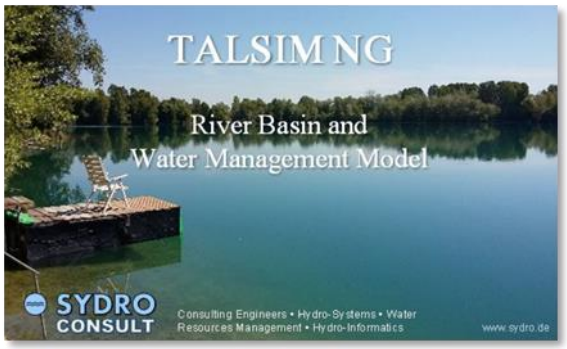
TALSIM-NG

(Talsim Next Generation)

River Basin Modelling
and
Water Resources Management



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INTRODUCTION

Water management is considered the sector with the highest number of mutual dependencies to other sectors. Effective water management is a crucial component for planning, design and for operation of water infrastructure. Workable solutions require a comprehensive assessment of hydrology, hydraulics and cause and effect mechanisms arising from the operation of water infrastructure.

Evaluating and optimizing water management usually starts with the analysis of crosscutting causal chains. The causal chains, or cause-effect analyses, # all the components that are required to set up a comprehensive hydro-system. Subsequent the cause-effect analysis, a physically-based flow network with all hydrological and hydraulic elements such as sub-basins, point-sources of discharge, rivers, canals, pipes, weirs, wells, groundwater, consumers, irrigation, reservoirs, dams, etc. needs to be composed. In addition to the physical network, a logical network representing operational aspects must be established. At this point, it becomes obvious that the framework for water management extends the usual range of river basin models.

For this reason, SYDRO has developed a software package (Talsim-NG) which combines hydrological modelling of river basins with operational features. This ensures that water management aspects are comprehensively addressed by incorporating realistic operational aspects, the requirements of multiple sectors, as well as multipurpose objectives. As such, decision-makers and stakeholders obtain well-balanced, transparent and sustainable results.

The software Talsim-NG has been greatly extended since the first release in 1999. The software has been applied to all scales of river basins (< 10 km² and >> 50,000 km²) in Europe, Africa and Asia and comprises in its latest version:

- Precipitation-runoff component + snow compaction
- Non-linear atmosphere-vegetation-soil interface with up to 6 soil layers
- Hybrid hydrological/hydraulic flood routing,
- Hydraulic modelling of weirs, diversions, pipes
- Irrigation
- Reservoir operation
- Water quality
- Turbine characteristics for hydropower development
- Generic rule builder, [stochastic cause-effect modeller]
- Pre-processing and post-processing
- Multicriteria optimization
- Time series manager
- Project and scenario manager
- Client-Server architecture

APPLICATION OF TALSIM-NG

Talsim-NG combines precipitation-runoff components, flow routing, water management and time series/scenario management as well as water quality components in one tool. Manifold water resources problems and in particular water management can be addressed and complex interactions can be incorporated and made visible. Thus, short-term or long-term effects of planned interventions, implementation of infrastructure, or operation of water infrastructure encompass the capability of the model. The tool can also be linked to monitoring systems and allows users to operate the program in an operational mode.

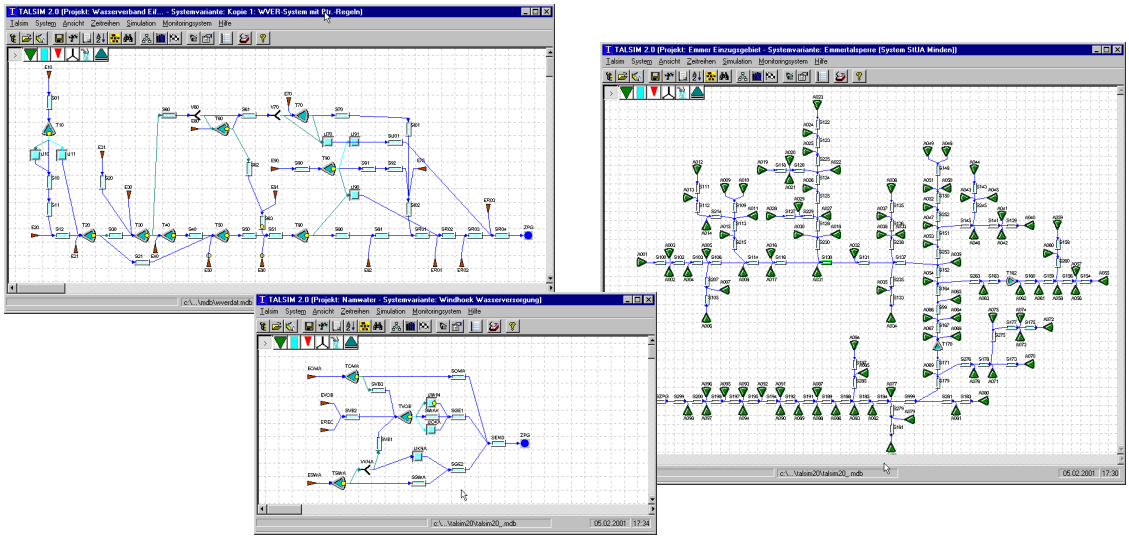
Talsim-NG is based on generic software architecture enabling the user to compose its systems in order to carry out:

- Precipitation-runoff modelling for flood control (short-term scenarios), drought situations (long-terms scenarios)
- River basin modelling with water management and operation of water infrastructure
- Operation of dams, detention basins as single purpose or multipurpose reservoirs, as stand-alone reservoirs or within a reservoir system (water supply, flood control, low flow augmentation, hydro power generation, environmental flows, others)
- Design of water infrastructure
- Operational use in combination with a monitoring system
- Coupling of water quantity and quality
- Climate change studies

It is possible to run the model in Monte-Carlo Simulation mode, however, this requires all pre- and post-processing features.

HYDRO SYSTEMS
(FLOW NETWORK)

Modelling with TALSIM-NG requires the user to select and compose hydrological components in order to represent a river basin. Each hydrological component or element in the model is a representation of the real-world object and offers different calculation methods. A hydro system is mapped out according to the water resources elements such as sub-basins as urban and rural areas, river reaches, dams, weirs, diversions, discharge points, water consumers (e.g. agriculture), irrigation, simplified groundwater aquifers and generic sinks and sources. Each of the elements are placed according to their location and linked to form a flow network. The set-up of the hydro systems is done graphically.



The most important calculation options are:

<u>Sub-basins (natural or urban):</u>

Precipitation-runoff simulation by means of:

- runoff coefficient
- SCS-method with 21 days previous rain index
- Complex non-linear soil moisture calculation with hydrologic response units
- Sub-basin delineation or raster-based

<u>Discharge points:</u>

Reading of time series or patterns to be used in the hydro systems

- Time series (observed, synthetic, generated)
- hourly / daily / weekly / monthly patterns

<u>Water Transport:</u>

Calculating flow propagation by means of:

- Simple translation without retention

- Pipe with translation and flow retention
- Open channel with cross sections, calculation with extended approach of Kalinin-Miljukov
- Stage-discharge-cross section relations

Weirs, diversions:

Hydraulic calculation with:

- Simple proportional approach
- Diversion based on thresholds
- Diversion according to inflow-dependent capacity curves
- Diversion according to operation rules

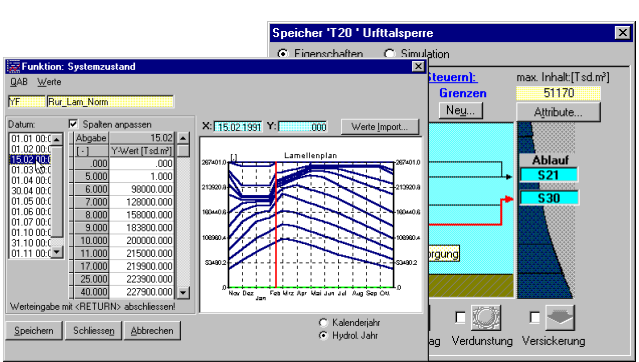
Dams / reservoirs:

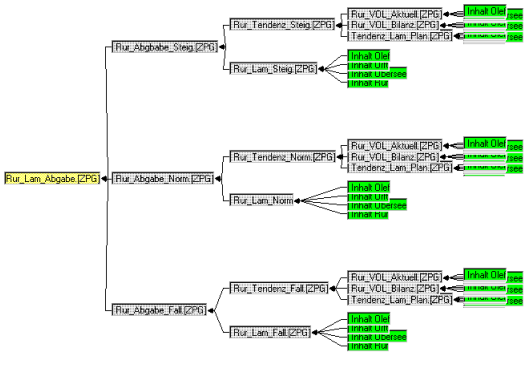
- Non-linear calculation of lake retention
- Application of unlimited operation rules. Examples are:
  - Rules depending of reservoir level
  - Pool-based rules
  - Inflow depending rules
  - Hydro power generation
  - Free configuration of control clusters using system states or decision-trees of system states

OPERATION STRATEGIES

Hydro systems are designed to meet certain objectives with regard to water supply, flood control, water quality goals, hydropower, environment and others. These goals are often achieved by implementing water infrastructures like canals, dams or others. The implementation is usually accompanied with facilities to operate the structures. Once these facilities are known and established in the model, all necessary elements are given to start operation. Talsim-NG can be used to model any operational aspects of operation of water infrastructure. It is also possible to use Talsim-NG in a reverse way to assess the needs for water infrastructure and control facilities.

Operation of water infrastructure or water management requires rules. Generic modeling of operation rules and water management is a distinct advantage of Talsim-NG. There are no restrictions in incorporating rules, cause-effect relationships and setting-up of decision trees as to consider water management options and assign them to water infrastructure elements.





WATER QUALITY

TALSIM-NG has been extended with the capability to model water quality components. In the current version substances can be considered by means of conservative modelling without interactions between substances or decomposition or decay respectively.

SIMULATION

Simulations can be performed in different ways. Long-term simulations are defined for a period of time requiring input time series. All kind of parameters for input are possible whereas hydro-meteorological time series like precipitation and/or flow are required as drivers for a simulation run. Beyond that, water demand, population growth, crop patterns or other imaginable variables are applicable within the generic rule network. The time step can vary from 1 minute up to 1 month. Options are:

- Simulations based on historic/observed or synthetic (stochastically generated) time series
- Short-term simulations with design storms or design hydrographs
- Near real-time simulations in combination with monitoring system
- Forecast simulation runs based on weather forecasts
- Tools in the Talsim-NG package facilitate pre- and post-processing capabilities to prepare simulation logs, reports and automation

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