Precising target NO_3 concentrations to limit green algae blooms in Brittany

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Abstract

Green macroalgae blooms are a widespread manifestation of coastal eutrophication. In most cases, N inputs by rivers are the main anthropogenic cause. In Brittany, a severely impact region in France, first studies recommended a target NO_3 streamwater concentration around 2.5 mg/L to limit the blooms. After two decades of decrease, although the concentrations remain well above this target, bloom limitations occurred recently, under specific climatic conditions. Coupling the ecological model MARS-ULVES with the agro-hydrological model TNT2 allowed testing contrasted climate sequences and precising the target concentrations for future policy.

Keywords: coastal eutrophication, NO3 pollution, mitigation policy, integrated modelling

1. Introduction

Green macroalgae blooms are a widespread manifestation of coastal eutrophication. They occur where specific conditions coincide, i.e. closed bays fed by nutrient-rich streams, shallow and clear coastal waters, sunny and warm weather. Brittany (Western France) is severely impacted by this nuisance since the early 1970s. The high nitrate concentration in streams (>20 mg/L N-NO3 in some coastal rivers) due to intensive agriculture is the main anthropogenic cause of the phenomenon. Ecological modelling studies suggested that the algae biomass would be significantly limited only with low concentrations, 1-3 mg/L (Perrot et al., 2014). Mitigation plans decreased N losses since the early 2000s, but they failed to reach such low levels, the concentrations ranging currently from 6 to 12 mg.L: the socio-economic cost of the agriculture changes required may be too high. However, signs of biomass limitation began to appear a few years ago, including smaller and more variable algae beachings. Our study aimed at precising the range of limiting concentrations in the largest impacted bay (Saint-Brieuc) to help the authorities to define more reachable targets.

2. Methods

Since climatic conditions affect both the growth of the algae on the coast and the terrestrial fluxes of nitrogen, we coupled the coastal ecological model MARS-ULVES (Perrot et al., 2014) and the agro-hydrological model TNT2 (Casal et al., 2019) to test a range of past and future climate and agriculture scenarios.

First the models are calibrated in the St Brieuc bay using data on climate, hydrology, water quality, algal beachings and agriculture practises for 1998-2018.

Then the models are run on a set of scenarios crossing contrasting climate sequences and agriculture changes.

3. Results

The calibration is in progress and scenario simulations will be run this autumn. We expect to quantify the response of the algae to varying climate conditions when the potential nitrogen losses decrease. This will help define more precise N concentration targets.

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References

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