

Evaluation of SWAT Model for Irrigation Reservoir Operation



2010. 8.

Ki-wook Park*, Sung-Tae Oh, Jin-Hoon Jo, Nam-Won Kim

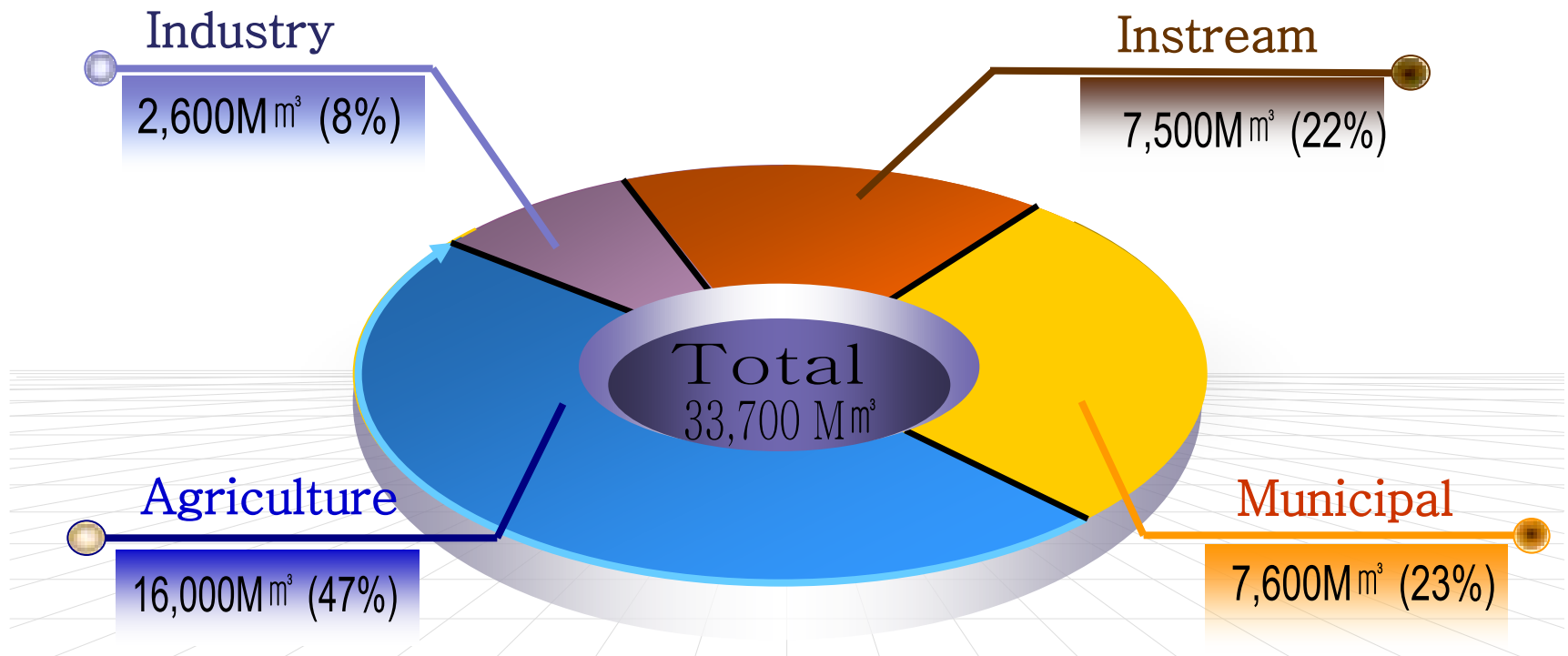
Korea Rural Community Corporation
Korea Institute of Construction Technology

Contents

- ▣ Agricultural water in South Korea
- ▣ Model development
- ▣ Model application
- ▣ Conclusions

Water resources

Average rainfall are 1,283 mm per year



✧ Agricultural water use is 69 % of total water resources

Paddy irrigation (Rice)



Irrigation systems in South Korea

- ❑ Total length of irrigation canal : 183,286 km
 - Irrigation canal : 116,201 km
 - Drainage canal : 70,444 km
- ❑ Water source for agricultural water
 - Total : 66,523 (Reservoir : 17,849, Weir : 18,008, etc)
- ❑ Average irrigation area
 - every water source : 12 ha
 - For reservoir : 27 ha
- ❑ Irrigation development are very widely implemented
 - land consolidaton is almost completed (80~90%)
 - Concrete lining to reduce water losses for earthern canal



SWAT application in Korea

- Environment
 - SWAT 2000 with ArcView 3.2
- How SWAT adopt paddy cultivation environment?

	SWAT-K (AGRIMAN)	Remarks
Irrigation control	$S_{need} = S_{max} - S_i$ $S_{need}, S_i = \text{fn}(S, \text{pcp. Seep}, ET)$ $IRR = \text{Min}(S_{need}, IRR_{avail}, IRR_{fixed})$ ※depletion of reservoir, maintain water depth in paddy	According to actual water management in paddy
Paddy Area	conical → cube(cascade) $SA = \text{fraction} \times \text{total HRU area}$	
Infiltration and Soil water routing	infiltration+soil water > max. of water in each HRU → can't simulate of soil water movement to downward	
Evapotranspiration	$ET = ET_{\text{in soil}} + \text{Transpiration}$ → $ET = ET + \text{Transpiration} + ET_{\text{from water surface}}$	Paddy field store irrigation water for along time

Experimental site

□ Location

- Pyeongtaek, Yongin city, Gyeonggi do

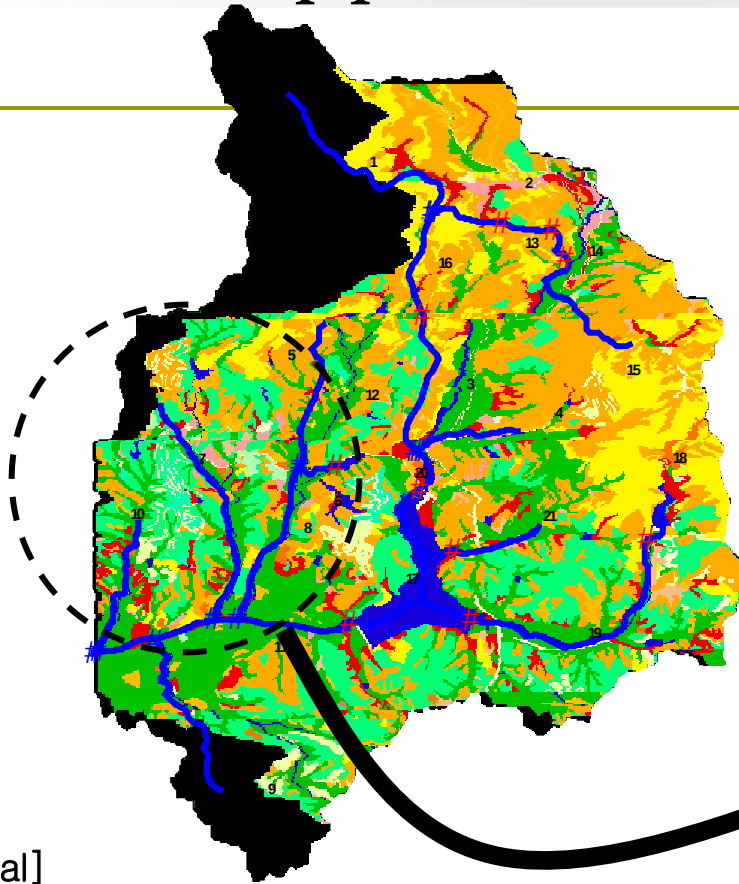
□ Monitoring facilities

- Rainfall gauge : 4
- Irrigation reservoir stage : 3
- stream flow : 3
- irrigation canal : 3 / lateral channel : 20

*) All facilities installed in 2000

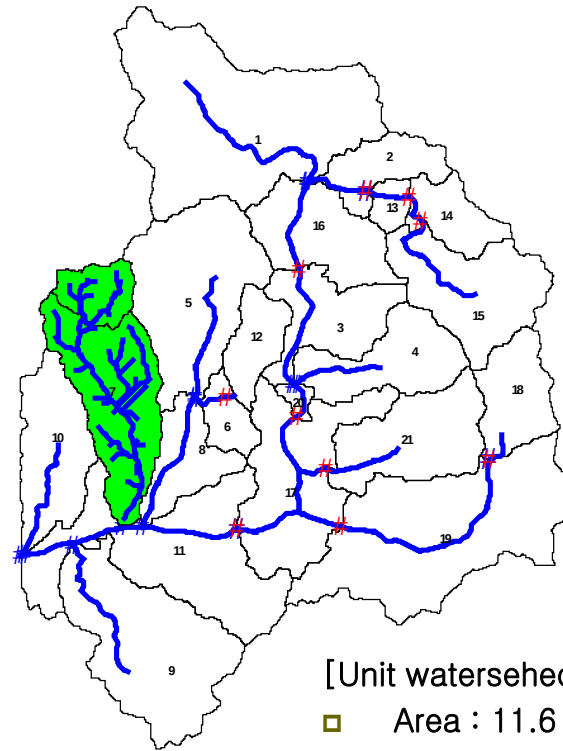


Model application



[Total]

- Area : 159.744 km²
- Sub-basub : 21
 - Reservoir : 4
 - Beneficial area
 - Idong reservoir : 2,156ha
 - Yongduk reservoir : 193.3ha
 - Misan reservoir : 149.3ha
- Available data : 2001~2008



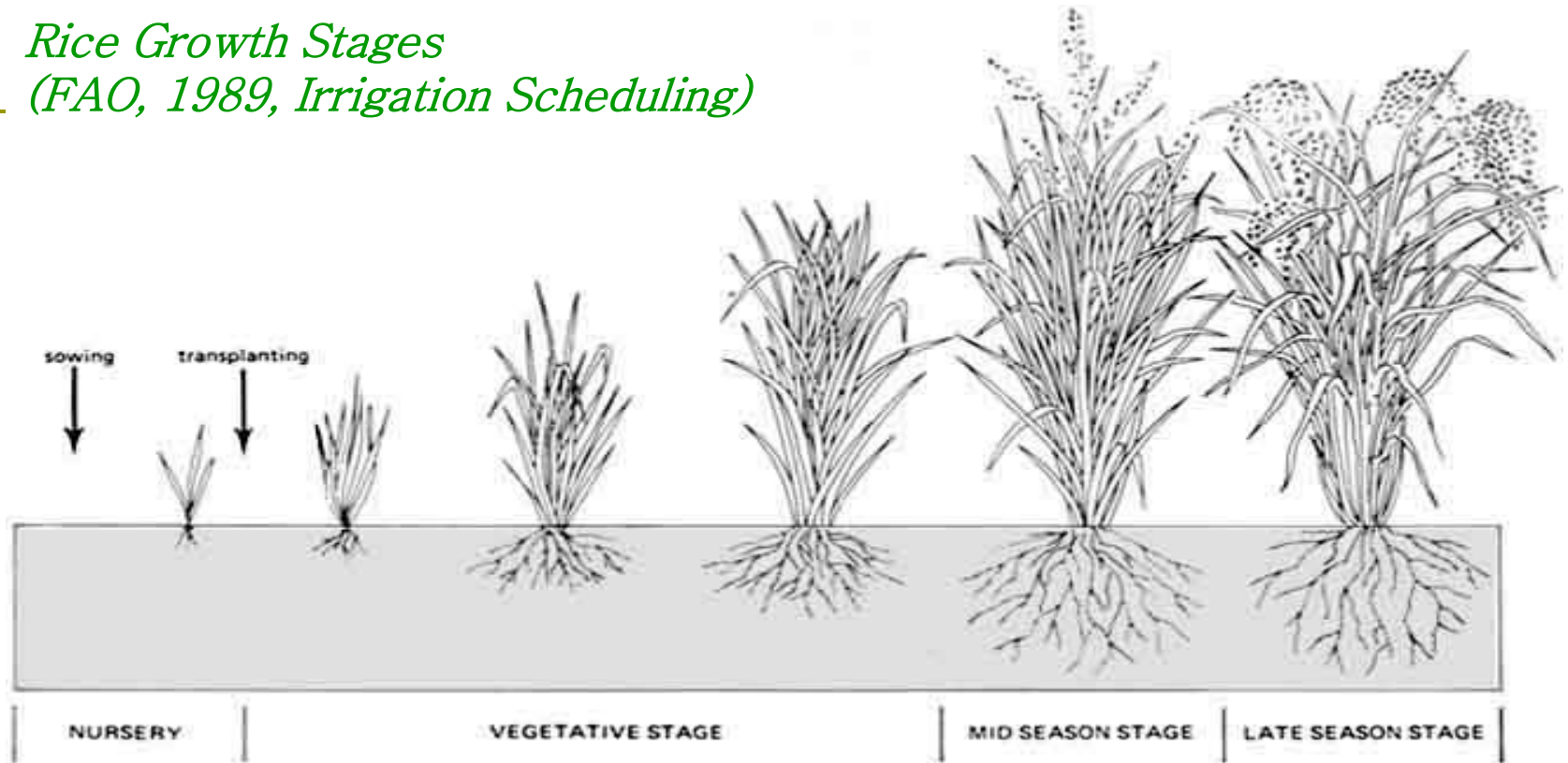
[Unit watersehed 2009]

- Area : 11.6 km²
- Sub-basin : 2
 - Reservoir : 1
 - BA : 122.5ha
- Available data : 2001~2008

Irrigation management

Rice Growth Stages

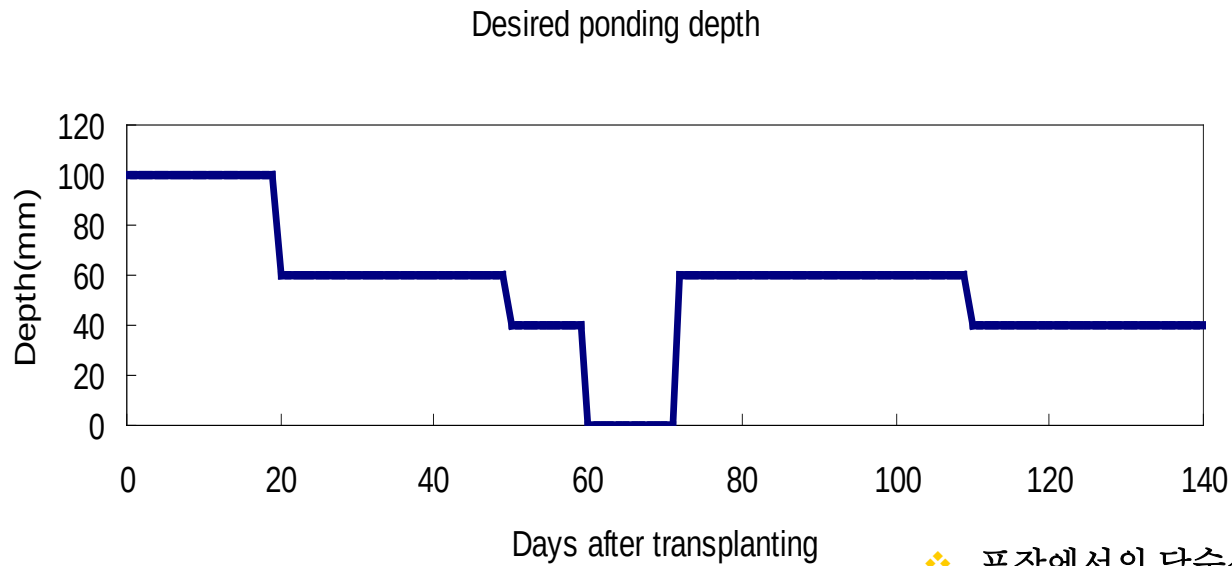
— *(FAO, 1989, Irrigation Scheduling)*



Ponding depth for growth stage(RDA, KOREA)

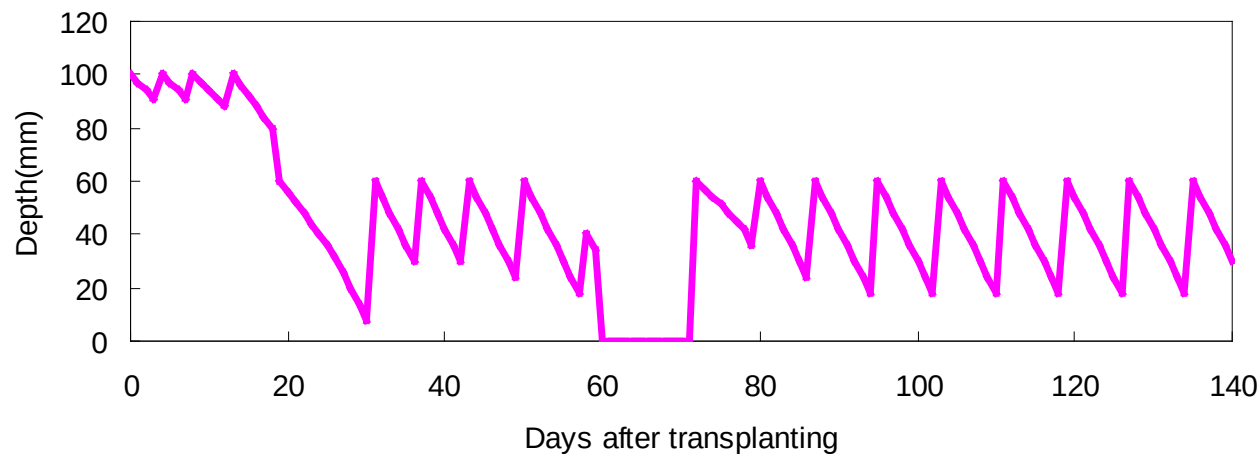
Growth stage	Transplanting stage		Vegetative stage		Mid-season	Late-season
Days after transplanting	20	40	60	80	100	140
Ponding depth(mm)	-	60	40	0	60	40

1. Ponding depth for growth stage

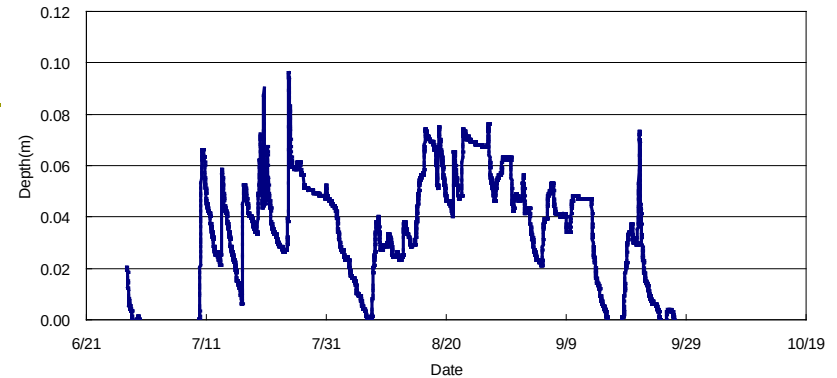


- ❖ 포장에서의 담수심 관리형태는 1회 관개후, 소비수량 (증발산량+침투량) 만큼 줄어들고,
- ❖ 일정 담수심 이하로 떨어지면 재차 관개 실시

2. In-situ water management



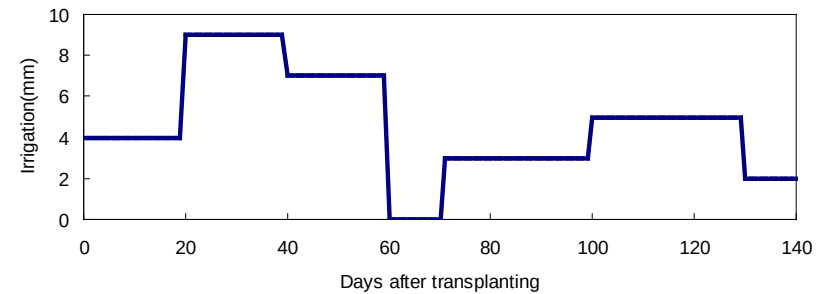
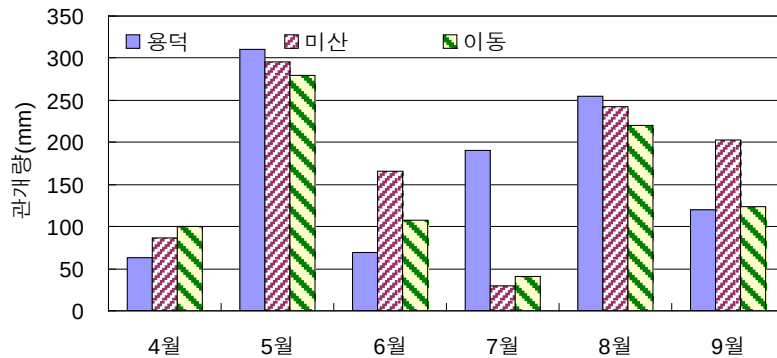
3. Measurement of daily ponding depth



5. Average ponding depth for SWAT

- ❖ Actual : 100mm for 10day → SWAT : water depletion
- ❖ Irrigation water must be applied evenly for daily : 2~9mm

4. Monthly applied water



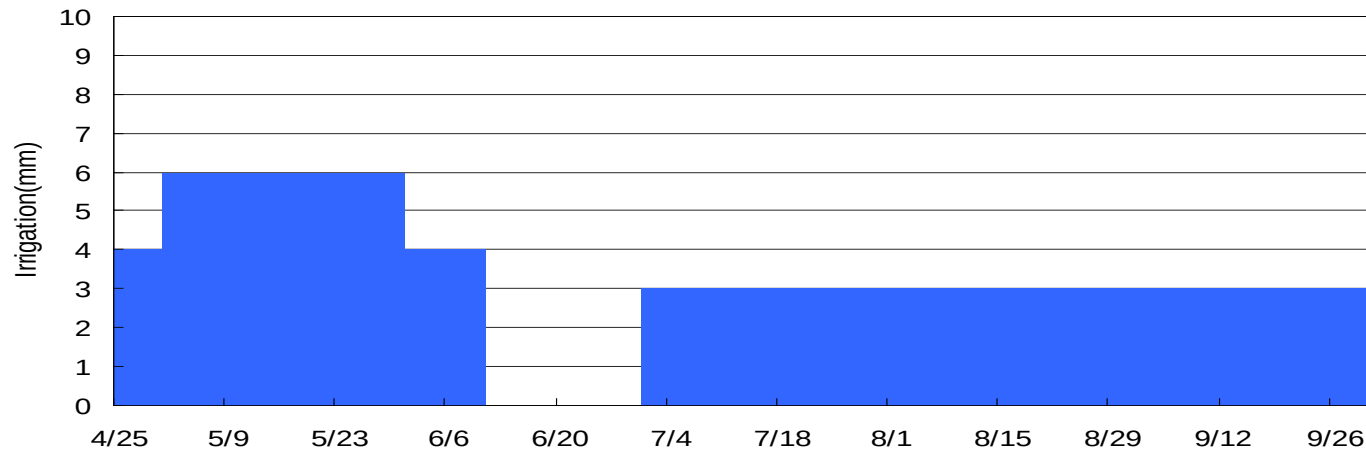
.Mgt for paddy land (HRU)

- ❑ **Crop type : rice**
- ❑ **Operation : Irrigation operation**
 - Planting/beginning : April 20
 - Irrigation operation : May 1 (IRR_AMT : 7 mm)
 - (same for each day)
 - Harvest and Kill Operation : Oct. 10

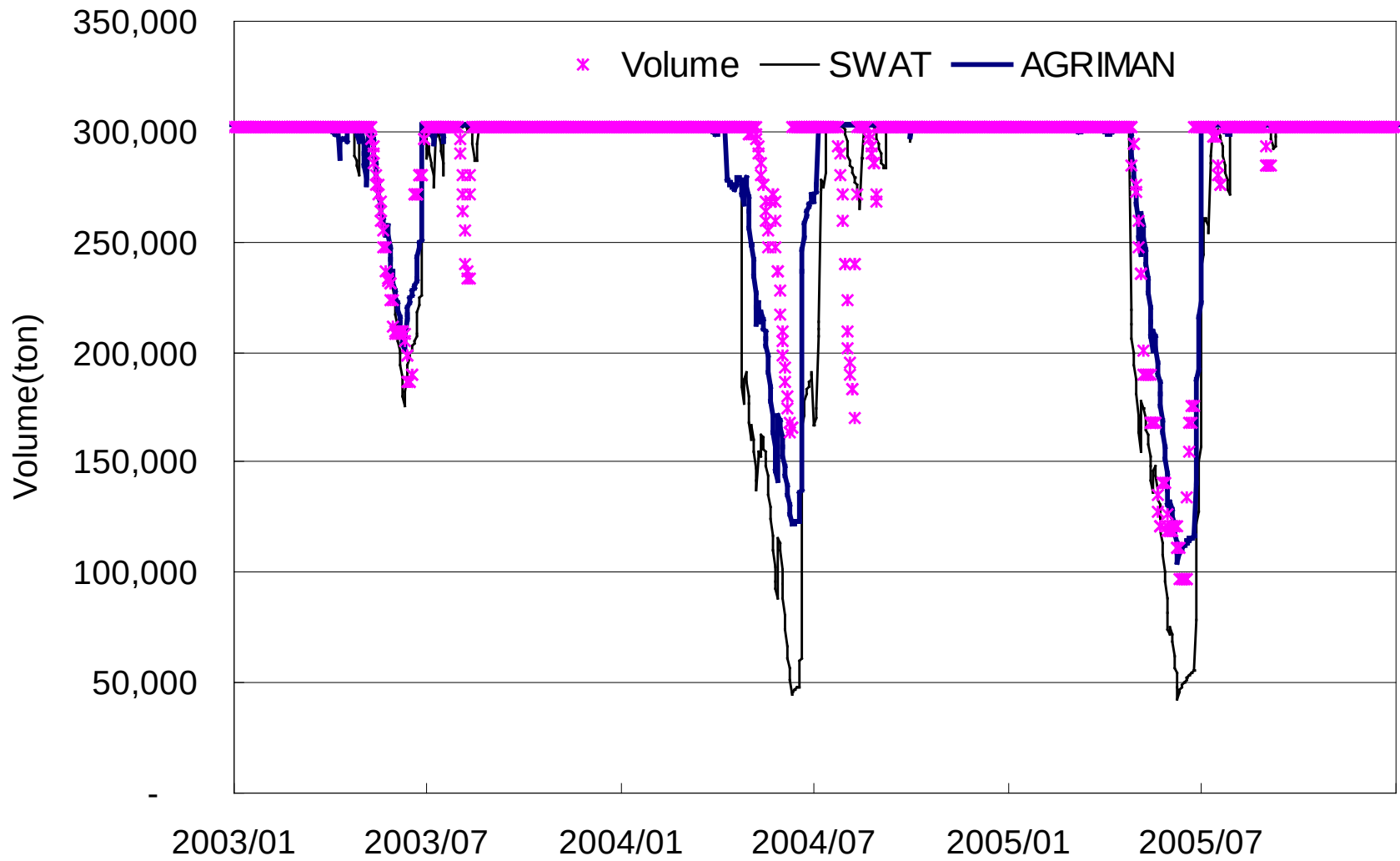
The screenshot shows the 'Mgt: I_RICE_ScC' window. It has a 'Management Data' section with buttons for 'Load Scenario' and 'Save Scenario'. Below this is a section for 'NCRP' with a dropdown menu set to 'Rice'. There are input fields for 'ALAI' (0.00), 'BIO_MIN' (0.00), 'CN2' (73.00), 'BIO_MS' (0.00), 'BIOMIX' (0.20), 'USLE_P' (1.00), and 'PHU' (0.00). A 'Curve' button is next to the 'USLE_P' field. Below the input fields are two radio buttons: 'Schedule by Date' (selected) and 'Schedule by Heat Units'. At the bottom is a table with columns 'Year', 'Operation', 'Crop', 'Month', and 'Day'. The table contains the following data:

Year	Operation	Crop	Month	Day
1	Plant/begin. growing season	RICE	April	20
1	Irrigation operation	RICE	May	1
1	Auto fertilization initialization	RICE	May	1
1	Tillage operation	RICE	May	1
1	Harvest and kill operation	RICE	October	10
2	Plant/begin. growing season	RICE	April	20

Buttons for 'Add Year', 'Delete Year', 'Add Operation', 'Delete Operation', 'Edit Operation', 'Help', 'Cancel', and 'OK' are located on the right side of the window.



SWAT Results (Reservoir volume)



R^2 : SWAT - 0.504, AGRIMAN - 0.580

SWAT Results

		PRECIP	SNOFALL	SNOMELT	IRR	PET	ET	SW	PERC	GW_RCHG
SWAT	2000	1328.8	39.4	39.4	577.7	1005.0	772.8	168.6	151.0	152.5
	2001	1067.2	70.9	64.4	686.7	1123.2	876.6	149.8	134.5	135.7
	2002	1231.7	29.1	33.1	648.9	1061.3	780.6	157.1	187.2	186.8
	2003	1514.8	18.7	20.4	591.9	990.0	801.2	150.8	234.0	232.6
	2004	1217.0	20.6	20.1	687.0	1156.4	835.4	150.2	215.0	215.8
	2005	1427.7	14.7	14.7	647.1	1116.4	812.7	154.6	230.7	229.3
	2006	1362.7	32.3	32.3	704.0	1162.9	875.3	157.8	187.3	189.8
	2007	1325.0	21.8	21.8	531.8	909.6	704.8	160.3	215.8	213.9
	2008	1342.9	21.6	21.1	594.2	971.8	737.0	157.9	216.2	217.3
	AVG	1363.7	28.0	27.8	615.7	1017.4	775.6	157.9	205.9	205.8
SWAT-K	2000	1328.8	39.4	39.4	473.8	1005.0	749.5	167.3	81.7	83.3
	2001	1067.2	70.9	64.4	509.6	1123.2	795.1	128.4	72.2	73.2
	2002	1231.7	29.1	33.1	477.7	1061.3	747.4	154.8	62.6	62.4
	2003	1514.8	18.7	20.4	469.2	990.0	780.6	145.8	151.4	149.7
	2004	1217.0	20.6	20.1	481.9	1156.4	771.9	148.5	95.0	96.5
	2005	1427.7	14.7	14.7	485.0	1116.4	781.9	154.6	120.3	119.0
	2006	1362.7	32.3	32.3	489.4	1162.9	781.5	135.4	107.3	109.0
	2007	1325.0	21.8	21.8	450.2	909.6	688.0	160.3	141.7	139.9
	2008	1342.9	21.6	21.1	466.4	971.8	722.7	156.9	121.5	123.0
	AVG	1363.7	28.0	27.8	472.7	1017.4	738.4	156.9	118.4	118.4

Results and conclusions

- ❑ SWAT application including paddy cultivation area
 - Irrigation option should be modified by in-situ water management practices, if possible.
- ❑ Model application
 - SWAT and SWAT-K shows good agreement on irrigation reservoir operation

Thanks for your attention!

