



## Quantitative and Qualitative River Monitoring Using an Innovative UAV-USV Tandem System

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The use of modern digital technologies in water management is an important driver for obtaining better data for assessing the status of water bodies and their development. These data can be beneficially implemented for the monitoring and management of rivers and especially waterways.

In the BMDV-funded project RiverCloud, an autonomous tandem system consisting of an Unmanned Aerial Vehicle (UAV) and an Unmanned Surface Vehicle (USV) is being developed under the coordination of the gia of RWTH Aachen University, which will provide spatially and temporally high-resolution data for the development and maintenance of waterways as well as for river management. The contribution introduces the developed coupled UAV/USV tandem system with its mounted sensors for high resolution data acquisition and continuously accurate georeferencing and presents some significant results using the example of a study area on the Rhine River (Tomateninsel).

The data presented are, among others, camera-based flow measurements using an image processing method, discharge data of a precise ADCP (Acoustic Doppler Current Profiler) with 2000 kHz frequency and ten water quality parameters using a multi-parameter probe. All data mentioned were simultaneously collected in two locations of the study area on the Rhine River in September 2022. The 4 seconds videos collected by the UAV-camera were processed using an image processing method based on the surface velocity after implementing a new developed stabilisation tool. The cross-section data collected by ADCP were used for the configuration of the two sites. The agreement between ADCP and camera-based flow and discharge data was very good on both sites with less than 5% deviation for a discharge value of approx. 600 m<sup>3</sup>/s and 1.63 m/s mean velocity. The water quality parameters collected during the measuring campaign were temperature, conductivity, salinity, pH value, oxygen concentration, oxygen saturation,

ammonium, turbidity, Total suspended solids (TSS) and total dissolved solids (TDS). The water quality data were in the expected ranges for river water (e.g. average values: pH 7.8, T 21.8°C, EC 0.35 mS/cm, Sal 0.71‰, O<sub>2</sub> 7.5 mg/l, NH<sub>4</sub><sup>+</sup> 0.3 mg/l).

The results, specific requirements of the developed solution and challenges under the measuring conditions of the study area are presented in this paper. The data collected are used as the input of an overview report for river or waterway water flow and quality monitoring.