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Investigating manganese dynamics in a coupled catchment-reservoir system: Lake Blagdon – SW England

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Drinking water security in the UK is facing increasing pressure from rising demand, fuelled by population growth and rising periods of drought. Monitoring and regulation of water quality and related internal biogeochemical processes within drinking-water reservoirs is therefore paramount to maintaining security of supply, as well as allowing continued efficient and cost-effective management. In aquatic systems, internal biogeochemical processes are controlled by a complex set of oxygen-controlled forcing mechanisms; as diffuse pollution inputs from upstream catchments enter oxygen-dynamic reservoirs that frequently include nutrient- and metal-rich sediment, deleterious soluble chemical species (e.g., trace metals such as manganese, Mn) can be released from the sediment to the overlying water. Mn in particular is a problem for drinking water treatment plants. In light of oxygen-related water quality issues, almost all UK drinking water utilities use aeration systems to optimise oxygen concentrations and corresponding water quality and ecosystem health.

Blagdon Lake in Somerset, SW England is one such medium-size (1.8km2), shallow depth (max: 13.1m) drinking-water reservoir underlain by Mn-rich sediments. The goal of this project was to investigate the dynamics of Mn release into the overlying water, by coupling a catchment model (SWAT) and a reservoir model (CE-QUAL-W2) together. The coupled whole-system model would be assessed using multiple atmospheric, land-use, and catchment management scenarios to discern the driving processes of Mn release and quantify risk to future water security.

An extensive five-month field campaign was undertaken in Summer 2019 to build water quality time series and calibration datasets for the reservoir model (CE-QUAL-W2). Techniques and equipment deployed during the field work included: water sample filtration & soluble/insoluble Mn analysis at 2m depth intervals; permanently installed thermistor chains using Onset TidbiT v2 loggers at 1m depth resolution; water quality profiles from an EXO3 Sonde, logging pH, chlorophyll-α, conductivity, and turbidity; and surface sediment core Mn analysis. This data was then collated with atmospheric data (ERA5), and existing datasets of nutrient concentration data at multiple inflows (inc. NO2/NO3, Ammonium, Total P/Ortho P). Initial analysis of the data collected during the field campaign suggest that periods of stratification align with elevated Mn concentrations in the water column, directly relating soluble Mn release to air temperature.