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Assessing risk of non-compliance of phosphorus standards for lakes in England and Wales

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High population densities, use of inorganic fertilizer and intensive livestock agriculture have increased phosphorus loads to lakes, and accelerated eutrophication is a major pressure for many lakes. The EC Water Framework Directive (WFD) requires that good chemical and ecological quality is restored in all surface water bodies by 2015. Total phosphorus (TP) standards for lakes in England and Wales have been agreed recently, and our aim was to estimate what percentage of lakes in England and Wales is at risk of failing these standards. With measured lake phosphorus concentrations only being available for a small number of lakes, such an assessment had to be model based. The study also makes a source apportionment of phosphorus inputs into lakes.

Phosphorus loads were estimated from a range of sources including agricultural loads, sewage effluents, septic tanks, diffuse urban sources, atmospheric deposition, groundwater and bank erosion. Lake phosphorus concentrations were predicted using the Vollenweider model, and the model framework was satisfactorily tested against available observed lake concentration data. Even though predictions for individual lakes remain uncertain, results for a population of lakes are considered as sufficiently robust. A scenario analysis was carried out to investigate to what extent reductions in phosphorus loads would increase the number of lakes achieving good ecological status in terms of TP standards.

Applying the model to all lakes in England and Wales greater than 1 ha, it was calculated that under current conditions roughly two thirds of the lakes would fail the good ecological status with respect to phosphorus. According to our estimates, agricultural phosphorus loads represent the most frequent dominant source for the majority of catchments, but diffuse urban runoff also is important in many lakes. Sewage effluents are the most frequent dominant source for large lake catchments greater than 100 km^2. The evaluation in terms of total load can be misleading in terms of what sources need to be tackled by catchment management for most of the lakes. For example sewage effluents are responsible for the majority of the total load but are the dominant source in only a small number of larger lake catchments. If loads from all sources were halved this would potentially increase the number of complying lakes to two thirds but require substantial measures to reduce phosphorus inputs to lakes. For agriculture, required changes would have to go beyond improvements of agricultural practise, and need to include reducing the intensity of land use. The time required for many lakes to respond to reduced nutrient loading is likely to extend beyond the current timelines of the WFD due to internal loading and biological resistances.