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Controlling metalimnetic bloom of Planktothrix rubescens by a novel water withdrawal strategy: a modelling study

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Aggregations of cyanobacteria in lakes and reservoirs are commonly associated with surface blooms, but may also occur in the metalimnion as subsurface or deep chlorophyll maxima. Metalimnetic cyanobacteria blooms are of great concern when potentially toxic species, such as Planktothrix rubescens (P. rubescens), are involved. Apparently, metalimnetic blooms of P. rubescens have increased in frequency and severity in recent years so there is a strong need to establish the external factors controlling its growth. We hypothesized that P. rubescens blooms in reservoirs can be managed by modifying the water withdrawal strategy and altering the light climate experienced by the algae. We tested our hypothesis in Rappbode Reservoir by establishing a series of withdrawal and light scenarios based on a calibrated water quality model (CE-QUAL-W2). Our scenarios demonstrated that metalimnetic water withdrawal reduced P. rubescens biomass in the reservoir. According to the simulation results we defined an optimal withdrawal volume to control P. rubescens blooms in the reservoir as approximately 10 million m^3 during its blooming period. The numerical results also indicated that P. rubescens growth can be most effectively suppressed if the metalimnetic withdrawal is applied in the early stage of its rapid growth (i.e. before the occurrence of blooms). Additionally, the results showed that P. rubescens biomass gradually decreased with increasing light extinction and nearly disappeared when the extinction coefficient exceeded 0.55 m^{-1}. Our results indicated that close linkages among in situ measurements, model simulations, empirical growth rate and flushing rate calculations could inform management strategies to minimise the harmful impacts of P. rubescens in water supplies. Such a strategy could be used in reservoir operational strategies as an adaptation way to offset the rise in P. rubescens populations that has been linked to climate change.