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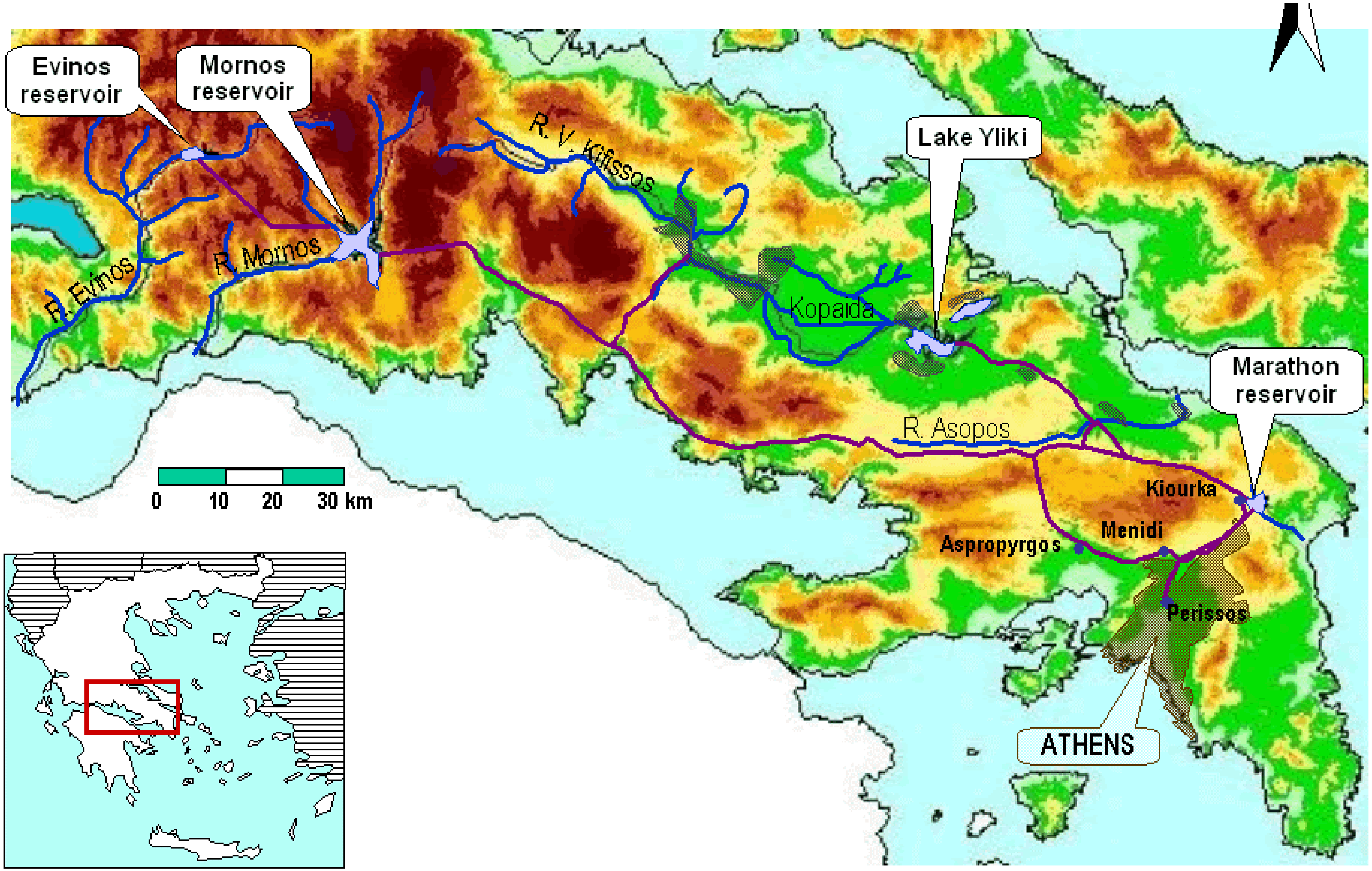
Integrating Groundwater Models within a Decision Support System

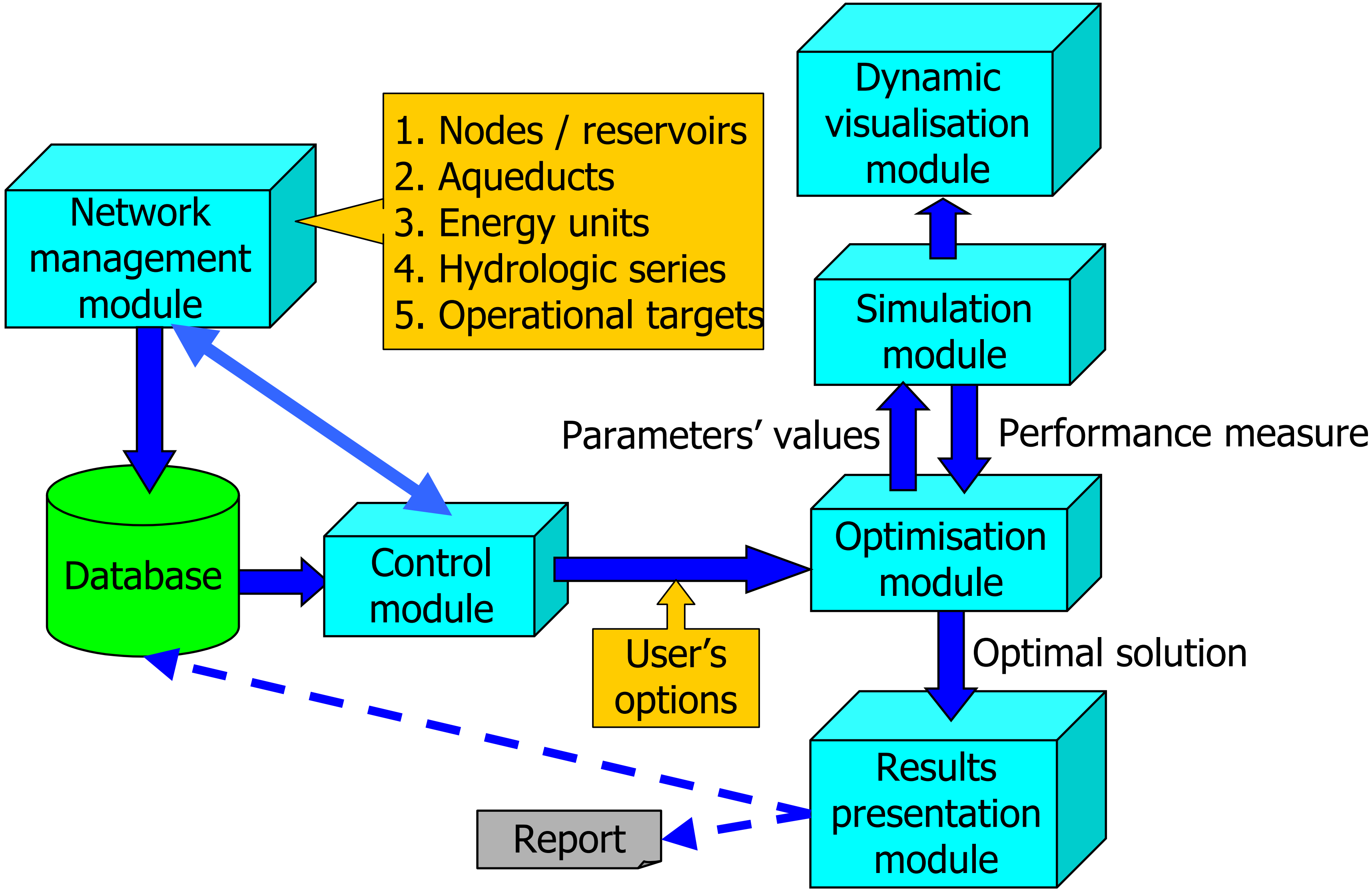
Nalbantis, I., E. Rozos, G. Tentes,
A. Efstratiadis, and D. Koutsoyiannis

National Technical University of Athens
Dept. of Water Resources, Hydraulic & Maritime Engineering
5 Heroon Polytechneiou, 15700 Zographou, Greece

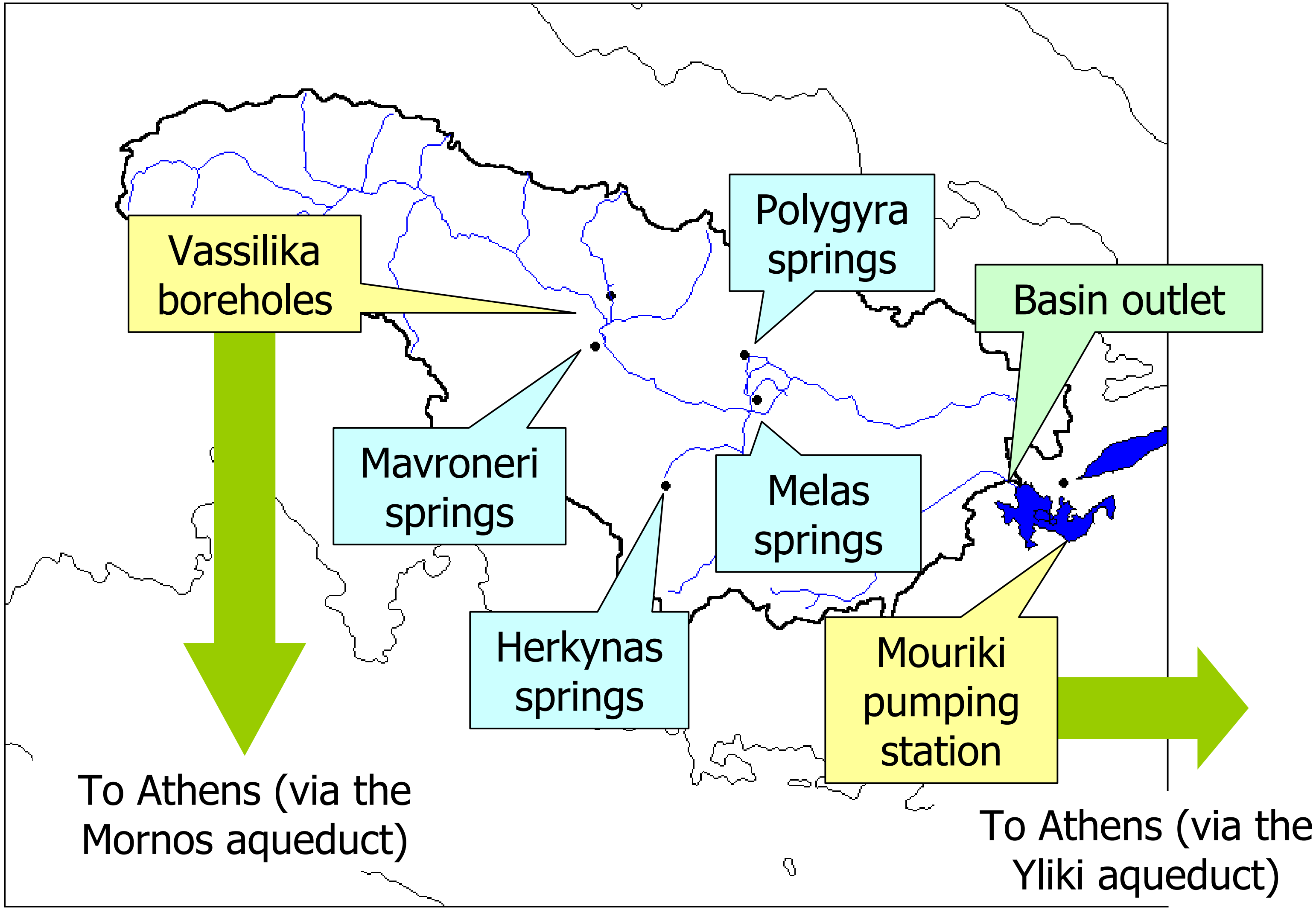
The geographical setting: The Athens water supply system



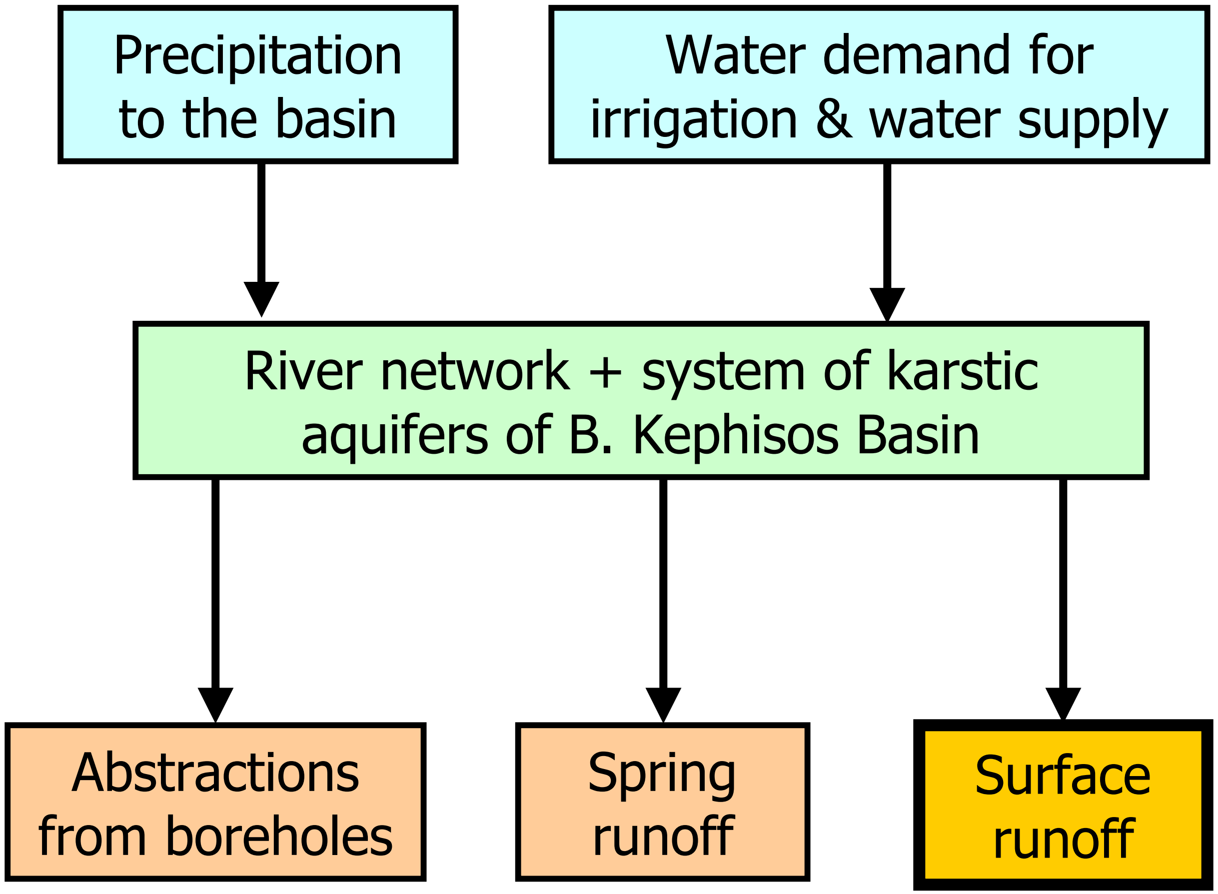
The HYDRONOMEAS Decision Support System



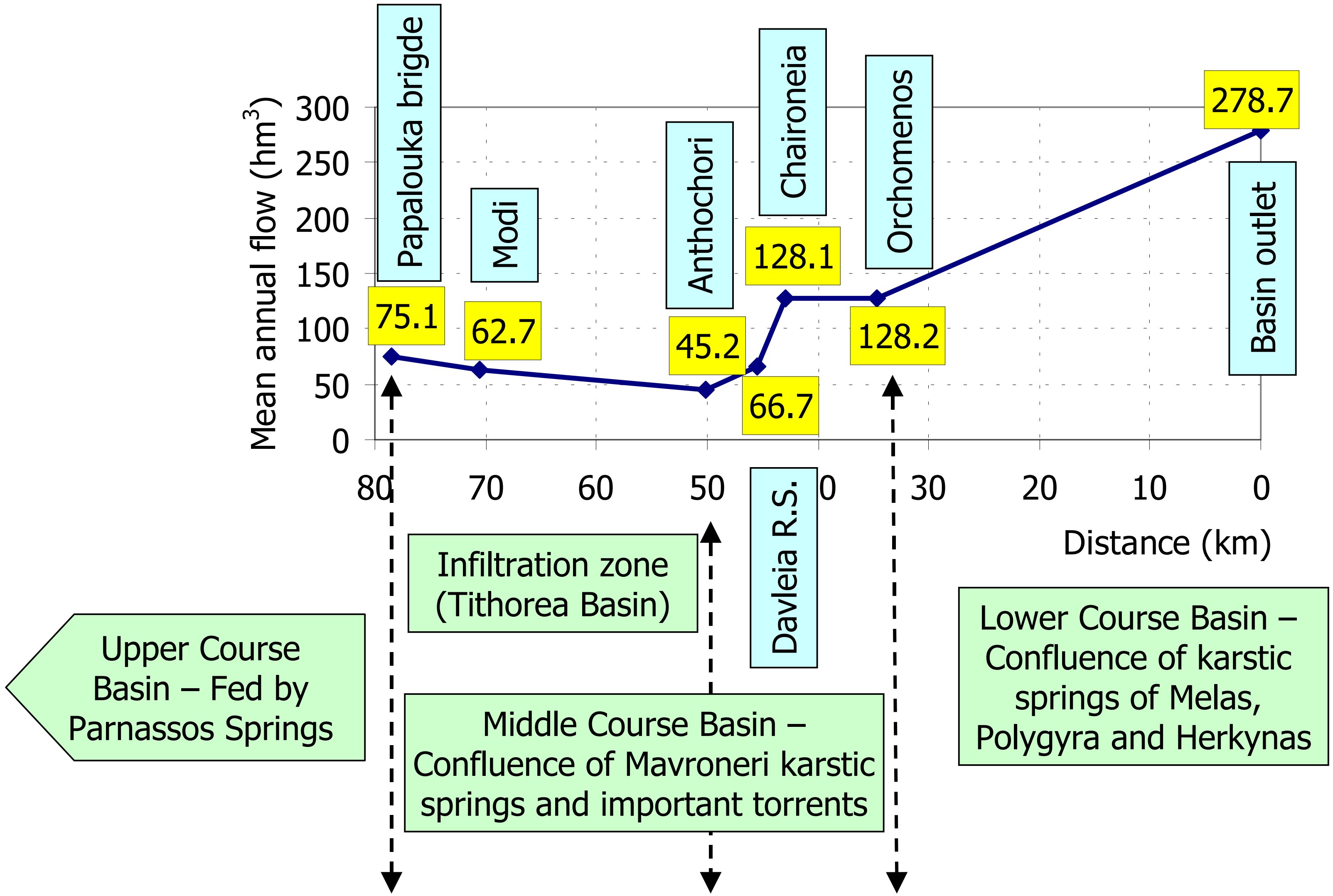
The Boeoticos Kephisos Basin: Why a groundwater model?



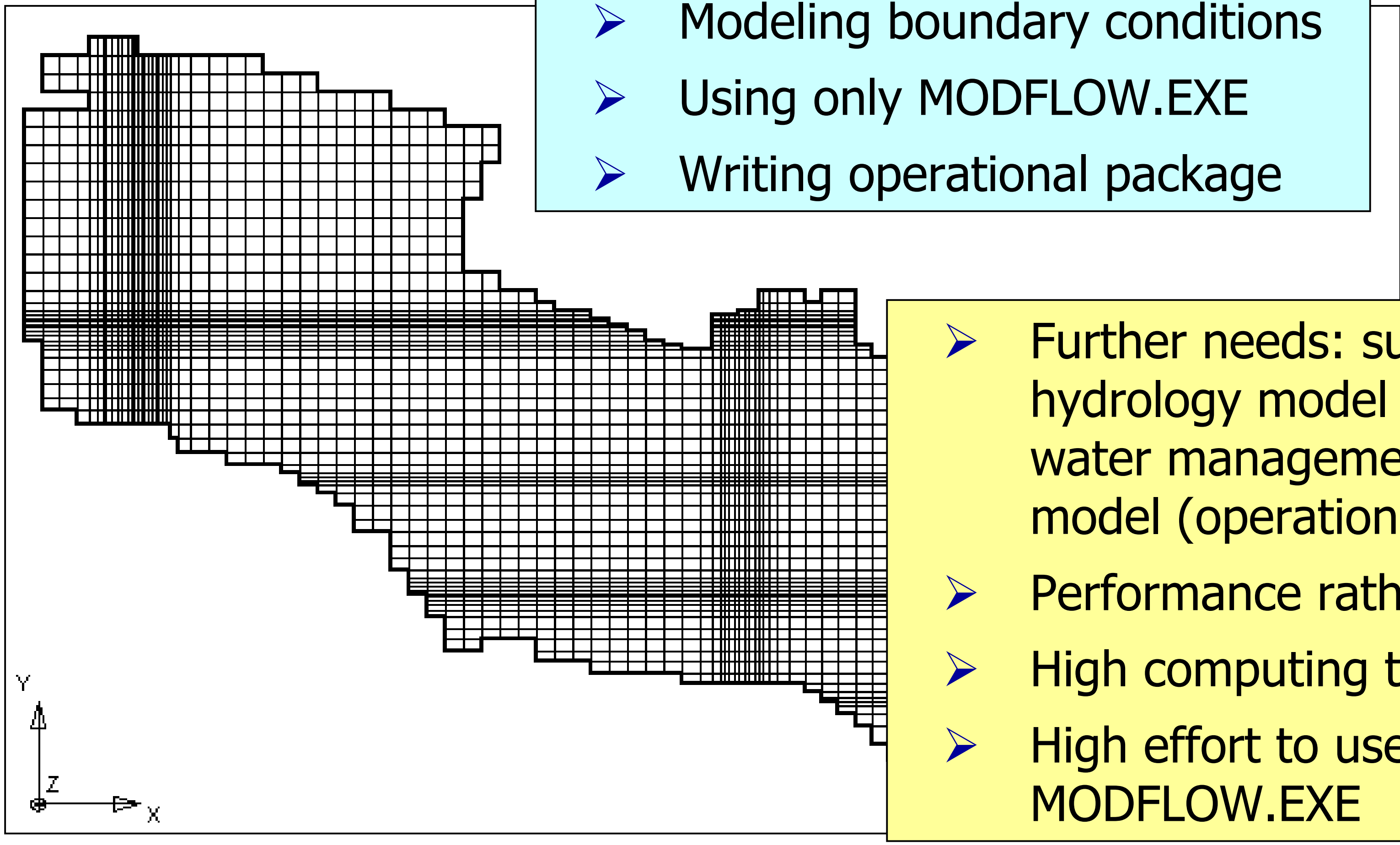
Overview of the hydrological processes in the Boeoticos Kephisos Basin



Mean annual flow rate of B. Kephisos River
(Hydrological years 1970-71 to 2000-01)



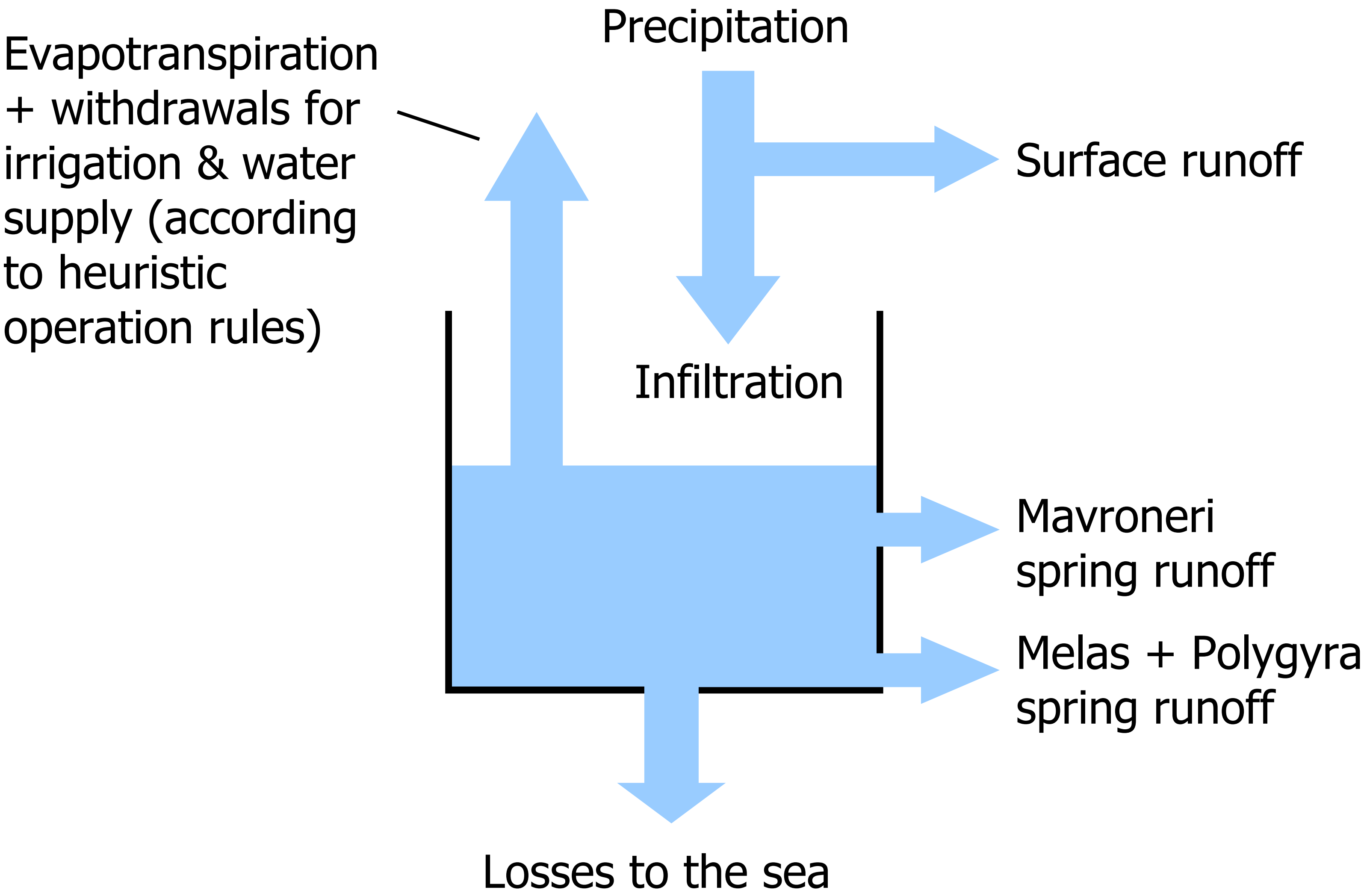
Pre-existing MODFLOW model: Adaptation to operational context



- 500×500 m^2 grid
- Modeling boundary conditions
- Using only MODFLOW.EXE
- Writing operational package

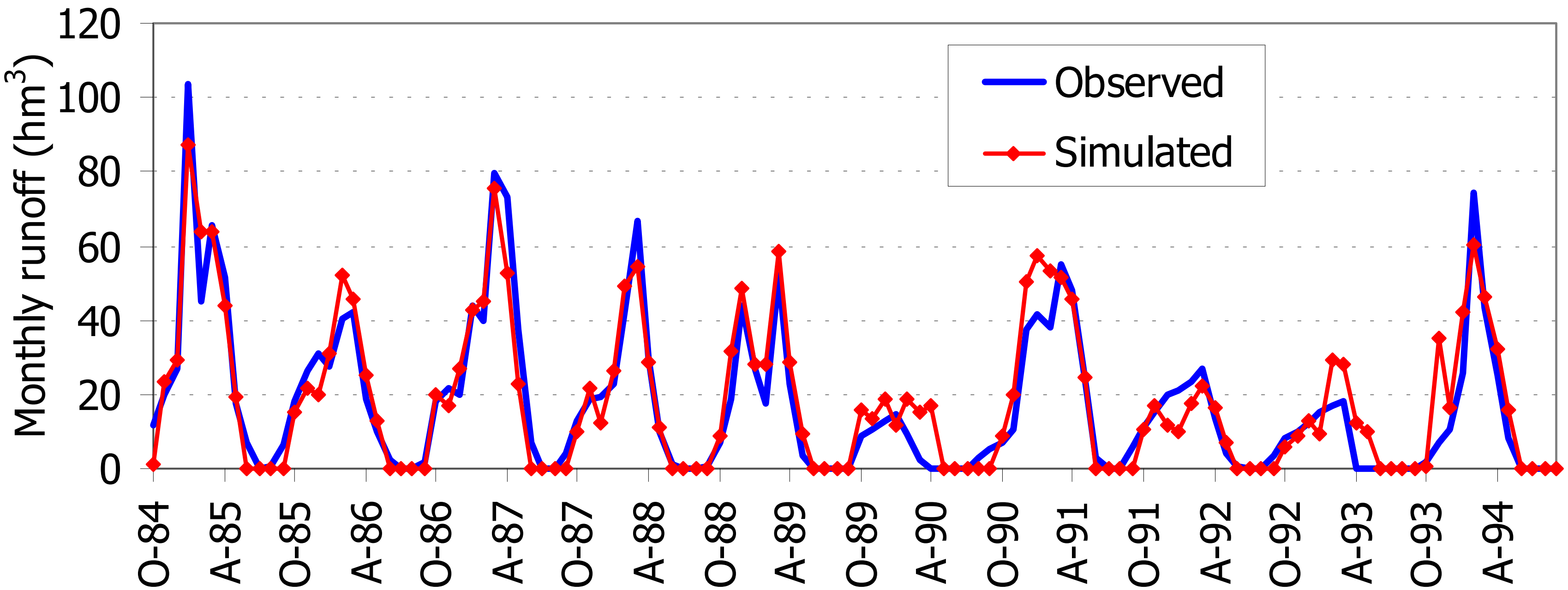
- Further needs: surface hydrology model + water management model (operation rules)
- Performance rather poor
- High computing time
- High effort to use MODFLOW.EXE

Approach A: Lumped conceptual model (1)

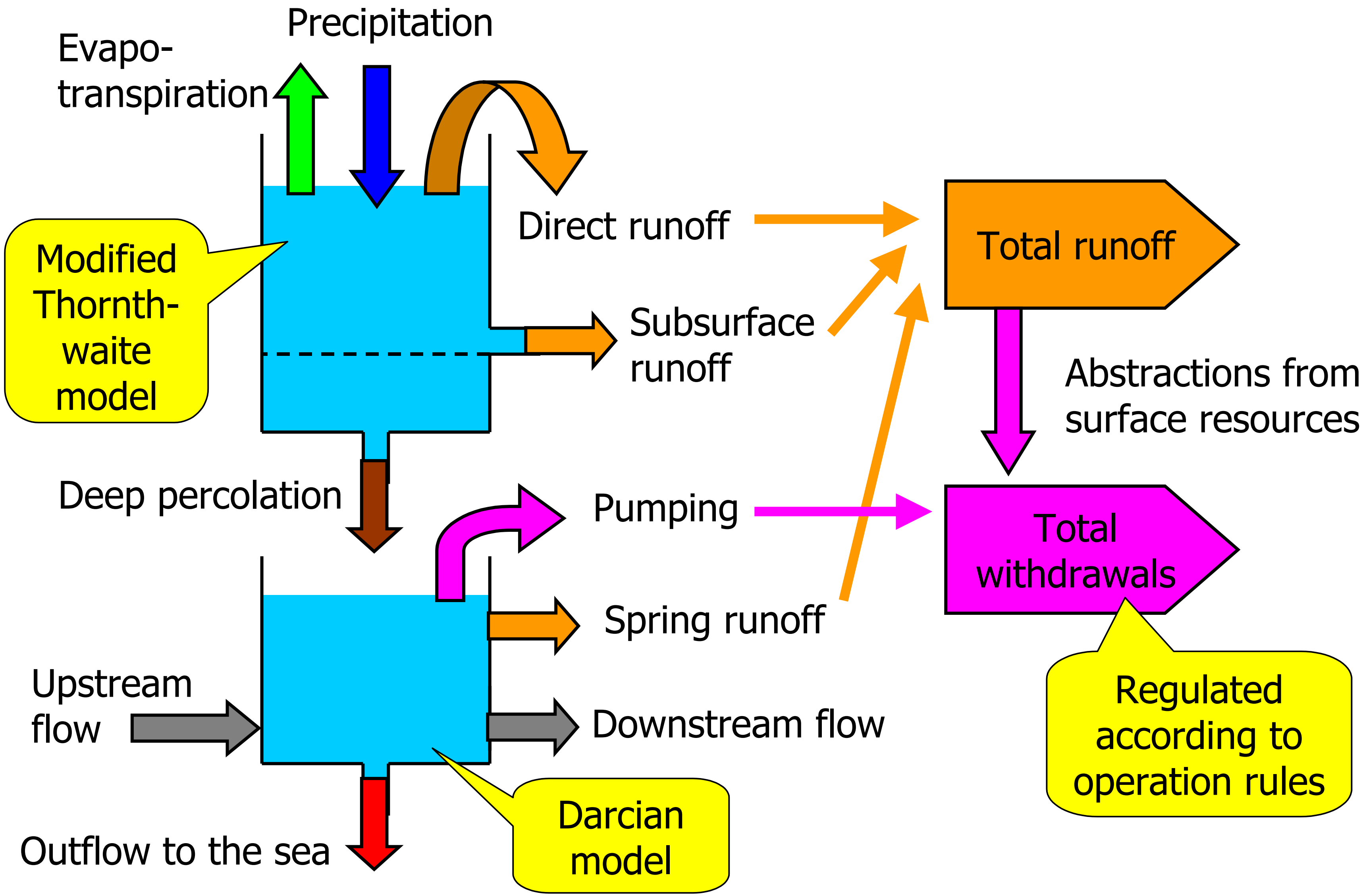


Approach A: Lumped conceptual model (2)

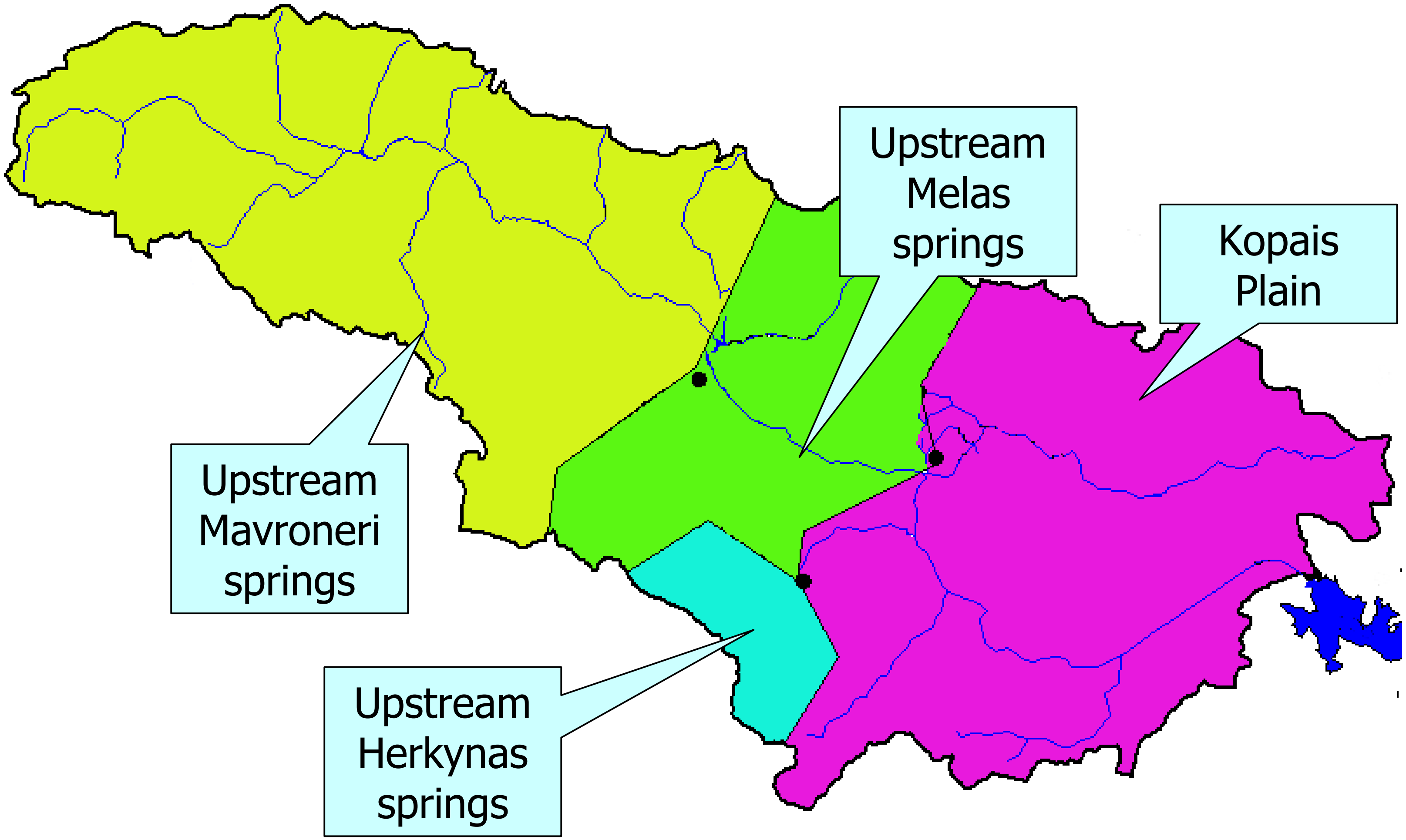
- Small number of parameters (5)
- Calibration on the 5-year discharge data at the basin outlet (hydrological years 1984-85 to 1988-89)
- Validation on the 5-year discharge data at the basin outlet (hydrological years 1989-90 to 1994-95)



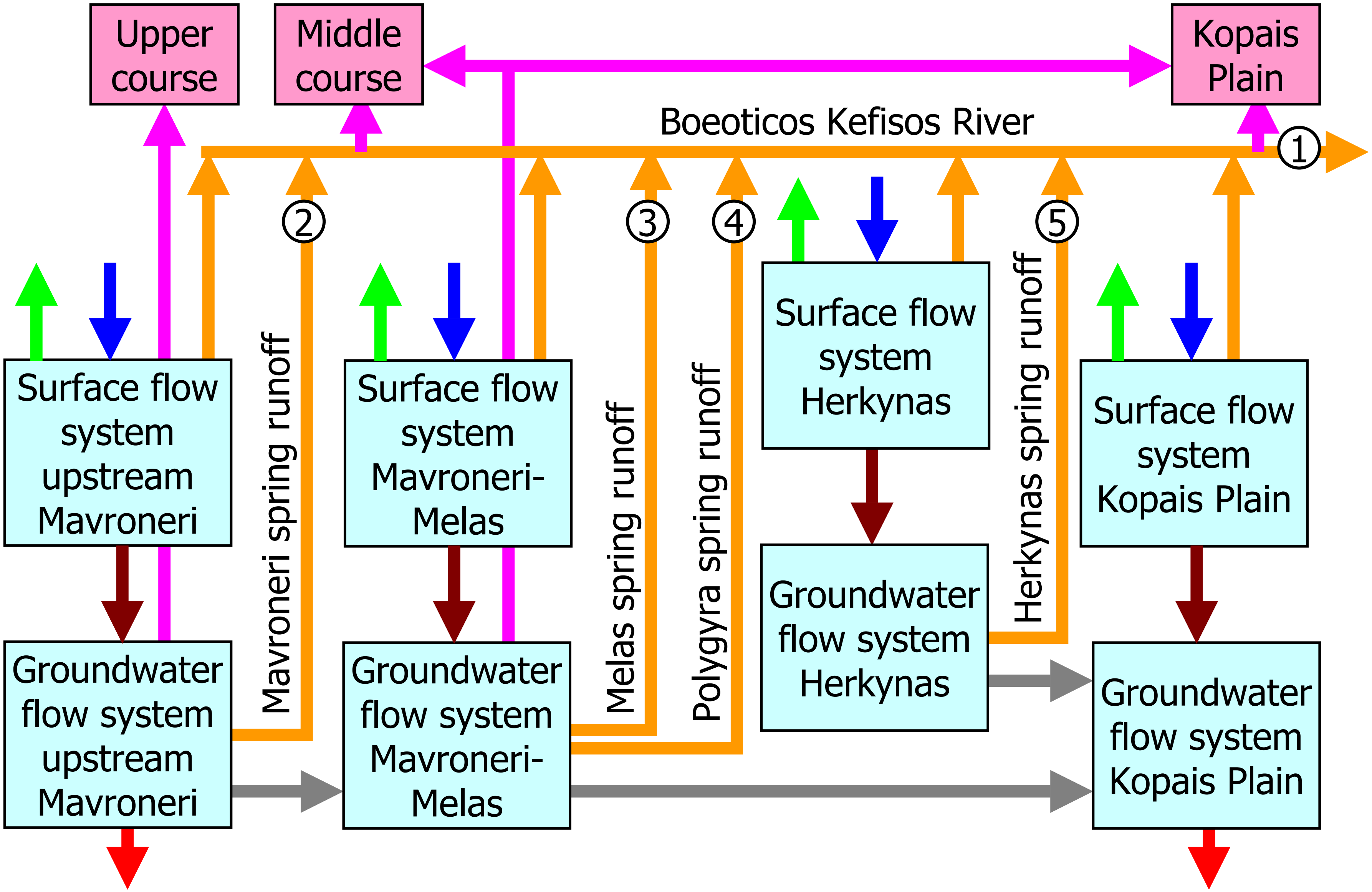
Approach B: Semi-distributed model (1)



Approach B: Semi-distributed model (2): Division into 4 cells

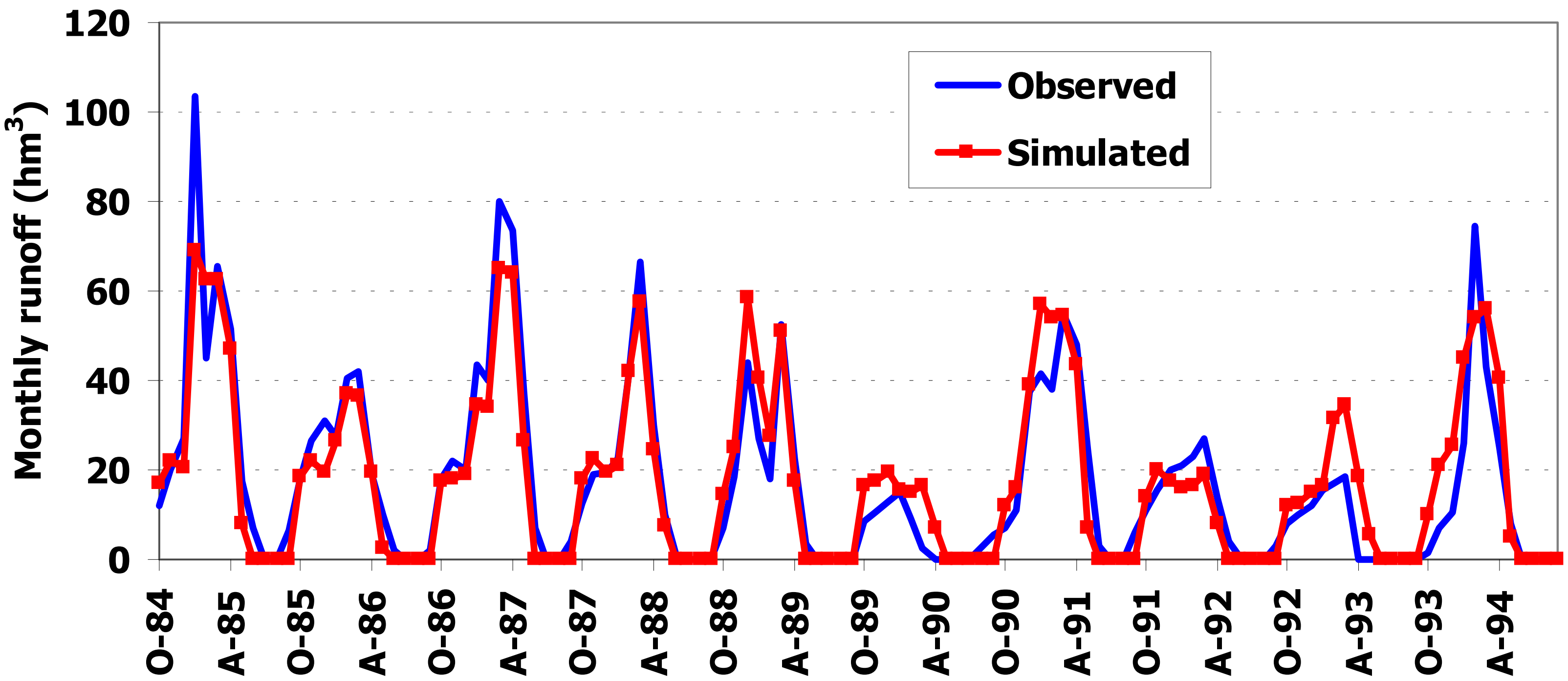


Approach B: Semi-distributed model (3)

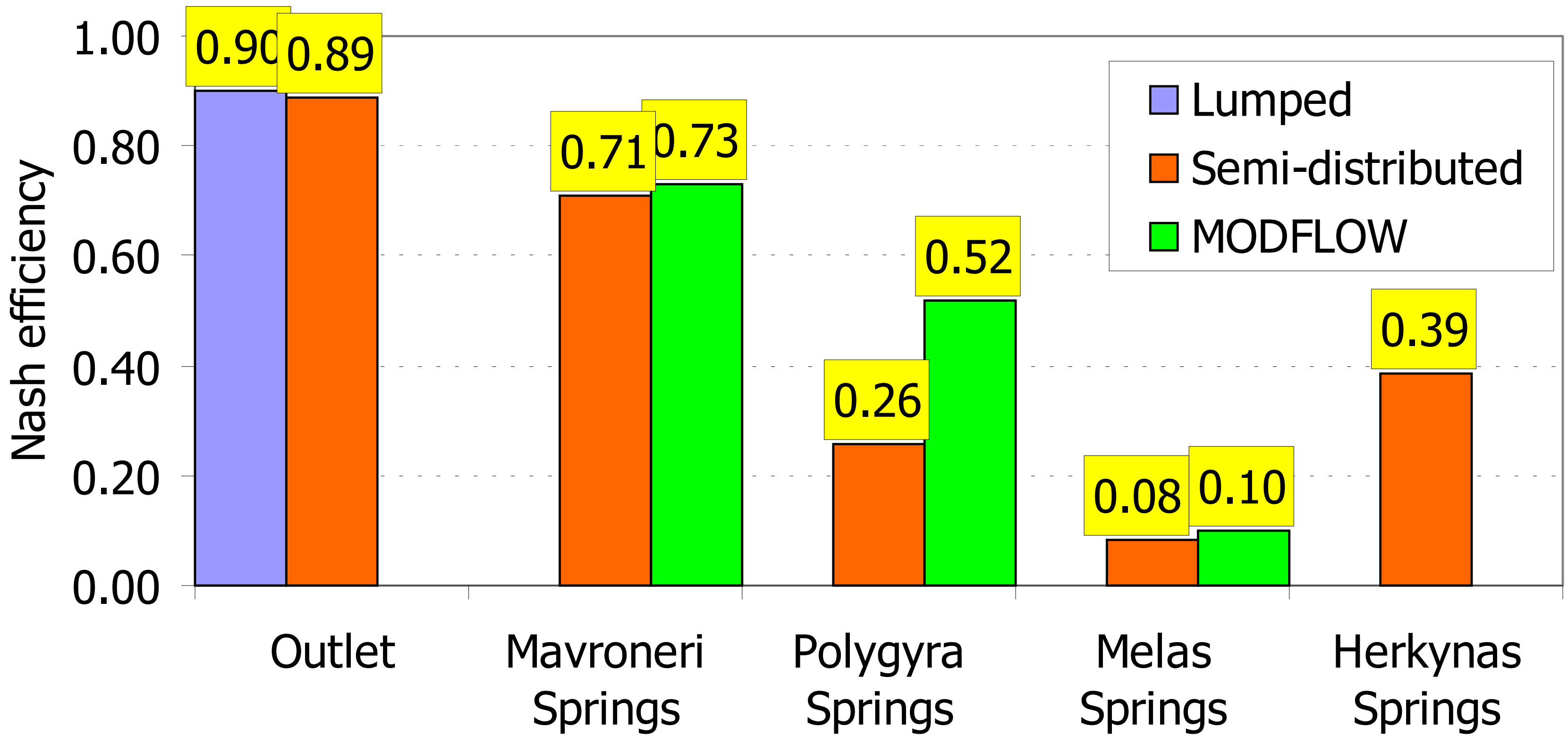


Approach B: Semi-distributed model (4)

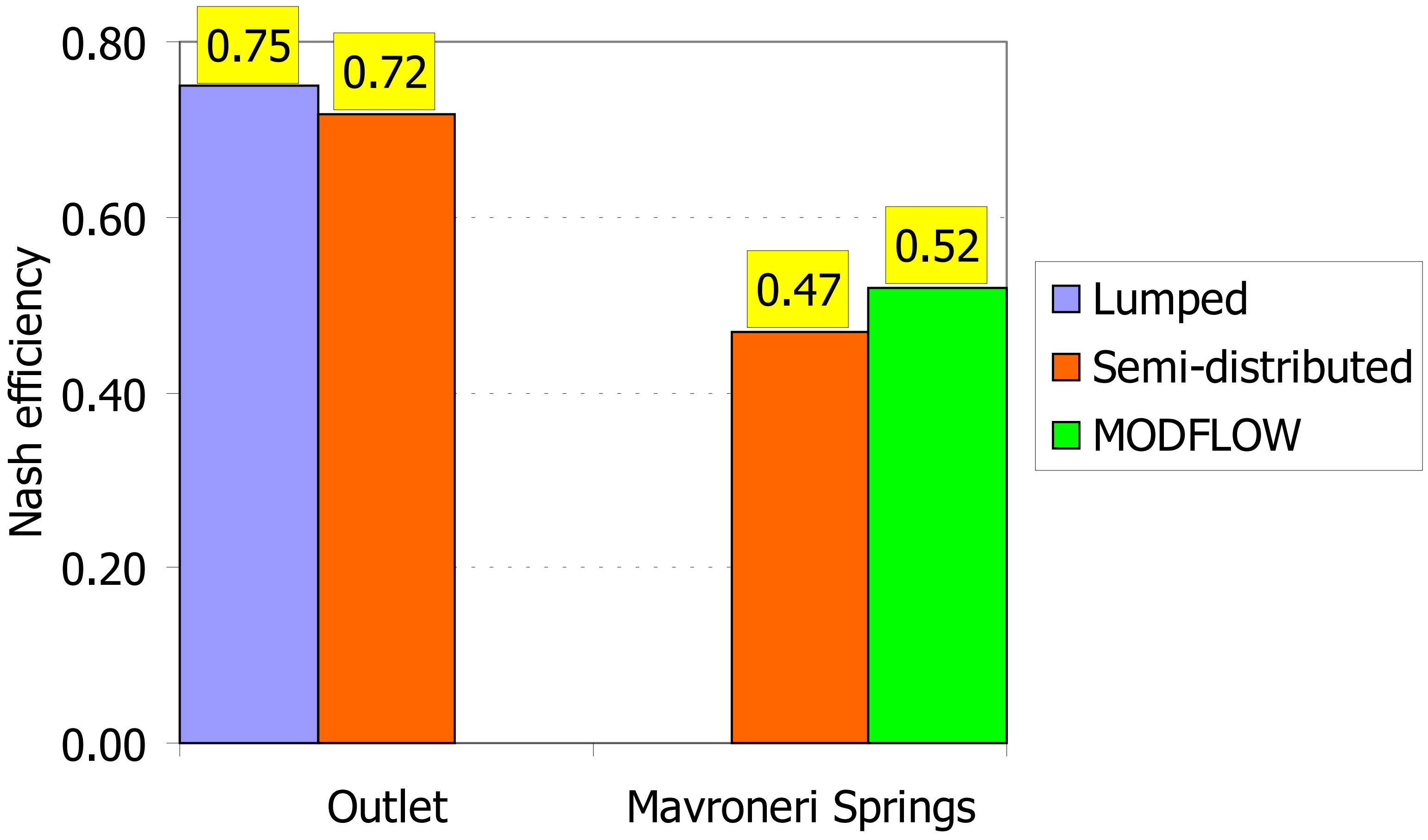
- Large number of control variables (18 model parameters + 6 initial conditions)
- Calibration on the 5-year discharge data at the basin outlet (hydrological years 1984-85 to 1988-89)
- Validation on the 5-year discharge data at the basin outlet (hydrological years 1989-90 to 1994-95)



Model performance criteria in calibration

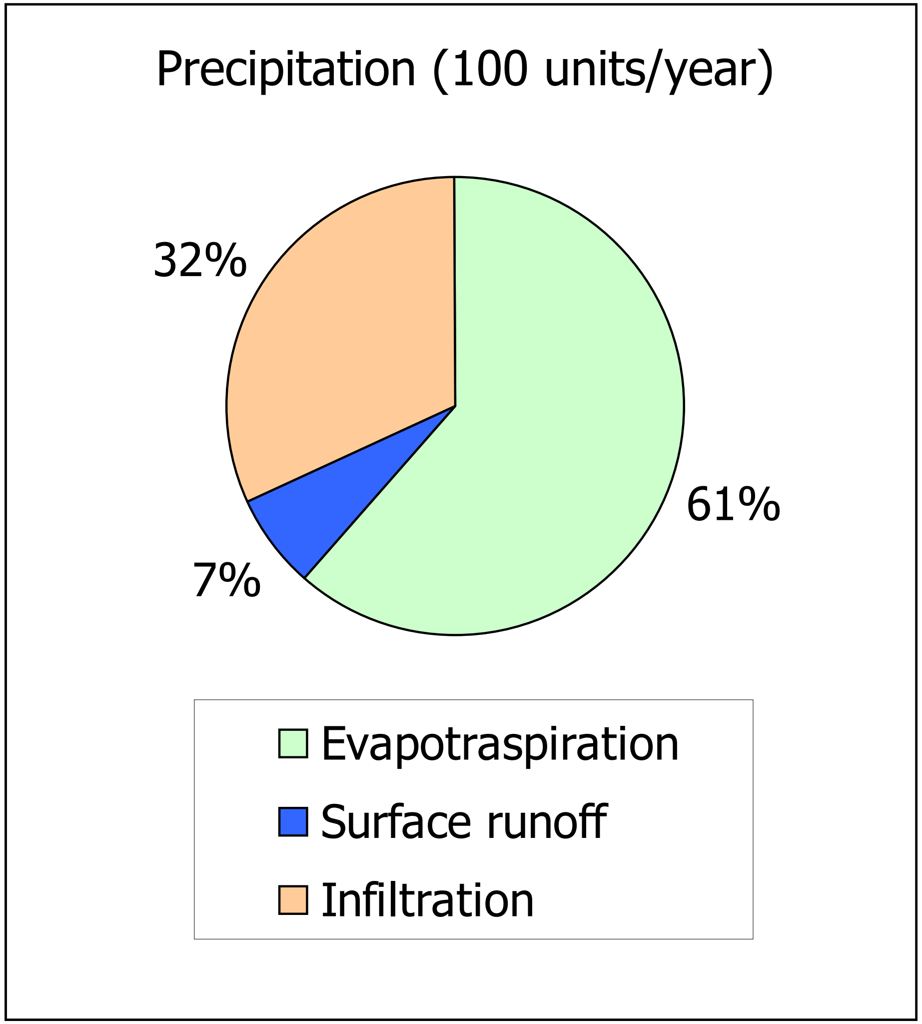


Model performance criteria in validation

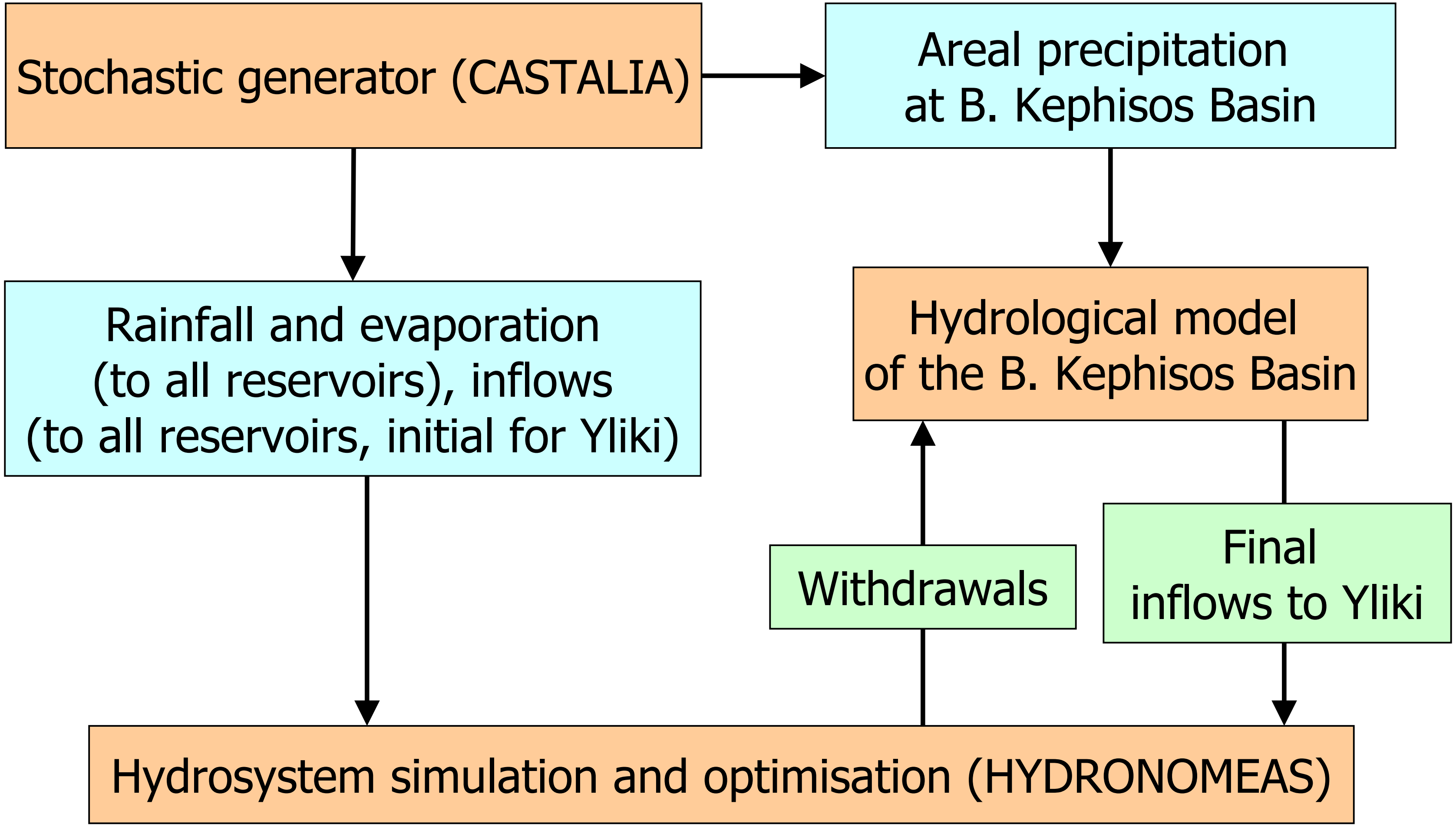


Basin mean annual water balance
(through the multi-cell model)

Component	hm^3	(%)
Precipitation	1835	
Evapotraspiration	1128	61
Surface runoff	123	7
Infiltration	584	32
Losses to sea	165	28
Spring runoff	183	31
Groundwater abstractions	236	40
Total runoff	306	
Runoff at the outlet	212	69
Surface water abstractions	94	31
Water demand for irrigation and supply	330	
Surface water abstractions	94	28
Groundwater abstractions	236	72



Integration of hydrological models into HYDRONOMEAS



Concluding remarks

- The ability of our DSS to manage water resource was enhanced through integrating hydrologic models into it
- Three models were tested: a multi-cell model, a lumped model and MODFLOW
- Prediction accuracy for the multi-cell model and the lumped model was similar both in calibration and validation
- One five-year simulation (with a monthly time step) lasts 1.5×10^{-6} s, 0.5 s and 5 min for the lumped, the multi-cell and the MODFLOW model respectively (for PC Pentium III at 600 MHz)
- In the optimisation phase, HYDRONOMEAS can afford only the lumped model, while for a single simulation cycle the multi-cell model is proposed
- Distributed models, although useful for better spatial information treatment, remain ineffective