HYDROGEIOS is an integrated approach for conjunctive simulation of hydrological processes, where natural processes are significantly affected by human interventions. It optimizes a systems-oriented management scheme, to ensure a faithful representation of hydrological mechanisms and, hence, a rational water management policy. It provides tools for automatic parameter estimation, based on multiple error criteria and a robust optimization method, adapted for both single and multiobjective calibrations.

**Definition of HYDROGEIOS**

HYDROGEIOS is a GIS-based application, suitable for complex hydrosystems, where natural processes are significantly affected by human interventions. It integrates a conjunctive (surface and groundwater) hydrological model, based on a semi-distributed approach, within a systems-oriented management scheme, to ensure a faithful representation of hydrological mechanisms and, hence, a rational water management policy. It provides tools for automatic parameter estimation, based on multiple error criteria and a robust optimization method, adapted for both single and multiobjective calibrations.

**Input Data**

- Raw geographical data: terrain model, soil properties (e.g., permeability), land cover, monitoring stations
- Surface hydrology components: hydrographic network (river nodes and segments), sub-basins, hydrological response units (HRUs)
- Groundwater components: aquifers, springs, boreholes
- Water management components: channels, pipes, demand sites, irrigated areas, borehole groups, water uses and priorities, operational costs and constraints
- Time series: precipitation & potential evapotranspiration (for each sub-basin), water needs, control series (discharge measurements, observed aquifer levels)
- Scenario data: computational parameters for simulation and optimization procedures, error criteria for calibration

**Groundwater Hydrology Processes**

A Darcian multi-cell scheme is established, based on a non-rectangular discretisation of the groundwater system. Each cell is represented as a conceptual tank, of which the stress components are: (a) percolation from each sub-basin and HRU combination, (b) infiltration losses from each river segment, and (c) pumping from each borehole. Springs are modelled as tanks with very large base.

**Surface Hydrology Processes**

For each sub-basin and HRU combination, a conceptual soil moisture accounting model runs to compute the transformation of precipitation to real evapotranspiration, deep percolation and flood runoff; the latter, together with the estimated spring runoff (baseflow) is directly transferred to the downstream node of the corresponding basin.

**Water Resources Management: A Network Optimisation Approach**

- basin and spring runoff, assumed point supply
- groundwater yield (= pumping capacity)
- water needs, constraints and priorities
- real capacities and unit cost values of hydrosystem components

**Objectives**

- Establishing a physically-based approach while keeping a parsimonious structure, by conceptually relating the hydrological responses of a watershed with its geomorphological and physiographic characteristics.
- Taking into account all available spatial and hydrological data.
- Understanding the main physical mechanisms along a river network, and their interactions under a specific hydroclimatic scenario or management policy.
- Assessing the actual surface and groundwater yield at various control sites.

**AN INTEGRATED MODEL FOR CONJUNCTIVE SIMULATION OF HYDROLOGICAL PROCESSES AND WATER RESOURCES MANAGEMENT IN RIVER BASINS – Part 1**

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Session HS4: Incorporating hydrological processes knowledge into catchment modelling

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Case study: The Boeoticos Kephisos river basin
- Watershed area: 1955.6 km² (the largest of the Eastern Sterea Hellas water district)
- Altitudes: 469 m (average), 2400 m (maximum)
- Geology: heavily karstified limestones (mountainous areas), alluvial deposits (plain areas)
- Hydrographic network: a main branch of length 100 km; last 35 km segment is an artificial channel, diverting flows to the neighbouring Lake Hylike (the basin has no physical outlet to the sea)
- Hydrology: mean annual precipitation 765 mm, mean annual runoff 172 mm
- Groundwater: due to the karstic background, significant percentage (~50%) of runoff is baseflow, arising from large springs in the upper and middle part of the basin; unknown amount of groundwater is conducted to the sea
- Water uses: (1) abstractions from both surface and groundwater resources for irrigation (220 hm³/year); (2) abstractions from Lake Hylike and water supply boreholes lying in the middle part of the basin, directed to Athens

HYDROGEIOS: Software implementation
- Model schematisation: 5 sub-basins, 6 HRUs, 30 groundwater cells
- Control period: 10-years (1984-1994), for monthly and daily simulation time steps
- Calibration data: daily discharge series at the basin outlet, sparse (1-2 per month) flow measurements along the river and downstream of the main karstic springs
- Objective function: formulation of a weighted performance measure, based on multiple responses and multiple fitting criteria
- Optimisation method: evolutionary annealing-simplex (single- and multiobjective)

HYDROGEIOS is developed within the project “ODYSSEUS: Integrated Management of Hydrosystems in Conjunction with an Advanced Information System”.
Project web page: http://www.odysseusproject.gr/
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