THE SOIL WATER ATMOSPHERE PLANT MODEL (SWAP): CONCEPTS, DATA REQUIREMENTS AND COMPUTATION PROCEDURES

The Soil Water Atmosphere Plant model (SWAP) is incorporated in this CD mainly to validate the Soil Water Accounting Model (SWAM) results. SWAP is a physically based, comprehensive agro-hydrological model that simulates the relationship between soil, weather and plant (Kroes and Van Dam, 2003). The model is based on Richards' equation; SWAP models the soil water movement under unsteady flow conditions and simulates the bottom flux (deep percolation) using the $\theta(h)$ and $k(\theta)$ functions developed by Van Genuchten (1980) and Mualem (1976). With regard to evaporation, the model can choose between the empirical functions of either Black et al (1969) or Boesten and Stroosnijder (1986). In the Wadi Laba, as in several other spate irrigation systems, simulation is predominantly carried out during a drying cycle. Thus, the equation of Black et al (1969), which calculates the cumulative actual evaporation during the dry period, is preferred. The equation is written as

$$\sum Ea = \beta_1 \sqrt{t_{dry}} \qquad (1)$$

where ΣEa is the cumulative actual evaporation in cm, β_1 is a soil specific parameter in cm $d^{-1/2}$ that characterizes the evaporation, t_{dry} *is* the time (day) after a significant amount of rainfall or irrigation, P_{min}. SWAP resets t_{dry} to zero if the net irrigation exceeds P_{min}. For β, the value of 0.35 cm $d^{-0.5}$ is recommended for very large irrigation gifts and medium sized soil textures such as the Wadi Laba silt loam soils. SWAP uses a default value of 0.5 cm d^{-1} for P_{min} . In the case of Wadi Laba, however, the P_{min} can be set to zero as the irrigation application is either zero or 50 cm d^{-1}.

The model is used with a daily time step. Since 50 cm, which is an irrigation gift in the Wadi Laba and many other spate irrigation areas, is too large to be applied in one day - it is assumed that the gift is supplied in three consecutive days in the order of 20, 20 and 10 cm.

The initial soil moisture storage in the rootzone SMS_0 is set in terms of the soil depth and the matric pressure, h. An h value of -6,000 cm corresponding to 22.47 cm of SMS_0 is used for the Wadi Laba. As indicated in the SWAM Manual, the measured SMS_0 at the onset of the Wadi Laba flood season is 22.5 cm.

For the boundary condition at the bottom, the SWAP provides several options (see the *swap.swp* file in the SWAP Simulation folder). The Wadi Laba fields meet the two key requirements of a 'free drainage profile', which are: at least a 2.5 m deep soil profile and a deep groundwater table with negligible influence on the vertical flux.

For detailed concepts and computation procedures, please see the SWAP 3.0.3 manual. To run bare soil evaporation, deep percolation and *SMS* simulations, visit: SWAP Simulations. The *swap.swp* file contains the necessary input data for the Wadi Laba fields, but it is also possible to use own field data. However, if SWAP is used for simulations for the Wadi Laba and the results are compared with the outcomes from SWAM (being the main objective of including SWAP in this CD) only the *irrigation schedule section* has to be changed in the *swap.swp* file on the basis of Table 1.

Table 1 Scenarios and irrigation schedule combinations for the Wadi Laba spate irrigated fields

Irrigation schedule scenarios and combinations	Flood months				
	June	July		August	
	15	1	15	1	15
Highly likely scenario					
Three irrigation turns	*I*	*I*	*I*		
	I		*I*	*I*	
	I	*I*		*I*	
		I	*I*	*I*	
	I	*I*		*I*	
	I	*I*			*I*
	I		*I*	*I*	
	I		*I*		*I*
	I			*I*	*I*
		I	*I*	*I*	
		I	*I*		*I*
		I		*I*	*I*
		I	*I*	*I*	
		I	*I*		*I*
		I		*I*	*I*
			I	*I*	*I*
Two irrigation turns	*I*	*I*			
	I		*I*		
	I			*I*	
	I			*I*	
	I				*I*
		I	*I*		
		I		*I*	
		I			
		I	*I*		
		I		*I*	
		I			*I*
			I	*I*	
			I	*I*	
			I		*I*
				I	*I*
Less likely scenario					
Three irrigation turns	*I*	*I*	*I*		
	I	*I*		*I*	
	I	*I*		*I*	
	I	*I*			*I*
		I	*I*	*I*	
		I		*I*	*I*
			I	*I*	*I*
Two irrigation turns	*I*	*I*			
				I	*I*

Unlikely, yet possible scenario	June		July		August		
	15	22	1	15	1	7	15
Three irrigation turns	*I*	*I*	*I*				
					I	*I*	*I*
Two irrigation turns	*I*	*I*					
					I	*I*	
		I	*I*				
						I	*I*

I is irrigation gift of 50 cm