Consulting Engineers • Hydro-Systems •
Water Resources Management • Hydro-Informatics

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Water Resources Management ● Risk assessment floods and droughts
Modelling: Hydrology ● Hydraulics ● Water Allocation ● Erosion/Sediments
Dam Safety and Risk ● Reservoir Operation
Non-Structural Measures ● Early Waring Systems ● Ecosystem Services
Information Technology ● GIS ● Data Management

Sydro Consult GmbH

SYDRO Consult is an **independent consulting company** with in-depth knowledge and experience in the field of **Water Resources Management**. The company provides expertise in **integrated water resources management**, **modelling** and **operation of water infrastructure**, **risk and impact assessments**, **flood control**, **early warning** and in particular integrating **non-structural measures**.

Founded in 1999, SYDRO Consult initially started as a consulting and engineering company focusing on urban hydrology and reservoir operation. SYDRO implemented projects with integrated concepts combining design and subsequent operation of water infrastructure. SYDRO rapidly attracted attention of reservoir operators, large consultants and water authorities due to its highly specialized expertise.

Today, SYDRO is involved in water projects of all scales and works as a consultant for water authorities, operators of water infrastructure, private enterprises, mining companies, river basin committees, ministries, state agencies and international organizations. SYDRO comes into play if integrated and cross-cutting concepts are requested in conjunction with assessments and operation. Thus, most of our projects are associated with operation of water infrastructure, assessment of natural hazards or evaluation of complex cross-cutting cause-effect relationships.

The portfolio of SYDRO comprises

- **Integrated water resources management (IWRM) and cause-effect analyses**
- **Modelling of hydrology, water allocation, 1D/2D/3D hydraulics, erosion and sedimentation**
- **Risk assessment of dams, reservoir operation including real-time operation**
- **Risk assessment of floods and droughts**
- **Non-structural measures like early warning systems, emergency preparedness plans**
- **River basin and flood-control management**
- **Integrating ecosystem services and ecosystem-based measures**
- **Risk and impact assessment of effects of climate change, mining, land use management**
- **GIS, data management and data modelling**
- **Consulting and capacity building for river basin committees, water authorities and operators**

Besides water resources and modelling projects, SYDRO is involved in capacity building and contributes to working groups dealing with regulatory frameworks. As advisor to Ministries and Government Agencies, SYDRO developed guidelines for the design of extreme flood events for reservoirs and detention basins and is currently a member of the working group *Wastewater Discharge Impact Assessment in Receiving Rivers*. In addition, staff of SYDRO participates in Technical Committees of ICOLD.

SYDRO Consult employs water resources and civil engineers, hydrologists, geo-ecologists and information scientist.

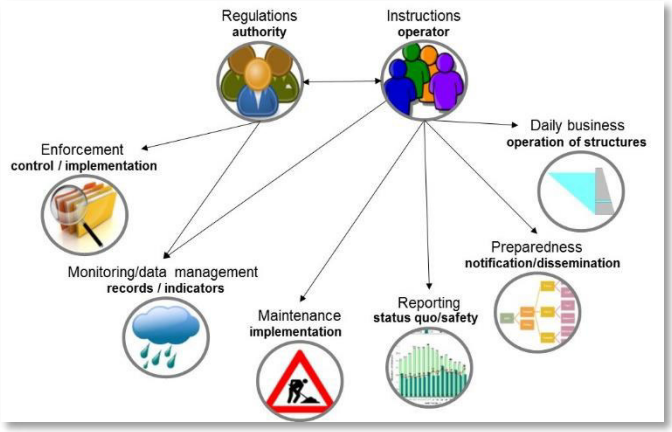
Integrated Water Resources Management

Water resources are considered to be the sector with the highest number of mutual dependencies to other sectors. Water management affects not only the water sector, but also has an impact on sectors like agriculture, energy, urban planning and fisheries, to mention some.

SYDRO supports the process of **I**ntegrated **W**ater **R**esources **M**anagement by

- **data monitoring, management and modelling**
- **cross-cutting cause-effect analysis**
- **modelling of river basins**
- **stakeholder involvement**
- **incorporation of ecosystem services**
- **integration of non-structural measures**

A variety of topics need to be incorporated to achieve sustainable solutions.

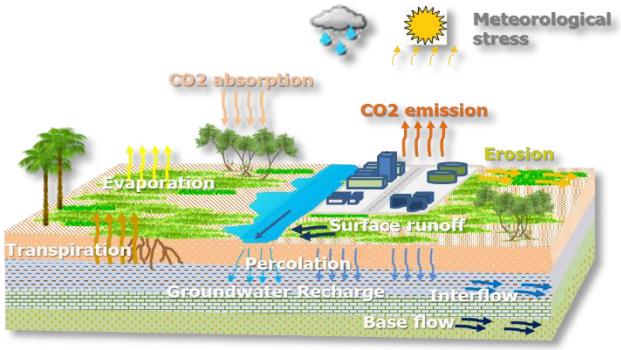


Cross-sectoral approach

A **physically-related flow network** with all hydrologic and hydraulic elements like **sub-basins**, **point-sources** of discharge, **rivers**, **canals**, **pipes**, **weirs**, **wells**, **groundwater**, **consumers**, **reservoirs**, **dams** pertaining to the basin specific requirement must be composed.

In addition to the physical network, a **logical network** representing the structure for operational aspects and decision-making from different sectors must be established

For this reason, SYDRO has developed a software package (Talsim-NG) which combines hydrologic modelling with generic causal-chain modelling features. This enables the modeller to integrate causal-chains regardless the origin. As long as a cause-effect relationship can be determined – including uncertainties – it can be integrated. Thus, interplay between different sectors and their relationships to the water sector become an integrative part of water resources modelling.



Talsim-NG 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:

- **user friendly graphical interface**
- **precipitation-runoff modelling**
- **flood routing**
- **atmosphere / vegetation / soil interface**
- **unlimited reservoir operation features**
- **flood control**
- **water quality assessment**
- **hydropower evaluation**
- **real-time operation of water infrastructure**
- **unlimited integration of cause-effect relationships**
- **integration of uncertainties**
- **time series management**

Cause-Effect Analysis

Cross-Sectoral Cause-Effect Analysis

The use of water resources interacts with many physical and socio-economic elements and constraints. The design of water infrastructure and even more importantly operation must meet requirements arising from different sectors like:

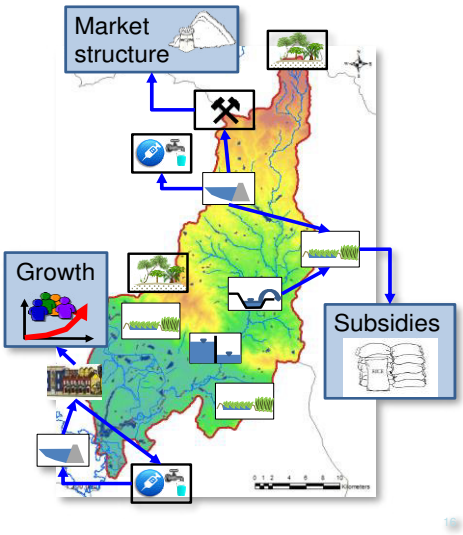
- **Domestic and industrial water supply**
- **Agriculture**
- **Mining**
- **Rangelands and livestock**
- **Forestry**
- **Biodiversity**
- **Fisheries**
- **Energy**

Evaluating and optimising integrated water management starts with the analysis of causal chains.

Cross-cutting issues and objectives from different stakeholders need to be incorporated to obtain wide acceptance and to achieve sustainability.

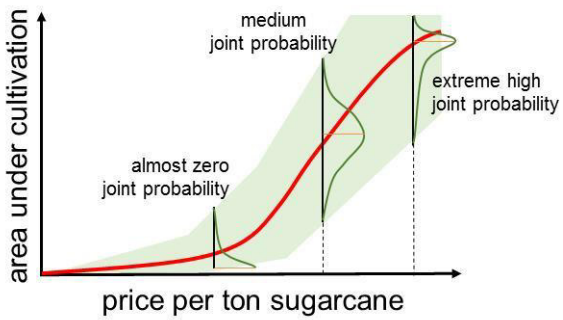
An assessment framework based on the Global International Waters Assessment (GIWA, UNEP) was adopted to be used at river basin scale.

Apart from hydro-meteorological stress, watershed management policies, urban planning and land use/agricultural practices are mostly major drivers for conflicts and water resources related problems.



Incorporating Uncertainties

Cause-effect relationships typically entail uncertainties. To cope with uncertainties, probability functions in association with Monte-Carlo-Simulation are used.



Causal-chain analysis with Monte-Carlo Simulation is an intuitive and effective tool to assess:

- **Effects of maintenance**
- **Land use practices and impact on erosion**
- **Failure mode analysis of dams**
- **Malfunction of hydraulic structures**

Ecosystem Services

Integration of ecosystem-based measures

Ecosystem-based management builds on the Convention on Biological Diversity's definition, stating that:

„... the ecosystem approach is a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way ..."

In particular, ecosystem-based measures help maintain long-term socio-economic benefits without compromising ecosystems.

Concerning ecosystem-based measures, SYDRO

- **identifies, locates and designs ecosystem-based adaptation measures**
- **evaluates and compares engineered solutions with ecosystem based measures**
- **conducts stakeholder meetings to raise awareness and create ownership**
- **consults on watershed management policies**

Usually, implementing ecosystem-based measures requires adjustment of management policies, urban and land use planning which is supported by **capacity building** and **training.**

Economic value of ecosystem services

SYDRO addresses benefits of ecosystem services by modelling scenarios with and without ecosystems. This works straight forward in terms of floods and drought situations, but is not sufficient to cover all services.

A more complex approach considers intrinsic values of ecosystems by means of hydrologic response units (HRU) and CO2 balance, water footprint of land use and storage potential for each HRU. By linking accepted economisation of CO2 emission/absorption with water storage capacities a clear and concise concept is derived in order to

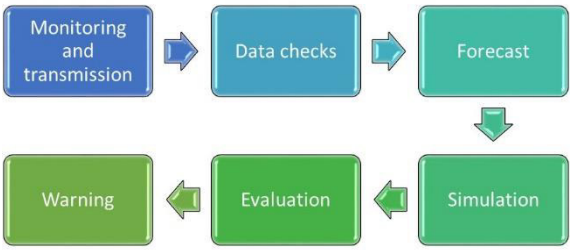
- **evaluate land according to their effects on climate change and net water storage**
- **identify most favourable locations to preserve or promote ecosystem services**
- **focus and streamline discussions between stakeholders from different sectors in view of disaster risk management**
- **display the spatially-distributed value of carbon absorption and water storage**
- **generate coherent and fair values to less favoured regions**

HRUs with a high net water storage capacity and a high CO2 absorption rate score higher compared to cells with negative water storage capacity due to water consumption, production of waste water and CO2 emission. The analysis can be applied to rather small plots up to large river basins.

Non-Structural Measures

Early Warning Systems

Design, Monitoring, Operation and Preparedness are the pillars of reliable, robust and safe operation of water infrastructure. SYDRO supports operators in their day-to-day business with Early Warning and Real-Time Operation systems.



SYDRO's software package Talsim-NG serves as simulation engine either within the framework of FEWS (© Deltares) or as web-service in a web-based solution.

Information originate from

- **observed states**

or

- **forecasts**

in combination with

- **operation rules**
- **release strategies**
- **opening and adjustments of gates**
- **current downstream conditions**

SYDRO creates or supports Early Warning Systems / Real-Time Operation with a performant modelling engines, different Graphical User Interfaces, workflow generation, log panels which are tailored according to specific needs.

Emergency Preparedness Plans

SYDRO develops Emergency Preparedness Plans or Emergency Action Plans providing concise information about

- **Emergency identification, evaluation and classification**
- **Notification flowcharts and communication trees**
- **Emergency actions**
- **Preventive actions**
- **Inundation maps**

Inundation maps indicate flooded areas, lead time, trigger for warning procedures, evacuation routes, meeting points or storage of flood response facilities.

yellow = inundated, red = loss of stability for people

Vital elements of preparedness plans are clear call down trees and the strong commitment of all parties involved to assume responsibility. Operators and authorities have a role to play in the joint development of the plans. Regular updates of the communication line and drill is necessary to make these plans function. SYDRO conduct stakeholder meetings to raise awareness and create strong commitment among the parties involved.

Dam Safety and Risk

Integrated Risk Assessment

Risk assessment of dams is a determining factor for planning and design. Furthermore, risk assessments need to be re-evaluated in regular periods during the life-time of a dam.

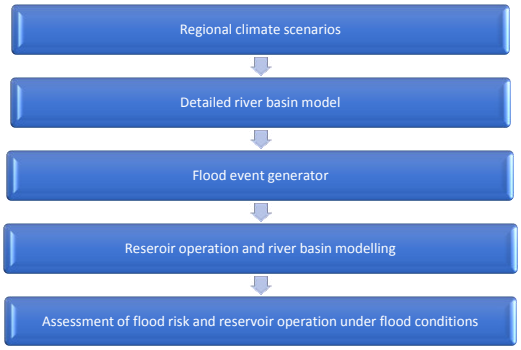
source: LTV Sachsen

Analysing **extreme flood events** and associated flood risk is the first step in a sequence of dam safety related actions. Investigations of issues like **landslides**, **earthquake**, **geotechnical** investigation, **operability** of facilities follow. The integrated risk assessment interlinks these subjects and assesses mutual dependencies and joint probabilities which lead to different scenarios and failure modes from which **dam break scenarios** are derived.

From the beginning, SYDRO has been working in the field of integrated risk assessment.

Dam Safety and Operation Approach

SYDRO devised an approach which statistically evaluates characteristics of flood events, the events can either be observed records or originate from precipitation-runoff models. Once the characteristics are determined and transferred into probability functions, new flood events can be generated and subsequently used in a Monte-Carlo-Simulation. By using a combined reservoir and river basin model, hydraulic characteristics of outlets, release strategies and all kinds of boundary conditions or constraints which emerge at the dam or are related to the dam, e.g. from downstream river reaches, can be incorporated.



By embedding additional safety-related issues, like operability of hydraulic structures and controllable gates, driftwood, uncertainties of readings, etc. the method integratively assesses safety indicators. These issues could either be considered as static or applied with own probability functions and can be combined in a failure tree.

Reservoir Operation

Reservoir Systems and Operation

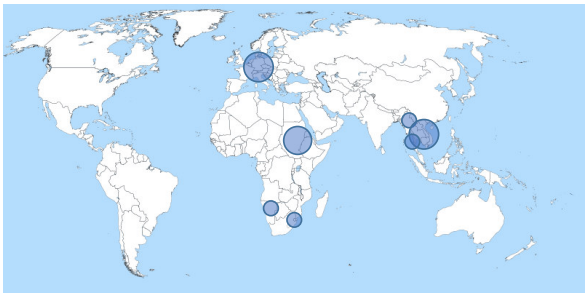
SYDRO has a long track record of analysing and optimising reservoir systems. Reservoir operation in highly populated areas, multipurpose and multi reservoir systems with multiple water quantity and quality constraints, hydropower schemes as well as large transboundary reservoir schemes are part of SYDRO's references.

The projects of SYDRO encompass the development of overarching water management strategies up to the implementation of early warning systems and operation rules at the operation centre.

SYDRO evaluates, documents and implements:

- **detailed release rules**
- **flood control strategies**
- **allocation and contingency plans**
- **multi-reservoir operation policies**
- **transboundary reservoir operation**

The need for long term planning and the requirement to cope with long term changes impacting on multipurpose storage schemes turn out to be of crucial importance for successful reservoir operation.



Locations of reservoir operation projects

Adaptive Concepts

During the planning process and in recurrent periods, assumptions about hydrology, socio-economics, priorities of purposes, existing or upcoming requirements should be reviewed. The use of scenarios covering the lifetime of a multipurpose storage system help identify different pathways along a system might develop over time. Although assumptions about future trends incorporate a great deal of uncertainty, scenario generation with long term perspectives, developed and agreed upon by all stakeholders, do have the potential to reveal the flexibility (or inflexibility) of multipurpose storage schemes and their ability to be adapted to new situations. In doing so, the understanding to what extent adaptation measures are required if underlying conditions change is greatly improved and insight to estimate design, costs, maintenance needed is provided. Moreover, scenarios established by all stakeholders deliver the mean to learn and understand the view of all parties involved.

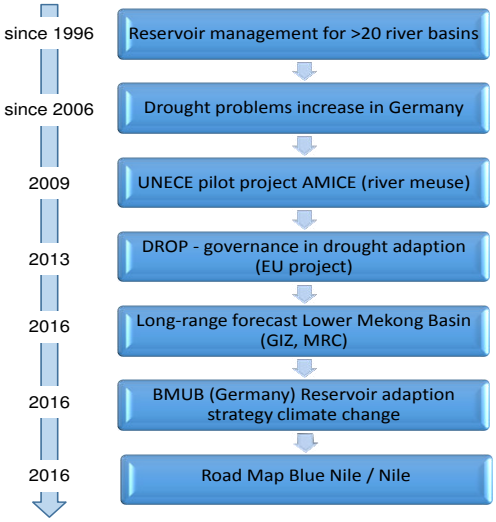
Anticipating future demands, goals and identifying limitations of the system helps to create adaptive, viable and environmentally sustainable solutions which are more efficient in the long run compared to water infrastructure designed to maximise short term benefits. Thus, a political willingness to think in long terms is a basic prerequisite.

Impact Assessment

Flood and Drought Assessments

The assessment of **natural hazards**, their probability of occurrence, the identification of intensity and spatio-temporal distribution is a pivotal key for preparedness and mitigation. SYDRO's track record in assessing hydrological hazards captures both flood and drought.

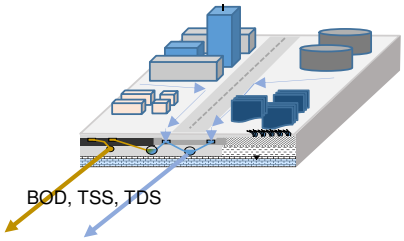
Due to the slow onset, it is difficult to identify a situation as a **drought**. SYDRO has developed methods to ascertain the status of the hydrological regime in a clear and concise way to comprehensively assign **drought severity classes**. This is of great importance in launching drought mitigation actions, water resources management and contingency plans.



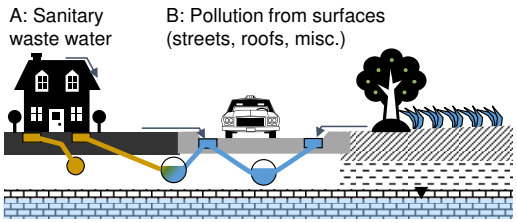
SYDRO prepares **flood hazard maps**, **flood risk maps** and **flood action maps** which are prerequisites for structural and non-structural measures like emergency preparedness plans. Rain patterns and **Intensity-Duration-Frequency** (IDF) curves are common features to be evaluated and usually constitute the start into a comprehensive flood risk analysis.

Water Quantity and Quality

Impact assessment of **effluents from urban areas**, treated or un-treated **discharges of wastewater** are part of the SYDRO portfolio. The knowledge of water quantity in combination with water quality becomes an invaluable source for integrated water resources management. SYDRO conducts measurements and calculates **conservative and non-conservative substances**, their **distribution** and **dilution** within rivers and lakes, integrating the assimilative capacity of water bodies.



The water quality tool of SYDRO is a certified water quality model in Germany. 1D, 2D and 3D models are applied depending on scale and project goals.



Mining Impact Assessments

SYDRO evaluates the impact of wastewater discharges from salt and potash mining in order to identify and implement operational solutions minimizing the risk of adverse environmental impacts and to ensure the continuation of potash mining. The river basins cover more than 65,000 km² with several discharge points. SYDRO is acknowledged as impartial consultant and provides services to the mining industry as well as the ministries and approving state agencies.