Simple water balance model using a Geographical Information System

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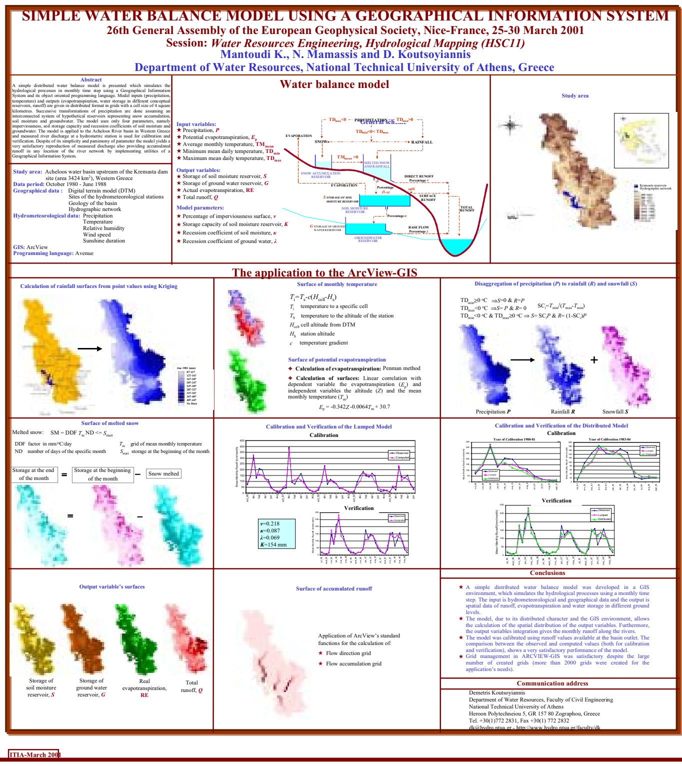
Topics of the presentation

- ★ Water balance model
- ★The application to GIS
- ★ Calibration-verification
- ★ Conclusions



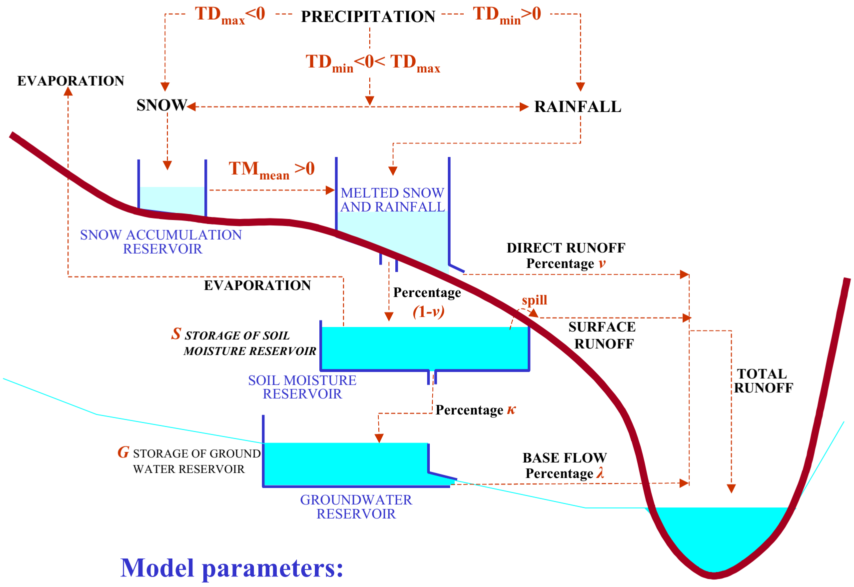
Water balance model

Input variables:

- ★ Precipitation, ***P***
- ★ Potential evapotranspiration, E_p
- ★ Average monthly temperature, TM_{mean}
- ★ Minimum mean daily temperature, TD_{min}
- ★ Maximum mean daily temperature, TD_{max}

Output variables:

- ★ Storage of soil moisture reservoir, ***S***
- ★ Storage of ground water reservoir, ***G***
- ★ Actual evapotranspiration, **RE**
- ★ Total runoff, ***Q***



Model parameters:

- ★ Percentage of imperviousness surface, v
- ★ Storage capacity of soil moisture reservoir, K
- ★ Recession coefficient of soil moisture, κ
- ★ Recession coefficient of ground water, λ

The application to GIS

Model characteristics

Time step: monthly

Cell size: 2X2 km^2

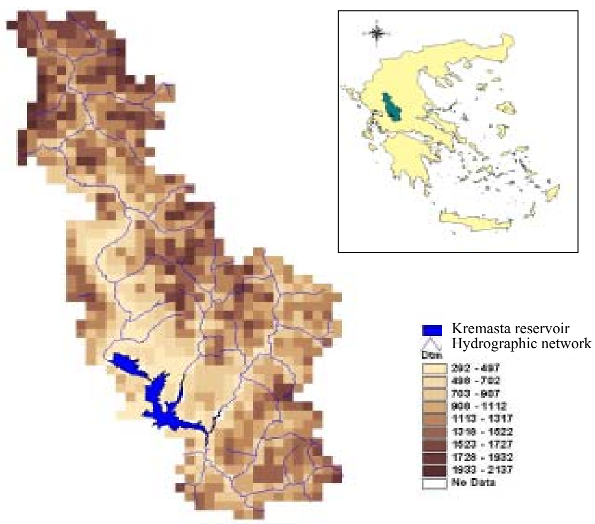
Data period:
October 1980-June 1988

GIS: ArcView

Programming language:
Avenue

Study area

Acheloos water basin upstream of the Kremasta dam site (area 3424 km^2), Western Greece



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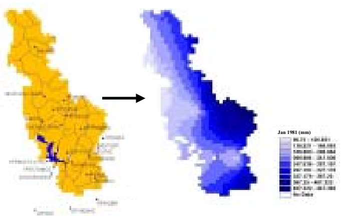
The application to GIS
(data used)

Geographical data
- Digital elevation model (DEM)
- Sites of the hydrometeorological stations
- Geology of the basin
- River network

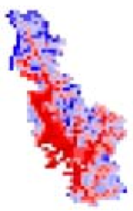
Hydrometeorological data
- Precipitation
- Temperature
- Relative humidity
- Wind speed
- Sunshine duration
- Discharge at the basin outlet

The application to GIS
Calculated surfaces

Precipitation
(from point values using Kriging method)

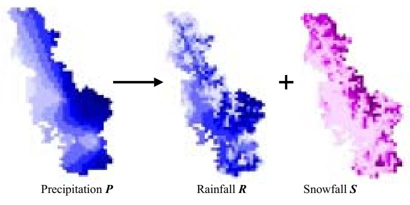


Temperature
(using points values, cell altitude and temperature gradient)

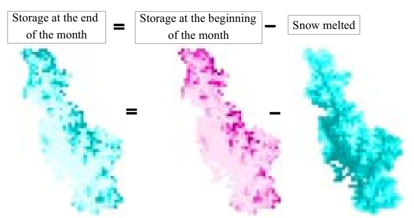


Potential evapotranspiration
(using points values cell altitude and temperature)

Dissaggregation of precipitation
(to rainfall and snowfall using minimum and maximum daily temperature)

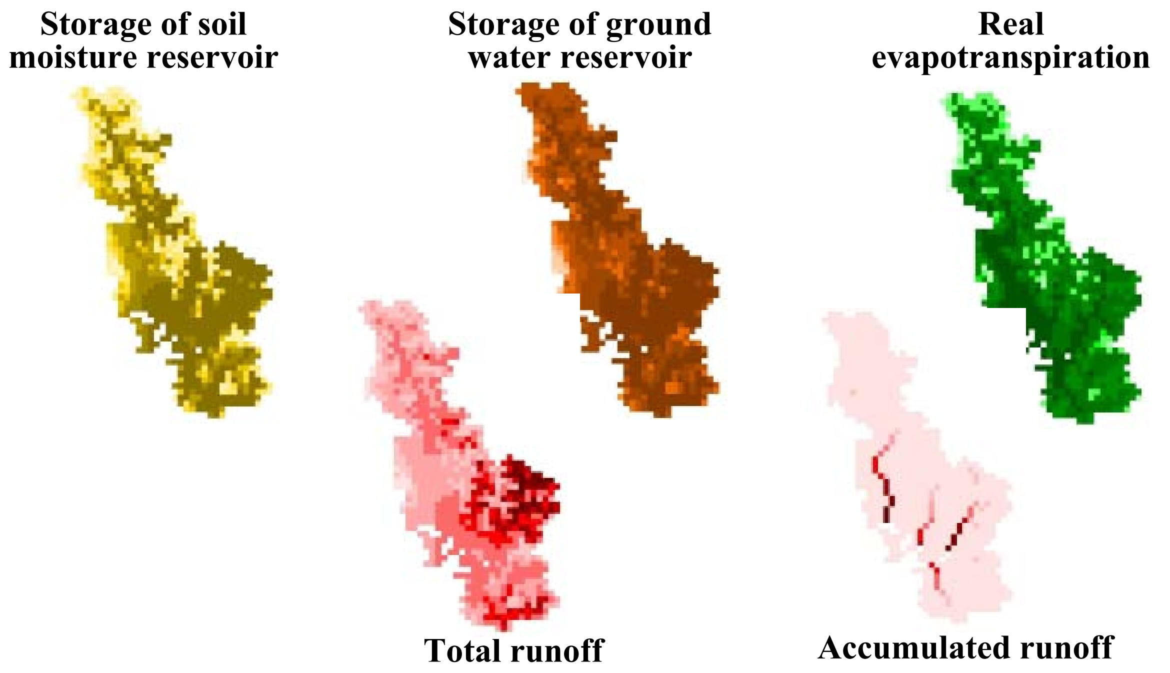


Melted snow
(using temperature and storage)



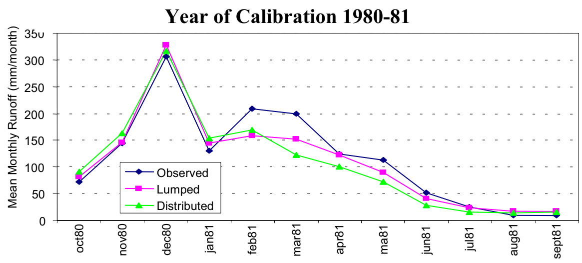
The application to GIS

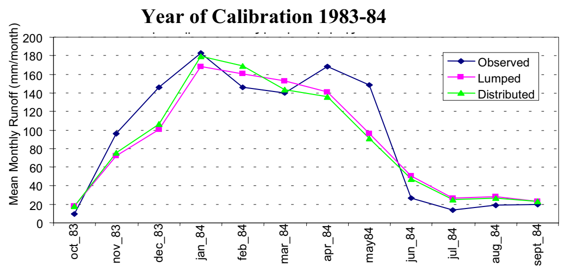
Output variable’s surfaces



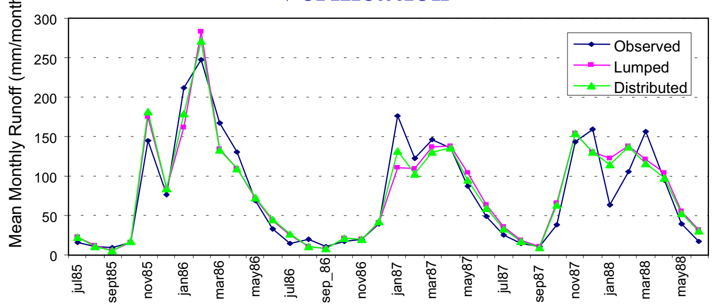
Calibration and verification of the distributed model

Calibration





Verification



Conclusions

★ A simple distributed water balance model was developed in a GIS environment, which simulates the hydrological processes using a monthly time step. The input is hydrometeorological and geographical data and the output is spatial data of runoff, evapotranspiration and water storage in different ground levels.

★ The model, due to its distributed character and the GIS environment, allows the calculation of the spatial distribution of the output variables. Furthermore, the output variables integration gives the monthly runoff along the rivers.

★ The model was calibrated using runoff values available at the basin outlet. The comparison between the observed and computed values (both for calibration and verification), shows a very satisfactory performance of the model.

★ Grid management in ARCVIEW-GIS was satisfactory despite the large number of created grids (more than 2000 grids were created for the application's needs).