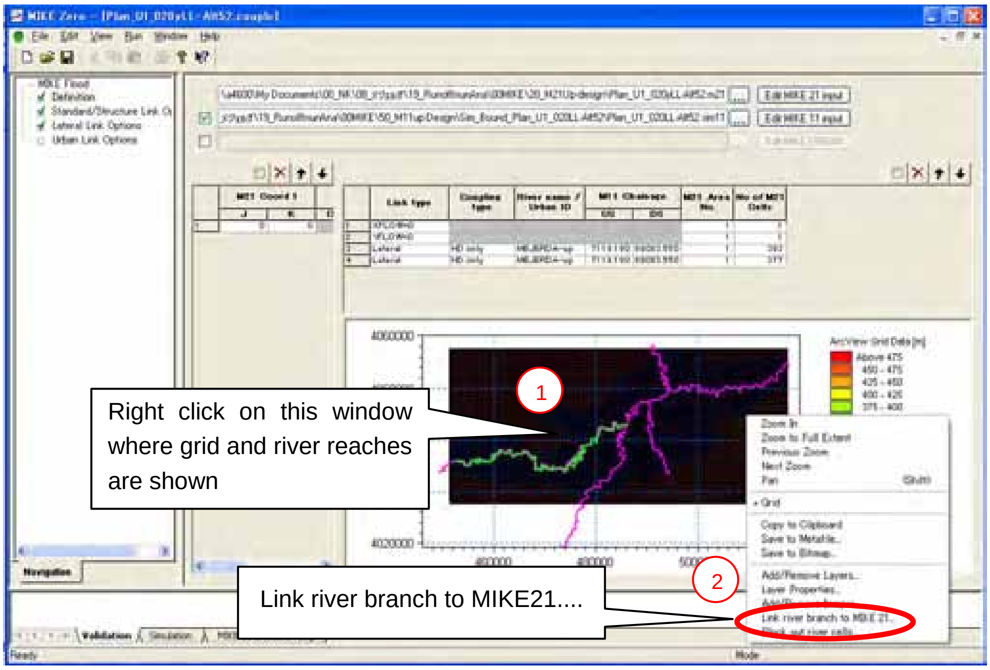
(iii) Save "**.couple" file in an appropriate folder

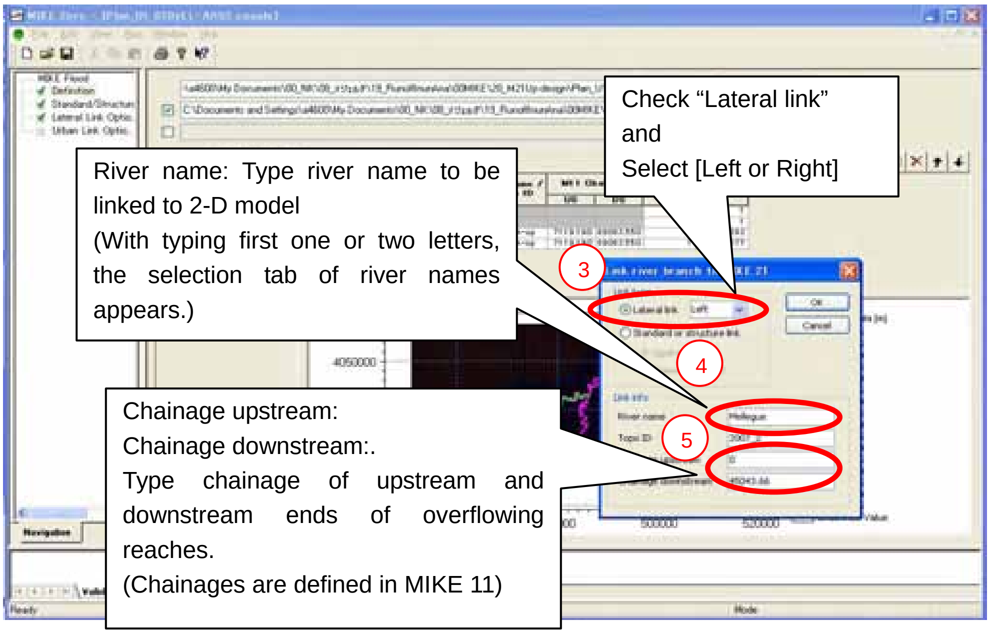
(2) Step 2: Specify MIKE11 simulation file (**.sim11) and MIKE21 definition file (**.m21) file



(3) Step 3: Define overflowing reaches

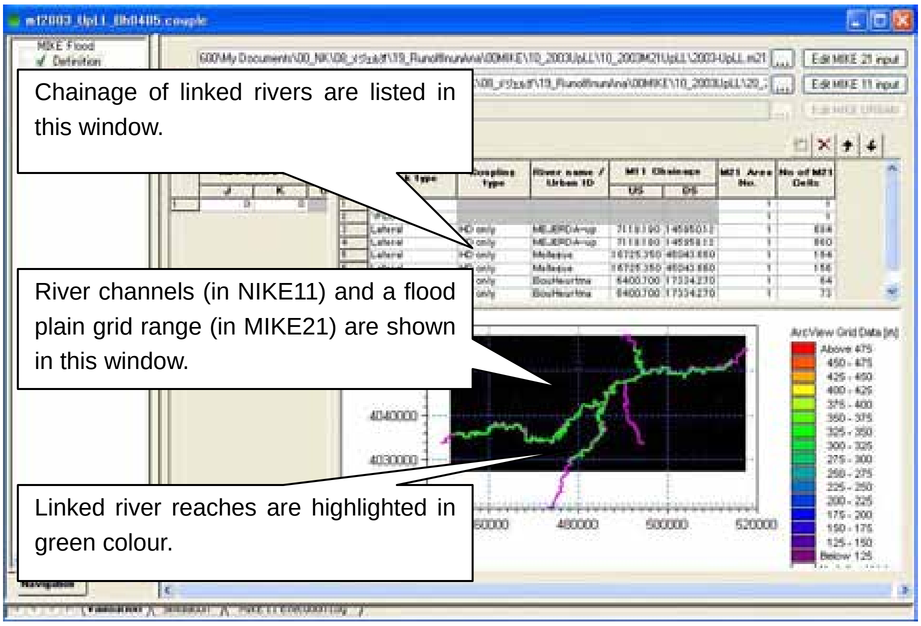
(i) Define river names and chainages of overflowing reaches





The parameters and values applied to this linking procedure are summarized in (ii) below.

The following figure is an example of the "definition" window of a "**.couple" with successful linking of river reaches (in green colour).



(ii) Notes on chainages

The ranges of linking river reaches is defined by "chainage", the cumulated distance from the upstream end of the channel determined in MIKE11. In order to know chainages of the concerned reaches, the MIKE11 window (Network File) should be opened and investigated.

The following table summarizes the values of linking chainages for the present condition of river channels. Linking chainages for improved river cases are being finalized and are not presented here. Chainages for linking river reaches are determined based on the following concept:

- Present condition (before river improvement) : All reaches situated within the bathymetry (except on the land value areas) in the MIKE21 Model are basically linked, because all reaches hold the possibility of overflowing.
- After river improvement condition: River reaches with planned levees are not linked to the 2-D model, because no inundation could be expected along these reaches with levees designed to have enough height. All other reaches in the bathymetry (except on the land value) in the MIKE21 Model are basically linked with the same concept to the present condition case.

Linked Chainage (Present Condition of River Channels)

River Name		Chainage Upstream	Chainage Downstream
Upstream Model			
MEJERDA-up	Left / Right	7119.190	145950.120
Mellegue	Left / Right	16725.350	45043.660
BouHeurtma	Left / Right	6400.700	17334.270
Tessa	Left / Right	2772.070	20209.790
Downstream Model			
MEJERDA-down	Left / Right	1583.980	150037.000

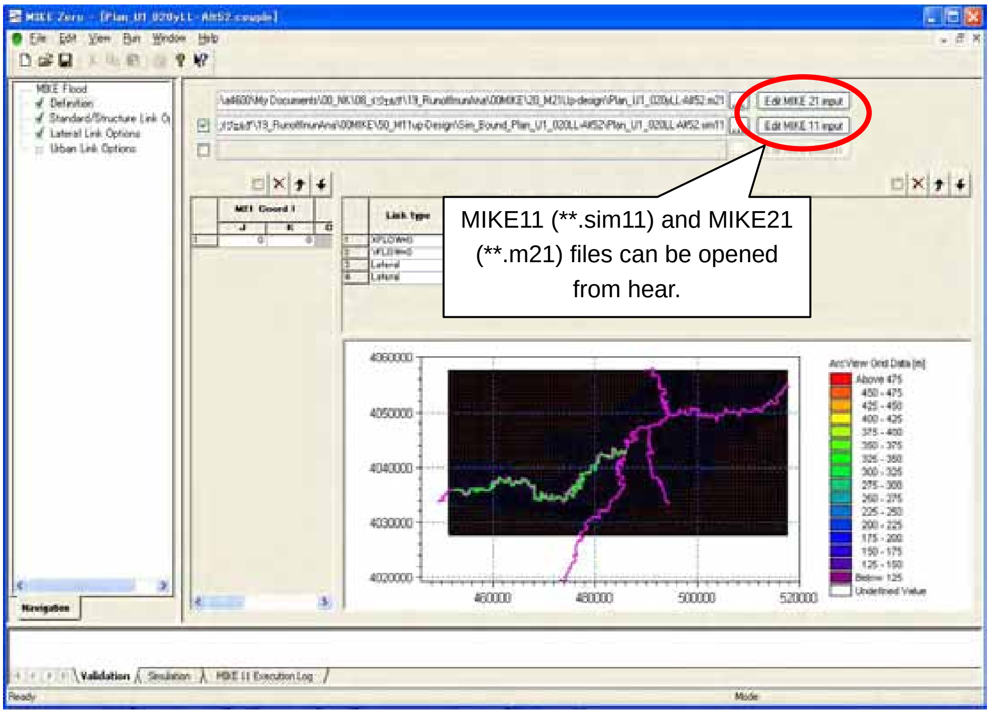
(iii) Inputting other parameters

The following table summarizes other parameters applied. They define hydraulic conditions of overflowing. Details on each parameter are described in the software users' manual (MF-2 in **Table I.1.1**).

Parameter	Selection / Value
Method	Cell to Cell
Type	Weir 1
Source	HGH

(4) Step 4 : Final check of MIKE11 and MIKE21 models

Before starting simulation, careful checking of the MIKE11 and MIKE21 Models are suggested to be made in order to avoid failure of simulation which requires significantly long time.



Some examples are enumerated below.

<u>MIKE11</u>

- Simulation time step and simulation period is consistent with the ones in MIKE21 model
- Directory and name of result file is defined what want to be. (If a result file name is set as the same to an existing result file name by mistake, a new result is over written on the folder and result of previous case will disappear!!!)

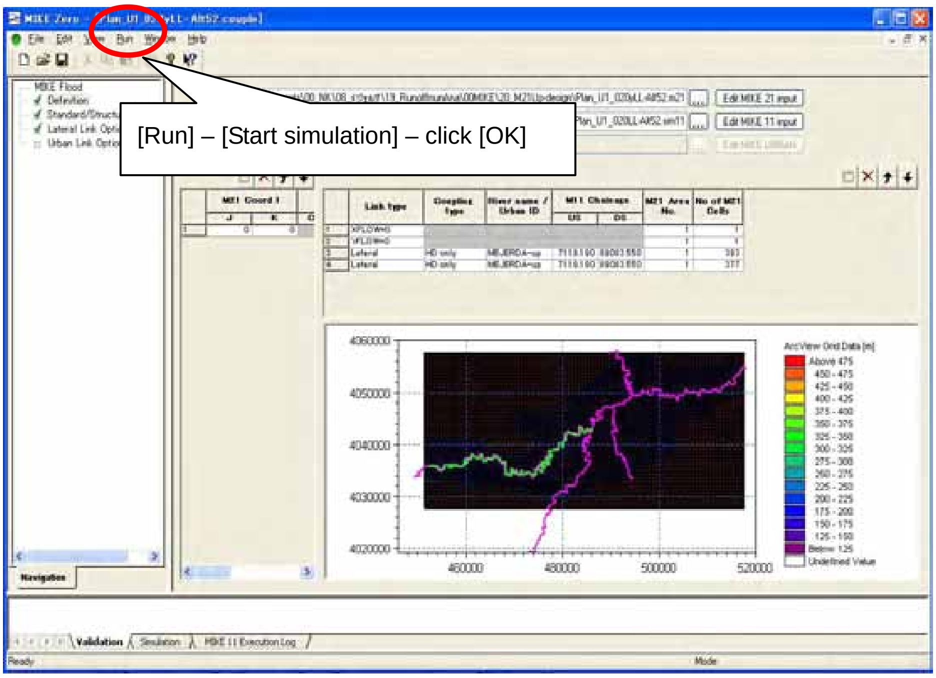
<u>MIKE21</u>

- Simulation time step and simulation period is consistent with the ones in MIKE11 model

- Ranges of time and grid for storing result should cover required time and area.
- Directory and name of result file is defined what want to be. (If a result file name is set as the same to an existing result file name by mistake, a new result is over written on the folder and result of previous case will disappear!!!

(5) Step 5 : Simulation

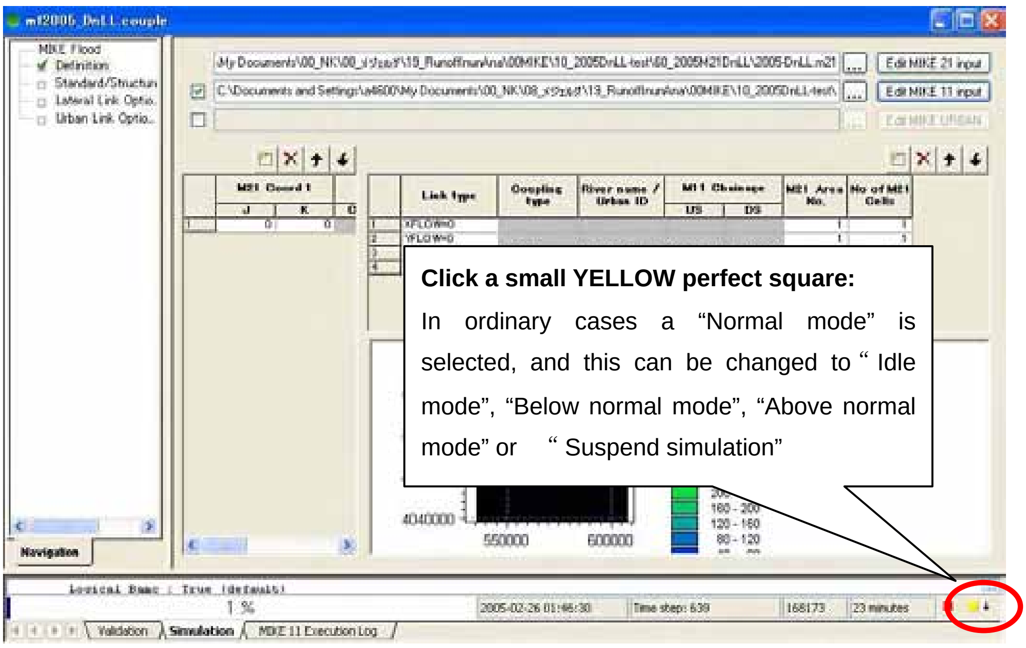
(i) How to start simulation



(ii) Simulation of 1-D and 2-D models

With starting simulation on MIKE FLOOD (**.couple file), both 1-D (MIKE11) and 2-D (MIKE21) models start simulation automatically.

(iii) How to decrease/increase performance of simulation or suspend simulation



It should be noted that resuming the simulation could fail, and simulation result acquired before the suspension could be lost by accident.

(iv) How to terminate simulation

Click a small RED perfect square at the left of the yellow perfect square mentioned above.

(6) Result files to be obtained

Result files of 1-D (MIKE11) (**.res11) and 2-D (MIKE21) (**.dfs2) models are created in folders determined in MIKE11 and MIKE21 respectively. Data contained in each result file are listed in **Table I.3.1** in **Part I** of this explanation note.

IV.2.4 Positions of levees on cross sections in MIKE11 Model used for MIKE FLOOD Model

Overflow from a river channel determined by elevation of ends of cross section (Marks 1 and 3 in MIKE11 cross sections) and/or grid elevation of flood plain where the cross section ends situated. Hence, determining positions of the Marks is important for MIKE FLOOD Modelling. Details are discussed in **Section II.3.4** in **Part II** of this explanation note.

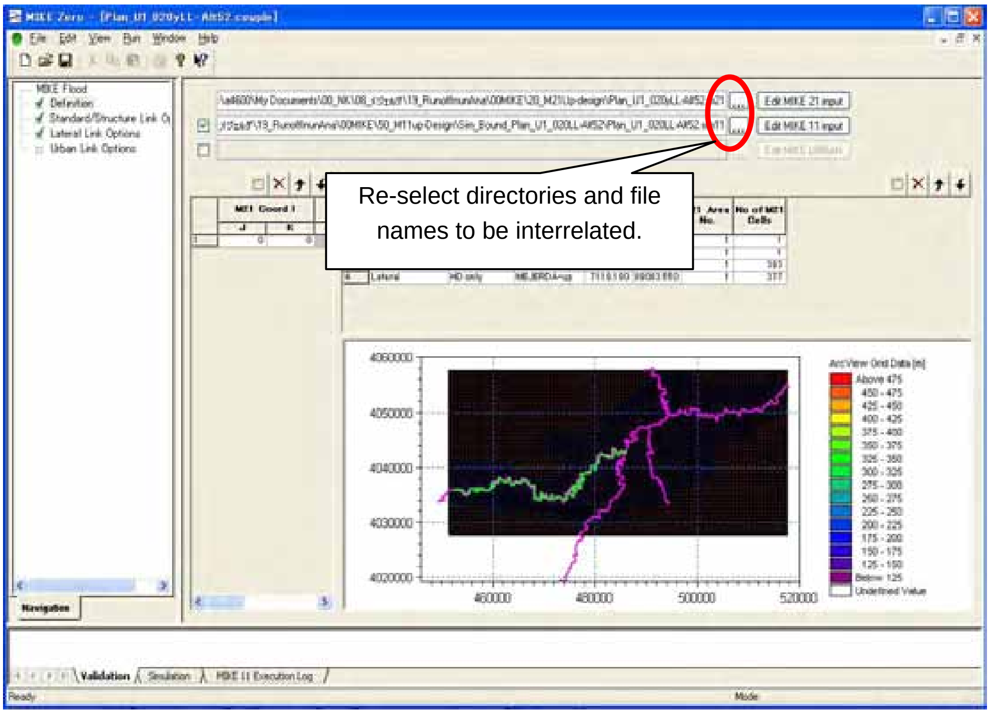
IV.3 How to Modify/ Update the MIKE FLOOD Mejerda Model

The following items can be modified in the MIKE FLOOD “**.couple” file.

- MIKE11 (**.sim11) and MIKE21(**.m21) files to be combined
- River names and chainages of linked river reaches

Conditions and parameters determined in MIKE11 and MIKE21, such as boundary inflow hydrographs and simulation period, should be modified in the input and simulation files of the MIKE11 and MIKE21 models. The interrelated MIKE11 and MIKE21 files can be opened from the MIKE FLOOD window.

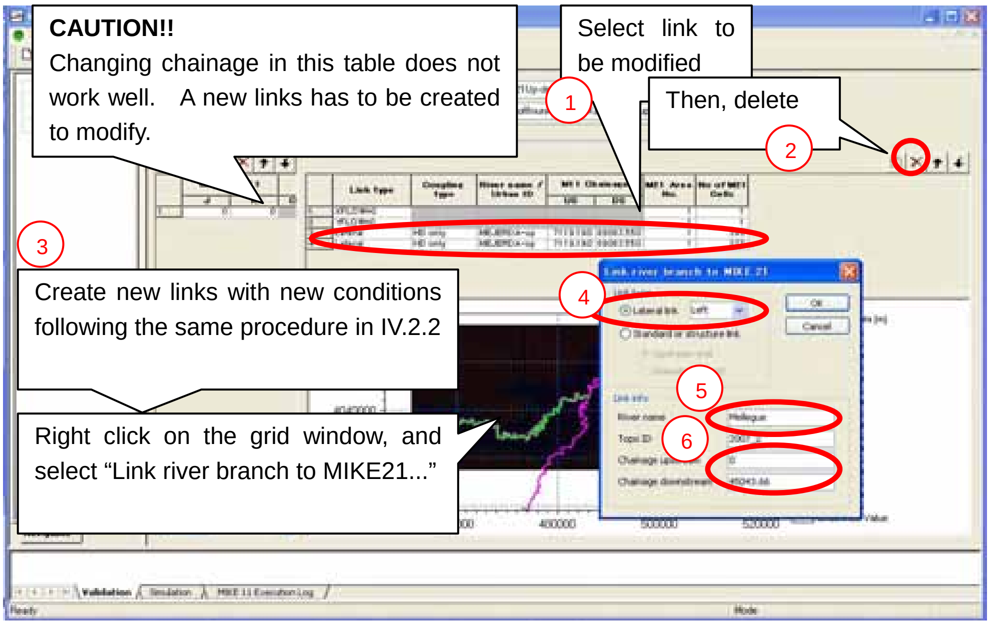
(1) How to change MIKE11 (**.sim11) and MIKE21(**.m21) files to be combined



(2) River names and chainages of linked river reaches

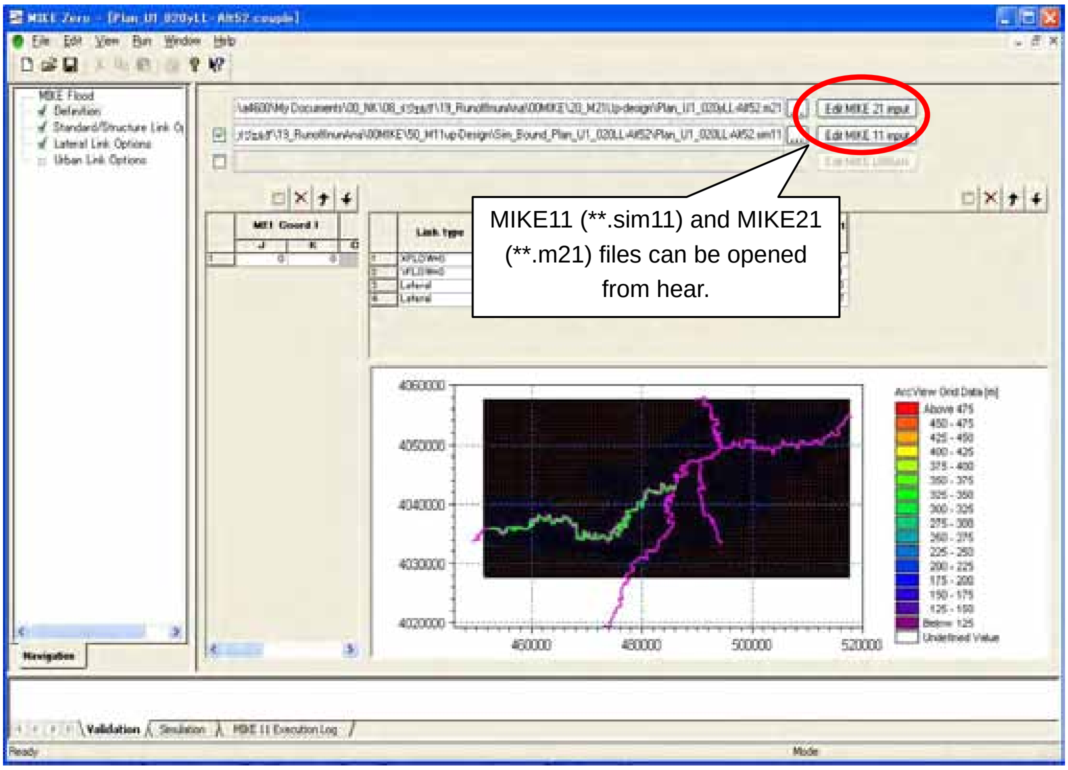
Overflow from a river channel determined by elevation of ends of cross section and/or grid elevation of flood plain where the cross section ends situated. Hence, determining positions of calculation ends of cross section is important for MIKE FLOOD Modelling.

- Delete defined link to be modified
- Insert a new definition of the link



(3) How to change conditions/parameters defined in MIKE11 and MIKE21

Other parameters which belong to the 1-D and 2-D models can be modified in MIKE11 and MIKE21 respectively. MIKE11 and MIKE21 windows can be opened from the MIKE FLOOD "**.couple" file like below. See **Part II and Part III** of this explanation note for methods how to modify the MIKE11 and MIKE21 parameters.



PART V : EXPLANATION NOTE ON POST-PROCESSING AND EVALUATION OF RESULTS

V.1 Viewing and Post-Processing Results

V.1.1 Necessity of post-processing simulation results

This Part introduces ideas how to process the following 1-D and 2-D simulation result files.

Appli-cation	File Extension	Explanation of Simulation Results	Examples of output parameters
MIKE11	*.res11	1-D Results • Hydraulic conditions in channels.	Water level Velocity Discharge
MIKE21	*.dfs2	2-D Results • Hydraulic conditions on flood plains	Water depth Velocity

Source: Study Team

These result files require one of MIKE software to open and process. However, after the post-processing procedures explained in this Part, the inundation analysis results come to be accessed by other popular software, such as MS Excel and ArcGIS, which enables further analyses of inundation conditions.

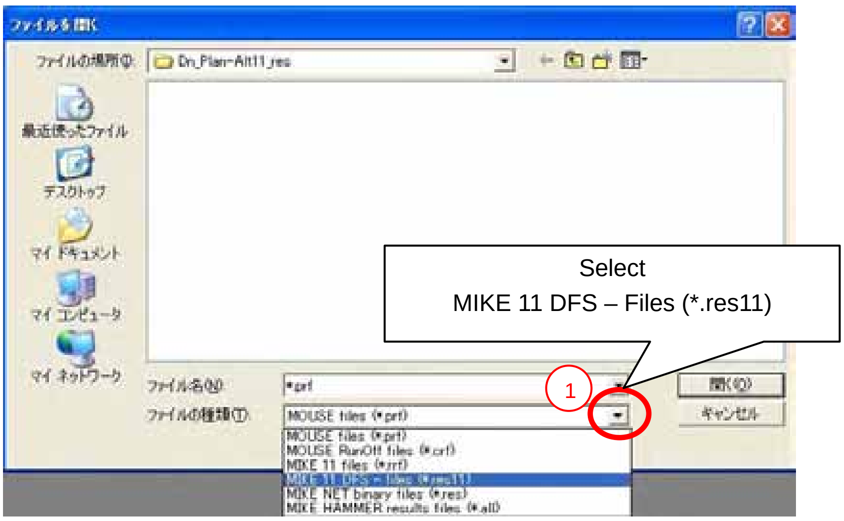
V.1.2 1-D (MIKE11) results

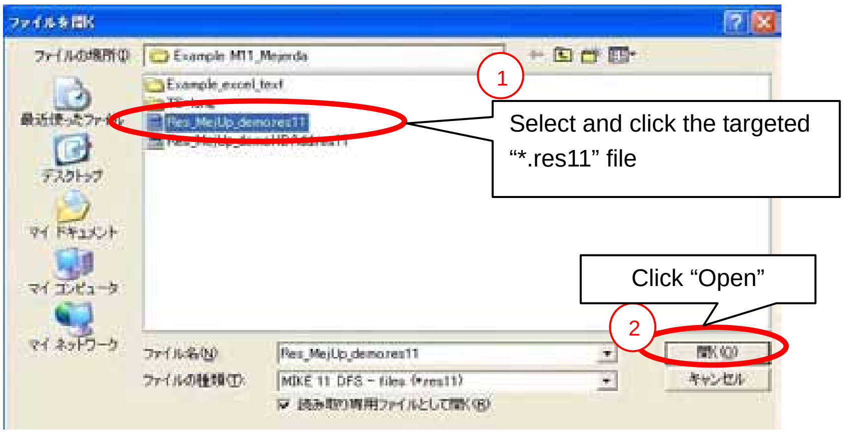
File extension	*.res11
Related Applications	• MIKE VIEW (See software manual M11-4 in **Table I.1.1**)

The methodologies of viewing a MIKE11 result file (*.res11) are briefly described below. (See the MIKE VIEW software manual (M11-4 in **Table I.1.1**) for further details.)

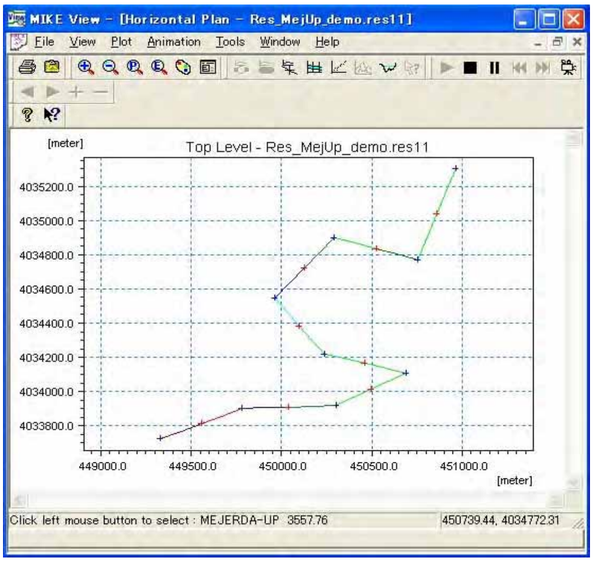
(i) Open a result file

Windows [Start] – [All Program] – [MIKE BY DHI] – [MIKE11] – [MIKE VIEW]

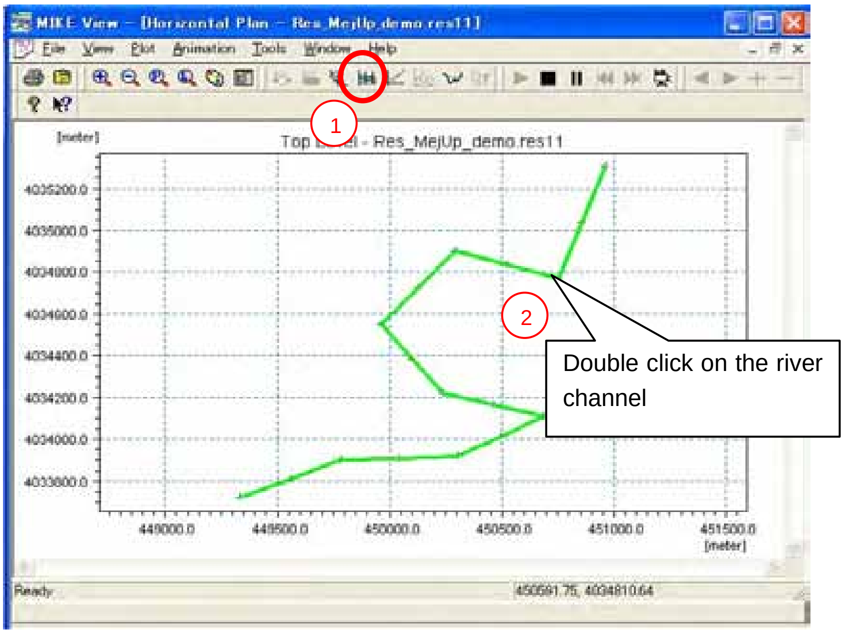




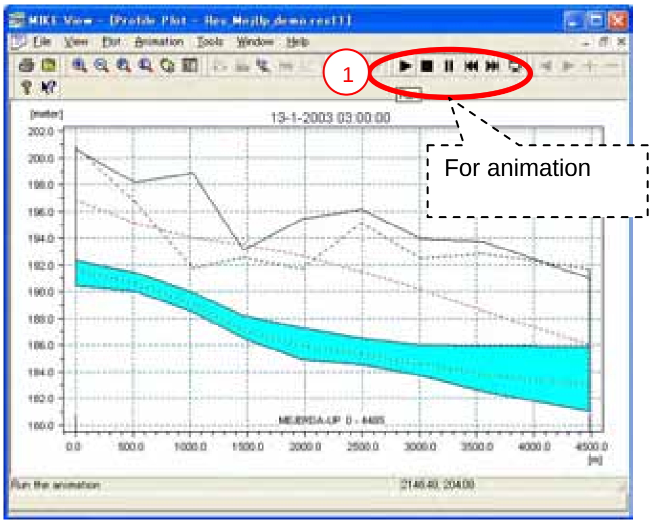
Click [OK] on next screen



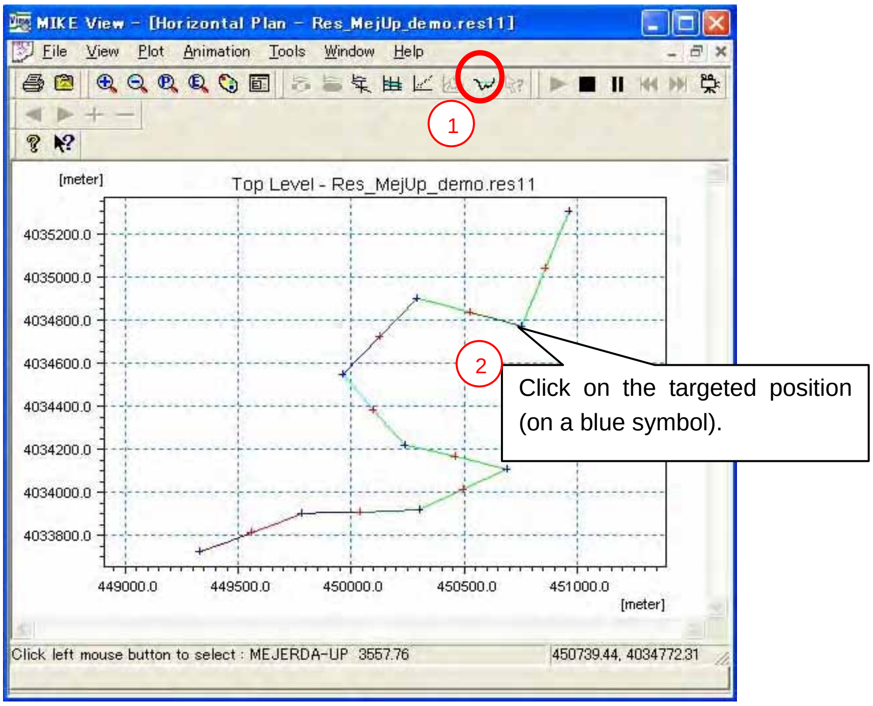
(ii) View profile

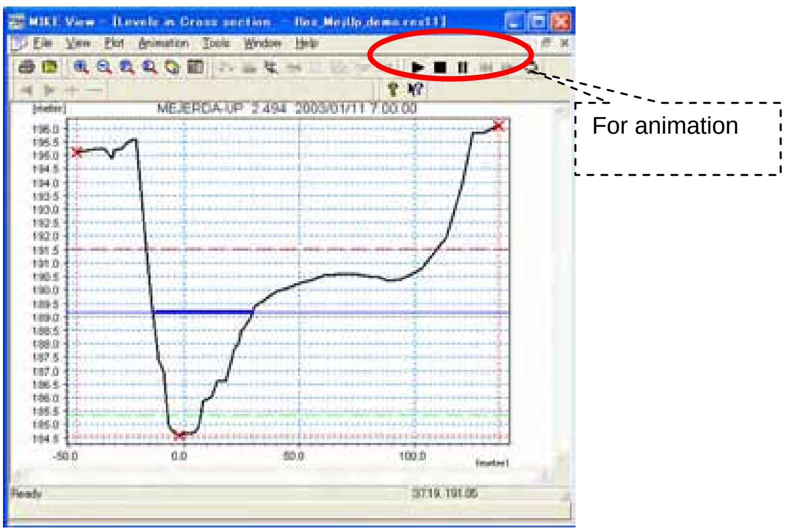


Click [OK] on next screen – Select “Water Level”

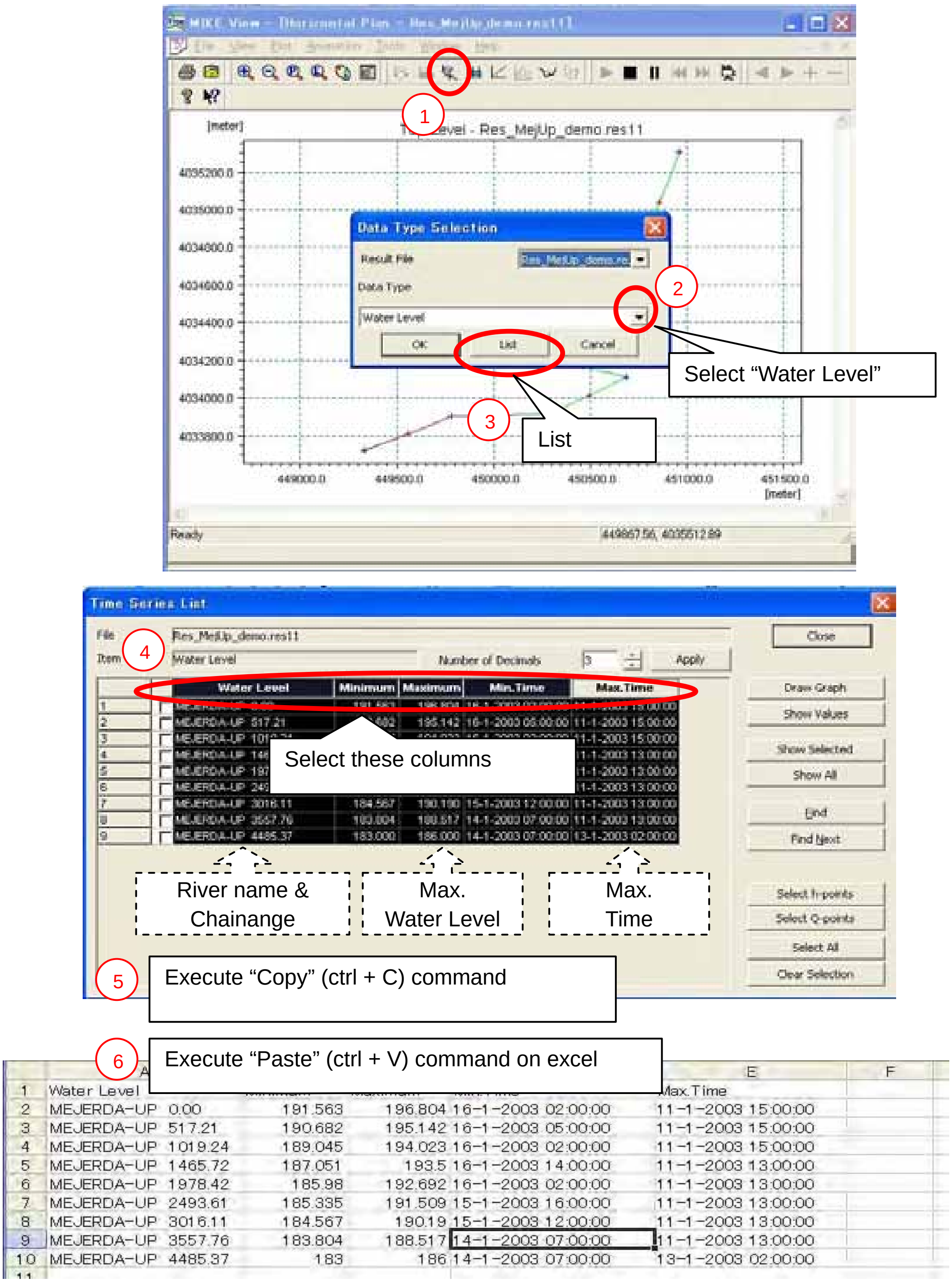


(iii) View cross section





(iii) Copy maximum water surface profile data to excel



1	Water Level				Max.Time
2	MEJERDA-UP 0.00	191.563	196.804	16-1-2003 02:00:00	11-1-2003 15:00:00
3	MEJERDA-UP 517.21	190.682	195.142	16-1-2003 05:00:00	11-1-2003 15:00:00
4	MEJERDA-UP 1019.24	189.045	194.023	16-1-2003 02:00:00	11-1-2003 15:00:00
5	MEJERDA-UP 1465.72	187.051	193.5	16-1-2003 14:00:00	11-1-2003 13:00:00
6	MEJERDA-UP 1978.42	185.98	192.692	16-1-2003 02:00:00	11-1-2003 13:00:00
7	MEJERDA-UP 2493.61	185.335	191.509	15-1-2003 16:00:00	11-1-2003 13:00:00
8	MEJERDA-UP 3016.11	184.567	190.19	15-1-2003 12:00:00	11-1-2003 13:00:00
9	MEJERDA-UP 3557.76	183.804	188.517	14-1-2003 07:00:00	11-1-2003 13:00:00
10	MEJERDA-UP 4485.37	183	186	14-1-2003 07:00:00	13-1-2003 02:00:00

Other numerical data, such as time series water level at selected points, can also be extracted in MIKE VIEW.

Further data processing and analysis, such as comparing water profiles of different simulation cases, can be conducted in Excel files.

V.1.3 2-D (MIKE21) results

(1) Products which can be developed from MIKE21 result files and required applications

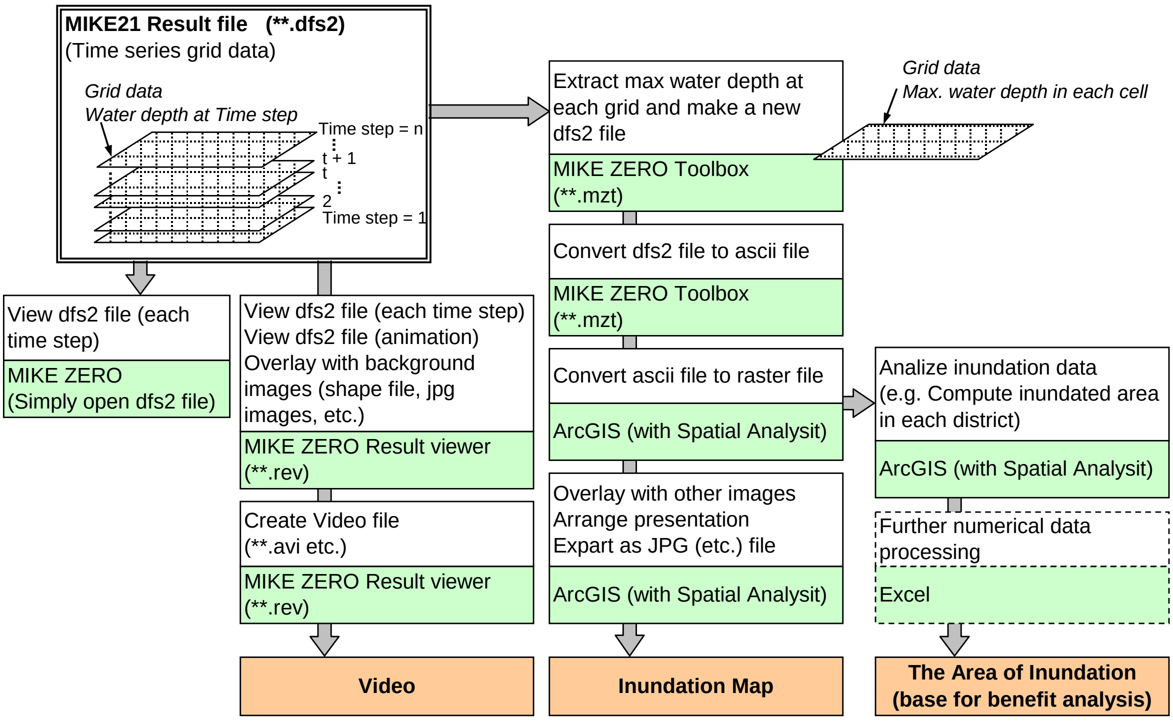
The MIKE21 result files can contribute to developing the following products, which can provide important information for the study on flood management plan, such as;

- an animation **video file**, which can show behaviours of flood flows, such as overflowing points and flow directions, without MIKE software
- an **inundation map**, which shows the maximum extent of the inundation and inundation depth
- **the area of inundation (numerical data)**, which becomes basic data for the benefit analysis

The following applications are utilized for processing MIKE21 result files (**.dfs2) to obtain the above products under the Study.

- MIKE ZERO (simply open a dfs2 file)
- MIKE ZERO Result Viewer
- MIKE ZERO Tool Box
- GIS Software (ArcGIS (ArcView) ver.9 with Spatial Analyst)
- MS Excel

The following chart summarise overall procedure of post-processing and applications employed.



Source : Study Team

Figure V.1.1: Post-Processing Procedures of 2-D Result of the Mejerda Model

Methodologies of the following post-processing procedures of MIKE21 result files are briefly described in this section. (See the software manuals for the details.)

i) View MIKE21 result (*.dfs2) files by the dfs2 file editor

ii) View MIKE21a result (*.dfs2) files and develop animation video files by the Result Viewer

iii) Prepare inundation maps
iv) Compute the area of inundation

(2) View MIKE21 result (*.dfs2) files by the dfs2 file editor

Application Used	• MIKE ZERO
Related software Manual	MIKE ZERO User Guide (MZ-2 in **Table I.1.1**)
Procedure	Simply open the dfs2 file

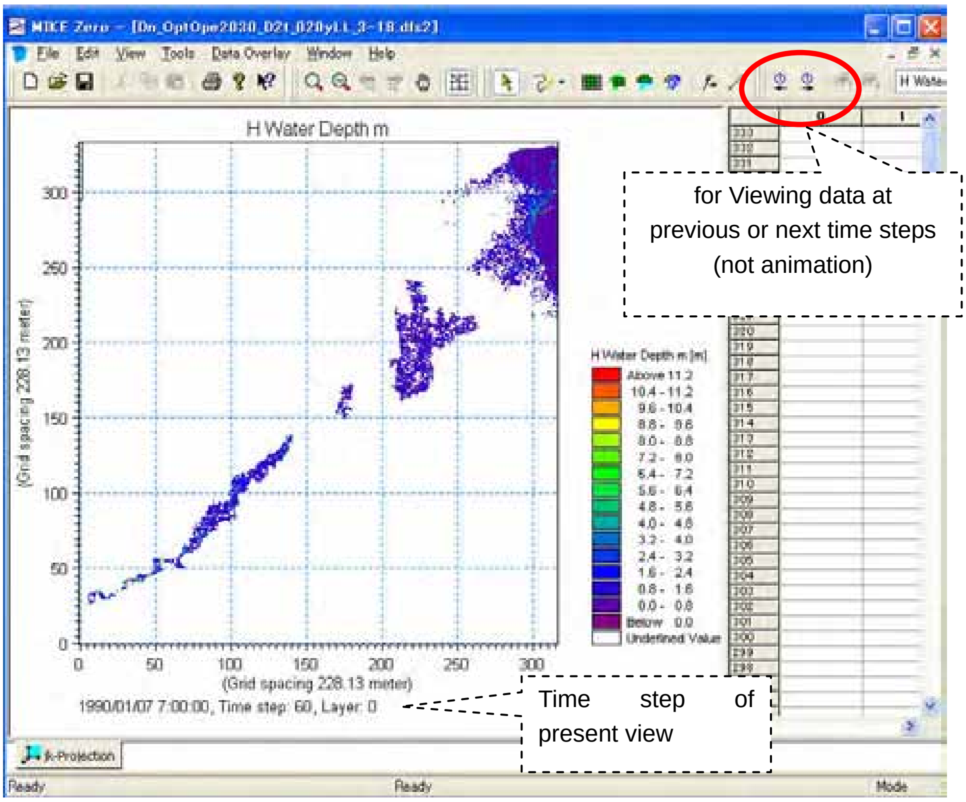
(i) Open dfs2 file

Double click on a dfs2 file icon in the explore of Windows.

(ii) View data at different time steps

Method 1: [Tools] – [Navigation.....] – (slide a bar of Time Step)

Method 2: Click the “Timestep Forward” or “Timestep Back” icon on the command bar (see below)

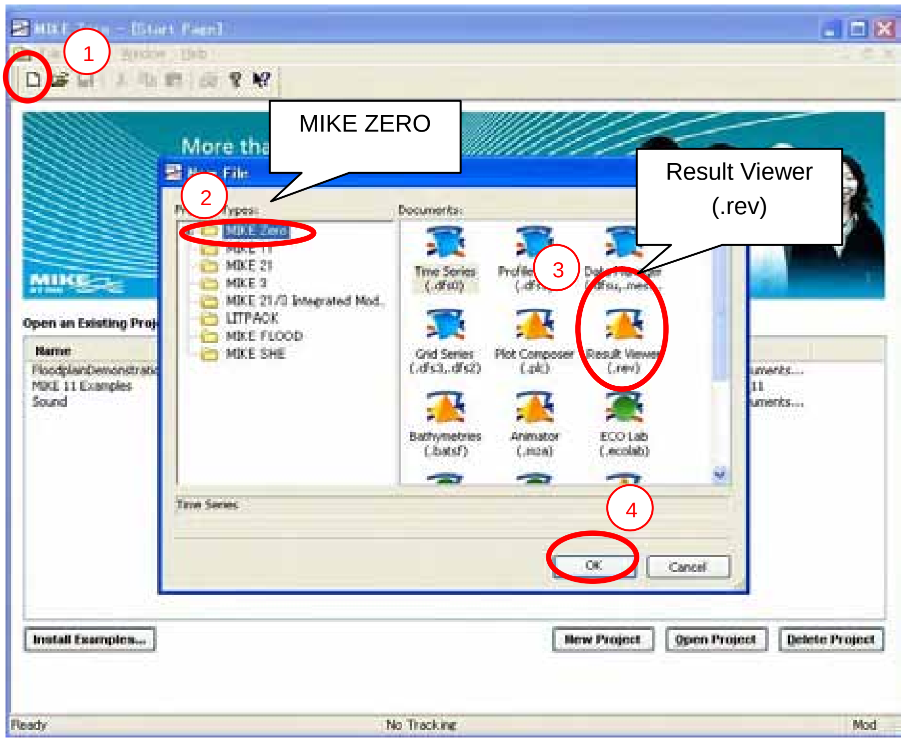


(3) View MIKE21 result (*.dfs2) files and develop animation video files by the Result Viewer

Application Used	• MIKE ZERO Result Viewer
Related software Manual	MIKE ZERO Prerocessing & Postprocessing, User Guide (MZ-3 in **Table I.1.1**)
Procedure	Create a new MIKE ZERO Result Viewer file → View result (dfs2) file and combine with background images → Create a video file

(i) Create a new MIKE ZERO Result Viewer file

Windows [Start] – [All Programs] – [MIKE BY DHI] – [MIKE21] – [MIKE21]

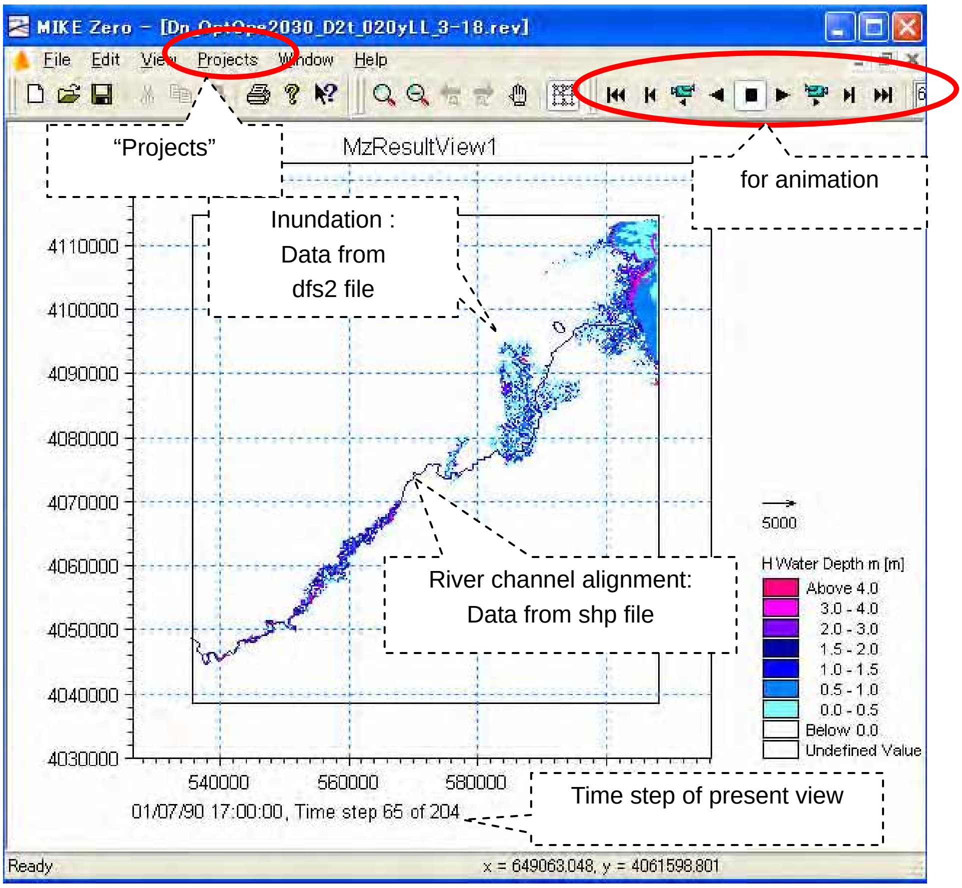


(ii) View result (dfs2) file and combine with background images

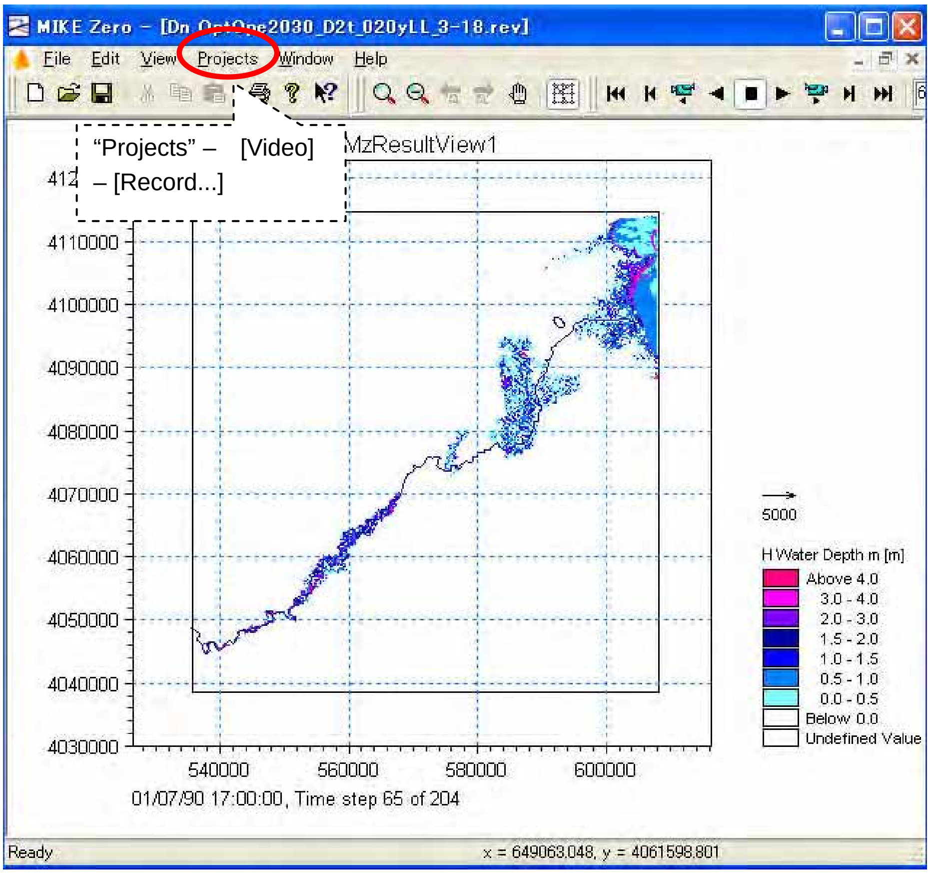
[Projects] – [Add Files to Project] – Press “new” icon – [MIKE21 Result File] – Specify directories and file names of dfs2 file

[Projects] – [Work Area] – “browse” – “D_Carthage” – “Carthage_UTM_Zone_32N” (or UTM_Carthage)

[Projects] – [Add Files to Project] – Press “new” icon – [Shape file] – Specify directories and file names of GIS shape file of the Mejerda River



(iii) Create a video file



Specify directory and file name of a video file to be recorded – [OK] – Select vide file type (e.g. Microsoft Video 1) – [OK] – (recording starts)

– (Message : A video file .... has been created.) – [OK]

(iv) Note on video type

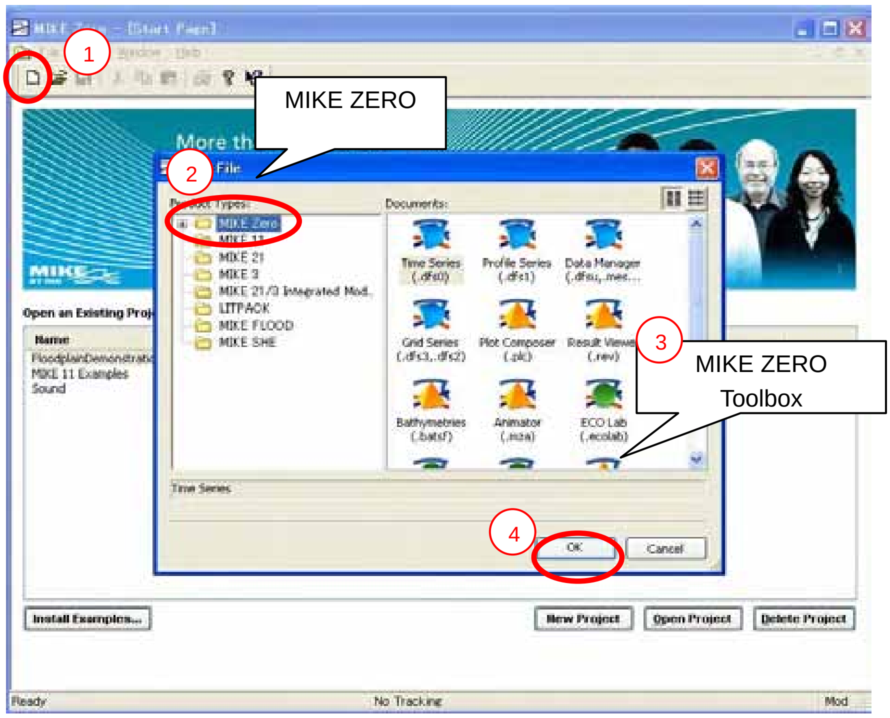
Selection of the video type is according to the users' preference, purposes and available video software. For example, when the video type of "Microsoft Video 1" is selected, a **.avi" file is created. This video file can be opened by popular applications, such as Windows Media Player (according to the setting of a computer used), without the MIKE software.

(4) Prepare inundation maps

Application Used	• MIKE ZERO Toolbox • GIS (e.g. ArcGIS ver.9 with Spatial Analyst)
Related software Manual	MIKE ZERO Prerocessing & Postprocessing, User Guide (MZ-3 in **Table I.1.1**)
Procedure	Extract max water depth at each grid from the MIKE21 result dfs2 file →Convert dfs2 file to Ascii file →Convert ascii file to GIS raster file

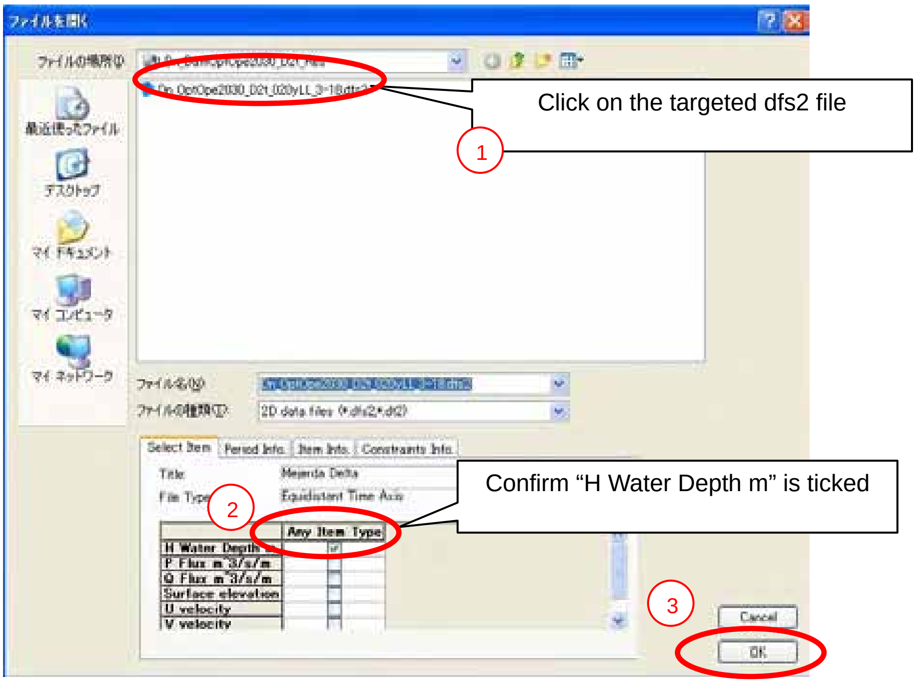
(i) Extract max water depth at each grid from the MIKE21 result dfs2 file

Open the Start Page of MIKE Software (Windows [Start] – [Program] – [MIKE BY DHI] – [MIKE21] – [MIKE21])

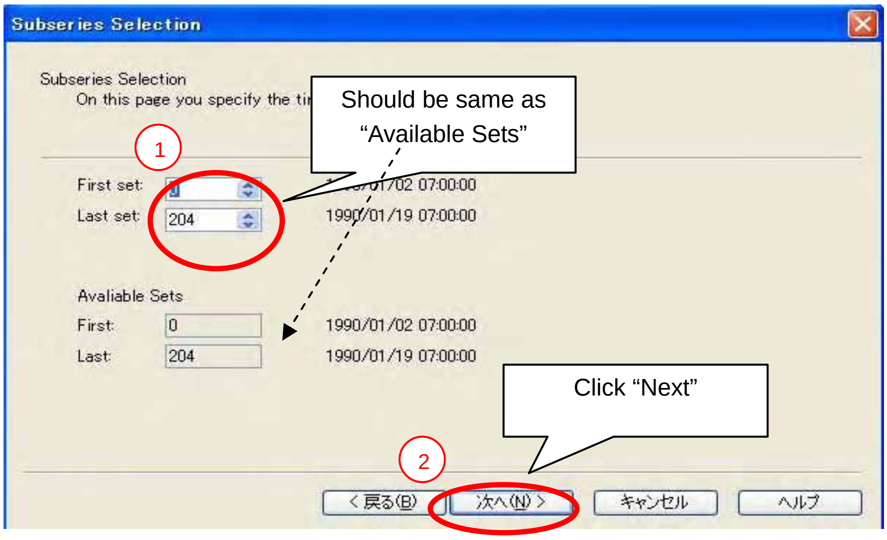


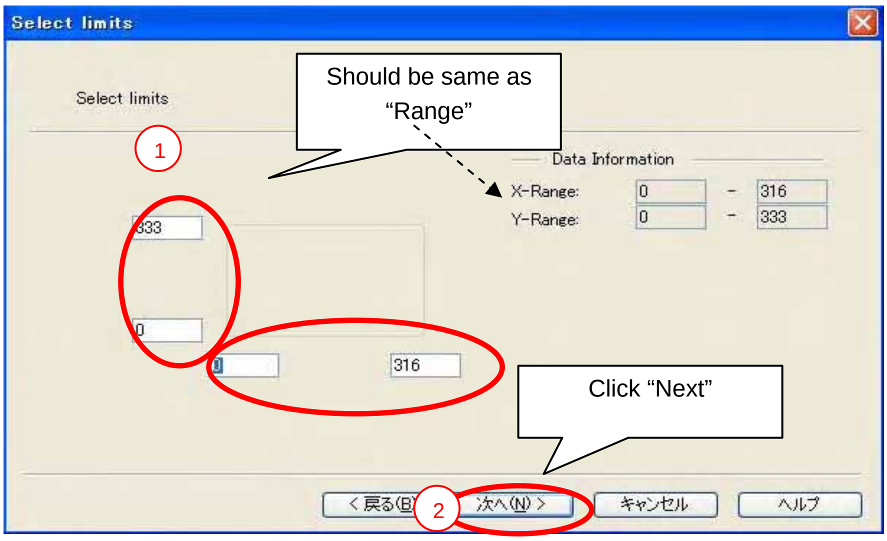
[Statistics] – [TxStat] – (Double click)

– (Ignore "Setup Name") [Next] – [Statistics on matrix series] – [Next] – (Brows / specify directory of MIKE21 result dfs2 file)


ファイルを開く
Click on the targeted dfs2 file
1
Confirm "H Water Depth m" is ticked
2
3
Select Item
Period Info.
Item Info.
Constraints Info.
Title
Mejerda Delta
File Type
Equidistant Time Axis
Any Item Type
H Water Depth
P Flux m^3/s/m
Q Flux m^3/s/m
Surface elevation
U velocity
V velocity
Cancel
OK

[Next]


Subseries Selection
Subseries Selection
Should be same as "Available Sets"
1
First set:
Last set:
204
1990/01/19 07:00:00
Avaliable Sets
First:
0
1990/01/02 07:00:00
Last:
204
1990/01/19 07:00:00
Click "Next"
2
< 戻る(B)
次へ(N) >
キャンセル
ヘルプ


Select limits
Select limits
Should be same as "Range"
1
Data Information
X-Range:
0
316
Y-Range:
0
333
333
0
316
Click "Next"
2
< 戻る(B)
次へ(N) >
キャンセル
ヘルプ

Check " Maximum values" – [Next] – Specify directory and name of output maximum depth dfs2 file – [Next] – [Execute]

A dfs2 file containing maximum water depth at each cell has been created.

(ii) Convert dfs2 file to Ascii file

Go to the first page of MIKE ZERO Toolbox

[GIS] – [MIKE2Grd] – (Double click)

– (Ignore "Setup Name") [Next] – Brows / specify directory and name of maximum depth dfs2 file – [Next]

– Confirm Map projection is Carthage_UTM_Zone_32N or (UTM_Carthage) – [Next]

– Brows / specify directory and name of output ascii file – [Next] – [Execute]

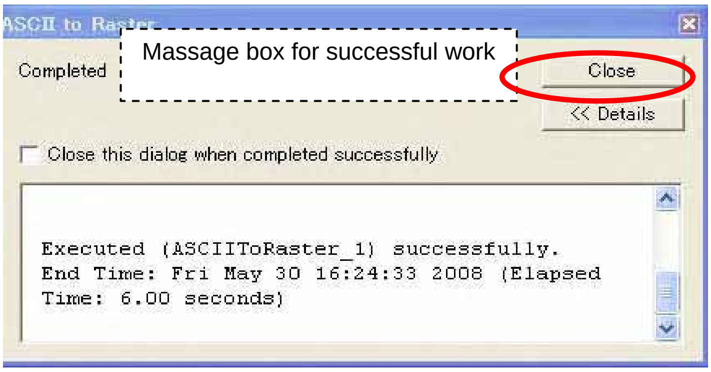
An ascii file has been created. (File extension: **.asc)

(iii) Convert ascii file to GIS raster file

Change an extension of the ascii from **.asc to **.txt

Start ArcGIS ver 9 – [ArcToolbox] – [To Raster] – [ASCII to Raster]

– Specify directory and name of Input ASCII raster file - Specify directory and name of an output GIS raster file – "Output data type": Float – [OK] – Conversion process shows on a message screen



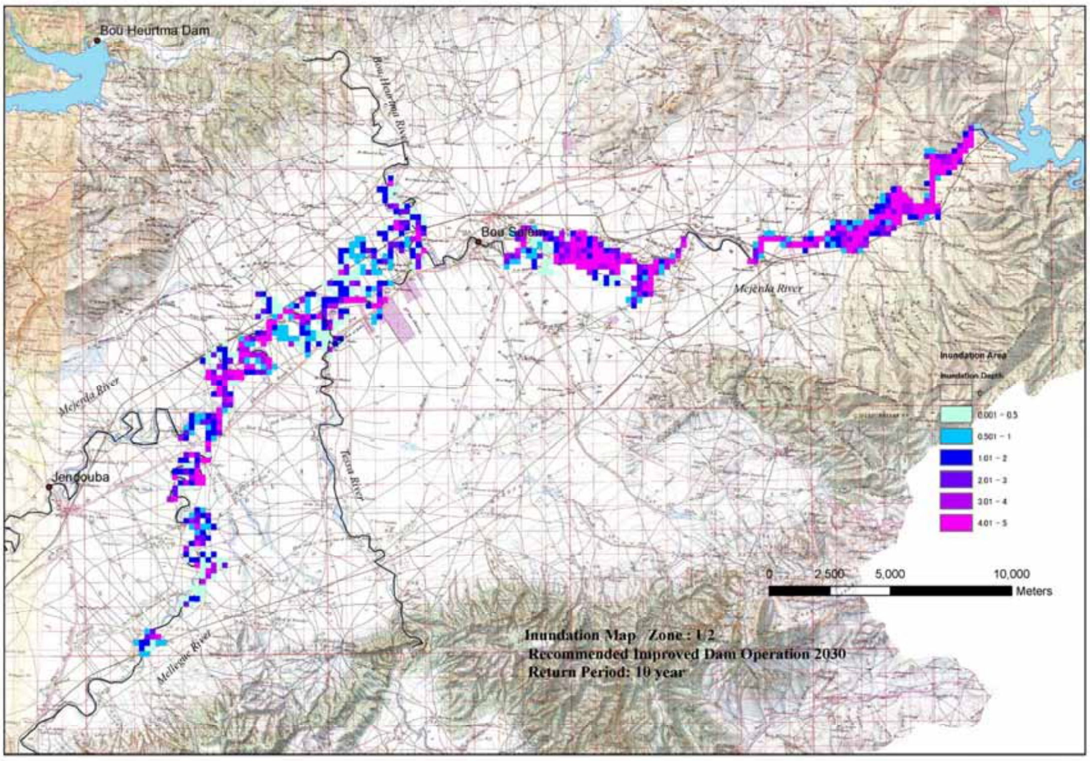
– Converted grid data is added on the data view window of GIS.

(iv) Organizing presentation of the map in GIS

The following arrangements in the GIS software (ArcGIS ver.9.1 with Spatial Analyst was used for the Study) should be required to prepare inundation maps with a good appearance. (See the manuals of the GIS software for further details)

- Insert required GIS files, such as background topographic maps and shape files (GIS files) of rivers and reservoirs.
- Display grid data with different colour according to the values of the ranks of the inundation depth (Change properties of the grid data)

An example of the inundation map prepared by GIS is presented below.



Source : Study Team

Example of Inundation Map (Upstream Model)

(5) Compute the area of inundation

Application Used	• GIS (e.g. ArcGIS ver.9 with Spatial Analyst) • Excel
Procedure	Prepare GIS grid data of max. inundation depth from a MIKE21 result dfs2 file →Create delegation grid data from delegation polygon data →Classify inundation grid data →Export table data →Analysis in Excel

This is an example of the computation of the inundation area with different inundation depth in each delegation (administrative unit) as in the table below.

(Unit: in ha)

Depth / Delegation	0m	<0.5m	0.5-1m	1-2m	2-3m	3-4m	4-5m	5-6m	6m≤
BEJA SUD	525	26	14	53	26	18	6	0	0
BOU SALEM	204	28	639	20	22	15	16	1	2
DOUAR HICHER	123	259	40	56	12	0	0	0	0
EL BATTANE	45	425	377	541	253	32	4	2	2
.....		.....	.....	.....	.....	.....	.....	.....	.....

Note : Above table shows an example of data formats only. The values in the table do not based on actual computations.

The computation can be made from the following two data sources.

- GIS grid inundation data (maximum inundation depth) developed from a MIKE21 result file (the GIS grid data made for preparing an inundation map. See (3) above.)
- A polygon GIS shape file of delegation (administrative unit) boundaries. The delegation names or IDs have been input in the attribute table of the shape file.

The procedures are briefly described below.

(i) Prepare GIS grid data of max. inundation depth from a MIKE21 result dfs2 file

See (4) above.

(ii) Create delegation grid data from delegation polygon shape file (by ArcGIS ver. 9 with Spatial Analyst)

[Spatial Analyst Tool Bar] – [Convert] – Field: Delegation, Output cell size: 228.12952000000001

Note : Output cell size should be the same to the one in MIKE 21.

(iii) Classify inundation grid data (by ArcGIS ver. 9 with Spatial Analyst)

The inundation depth (h) should be classified. The following 9 ranks are applied to this example.

Rank	**Range**	**Rank**	**Range**
1	h = 0 m	6	3 ≤h < 4 m
2	h < 0.5 m	7	4 ≤h < 5 m
3	0.5 ≤h < 1 m	8	5 ≤h < 6m
4	1 ≤h < 2 m	9	6 m ≤h
5	2 ≤h < 3 m		

[Spatial Analyst Tool Bar] – [Reclassify] – [Reclass field <value>] – [Classify] – set classification classes (9) – “break values” (0, 0.5, 1, 2, 3, 4, 5, 6, 100) – Specify the directories and name (max. 13 letters) of the output raster.

(iv) Combine raster information of the inundation depth rank and delegation (by ArcGIS ver. 9 with Spatial Analyst)

[ArcToolBox] – [Spatial Analyst Tools] – [Local] – [Combine]

– “Input raster”: Specify directories and the name of the input raster files (select Reclassed Inundation file (prepared in (iii)) first, then select delegation grid file (prepared in (ii))

– “Output raster”: Specify directories and the name of a new output raster

The newly developed raster file contains information of the rank of inundation depth and delegation in each cell.

(v) Export table data (by ArcGIS ver. 9 with Spatial Analyst)

(Open attribute table) – [Options] – [Export] – Export: All records – Specify directories and the name of an output data base file(dn020_dlg.dbf)

(vi) Analysis in Excel

The database file developed in (v) can be opened by MS Excel. The function of “Pivot Table” in MS Excel is a strong tool to organize the data crossing to the two parameters (inundation depth rank and delegation) as the sample table above.