Operational Optimization for environmental system: smart water management in practice

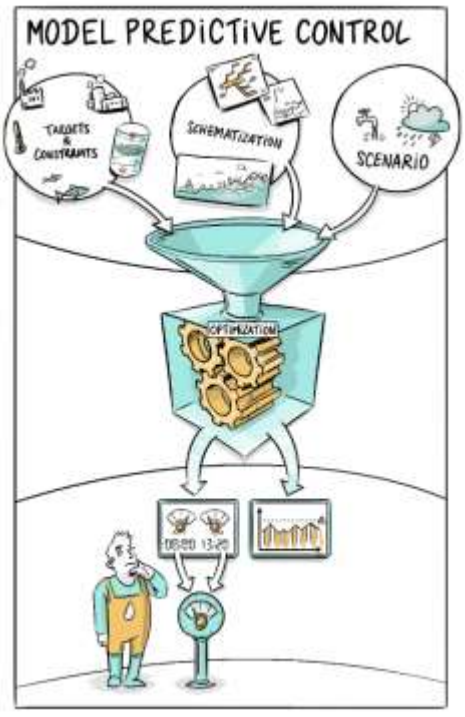
The challenge of many water systems is to manage the operation such that various objectives are met as good as possible. Some of these objectives are in line with each other, while others are conflicting. With growing demands on our environment and resources, we will have to be smarter within the constraints of the existing system.

RTC-Tools

Examples of water systems, both in The Netherlands, as worldwide, in which decision support and optimization can be of clear benefit are:

- Polder management
  - Flood/Drought control
  - Cost-efficient pump operations
- Reservoir management
  - water supply for domestic, industrial and agricultural use
  - hydro power production,
  - flood control
  - recreation
  - environmental obligations,
- Water allocation (local, regional and national)
- Water distribution through pipesystems (drinkingwater/sewage)

(Hydrological) conditions and system demand vary over time, making operational management a complex task. This becomes even more complex if a system consists of multiple elements that interact with each other and influence each other.



In many of these applications, a lot of information is available that is not optimally used to decide on the real-time operation. At the same time, information about the future demands of or constraints on the system is not taken into account. Optimization can also be a powerful tool for long-term strategic planning, for feasibility studies, design studies, climate change adaptation studies, and climate change stress tests. Mediumterm or longterm optimization would allow for determining operating guidelines and operational goals that will lead to increased longterm benefits.

Optimization Techniques and Model Predictive Control

Mathematical optimization is a powerful approach to support operational water management: with the help of optimization techniques it is possible to adapt the management to forecasted events like floods and droughts, and future water demand. When the controlled system has complex interactions and responses to the control action, it becomes a necessity to represent the behavior of complex dynamical systems as a model within the optimization: this is referred to as Model Predictive Control (MPC). MPC has the ability to anticipate future events and can take control actions accordingly.

RTC-Tools

RTC-Tools is an open-source “Model Predictive Control” toolbox for control and optimization of water systems. One of the most important features is that RTC-Tools can functions as a robust optimization engine within a decision support system: it was developed with a focus on operational use. Optimization in an operational context requires stable results, which RTC-Tools can deliver and a lot of other optimization approaches cannot guarantee. It has been developed to support

- planning ahead with a model of water system under the expected hydrological conditions;
- to resolve conflicting constraints and optimization goals;
- incorporate meteorological/hydrological forecast uncertainty.

There are many opportunities where a Model Predictive Control optimization approach can be of benefit. RTC-Tools supports a very flexible set-up of the optimization problem to account for all different aspects of water management on different time scales.

We are interested to work with other parties and collaboration on further development and implementation of the RTC-Tools in conjunction with other software or digitizing projects.