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Modelling chlorophyll-a concentrations in Lakes: Water Quality Drivers, Recent Changes, Status and Trends across European Perialpine and Balkan Mountain Lakes

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Modelling chlorophyll-a as approximation of phytoplankton biomass has become important for identifying influential factors of water quality. However, a comparison of modelling approaches is missing. We aimed at identifying the best statistical method among three linear and non-linear approaches: panel data models, generalized additive models and boosted regression trees. Chlorophyll-a relationships were established for two variable sets, both containing observations of total nitrogen, total phosphorus and maximum depth from 156 European lakes. For investigating the usefulness of temperature surrogates, variable sets were either extended with lake surface water temperature (LSWT) or altitude. LSWT in situ data were further complemented by remote sensing measurements. Water quality modelling results were afterwards combined with the status and trends of 28 selected perialpine and Balkan mountain lakes in terms of the surrounding land cover from 2000 to 2012, seasonal temperature developments for up to 25-year periods and biodiversity. Our study highlighted non-linear approaches, implying that complex relationships between chlorophyll-a and explanatory variables exist. Overall, boosted regression trees performed best. In comparison with the often-used temperature surrogate altitude, the utilisation of LSWT led to similar predictive performances but different influence directions. These results recommend utilisations of LSWT rather than temperature surrogates when focussing on understanding water quality – temperature relationships. Total phosphorus evolved as most influential variable in explaining chlorophyll-a, suggesting that water quality can be controlled by monitoring phosphorus concentrations. In addition, as agricultural areas covered 10 – 60% of the surrounding area of the 28 selected lakes, analyses of land cover categories that are connected to phosphorus pollution can identify lakes being prone to chlorophyll-a increases. While all 28 lakes are a habitat to at least three globally threatened species, the majority of the selected lakes experienced warming with spatially heterogeneous warming rates.