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**INTEGRATED MANAGEMENT OF  
HYDROSYSTEMS IN CONJUNCTION WITH  
AN ADVANCED INFORMATION SYSTEM**

**ODUSSEUS**

Synoptic description of computer tools  
and information systems

Athens  
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# ODUSSEUS

Integrated Management of Hydrosystems in Conjunction with an  
Advanced Information System

## Main software systems

### HYDROGNOMON-COM

#### Hydrological data management and processing

HYDROGNOMON is a client-server system for managing and processing hydrological data. The data management framework is based on the geographical organisation of entities (river basins, measurements stations, reservoirs, etc.), in which are assigned physical properties, technical characteristics, time series and multimedia. The program employs typical time series processing as well as specific applications, such as evapotranspiration modelling, construction of stage-discharge curves, and reservoir water balance analysis. It provides data capabilities and links with geographical information systems.

### HYDROGEIOS-COM

#### Geo-hydrological simulation of river basins

HYDROGEIOS is an integrated model that represents the surface and groundwater processes and, simultaneously, the man-made interventions in a river basin, for monthly and daily time scales, according to a semi-distributed schematisation. Model inputs comprise geographical data (river network, sub-basins, aquifers, geology, land cover, terrain slope, etc.), data for the hydrosystem components (water conveyance and abstraction facilities, demand points, etc.) and hydrological data (precipitation and potential evapotranspiration time series). The model is automatically calibrated on the basis of multiple goodness-of-fit criteria, and estimates the hydrosystem fluxes, including the discharge values along the river network, the groundwater levels and the necessary abstractions.

### HYDRONOMEAS-COM

#### Optimisation of hydrosystem operation

HYDRONOMEAS provides decision support regarding the optimal design and control of complex hydrosystems, by incorporating numerous physical, technical, economical and environmental aspects of integrated river basin management. A stochastic simulation framework enables the assessment of the projected hydrosystem fluxes on a probabilistic basis. The model detects suitable management policies, by means of simultaneous minimisation of costs and risks regarding both water quantity and quality efficiency for the various uses. The system provides a user-friendly environment tools for the schematisation of the network, the tabular and graphical presentation of results, and the dynamic visualisation of simulations.

## **Additional modules**

### **CASTALIA-COM**

#### **Generation of synthetic time series**

CASTALIA is an extension of the HYDROGNOMON software, used for the generation of synthetic time series of various processes at multiple locations, which are statistically consistent with the historical data. It implements a two-level (i.e. monthly, annual) multivariate stochastic scheme, suitable for reproducing the peculiarities of the hydrological processes, including long-term persistence (the “Hurst phenomenon”), periodicity and skewness. The model also runs in forecast mode, to generate ensemble time series representing possible future trajectories of the hydrological processes.

### **PYTHIA-COM**

#### **Statistical analysis of hydrological data**

PYTHIA is an extension of the HYDROGNOMON software, implementing an integrated statistical analysis framework for hydrological time series. This analysis includes the estimation of statistical characteristics and parameters (typical as well as specialised, such as hydrological persistence parameters), fitting of distribution functions, estimation of confidence intervals (either by analytical method or through Monte Carlo techniques), statistical tests, Fourier analysis and statistical forecast.

### **OMBROS-COM**

#### **Construction of idf curves**

OMBROS is an extension of the HYDROGNOMON software, used to analyse hydrological extremes and formulate intensity-duration-frequency (idf) curves. The program embraces a wide spectrum of distributions and methods to estimating their parameters, also providing graphical tools for visualising probability functions and idf curves. Moreover, it estimates the confidence limits of the curves through Monte-Carlo methods.

### **ZYGOS-COM**

#### **Lumped hydrological model**

ZYGOS is an extension of the HYDROGNOMON software, implementing a conceptual water balance model that represents the main hydrological processes of a river basin and its underlying aquifer. The program provides alternative model structures, selected on the basis of the available data, by enabling from one to nine parameters. It also provides automatic calibration tools, using an evolutionary algorithm.

### **DIPSOS-COM**

#### **Water demands assessment**

DIPSOS estimates the water demand for various consumptive uses. Specifically, the domestic, industrial and farming demands are estimated using typical literature values, whereas irrigation needs are based on potential evapotranspiration and crop development coefficient estimations. Four methods are provided for evapotranspiration modelling, with respect to the available meteorological data.

## **RYPOS-COM**

### **Pollutant loads assessment**

RYPOS estimates the pollutant loads from point and non-point sources. Regarding the former, it enables a detailed representation of the pollutant processes in industries and the operational parameters of sewage treatment plants, as well as a direct estimation of emitted loads, in time series format. On the other hand, for the non-point sources, the model uses suitable emission factors, by taking into account the geomorphological conditions, the land uses, the agricultural activities and the hydrologic regime.

## **HERIDANOS-COM**

### **River quality modelling**

HERIDANOS combines a one-dimensional hydrodynamic model to calculate the river flow characteristics, with a water quality model, which estimates the pollutant diversion and the representation of chemical and biological processes in a water column. A variety of parameters are examined, including dissolved and suspended organic carbon, nutrient, phosphorus, dissolved oxygen, algae, heterotrophic and autotrophic biomass, higher micro-organisms, conservative pollutants, etc. The model results are discharge, velocity and concentration time series, regarding all water quality characteristics along the river segment.

## **LERNE-COM**

### **Lake quality modelling**

LERNE is a water quality simulation model for lakes. The lake is handled as a completely mixed element, to represent dilution as well as the physical, chemical and biological processes for each pollutant. For a faithful representation of the eutrophication phenomenon, several quality indicators are examined, as chlorophyll, phosphorous, nutrients, organic carbon and dissolved oxygen. Moreover, the program implements stochastic simulation to express concentrations in probabilistic terms. The model results include concentration time series and various statistical characteristics.

## **ALS-COM**

### **Costal aquifers modelling**

The hydrogeological model ALS simulates and optimises the pumping rates within costal aquifers, aiming to estimate the safe groundwater yield. The model describes the flow characteristics in coastal zones, as a function of the aquifer geometry, the hydraulic parameters and the supply regime. An optimisation framework provides the maximised groundwater abstractions, which simultaneously ensure protection against salutation.

## **HERMES-COM**

### **Economic evaluation of water resource management policies**

HERMES is an extension of the HYDRONOMEAS software, used as the main economical tools for the analysis and evaluation of specific operation policies. The model handles the financial and environmental aspects of water management scenarios, taking into account the guidance of the 2000/60 Water Framework Directive, thus providing further support regarding the choice of the optimal policy.

# Information systems

## HYDRIA

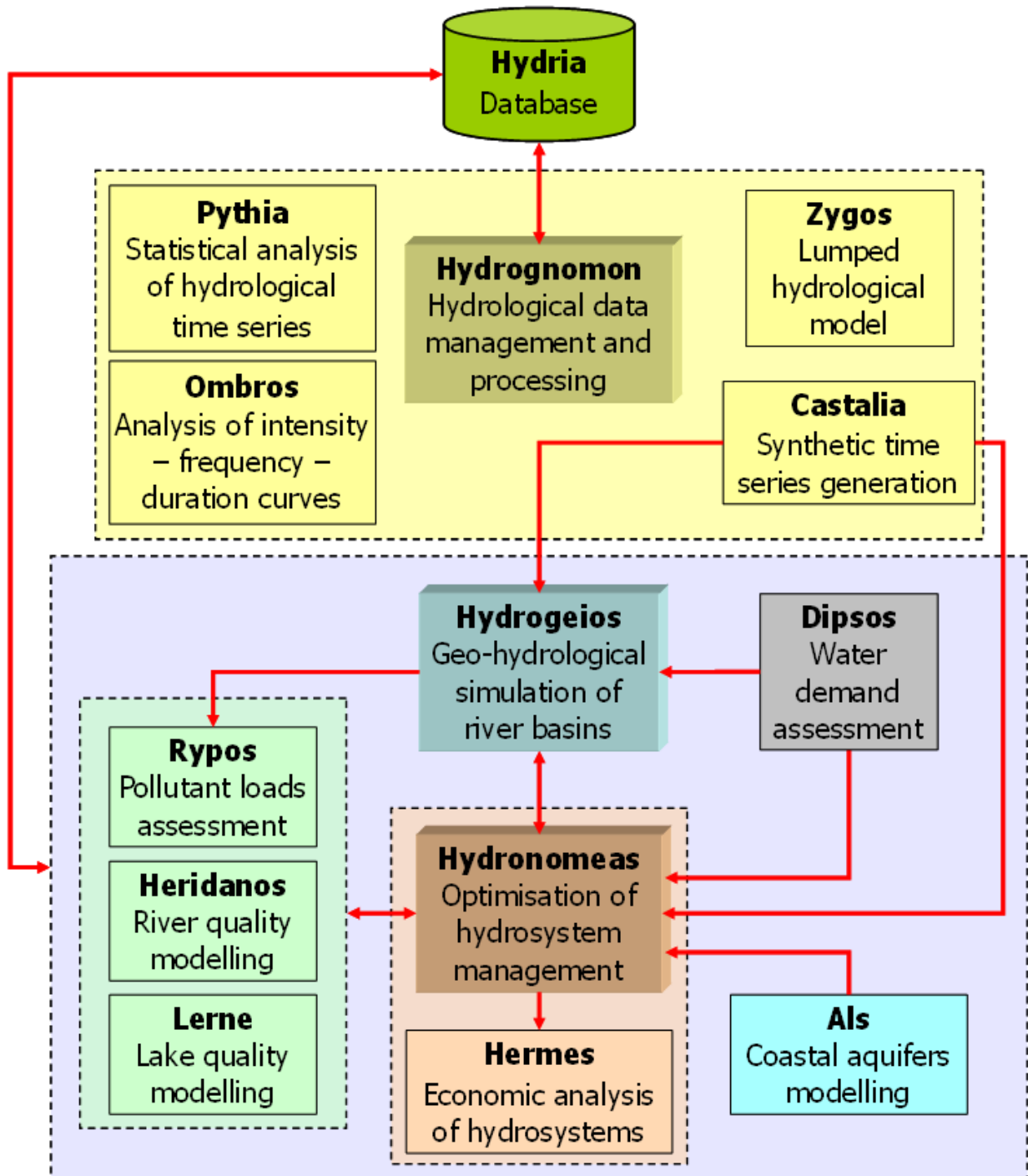
### Hydrological database

HYDRIA is a relational database, for storing all information related with the supervision, management and mathematical representation of water resource systems. This includes the physiographic, hydrological, water quality and economic data, the hydraulic structures, the water uses as well as the input and output data of the mathematical models. The database structure allows the co-operation and data exchange between the software applications. The system, which is implemented with the open source RDBMS PostgreSQL, is suitable for high-demanding applications in network environments with multiple parallel users as well as stand-alone operations.

## Application fields for the software systems

Applications	HydroGnomon-Com	HydroGeios-Com	HydroNomeas-Com	Castalia-Com	Pythia-Com	Ombros-Com	Zygos-Com	Dipsos-Com	Rypos-Com	Heridanos-Com	Lerne-Com	Als-Com	Hermes-Com
Hydrological modelling at watershed scale		√					√						
Optimisation of reservoir operation			√								√		
Conjunctive representation of surface and groundwater processes		√	√										
Water resource systems planning and management		√	√					√	√	√	√	√	√
Economical analysis of hydrosystem operation			√										√
Hydropower production			√										√
Water needs assessment	√							√					
Hydrological data management and processing	√				√								
Stochastic simulation of hydrosystems		√	√	√									
Hydrological extremes				√	√	√							
Hydrological and demand-supply balance	√	√	√				√	√					
Pollutant loads modelling			√						√	√	√		
Pollutant loads assessment									√				
Υφαλμύριση υπόγειων υδροφορέων												√	
Evaluation of water resource infrastructures		√	√					√	√	√	√	√	√
Co-operation with geographical information systems (GIS)	√	√	√					√	√	√	√		√

# Software architecture



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