Monitoring of alpine lakes: approach and results from Canton Ticino

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Background
Alpine ecosystems are facing environmental change including climate warming and the atmospheric deposition of pollutants. Alpine catchments offer valuable vantage points to monitor global environmental changes, because they are often remote and free from local pressures. Moreover, because of their vulnerability, these catchments are considered to be among the most sensitive of environmental change (Beniston et al., 1997).

The scheme is to develop a comprehensive monitoring of the effects of climate warming and nitrogen deposition on lakes and associated ecosystems. This approach will provide the following main advantages: (i) comparative and extrapolative analysis of the effects of climate warming and nitrogen deposition on lakes and associated ecosystems; (ii) an intensive monitoring of the Lake Nero catchment (Fig. 2); (iii) an extensive programme to investigate the spatial extent of the impacts of climate warming and nitrogen deposition on lakes and associated ecosystems; and the intensive programme aims at developing predictive models of ecosystem responses to environmental change.

Together, these programmes contribute to form a basis for decisions on environmental management at national and international levels. The international influence of these programmes is enhanced through the participation to the Convention on Long-Range Transboundary Air Pollution of the UNECE, namely the international cooperative programmes on waters (ICPs, BX1.1 which involves the extensive programme) and integrated monitoring (ICP-Integrated Monitoring, BX2.2 which involves the intensive programme).

The extensive programme has been running for over 30 years. A main goal of the programme was to assess the effects of acid deposition, which was most severe in the 1970s and 1980s. The long-term results have recorded a remarkable recovery in the chemistry of the deposition and the water of receiving lakes, which reflects international efforts to manage sulfur (S) emissions (Rogora et al., 2011). For example, between the early 1980s and 2014, most of the lakes displayed trends toward lower concentrations of sulfate (13 of 20 lakes) and higher alkalinity (14 of 20). However, nitrate decreased less frequently (7 of 20) probably because nitrogen deposition declined comparatively less and more lately than S deposition.

The intensive programme started in 2014 with a pilot study, and the results are preliminary. Nonetheless, the high N concentrations recorded at the outlet throughout the 2014-2015 hydrological season (including the vegetative season) indicate that the soils of Lake Nero’s catchment have become saturated with this nutrient (Stoddart, 1994). An input-output budget for nitrogren suggests that the catchment of Lake Nero retains a substantial percentage of the yearly input (Fig. 5). Although the export peaked during the snow melt period, it decreased also during the subsequent vegetative period, indicating that the catchment soils have become saturated with this nutrient.

Figure 4: The scheme is to develop a comprehensive monitoring of the effects of climate warming and nitrogen deposition on lakes and associated ecosystems.

Results

The extensive monitoring programme is based on 65 stations along the Swiss part of the Alps (BX1.1). It includes hydrochemistry, vegetation, biota, and climate (among others). The programme was designed to assess the effects of climate warming and nitrogen deposition on lakes and associated ecosystems. This approach will provide the following main advantages: (i) comparative and extrapolative analysis of the effects of climate warming and nitrogen deposition on lakes and associated ecosystems; (ii) an intensive monitoring of the Lake Nero catchment (Fig. 2); (iii) an extensive programme to investigate the spatial extent of the impacts of climate warming and nitrogen deposition on lakes and associated ecosystems; and the intensive programme aims at developing predictive models of ecosystem responses to environmental change.

Discussion

The synergistic monitoring programmes provide the following main advantages: (i) comparison and extrapolation of findings from Lake Nero to the regional scale and (ii) understanding the ecological effects of environmental change detected at the regional scale. As climate warms and N deposition increases at the global scale, monitoring programmes in mountain catchments will become increasingly important to detect the effects as early as possible and prevent damage to these important landscape features. Because the southern slope of the Alps appears to be changing particularly fast, monitoring programmes in this region may play an especially important role in detecting early signals of environmental change.

References


Box 1: Monitoring of the basin of Lake Nera.

Box 2: Monitoring of the basin of Lake Nera.

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