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Abstract book

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Fuzzy modelling of cyanobacterial surface water blooms, validation with 12 years of NOAA-AVHRR satellite image

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This paper presents an early warning system for the occurrence of cyanobacterial surface waterblooms. The model is based upon a sound understanding of the ecology of the cyanobacteria that make up the blooms. Surface waterblooms of toxic cyanobacteria are a serious impediment for the use of lakes (drinking water, recreation etc.). In a waterbloom a pre-existing population of buoyant cyanobacteria concentrates manifold at the lake surface, resulting in a thick scum. Routine monitoring data are not sufficient for early warning against the occurrence of these blooms. In a novel approach we combined deterministic modeling with fuzzy logic to describe the three main conditions governing waterbloom formation: 1) a pre-existing population of cyanobacteria, 2) buoyancy of the cells and 3) stability of the water column. The attributes and membership rules of the fuzzy model were based upon earlier field studies of diel changes in buoyancy and vertical distribution of cyanobacteria. The model was applied without further calibration to the large Dutch lake IJsselmeer, and validated using 12 years of NOAA-AVHRR satellite images on which surface blooms are discernable as an enhanced vegetation index (NVI) or increased surface temperature. Surface blooms were observed only on 23 out of a selection of 309 images. The model gives a proper prediction in 19 of these cases (83 %), but fails to predict 4 surface blooms. Surface blooms were absent on the remaining 286 images; here the model predicted 266 cases correctly (93 %), but also produces another 20 blooms. The model does not have a bias towards predicting too many or too little blooms. Surface blooms were predicted during 5,4 % of the time only July-October). The model can be used to predict the occurrence of surface waterblooms in advance on basis of the long-term weather forecast, leaving time for appropriate management of the problem (for instance increased surveillance, ban on recreation). The current model, however only describes surface waterbloom formation in the open water. More persistent blooms in sheltered places are not yet covered. The lake management has expressed a keen interest to convert the present model into a fully operational early warning system.