# 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.

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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.

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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.

# <u>M</u>odel 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>Abstractions (A001, A002, A00...)</u>

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.

## Distributed Domestic 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.

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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.

# Domestic Point 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.

Joundary Dr	scription	Boundary T	vpe Branch Name	Chainage	Chainage	Gate ID	Boundary ID	
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loint Source	In	flow	ST_STR	5510	0		DP026 Kamalovo	
oint Source	In	flow	ST_STR	18716	0		DP027 Kolarovo	-
cont Source	In	Row	ST_STR	15115	0		DP020 Pervowey	
cent Source	In	flow	ST_STR	8576	0		OP029_Petrich	
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coint Source	In	Row	ST_M	91251	0		1P002_01M+1.1D	
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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 = <u>Livestock Point</u> 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.

	Boundary De	scription	Boundary 1	Type Bear	ch Name	Chainage	Chainage	Gate ID	Boundary ID		
	Point Source	1	nillow	ST_M	1	144575	0		SLSP01 "Atanas "Yosifov" calt	els	
	Point Source	4	niflow	ST	t i	156200	0		SLSP02 Poultry Farm "Valde"		
	Point Source	1	nflow	51_1	t	104477	0		SLSP03 "Boris Kiroychev" catte	45	
-	Point Source	1	niflow	ST_D	ZH	6526	0		SLSP04 "Nikola Malmov" Cattel	8	
	Point Source	1	nflow	51.9		92720	0		SLSP05 "Kenibarou MM 5" JSC	o-Pigs	
Mike	Data Type Discharge:	TS Type Const :0	File / 1	/alue	TS Info				-		
	Component	Data Type	ТЅТуре	78e	/ Value	TSI	info Scale	Facto			
_	3	Concentra	Charles Device the	SPECIFIC F							
	2	Concentra Concentra	Constant	109.115068							
	3 5 6	Concentra Concentra Concentra	Constant Constant	109.115068				i			
	3 5 6	Concentra Concentra Concentra	Constant	109.315066				i			
	3	Concentra Concentra Concentra	Constant	10.116438				1			
	3	Concentre Concentre Concentre	Constant Constant	109.315068				i			
	3	Concentra Concentra Concentra	Constant	109.315068				i			
	3	Concentra Concentra Concentra	Constant	100.115086				i			

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.

oint Source oint Source our Source oint Source oint Source oint Source oint Source oint Source oint Source oint Source	Copy/Paste Boundary o Change Scale Pactor Inflow Inflow Inflow Inflow	Table H A H H H H H H H	14644 14644 14644	0	DP002_Bistritsa DP002_Bistory dol	
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Figure 7 Activation of facility for Copy/paste Boundary Condition

	soment 1	Compos	nent 2	Compo	nent 3	Compos	nent 4	Compo	event 5	Compos	neni f	Compo	event 7
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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.

- I DOWNING P	Description	Boundary Type	Branch Name	Chainage	Chainage	Gate ID	Boundary ID	1
Distributed	Source 1	nilow	ST M	200053	244563		[Load: Nonpoint, Interflow]	
2 Distributed	Source 1	rficine	ST_M	200353	244563		[Load: Nonpoint, Baseflow]	
8 Distributed	Source 1	inflow	ST_PIR	1000	12938		[Load: Norpoint, Overland]	
9 Distributed	Source 1	inflow	ST_PR	1000	12938		[Load: Nonpoint, Interflow]	
0 Distributed	Source 1	nBave	ST_PIR	1000	12938		[Load: Norpoint, Baseflow]	
Point Source	e 1	Inflow	ST_PIR	12938	12938		[Load: Nonpoint, Overland]	
<ol> <li>Point Source</li> </ol>	• 1	infigue	ST_FOR	12938	12938		[Load: Nonpoint, Interflow]	
3 Point Source	e 1	Inflam	57_P39.	12938	12938		[Load: Nonpoint, Basellow]	
4 Point Source	e 1	nflore	ST_M	100421	100421		[Load: Nonpoint, Overland]	
S Point Source	e : 1	inflow	ST_M	100421	100421		[Load: Nonpoint, Interflow]	
6 Point Source	e  1	Max	ST_M	100421	100421		[Load: Nonpoint, Baseflow]	
2 Point Source	e 3	inflow	ST_M	23568	23560		[Load: Nonpoint, Overland]	
8 Point Source	é 3	trificae	ST_M	23568	23568		[Load: Nonpoint, Interflow]	
9 Point Source	e 1	Inflore	ST_M	23568	23568		[Load: Nonpoint, Baseflow]	
D Pont Source	6 1	nflow	ST_M	150055	150055		[Load: Nonpoint, Overland]	
1 Point Source	e 1	Inflowe	ST_M	150895	150855		[Load: Nonpoint, Interflow]	
2 Point Source	e 1	inflow	ST_M	150055	150055		[Load: Nonpoint, Baseflow]	
B Distributed	Source 1	offere	ST_STR	0	22779		[Load: Norpoint, Overland]	
04 Distributed	Source 1	Inflow	ST_STR	0	22779		[Load: Nonpoint, Interflow]	
5 Distributed	Source 1	пЛан	ST_STR	Ó	22779		[Load: Nonpoint, Baseflow]	
55 Distributed	Source 1	Inflaw	ST_STR	22779	29203		[Load: Nonpoint, Overland]	
AD - RR		Catchwork Acea RB Row type	ST_STR1 360.68 Surface Runolf	-				
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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 %.

Boundary De	scription	Boundary Type	Branch Name	Chainage	Chainage	Gate ID	Boundary ID	0
Distributed Sou	ece D	nillow	ST M	51060	56206		[Load: Nonpoint, Baseflow]-fertil	
Distributed Sou	rce D	Allow	ST.M	66206	90002		[Load: Nonpoint, Overland]-Fertil	
Distributed Sou	rce D	wolk	ST_M	56206	90002		[Load: Nonpoint, Interflow] fertil	
Distributed Sou	rce D	niflow	ST_M	56206	90002		[Load: Nonpoint, Baseflow]-fertil	
Distributed Sou	rce b	work	ST M	90002	111071		Load: Nonpoint, Overland]-fertil	
Distributed Sou	rce b	wolki	ST_M	90002	111071		[Load: Nonpoint, Interflow]-fertil	
Distributed Sou	rce D	niflow	ST_M	90002	111071		[Load: Nonpoint, Baseflow]-fertil	
Distributed Sou	rce b	nflow	ST_BAN	U	9330		[Load: Nonpoint, Overland]-fertil	
Distributed Sou	rce li	allow	ST_BAN	0	9330		[Load: Nonpoint, Interflow]-fertil	
Distributed Sou	rce D	niflow	ST_BAN	Ó	9330		[Load: Nonpoint, Baseflow]-ferts	
Distributed Sou	rcé b	nflow	ST_M	311071	150021		[Load: Nonpoint, Overland]-ferti	
Distributed Sou	rce b	nflow	IST_M	111071	158021		[Load: Nonpoint, Interflow]-fertil	
Distributed Sou	ece D	niflow	ST_M	111071	158021		[Load: Nonpoint, Baseflow]-fertil	
Distributed Sou	rce b	nflow	\$7_M	150021	192057		[Load: Nonpoint, Overland]-fertil	
Distributed Sou	rce D	nflow	ST_M	158021	192057		[Load: Nonpoint, Interflow]-fertil	
Distributed Sou	rce D	niflow	ST_M	158021	192057		[Load: Nonpoint, Baseflow]-fertil	
Distributed Sou	rce b	nflow	\$T_M	192057	200353		[Load: Nonpoint, Overland]-fertil	
Distributed Sou	rce b	allow	ST_M	192057	200353		[Load: Nonpoint, Interflow]-fertil	
Distributed Sou	rco D	niflow	ST_M	192057	200353		[Load: Nonpoint, Baseflow]-fertil	
Distributed Sou	rce D	nflow	ST_M	200053	244563		[Load: Nonpoint, Overland]-fertil	
Distributed Sou	rce li	nélow	5T_M	200353	244563		[Load: Nonpoint, Interflow]-fertil	
		Aves Fift flow type	516.02  Surface Runolf	-				
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	Concentry of	Constant Los	NTO DE CELORO N	THE PARTY OF	_			
-	Terrane alter	TO FILE	Inco & Time Series ( To	In an I Town				
	and the second	110100 100	Abor Interstite	IESCI (colo)				
12 1								

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.

iource iource iource	Inflore	the second se	Chamage	Chainage	Gate ID	Boundary ID	
iource iource		ST M	51060	56206		Road: Nonpoint, Baseflow)-ferti	
lource	anficee	ST_M	56206	90002		[Load: Nonpoint, Overland]-fertil	
	Inflow	ST_M	56206	90002		[Load: Norpoint, Interflow]-fertil	
durot	Inflow	ST_M	\$6206	90002		[Load: Nonpoint, Baseflow]-Fertil	
lource	Inflore	ST_M	90002	111071		[Load: Norpoint, Overland)-fertil	
iource	Inflore	ST_M	90002	111071		[Load: Nonpoint, Interflow]-fertil	
iource	Infine	ST_M	90002	111071		[Load: Nonpoint, Baseflow]-Fertil	
kource	Inform	ST_BAN	0	9330		[Load: Nonpoint, Overland]-ferbil	
lource	Inflore	ST_DAN	0	9330		[Load: Nonpoint, Interflow]-fertil	
iource :	Inflore	ST_BAN		9330		[Load: Norpoint, Baseflow]-fertil	
ource	1Mon	ST_M	111071	158021		[Load: Nonpoint, Overland] fertil	
ource	Inflore	ST_M	111071	150021		[Load: Nonpoint, Interflow]-fertil	
iource	3rd Con	ST_M	111071	158021		(Load: Norpoint, Baseflow) fertil	
iource	Inflore	ST_M	158021	192057		[Load: Nonpoint, Overland]-Fertil	
ource	Infloire	ST_M	150021	192057		[Load: Nonpoint, Interflow]-Fertil	
lource	3rdfore	ST_M	158021	192057		[Load: Norpoint, Baseflow]-fert/	
lource	Inflore	ST_M	192057	200353		[Load: Nonpoint, Overland]-fertil	
ource	Infigue	57_M	1903057	200353		[Load: Norpoint, Interflow]-fertil	
ource	3/4/044	ST M	192057	200353		[Load: Nonpoint, Baseflow]-fertil	
ource	Inform	5T_M	200353	244563		[Load: Nonpoint, Overland]-fertil	
ource	Indian	ST_M	200353	244563		[Load: Nonpoint, Meethow]-fertil	
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Stock         111071           ource         Inflow         ST, M.M.         00002         111071           ource         Inflow         ST, BAN.         0         9339           ource         Inflow         ST, BAN.         0         9330           ource         Inflow         ST, BAN.         0         9330           ource         Inflow         ST, M.M.         0         9330           ource         Inflow         ST, M.M.         0         9330           ource         Inflow         ST, M.         111071         158021           ource         Inflow         ST, M.         111071         158021           ource         Inflow         ST, M.         111071         158021           ource         Inflow         ST, M.         110071         158021           ource         Inflow         ST, M.         150021         192057           ource         Inflow         ST, M.         159021         192057           ource         Inflow         ST, M.         192057         200053           ource         Inflow         ST, M.         192057         200053 <th>0006 2HNe 31,21 90002 111071 0006 2HNe 37,844 0 9330 0006 2HNe 37,844 0 9330 0006 2HNe 37,844 0 9330 0006 2HNe 37,844 0 9330 0006 2HNe 37,44 111071 158021 0006 2HNe 37,44 111071 158021 0006 2HNe 37,44 111071 158021 0006 2HNe 37,44 111071 198021 0006 2HNe 37,44 11071 198021 0006 2HNe 37,44 10001 19007 0006 2HNe 37,44 198021 20053 0006 2HNe 37,44 19805 0006 2HNe 37,44 19805 0HNE 316,02 HR How type Groundwater Runoll ■</th> <th>DUCE         DVDM         D-1_m         D0002         1110/1         DUDM (Norport, sternborgetto)           parter         Dribes         ST_BM         0         9339         DubM (Norport, Sternborgetto)           parce         Dribes         ST_BM         0         9339         DubM (Norport, Sternborgetto)           parce         Dribes         ST_BM         0         9330         DubM (Norport, Sternborgetto)           parce         Dribes         ST_BM         0         9330         DubM (Norport, Sternborgetto)           parce         Dribes         ST_BM         0         9330         DubM (Norport, DetFind)           parce         Dribes         ST_M         111071         158021         DubM (Norport, DetFind)           parce         Dribes         ST_M         111071         158021         DubM (Norport, DetFind)           parce         Dribes         ST_M         111071         158021         DubM (Norport, DetFind)           parce         Dribes         ST_M         110011         158021         DubM (Norport, DetFind)           parce         Dribes         ST_M         158021         DubM (Norport, DetFind)         DetFind)           parce         Dribes         ST_M         158021&lt;</th>	0006 2HNe 31,21 90002 111071 0006 2HNe 37,844 0 9330 0006 2HNe 37,844 0 9330 0006 2HNe 37,844 0 9330 0006 2HNe 37,844 0 9330 0006 2HNe 37,44 111071 158021 0006 2HNe 37,44 111071 158021 0006 2HNe 37,44 111071 158021 0006 2HNe 37,44 111071 198021 0006 2HNe 37,44 11071 198021 0006 2HNe 37,44 10001 19007 0006 2HNe 37,44 198021 20053 0006 2HNe 37,44 19805 0006 2HNe 37,44 19805 0HNE 316,02 HR How type Groundwater Runoll ■	DUCE         DVDM         D-1_m         D0002         1110/1         DUDM (Norport, sternborgetto)           parter         Dribes         ST_BM         0         9339         DubM (Norport, Sternborgetto)           parce         Dribes         ST_BM         0         9339         DubM (Norport, Sternborgetto)           parce         Dribes         ST_BM         0         9330         DubM (Norport, Sternborgetto)           parce         Dribes         ST_BM         0         9330         DubM (Norport, Sternborgetto)           parce         Dribes         ST_BM         0         9330         DubM (Norport, DetFind)           parce         Dribes         ST_M         111071         158021         DubM (Norport, DetFind)           parce         Dribes         ST_M         111071         158021         DubM (Norport, DetFind)           parce         Dribes         ST_M         111071         158021         DubM (Norport, DetFind)           parce         Dribes         ST_M         110011         158021         DubM (Norport, DetFind)           parce         Dribes         ST_M         158021         DubM (Norport, DetFind)         DetFind)           parce         Dribes         ST_M         158021<

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: <u>www.dhigroup.com</u>).

Mouse click on the *<View table>* ( $\rightarrow$  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.

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wry Cows	Livestock	Agrouture	Exiginia (Intestock/EgMun_L3	shp DelFD (constant	1 Tr 260	kglyr	0 -	118	Rght	0 -	17.5	1(plyr
ga	Livestock	Agrouture	Dugaria_Eventock/DgMun_L1	shp Pig PD [constant	TTr 0.0	kg/yr	0-	2.8	Rg/yr	0 -	1.6	Alg/yt
2005	Livestock	Agiculture	. Eugena (Nettock EgMun (L)	ste Br FD condet	T IP 33	kg/yr	014	5.0	89/14	0 =	- 4	8g/yr
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<ul> <li>I old old Node fre Node Type</li> <li>River node</li> </ul>		12	Outre The second	222 1941	IKE BASIN		17 M	ar it	11			

*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 livestock.

## 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/I).

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

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🚒 File Edit View Window Help											
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Model selection	·										
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C:\MIKE11_Bulgaria_WQ-template	WQIevel4PhosTNTF	P_TBOD.ecolab		·							
<u> </u>											
Solution parameters											
Integration method RKQC	·]										
Update frequency 1											
MIKE Zero - [ECOLab_Arda_Imal.ecolab11]     File Edit View Window Help     Model definition     State variables   Constants   Forcings   Auxiliary variables   Processes Derived output      Model selection     From File     C:\MIKE11_Bulgaria_WQ-template\WQlevel4PhosTNTP_TBOD.ecolab     Solution parameters   Integration method      RKQC        Update frequency     Disable calculation of processes, AD results only											
Summary											
State variables 7	Auxiliary v	ariables  22	_								
Constants 54	Processes	21	_								
Forcings 4	Derived or	utput  3									

Figure 16 User interface of the ECOLab Parameter file

	MIKE Zero - [ECOLab_Struma1.ecolab11]											
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Model	definition State variables	Constants	Forcings	Auxiliary	variables	Processes	Derived output					
	Description	Туре		Unit	¥alue	Local						
1	Dissolved oxygen	Transport	Concentration_3		mg/l	8						
2	Temperature	Transport	Undefined		Degrees	15						
3	Ammonia	Transport	Concentration_3		mg/l	0.2						
4	Nitrate	Transport	Concentration_3		mg/l	1						
5	BOD	Transport	Concentration_3		mg/l	5						
6	OrthoPhosphate	Transport	Concentration_3		mg/l	0.1						
7	Particulate Phosphorus	Transport	Concentration_3		mg/l	0.01						

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

🔀 MIKE Zero - [ECOLab_Ardafinal.ecolab11]												
👰 File Edit View Window Help												
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Select												
N N												
	Forcings Select V V	Forcings Auxiliary variables	Forcings     Auxiliary variables     Processes       Select     Image: Constraint of the second s	Forcings     Auxiliary variables     Processes     Derived output       Select     Image: Constraint of the second s								

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

- **D** 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

- **D** Existing condition
- D 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

25											
26											
27											
28											
29											
I4 4	H / Figure	Exis ing Pe	<u>rmission (Pe</u>	rmit_HPP 🖌 P	ermit_IRR <b>/</b> P	ermit_DWS 🖌	Permit_IWS 🏑	Transer_NoF	Record <mark>(MIKE</mark>	11_BC_File	Sum_AbstW_
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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.

1			P	D D	E	-	6		1	
	Title	Permission for Hydrong		U						•
0	Data Course	wapp	wei							
2	bata source	WADD								
4	Data Origin	Original								
5	bata origin	ongma								
6										
7										
8										
q q					liser					ocation of Intake
-										
	NO	Permission No	Expiry Date	Tytle	Name	Place	Category	1:SignificantRes 2:Local 3:Pipe	Name of WaterObject	Name of Milage
11		100010-000/19-09-2003	18.09.2009	Laki	"Lucky Energia" JSC	Sandanski	MR	2	Pirinska Bistritsa	1000
12	2	0225/28.03.2005	26.02.2011	2000		A //		2	Pinnska 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<sup>6</sup> 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	В	0	D	E	F	G	н	1	J	к		
	Title	Perm	nissio	n for Irrigation									
2	Data Source	WAB	D										
3													
1	Data Origin	Origi	inal										
5													
5													
7													
3													
							licer					Looption	
)							usei					Location	
			<b>n</b> (							Intake-ID			
	No	Regi	Ret.	Permission No	Expiry Date	Tytle	Name	Branch	Category	1:Significant Res	Name of WaterObject	Name o	
		INO			1	1			• •	2:Local	í í		
1	1	IRR			01.02.2005	Robeling Rec	Intrination Systems PLC Pemik Branch	Pernik	S1			Lobosh	
1	1	IRR	2	0105/01-00	27.06.2005	Pobeling Res	Irrigation Systems PLC Pernik Branch	Pemik	SI	2	Oslome	Lobosh	
1 2 3	1	IRR IRR	2	0383/27.06.2001 0384/27.06.2001	27.06.2005 27.06.2005	Pohelina Res Oslome Res	Imigation Systems PLC Pemik Branch Imigation Systems PLC Pemik Branch Imigation Systems PLC Pemik Branch	Pemik Pemik Pemik	si L	2	Oslome	Lobosh Yardzhi	
0 1 2 3 4	1 2 3	IRR IRR IRR	2 3 4	0383/27.06.2001 0384/27.06.2001 0384/27.06.2001	04.02.2005 27.06.2005 27.06.2005 27.06.2005	Pohelina Res Oslome Res Izvor Res Dona Dikania Res	Imigation Systems PLC Pemik Branch Imigation Systems PLC Pemik Branch Imigation Systems PLC Pemik Branch Imigation Systems PLC Pemik Branch	Pemik Pemik Pemik Pemik	SL L L	2	Oslome Izvor Dona Dikania	Lobosh Yardzhi Izvor	
0 1 2 3 4 5	1 2 3 4 6	IRR IRR IRR IRR	2 3 4 5	0383/27.06.2001 0384/27.06.2001 0385/27.06.2001 0385/27.06.2001	27.06.2005 27.06.2005 27.06.2005 27.06.2005 27.06.2005 27.06.2005	Pobelina Res Oslome Res Izvor Res Dona Dikania Res Goma Grachitza Res	Impation Systems PLC Penik Branch Impation Systems PLC Penik Branch Impation Systems PLC Penik Branch Impation Systems PLC Penik Branch Impation Systems PLC Penik Branch	Pemik Pemik Pemik Pemik Pemik		222222	Ponemia Oslome Izvor Dona Dikania Goma Grachitea	Lobosh Yardzhi Izvor Arkata	
1 2 3 4 5	1 2 3 4 6	IRR IRR IRR IRR	2 3 4 5 6	0383/27.06.2001 0384/27.06.2001 0385/27.06.2001 0385/27.06.2001	27.06.2005 27.06.2005 27.06.2005 27.06.2005 27.06.2005	Bohelina Res Oslome Res Izvor Res Dona Dikania Res Goma Grashitsa Res	Imigation Systems PLC Pemik Branch Imigation Systems PLC Pemik Branch Imigation Systems PLC Pemik Branch Imigation Systems PLC Pemik Branch Imigation Systems PLC Pemik Branch	Pemik Pemik Pemik Pemik Pemik		22222222	Oslome Izvor Dona Dikania Goma Grashitsa	Lobosh Yardzhi Izvor Arkata Goma (	
0 1 2 3 4 5	1 2 3 4 4 5 6	IRR IRR IRR IRR IRR IRR	2 3 4 5 6 7	0383/27.06.2001 0384/27.06.2001 0385/27.06.2001 0385/27.06.2001 0387/27.06.2001	27.06.2005 27.06.2005 27.06.2005 27.06.2005 27.06.2005 27.06.2005	Bobelina Res Oslome Res Izvor Res Dona Dikania Res Goma Grashitsa Res Drenov Dol Res	Imigation Systems PLC Pemik Branch Imigation Systems PLC Pemik Branch Imigation Systems PLC Pemik Branch Imigation Systems PLC Pemik Branch Imigation Systems PLC Pemik Branch	Pemik Pemik Pemik Pemik Pemik Pemik		2 2 2 2 2 2 2 2 2	orenina Oslome Izvor Dona Dikania Goma Grashitsa Drenov Dol	Lobosh Yardzhi Izvor Arkata Goma ( Kyuste	
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0 1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 7 8	IRR IRR IRR IRR IRR IRR IRR	2 3 4 5 6 7 7 7	0103/07120-0201 0383/27.06.2001 0384/27.06.2001 0385/27.06.2001 0388/27.06.2001 0388/27.06.2001 0388/27.06.2001	27.06.2005 27.06.2005 27.06.2005 27.06.2005 27.06.2005 27.06.2005 27.06.2005 27.06.2005 27.06.2005	Pohelina Res Oslome Res Izvor Res Dona Dikania Res Gorna Grashitsa Res Drenov Dol Res Lozno Res Barenoti Res	Imitation Systems PLC Pernik Branch Imitation Systems PLC Pernik Branch	Pemik Pemik Pemik Pemik Pemik Pemik Pemik		2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	Osheina Oslome Izvor Dona Dikania Goma Grashitsa Drenov Dol Banska Bancentei	Lobosh Yardzhi Izvor Arkata Goma ( Kyuster Zhilintsi Baggent	
0 1 2 3 4 5 6 7 8 9	1 2 3 4 6 6 7 8 9	IRR IRR IRR IRR IRR IRR IRR IRR IRR	2 3 4 5 6 7 7 8	0183/27.06.2001 0383/27.06.2001 0384/27.06.2001 0387/27.06.2001 0387/27.06.2001 0388/27.06.2001 0388/27.06.2001 0388/27.06.2001	94.03.2005 27.06.2005 27.06.2005 27.06.2005 27.06.2005 27.06.2005 27.06.2005 27.06.2005 27.06.2005 27.06.2005	Pohalina Res Ostome Res Dava Res Dona Dikania Res Goma Grashitsa Res Drenov Dol Res Lozno Res Bagrentsi Res Bersin Res	Imitation Systems PLC Penik Branch Imitation Systems PLC Penik Branch	Pemik Pemik Pemik Pemik Pemik Pemik Pemik Pemik Pemik		2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	Porteinta Oslome Izvor Dona Dikania Goma Grashitsa Drenov Dol Banska Bagrentsi Bersin	Lobosh Yardzhi Izvor Arkata Goma ( Kyuster Zhilintsi Bagrent Bersin	
0 1 2 3 4 5 6 7 8 9 0	1 2 3 4 6 6 7 8 9 9	IRR IRR IRR IRR IRR IRR IRR IRR IRR IRR	2 3 4 5 6 7 7 8 8 8	0183/07.06.2001 0383/27.06.2001 0386/27.06.2001 0386/27.06.2001 0386/27.06.2001 0386/27.06.2001 0386/27.06.2001 0386/27.06.2001 0386/27.06.2001	21.00.2005 27.06.2005 27.06.2005 27.06.2005 27.06.2005 27.06.2005 27.06.2005 27.06.2005 27.06.2005 27.06.2005 27.06.2005	Pohalina: Bas Oslome Res Izvor Res Dona Dikania Res Ooma Grashitsa Res Drenov Dol Res Lozno Res Bagrentsi Res Bersin: Res Mi Bercin, canal	Imigation Systems PLC Pernik Branch Imigation Systems PLC Pernik Branch	Pemik Pemik Pemik Pemik Pemik Pemik Pemik Pemik Pemik Pemik	L L L L L L L	2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	Ostreina Oslome Izvor Dona Dikania Goma Grashitsa Drenov Dol Banska Bagrentsi Bersin Novoceleka	Lobosh Yardzhi Izvor Arkata Gorna ( Kyuster Zhilintsi Bagrent Bersin	

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<sup>6</sup> 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	в	C	D	E	F	G	н	1	J	K	L	
1	Title	Perm	nissi	on for DrinkingWater	r								
2	Data Source	WAB	D										
3													
4	Data Origin	Orig	inal										
5	_												
6													
7													
8													
9						User					Location of Intake		
F	No	Reg Ref.		Permission No	Expiry Date	Name	Place	Category	Intake-ID 1:SignificantRes 2:Local	Name of WaterObject	Name of Village	Municipality	2
10		1 DI	3	0323/28.05.2001	4.1.1900	WSSC Ltd. Pemik	Pemik	R	2	Matnitsa Struma	Pernik	Pemik	
12	:	2 DI	3	0323/28.05.2001	4.1.1900	WSSC Ltd. Pemik	Pemik	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	W/SSC Private Ltd. Dupnitsa	Dupnitsa	R	2		Samoranovo	Dupnitsa	
16		B DI	7	0403/10.02.2003	10.02.2003	WSSC Private Ltd. Dupnitsa	Dupnitsa	R	2		Kraynitsi	Dupnitsa	
17	i i	7 DI	7	0403/10.02.2003	10.02.2003	WSSC Private Ltd. Dupnitsa	Dupnitsa	R	2		Kremenik	Dupnitsa	
18	8	B DI	8	0462/23.07.2001	23.07.2004	W/SSC Private Ltd. Breznik	Breznik	L	2	Krasava	Krasava	Breznik	
19	(	9 DI	12	0640/15.11.2001	15.11.2007	W/SSC Private Ltd. Kresna	Kresna	MR	2	Mahinska		Kresna	
20	10	DI	15	0877/16.05.2002	16.05.2008	W/SSC Private Ltd. Dupnitsa	Dupnitsa	R	2	Fudina	Ovchartsii	Sapareva banya	
21	1	1 DI	16	0878/16.05.2002	16.05.2008	WSSC Private Ltd. Dupnitsa	Dupnitsa	R	2	Goritsa	Ovchartsii	Sapareva banya	1
22	13	2 DI	17	0932/10.06.2002	10.06.2008	MRDPA	Sofia	R	2	Rakochevitsa	Gorno Osenovo	Blagoevgrad	
23	10	3 DI	23	1618/30.05.2003	30.05.2009	WSSC Private Ltd. Petrich	Petrich	R	2	Luda Mara	Petrich	Petrich	
24	14	4 DI	27	3056/16.07.2003	16.07.2009	Bobovdol mines	Bobowdol	MR	2	Dupnishka Bistritsa		Dupnitsa	
25	12	5 DI	28	3090/29.09.2003	18.09.2009	WSSC Ltd.Kyustendil	Kyustendil	MR	2	Dupnishka Bistritsa		Dupnitsa	
26	10	B DI	29	3156/28.11.2003	28.11.2009	WSSC Private Ltd Dupnitsa	Dupnitsa	SL	1	Dyakovo	Dyakovo	Dupnitsa	
27	17	7 D1	34	400084/02.02.2004	02.02.2010	Mayoralty of Goma Dikanya	Goma Dikanya	MB	2	Arkata	Goma 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<sup>6</sup> 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	в	C	D	E	F	G	н		J	K	L
1	Title	Perr	missi	on for Industrial Water								
2	Data Source	WAE	BD									
3												
4	Data Origin	Orig	ginal									
5												
б												
7												
8												
9					U	ser					Location of Intak	
		Reg							Intake-ID			
	No	Ref. Permission No Expiry		Expine Date	Name	Place	lace Tyrne		1:Significant Res	Name of MaterObject	Name of Village	
		Ref. Permission No Expiry		Dopay Date		11000	1784	Caregory	2:Local	manie or waterobjest	Hume of the	
10			-							2.0000		
11	1	DI	1	0035-1/16.08.2004	01.10.2010	Toplofikaciya PrivateJSC Pernik	Pemik	Industry	MB	2	Struma	Pemik
12	2	DI	11	0635/15.11.2001	13.11.2007	TPS Bobovdol Private JSC	Golerno selo	Cooling	MB	2	Dzherman	Dupnitsa
13	3	DI	13	0647/16.11.2001	16.11.2007	TPS Bobovdol Private JSC	Golerno 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	MB	2	Struma	Pokrovnik
16	6	DI	19	1391/14.01.2003	14.01.2009	Demo Bulgaria JSC	Sofia	Industry	MR	2	Struma	Pemik
17	7	DI	22	1599/21.05.2003	21.05.2009	Toplofikacia Private JSC Pernik	Pemik	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	Pemik	Industry	SL	1	Studena	Studena
20	10	DI	27	3056/16.07.2003	16.07.2009	Bobovdol mines	Bobovdol	Industry	SL	1	Dyakovo	Dyakovo
	11	DI	30			Stomana industry JSC	Pemik	Industry	SL	1	Studena	Studena
			1	2167/01 12 2002	04 40 0000			1 .		1		
21				3107/01.12.2003	01.12.2009							

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<sup>6</sup> 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	В	С	D	E	F	G	н	I	J	
1	Title	Transfer of Water with No Available	e Record								
2	Data Source	JICA Study Team									
3											
4											
5											
6											
7											
8			Fro	om	Т	ò	Transfer Mode	Maximum unic			
	No.	Description	NAM Catchment	Catchment ID	NAM Catchment	Catchment ID	1 - Maximum Limit 2 - Percent	m3/s	x		
10			OT CAN	502	ST MI	270				1	
11	-	2 HPP No.27	ST RIL	383	ST M5	390	1	0.6		-	
12		3								-	
13		4								-	
14		5								1	
15	-	6								-	
16		7								1	
17		8								1	
18		9								1	
19	1	0								1	
20											
21											
22											
23								1			
24											
25											
26											
27											
0.0		-i								1	-

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	В	С	D	E	F	G	н	I	J
1	Title	Summary	Comparisio	n Table for	r Reference	Points for	Local + Ex	isting Wat	er Abstracti	on by Sigr
2	Data Source	JICA Study	/ Team							
3										
Ľ	Data Origin	Colouisted								
<b></b>	Data Origin	Carculated								
	Data Type									
6	Unit									-
7			2	3	4	0	6		8	9
8	No.	ST	ST2	ST3	ST4	ST5	ST6	ST7	ST8	ST9
9	NAM Catchment	ST_MIN	ST_M9	ST_M8	ST_M7	ST_M6	ST_M5	ST_M4	ST_M3	ST_M2
10	Catchment JICA_IE	574	327	573	336	374	421	459	489	534
11	Down Stream or Up Stream	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										
	All Year Ave									
15	(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										
22	Ave in July-September									
H 4	I ▶ ▶I∖Control∕ <mark>Result</mark> 1	Summa	ary_RefPo	oin ts 🔊	ım mary 🖌	Figure 🔏	TimeSeri	es_Plot 🗸	TimeSer	ies <mark>(Re</mark> s

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	В	С	D	E	F	G	н	I	J		K	
1	Macro No.	Macro Name	Step	Total Step	Status	P	rogress	Last update	ed Date&Time	olobal Coefficient for Permission	Max Pei ARe	:. Num. of rmission ef. Points	
2	PM001	IRR_Permit	3	3	Completed!	100	% finished	2007 <i>171</i> 22	11:22:19 AM	1.00		200	
3	PM002	DWS_Permit	3	3	Completed!	100	% finished	2007 <i>171</i> 23	3:09:01 PM	1.00		100	
	PM003	IV/S_Permit	3	3	Completed!	100	% finished	2007 <i>171</i> 22	11:22:34 AM	1.00		100	
	PM004	MaxHPP_Permit	1	1	Completed!	100	% finished	2007 <i>171</i> 22	11:22:37 AM	1.00		100	
6	PM005	TransNoRecord	1	1	Completed!	100	% finished	2007 <i>171</i> 23	1:28:06 PM		X	10	
7	PM101	Ref_Points_Summary	2	2	Completed!	100	% finished	2007 <i>171</i> 22	11:23:17 AM			20	
8	PM102	Plot_LongitudinalMain	1	1	Completed!	/		2007 <i>171</i> 23	4:31:27 PM				
9	PM201	ForMIKE11	1	1	Completed!	100	% finished	2007 <i>171</i> 22	11:24:00 AM				
10													1
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	В	С	D	E	F	G	н	1	J	K	L	M	N	0	P	Q	Π
1	Title	Summary	Comparisi	on Table fo	r Local + E	xisting Wat	ter Abstract	tion by Sig	nificantRes									С
2	Data Source	JICA Study	v Team															
3			1															
4	Data Origin	Calculated	1															
5	Data Tyrne																	
6	Upit						1											
	on the						ů											
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	S
9	Catchment JICA ID	342	547	560	397	414	419	331	338	341	369	556	597	343	349	362	364	Г
10	FlowTo	560	560	327	414	432	414	345	331	331	556	392	369	364	364	367	367	Г
11	Rag	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Г
12	Unctorum 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	Г
	Un Stream drea evoluting out of																	
12	Tagitage (Jun 2)	30.17	83.81	360.10	172.57	231.05	31.49	177.00	15.38	43.63	56.8D	770.25	0.32	132.27	120.25	111.30	253.77	L
14	Territory (km2)																L	⊢
1.4																		⊢
	All Year Ave																	L
15	(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	D.595	0.480	0.852	1.078	r
17	Potential Flow (m3/s)	0.021	0.104	0.297	2.742	3.162	D.289	3.684	2.781	D.326	D.652	4.471	0.000	D.966	0.480	0.852	1.449	r
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	Г
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	Г
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	Г
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	Г
	Accumulated Permitted Water	0.000	0.055	0.055	0.000	0.055	0.000	0.400	0.000	0.000	0.000	0.044	0.000	0.000	0.000	0.400	0.000	Г
22	for Imigation (m3/s)	0.000	0.055	0.000	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	L
	Accumulated Permitted Water	0.000	0.005	0.005	0.404	0.407	0.000	0.000	0.000	0.000	0.007	0.005	0.000	0.454	0.000	0.074	0.400	Г
23	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	U.465	0.000	U.104	800.0	0.071	0.162	L
	Accumulated Permitted Water																	Г
24	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	L
	Accumulated Total Permitted																	Г
25	)iliater (m3/s)	0.000	0.060	0.060	D.181	0.262	0.000	D.139	0.000	0.000	0.227	1.418	0.000	0.494	800.0	0.180	0.502	L
	Maximum Permitted Water for																	
26	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	L
27	IRR/P (%)	0.0	53.1	18.5	0.0	17	0.0	3.7	0.0	0.0	0.0	48	0.0	0.0	0.0	12.7	0.0	Н
28	Dials/B (%)	0.0	4.8	17	6.6	5.9	0.0	0.0	0.0	0.0	34.8	10.4	0.0	16.0	17	84	11.2	Н
20	000071 (8)	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	TotalBormit/B (2)	0.0	57.9	20.2	6.6	83	0.0	3.8	0.0	0.0	34.8	31.7	0.0	51.1	17	21.1	34.6	H
31	HEBROAK (%)	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	H
32	in rmak/r (s)	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	H
52	And in Adv. Contraction																<i>!</i>	H
22	we moury-september																	L
33	[2001-2005]	0.010	0.000	0.224	1.104	1.267	0.110	1.460	1.147	0.105	0.200	2.6.42	0.000	0.207	0.274	0.677	0.720	+
34	uuasi-natural Flow (m3/s)	0.010	0.000	0.220	1.104	1.207	T 0.112	1.40Z		0.120	0.338	2.042	D - (D - in	0.397	0.371	0.007	0.00	1
14 4	I ▶ MINGONTROLA Result	ASU mm	ary Kethi	orines 1.5t	ımmary A	Figure 🤇	Imeber	ies riot /	i imeber	TIES AIRES	suns 2 🖉	bummary	RetPoint	(s z <u>(</u> au)	nmary 2			a 1

When you click "PM101", summary results for reference points are calculated. After complete the calculation, please see "Summary\_RefPoints" and "Summary\_RefPoints\_2".

	A	в	С	D	E	F	G	н	1	J	ĸ	L	M	N	0	P	Q	F
1	Title	Summary.	Comparisio	on Table fo	r Reference	Points for	Local + Ex	disting Wat	er Abstracti	on by Sign	ificantRes							
2	Data Source	JICA Stud	v Team															
3																		
4	Data Origin	Calculated	1															
5	Data Tupe																	
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	ST1D	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	ō	556						
11	Down Stream or Up Stream	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	C
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	C
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	<u> </u>
19	P/N (%)	0.0	-6.4	-0.3	-2.1	-0.8	-4.U	-3.4	-3.2	-2.7	-2.0	-2.4	0.0	0.0	0.0	0.0	0.0	
20																		_
0.0	Accumulated Permitted Water	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	C
	Accumulated Permitted Water																	
23	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	C
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	C
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	C
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	3.6	3.8	3.8	3.2	2.4	10.4	0.0	0.0	0.0	0.0	0.0	
29	NWS/P (%)	0.0	42.4	35.3	13.3	0.1	0.7	4.6	4.3	3.6	2.7	16.5	0.0	0.0	0.0	0.0	0.0	
30	HRPmax/R (%)	0.0	07.8	50.4	21.0	12.3	14.5	12.7	12.5	11.0	10.0	31.7	0.0	0.0	0.0	0.0	0.0	
32	nrrma0/P(%)																	
2.2	Ave in July-September																	-
14 4	I ▶ N\Control Result 1	Summ	arv RefPo	oints /St	ummarv X	Figure /	TimeSer	ies Plot <i>i</i>	TimeSer	ies / Res	ults 2 🖉	Gummarv	RefPoint	s 2 /Sur	n marv 2			

# 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.

	A	В	С	D	E	F	G	Н	1	J	к	
1	Macro No.	Macro Name	Step	Total Step	Status	Ρ	rogress	Last update	ed Date&Time	Global Coefficient for Permission	Max. Num. of Permission / Ref. Points	
2	PM001	IRR_Permit	3	3	Completed!	100	% finished	2007 <i>/71</i> 22	11:22:19 AM	1.00	200	
3	PM002	DVVS_Permit	3	3	Completed!	100	% finished	2007 <i>/71</i> 23	3:09:01 PM	1.00	100	
4	PM003	MVS_Permit	3	3	Completed!	100	% finished	2007 <i>171</i> 22	11:22:34 AM	1.00	100	ſ
5	PM004	MaxHPP_Permit	1	1	Completed!	100	% finished	2007 <i>/71</i> 22	11:22:37 AM	1.00	100	
6	PM005	TransNoRecord	1	1	Completed!	100	% finished	2007 <i>/71</i> 23	1:28:06 PM		10	
7	PM101	Ref_Points_Summary	2	2	Completed!	100	% finished	2007 <i>/71</i> 22	11:23:17 AM		20	
8	PM102	Plot_LongitudinalMain	1	1	Completed!			2007 <i>/71</i> 23	4:31:27 PM			
9	PM201	ForMIKE11	1	1	Completed!	100	% finished	2007 <i>/71</i> 22	11:24:00 AM			
1												ſ
11												Ļ

# 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 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

- **D** 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

- **D** Existing condition
- D 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

	0.0	0.0	100 - 010 - 0	1 14 1				0.0010020	0.00000			
29	95	95	MA_STA1	123	220	0.0	50	0.0076285	0.00000			
30	424	424	MA_M2	140	220	0.0	50	0.0340472	0.00000			
31	893	893	MA_M2	147	220	0.0	50	0.0717079	0.00000			
32	299	299	MA_M2	104	220	0.0	50	0.0240097	0.00000			
33	965	965	MA_M2	147	220	0.0	50	0.0774895	0.00000			
34	41840	41840	MA_M2	148 🔺	220	0.0	50	3.359752	0.00000			
35	184	184	MA M2	104	220	0.0	50	0.0147752	0.00000			
36	1466	1466	<u>MA M2</u>	152	220	0.0	50	0.1177198	0.00000			
37	374	374	MA_M2	102	220	0.0	50	0.0300322	0.00000			
38	343	343	MA M2	85	220	0.0	50	0.0275429	0.00000			
39	1552	1992	MA_M2	152	220	0.0	50	0.1246256	0.00000			
	► N\Contro	l Di/Dymand/Dem	and_IRR \	Demand D	WS Repult /Su	mmary <u>(</u> Sun	nmary_RefP	oin ts <u>(</u> Figure ( <mark>T</mark>	imeSeries_Plot /Time	Ser		
i st												

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).



### 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	В	С	D	E	F	G	н	1	J
1	Title	Summary	Comparisio	n Table for	r Reference	Points for	Local + Ex	isting Wat	er Abstracti	on by Sign
2	Data Source	JICA Study	/ Team							
3										
Ľž	Data Origin	Colouisted								
<u><u></u></u>	Data Origini	Carculated								
	Data Type									
Б	Unit									
17			1	3	4	5	0		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	IW/S/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	55.4	21.5	12.3	14.5	12.7	12.5	11.0
31	HPPmax/P (%)									
32										
2.2	Ave in July-September									
H A	(	Summa	ary_RefPo	oin ts 🔊	ımmary 🖌	Figure 🔏	TimeSeri	es_Plot /	TimeSer	ies <u>/ Res</u>

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.

7	12 ⊊ : 🚑 ⊊ E15 🗣	fx								
	A	В	С	D	E	F	G	Н	I	J
1	Macro No.	Macro Name	Step	Total Step	Status	F	rogress	Last update	d Date&Time	Max. Num. of Demand Cal. / Ref. Points
2	PM001	IRR_Demand	3	3	Completed!	100	% finished	2007/8/26	11:03:14 AM	70
3	PM002	DWS_Demand	2	2	Completed!	100	% finished	2007/8/26	10:41:54 AM	000
4	PM101	Ref_Points_Summary	1	1	Completed!	100	% finished	2007/8/26	11:03:15 AM	30
5	PM102	Plot_LongitudinalMain	1	1	Completed!	/		2007/8/26	11:03:16 AM	
6	PM201	ForMIKE11	1	1	Completed!	100	% finished	2007/8/25	5:02:10 PM	
7		MVS_Demand Parameters	Coeff Econom	iicient for nic Growth	1	Coe Recycl	efficient for ing Water Use	1		
8 9										

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	В	C	D	E	F	G	н	1	J	K	L	M	1
1 Title	Summary	Comparisi	on Table										_
2 Data Source	JICA Stud	y Team											
3													
4 Data Origin	Calculated	1											_
5 Data Type													_
6 Unit													_
7 NAM Critebraset	MA BLA	MA CRI1	MA CRI1	MA CRI1	MA CRIT	MA CRIT	MA CRI2	MA CRI2	MA CRI2	MA CRI2	MA CRI2	MA CRI2	МА
Cetebrant UCA ID	56	290	412	416	419	420	411	426	429	441	444	449	100
ElemTe		256	290	290	410	412	420	420	420	429	450	429	
B==		330	300	300	415	415	72.0	420	42.0	+50	450		-
neg	642.01	077.56	617.00	220.21	20.79	465.44	110.58	92.06	240.48	40.20	26.70	126.77	-
2 Upsteram Area (km2)	842.01	077.50	617.00	220.31	30.70	405.44	110.50	03.00	240.40	49.29	35.70	106.77	+
<ul> <li>Upstream#realexcluding out of Territory (km2)</li> </ul>	042.01	877.00	017.08	220.51	30.70	400.44	118.00	03.00	240.40	49.28	30.70	130.00	-
Appund Average													-
Annual Average     Dunci-Natural Flam (m2/c). 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	-
Outrai Natural Flow (m3/s) 76% Brobability of Exceedence	2.021	6.863	4 366	1 477	0.180	4 041	0.905	0.730	2.000	0.418	0.351	1.375	-
Outasi-Natural Flow (m3/s) 10 % Probability of Exceedence     Outasi Natural Flow (m3/s) 00% Probability of Exceedence	1 703	5.676	3 604	1 220	0.140	3.336	0.747	0.603	1.205	0.345	0.200	1 135	-
Quasi-Natural Flow (m3/s) as a Frobability of Exceedence     Quasi-Natural Flow (m3/s) 05% Brobability of Exceedence	1.440	4 969	3 131	1.090	0.132	2,903	0.649	0.522	1.643	0.200	0.251	0.994	+
Retential Flow (m3/s) as a Probability of Exceedence	2.886	11 244	3 503	6.467	0.225	3.098	1 009	0.418	1.536	0.467	0.177	0.726	-
Potential Flow (m3/s) Average (2004) Retential Flow (m3/s) 75% Brobability of Exceedence	2.000	10.722	2.618	7.083	0.180	2 204	0.905	0.951	1.038	0.418	0.100	0.423	+
Potential Flow (m3/s) 13 % Probability of Exceedence	2.162	8.871	2.162	5.866	0.140	1 804	0.747	0.207	0.849	0.345	0.082	0.340	+
Potential Flow (m3/s) 36's Probability of Exceedence     Potential Flow (m3/s) 06's Probability of Exceedence	1 904	7 720	1 991	5 110	0.132	1.643	0.649	0.190	0.735	0.200	0.071	0.303	+
Potential Flow (mars) as a Flobability of Exceedence	0.000	10.001	0.000	10.991	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	+
Accumulated Water Demand for Brighting Writer (m2/c)	0.002	0.116	0.000	0.012	0.066	0.025	0.019	0.000	0.000	0.002	0.000	0.000	+
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	+
7 Assumulated Tetral Water Demand (m2/a)	0.002	20.269	0.207	20.049	0.066	0.140	0.010	0.000	0.006	0.002	0.000	0.000	+
Accomplated fotal water bemand (movs)	0.002	20.200	0.201	20.040	0.000	0.140	0.010	0.000	0.000	0.002	0.000	0.000	+
9													-
9 Rue in Julio Sentember													+
1 Ouaci-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	
2 Duasi-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	+
3 Duasi-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	-
4 Ouasi-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	
5 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	-
Potential Flow (mole) / Weinge (2001)     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	-
7 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	+
8 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	
Accumulated (Rater Demand for Intraction (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	-
Accumulated Water Demand for Dripking 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	1
1 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	1
2 Accumulated Total (litter 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	1
3	0.002		5.201		5.000	5.110	5.010	0.000	5.000	0.002	5.000	5.000	-
4													
A A ALA CARANAL (Daman d) (Daman d) IDD (Daman d)	DWC (Boould) C		10	DofDoi	nto /Fim	In Tim	Cariaa I	Lat /Tim	Series	<b>10</b>   a	•		

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

	A	в	С	D	E	F	G	н	1	J	к	L	м	N	0 1	Ξ
1	Title	Summary Comparision Table for			erence Point											<b>^</b>
2	Cata Source	JICA Study	Feam													
2																
4	Ceta Otiain	Calculated														
-	Data Data	Cerculation														
0	Lead type															
6	UNIT															
7		1	2	3		5	6	7	8	9	10	11	12	13		
8	No.	MA1	III.A2	MA3	II.A4	MAS	MA6	MA7	MAI1	MAT1	MAT2	MAT3	MAT4	MAU1	MAV1	
9	NAM Carbiment	MA_M7	MA_N6	MA_MS	MA_M4	MA_M3	MA_M2	MA_M1	MA_CPI1	MA_TOP4	MA_TOP3	MA_TOP2	MA_TOP1	MA_LUD1	IIIA_VAC	
10	CatcimentulCA_ID	357	365	109	113	131	132	539	390	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 (km.2)	173.41	1031.94	5461.57	9968.62	137 18.32	15321.83	21272.26	977.95	337.69	946.75	1433.96	1775.18	តា.រេ	1679.	
13	LinStreamArea excluding out of Territon (4m2)	1(3.61	1031.94	5461.57	9968.62	13(18.32	15321.83	212(2:25	900.56	331.69	945.15	143398	1(15.18	pLeters	1619.	
14																
15	Annual Australia															
16	O sor Littati Arrelage	28/3	7 579	26,659	57 597	73 306	70 6777	103.653	7 0873	17/3	3.062	1095	4 703	1.517	19.55	
17	D rat ENational Flow (mark) 75%. Brobability of Ensedence	2845	6279	19.995	49,365	61.60	63.192	81.037	6263	1530	2312	2759	374	1909	18.95	
18	Quas ENatural Flow (m38) 90%. Probability of Exceedence	2023	4.332	14.871	36316	47 041	48,759	61.975	5676	0.992	1.458	1733	2.108	0.650	15.45	
19	Quast-Evatural Flow (m.34), 95%. Probability of Procedence	1724	3.337	12 147	32736	39,259	เกรลา	51677	4.968	0.678	1 021	1.217	1.519	11535	13.52	
20	Potential Flow (m38) Average (2004)	1.274	10.217	29.851	60.924	76.691	82,992	113.848	11.244	1.743	2,777	4.096	4.335	1.517	18.62	
21	Potential Flow (m38) 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 (m38) SD% Probability of Exceedence	1.036	5,864	18.903	42,653	SI.831	52,596	70.344	8,871	0.992	1.468	1.733	2006	0.650	15.32	
23	Potenttal Flow (m38) 95% Probability of Exceedence	0.883	4.512	15,595	35.751	42.269	43,590	57,955	7.739	0.678	1.020	1.217	1.510	0.535	13.05	
24	Acoum stated Water Demand for Irrigation (m38)	0.000	4.794	31.525	50.943	65,367	តា.តាខ	70.824	19,581	0.000	0.000	0.250	6.850	0.000	3.70	
25	Accum stated Water Demand for Drinking Water (m 3%)	0.006	0.066	0.443	0.571	0.606	0.607	0.624	0.116	0.014	170.0	0.120	0.120	6057	002	
26	Account stated Water Demand for Industrial Water (m38)	0.000	10034	0.460	0.518	0.524	0.947	2.874	0.271	0.149	0.154	0.154	0.154	0.001	0.0	
27	Accumulated Total Water Demand (m36)	0.005	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	Q vas F-Nativral Flow (m3#) Average (2004)	0.883	3,783	12,061	26.085	36,316	36,016	62,379	4,820	0.783	1.270	1.639	1,839	0.369	9.76	_
32	Q was I-National Flow (m3#) 75% Probability of Exceedence	1.266	3.507	10.206	24.971	31,236	31,755	45,619	4,119	0.724	1,040	1245	1,361	0.232	9.3	
33	Q was I-National Flow (m.3.6) SB% Probability of Exceedence	0.652	2.352	7.937	19.903	25.074	25.505	36,330	3.439	0.555	0.831	8,993	1.094	0.202	7.36	
34	Q was I-National Flow (m.38) 95% Probability of Exceedence	0.535	1.932	6.811	17.135	21.583	21,995	31,001	3037	0.463	0.671	0.816	0.908	0.187	6.70	
35	Potenttal Flow (m38) Average (2004)	0.277	7.687	34.122	\$3,230	62.524	63.225	92,004	14,005	0.783	2054	1.639	11.246	0.369	11.2	
36	Potenttal Flow (m38) 75% Probability of Exceedence	0.649	6.032	29.539	47 D68	54,955	55.424	79.952	14,548	0.724	1.961	1.245	8.152	0.232	11.3	
37	Potential Flow (m38) 90% Probability of Exceedence	0.334	4.413	22.372	36,343	42.705	(3.135	61.302	12.074	0.585	1,309	0.993	5.148	0.202	9.3	
38	Potential Flow (m38) 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	3.636	0.187	811	
39	Accumulated water Demand for Irrigation (m38)	0.000	14.010	92,315	145.625	186.168	191.713	202.424	581196	0.000	0.000	0.924	20,210	0.000	10.16	
40	Accountianed waner Demand for Drinking waner (m.3%)	0.006	0.066	0.443	0.571	0.606	0.607	0.624	0.116	0014	0.071	0.120	0.120	60057	00	
41	Account table of the number of the table of table	0000	0.029	0.463	0.521	0.527	0.950	3,280	0.279	0.149	0.154	0.154	0.154	0.001	10.0	
42	Accentrated rotarovater Demand (mats)	0106	16.106	93222	145./18	187.301	1932/0	205.327	58.691	U.163	0.224	1.198	20.484	01058	10.15	
45								-		171 0		1.1				-
141	A NULL CONTROL OF A DATE AND A	INCOMPANY AND A	THE R P. LEWIS CO., NAME AND ADDRESS OF ADDR	3. No. 1 (1995) 1			the second se	the second se		and the second s		the second second			Accessed in Manual Pro-	

# 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.

~												
	E15 👻	fx										
	A	В	С	D	E	F	G	Н	I	J		
1	Macro No.	Macro Name	Step	Total Step	Status	Progress		Progress Last updated Date&Time		Max. Num. of Demand Cal. / Ref. Points		
2	PM001	IRR_Demand	3	3	Completed!	100	% finished	2007/8/26	11:03:14 AM	70		
3	PM002	DVVS_Demand	2	2	Completed!	100	% finished	2007/8/26	10:41:54 AM	800		
4	PM101	Ref_Points_Summary	1	1	Completed!	100	% finished	2007/8/26	11:03:15 AM	30		
5	PM102	Plot_LongitudinalMain	1	1	Completed!			2007/8/26	11:03:16 AM			
6	PM201	ForMIKE11	1	1	Completed!	100	% finished	2007/8/25	5:02:10 PM			
7		IWS_Demand Parameters	Coeff Econom	icient for hic Growth	1	Coefficient for Recycling Water Use		1				
8 9												

## 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





# 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
  - **D** Reservoir Operation Data
  - □ Water Abstraction Data
    - ➢ Irrigation Use
    - ➢ Domestic & Industrial Water Use
  - □ Water Discharge (Waste Water) Data
- Water Quality Monitoring data

.....etc.

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

БАЛА РЕКА - С. БОСТИНА						м б1000 200010Д.									
	вод	ни колич	ЕСТВА, м	3/s											
	I	II	III	IV	V	VI	VII	VIII	IX	Х	IX	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			

What useful time series data for analysis looks like

(Value 2) ■ Time Value 1 (ZZZZ) XXXX уууу (ZZZZ) XXXX уууу (ZZZZ) XXXX уууу (ZZZZ) уууу XXXX (ZZZZ) XXXX уууу (ZZZZ) уууу XXXX (ZZZZ) уууу XXXX . . . . . . . . . . . . .

# 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/

# Example of Useful Time series data for Analysis (2)



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

# 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
  - **D** the wind velocity at a particular time is an instantaneous value.
  - □ Water Quality monitoring data



# (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

# (3) Step\_Accumulated

- The values are accumulated over a time interval, relative to the beginning of the interval.
- ExampleA 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

# (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

# ArcHydro

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






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

## 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	-

# Time Type

#### ■ Regular

**D** Time interval is fixed and its value is specified

► Example

- Daily Rainfall amount
- Daily average Water quantity

#### Irregular

**D** *Time interval is not fixed.* 

► Example

• Water quality monitoring data

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



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# Data Access by Temporal Analyst (1)



## Data Access by Temporal Analyst (2)

### Export to other data storages



Data Access by Temporal Analyst (3)

Link Only



# Rainfall – Runoff Model General





### Process-based model



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

# Model Parameters and Calibration

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



Uncertainty of Prediction

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





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. АНАЛИЗНА ВЛИЯНИЕТО НА ЯЗ. ТОПОЛНИЦА. (in Bulgarian).

# Hydro Dynamic Model General





# **Governing Equations**

- Governing Equations
  Continuity of Fluid flow (Mass balance)
  - □ Momentum Conservation of Fluid Flow (Momentum Balance)
- Governing equations are originally 3-dimensional
  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.



### **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. **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.), 2<sup>nd</sup> 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.

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 Surveillance (Control) Monitoring Points for Surface Water

Number of the New Oper	ational Monitoring	Points fo	r Surface	Water
------------------------	--------------------	-----------	-----------	-------

		8	
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, <u>it is recommendable to set Key Monitoring Stations as</u> 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.

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.

Frequency of Measurement at Key and Important Stations

(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

- <u>Considering the efficient and cost effective monitoring, it is necessary to separate</u> 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.

