

KLASed Research Project

Continuous and Controlled Sediment Transport

Introduction

Reservoirs are an important resource for irrigation, drinking water supply and hydropower production worldwide. Hydropower is the most significant renewable energy source, with 16 % of the world's power production.

„Last century was used to build reservoirs. This one will be used to solve sediment problems.“
(World Bank, 2001)

Despite the benefits of reservoirs, the natural process of erosion, transport and sedimentation is affected by the construction of such barriers in a flowing river. The sediment is trapped in the reservoirs and reduces the storage capacity. Beside storage losses, sediment-related problems occur both downstream and upstream of dams: The ecology, water transparency, sediment balance, nutrient budget and river morphology is affected.

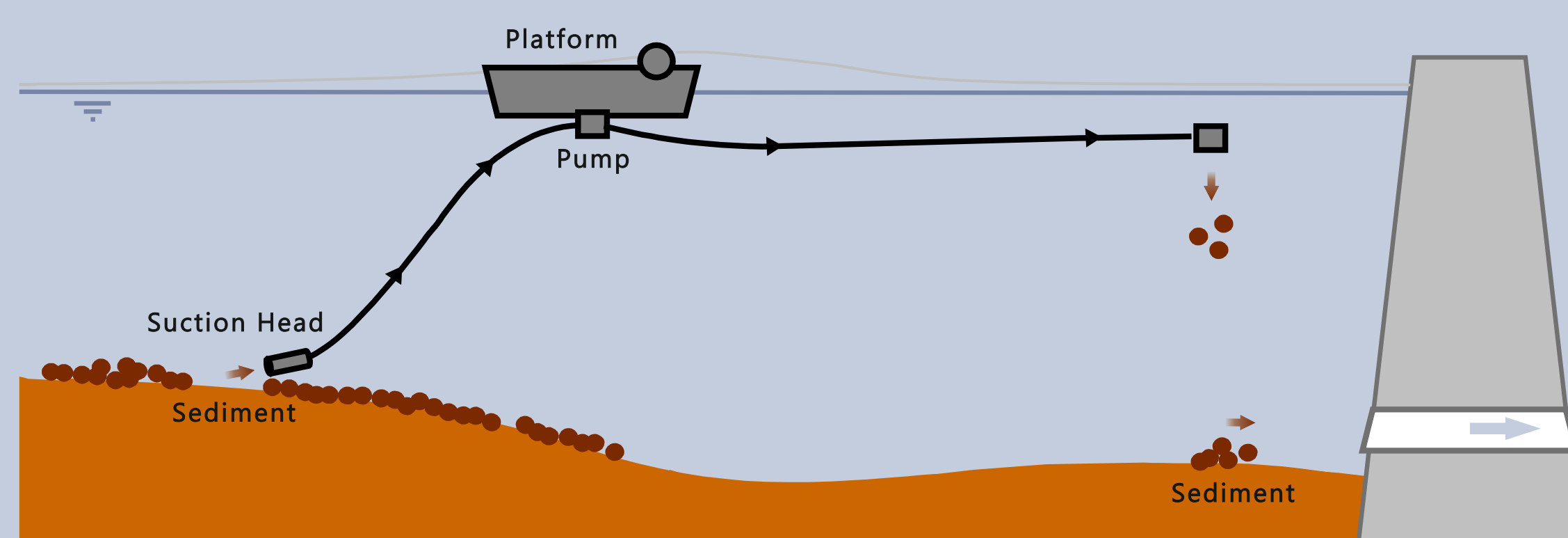


Fig. 1: Continuous Sediment Transfer Approach

Innovative approach to reservoir siltation

The importance of reservoir sedimentation has increased, as the number of reservoirs and their ages increase. Conventional counter measurements for sedimentation are often expensive and difficult to implement in an effective and sustainable way.

An innovative, cost-effective and environmentally friendly method to counteract reservoir siltation (ConSedTrans) has been developed by DB Sediments in cooperation with Aachen University of Technology. The deposited sediment is taken up, transferred across the reservoir and dropped in front of the power stations / hydro facilities intakes. The transferred sediments are eroded by the intake structures and flushed downstream.



Fig. 2: Application at Lake Olsberg (Germany)

A first application at Lake Olsberg (Germany) proved that sedimentation and erosion are shifted back to a near-nature state, restoring longitudinal connectivity for sediments as stipulated in the Water Framework Directive and the U.S. Sedimentation Pollution Control Act.

Research and Development Project

The ConSedTrans approach, applied at Lake Olsberg, works stable and reliable. However, it also became apparent, that the efficiency of loosening and transporting deposited sediments depends on site and sediment specific properties (e.g. compaction of depositions, organic content, etc.). Thus specific research is required to optimize the loosening and up-take of deposited sediment in a continuous and controlled manner under hydraulic considerations.

This is the focus of the research and development project KLASed, funded by the Federal Ministry of Education and Research of Germany. The concept is the development of a fully automatic method, which is based on submerged water-jets that penetrate and disintegrate consolidated sediments. In order to work fully automatic, the following control parameters have to be controlled and adapted to optimize the sediment up-take:

- Angled position and height of the suction head above the sediment layer,
- the energy input to loosen the sediment (e.g. impact pressure of the water jet), and
- the flow rate (suction power) through the suction head.

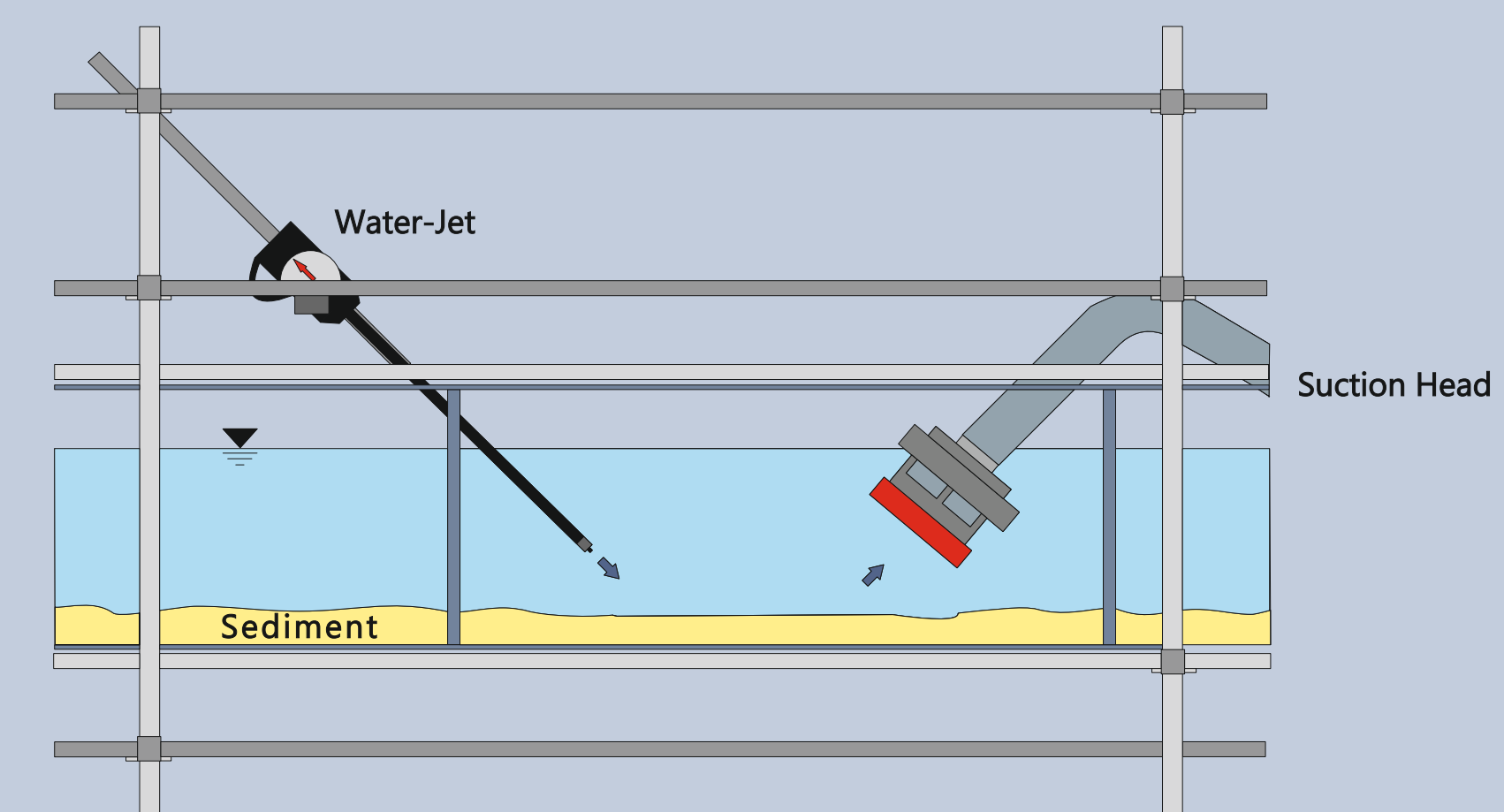


Fig. 3: Water-jets for sediment loosening; Suction head for up-take

The basic indicator for the overall efficiency of the system is the sediment concentration in the mass flow, which shall be optimized to a target range of 5-15 %. This is also the key performance value to adapt the above-mentioned control parameters. Therefore, an innovative mass-flow meter to quasi-continuously measure inhomogeneous water-sediment-mixtures, has been developed.

Results

The developed mass-flow meter prototype allows an automatic measurement of the sediment concentration with a precision of 0.025 % and an accuracy of 99.95 %. The processing time is 30 seconds for each sample.

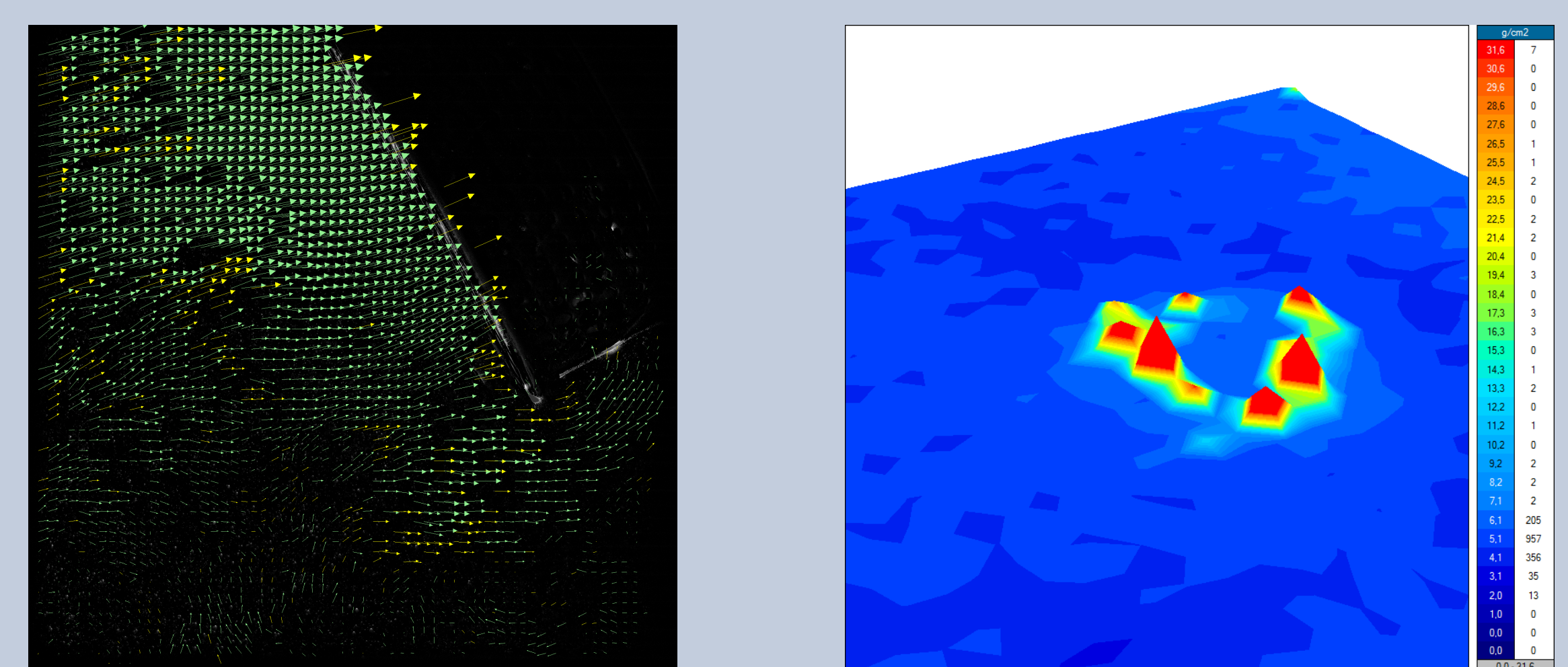


Fig. 4: Flow vectors (obtained with PIV); Spiral water-jet (obtained with force measurement sensor plate)

To measure and visualize the impact pressure of submerged water-jets, a new experimental method has been developed. A force measurement sensor plate, which allows 2d high resolution pressure field measurements, has been modified for application in hydraulic research.

Outlook

The ConSedTrans approach will work fully automatic and remote-controlled, regardless of the existing site conditions or sediment specific characteristics.

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