Annex 6

Practical Guideline

for

MIKE 11 Water Quality Model

JICA Study Team

MIKE 11 Files used for Water quality Modelling

The MIKE 11 water quality modelling utilizes the files created during the MIKE hydrodynamic model set-up. Few adjustments have been made for the most upstream part of the rivers to ensure sound and stable water quality simulation. The files used for the water quality modelling is therefore stores in a special directories named:

C:¥MIK11WQ_Bulagria
C:¥MIK11_Bulgaria_WQ-template

Simulation files
The primarily simulation files used for the model set-up, calibration and scenario simulation is specified in the MIKE 11 sim-files (*.sim11)

There has been prepared sim- files for following the Struma River, Mesta-Dospat River, Tundzha River, Maritza River and Arda-Biala River representing the scenarios:

- Prensent
- Near Future
- Near Future with 10 % loss
- High Priority Future
- High and Medium Priority Future

The difference between the sim-files for different scenarios is the selection Boundary file (se below). For description of these scenarios please see the MAIN REPORT and SUPPORTING REPORT of this project.

The appearance of that part of the user-interface of the sim-file, where the differences simulation files is selected, is shown in Figure 1.

The Network file, The Cross-section files and the HD-parameter file is not described in any details here in this section. Please refer to the guideline for the Hydrodynamic Model and the MIKE 11 Manual.

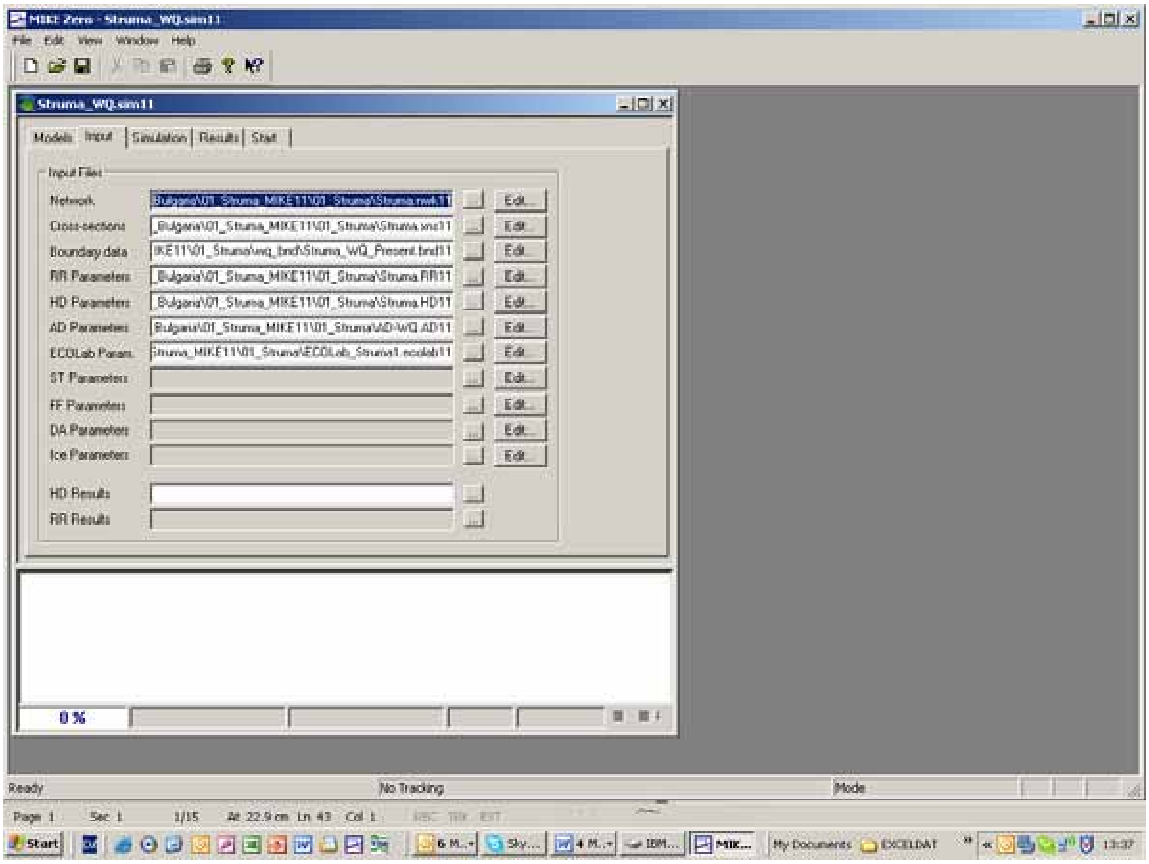


Figure 1 Example of simulation file (.sim11) where specific file is selected the model simulation.*

AD Parameters

When using the EcoLab water quality modelling facilities of MIKE 11 the only parameter that is to be specified in the AD parameter file is the Dispersion factor. Figure 2 shows an example of the user-interface where this value is specified. For the rivers in general are used a dispersion factor of 25. For some of the rivers local higher values have been used at a few most upstream calculation points in the rivers and at some structures within the rivers, e.g. weirs.

Specification of Components, initial condition and decay is not utilised. The initial (e.g. the start) concentrations as well as the components are specified in the EcoLab modelling file.

The <*Additional output*> facilities can be utilised by the model user it more information is desired together with the results. For utilisation of these facilities explore the software and consult the MIKE 11 manual.

The other features of the user interface for the AD Parameter file is not relevant in relation to MIKE 11.

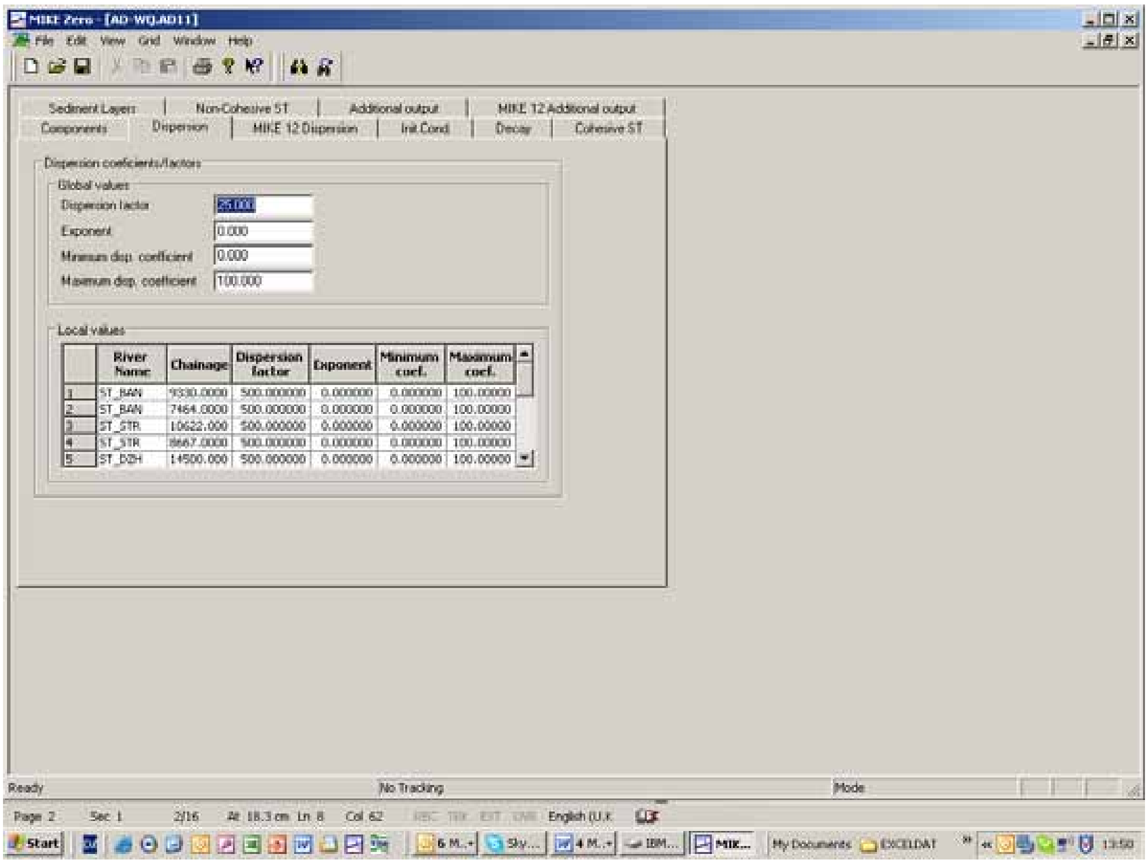


Figure 2 Example of AD Parameter file (.AD11) where dispersion factor is specified.*

Boundary data

Specification of the pollution load for the different scenarios (present situation and all future scenarios) is made in the boundary files name with the MIKE11 extension ".bnd11"

The user interface and editing menu for these files looks like the below in Figure 3 with an example from Struma river - present situation.

For each river is created 5 boundary files - one for each of the 5 scenarios.

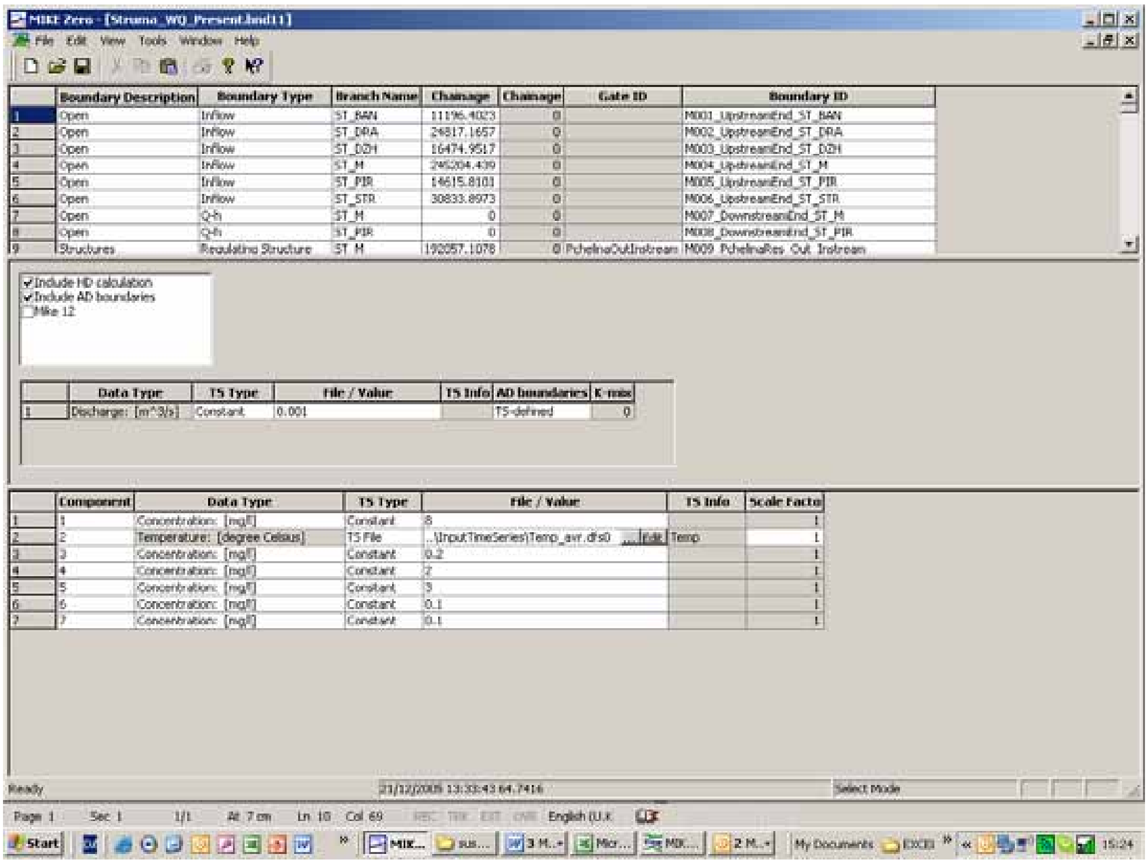


Figure 3 Example of user interface where open model boundaries as well as lateral inflow boundaries can be specified.

In this menu is specified where (river branch name and chainage) the inflow to the model/river occur.

For each inflow item the discharge and the concentration of pollutants is specified in the two windows in the second half of this menu.

For the pollutants in the lower part of the menu is the concentration for different component number specifies. These component numbers refer to the EcoLab template that is used. For the model set-up for these Bulgarian rivers the component number corresponds to the following substances:

Component 1 : Oxygen
Component 2: Temperature
Component 3: Ammonium-N

Component 4: Nitrate-N
Component 5: BOD
Component 6: Dissolved (ortho) phosphate-P
Component 7: Particulate-P

For additional description of the EcoLab template, the component and the processes transforming these components, please refer to the MIKE 11 manual and to the compendium with power point presentations given during the training course.

To the most left in the upper part of the boundary file editor you find *Boundary ID* – information.

This information has in the model set-up be organised and defined in a way that should facilitate the overview and future editing for creation of new scenarios.

Each group of boundaries have in the *Boundary ID* been given different recognisable code numbers together with a more common under stood identification name.

Model boundaries (M0001, M002, M00…)
The first boundary items concerns the inflow at the model boundary. All this type of boundaries starts with an **M** followed by a number and name, (ex.: M004_UpstreamEnd_ST_M).

These are primarily important for the upstream boundary, but values have also to be specified at down stream boundaries. However the inflows at the boundaries are in these set-ups general low and will not influence the simulated condition further down stream.

I addition there exist some internal boundaries defined in hydrodynamic model (MIKE 11 HD). These will not be comment further here. Refer to the HD set-up for additional information.

For most future scenarios **no changes** is to be made in these boundary items starting with **M**.

<u>A</u>bstractions (A001, A002, A00…)

The next group concerns the water abstraction. These are named with **A** followed by a number and a name, (ex.: A001_Abst_ST_ARK).

Most of these are outflows from the river as the nature of abstractions. The discharges at such boundaries are negative. However some are positive or periodically positive which mean inflow. Therefore concentration for these has as well been specified in the boundary files.

For none of the scenarios that have been defined and simulated within the project, these boundaries have been changed. It could however in future scenarios be relevant to change both the abstraction amount and in case the abstraction is positive (e.g. inflow to the river), it could also be relevant to change the concentrations.

<u>D</u>istributed <u>D</u>omestic Sources (DD001, DD002, DD0…)

The group of boundary item with Boundary ID named DD (followed by a number and a name (ex. DD006_Dis_ST_ELE) describe the distributed domestic pollution sources in the catchment (NAM-catchments).

Domestic population living outside the main villages and towns (e.g. individual houses and villages with less than 2000 persons) are included in the model as so called distributed domestic sources. The contribution from these is equally spread along the main river sections. These are general inserted with the MIKE 11 *Boundary Description*: *distributed source,* (see Figur 4). For this type of MIKE 11 boundaries there are required an upstream and downstream chainage between which the inflow is equally distributed. These chainages are typical up- and downstream chainage for inflow from each NAM-catchment.

However some of the boundaries with the Boundary ID "DD0… " are give in the model as MIKE11 Point sources. This is the case when the MAM catchment isn't distributed along a river stretch, but is inflowing in one point of the model. This will be the case for rivers which is not included as MIKE 11 river branches in the set-up but only represented by a NAM-catchment. Example is shown in Figure 2 for the items 55, 56 and 57 from the Struma River set-up.

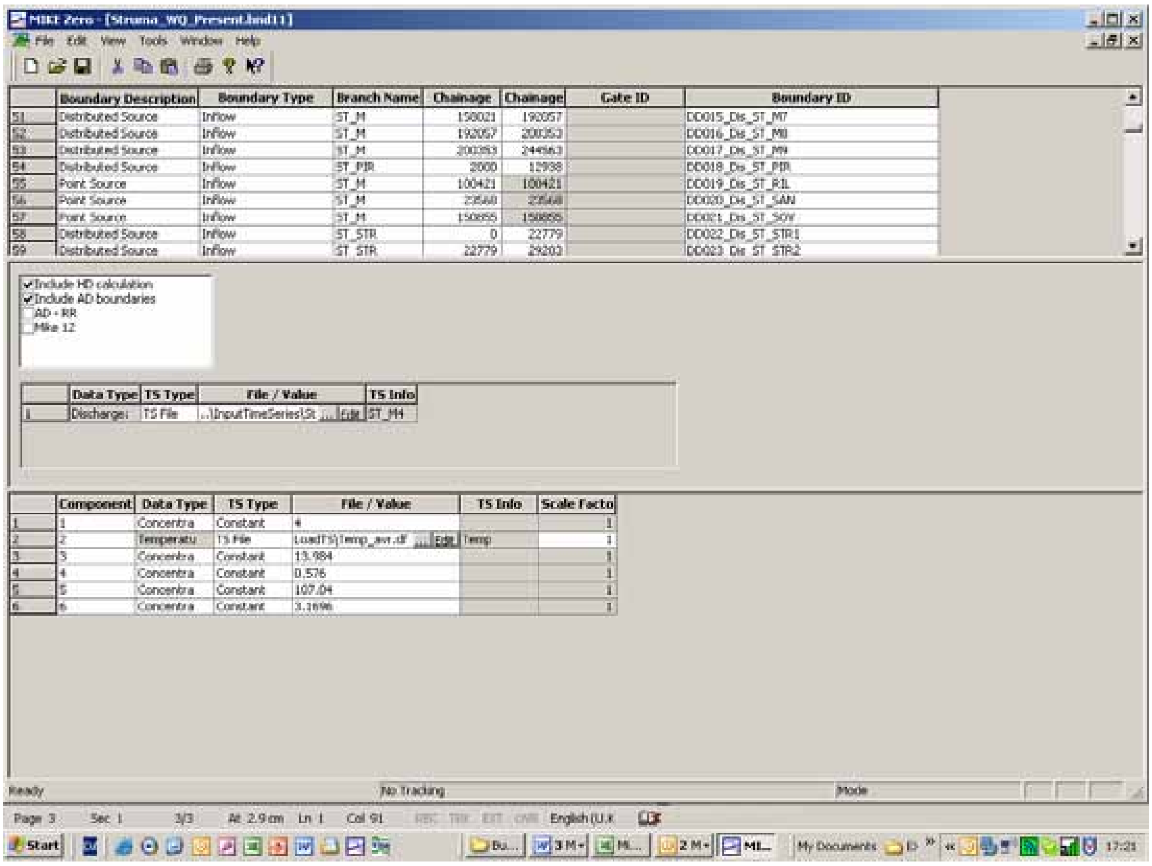


Figure 4 Example of user interface where lateral inflows from distributed domestic sources are specified.

The discharges used from these sources have been calculated based on statistical data and a unit amount of sewage water produced per person.

The concentrations have been estimated using unit pollution load per person for the individual components (variables) together with an assumed average loss percentage in the catchment its way form the pollution source to the river.

These pollution sources are one of the typical issues for editing when crating scenarios. This concerns both the discharge and the concentration. These data can furthermore to be updated when additional or improved information becomes available.

<u>D</u>omestic <u>P</u>oint Sources (DP001, DP002, DP0…)

Pollution from towns above 2000 person equivalents are given boundary IDs starting with **DP** followed by a number and a name (ex. DP009_Breznik). All theses sources are include with the MIKE 11 *Boundary Description: Point Source,* discharging into a specific chainage of a river branch. Examples hereof are given in Figure 5.

These pollution sources are typical subject for editing when crating scenarios. This concerns both the discharge and the concentration. These data furthermore to be updated when additional or improved information becomes available.

The pollution data from the town have been estimated primarily based information delivered the Bulgarian Environmental Executive Agency are based on resent monitoring data.

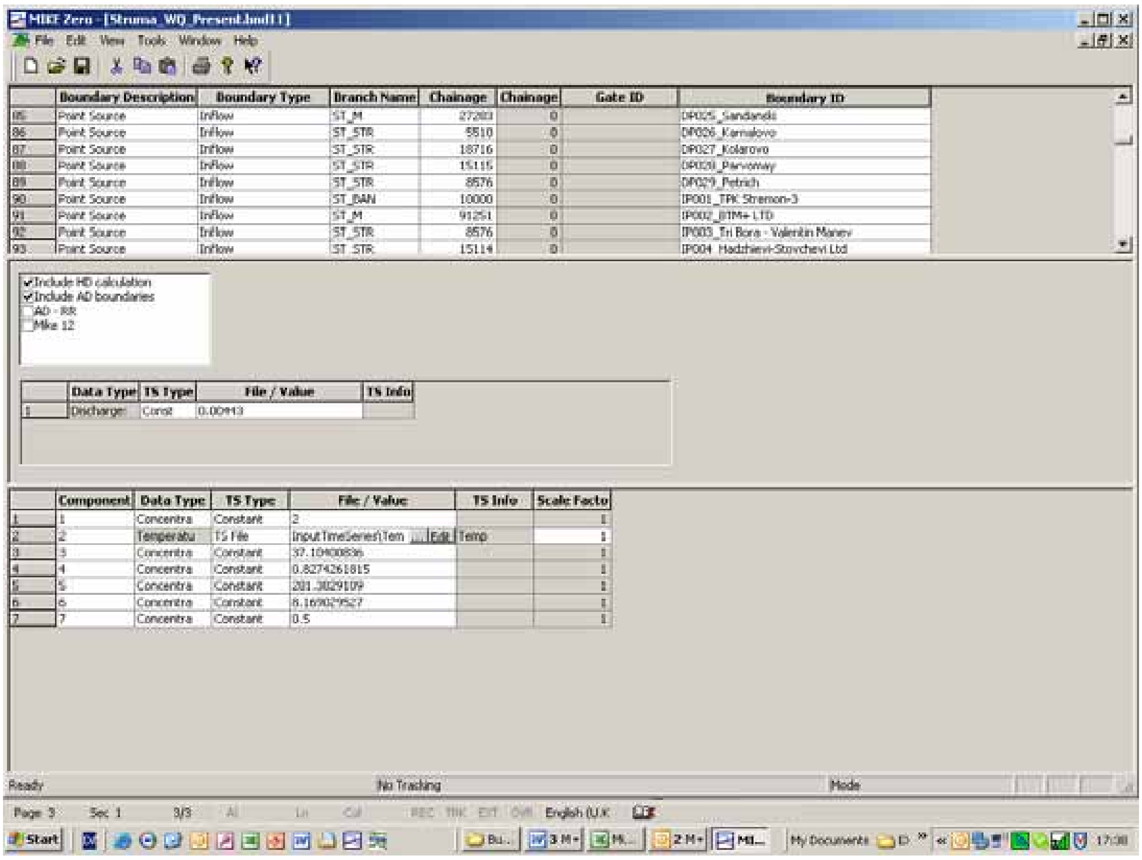


Figure 5 *Example of user interface where lateral inflows from domestic point sources and industrial point sources are specified.*

Industrial Point Sources (IP001, IP002, IP0…)
Pollution from industries are given boundary IDs starting with **IP** followed by a number and a name (ex. IP082_Dimankov SPLTD). All theses sources are include with the MIKE 11 *Boundary Description: Point Source,* discharging into a specific chainage of a river branch. Examples hereof are given in Figure 5.

These pollution sources are typical subject for editing when crating scenarios. This concerns both the discharge and the concentration. These data furthermore to be updated when additional or improved information becomes available. The data inserted in the model are primarily based on data delivered by EABD and WABD and based on a combination of monitoring data and licence information.

Agricultural Point Sources = Livestock Point Sources (XLSP01, XLSP02, XLSP0…)
The agricultural point sources such as livestock farms have been include individually according to the information that have been received from EADB and WADB.

The livestock farms are in the model included as MIKE 11 *Point sources* with the *Boundary ID* starting with the start letter of the river names (e.g. for Struma: **S**), followed by **LSP** (livestock point source), a number, a name and characterisation of the animal type, (for example: SLSP05 "Kembarou MM 5" JSCo – Pigs) – see Figure 6.

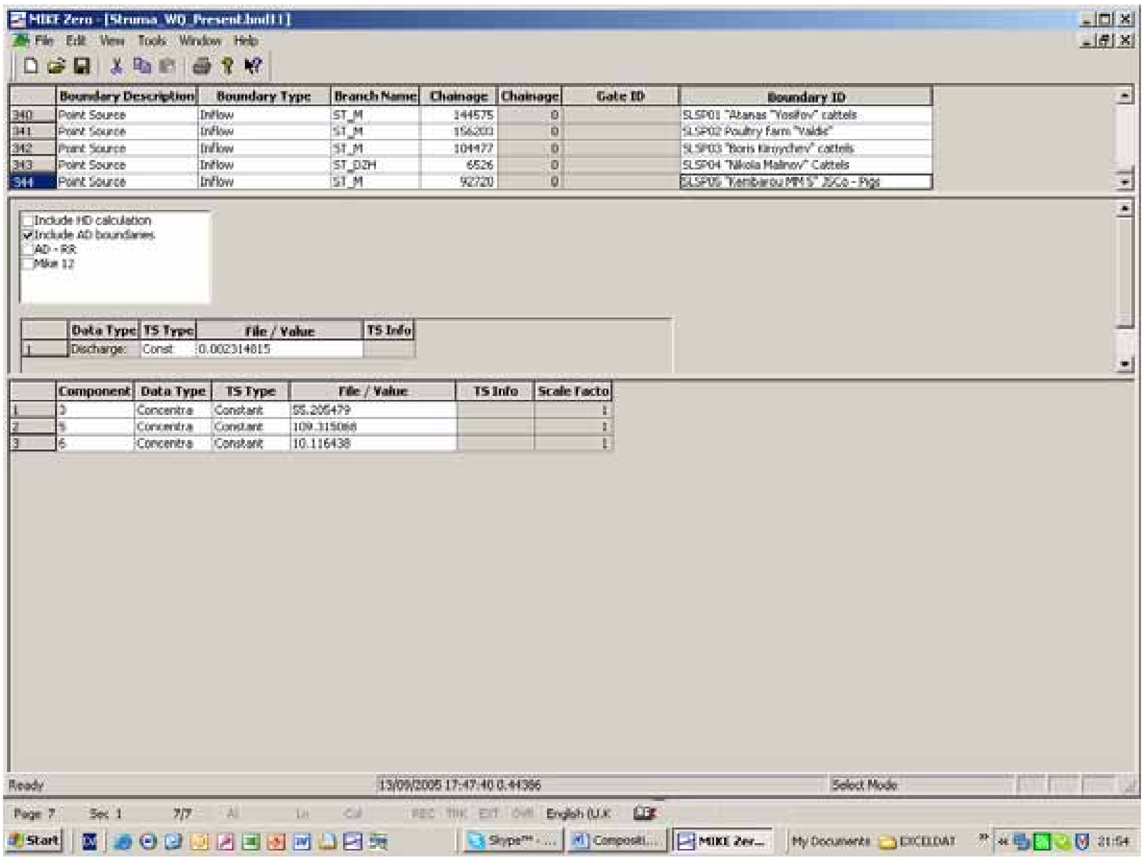


Figure 6 Example of user interface where lateral inflows from livestock point sources are specified.

Point sources - in general

Additional boundary items, with the MIKE 11 *Boundary Description: Point source,* can be inserted manual in the editing menu shown in Figure 4 - 6.

Alternatively the point sources can be created and edited for example an Excel spread sheet or a text file editor and copied into the MIKE 11 using the following facility.

Step 1: Create one point source boundary item of the type that is wanted to be copied in. Mark this with the curser.

Step 2: click on <*Tools*> in the command line menu of the MIKE11 window and select <*Copy/paste Boundary Condition*> – see Figure 7. Click and a new window will appear like Figure 8.

Step 3: Copy from for example an excel sheet with the same format as outlined in the “copy/paste Boundary Condition - window” and past into the window shown in Figure 8. When you hereafter close the Figure 8 window, the new boundary items will appear in the boundary editor/file.

Step 4: Check the unit. If the unit is not correct or as expected, then delete the inserted boundary items. Check and modify to necessary extent the values in the Excel file and repeat the procedure.

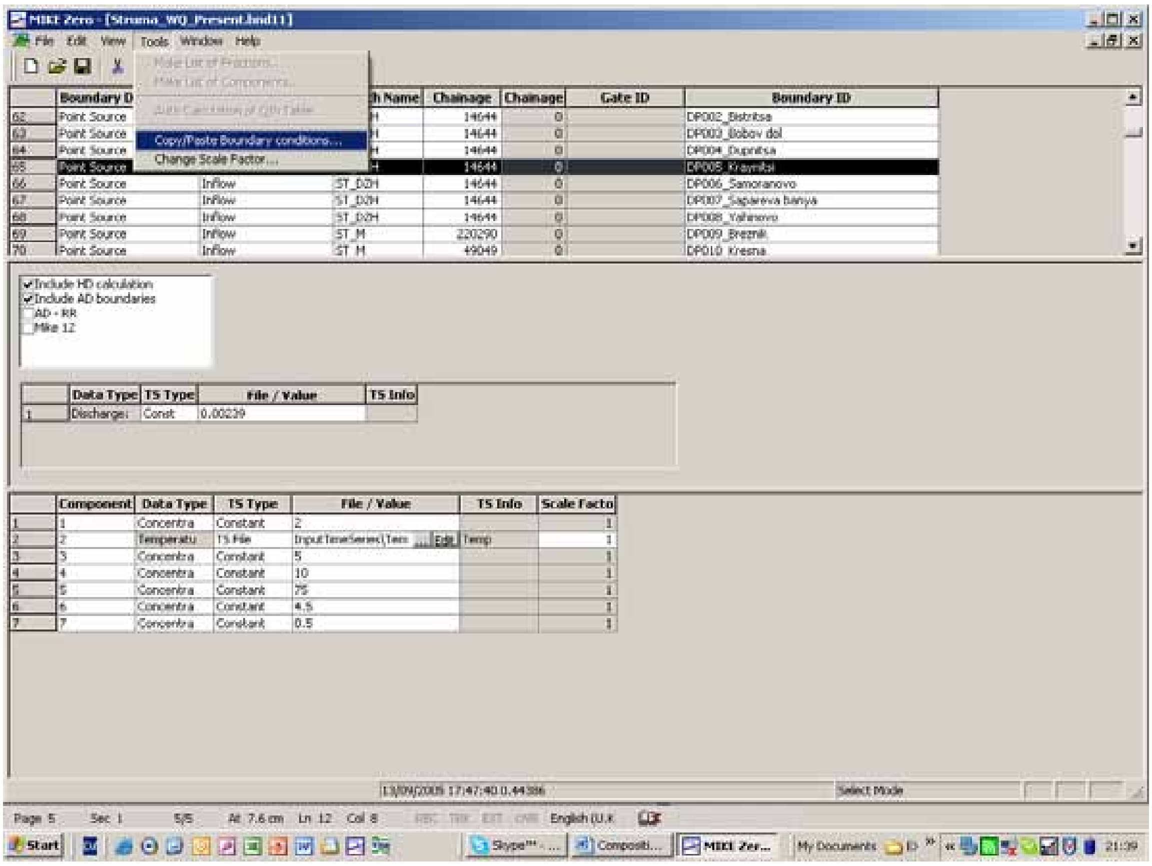


Figure 7 *Activation of facility for Copy/paste Boundary Condition*

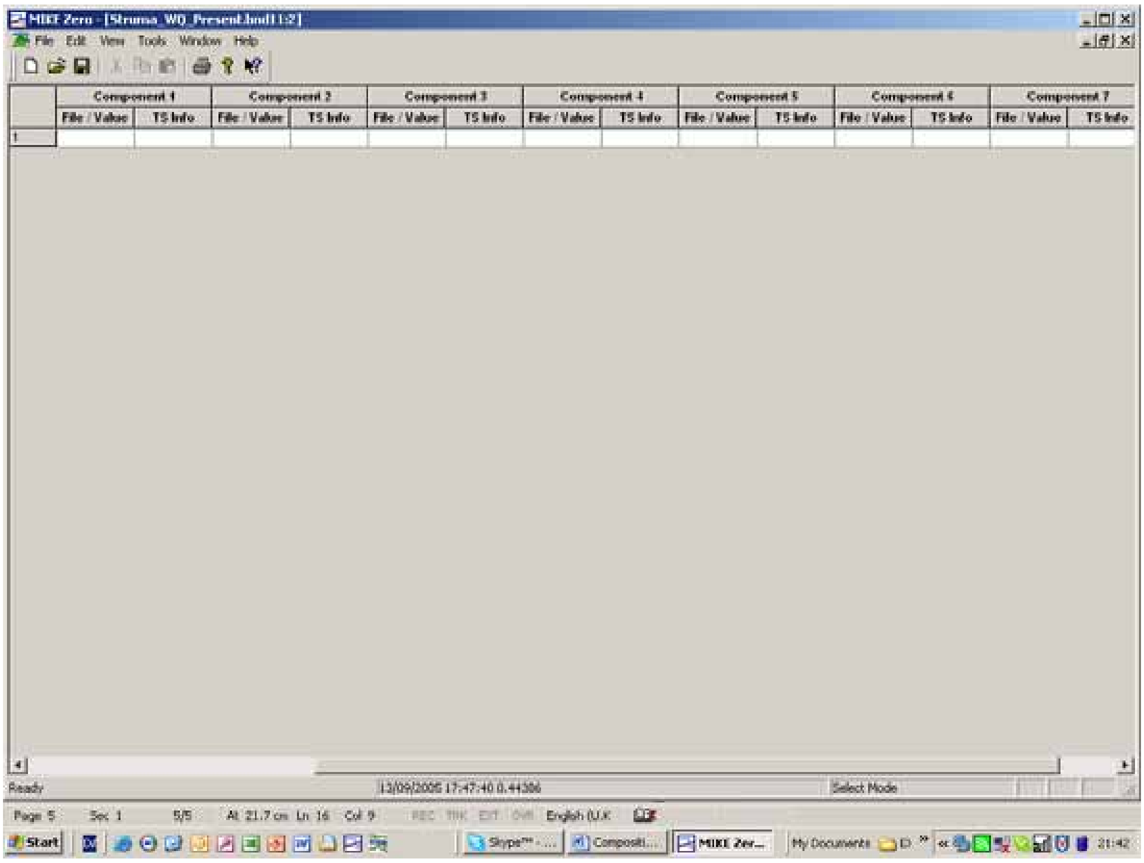


Figure 8 Copy/paste Boundary Condition – window.

Non-point sources

Non-point sources are in general flowing into the river branches together with the inflow from the Rainfall-Runoff / NAM catchments.

The water inflow has already been specified in the NAM-MIKE 11 HD interface. These inflow chainages can be seen from opening the network file (*.nwk11), click <*View*> and <*Tabular View*> from the MIKE 11 command line – (Please for additional information refer to the HD-model specification and the MIKE 11 manual).

Because the amount of water already is given form the NAM-MIKE11HD interface no water is to be specified for the non-point pollution – specification has only to be made for the pollutants (the AD components). This is ensured by activating (checking in) the AD-RR option in the second window of the menu. By doing so, the appearance of the editor will look some what like Figure 8.

Here you have to specify the name of the NAM-catchment, the area from which the inflow occurs the specific river stretch (specified in the top part of the boundary editor).

In addition the flow component from the Rainfall-Runoff/NAM model has to be used together with the following specified concentration has to be selected.

Following option for flow components can be selected:
Total runoff, Overland = Surface Runoff,
Interflow = Rootzone Runoff,
Baseflow = Groundwater Runoff,
Rainfall (directly on the water surface).
For additional information on these runoff options, please refer to the description of the Rainfall runoff / NAM Model and the MIKE 11 Manual.

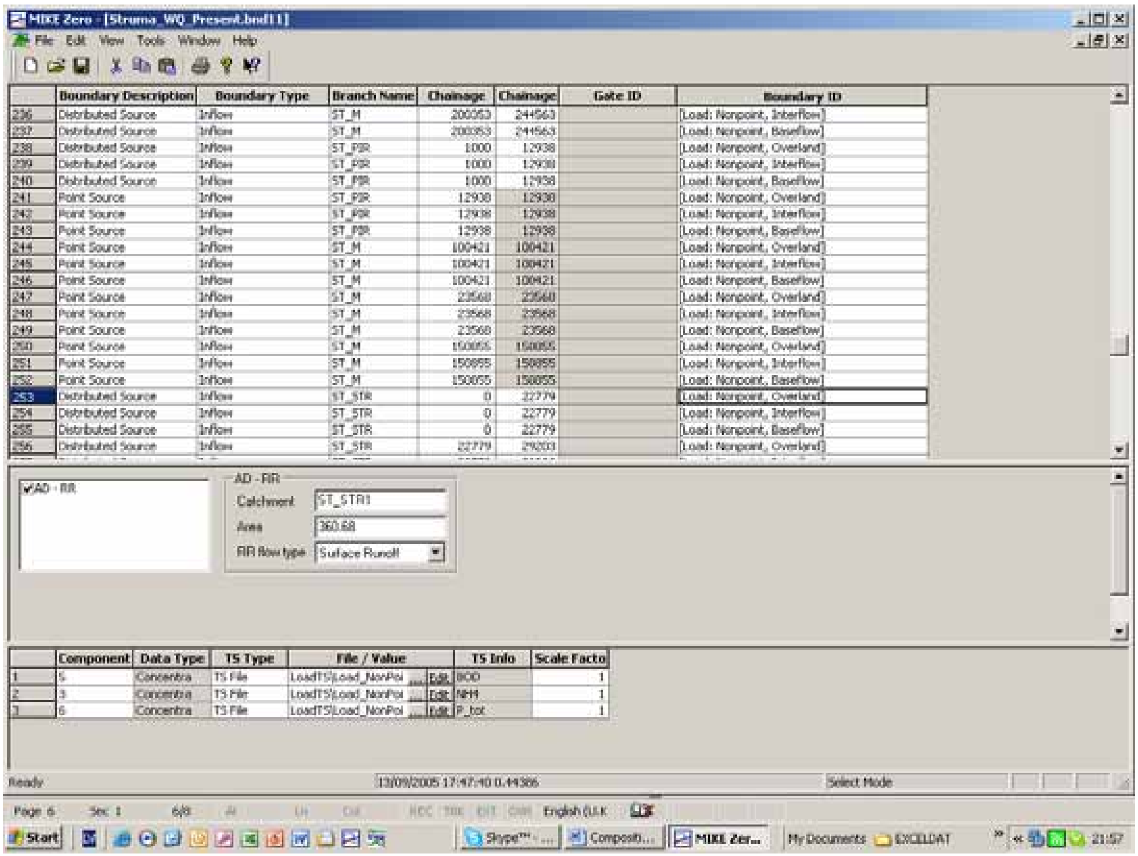


Figure 9 Example of specification of Non-point pollution together with inflow from NAN catchment. (The inflow of water is described by the Rainfall-Runoff MIKE11DH interface- see the MIKE 11 Manual)

In the model set-up for the Bulgarian rivers non-point sources with two groups of *Boundary ID* have been used as shown in Figure 9 and 8:

[Load: Nonpoint, Baseflow]
[Load: Nonpoint, Overland]
[Load: Nonpoint, Interflow]

[Load: Nonpoint, Overland]-fertil
[Load: Nonpoint, Interflow]-fertil
[Load: Nonpoint, Baseflow]-fertil

The boundary items with the *Boundary ID*
[Load: Nonpoint, Baseflow]
[Load: Nonpoint, Overland]

includes the pollution from non-point contribution from livestock. This has been based on statistical information on livestock density, unit load from the different types of animal and a runoff coefficient of 5 %.

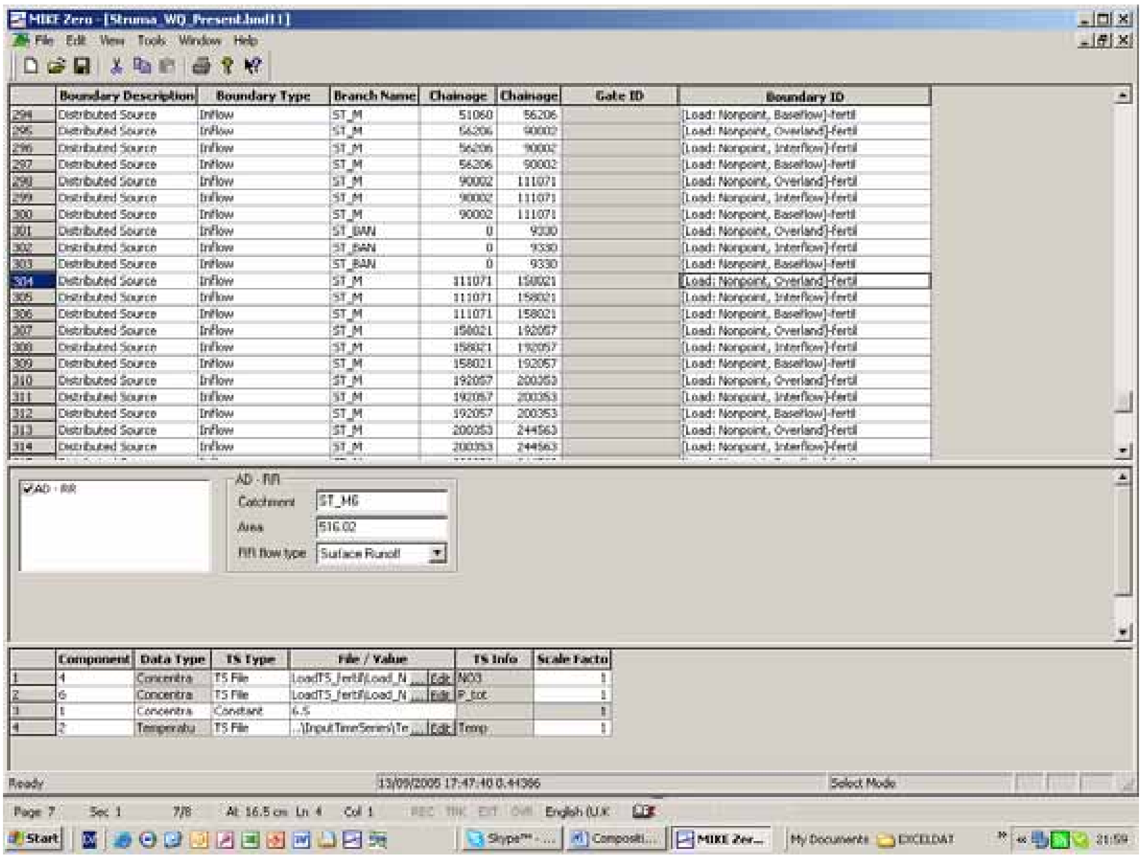


Figure 10 Example of specification of Non-point pollution fro the use of fertiliser together with inflow from NAN catchment. (The inflow of water is described by the Rainfall-Runoff MIKE11DH interface- see the MIKE 11 Manual).

The boundary items with the *Boundary ID*
[Load: Nonpoint, Interflow]

Includes the inflow of different potential pollution components with the groundwater.

The boundary items with the *Boundary ID*
[Load: Nonpoint, Overland]-fertil
[Load: Nonpoint, Interflow]-fertil

includes the potential pollution components from the use of fertilisers. The use of fertiliser is from statistical data. The amounts and concentrations discharged into the rivers have been estimated using a runoff coefficient of 10 %.

The boundary items with the *Boundary ID*
[Load: Nonpoint, Baseflow]-fertil

Include oxygen concentration and temperature assumed in the groundwater. The name “-fertile” is therefore misleading as it has noting to do with fertilisers. The values have only been inserted here under this name due to practical and pragmatic reasons.

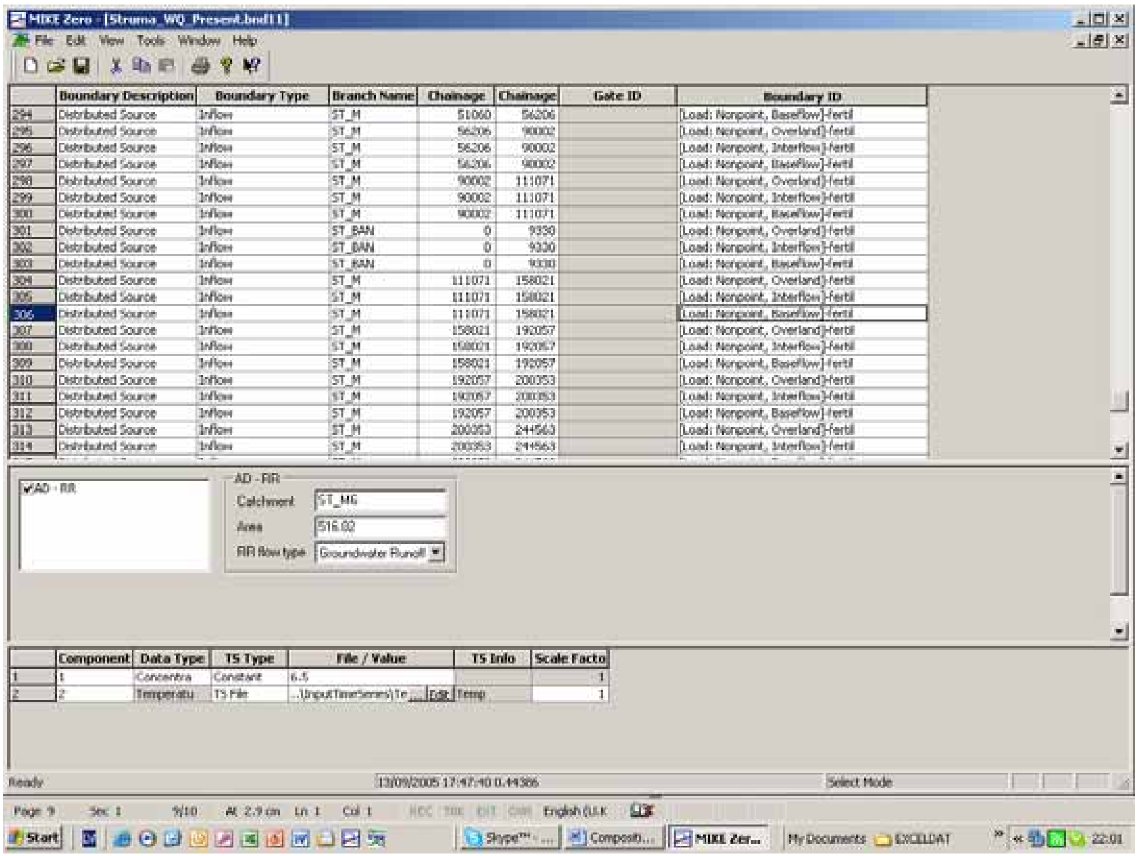


Figure 11 Example of specification of temperature and oxygen content of groundwater inflow from NAN catchment. (The inflow of water is described by the Rainfall-Runoff MIKE11DH interface- see the MIKE 11 Manual).

Creation of Non Point Boundary conditions (items) using LOAD CALCULATOR

The non point boundary conditions can be edited directly in the *.bdn11 file described above. However MIKE BASIN (which is delivered to the EABD and WABD together with the MIKE 11 software) includes a tool for assisting in quantification of the non-point load to different river stretches in a MIKE 11 set-up. This facility has been used for distribution of the non-point livestock pollution and the fertiliser runoff along the MIKE 11 branches. The result hereof is illustrated above. It is not necessary to use this facility for changing the load and create input to new scenarios. This can be done directly in the MIKE 11 Boundary Editor described above.

It is not the intention here to give a detailed introduction to the LOAD CALCULATOR, which is a DHI produces ArcGIS-extension. Please refer to the available manual etc. that follows with the software.

The following description only outlines how the software has been used for the model set-up in these specific cases.

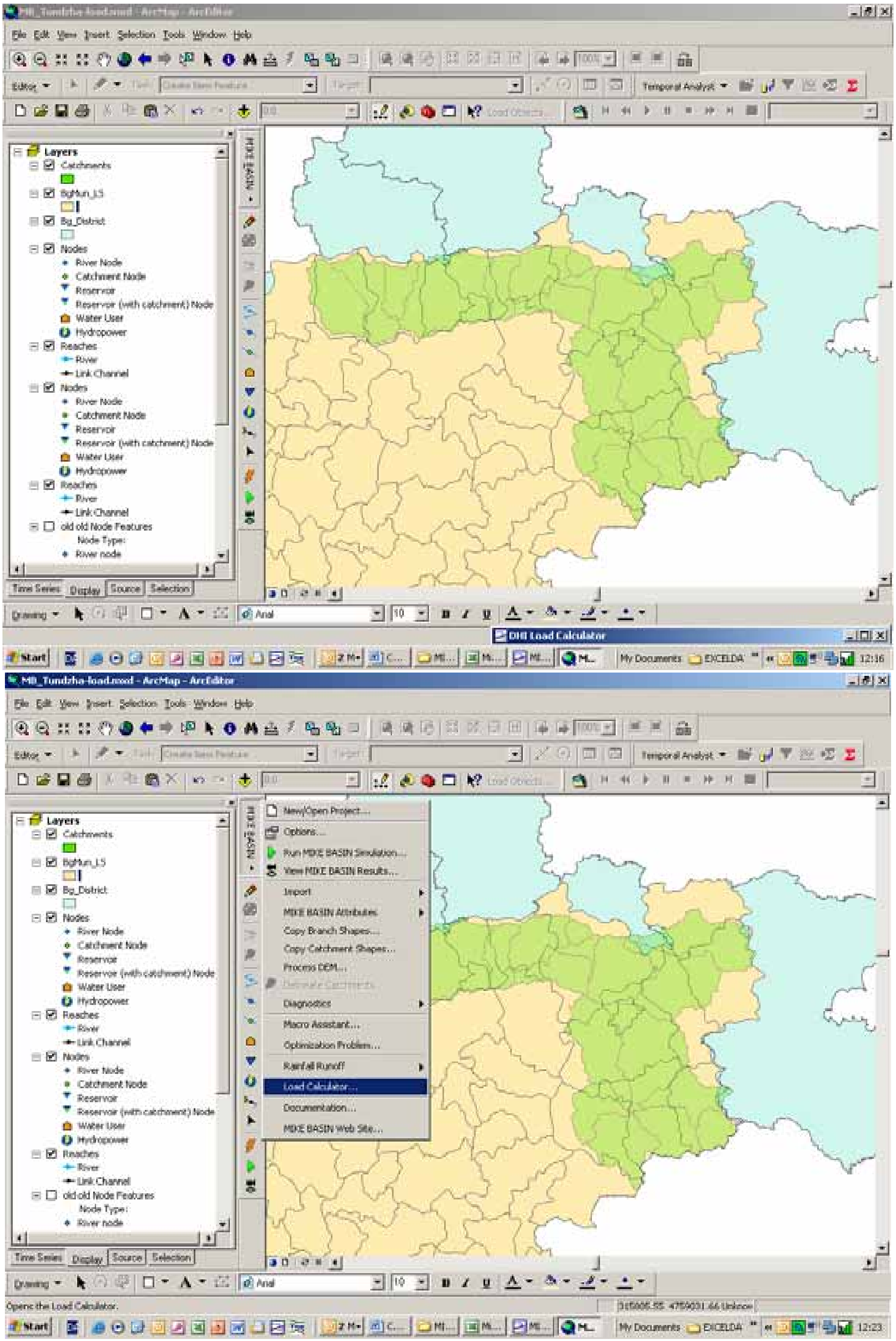


Figure 12 MIKE BASIN - LOAD CALCULATOR. Example: Tundzha.

The NAM-catchment is transfer into MIKE Basin catchment type (through a standard ArcGIS procedure).

The NAM catchment layer is opened in ArcGIS /MIKE BASIN. An ArcGIS layer with information of the Livestock density or Fertiliser use in different areas is opened. These layers do not need to have the same resolution. An example where the livestock layer and the NAM catchment for Tundzha have been opened is shown in Figure 12.

By mouse click on MIKEBASIN will open the MIKEBASIN menu (Figure 12,lower), from where the Load Calculator can be activated (Figure 13).

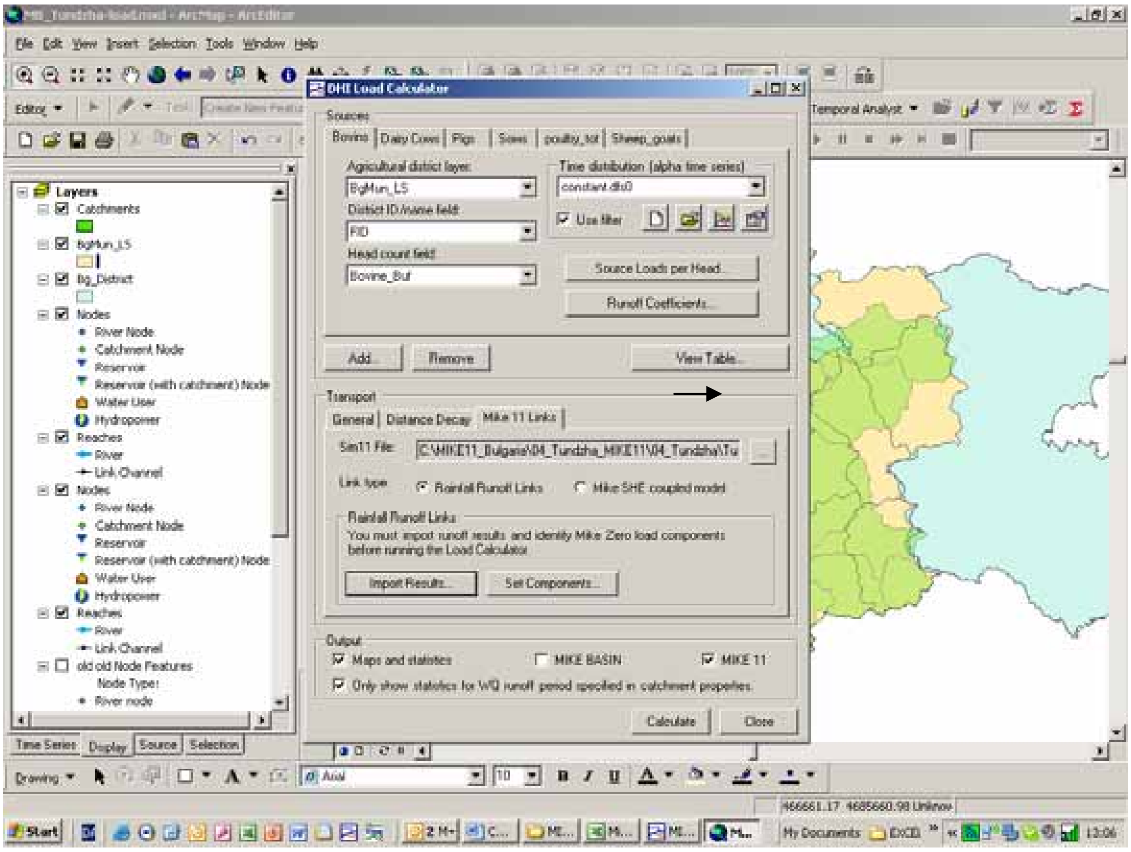


Figure 13 DHI Load Calculation menu. Example: Tundzha Livestock set-up.

The DHI LOAD CALCULATOR is now open for editing (Figure 13). In this example the livestock layer (BGMun_LS) is specified. Fields and values in the attribute table have to be selected for the different species of animals. For more details, please consult the set-up of the LOAD CALCULATOR for the individual rivers and the manual and information that follow with the software. (Information can also be achieved from DHI homepage: www.dhigroup.com).

Mouse click on the <*View table*> (→ in Figure 13) gives an overview of unit pollution load data used for the estimation of the non-point load (Figure 14).

Click on <*Import Result*> (Figure 13) and browse for the relevant NAM-results.

Click on <*Set component*> (Figure 13) and set the component correct according to the used ECOLab model.

Ensure that <*MIKE11*> in checked in the lower right corner of the DHI Load Calculator window.

Browse for the correct MIKE 11 sim-file. Select the MIKE 11 sim-file with the boundary file where the new boundary items have to be added.

Press <*Calculate*> and the boundary item is added to the selected MIKE 11 boundary file.

It is highly recommended carefully to consult the LOAD CALCULATOR manual and explore the different opportunities before creation of scenarios by using the described facility. You will find a lot of possibilities, which among other includes option for time varying outflow for the non-point source over the year, changes in runoff coefficients, option for specification of decay within the catchments and concentration in groundwater inflow etc.

In addition to the inserting of the boundary items into the MIKE11 boundary file the LOAD CALCULATOR also give the calculated yearly load from each NAM catchment. Example is shown in Figure 15. The results can be exported to dbf-files and Excel-files.

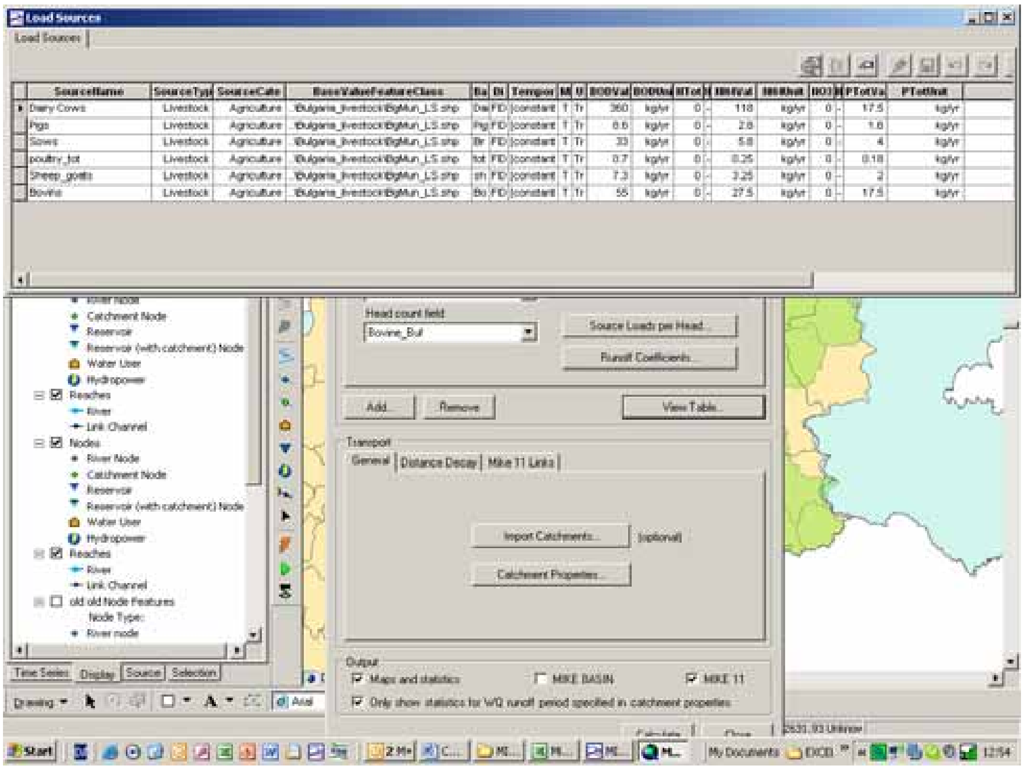


Figure 14 Example of the unit load used for livestock in the Tundzha catchments.

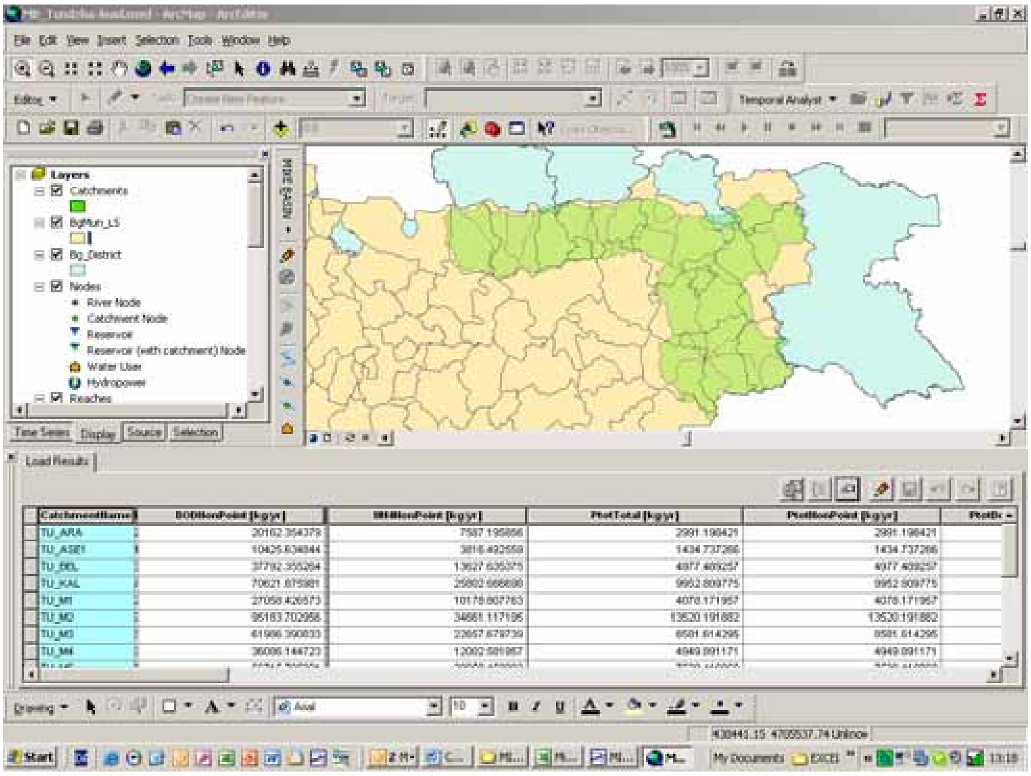


Figure 15 Example on simulated yearly load from domestic livestock in Tundzha River Basin.

The LOAD CALCULATOR set-up for the Bulgarian catchments can be launched from the directories named “MIKE_*rivername*_LoadCal” by loading the “MB_*rivername*_load.mxd” files into MIKE BASIN / ArcGIS. Using the geodatabase “MB_*rivername*_load.mdb” will activate the set-up for calculation of the non-point load from the livestock. Using the geodatabase “MB_*rivername*_load-fertile.mdb” will activate the set-up for calculation of the non-point load from the use of fertiliser.

ECOLab parameter file (water quality model)

The water quality model used is specified through the *.ecolab11 files. Theses are as the other modelling files specified in the *sim11 file (Figure 1).

From the MIKE 11 software different predefined types of water quality models (model templates) can be selected as described in the MIKE 11 Manual.

For the Bulgarian Rivers the templates have been slightly modified for the description of condition in the specific rivers. Please consult the delivered model set-ups for specification of the template used for the individual rivers.

The modified ECOLab templates are found the directory: “C:¥MIK11_Bulgaria_WQ-template”

Figure 17 illustrates the variables that are described by the models. The parameters (variables) shown in Figure 17 are stores in MIKE 11 result files named *.res11, where as the parameters (variables) shown in Figure 18 are stored in result files named *Add.res11. The Total BOD is calculated as the BOD from pollution sources plus the BOD from background contribution (~1mg/l).

The result files are viewed using the MIKE 11 software *MIKE VIEW.* For information of using this software please consult the MIKE 11 Manual.

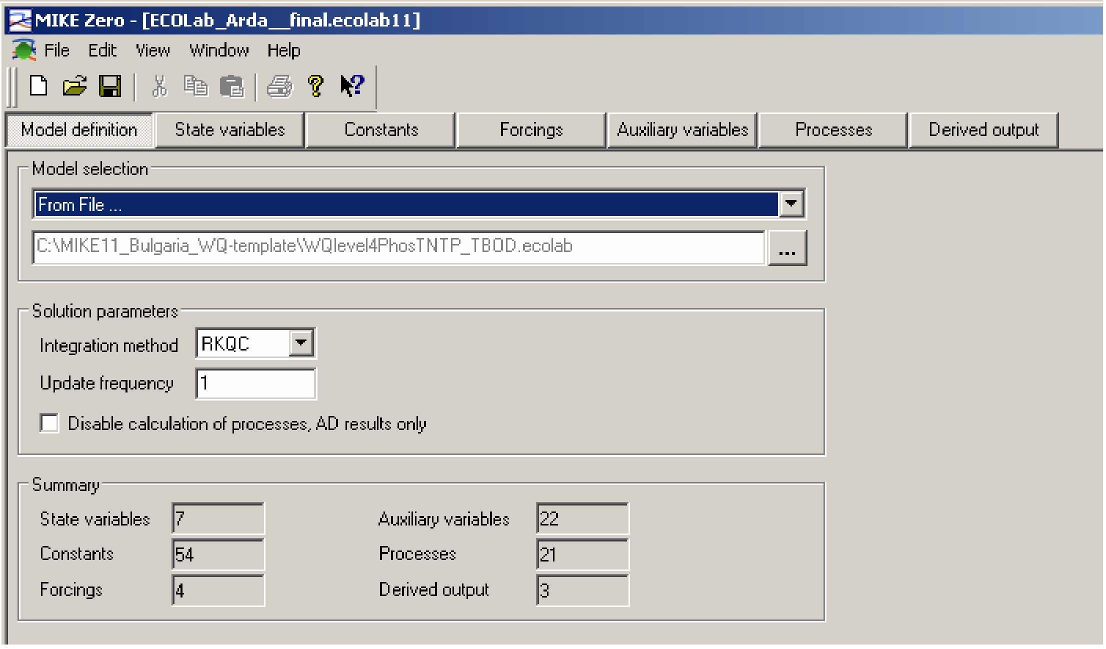


Figure 16 *User interface of the ECOLab Parameter file*

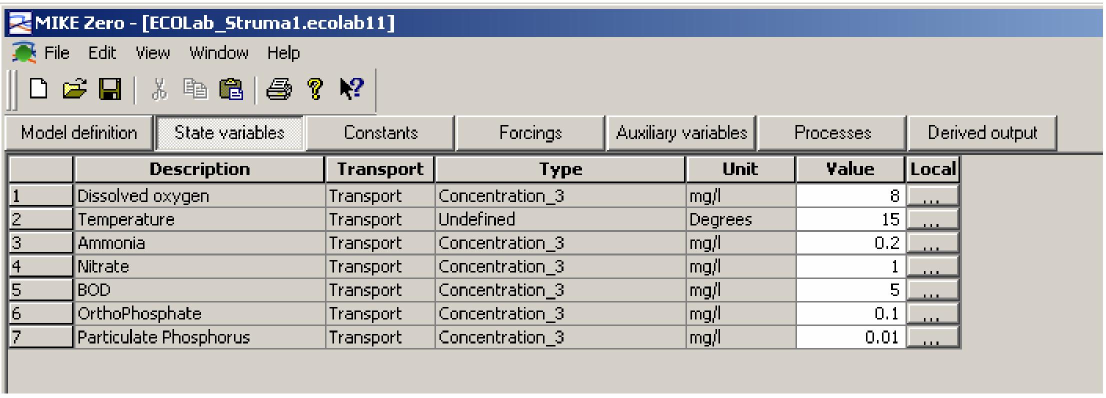


*Figure 17 Parameters (State variables) that are simulated by the models. In the column values the start (initial) values are set. They are stored in result file named *.res11*

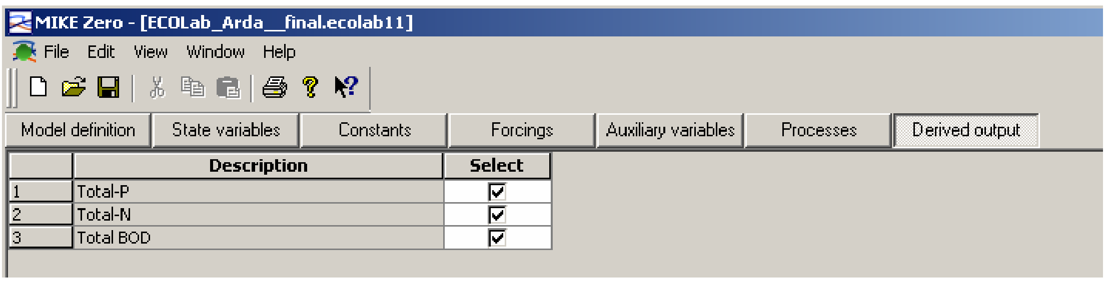


*Figure 18 Additional Parameters (derived output) that are simulated by the models. They are stored in result file named *Add.res11 when they are checked as shown here.*

Annex 7

Manual

for

Simple Model_ver_Permit

(A Simple Water Quantity Assessment Tool)

JICA Study Team

1. General

Simple Model_ver_Permit is prepared to examine the effect of permitted water amount on water quantity condition in rivers. By imputing permission data, the model can summarize the total permitted water quantity at observation points.

There are two versions for Simple Model_ver_Permit.

- Version 1: Simple Model_ver_Permit
- Version 2: Simple Model_ver_Permit2

In Version1, the model gives the following two results, together with existing flow condition during 2001-2005.

- Local (Permitted water abstraction from local water object) + Existing water abstraction from significant reservoir
- Local (Permitted water abstraction from local water object) + Permitted water abstraction from significant reservoir

In Version2, the following result can be compared with expected flow conditions for several probabilistic precipitation conditions.

- Local (Permitted water abstraction from local water object) + Permitted water abstraction from significant reservoir

The quasi-natural, potential with significant reservoir, disturbed flows for the existing condition during 2001-2005 and the expected probabilistic condition are estimated by other versions, Simple Model_ver_Exsiting and Simple Model_ver_Potential, which have been also prepared by JICA Study Team. The ver_Permit just utilizes those results. The comparison between the permitted water quantity and the quasi-natural, potential with significant reservoir, disturbed flows may give an idea on strategy for river management. However, even if there are no data for quasi-natural, potential with significant reservoir, disturbed flows, calculation of total amount of permitted water at observation points is possible and it may give also valuable information for river managers.

The main features are as follows:

- Entering permission data for HPP, IRR, DWS, IWS
- Selection of reference points for management
- Summary table for annual average and average during summer time (Jul. to Sep.) for year 2001 -2005 for each catchment/segment and reference point
- Longitudinal plot of the summarized results along main channel
- Time series plot for each reference point and/or catchment/segment
- Globally and locally changeable coefficient for permitted water amount
- Preparation of an input file related to local water abstraction for each NAM catchment for MIKE11 water quantity model prepared by JICA Study Team

This manual is written for “Simple Model_ver_Permit”. Operation of “Simple Model_ver_Permit2” is same as “Simple Model_ver_Permit”. Only presentation of results is different.

2. Definition of terms

In this model, the following definition is used.

- **Quasi-Natural Flow**
  - Flow without disturbance such as abstraction, discharge, transfer
  - Likely natural, however, not exactly natural.
  - In the model, regime change of local reservoir is not taken into account.
- **Potential Flow with Significant Reservoir**
  - Flow with influence of significant reservoir, including transfer from and to a reservoir, but no abstraction of water
  - Potentially usable water amount after regime change by significant reservoir
- **Disturbed Flow**
  - Existing condition
  - Potential Flow – Total abstracted water + Total discharged water

Abbreviation

HPP:	Hydro Power Plant
IRR:	Irrigation (Note: Irrigation water use includes only water for Irrigation area managed by Irrigation Systems)
DWS:	Drinking Water Supply
IWS:	Industrial Water Supply (Note: Industrial Water supply includes agricultural and fish breeding water use)
S_Res:	Significant Reservoir
NAM Catchment:	Catchment for NAM (Rainfall-Runoff) model
NF:	Quasi-Natural Flow
PF:	Potential Flow with Significant Reservoir
DF:	Disturbed Flow

3. Remarks for treating Excel sheet in the model

The model just utilizes excel spread sheets and macros. Some sheets are hidden, because the hidden sheets are usually not necessary to be edited by users. If you want to see the hidden sheets, please do the followings.

Format -> Sheet -> Unhide
Then, select the sheets you want to open.

In each spread sheet, you may see cells with different colors. The meaning of the colors is as follows.

White: User can edit
Light blue: Value in cell is automatically calculated.
Yellow: Value in cell is calculated by macros.

DO NOT edit the cells with light blue and yellow. If you change it, the model will give wrong results.

4. Model Outline

1) Struma River

File Name:

Struma_WaterBalance_Permit.xls

Struma_WaterBalance_Permit2.xls

Number of catchment = 104

Number of NAM catchment = 25

2) Mesta & Dospat River

File Name:

Mesta&Dospat_WaterBalance_Permit.xls

Mesta&Dospat_WaterBalance_Permit2.xls

Number of catchment = 75

Number of NAM catchment = 14

3) Arda & Biala River

File Name:

Arda&Biala_WaterBalance_Permit.xls

Arda&Biala_WaterBalance_Permit2.xls

Number of catchment = 69

Number of NAM catchment = 12

4) Tundzha River

File Name:

Tundzha_WaterBalance_Permit.xls

Tundzha_WaterBalance_Permit2.xls

Number of catchment = 84

Number of NAM catchment = 19

5) Maritsa River

File Name:

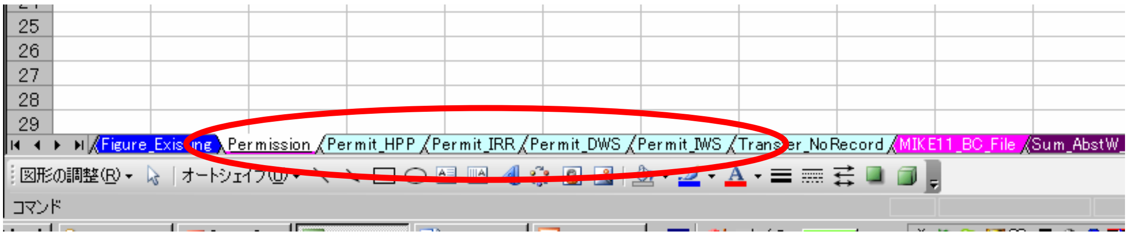
Maritsa_WaterBalance_Permit.xls

Maritsa_WaterBalance_Permit2.xls

Number of catchment = 251

Number of NAM catchment = 34

5. Input of permission data

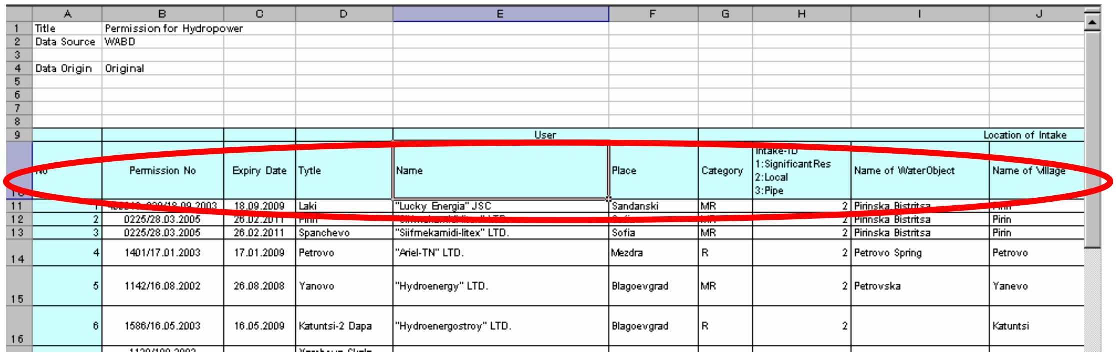


You can see the following five tabs for input of permission data.

1) Permit_HPP
2) Permit_IRR
3) Permit_DWS
4) Permit_IWS
5) Transfer_NoRecord

(1) HPP

Input necessary data according to the items shown in Line10.



	A	B	C	D	E	F	G	H	I	J
1	Title	Permission for Hydropower								
2	Data Source	WABD								
3										
4	Data Origin	Original								
9					User					Location of Intake
10	No	Permission No	Expiry Date	Tytle	Name	Place	Category	Intake-ID 1:Significant Res 2:Local 3:Pipe	Name of WaterObject	Name of Village
11	1	[illegible]	18.09.2009	Laki	"Lucky Energia" JSC	Sandanski	MR	2	Pirinska Bistritsa	[illegible]
12	2	0225/28.03.2005	26.02.2011	Pirin	[illegible]	[illegible]	[illegible]	2	Pirinska Bistritsa	Pirin
13	3	0225/28.03.2005	26.02.2011	Spanchevo	"Siifmekamidi-litex" LTD.	Sofia	MR	2	Pirinska Bistritsa	Pirin
14	4	1401/17.01.2003	17.01.2009	Petrovo	"Ariel-TN" LTD.	Mezdra	R	2	Petrovo Spring	Petrovo
15	5	1142/16.08.2002	26.08.2008	Yanovo	"Hydroenergy" LTD.	Blagoevgrad	MR	2	Petrovska	Yanevo
16	6	1586/16.05.2003	16.05.2009	Katuntsi-2 Dapa	"Hydroenergostroy" LTD.	Blagoevgrad	R	2		Katuntsi

You must al least input the following data.

Location of Intake : Intake-ID (column H)
Location of Intake : Catchment-ID (column N)
Location of Discharge : Catchment-ID (column T)
WaterUse : Permitted Amount (m3/s) (column X)
WaterUse : Permitted Annual Volume (10^6 m3) (column Y)
WaterUse : Local Coefficient for Permission (column AC)

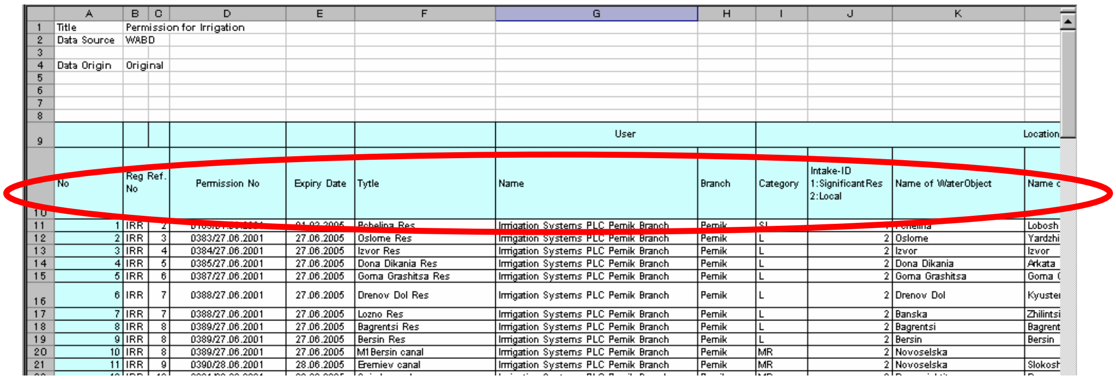
By changing *Local Coefficient for Permission,* you can examine the effect of permitted amount for each one of permissions.

The calculated water used will be:

(Permitted amount) x (Global Coefficient) x (Local Coefficient)

(2) IRR

Input necessary data according to the items shown in Line10.



	A	B	C	D	E	F	G	H	I	J	K	L
1	Title	Permission for Irrigation										
2	Data Source	WABD										
3												
4	Data Origin	Original										
5												
6												
7												
8												
9							User					Location
10	No	Reg Ref. No		Permission No	Expiry Date	Tytle	Name	Branch	Category	Intake-ID 1:Significant Res 2:Local	Name of WaterObject	Name o
11	1	IRR	2	[illegible]	[illegible]	Pchelina Res	Irrigation Systems PLC Pernik Branch	Pernik	SL	[illegible]	[illegible]	Lobosh
12	2	IRR	3	0383/27.06.2001	27.06.2005	Oslome Res	Irrigation Systems PLC Pernik Branch	Pernik	L	2	Oslome	Yardzhi
13	3	IRR	4	0384/27.06.2001	27.06.2005	Izvor Res	Irrigation Systems PLC Pernik Branch	Pernik	L	2	Izvor	Izvor
14	4	IRR	5	0385/27.06.2001	27.06.2005	Dona Dikania Res	Irrigation Systems PLC Pernik Branch	Pernik	L	2	Dona Dikania	Arkata
15	5	IRR	6	0387/27.06.2001	27.06.2005	Goma Grashitsa Res	Irrigation Systems PLC Pernik Branch	Pernik	L	2	Goma Grashitsa	Goma (
16	6	IRR	7	0388/27.06.2001	27.06.2005	Drenov Dol Res	Irrigation Systems PLC Pernik Branch	Pernik	L	2	Drenov Dol	Kyuster
17	7	IRR	7	0388/27.06.2001	27.06.2005	Lozno Res	Irrigation Systems PLC Pernik Branch	Pernik	L	2	Banska	Zhilintsi
18	8	IRR	8	0389/27.06.2001	27.06.2005	Bagrentsi Res	Irrigation Systems PLC Pernik Branch	Pernik	L	2	Bagrentsi	Bagrent
19	9	IRR	8	0389/27.06.2001	27.06.2005	Bersin Res	Irrigation Systems PLC Pernik Branch	Pernik	L	2	Bersin	Bersin
20	10	IRR	8	0389/27.06.2001	27.06.2005	M1 Bersin canal	Irrigation Systems PLC Pernik Branch	Pernik	MR	2	Novoselska	
21	11	IRR	9	0390/28.06.2001	28.06.2005	Eremiev canal	Irrigation Systems PLC Pernik Branch	Pernik	MR	2	Novoselska	Slokosh

You must al least input the following data.

User : Branch (column H)

Location of Intake : Intake-ID (column J)

Location of Intake : Catchment-ID (column P)

WaterUse : Permitted Amount (m3/s) (column R)

WaterUse : Permitted Annual Volume (10^6 m3) (column S)

WaterUse : Local Coefficient for Permission (column U)

By changing *Local Coefficient for Permission,* you can examine the effect of permitted amount for each one of permissions.

The total calculated water abstraction per year will be:

(Permitted Annual Volume) x (Global Coefficient) x (Local Coefficient)

In case of irrigation, water abstraction pattern within a year will be given based on actually used water for each one of Irrigation Branches in 2001-2005. The data for actually used water was obtained from Irrigation Systems.

Spatial pattern of water use within an Irrigation branch is assumed to be proportional to the permitted amount for each one of permissions.

(3) DWS

Input necessary data according to the item shown in Line10.

	A	B	C	D	E	F	G	H	I	J	K	L
1	Title	Permission for DrinkingWater										
2	Data Source	WABD										
3												
4	Data Origin	Original										
5												
6												
7												
8												
9						User		Location of Intake				
10	No	Reg Ref. No		Permission No	Expiry Date	Name	Place	Category	Intake-ID 1:SignificantRes 2:Local	Name of WaterObject	Name of Village	Municipality
11	1	DI	3	0323/28.05.2001	4.1.1900	WSSC Ltd. Pernik	Pernik	R	2	Matnitsa Struma	Pernik	Pernik
12	2	DI	3	0323/28.05.2001	4.1.1900	WSSC Ltd. Pernik	Pernik	R	2	Siva Gramada Eryak	Breznik	Breznik
13	3	DI	4	0331/04.06.2001	04.06.2011	WSSC Private Ltd. Dupnitsa	Dupnitsa	MR	2	Dupnishka Bistritsa	Bistritsa	Dupnitsa
14	4	DI	6	0375/25.06.2001	25.06.2003	UVEKS Private Ltd. Sandanski	Sandanski	R	2	Bozhdovska	Bozhdovo	Sandanski
15	5	DI	7	0403/10.02.2003	10.02.2003	WSSC Private Ltd. Dupnitsa	Dupnitsa	R	2		Samoranovo	Dupnitsa
16	6	DI	7	0403/10.02.2003	10.02.2003	WSSC Private Ltd. Dupnitsa	Dupnitsa	R	2		Kraynitsi	Dupnitsa
17	7	DI	7	0403/10.02.2003	10.02.2003	WSSC Private Ltd. Dupnitsa	Dupnitsa	R	2		Kremenik	Dupnitsa
18	8	DI	8	0462/23.07.2001	23.07.2004	WSSC Private Ltd. Breznik	Breznik	L	2	Krasava	Krasava	Breznik
19	9	DI	12	0640/15.11.2001	15.11.2007	WSSC Private Ltd. Kresna	Kresna	MR	2	Vlahinska		Kresna
20	10	DI	15	0877/16.05.2002	16.05.2008	WSSC Private Ltd. Dupnitsa	Dupnitsa	R	2	Fudina	Ovchartsii	Sapareva banya
21	11	DI	16	0878/16.05.2002	16.05.2008	WSSC Private Ltd. Dupnitsa	Dupnitsa	R	2	Goritsa	Ovchartsii	Sapareva banya
22	12	DI	17	0932/10.06.2002	10.06.2008	MRDPA	Sofia	R	2	Rakochevitsa	Gorno Osenovo	Blagoevgrad
23	13	DI	23	1618/30.05.2003	30.05.2009	WSSC Private Ltd. Petrich	Petrich	R	2	Luda Mara	Petrich	Petrich
24	14	DI	27	3056/16.07.2003	16.07.2009	Bobovdol mines	Bobovdol	MR	2	Dupnishka Bistritsa		Dupnitsa
25	15	DI	28	3090/29.09.2003	18.09.2009	WSSC Ltd.Kyustendil	Kyustendil	MR	2	Dupnishka Bistritsa		Dupnitsa
26	16	DI	29	3156/28.11.2003	28.11.2009	WSSC Private Ltd Dupnitsa	Dupnitsa	SL	1	Dyakovo	Dyakovo	Dupnitsa
27	17	DI	34	400084/02.02.2004	02.02.2010	Mayoralty of Gorna Dikanya	Gorna Dikanya	MR	2	Arkata	Gorna Dikanya	Radomir

You must al least input the following data.

Location of Intake : Intake-ID (column I)

Location of Intake : Catchment-ID (column O)

WaterUse : Permitted Amount (m3/s) (column P)

WaterUse : Permitted Annual Volume (10^6 m3) (column Q)

WaterUse : Local Coefficient for Permission (column S)

By changing *Local Coefficient for Permission,* you can examine the effect of permitted amount for each one of permissions.

The total calculated water abstraction per year will be:

(Permitted Annual Volume) x (Global Coefficient) x (Local Coefficient)

In case of drinking water supply, constant value based on total water abstraction per year will be given.

(4) IWS

Input necessary data according to the item shown in Line10.

	A	B	C	D	E	F	G	H	I	J	K	L
1	Title	Permission for Industrial Water										
2	Data Source	WABD										
3												
4	Data Origin	Original										
5												
6												
7												
8												
9						User						Location of Intak
10	No	Reg Ref. No		Permission No	Expiry Date	Name	Place	Type	Category	Intake-ID 1:SignificantRes 2:Local	Name of WaterObject	Name of Village
11	1	DI	1	0035-1/16.08.2004	01.10.2010	Toplofikaciya PrivateJSC Pernik	Pernik	Industry	MR	2	Struma	Pernik
12	2	DI	11	0635/15.11.2001	13.11.2007	TPS Bobovdol Private JSC	Golemo selo	Cooling	MR	2	Dzherman	Dupnitsa
13	3	DI	13	0647/16.11.2001	16.11.2007	TPS Bobovdol Private JSC	Golemo selo	Cooling	SL	1	Dyakovo	Dyakovo
14	4	DI	14	0741/28.01.2002	28.08.2007	Balkanpharma JSC	Dupnitsa	Industry	SL	1	Dyakovo	Dyakovo
15	5	DI	18	1314/21.11.2002	21.11.2008	Bistritsa Ltd.	Blagoevgrad	GravelWash	MR	2	Struma	Pokrovnik
16	6	DI	19	1391/14.01.2003	14.01.2009	Demo Bulgaria JSC	Sofia	Industry	MR	2	Struma	Pernik
17	7	DI	22	1599/21.05.2003	21.05.2009	Toplofikacia Private JSC Pernik	Pernik	Industry	SL	1	Studena	Studena
18	8	DI		400005/03.07.2003	03.07.2009	Bistritsa Ltd.	Blagoevgrad	GravelWash	MR	2	Struma	Kocherinovo
19	9	DI	26	3046/15.07.2003	10.07.2009	Pektin JSC	Pernik	Industry	SL	1	Studena	Studena
20	10	DI	27	3056/16.07.2003	16.07.2009	Bobovdol mines	Bobovdol	Industry	SL	1	Dyakovo	Dyakovo
21	11	DI	30	3157/01.12.2003	01.12.2009	Stomana industry JSC	Pernik	Industry	SL	1	Studena	Studena

You must al least input the following data.

Location of Intake : Intake-ID (column J)

Location of Intake : Catchment-ID (column P)

WaterUse : Permitted Amount (m3/s) (column Q)

WaterUse : Permitted Annual Volume (10^6 m3) (column R)

WaterUse : Local Coefficient for Permission (column T)

It is recommended to input the following data.

User : Type (column H)

By changing *Local Coefficient for Permission,* you can examine the effect of permitted amount for each one of permissions.

The total calculated water abstraction per year will be:

(Permitted Annual Volume) x (Global Coefficient) x (Local Coefficient)

In case of industrial water supply, constant value based on total water abstraction per year will be given.

(5) Transfer_NoRecord

If there is a water transfer between catchments by local HPP, but no record exists, you can specify the transferred water amount here.

Input necessary data according to the item shown in Line9.

	A	B	C	D	E	F	G	H	I	J
1	Title	Transfer of Water with No Available Record								
2	Data Source	JICA Study Team								
3										
4										
5										
6										
7										
8			From		To		Transfer Mode	Maximum Limit	Percent	
9	No.	Description	NAM Catchment	Catchment ID	NAM Catchment	Catchment ID	1 - Maximum Limit 2 - Percent	m3/s	%	
10	1	HPP No.[illegible]	ST_SAN	502	ST_M1	270	1	1.1		
11	2	HPP No.27	ST_RIL	383	ST_M5	390	1	0.6		
12	3									
13	4									
14	5									
15	6									
16	7									
17	8									
18	9									
19	10									

You have to at least specify the following data.

From : Catchment-ID (column D)

To : Catchment-ID (column F)

Transfet Mode (column G)

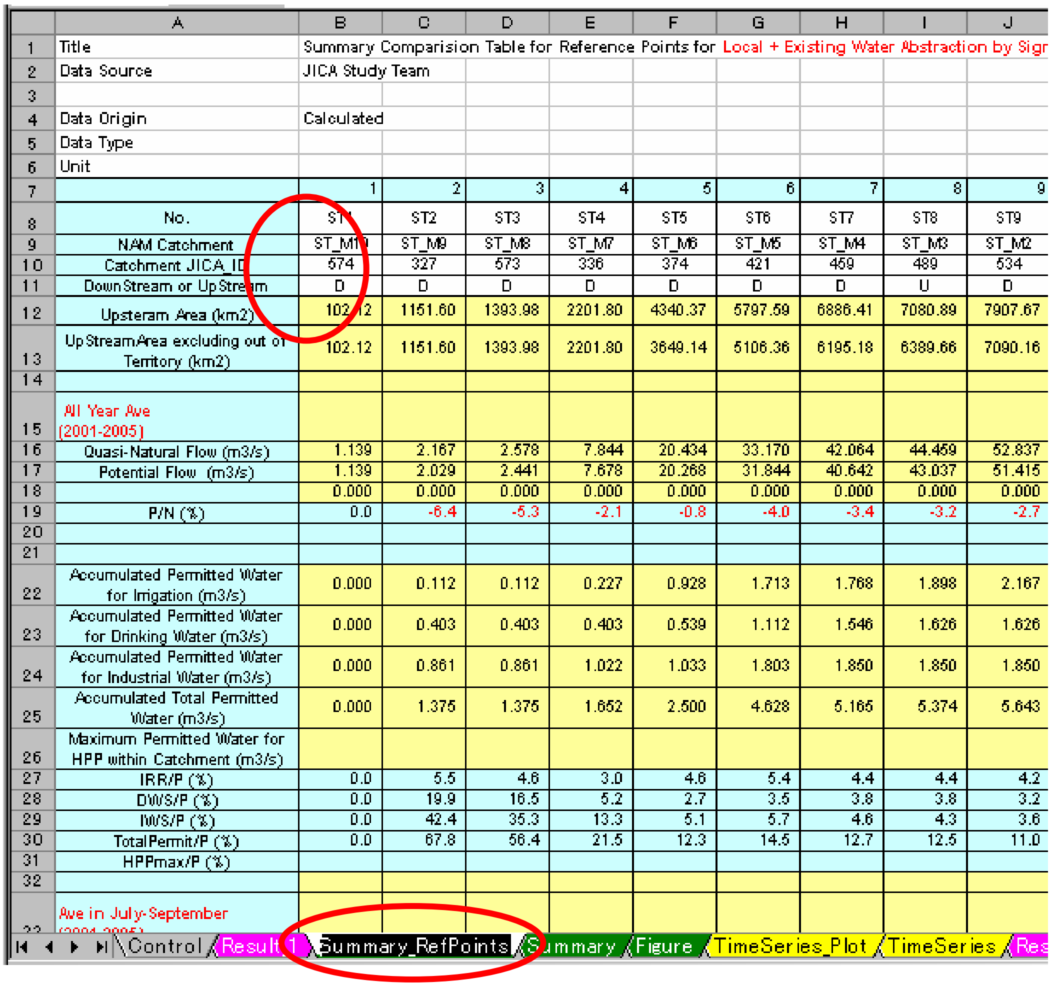
If TransferMode =1 MaximumLimit (column H)

If Transfer Mode =2 Percent (column I)

This water transfer is not taken into account for water abstraction. However, it is taken into account when MIKE11 input file is prepared.

6. Setting reference points for management

Default reference points have been set by JICA Study Team. However, in the model, you can set reference points as you like in " Summary_RefPoints" tab.



	A	B	C	D	E	F	G	H	I	J
1	Title	Summary Comparision Table for Reference Points for Local + Existing Water Abstraction by Sigr								
2	Data Source	JICA Study Team								
3										
4	Data Origin	Calculated								
5	Data Type									
6	Unit									
7		1	2	3	4	5	6	7	8	9
8	No.	ST1	ST2	ST3	ST4	ST5	ST6	ST7	ST8	ST9
9	NAM Catchment	ST_M10	ST_M9	ST_M8	ST_M7	ST_M6	ST_M5	ST_M4	ST_M3	ST_M2
10	Catchment JICA_ID	574	327	573	336	374	421	459	489	534
11	DownStream or UpStream	D	D	D	D	D	D	D	U	D
12	Upsteram Area (km2)	102.12	1151.60	1393.98	2201.80	4340.37	5797.59	6886.41	7080.89	7907.67
13	UpStreamArea excluding out of Territory (km2)	102.12	1151.60	1393.98	2201.80	3649.14	5106.36	6195.18	6389.66	7090.16
14										
15	All Year Ave (2001-2005)									
16	Quasi-Natural Flow (m3/s)	1.139	2.167	2.578	7.844	20.434	33.170	42.064	44.459	52.837
17	Potential Flow (m3/s)	1.139	2.029	2.441	7.678	20.268	31.844	40.642	43.037	51.415
18		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
19	P/N (%)	0.0	-6.4	-5.3	-2.1	-0.8	-4.0	-3.4	-3.2	-2.7
20										
21										
22	Accumulated Permitted Water for Irrigation (m3/s)	0.000	0.112	0.112	0.227	0.928	1.713	1.768	1.898	2.167
23	Accumulated Permitted Water for Drinking Water (m3/s)	0.000	0.403	0.403	0.403	0.539	1.112	1.546	1.626	1.626
24	Accumulated Permitted Water for Industrial Water (m3/s)	0.000	0.861	0.861	1.022	1.033	1.803	1.850	1.850	1.850
25	Accumulated Total Permitted Water (m3/s)	0.000	1.375	1.375	1.652	2.500	4.628	5.165	5.374	5.643
26	Maximum Permitted Water for HPP within Catchment (m3/s)									
27	IRR/P (%)	0.0	5.5	4.6	3.0	4.6	5.4	4.4	4.4	4.2
28	DWS/P (%)	0.0	19.9	16.5	5.2	2.7	3.5	3.8	3.8	3.2
29	IWS/P (%)	0.0	42.4	35.3	13.3	5.1	5.7	4.6	4.3	3.6
30	TotalPermit/P (%)	0.0	67.8	56.4	21.5	12.3	14.5	12.7	12.5	11.0
31	HPPmax/P (%)									
32										
33	Ave in July-September									

The value calculated for each one of catchments represents the value at the downstream end of river segment in the catchment.

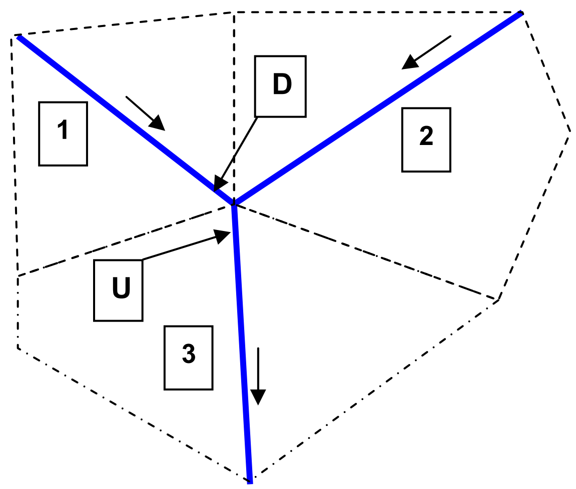
When you select a reference point around river confluence, you have two choices. One is before confluence. Another is after the confluence.

If you select the point before the confluence, you have to specify Catchment ID for upstream segment and "D" for "Downstream or Upstream". Similarly, you have to select Catchment ID for downstream segment and "U" when the point after the confluence is selected.

Example:

Before confluence: Catchment ID =1 and "D"

After confluence: Catchment ID =3 and "U"



You can choose "No." as you like. However, this "No." will be used when you plot time series data.

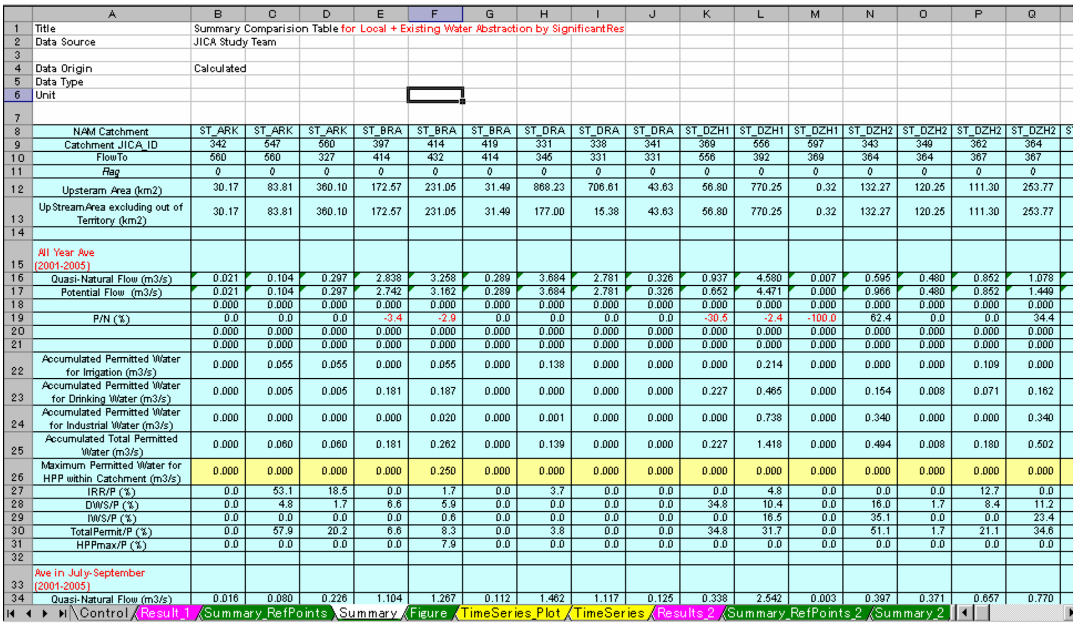
"NAM catchment" is used for reference for default setting. If you do not consider "NAM cacthment", this can be left as blank.

7. Calculation

In “Control” tab, you can calculate to summarize the permission data.
In column “K”, maximum number of permission and/or reference points can be set. The maximum number must be greater than the number which has been inputted in each input page.
In column “ J”, Global coefficient for permission can be specified.

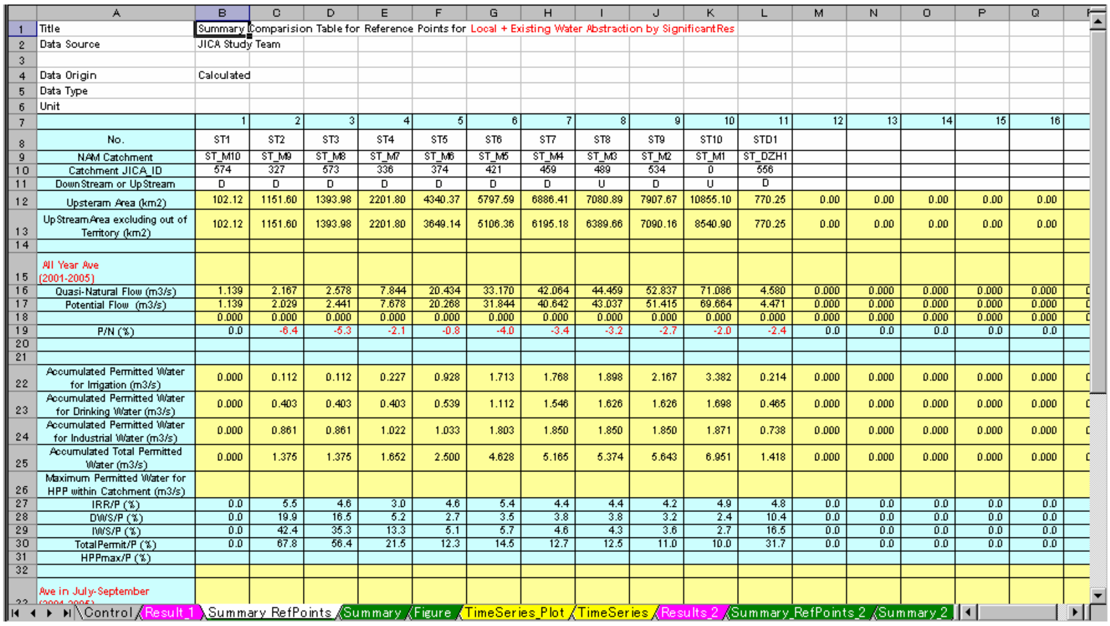
	A	B	C	D	E	F	G	H	I	J	K
1	Macro No.	Macro Name	Step	Total Step	Status	Progress		Last updated Date&Time		Global Coefficient for Permission	Max. Num. of Permission / Ref. Points
2	PM001	IRR_Permit	3	3	Completed!	100	% finished	2007/7/22	11:22:19 AM	1.00	200
3	PM002	DWS_Permit	3	3	Completed!	100	% finished	2007/7/23	3:09:01 PM	1.00	100
4	PM003	IWS_Permit	3	3	Completed!	100	% finished	2007/7/22	11:22:34 AM	1.00	100
5	PM004	MaxHPP_Permit	1	1	Completed!	100	% finished	2007/7/22	11:22:37 AM	1.00	100
6	PM005	TransNoRecord	1	1	Completed!	100	% finished	2007/7/23	1:28:06 PM		10
7	PM101	Ref_Points_Summary	2	2	Completed!	100	% finished	2007/7/22	11:23:17 AM		20
8	PM102	Plot_Longitudinal_Main	1	1	Completed!			2007/7/23	4:31:27 PM		
9	PM201	ForMIKE11	1	1	Completed!	100	% finished	2007/7/22	11:24:00 AM		
10											
11											

When you click the button “PM001” to “PM005”, the permission values are calculated and summarized. You must calculate once after permission data are updated. You can refer the “Last updated Date&Time”.
After calculation completed, Summary table in “Summary” and “Summary_2” are updated. Summary table shows annual average and average during summer time (Jul. to Sep.) for year 2001 -2005.
There are two results groups: Result_1 and Result_2
Result_1 is for:
Local (Permitted water abstraction from local water object) + Existing water abstraction from significant reservoir.
Result_2 is for:
Local (Permitted water abstraction from local water object) + Permitted water abstraction from significant reservoir.



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	Title	Summary Comparision Table for Local + Existing Water Abstraction by SignificantRes															
2	Data Source	JICA Study Team															
3																	
4	Data Origin	Calculated															
5	Data Type																
6	Unit																
7																	
8	NAM Catchment	ST_ARK	ST_ARK	ST_ARK	ST_BRA	ST_BRA	ST_BRA	ST_DRA	ST_DRA	ST_DRA	ST_DZH1	ST_DZH1	ST_DZH1	ST_DZH2	ST_DZH2	ST_DZH2	ST_DZH2
9	Catchment JICA_ID	342	547	560	397	414	419	331	338	341	369	556	597	343	349	362	364
10	FlowTo	560	560	327	414	432	414	345	331	331	556	392	369	364	364	367	367
11	Flag	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	Upsteram Area (km2)	30.17	83.81	360.10	172.57	231.05	31.49	868.23	706.61	43.63	56.80	770.25	0.32	132.27	120.25	111.30	253.77
13	UpStreamArea excluding out of Territory (km2)	30.17	83.81	360.10	172.57	231.05	31.49	177.00	15.38	43.63	56.80	770.25	0.32	132.27	120.25	111.30	253.77
14																	
15	All Year Ave (2001-2005)																
16	Quasi-Natural Flow (m3/s)	0.021	0.104	0.297	2.838	3.258	0.289	3.684	2.781	0.326	0.937	4.580	0.007	0.595	0.480	0.852	1.078
17	Potential Flow (m3/s)	0.021	0.104	0.297	2.742	3.162	0.289	3.684	2.781	0.326	0.652	4.471	0.000	0.966	0.480	0.852	1.449
18		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
19	P/N (%)	0.0	0.0	0.0	-3.4	-2.9	0.0	0.0	0.0	0.0	-30.5	-2.4	-100.0	62.4	0.0	0.0	34.4
20		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
21		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
22	Accumulated Permitted Water for Irrigation (m3/s)	0.000	0.055	0.055	0.000	0.055	0.000	0.138	0.000	0.000	0.000	0.214	0.000	0.000	0.000	0.109	0.000
23	Accumulated Permitted Water for Drinking Water (m3/s)	0.000	0.005	0.005	0.181	0.187	0.000	0.000	0.000	0.000	0.227	0.465	0.000	0.154	0.008	0.071	0.162
24	Accumulated Permitted Water for Industrial Water (m3/s)	0.000	0.000	0.000	0.000	0.020	0.000	0.001	0.000	0.000	0.000	0.738	0.000	0.340	0.000	0.000	0.340
25	Accumulated Total Permitted Water (m3/s)	0.000	0.060	0.060	0.181	0.262	0.000	0.139	0.000	0.000	0.227	1.418	0.000	0.494	0.008	0.180	0.502
26	Maximum Permitted Water for HPP within Catchment (m3/s)	0.000	0.000	0.000	0.000	0.250	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
27	IRR/P (%)	0.0	53.1	18.5	0.0	1.7	0.0	3.7	0.0	0.0	0.0	4.8	0.0	0.0	0.0	12.7	0.0
28	DWS/P (%)	0.0	4.8	1.7	6.6	5.9	0.0	0.0	0.0	0.0	34.8	10.4	0.0	16.0	1.7	8.4	11.2
29	IWS/P (%)	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	16.5	0.0	35.1	0.0	0.0	23.4
30	TotalPermit/P (%)	0.0	57.9	20.2	6.6	8.3	0.0	3.8	0.0	0.0	34.8	31.7	0.0	51.1	1.7	21.1	34.6
31	HPPmax/P (%)	0.0	0.0	0.0	0.0	7.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
32																	
33	Ave in July-September (2001-2005)																
34	Quasi-Natural Flow (m3/s)	0.016	0.080	0.226	1.104	1.267	0.112	1.462	1.117	0.125	0.338	2.542	0.003	0.397	0.371	0.657	0.770

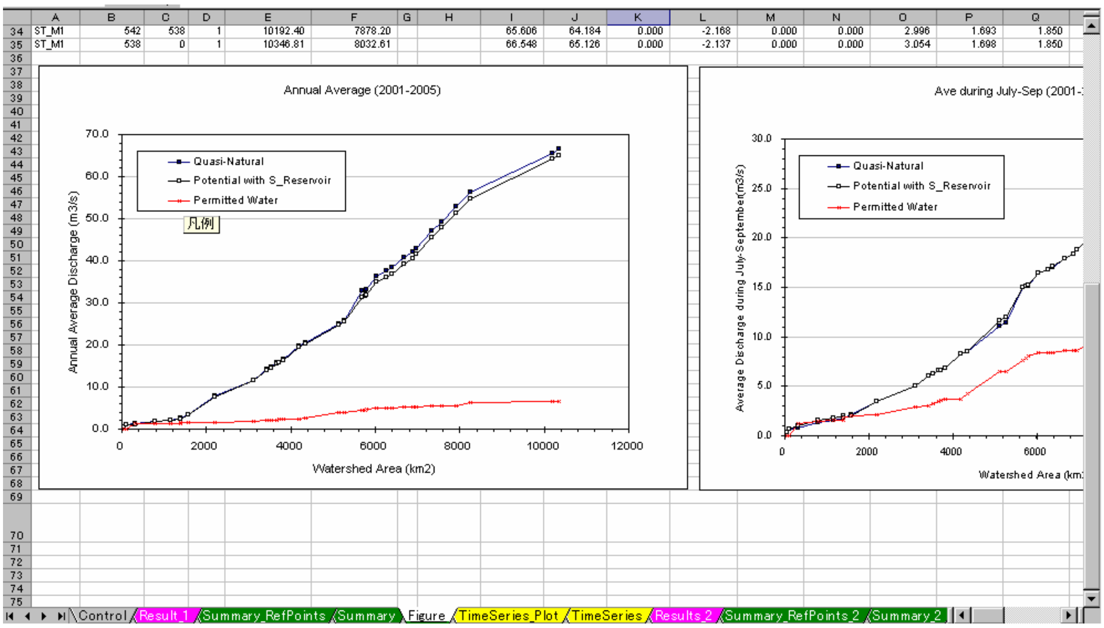
When you click "PM101", summary results for reference points are calculated. After complete the calculation, please see "Summary_RefPoints" and "Summary_RefPoints_2".



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	Title	Summary Comparision Table for Reference Points for Local + Existing Water Abstraction by SignificantRes															
2	Data Source	JICA Study Team															
3																	
4	Data Origin	Calculated															
5	Data Type																
6	Unit																
7		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
8	No.	ST1	ST2	ST3	ST4	ST5	ST6	ST7	ST8	ST9	ST10	STD1					
9	NAM Catchment	ST_M10	ST_M9	ST_M8	ST_M7	ST_M6	ST_M5	ST_M4	ST_M3	ST_M2	ST_M1	ST_DZH1					
10	Catchment JICA_ID	574	327	573	336	374	421	459	489	534	0	556					
11	DownStream or UpStream	D	D	D	D	D	D	D	U	D	U	D					
12	Upsteram Area (km2)	102.12	1151.60	1393.98	2201.80	4340.37	5797.59	6886.41	7080.89	7907.67	10855.10	770.25	0.00	0.00	0.00	0.00	0.00
13	UpStreamArea excluding out of Territory (km2)	102.12	1151.60	1393.98	2201.80	3649.14	5106.36	6195.18	6389.66	7090.16	8540.90	770.25	0.00	0.00	0.00	0.00	0.00
14																	
15	All Year Ave (2001-2005)																
16	Quasi-Natural Flow (m3/s)	1.139	2.167	2.578	7.844	20.434	33.170	42.064	44.459	52.837	71.086	4.580	0.000	0.000	0.000	0.000	0.000
17	Potential Flow (m3/s)	1.139	2.029	2.441	7.678	20.268	31.844	40.642	43.037	51.415	69.664	4.471	0.000	0.000	0.000	0.000	0.000
18		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
19	P/N (%)	0.0	-6.4	-5.3	-2.1	-0.8	-4.0	-3.4	-3.2	-2.7	-2.0	-2.4	0.0	0.0	0.0	0.0	0.0
20																	
21																	
22	Accumulated Permitted Water for Irrigation (m3/s)	0.000	0.112	0.112	0.227	0.928	1.713	1.768	1.898	2.167	3.382	0.214	0.000	0.000	0.000	0.000	0.000
23	Accumulated Permitted Water for Drinking Water (m3/s)	0.000	0.403	0.403	0.403	0.539	1.112	1.546	1.626	1.626	1.698	0.465	0.000	0.000	0.000	0.000	0.000
24	Accumulated Permitted Water for Industrial Water (m3/s)	0.000	0.861	0.861	1.022	1.033	1.803	1.850	1.850	1.850	1.871	0.738	0.000	0.000	0.000	0.000	0.000
25	Accumulated Total Permitted Water (m3/s)	0.000	1.375	1.375	1.652	2.500	4.628	5.165	5.374	5.643	6.951	1.418	0.000	0.000	0.000	0.000	0.000
26	Maximum Permitted Water for HPP within Catchment (m3/s)																
27	IRR/P (%)	0.0	5.5	4.6	3.0	4.6	5.4	4.4	4.4	4.2	4.9	4.8	0.0	0.0	0.0	0.0	0.0
28	DWS/P (%)	0.0	19.9	16.5	5.2	2.7	3.5	3.8	3.8	3.2	2.4	10.4	0.0	0.0	0.0	0.0	0.0
29	IWS/P (%)	0.0	42.4	35.3	13.3	5.1	5.7	4.6	4.3	3.6	2.7	16.5	0.0	0.0	0.0	0.0	0.0
30	TotalPermit/P (%)	0.0	67.8	56.4	21.5	12.3	14.5	12.7	12.5	11.0	10.0	31.7	0.0	0.0	0.0	0.0	0.0
31	HPPmax/P (%)																
32																	
33	Ave in July-September																

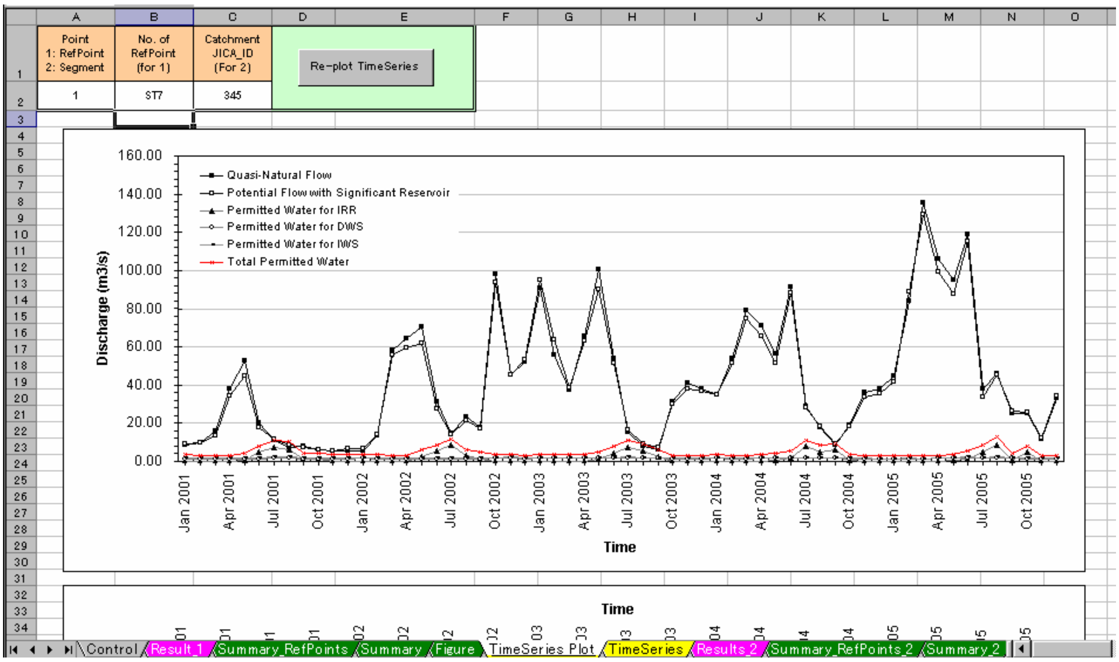
8. Longitudinal Plot along Main channel

When you click “PM102”, longitudinal plots along main channel for annual average and average during summer time (Jul. to Sep.) for year 2001 -2005 are plotted. The results can be seen in “Figure” and “Figure_2” tabs.



9. Time Series Plot

Time series can be plotted in “TimeSeries_Plot” tab.



You have to firstly specify the location for time series plot.
You have two choices. One is to select a point from the reference points(1:RefPoint). Another is to specify Catchment ID (2:segment).
Please select “1” or “2” in the cell ”A2”.
Then, please specify “No. of RefPoints” or “Catchment ID”.
After specifying the location, click button “Re-plot TimeSeries”.
You will see new plots.

10. Preparation of MIKE11 Input file

Macro No.	Macro Name	Step	Total Step	Status	Progress		Last updated Date&Time		Global Coefficient for Permission	Max. Num. of Permission / Ref. Points
PM001	IRR_Permit	3	3	Completed!	100	% finished	2007/7/22	11:22:19 AM	1.00	200
PM002	DWS_Permit	3	3	Completed!	100	% finished	2007/7/23	3:09:01 PM	1.00	100
PM003	IWS_Permit	3	3	Completed!	100	% finished	2007/7/22	11:22:34 AM	1.00	100
PM004	MaxHPP_Permit	1	1	Completed!	100	% finished	2007/7/22	11:22:37 AM	1.00	100
PM005	TransNoRecord	1	1	Completed!	100	% finished	2007/7/23	1:28:06 PM		10
PM101	Ref_Points_Summary	2	2	Completed!	100	% finished	2007/7/22	11:23:17 AM		20
PM102	Plot_Longitudinal_Main	1	1	Completed!			2007/7/23	4:31:27 PM		
PM201	ForMIKE11	1	1	Completed!	100	% finished	2007/7/22	11:24:00 AM		

In "Control" tab, click button "PM201". Then, MIKE11 input file will be updated in "Sum_AbstW_NAMcatchment_MIKE11" tab.

Title	Total Abstracted Water (excluding by Significant Reservoir) by NAM_Catchment for MIKE11_BC																	
Data Source	JICA Study Team																	
Data Origin	Calculated																	
Data Type	Instantenious																	
Unit	m3/s																	
	ST_ARK	ST_BRA	ST_DRA	ST_DZH1	ST_DZH2	ST_ELE	ST_GRA	ST_KON	ST_M1	ST_M10	ST_M2	ST_M3	ST_M4	ST_M5	ST_M6	ST_M7	ST_M8	ST_M
2000/1/1 0:00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0
2000/1/2 0:00	-0.005	-0.207	-0.001	-0.626	-0.085	-0.005	-0.246	-0.030	-0.015	0.000	0.000	-0.079	-0.028	-0.008	-0.050	0.000	0.000	-0.3
2000/2/1 0:00	-0.005	-0.207	-0.001	-0.626	-0.085	-0.005	-0.246	-0.030	-0.015	0.000	0.000	-0.079	-0.028	-0.008	-0.050	0.000	0.000	-0.3
2000/2/2 0:00	-0.005	-0.207	-0.001	-0.626	-0.085	-0.005	-0.246	-0.030	-0.015	0.000	0.000	-0.079	-0.028	-0.008	-0.050	0.000	0.000	-0.3
2000/3/1 0:00	-0.005	-0.207	-0.001	-0.626	-0.085	-0.005	-0.246	-0.030	-0.015	0.000	0.000	-0.079	-0.028	-0.008	-0.050	0.000	0.000	-0.3
2000/3/2 0:00	-0.005	-0.207	-0.001	-0.626	-0.085	-0.005	-0.246	-0.030	-0.015	0.000	0.000	-0.079	-0.028	-0.008	-0.050	0.000	0.000	-0.3
2000/4/1 0:00	-0.005	-0.207	-0.001	-0.626	-0.085	-0.005	-0.246	-0.030	-0.015	0.000	0.000	-0.079	-0.028	-0.008	-0.050	0.000	0.000	-0.3
2000/4/2 0:00	-0.005	-0.207	-0.001	-0.626	-0.085	-0.005	-0.246	-0.030	-0.015	0.000	0.000	-0.079	-0.028	-0.008	-0.050	0.000	0.000	-0.3
2000/5/1 0:00	-0.005	-0.207	-0.001	-0.626	-0.085	-0.005	-0.246	-0.030	-0.015	0.000	0.000	-0.079	-0.028	-0.008	-0.050	0.000	0.000	-0.3
2000/5/2 0:00	-0.005	-0.207	-0.001	-0.626	-0.085	-0.005	-0.246	-0.030	-0.015	0.000	0.000	-0.079	-0.028	-0.008	-0.050	0.000	0.000	-0.3
2000/6/1 0:00	-0.005	-0.207	-0.001	-0.626	-0.085	-0.005	-0.246	-0.030	-0.015	0.000	0.000	-0.079	-0.028	-0.008	-0.050	0.000	0.000	-0.3
2000/6/2 0:00	-0.094	-0.261	-0.224	-0.730	-0.192	-0.005	-0.246	-0.121	-0.749	0.000	-0.668	-0.403	-0.028	-0.199	-0.839	-0.171	0.000	-0.3
2000/7/1 0:00	-0.094	-0.261	-0.224	-0.730	-0.192	-0.005	-0.246	-0.121	-0.749	0.000	-0.668	-0.403	-0.028	-0.199	-0.839	-0.171	0.000	-0.3
2000/7/2 0:00	-0.184	-0.343	-0.449	-0.887	-0.354	-0.005	-0.246	-0.213	-0.847	0.000	-0.757	-0.446	-0.028	-0.488	-1.727	-0.343	0.000	-0.3
2000/8/1 0:00	-0.184	-0.343	-0.449	-0.887	-0.354	-0.005	-0.246	-0.213	-0.847	0.000	-0.757	-0.446	-0.028	-0.488	-1.727	-0.343	0.000	-0.3
2000/8/2 0:00	-0.312	-0.580	-0.771	-1.339	-0.819	-0.005	-0.246	-0.345	-1.714	0.000	-1.547	-0.828	-0.028	-1.321	-3.410	-0.590	0.000	-0.3
2000/9/1 0:00	-0.312	-0.580	-0.771	-1.339	-0.819	-0.005	-0.246	-0.345	-1.714	0.000	-1.547	-0.828	-0.028	-1.321	-3.410	-0.590	0.000	-0.3
2000/9/2 0:00	-0.090	-0.305	-0.215	-0.813	-0.278	-0.005	-0.246	-0.117	-0.289	0.000	-0.249	-0.200	-0.028	-0.354	-0.965	-0.164	0.000	-0.3
2000/10/1 0:00	-0.090	-0.305	-0.215	-0.813	-0.278	-0.005	-0.246	-0.117	-0.289	0.000	-0.249	-0.200	-0.028	-0.354	-0.965	-0.164	0.000	-0.3
2000/10/2 0:00	-0.005	-0.207	-0.001	-0.626	-0.085	-0.005	-0.246	-0.030	-0.015	0.000	0.000	-0.079	-0.028	-0.008	-0.050	0.000	0.000	-0.3
2000/11/1 0:00	-0.005	-0.207	-0.001	-0.626	-0.085	-0.005	-0.246	-0.030	-0.015	0.000	0.000	-0.079	-0.028	-0.008	-0.050	0.000	0.000	-0.3
2000/11/2 0:00	-0.005	-0.207	-0.001	-0.626	-0.085	-0.005	-0.246	-0.030	-0.015	0.000	0.000	-0.079	-0.028	-0.008	-0.050	0.000	0.000	-0.3
2000/12/1 0:00	-0.005	-0.207	-0.001	-0.626	-0.085	-0.005	-0.246	-0.030	-0.015	0.000	0.000	-0.079	-0.028	-0.008	-0.050	0.000	0.000	-0.3
2000/12/2 0:00	-0.005	-0.207	-0.001	-0.626	-0.085	-0.005	-0.246	-0.030	-0.015	0.000	0.000	-0.079	-0.028	-0.008	-0.050	0.000	0.000	-0.3
2001/1/1 0:00	-0.005	-0.207	-0.001	-0.626	-0.085	-0.005	-0.246	-0.030	-0.015	0.000	0.000	-0.079	-0.028	-0.008	-0.050	0.000	0.000	-0.3
2001/1/2 0:00	-0.005	-0.207	-0.001	-0.626	-0.085	-0.005	-0.246	-0.030	-0.011	0.000	0.000	-0.079	-0.028	0.446	-0.050	0.000	0.000	-0.3
2001/2/1 0:00	-0.005	-0.207	-0.001	-0.626	-0.085	-0.005	-0.246	-0.030	-0.011	0.000	0.000	-0.079	-0.028	0.446	-0.050	0.000	0.000	-0.3
2001/2/2 0:00	-0.005	-0.207	-0.001	-0.626	-0.085	-0.005	-0.246	-0.030	0.049	0.000	0.000	-0.079	-0.028	0.388	-0.050	0.000	0.000	-0.3
2001/3/1 0:00	-0.005	-0.207	-0.001	-0.626	-0.085	-0.005	-0.246	-0.030	0.049	0.000	0.000	-0.079	-0.028	0.388	-0.050	0.000	0.000	-0.3
2001/3/2 0:00	-0.005	-0.207	-0.001	-0.626	-0.085	-0.005	-0.246	-0.030	0.547	0.000	0.000	-0.079	-0.028	0.183	-0.050	0.000	0.000	-0.3
2001/4/1 0:00	-0.005	-0.207	-0.001	-0.626	-0.085	-0.005	-0.246	-0.030	0.547	0.000	0.000	-0.079	-0.028	0.183	-0.050	0.000	0.000	-0.3
2001/4/2 0:00	-0.005	-0.215	-0.001	-0.641	-0.101	-0.005	-0.246	-0.030	1.085	0.000	0.000	-0.079	-0.028	0.564	-0.078	0.000	0.000	-0.3
2001/5/1 0:00	-0.005	-0.215	-0.001	-0.641	-0.101	-0.005	-0.246	-0.030	1.085	0.000	0.000	-0.079	-0.028	0.564	-0.078	0.000	0.000	-0.3
2001/5/2 0:00	-0.005	-0.253	-0.001	-0.713	-0.175	-0.005	-0.246	-0.030	1.085	0.000	0.000	-0.079	-0.028	0.431	-0.208	0.000	0.000	-0.3

Permit HPP / Permit IRR / Permit DWS / Permit IWS / Transfer NoRecord / MIKE11 BC File / Sum AbstW NAMcatchment MIKE11

You can copy the updated value and paste it to "xxxx_AbstW.dfs0".

Using the updated "xxxx_AbstW.dfs0" with MIKE11 model, you can investigate the effect of several water use condition on water quantity along river in detail.

Please remind that MIKE11 model automatically stops abstraction when amount of water is not enough. In this case, you will see “warning”. However, it is OK for water quantity simulation, if you can recognize that the actually abstracted water amount is smaller than that is given as boundary condition.

It is highly possible that the above-mentioned case occurs if you assume total permitted water amount is abstracted.

Annex 8

Manual

for

Simple Model_ver_Demand

(A Simple Water Quantity Assessment Tool)

JICA Study Team

1. General

Simple Model_ver_Demand is prepared to examine the balance between water demand and water resources potential. By imputing parameters related to estimation of water demand, the model can summarize the total water demand at observation points.

The quasi-natural flow, potential flow with significant reservoir for the average year (2004) and the expected probabilistic flow are estimated by other versions, Simple Model_ver_Exsiting and Simple Model_ver_Potential, which have been also prepared by JICA Study Team. The ver_Demand just utilizes those results. The comparison between the water demand and the quasi-natural, potential with significant reservoir may give an idea on strategy for river management.

The main features are as follows:

- Entering parameters for estimation of water demand for IRR, DWS, IWS
- Selection of reference points for management
- Summary table for annual average and average during summer time (Jul. to Sep.) for each catchment/segment and reference point
- Longitudinal plot of the summarized results along main channel
- Time series plot for each reference point and/or catchment/segment
- Preparation of an input file related to local water abstraction for each NAM catchment for MIKE11 water quantity model prepared by JICA Study Team

2. Definition of terms

In this model, the following definition is used.

- **Quasi-Natural Flow**
  - Flow without disturbance such as abstraction, discharge, transfer
  - Likely natural, however, not exactly natural.
  - In the model, regime change of local reservoir is not taken into account.
- **Potential Flow with Significant Reservoir**
  - Flow with influence of significant reservoir, including transfer from and to a reservoir, but no abstraction of water
  - Potentially usable water amount after regime change by significant reservoir
- **Disturbed Flow**
  - Existing condition
  - Potential Flow – Total abstracted water + Total discharged water

Abbreviation

HPP:	Hydro Power Plant
IRR:	Irrigation (Note: Irrigation water use includes only water for Irrigation area managed by Irrigation Systems)
DWS:	Drinking Water Supply
IWS:	Industrial Water Supply (Note: Industrial Water supply includes agricultural and fish breeding water use)
S_Res:	Significant Reservoir
NAM Catchment:	Catchment for NAM (Rainfall-Runoff) model
NF:	Quasi-Natural Flow
PF:	Potential Flow with Significant Reservoir
DF:	Disturbed Flow

3. Remarks for treating Excel sheet in the model

The model just utilizes excel spread sheets and macros. Some sheets are hidden, because the hidden sheets are usually not necessary to be edited by users. If you want to see the hidden sheets, please do the followings.

Format -> Sheet -> Unhide
Then, select the sheets you want to open.

In each spread sheet, you may see cells with different colors. The meaning of the colors is as follows.

White: User can edit
Light blue: Value in cell is automatically calculated.
Yellow: Value in cell is calculated by macros.

DO NOT edit the cells with light blue and yellow. If you change it, the model will give wrong results.

4. Model Outline

1) Struma River

File Name:

Struma_WaterBalance_Demand2.xls

Number of catchment = 104

Number of NAM catchment = 25

2) Mesta & Dospat River

File Name:

Mesta&Dospat_WaterBalance_Demand2.xls

Number of catchment = 75

Number of NAM catchment = 14

3) Arda & Biala River

File Name:

Arda&Biala_WaterBalance_Demand2.xls

Number of catchment = 69

Number of NAM catchment = 12

4) Tundzha River

File Name:

Tundzha_WaterBalance_Demand2.xls

Number of catchment = 84

Number of NAM catchment = 19

5) Maritsa River

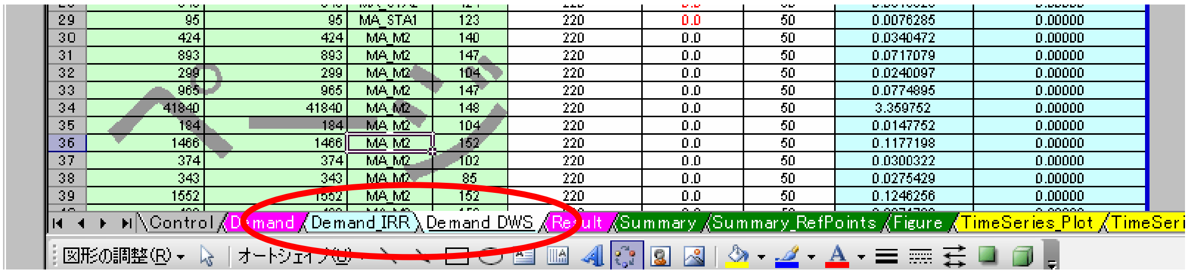
File Name:

Maritsa_WaterBalance_Demand2.xls

Number of catchment = 251

Number of NAM catchment = 34

5. Input of parameters for estimating water demand



You can see the following two tabs for input of parameters related to water demand.

1) Demand_IRR
2) Demand_DWS

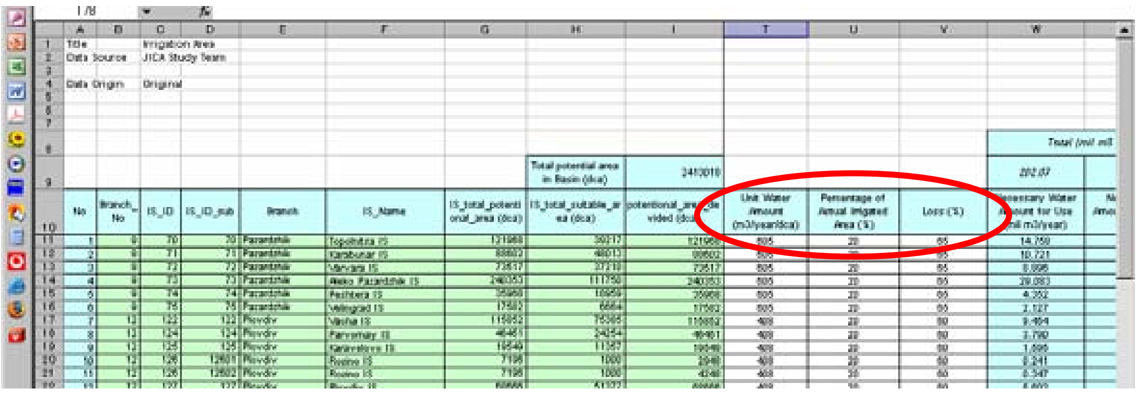
(1) IRR

Irrigation water demand is calculated based on the followings for each irrigation system.

1) Unit water demand (m3/year/dca)
2) Potential irrigation area (dca)
3) Percentage of actual irrigation area against potential irrigation area (%)
4) Loss rate (%)

Among those, 2) Potential irrigation area fro each irrigation system has already set together with its location of main water sources. You do not need to change these.

You have to input 1), 3) and 4).



(2) DWS

Drinking water demand is calculated based on the followings for each settlement.

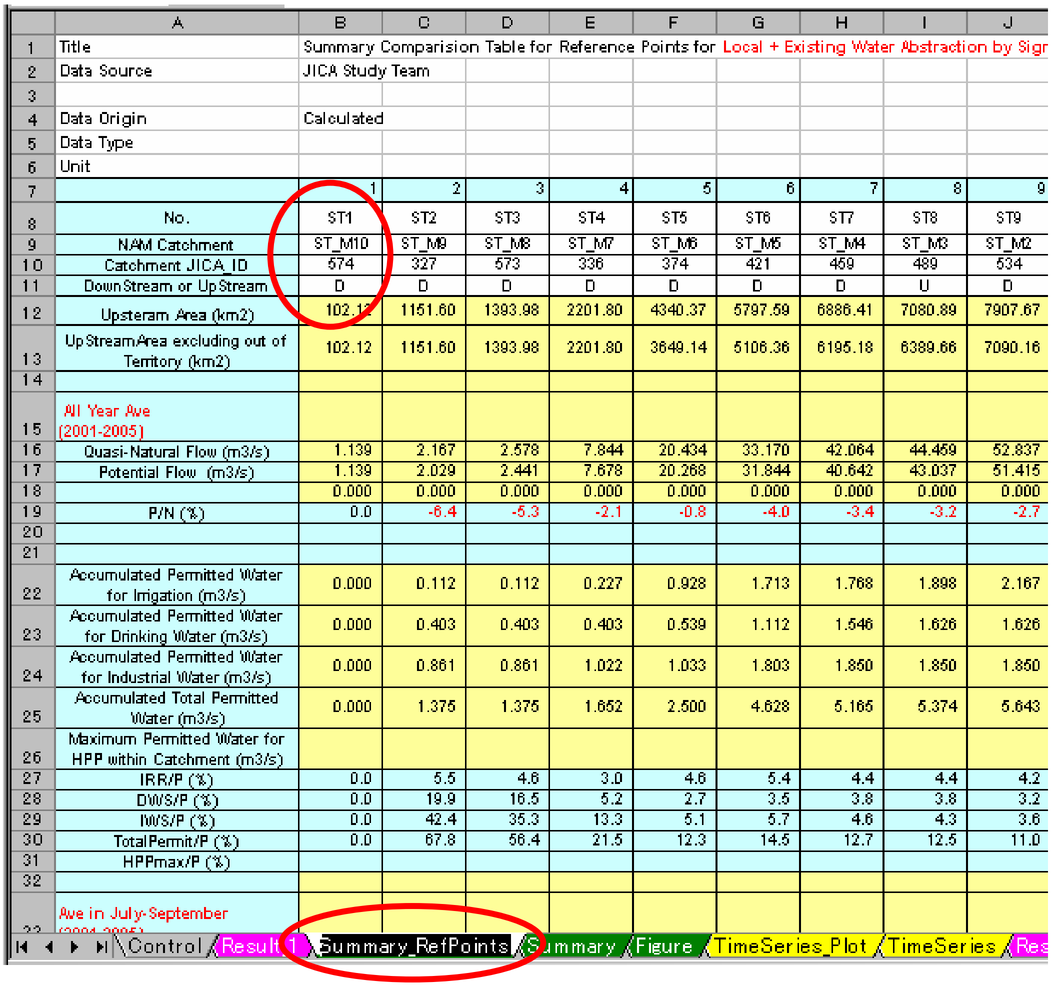
1) Unit water use (litter/day/person)
2) Percentage of Surface water use (%)
3) Loss rate (%)

You have to input all of 1), 2) and 3).

	Type (village, town)	Settlement	Municipality	Water Company	Population (by settlement, for 2005)	Expected Population (by settlement, for 2015)	NAM Catchment	Catchment ID	Unit Water Use (litter /day/person)	Percenrage of SW Use (%)	Total Loss (%)
11	town	Batak	Batak	Batak WS&S Co	3782	3782	MA_STA2	425	220	[illegible]	50
12	village	Fotinovo	Batak	Batak WS&S Co	794	794	MA_VAC2	457	220	61.5	50
13	village	Nova mahala	Batak	Batak WS&S Co	2133	2133	MA_STA2	434	220	61.5	50
14	village	Akandzhievo	Belovo	Belovo WS&S Co	482	482	MA_M6	365	220	45.2	50
15	town	Belovo	Belovo	Belovo WS&S Co	4095	4095	MA_M6	365	220	45.2	50
16	village	Dabravite	Belovo	Belovo WS&S Co	559	559	MA_M6	365	220	45.2	50
17	village	Gabrovitsa	Belovo	Belovo WS&S Co	569	569	MA_M6	360	220	45.2	50
18	village	Golyamo Belovo	Belovo	Belovo WS&S Co	585	585	MA_M6	381	220	45.2	50
19	village	Menenkyovo	Belovo	Belovo WS&S Co	1086	1086	MA_M6	365	220	45.2	50
20	village	Momina klisura	Belovo	Belovo WS&S Co	1135	1135	MA_M6	376	220	45.2	50
21	village	Sestrimo	Belovo	Belovo WS&S Co	1392	1392	MA_M6	378	220	45.2	50
22	village	Avramovo	Yakoruda	Blagoevgrad WS&S Co	680	680	MA_CPI2	411	220	59.0	50
23	town	Bratsigovo	Bratsigovo	Bratsigovo WS&S Co	4577	4577	MA_STA2	424	220	0.0	50

6. Setting reference points for management

Default reference points have been set by JICA Study Team. However, in the model, you can set reference points as you like in " Summary_RefPoints" tab.



	A	B	C	D	E	F	G	H	I	J
1	Title	Summary Comparision Table for Reference Points for Local + Existing Water Abstraction by Sigr								
2	Data Source	JICA Study Team								
3										
4	Data Origin	Calculated								
5	Data Type									
6	Unit									
7		1	2	3	4	5	6	7	8	9
8	No.	ST1	ST2	ST3	ST4	ST5	ST6	ST7	ST8	ST9
9	NAM Catchment	ST_M10	ST_M9	ST_M8	ST_M7	ST_M6	ST_M5	ST_M4	ST_M3	ST_M2
10	Catchment JICA_ID	574	327	573	336	374	421	459	489	534
11	DownStream or UpStream	D	D	D	D	D	D	D	U	D
12	Upsteram Area (km2)	102.12	1151.60	1393.98	2201.80	4340.37	5797.59	6886.41	7080.89	7907.67
13	UpStreamArea excluding out of Territory (km2)	102.12	1151.60	1393.98	2201.80	3649.14	5106.36	6195.18	6389.66	7090.16
14										
15	All Year Ave (2001-2005)									
16	Quasi-Natural Flow (m3/s)	1.139	2.167	2.578	7.844	20.434	33.170	42.064	44.459	52.837
17	Potential Flow (m3/s)	1.139	2.029	2.441	7.678	20.268	31.844	40.642	43.037	51.415
18		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
19	P/N (%)	0.0	-6.4	-5.3	-2.1	-0.8	-4.0	-3.4	-3.2	-2.7
20										
21										
22	Accumulated Permitted Water for Irrigation (m3/s)	0.000	0.112	0.112	0.227	0.928	1.713	1.768	1.898	2.167
23	Accumulated Permitted Water for Drinking Water (m3/s)	0.000	0.403	0.403	0.403	0.539	1.112	1.546	1.626	1.626
24	Accumulated Permitted Water for Industrial Water (m3/s)	0.000	0.861	0.861	1.022	1.033	1.803	1.850	1.850	1.850
25	Accumulated Total Permitted Water (m3/s)	0.000	1.375	1.375	1.652	2.500	4.628	5.165	5.374	5.643
26	Maximum Permitted Water for HPP within Catchment (m3/s)									
27	IRR/P (%)	0.0	5.5	4.6	3.0	4.6	5.4	4.4	4.4	4.2
28	DWS/P (%)	0.0	19.9	16.5	5.2	2.7	3.5	3.8	3.8	3.2
29	IWS/P (%)	0.0	42.4	35.3	13.3	5.1	5.7	4.6	4.3	3.6
30	TotalPermit/P (%)	0.0	67.8	56.4	21.5	12.3	14.5	12.7	12.5	11.0
31	HPPmax/P (%)									
32										
	Ave in July-September									

The value calculated for each one of catchments represents the value at the downstream end of river segment in the catchment.

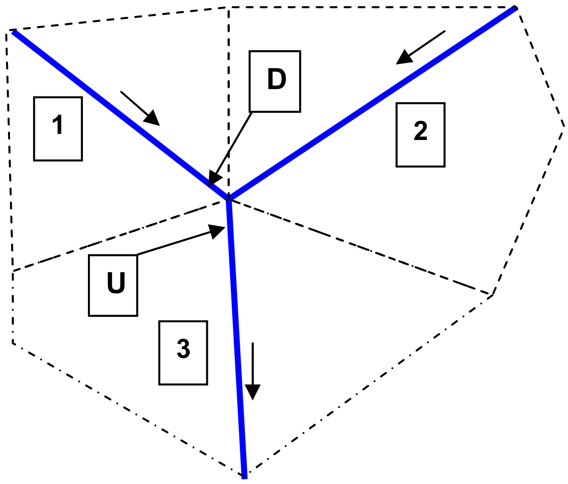
When you select a reference point around river confluence, you have two choices. One is before confluence. Another is after the confluence.

If you select the point before the confluence, you have to specify Catchment ID for upstream segment and "D" for "Downstream or Upstream". Similarly, you have to select Catchment ID for downstream segment and "U" when the point after the confluence is selected.

Example:

Before confluence: Catchment ID =1 and “D”

After confluence: Catchment ID =3 and “U”



You can choose “No.” as you like. However, this “No.” will be used when you plot time series data.

“NAM catchment” is used for reference for default setting. If you do not consider “NAM cacthment”, this can be left as blank.

7. Calculation

In "Control" tab, you can calculate to summarize the water demand by catchment.

In cell "J4", maximum number of reference points can be set. The maximum number must be greater than the number which has been set.

Macro No.	Macro Name	Step	Total Step	Status	Progress		Last updated Date&Time		Max. Num. of Demand Cal. / Ref. Points
PM001	IRR_Demand	3	3	Completed!	100	% finished	2007/8/26	11:03:14 AM	70
PM002	DWS_Demand	2	2	Completed!	100	% finished	2007/8/26	10:41:54 AM	900
PM101	Ref_Points_Summary	1	1	Completed!	100	% finished	2007/8/26	11:03:15 AM	30
PM102	Plot_Longitudinal_Main	1	1	Completed!			2007/8/26	11:03:16 AM	
PM201	ForMIKE11	1	1	Completed!	100	% finished	2007/8/25	5:02:10 PM	
	IWS_Demand Parameters	Coefficient for Economic Growth		1	Coefficient for Recycling Water Use		1		

In line"7", you can set the following two coefficients for estimating industrial water demand.

1. Coefficient for Economic Growth (CE)
2. Coefficient for Recycling Water Use (CR)

Industrial Water demand is calculated as follows.

(Industrial water demand) = (existing industrial water use) x CE x CR

When you click the button "PM001" to "PM002", the water demand are calculated and summarized. You must calculate once after parameters for water demand are updated. You can refer the "Last updated Date&Time".

After calculation completed, Summary table in "Summary" are updated. Summary table shows annual average and average during summer time (Jul. to Sep.).

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	Title	Summary Comparision Table												
2	Data Source	JICA Study Team												
3														
4	Data Origin	Calculated												
5	Data Type													
6	Unit													
7														
8	NAM Catchment	MA_BLA	MA_CPI1	MA_CPI1	MA_CPI1	MA_CPI1	MA_CPI1	MA_CPI2	MA_CPI2	MA_CPI2	MA_CPI2	MA_CPI2	MA_CPI2	MA_CPI
9	Catchment JICA_ID	56	380	413	416	418	429	411	436	438	441	444	448	450
10	FlowTo	90	356	380	380	413	413	429	429	429	438	450	438	448
11	Flag	0	0	0	0	0	0	0	0	0	0	0	0	0
12	Upsteram Area (km2)	642.01	977.56	517.89	220.31	30.78	465.44	119.56	83.06	240.46	49.29	35.70	135.77	73.5
13	UpStreamArea excluding out of Territory (km2)	642.01	977.56	517.89	220.31	30.78	465.44	119.56	83.06	240.46	49.29	35.70	135.77	73.5
14														
15	Annual Average													
16	Quasi-Natural Flow (m3/s) Average(2004)	2.321	7.983	4.925	1.784	0.225	4.520	1.009	0.816	2.560	0.467	0.395	1.542	0.79
17	Quasi-Natural Flow (m3/s) 75% Probability of Exceedence	2.132	6.863	4.366	1.477	0.180	4.041	0.905	0.730	2.296	0.418	0.351	1.375	0.70
18	Quasi-Natural Flow (m3/s) 90% Probability of Exceedence	1.703	5.676	3.604	1.229	0.149	3.336	0.747	0.603	1.895	0.345	0.290	1.135	0.58
19	Quasi-Natural Flow (m3/s) 95% Probability of Exceedence	1.449	4.968	3.131	1.090	0.132	2.893	0.648	0.522	1.643	0.299	0.251	0.984	0.50
20	Potential Flow (m3/s) Average (2004)	2.886	11.244	3.503	6.467	0.225	3.098	1.009	0.418	1.536	0.467	0.177	0.726	0.34
21	Potential Flow (m3/s) 75% Probability of Exceedence	2.769	10.722	2.618	7.083	0.180	2.294	0.905	0.251	1.028	0.418	0.100	0.423	0.19
22	Potential Flow (m3/s) 90% Probability of Exceedence	2.162	8.871	2.162	5.866	0.149	1.894	0.747	0.207	0.849	0.345	0.082	0.349	0.15
23	Potential Flow (m3/s) 95% Probability of Exceedence	1.804	7.739	1.881	5.110	0.132	1.643	0.648	0.180	0.735	0.299	0.071	0.303	0.13
24	Accumulated Water Demand for Irrigation (m3/s)	0.000	19.881	0.000	19.881	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.00
25	Accumulated Water Demand for Drinking Water (m3/s)	0.002	0.116	0.091	0.012	0.066	0.025	0.019	0.000	0.006	0.002	0.000	0.000	0.00
26	Accumulated Water Demand for Industrial Water (m3/s)	0.000	0.271	0.116	0.155	0.000	0.116	0.000	0.000	0.000	0.000	0.000	0.000	0.00
27	Accumulated Total Water Demand (m3/s)	0.002	20.268	0.207	20.048	0.066	0.140	0.019	0.000	0.006	0.002	0.000	0.000	0.00
28														
29														
30	Ave in July-September													
31	Quasi-Natural Flow (m3/s) Average(2004)	2.138	4.820	3.038	1.041	0.131	2.802	0.627	0.506	1.590	0.290	0.243	0.952	0.48
32	Quasi-Natural Flow (m3/s) 75% Probability of Exceedence	1.967	4.119	2.680	0.852	0.104	2.493	0.560	0.451	1.419	0.259	0.217	0.850	0.43
33	Quasi-Natural Flow (m3/s) 90% Probability of Exceedence	1.541	3.439	2.210	0.728	0.089	2.050	0.460	0.371	1.166	0.212	0.178	0.698	0.35
34	Quasi-Natural Flow (m3/s) 95% Probability of Exceedence	1.289	3.037	1.934	0.654	0.079	1.791	0.401	0.324	1.018	0.185	0.156	0.610	0.31
35	Potential Flow (m3/s) Average (2004)	4.011	14.008	2.305	10.962	0.131	2.069	0.627	0.301	1.062	0.290	0.131	0.532	0.25
36	Potential Flow (m3/s) 75% Probability of Exceedence	4.081	14.548	1.600	12.361	0.104	1.413	0.560	0.155	0.635	0.259	0.062	0.262	0.11
37	Potential Flow (m3/s) 90% Probability of Exceedence	3.063	12.074	1.323	10.250	0.089	1.163	0.460	0.128	0.522	0.212	0.051	0.215	0.09
38	Potential Flow (m3/s) 95% Probability of Exceedence	2.468	10.530	1.159	8.921	0.079	1.016	0.401	0.111	0.456	0.185	0.044	0.188	0.08
39	Accumulated Water Demand for Irrigation (m3/s)	0.000	58.096	0.000	58.096	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.00
40	Accumulated Water Demand for Drinking Water (m3/s)	0.002	0.116	0.091	0.012	0.066	0.025	0.019	0.000	0.006	0.002	0.000	0.000	0.00
41	Accumulated Water Demand for Industrial Water (m3/s)	0.000	0.279	0.116	0.163	0.000	0.116	0.000	0.000	0.000	0.000	0.000	0.000	0.00
42	Accumulated Total Water Demand (m3/s)	0.002	58.491	0.207	58.271	0.066	0.140	0.019	0.000	0.006	0.002	0.000	0.000	0.00
43														
44														

Control / Demand / Demand_IRR / Demand_DWS / Result / Summary / Summary_RefPoints / Figure / TimeSeries_Plot / TimeSeries

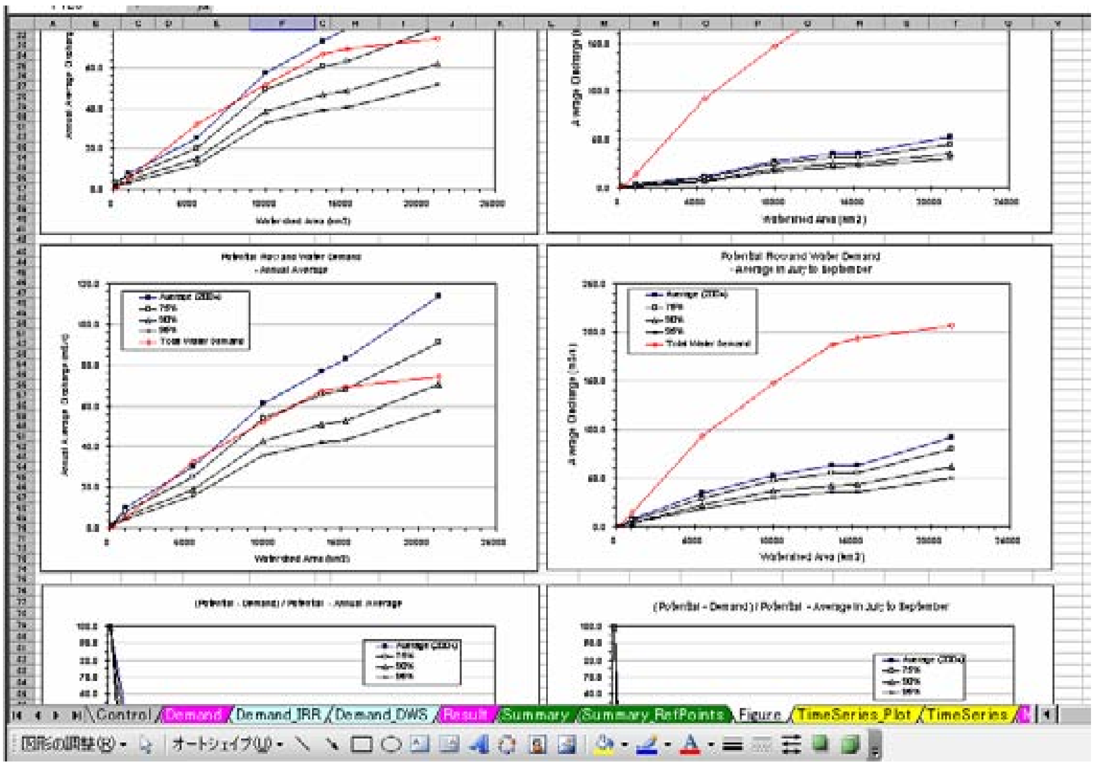
When you click "PM101", summary results for reference points are calculated. After complete the calculation, please see "Summary_RefPoints" .

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	Title	Summary Comparision Table for Reference Points													
2	Data Source	JICA Study Team													
3															
4	Data Origin	Calculated													
5	Data Type														
6	Unit														
7		1	2	3	4	5	6	7	8	9	10	11	12	13	
8	No.	MA1	MA2	MA3	MA4	MA5	MA6	MA7	MAI1	MAT1	MAT2	MAT3	MAT4	MAU1	MAV1
9	NAM Catchment	MA_M7	MA_M6	MA_M5	MA_M4	MA_M3	MA_M2	MA_M1	MA_CPI1	MA_TOP4	MA_TOP3	MA_TOP2	MA_TOP1	MA_LUD1	MA_VAC
10	CatchmentJICA_ID	357	365	109	113	131	132	589	380	321	324	564	339	347	120
11	DownStream or UpStream	U	D	U	D	D	D	D	D	U	D	D	D	D	D
12	Upsteram Area (km2)	173.41	1031.94	5461.57	9968.62	13718.32	15321.83	21272.26	977.56	337.69	946.75	1433.98	1775.18	674.43	1679.
13	UpStreamArea excluding out of Territory (km2)	173.41	1031.94	5461.57	9968.62	13718.32	15321.83	21272.26	977.56	337.69	946.75	1433.98	1775.18	674.43	1679.
14															
15	Annual Average														
16	Quasi-Natural Flow (m3/s) Average(2004)	2.843	7.879	25.559	57.597	73.306	79.607	103.658	7.983	1.743	3.068	4.096	4.793	1.517	19.52
17	Quasi-Natural Flow (m3/s) 75% Probability of Exceedence	2.845	6.289	19.985	49.366	60.569	63.192	80.037	6.863	1.530	2.312	2.759	3.274	0.909	18.56
18	Quasi-Natural Flow (m3/s) 90% Probability of Exceedence	2.023	4.332	14.871	38.808	47.041	48.759	61.975	5.676	0.992	1.468	1.733	2.108	0.650	15.49
19	Quasi-Natural Flow (m3/s) 95% Probability of Exceedence	1.724	3.337	12.147	32.736	39.259	40.580	51.677	4.968	0.678	1.021	1.217	1.519	0.536	13.52
20	Potential Flow (m3/s) Average (2004)	1.274	10.217	29.851	60.924	76.691	82.992	113.848	11.244	1.743	2.777	4.096	4.385	1.517	18.68
21	Potential Flow (m3/s) 75% Probability of Exceedence	1.457	8.124	24.817	54.248	65.441	68.065	91.368	10.722	1.530	2.311	2.759	3.254	0.909	18.63
22	Potential Flow (m3/s) 90% Probability of Exceedence	1.036	5.864	18.903	42.653	50.881	52.598	70.344	8.871	0.992	1.468	1.733	2.096	0.650	15.32
23	Potential Flow (m3/s) 95% Probability of Exceedence	0.883	4.612	15.595	35.751	42.269	43.590	57.956	7.739	0.678	1.020	1.217	1.510	0.536	13.09
24	Accumulated Water Demand for Irrigation (m3/s)	0.000	4.794	31.525	50.943	65.867	67.678	70.824	19.881	0.000	0.000	0.250	6.850	0.000	3.70
25	Accumulated Water Demand for Drinking Water (m3/s)	0.006	0.066	0.443	0.571	0.606	0.607	0.624	0.116	0.014	0.071	0.120	0.120	0.057	0.02
26	Accumulated Water Demand for Industrial Water (m3/s)	0.000	0.034	0.460	0.518	0.524	0.947	2.874	0.271	0.149	0.154	0.154	0.154	0.001	0.01
27	Accumulated Total Water Demand (m3/s)	0.006	4.894	32.429	52.032	66.996	69.232	74.322	20.268	0.163	0.224	0.524	7.124	0.058	3.73
28															
29															
30	Ave in July-September														
31	Quasi-Natural Flow (m3/s) Average(2004)	0.883	3.783	12.061	28.085	35.315	36.016	52.379	4.820	0.783	1.270	1.639	1.839	0.369	9.75
32	Quasi-Natural Flow (m3/s) 75% Probability of Exceedence	1.266	3.507	10.206	24.971	31.286	31.755	45.619	4.119	0.724	1.040	1.245	1.361	0.232	9.32
33	Quasi-Natural Flow (m3/s) 90% Probability of Exceedence	0.652	2.362	7.937	19.903	25.074	25.506	36.330	3.439	0.588	0.831	0.993	1.094	0.202	7.76
34	Quasi-Natural Flow (m3/s) 95% Probability of Exceedence	0.588	1.932	6.811	17.135	21.583	21.986	31.001	3.037	0.463	0.671	0.816	0.908	0.187	6.73
35	Potential Flow (m3/s) Average (2004)	0.277	7.687	34.122	53.230	62.524	63.225	92.004	14.008	0.783	2.054	1.639	11.246	0.369	11.27
36	Potential Flow (m3/s) 75% Probability of Exceedence	0.649	6.032	29.589	47.068	54.956	55.424	79.952	14.548	0.724	1.961	1.245	8.152	0.232	11.36
37	Potential Flow (m3/s) 90% Probability of Exceedence	0.334	4.413	22.372	36.343	42.705	43.136	61.302	12.074	0.588	1.309	0.993	5.148	0.202	9.39
38	Potential Flow (m3/s) 95% Probability of Exceedence	0.301	3.578	18.410	30.302	35.720	36.122	50.374	10.530	0.463	0.937	0.816	3.638	0.187	8.00
39	Accumulated Water Demand for Irrigation (m3/s)	0.000	14.010	92.315	145.625	186.168	191.713	202.424	58.096	0.000	0.000	0.924	20.210	0.000	10.16
40	Accumulated Water Demand for Drinking Water (m3/s)	0.006	0.066	0.443	0.571	0.606	0.607	0.624	0.116	0.014	0.071	0.120	0.120	0.057	0.02
41	Accumulated Water Demand for Industrial Water (m3/s)	0.000	0.029	0.463	0.521	0.527	0.950	3.280	0.279	0.149	0.154	0.154	0.154	0.001	0.01
42	Accumulated Total Water Demand (m3/s)	0.006	14.104	93.222	146.718	187.301	193.270	206.327	58.491	0.163	0.224	1.198	20.484	0.058	10.19
43															

Control / Demand / Demand_IRR / Demand_DWS / Result / Summary / Summary_RefPoints / Figure / TimeSeries_Plot / TimeSeries

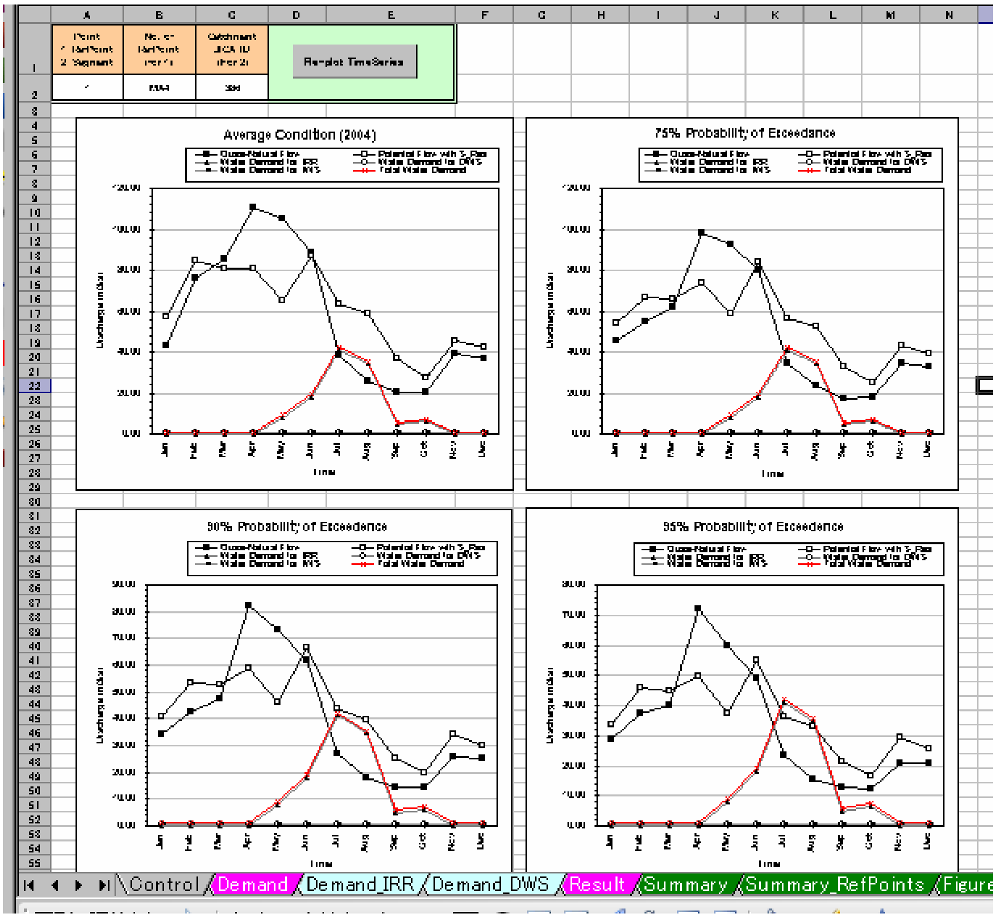
8. Longitudinal Plot along Main channel

When you click “PM102”, longitudinal plots along main channel for annual average and average during summer time (Jul. to Sep.) are plotted. The results can be seen in “Figure” tabs.



9. Time Series Plot

Time series can be plotted in "TimeSeries_Plot" tab.



You have to firstly specify the location for time series plot.

You have two choices. One is to select a point from the reference points(1:RefPoint). Another is to specify Catchment ID (2:segment).

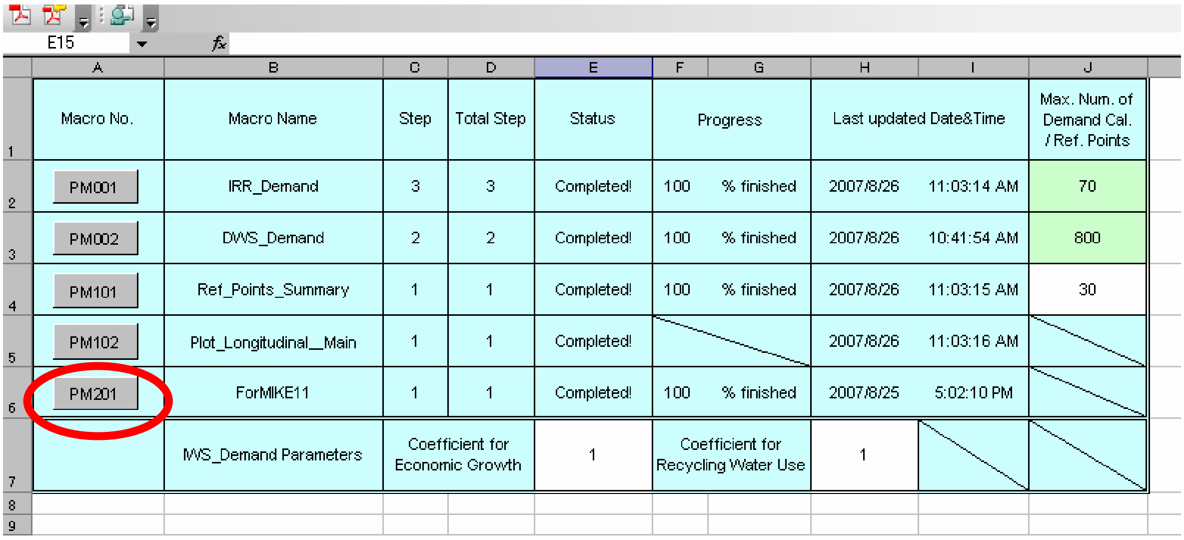
Please select "1" or "2" in the cell "A2".

Then, please specify "No. of RefPoints" or "Catchment ID".

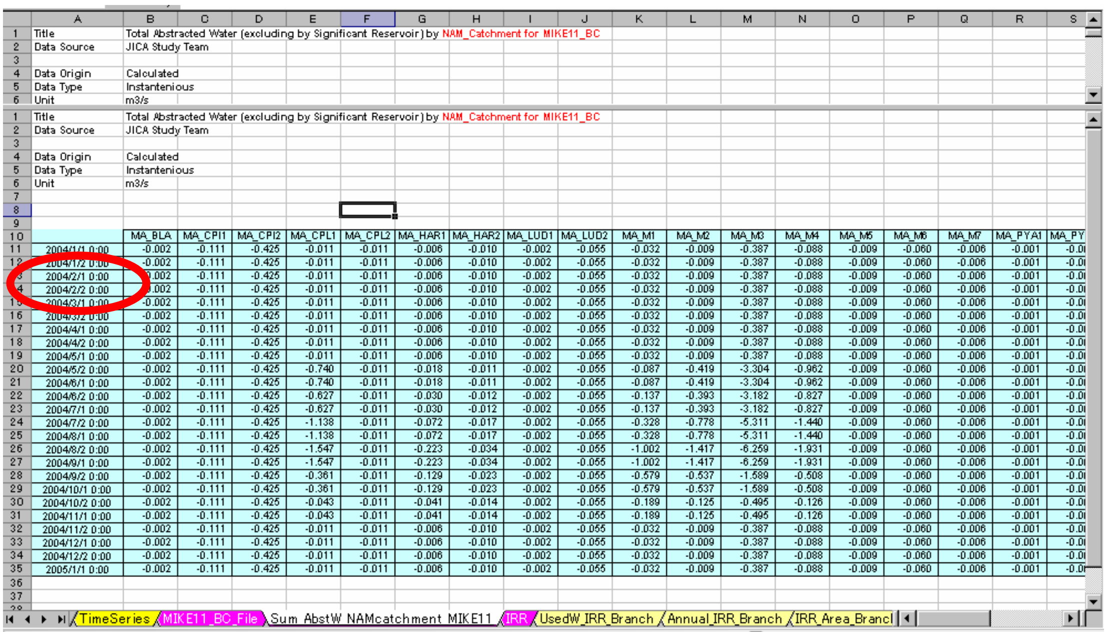
After specifying the location, click button "Re-plot TimeSeries".

You will see new plots.

10. Preparation of MIKE11 Input file



In “Control” tab, click button “PM201”. Then, MIKE11 input file will be updated in “Sum_AbstW_NAMcatchment_MIKE11” tab.



You can copy the updated value and paste it to “xxxx_AbstW.dfs0”. Using the updated “xxxx_AbstW.dfs0” with MIKE11 model, you can investigate the effect of several water use condition on water quantity along river in detail.

Please remind that MIKE11 model automatically stops abstraction when amount of water is not enough. In this case, you will see “warning”. However, it is OK for water quantity simulation, if you can recognize that the actually abstracted water amount is smaller than that is given as boundary condition.

It is highly possible that the above-mentioned case occurs if you assume total permitted water amount is abstracted.

Annex 9

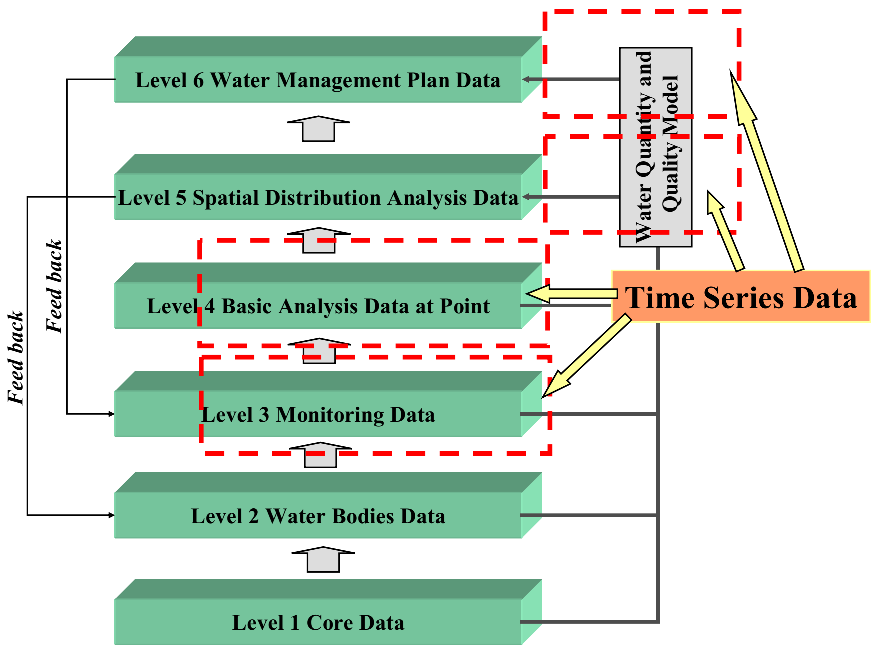
Supplimentary Material

JICA Study Team

Introduction – Time Series Data

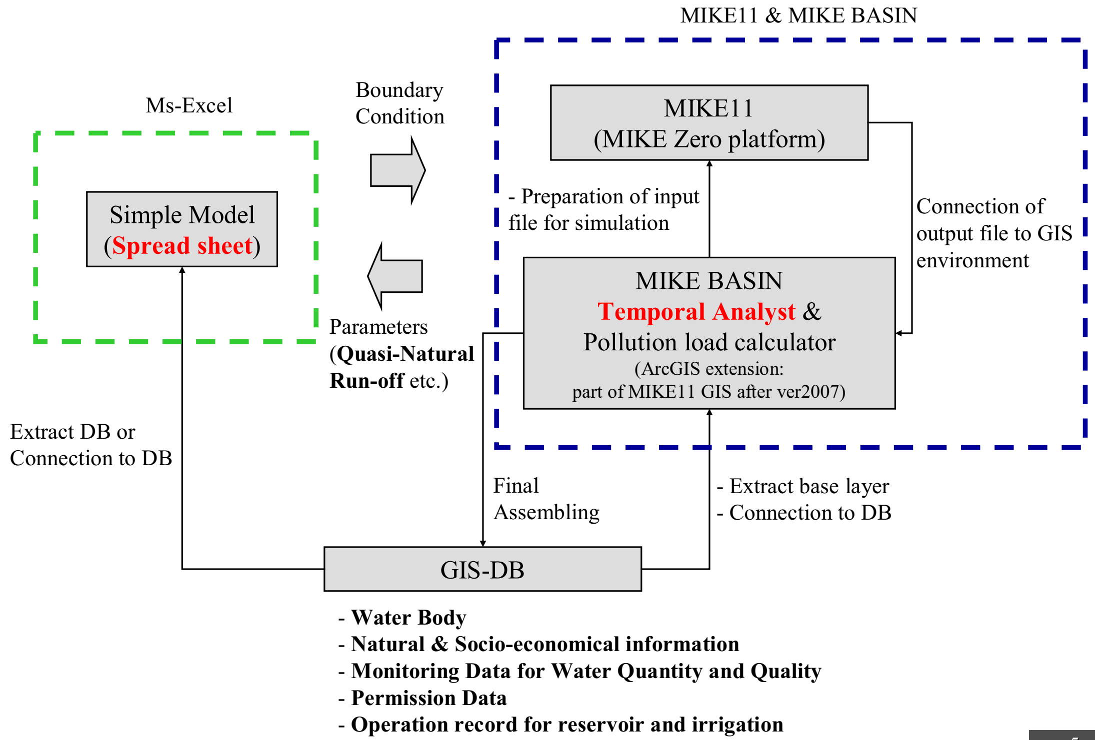
3

Data Level



4

Structure of Modeling Environment



5

Time Series Data used in the Model

- Meteo-Hydrological data
  - Daily Precipitation
  - Monthly Potential Evapo-Transpiration
  - Daily Air Temperature
  - Daily Water Quantity at key HMS
- Water Abstraction/Discharge data
  - Reservoir Operation Data
  - Water Abstraction Data
    - Irrigation Use
    - Domestic & Industrial Water Use
  - Water Discharge (Waste Water) Data
- Water Quality Monitoring data

……etc.

6

Example of Source data:
Daily Water Quantity from NIMH
Table is good. But, difficult to utilize for analysis…

БЯЛА РЕКА - С. БОСТИНА N 61050 2000ГОД.

ВОДНИ КОЛИЧЕСТВА, м3/s

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1	1.030>	.192	.552	2.075	1.140	.338	.122>	.029	.041	.021	.021	.029
2	.828	.400	.552	2.075	1.255	.235	.095	.029	.041	.021	.021	.029
3	.732	.640	.732	1.926	1.780	.235	.073	.029	.029	.021	.021	.029
4	.640	.732	.640	1.637	1.140	.235	.056	.021	.029	.021	.021	.029
5	.640	.552	.732	1.926	.927	.235	.056	.015<	.029	.021	.021	.029
6	.552	.552	.640	1.780	.828	.235	.056	.010	.041	.021	.021	.029
7	.552	.732	.470<	1.374	.732	.235	.056	.010	.029	.021	.021	.029
8	.552	.927	.470	1.030	.640	1.273>	.056	.010	.029	.021	.021	.029
9	.470:	1.140	.640	.828	.640	1.030	.056	.015<	.029	.041>	.021	.029
10	.400:	1.140	.927	.732	.552	.828	.056	.029	.029	.056	.021	.029
11	.338:	1.140	1.140	.732	.640	.400	.056	.021	.029	.029	.021	.029
12	.338:	1.500	1.030	.732	.470	.283	.041	.021	.029	.021	.021	.021
13	.338:	1.637	1.030	.640	.552	.155	.041	.021	.029	.021	.021	.021
14	.283:	1.374	.927	.552	.927	.122	.041	.021	.029	.021	.021	.021
15	.283:	1.140	.927	.552	.732	.122	.041	.021	.029	.021	.021	.015

7

What useful time series data for analysis looks like

- **Time Value 1 (Value 2)**

xxxx	**yyyy**	**(zzzz)**
xxxx	**yyyy**	**(zzzz)**
xxxx	**yyyy**	**(zzzz)**
xxxx	**yyyy**	**(zzzz)**
xxxx	**yyyy**	**(zzzz)**
xxxx	**yyyy**	**(zzzz)**
xxxx	**yyyy**	**(zzzz)**
….	**…..**	**….**

8

Example of Useful Time series data for Analysis (1)

Extracted from PPT material for explanation of ArcHydro provided in http://www.crwr.utexas.edu/giswr/

9

Example of Useful Time series data for Analysis (2)

- NWIS Data
  - Metadata
  - Tabular Output
    - Year.Month.Day
    - Discharge (cfs)

1976.03.23	10
1976.03.24	9.9
1976.03.25	9.7
1976.03.26	8.7
1976.03.27	7.9
1976.03.28	7.8

Extracted from PPT material for explanation of ArcHydro provided in http://www.crwr.utexas.edu/giswr/

10

Value Type of Time Series data

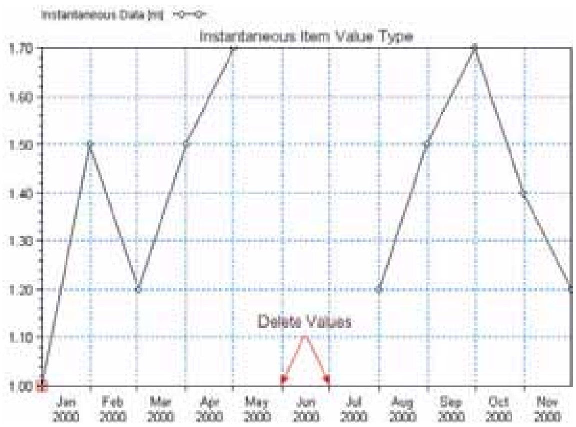
- How values are expressed with time?
  - Example:
    - Measured Velocity, water quality etc. at particular time
    - Measured rainfall amount for some time duration
    - Abstracted water amount in some tome period

Value Types of Time Series in DHI Data Model used in DHI software

- (1) Instantaneous
- (2) Accumulated
- (3) Step_Accumulated
- (4) Mean_Step_Accumulated
- (5) Reverse_Mean_Step_Accumulated

(1) Instantaneous

- The values are measured at a precise instant.
- Example
  - the wind velocity at a particular time is an instantaneous value.
  - Water Quality monitoring data

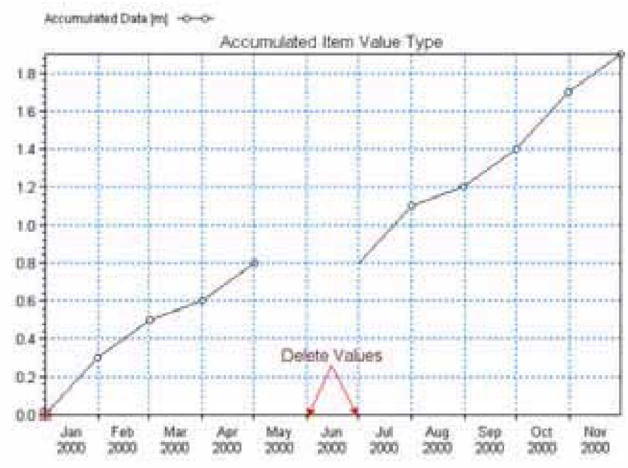


Extracted from User manual for Temporal Analysts

13

(2) Accumulated

- The values are summed over successive intervals of time and always relative to the same starting time.
- Example:
  - Total rainfall and/or total water amount abstracted accumulated over a certain total period.

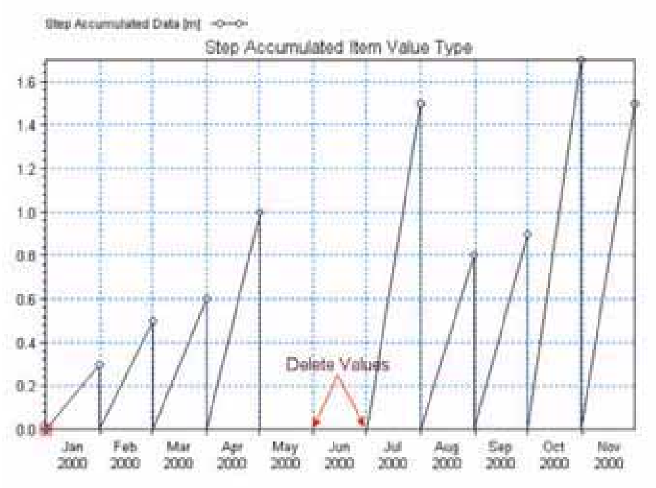


Extracted from User manual for Temporal Analysts

14

(3) Step_Accumulated

- The values are accumulated over a time interval, relative to the beginning of the interval.
- Example
  - A rain gauge measures

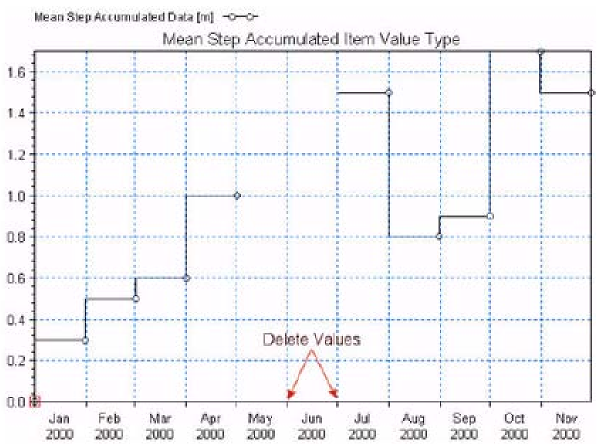


Extracted from User manual for Temporal Analysts

15

(4) Mean_Step_Accumulated

- The values are summed over successive intervals of time and always relative to the same starting time.
- Example:
  - Total rainfall and/or total water amount abstracted accumulated over a certain total period.

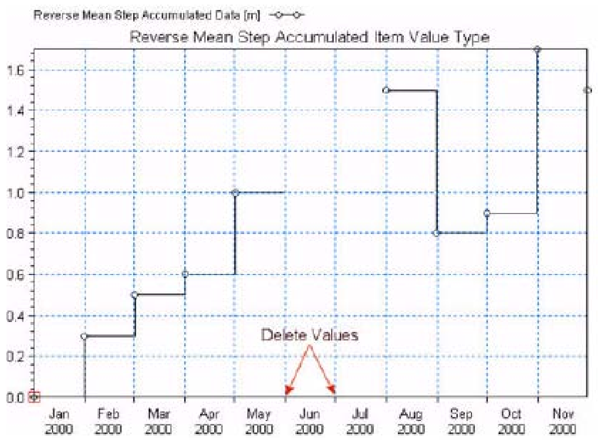


Extracted from User manual for Temporal Analysts

16

(5) Reverse_Mean_Step_Accumulated

- In this case, the values are the same as the Mean Step Accumulated, but the values represent the time interval from now to the start of the next time interval.



Extracted from User manual for Temporal Analysts

17

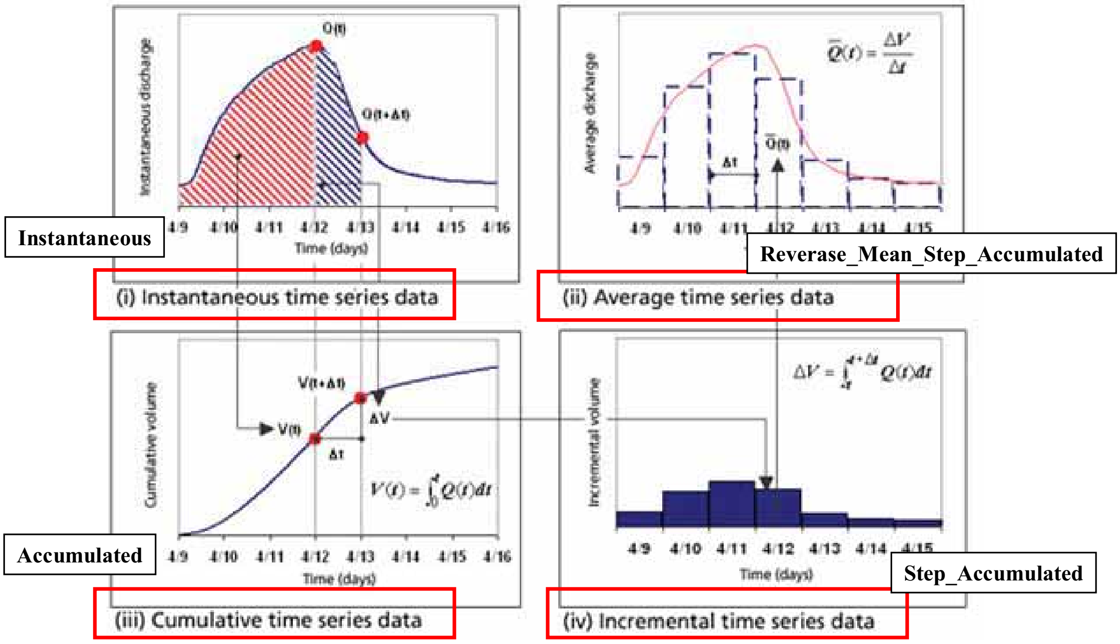
ArcHydro

- ArcHydro is a Data Model for water resources modeling developed in GIS Water Resources Consortium

http://www.crwr.utexas.edu/giswr/

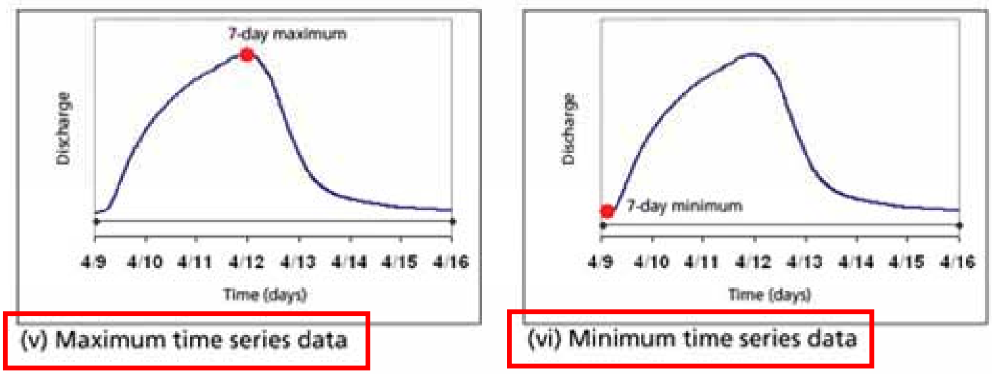
18

Value Type in ArcHydro (1)



Extracted from PPT material for explanation of ArcHydro provided in http://www.crwr.utexas.edu/giswr/ 19

Value Type in ArcHydro (2)



Extracted from PPT material for explanation of ArcHydro provided in http://www.crwr.utexas.edu/giswr/ 20

Comparison between Value type in ArcHydro data Model and Value Type in DHI data model

Domain in ArcHydro	***Domain in DHI data model***
TSDataType	**DHITSDataType**
1 Instantaneous	0 Instantaneous
2 Cumulative	1 Accumulative
3 Incremental	2 Step_Accumulated
-	3 MeanStepAccumulated
4 Average	4 Reverse_Mean_Step_Accumulated
5 Maximum	-
6 Minimum	-

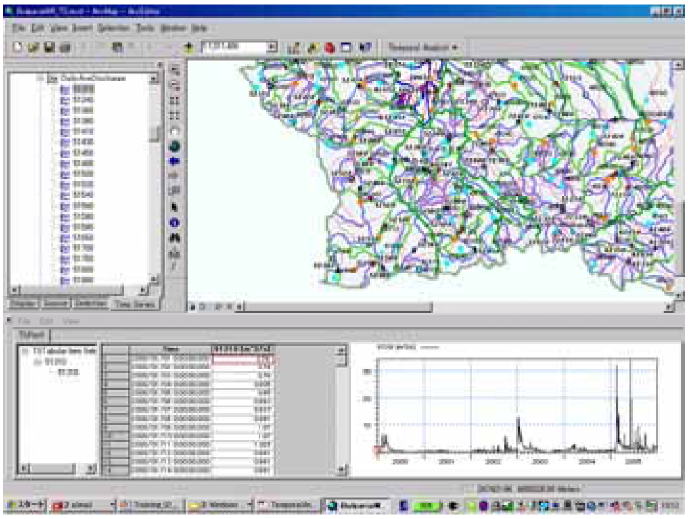
21

Time Type

- *Regular*
  - *Time interval is fixed and its value is specified*
    - *Example*
      - *Daily Rainfall amount*
      - *Daily average Water quantity*
- *Irregular*
  - *Time interval is not fixed.*
    - *Example*
      - *Water quality monitoring data*

22

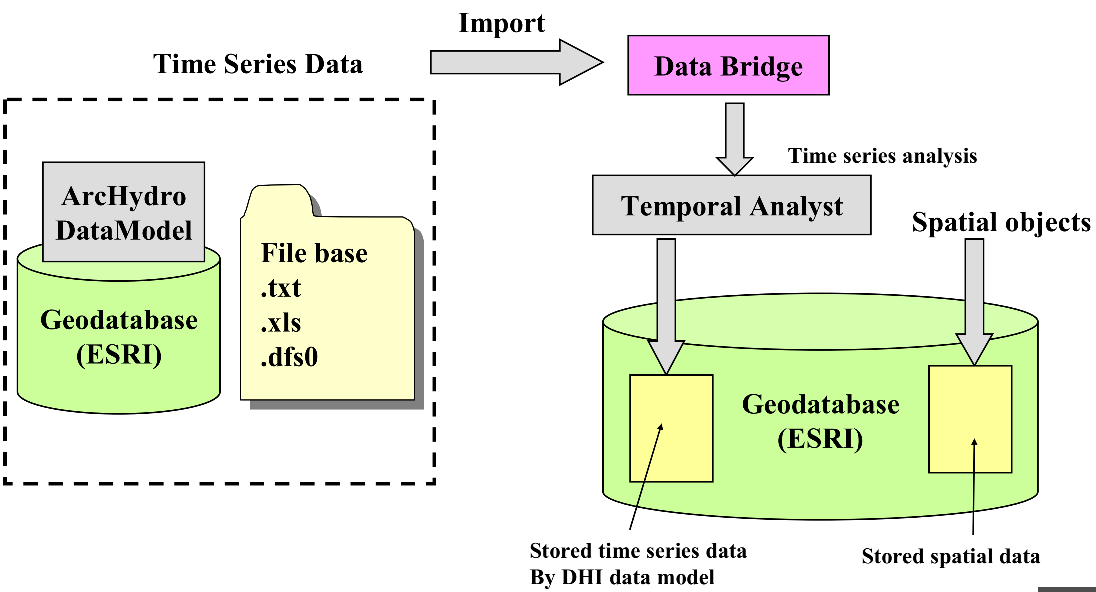
Demonstration of Time Series Data for Modeling in the Study using Temporal Analysts



23

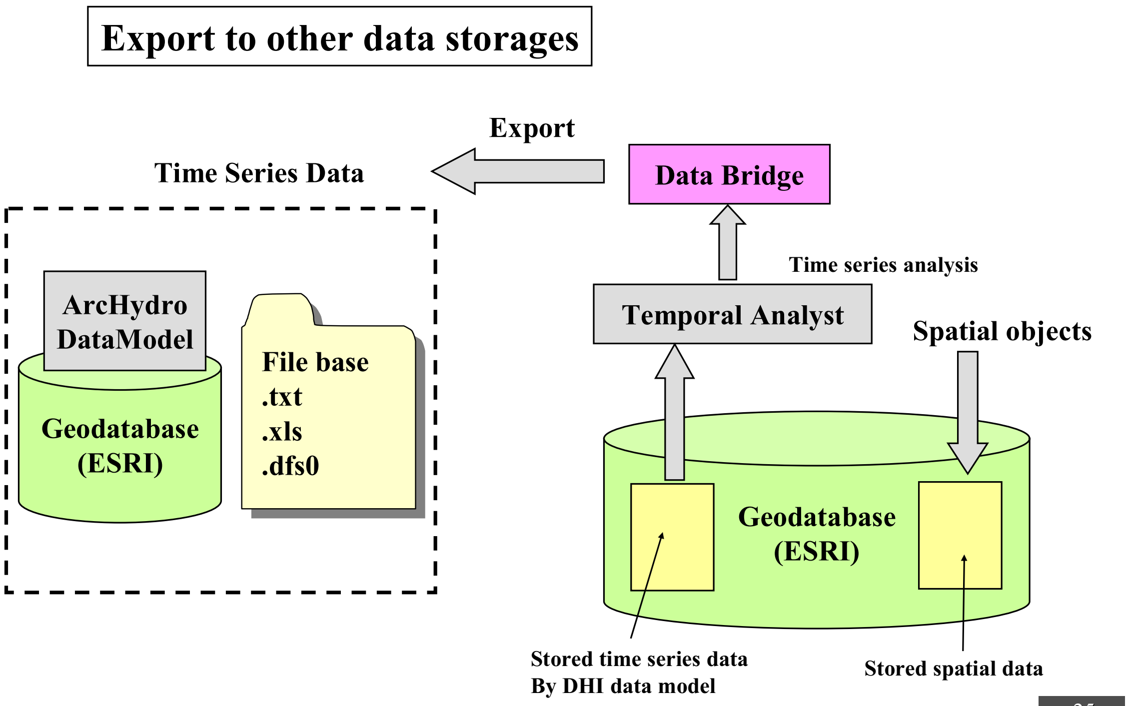
Data Access by Temporal Analyst (1)

Import from other data storages



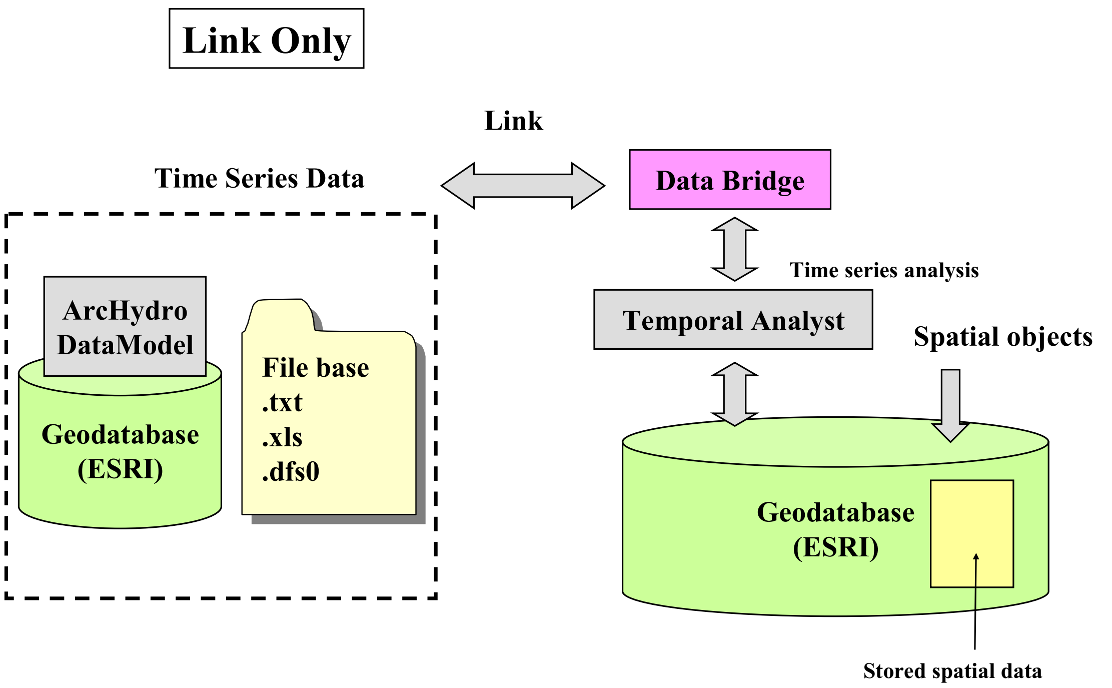
24

Data Access by Temporal Analyst (2)



25

Data Access by Temporal Analyst (3)

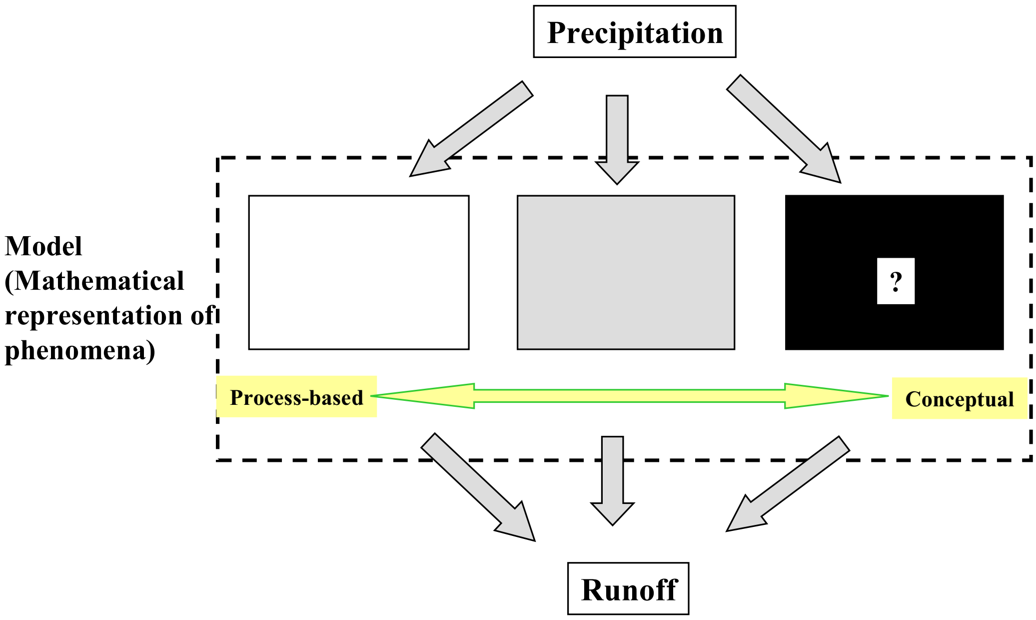


26

Rainfall – Runoff Model
General

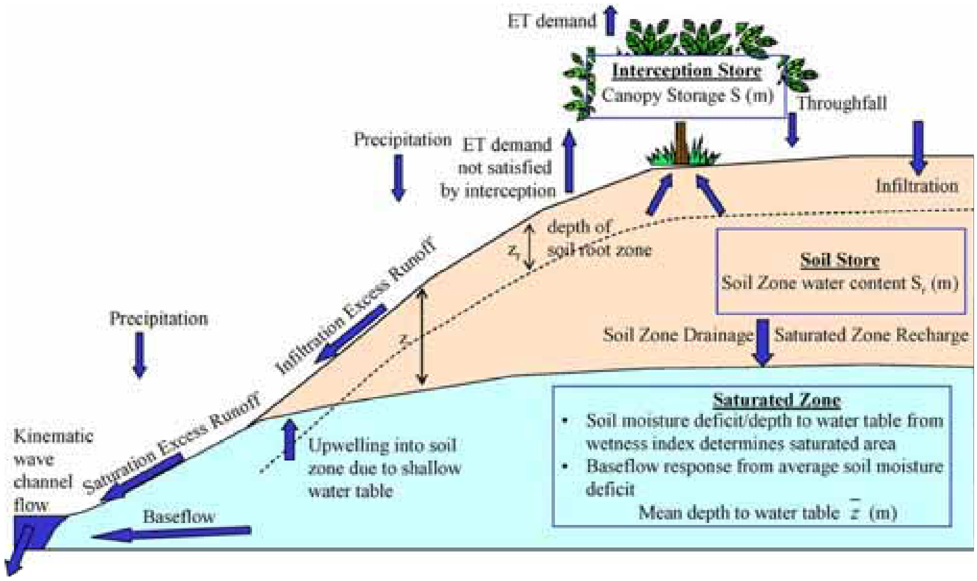
2

Process-based *vs* Conceptual



3

Process-based model



From C. Bandaragoda et al. / Journal of Hydrology 298 (2004) 178–201

4

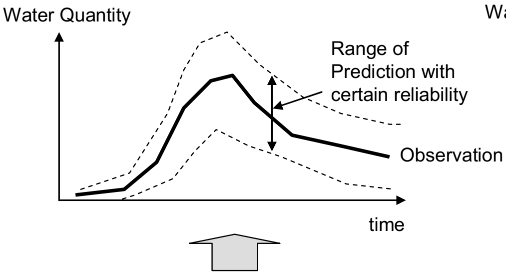
Model Parameters and Calibration

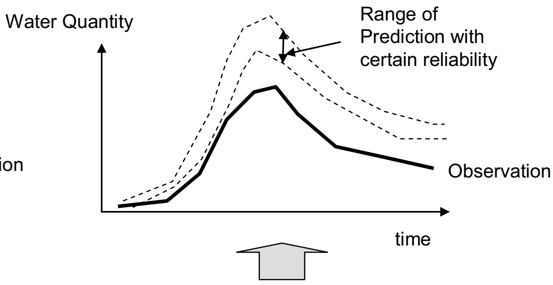
- Any model has model parameters.
- Calibration is necessary for any model.

5

Uncertainty of Prediction

General view on sensitivity of model output against model parameter





Process-based model with many components

- ***WIDE*** range of prediction with certain reliability
- Observation tends to be **within the range of prediction**

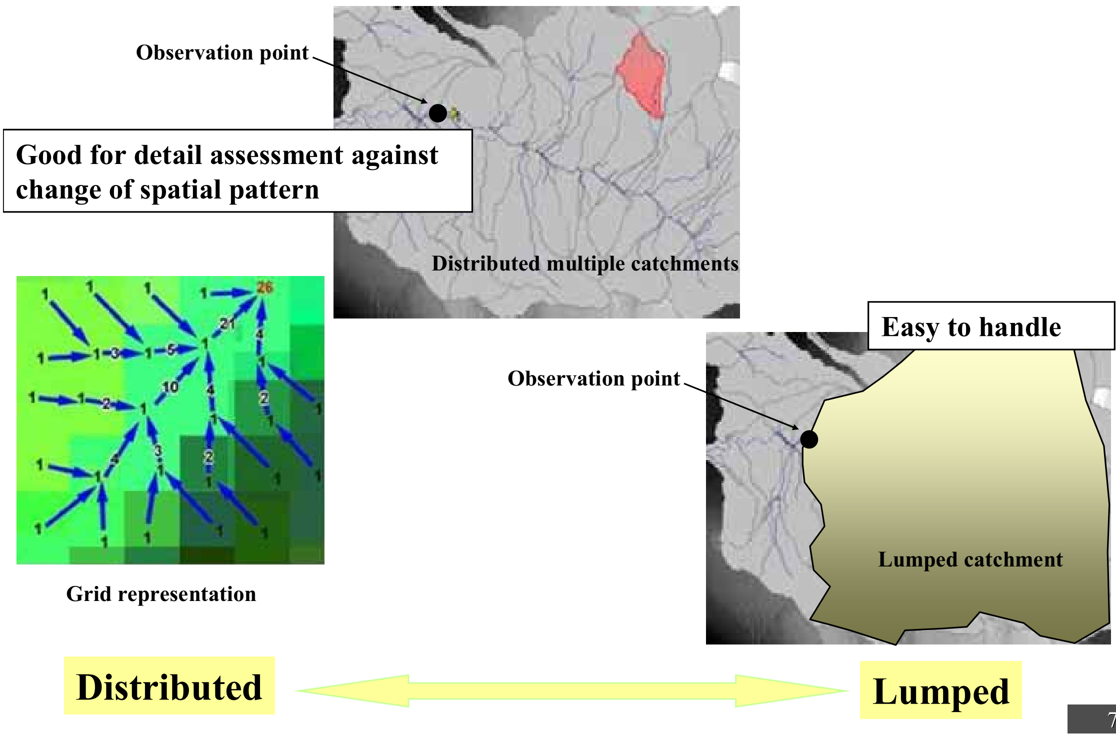
Conceptual model with simple components

- ***Narrow*** range of prediction with certain reliability
- Observation tends to be **out of the range of prediction**

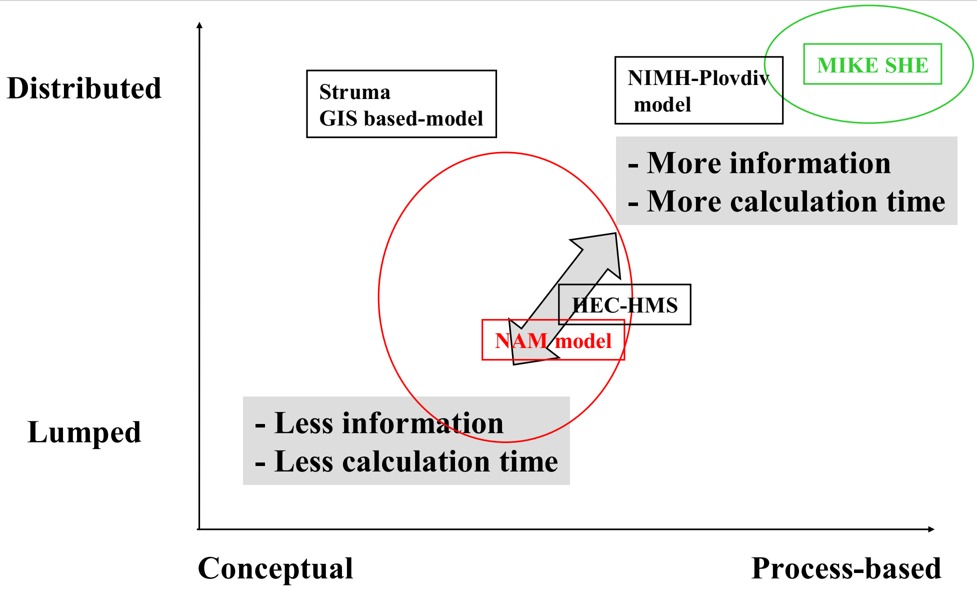
Prepared based on the research results by Sayama et.al (2005):Journal of Japan Society of Civil Engineers

6

Distributed *vs* Lumped



7



Struma GIS based model: Knight, C.G., Chang, H., Staneva, M.P. and Kostov, D.: A Simplified Basin Model for Simulating Runoff: The Stuma River GIS, Professional Geographer, 53(4), pp533-545, 2001.

NIMH-Plovdiv model: Ерам Артинян: ХИДРОЛОГИЧНО МОДЕЛИРАНЕ НА ВИСОКАТА ВЪЛНА ПРЕМИНАЛА ПРЕЗ БАСЕЙНА НА Р. МАРИЦА ДО ГРАД ПЛОВДИВ ОТ 4 ДО 7 АВГУСТ 2005 г. АНАЛИЗ НА ВЛИЯНИЕТО НА ЯЗ. ТОПОЛНИЦА. (in Bulgarian).

8

Hydro Dynamic Model
General

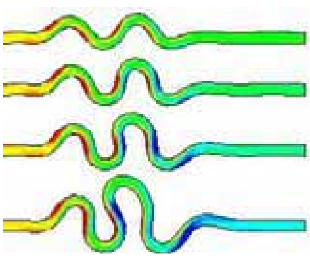
2

Dimension of model

from http://www.dhigroup.com/

1D Large scale assessment

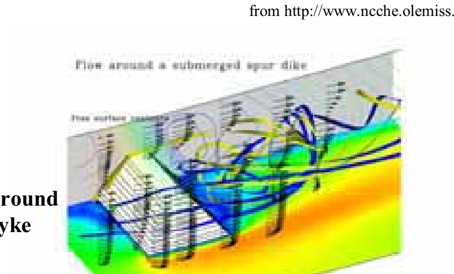
Meandering
Pool & Riffle



from http://www.ncche.olemiss.edu/

2D Reach scale assessment

Flow around
spur dyke

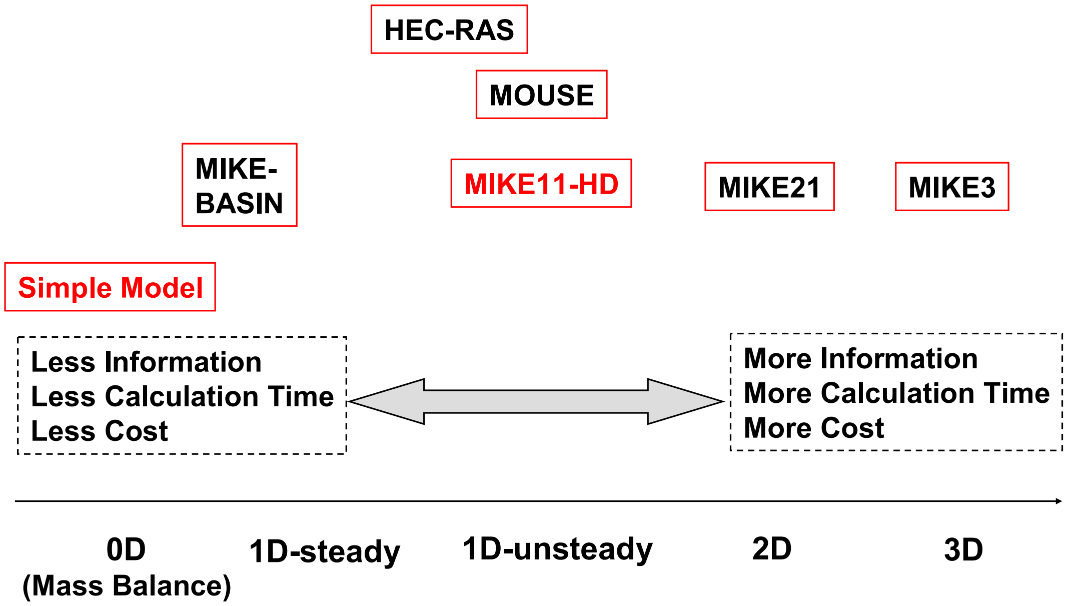


from http://www.ncche.olemiss.edu/

3D Near field scale assessment

3

Choosing dimension of model



4

Governing Equations

- Governing Equations
  - Continuity of Fluid flow (Mass balance)
  - Momentum Conservation of Fluid Flow (Momentum Balance)
- Governing equations are originally 3-dimenisonal
  - For 1-D simulation, spatial averaging of governing equations are applied.

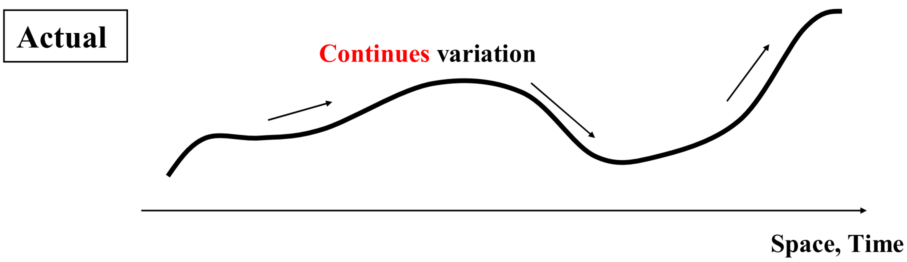
5

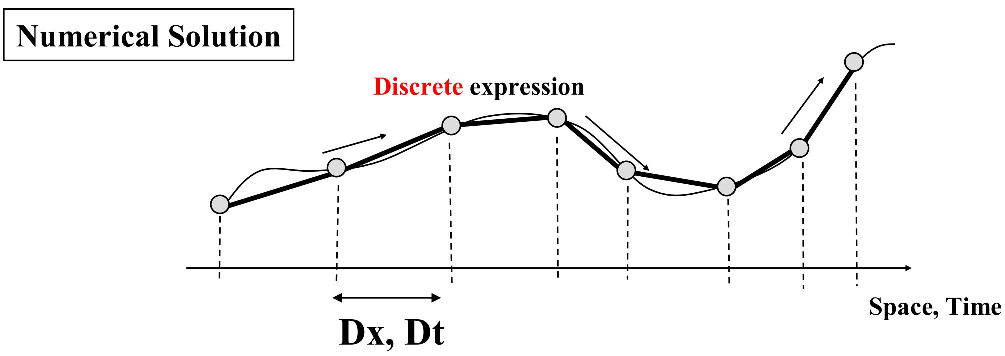
Options for Flow Approximation

- Dynamic wave model
  - Momentum equations for water flow are fully solved.
  - Mainly for flat area and low slope channel
- Diffusion wave model
  - Simplified expression of momentum equations rfor water flow
  - Mainly for mountain area and high slope channel
- Kinematic wave model
  - No momentum equations are solved. Only resistance law is applied.

6

Numerical Approximation





7

General Constraints

- It is very easy for numerical solution of flow to become unstable.
- To avoid numerical instability, Dt/Dx should be sufficiently small.

- Smaller Dx (High resolution in space) requires smaller Dt, which means more calculation time.

8

GUIDELINE

Formulating Monitoring System

1. Introduction

New Monitoring Program formulated by MoEW and Basin Directorates

Based on the risk assessment of surface water bodies and groundwater bodies, MoEW and the Basin Directorates formulated the New Monitoring Programs in March 2007, which is composed of new programs for surface water monitoring and groundwater monitoring.

In compliance with the requirements of the EU-WFD, the new program for surface water monitoring includes surveillance monitoring (control monitoring) and operational monitoring. The surveillance monitoring will make overview the condition of the basin, give idea for efficient monitoring program in the future, and monitor long-term changes of the basin. The operational monitoring will monitor the status of the water bodies at risk, and assess the impact of the programme of measures.

The surveillance monitoring and the operational monitoring will monitor surface water quality in terms of hydro-biological indicators and physico-chemical parameters. Hydro-biological indicators to be monitored are Phytoplankton, Macrophytes, Phytobenthos, Macrozo benthos / Bottom invertebrate, Fishes and others. Physico-chemical parameters to be monitored are 1st Group (common parameters such as pH, temperature, DO, BOD5, COD, NH4-N, NO2-N, NO3-N, and PO4-P etc.), 2nd Group (TN, TP, Ca, Mg, hardness etc.), the Group of Priority substances (33 harmful substances such as Alachlor, Anthracene, Benzene etc.), and the Group of Specific polluters (organic substances and heavy metals). Number of parameters to be monitored and frequency of monitoring differs for the monitoring stations, which is composed of once or twice per year for hydro-biological indicators and every month (especially the priority substances) to once in three months for physico-chemical parameters. The number of the monitoring points is shown in the table below.

Number of the New Surveillance (Control) Monitoring Points for Surface Water

Basin Directorate	River	Lake	Coastal Water
DRBD	92	41	-
BSBD	26	12	7
EABD	27	5	-
WABD	33	16	-
Sub-Total	178	74	7
Total	259		

Number of the New Operational Monitoring Points for Surface Water

Basin Directorate	River	Lake	Coastal Water
DRBD	55	-	-
BSBD	32	16	6
EABD	58	4	-
WABD	80	12	-
Sub-Total	225	32	6
Total	263		

Considering the existing insufficient capacity of experts in Basin directorates and laboratories, stage-wise implementation is considered by MoEW and Basin Directorates for the New Monitoring Program. After one year of full implementation of the above New Monitoring Program, it will be possible to review the results and performance of the New Monitoring Program, and will be improved to make more efficient and reliable monitoring program.

Purpose of This Guideline

This "Guideline for Formulating Monitoring System" has prepared for MoEW and Basin Directorates for referring in case of considering improvement of the New Monitoring Program on surface water to be more efficient and reliable one as well as cost effective one in the future.

2. Proposed Guideline

2.1 Setting Reliable Stations for Stable Monitoring

(1) Total number of the monitoring points of the New Surface Water Monitoring Program in the country is 522 points, which is slightly more than the number of the points of the existing surface water monitoring of EEA. However, the parameters to be monitored are very much increased and their frequency for monitoring is also rather high (ex. 12 times per year for the priority substances for surveillance monitoring during at least one year). Furthermore, Bulgaria has not so much experience for measuring many of the priority substances.

Considering this situation, it is recommendable to set Key Monitoring Stations as well as Important Monitoring Stations among the surveillance monitoring points to ensure stable monitoring, and to overview the water quality conditions of the river basins. Furthermore, at these Key and Important stations, it is necessary to measure the water quantity as well.

Frequency of Measurement at Key and Important Stations

Key/Important Monitoring Stations	Monitoring
1. Key Monitoring Station	• Daily ocular observation and simple on-site measurement. • Monthly sampling and laboratory tests.
2. Important Monitoring Station	• Weekly ocular observation and simple on-site measurement. • Monthly sampling and laboratory tests.

(2) By the observation at the Key and Important Monitoring Stations, not only sampling and laboratory tests, but also ocular observation and simple on-site measurements will be conducted every day at the Key Stations and once in every week at the Important Stations to conduct something like real-time monitoring of water quality conditions in the river basins. If any strange facts such as strange color of water or death of fish etc. is observed or abnormal value of water physico-chemical parameter is measured, immediately, further detailed

investigation shall be conducted to clarify the problem of pollution for making necessary countermeasures against the problem.

(3) Hydro-biological indicators and the physico-chemical parameters to be measured at the Key and Important Stations will be followed the requirement of EU-WFD.

(4) Example of the Key and Important Zones (area range to set the Key and Important Stations) in EABD and WABD is shown in Fig. 1, which is composed of 19 places for Key Zones (such as after junction of major tributaries, country border and some other problematic places for heavy metal pollution) and 14 places for Important Zone (such as supplementary places in the main river and main tributary). Like this way, if the Key Zones will be set in the whole country, the number will be around 50 or 60 places, and that of Important Zones will be around 30 to 40 places.

(5) It is recommendable to start monitoring at the above Key and Important Monitoring Zones under cooperation from some of the municipalities as the pilot cases, and will be extended to all over the Basin District Areas.

(6) Furthermore, the results of the monitoring at the Key Monitoring Zones and Important Monitoring Zones will be reported to EU instead of the above 259 surveillance stations.

2.2 Combinations of the Monitoring Stations for EU-WFD and Monitoring Stations for Domestic Purpose

(1) Considering the efficient and cost effective monitoring, it is necessary to separate the monitoring stations for EU-WFD (surveillance monitoring stations and operational monitoring stations) and the monitoring stations for domestic purpose in Bulgaria only.

(2) At the monitoring stations for EU-WFD, all of the hydro-biological indicators as well as many parameters required by EU-WFD will be measured.

(3) At the monitoring stations for domestic purpose only, smaller numbers of hydro-biological indicators and physico-chemical parameters (such as the current conventional parameters measured by EEA) will be measured.

(4) Even for the monitoring stations for EU-WFD, the numbers of the parameters including the priority substances to be measured will be optimized based on the results of measurement during two to three years.

(5) In this way, more efficient and cost effective monitoring can be conducted.

2.3 Quality Control and Training for the Monitoring Staff

In terms of physico-chemical measurement, the existing data seems to be unreliable in many cases such as BOD5, COD_{Mn}, and heavy metals. Therefore, it is very necessary to formulate quality control program for sampling and laboratory test. As many priority substances are required to be measured, quality control is also important.

Furthermore, EU-WFD requires to measure several hydro-bilogical indicators. As the existing hydro-biological monitoring is mainly based on the macrozo benthos / bottom invertebrate, there are not so much experience and experts for other indicators.

Considering the above situation, it is recommendable to formulate quality control program including training program for the monitoring staff of Basin Directorates and the Regional Laboratories among the monitoring program as follows;

(1) Central laboratory in EEA shall formulate quality control teams with qualified experts.

(2) In order to check the quality of the sampling and tests by different laboratories, test the same sample by different laboratories at the same time. In this case, the central laboratory (EEA) should coordinate the checking activity.

(3) For heavy metals and the priority substances, send samples to the reliable laboratories of other countries and compare the test results made by the laboratories in Bulgaria.

(4) The quality control team of the central laboratory shall periodically go around the regional laboratories in the country for checking the activity of sampling and the results of laboratory tests, and make guidance and training to the staff of the regional laboratories.

Proposed Key and Important Monitoring Zones in EABD and WABD