

HYPOS: Hydropower management from space

Hydropower, as the world's largest source of renewable energy, still has a large amount of untapped potential to be explored in times of a changing global energy policy. Improving sediment management is critical to ensuring sustainable hydropower operations. The first version of HYPOS, a new integrated toolbox combining satellite analytics, in-situ and model data, has just been launched. Providing quick, easy, and cost-efficient access to key hydrological and water parameters, it has been designed to support decision-making in the design and development of new hydropower projects, as well as in the operation and monitoring of existing plants.

A European consortium has launched a new tool, combining satellite and hydrological modelling data, to ensure sustainable sediment management in the design, construction and operation of hydropower plants. Described by the developers as “leading the next generation of water resources and sediment management tools”, the HYdro-POwer-Suite (HYPOS) has been developed over the last three years, with funding from the European Union’s Horizon 2020 Research and Innovation Programme, by a group led by EOMAP, a leading provider of commercial satellite-based mapping and monitoring of aquatic systems. The consortium also comprises the Swiss engineering and design consultancy Gruner Stucky, Italy’s largest public research institution Consiglio Nazionale delle Ricerche (CNR), the Swedish Meteorological and Hydrological Institute and the hydraulic engineering research team of NTNU, Norway.

The product is designed to provide quick, easy, and cost-efficient access to key hydrological parameters. This includes sediment data for all rivers and reservoirs worldwide for the last decade, as well as water quality and ecological indicators, such as surface water temperatures, the evolution of algae blooms, trophic state changes and nutrients, which are also increasingly of interest for the long-term impact assessments of reservoirs and associated catchment areas.

Holistic data set collection

An increasing number of satellites are launched every year offering ever higher temporal and spatial resolutions, while a number of hydrological and sediment models are already widely used. For the first time HYPOS offers integration of data and assessment tools to operators, developers and decision makers to improve their planning and monitoring tasks, according to Dr Thomas Heege, CEO of EOMAP. It integrates various data sources from established hydrological models, in-situ data and earth observation (EO)

data with tools for client-relevant assessments, which can be accessed through an easy-to-use, web-based portal.

The subscription portal brings together high quality satellite-based measurements, for both historic time periods and actual continuous monitoring of up-to-date hydrological parameters from modelling, with nowcasting on various orderable levels of detail available in-situ data and integrated baseline and environmental impact assessments, based on these data, for example on sedimentation regimes or trapping. HYPOS provides relevant parameters such as inflow and outflow volumes, turbidity and suspended sediment loads in the water column of dams and rivers, harmful algae blooms, trophic status indicators and geophysical parameters such as temperature and evaporation rates in lakes and adjacent rivers in near real-time, but also for selectable time periods and historic data.

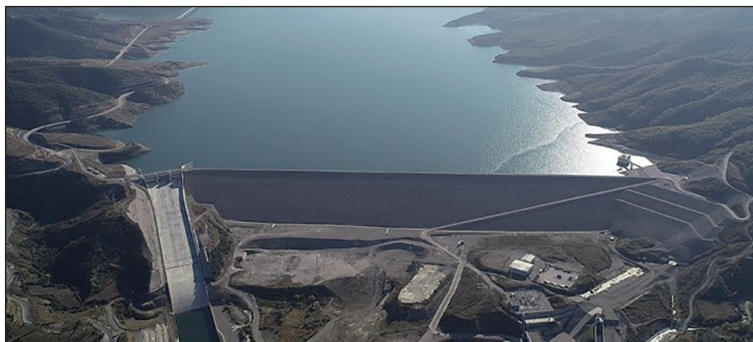
The new portal can address some of the most crucial issues faced on various levels, starting with a global perspective in medium temporal and spatial resolution, and will range up to local high and very high-resolution products. The data are presented in ready-to-use formats, to provide support for environmental evaluation, reporting and impact assessments. Access to key hydrological data means that the hydropower industry now has the most holistic data set collection currently available for any remote measurement in rivers and surface waters worldwide.

Critical tool for sustainable development and operation

Climate change and ever more stringent environmental regulations increase the importance of new hydropower development having a full economic and ecological evaluation to ensure sustainable long-term operation of the assets. Ready access to sediment and water quality data provides major opportunities for cost optimization and improved sustainability of development plans. The HYPOS tool is designed to help address the major environmental and economic impact of sedimentation, which, by filling reservoirs, limits the lifetime of storage hydropower projects. Sedimentation also has an impact on the cost of operation and maintenance of facilities, ranging from damage to the turbines and turbine efficiency losses and the need to implement sediment removal works, through to ensuring protection measures for watersheds and downstream river habitats.

Annual investments of about €20 billion to build new dams are negated by the annual capacity losses caused by sedimentation, according to the developers. Meanwhile, sediment-related costs can represent 10 to

An aerial view of the Banja dam and reservoir in Albania. (Photo © Statkraft).



40 per cent of total maintenance costs for the owner-operators of the assets.

“Hydrological and sedimentation data are thus critical to ensuring the optimal design and construction of appropriate infrastructure, including sediment release structures, as part of greenfield projects,” explained Dr Marcelo L. Ribeiro, head of the hydropower schemes department at Gruner Stucky. A typical situation at the pre-planning stage is the absence of such data, especially when extended areas and large river catchment systems need to be investigated. This is especially important in regions such as Africa, where the requisite data may not be available to allow developers to quantify the volume of sediment inflow, the seasonality of sediment transport and spatial information on the catchment. Even in more developed markets, in catchments with comprehensive monitoring networks, a full complement of data can help to ensure optimal design, development and operation. In addition, it enables developers to plan and define a sediment management plan at an early stage.

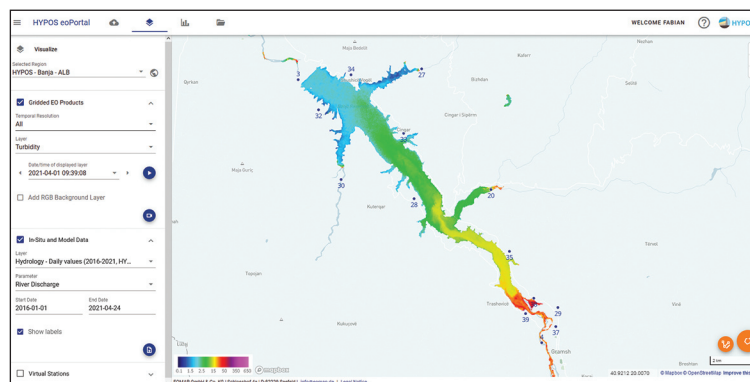
For schemes in operation, HYPOS can provide analytical tools to plan or improve sediment management plans, to identify the most appropriate operation and the frequency or duration of their implementation, as well as the best time of the year to carry out sediment management operations. Thus, it empowers hydro-power stakeholders to minimize water and energy losses or downstream impacts. The tool also allows for the monitoring of ongoing sediment management operations, enabling visualization of downstream sediment propagation, quantifying the effectiveness of the operations, and downstream control of sediment concentration to ensure compliance with regulatory environmental requirements. Ecological assessments analysing algae blooms, trophic state changes or nutrients are also increasingly required for the long-term impact assessments of the reservoirs and associated catchment areas. Thus, appropriate environmental and economic investment planning, and monitoring can significantly contribute to better management and value preservation concepts.

Calibration and validation at four hydropower sites

“HYPOS has been advanced to a practical application with ongoing data acquisition and observation across the globe in North America, Africa, Asia and Europe,” said Thomas Heege of EOMAP. The application of HYPOS is currently being tested at four sites: the Banja hydro plant in Albania, the Gebidem dam and Verbois/Chancy-Pougny hydro plant in Switzerland and the Enguri hydroelectric cascade in Georgia. These cases allow the developers to calibrate current and historical in-situ data with satellite-derived information, and to help understand and manage sedimentation issues better at the sites.

The Banja dam and hydropower plant on the river Devoll in southeastern Albania, which was commissioned in 2016, and is owned and operated by Statkraft, has provided the HYPOS developers with valuable in-situ data to be able to calibrate and validate the tool, according to Prof Nils Ruther of the Department of Civil and Environmental Engineering at NTNU.

“The facility was selected as a use case for two rea-



Screenshot of turbidity at Banja reservoir/Devoll river as shown by the HYPOS portal.

sons,” he explained. “First, it is located in a highly dynamic river catchment with a lot of active slopes and a high sediment yield, comparable with any region in the Himalayan range. Second its owner-operator, Statkraft, embraced the opportunity to collaborate with the HYPOS project to contribute to the sustainable development of the company’s assets, and had already been monitoring sedimentation in the river.”

A sediment transport measurement research station was installed at the end of 2015 at Kokel bridge, downstream from the dam. Since January 2016, the station has been logging every 30 minutes the suspended load concentrations (SSC) in periods when the river Devoll has had a water depth at Kokel bridge of more than 1 m. The data are transferred via GSM to a server in Italy, where its partners at the University of Bologna process the data. This research station complements a gauging station at the same location which has been operated by Statkraft since 2008.

HYPOS leverages the SSC data from Kokel, together with the SSC and turbidity data taken in the Banja reservoir, to ensure good data quality for the satellite-derived information. “This has created a unique data series, which is used to understand sediment processes in the catchment and is fed into the HYPOS portal to have detailed calibration data for conversion of turbidity to suspended matter,” explained Ruther. In addition, Statkraft is conducting thorough measurements of reservoir bathymetry and comparing these changes with the initial topography to have a sediment sink. As a result, HYPOS can calibrate and validate its methods and other models applied to the catchment, he said. “Statkraft continues to contribute in-situ data for calibration and validation to make the HYPOS portal as efficient and accurate as possible. In the case of Banja, we are able to look into the sediment fluxes in this highly dynamic catchment to have a better understanding of the processes,” he concluded.

While the current focus of HYPOS is on validation and development of decision support tools for sedimentation and evaporation issues, long-term plans include new services such as the integration of climate change impacts on water and sediment fluxes, as well as snow cover information and new methods of data acquisition such as remote sensing from drones. ◇

For further information, visit the website:
<https://hypos-project.eu>, or access the portal directly at:
<https://hypos.eoportal.de>