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GRoW
WATER AS A GLOBAL RESOURCE

MuDak-WRM: Forward-thinking Management of Reservoirs Worldwide

Water as a Global Resource (GRoW)

Reservoirs are used all over the world to supply water and generate electricity, with around one third of the water required for agricultural irrigation currently coming from these sources. Over 100,000 water reservoirs exist, with hundreds more in the planning or under construction. The problem, however, is that reservoirs also constitute a significant encroachment on the river ecosystem, impeding waterway continuity and dramatically impacting the speed of water currents. One of the consequences of this is that reservoirs become collecting points for sediments, fertilizers, and pollutants that adversely affect water quality. The aim of the joint research project MuDak-WRM is to develop a simple model that provides a long-term overview of reservoir water quality and that can be readily transferred to other countries around the world.

Simple Models for Ease of Application

Reservoir water quality depends largely on its drainage basin and how that area is managed. To develop a model that effectively depicts the processes taking place in reservoirs, the river drainage area has to be factored in. If large quantities of nutrients flow into the reservoir from intensive agriculture or forestry or a densely-populated area, this can lead to overfertilization of the reservoir or what experts refer to as "eutrophication". This then supports the growth of "cyanobacteria" (more commonly known as blue algae), which, in turn, produce toxins that can make the water in the reservoir unsuitable for use as drinking water.

With this in mind, MuDak-WRM project partners are keen to develop a straightforward model that facilitates the prediction of medium- to long-term changes in reservoir water quality. One of the research project's key objectives is to reduce the complexity of the scientific methods underpinning the model and the data it requires. This will make it easier to apply the model in regions with limited data availability, for example in developing countries.

Proper Measurements Mean Better Monitoring

In order to acquire a deeper understanding of the dynamic interplay between the drainage area and the water reservoir and to determine the optimum measurement points for reservoir monitoring, project researchers employ a range of methodologies, including innovative remote sensing techniques. Alongside multispectral satellite images provided by the European Space Agency (ESA), hyperspectral cameras attached to drones are used to acquire detailed spectra of the light reflected by the reservoir. In addition, the project partners investigate whether and to what extent remote sensing techniques can be used to aid the labour- and cost-intensive sampling process on the ground. Using this approach, project partners aim to develop a concept for optimized monitoring. The plan is for this "minimum monitoring" to encompass a set of basic parameters that effectively describe reservoir condition and are especially suited to forecasting at the same time.

The new measurement techniques, remote sensing technology, and modelling approaches will initially be tested at the Große Dhünntalsperre reservoir in North Rhine-Westphalia (Germany), where an extensive measurement network is already in place and local staff are familiar with the key processes. The next step will be to transfer the methods and techniques to the Passaúna reservoir and its drainage area in the Brazilian state of Paraná. Using a real-time data

Measurement platform equipped with water quality sensors (foreground) and water extraction at the Passaúna reservoir (background) network (sensor web), the project researchers and reservoir operators can access the measurements taken at any time.

This data network is used to access, maintain as well as visualize the data acquired both remotely and in situ. This enables the reservoir operators to capture and evaluate complex environmental data more rapidly and more effectively. By comparing the findings from the two case studies, the project partners can ensure that the knowledge acquired and methods developed are easily transferrable to other reservoirs.

Scientific Basis for Reservoir Management

The model to be developed as part of this project is intended to enable river dam operators to make scientifically sound decisions regarding the sustainable management of reservoirs, water quality and the river drainage area. It is hoped that the model will help answer questions such as "what is the volume of nutrients per year a reservoir can tolerate before water quality starts to deteriorate". Political stakeholders and authorities could also use the model to support their decision-making with a view to determining sustainable forms of land-use and land management in the drainage area. Dedicated reforestation, for instance, is one measure that could be taken to combat increasing soil erosion. It prevents large quantities of nutrients leeching out of fallow soil during heavy rainfall and being carried into the river and finally being deposited in the reservoir. This scenario is just one of the many challenges in water reservoir management.

Two doctoral students from the Karlsruhe Institute of Technology (KIT) extract a drill core for sediment analysis

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