Contrasted responses of three deep eutrophicated peri-alpine lakes to reduction of external phosphorus loading: some ecological processes and some social perceptions

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The studied lakes (Lake Annecy, Lake Bourget and Lake Léman shared with Switzerland) are peri-alpine lakes located within the same eco-region; they are subjected to the same kind of socio-economic development and history. The eutrophication of these lakes began in the 60's and control policies were implemented in the 80's. Based on the established role of phosphorus (P) in causing eutrophication of lakes (Vollenweider, 1968; Carpenter, 2008), the objective of managers was to reduce the external P loads. The implemented measures aimed at decreasing/controlling point sources of pollution (first, sewage facilities and treatments, then implementation of tertiary sewage treatments and finally TPP ban or reduction).

Despite the similarity in the characteristics of these French lakes, the policies implemented at the watershed scale to control point sources have been more or less drastic according to local situations. Progress in controlling point pollution has been consequently more or less slow (but always costly). Sharp and early reductions in point source discharges resulted in a return to an oligotrophic state in Lake Annecy. In the two other Lakes in contrast, less drastic measures and slower implementation of the latter, have globally led to significant but limited and delayed improvements.

The monitoring of these lakes since the 60's or the 80's has provided the opportunity to examine the processes and interactions determining these global ecological responses to P reduction (ORE Lacs, 2006). We will present data from Lake Bourget and Lake Léman which exhibit contrasting ecological responses, in terms of magnitude, phytoplankton composition and water quality. These differential responses seemed to be due to residual P from diffuse sources (CIPEL, 1988) and internal P loads, known to slow down and delay rehabilitation or to stabilize the lake trophic status. Biological and feedback processes or N/P interactions as well as climate warming (Anneville et al, 2005; Tadonléké et al. submitted) seemed also to be involved in the maintenance of relatively high trophic status or in the delay of water quality improvement in these lakes, even though both have experienced considerable reduction in in-lake P.

Because of the relative improvement of water quality observed since 2000 in these lakes, the services expected from them in the next future is greater: increase of water supply for cities (Lake Léman will supply water for 1 million persons), biodiversity (WFD, Natura 2000..), recreation, sport fishing and fisheries. Moreover, restored lakes are indicators of the regional quality of life and environment (Unesco project for Annecy) and as such are magnets for another step of development characterized by urban sprawl and the occurrence of a set of new pressures exerted on the sensitive lake ecosystems. This shows that a lake, its watershed and the people living within, constitute a functional unit that should be managed as a whole system (a "biosocial system"), at both long-term and short term scales.

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