Improving Pit Lake Monitoring by Using a Combination of Autonomous Robotic Devices and Drones

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Abstract

Pit lakes are formed from the voids that remain after surface mining has ended. They are filled either due to groundwater recovery or artificial flooding. These very young water bodies often have water quality issues. To understand the ongoing processes leading to the observed problems and finding ways to address them, monitoring of these lakes is an essential first step. Yet water levels far from the surface or restricted access to the shores due to unstable embankments can complicate the measurements. Not only in the Lusatia region of Germany, even helicopters are being used to collect water samples from such lakes. Due to the associated costs, monitoring is often restricted to multiple depths at a single point. However, it is questionable whether the obtained measurements are representative of the entire water body. Advanced monitoring systems offer the possibility of improving data gathering and considering spatial differences in more detail.

An autonomous surface vehicle (ASV), developed at the Technical University Bergakademie in Freiberg, was used at Lake Runstedt, a lignite mining pit lake in Germany, in 2023. The ASV was equipped with a multiparameter probe to perform automated in-situ measurements. The aim was to capture three-dimensional distributions of parameters such as pH and oxygen during three separate campaigns. Lake Runstedt (maximum depth: 32 m) had previously been used as a dumping site for fly ash and industrial waste. Since 2002, after flooding, its hypolimnion has been artificially aerated to mitigate contaminant release. Using the ASV, up to 13 in-situ measurement profiles were obtained during one day without causing any disturbance due to anchoring. The data revealed spatial differences in oxygen depletion and the effects of aeration. For example, in October 2023 the 6 mg L-1 oxygen isocline occurred at depths between 16 m and 24 m, with higher depths near the aerators.

In a new project, we will complement the ASV monitoring with an uncrewed aerial vehicle (UAV), i.e. a drone. The UAV will gather two-dimensional multispectral data that will be correlated with in-situ measurements, providing spatial distributions of turbidity, temperature and chlorophyll content in the uppermost layer of the lake. These data will then be used as input to design an ASV monitoring strategy that covers the most relevant areas. Additionally, technical adjustments will enable both the ASV and the UAV to collect water samples.

Besides the 2023 results, the poster will outline the planned project activities and present initial findings. A primary objective of the joint monitoring approach is to evaluate the effectiveness of (pit) lake treatments aimed at improving the water quality, such as in-lake neutralisation. Furthermore, the obtained data will be used to develop a lake model, which could help to predict and optimise such water quality treatments.

Keywords: Pit lake, uncrewed aerial vehicle (UAV), autonomous surface vehicle (ASV), environmental monitoring