SEVENTH FRAMEWORK PROGRAMME
THEME 6: Environment (including Climate Change)

REFRESH

Adaptive strategies to Mitigate the Impacts of Climate Change on European Freshwater Ecosystems

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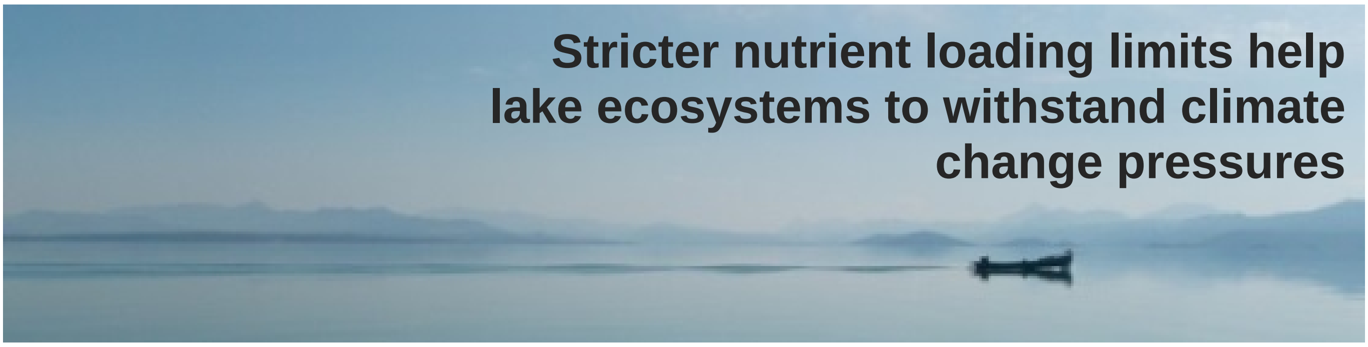
PU	Public	X
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

Abstract

The EU FP-7 Project REFRESH brings new evidence on climate change impacts on lakes showing that increased lake temperatures generally have a eutrophication-like effect as natural mechanisms that control phytoplankton development in lakes weaken in a future warmer climate. Based on that, REFRESH concludes that all measures leading to reduced nutrient losses from agriculture can be considered win-win measures as they meet environmental objectives set by the Water Framework Directive and will enhance the resilience of lake ecosystems in conditions of climate change. The project has pin-pointed a number of best agricultural practices and other measures which contribute to reduction of nutrient losses to surface waters.



Stricter nutrient loading limits help lake ecosystems to withstand climate change pressures

Synthesis

- ✓ Despite improvements in some regions, nutrient load from agriculture remains a major pressure on Europe's freshwater causing eutrophication. The main consequences of nutrient enrichment are excess phytoplankton growth, increased frequency of cyanobacteria blooms, and depletion of dissolved oxygen, all leading to a decline in water quality and biodiversity.
- ✓ The EU FP-7 Project REFRESH brings new evidence on climate change impacts on lakes showing that increased lake temperatures generally have a eutrophication-like effect as natural mechanisms that control phytoplankton development weaken in a future warmer climate.
- ✓ As the impact of eutrophication and climate change follow the same pathways affecting nutrient availability and cascading effects in the food web, and given the high variability of both pressures, it is unlikely that their impacts can be disentangled in each particular case.
- ✓ A review of more than 450 climate change adaptation measures related to water carried out by the REFRESH concludes that all measures leading to reduced nutrient losses from agriculture can be considered win-win measures as they meet environmental objectives set by the Water Framework Directive and will enhance the resilience of lake ecosystems in conditions of climate change.

Because the impacts of cultural eutrophication and climate change follow the same pathways, stricter nutrient loading limits are needed in a future warmer climate for achieving good ecological status in lakes as required by the Water Framework Directive

Climate change reinforces eutrophication of lakes

Riparian Warming exacerbates some symptoms of eutrophication in both cold and warm climates. Longer periods of thermal stratification lead to oxygen depletion, which enhances phosphorus release from lake sediments and boost cyanobacterial blooms. In warmer climates the sensitivity of lakes to nitrogen (N) loadings increases. In northern Europe N loss from agricultural soils is primarily associated with vegetation-free periods, where high soil mineral N concentrations may accumulate and be lost during periods of excess rainfall. In southern Europe, nitrogen concentrations in lakes increase due to higher evaporation. The food web structure and functioning of cold temperate shallow lakes are expected to become more similar to those of (sub) tropical shallow lakes, as the temperature increase will enhance the top-down controls of omnivorous and benthivorous fish as well as the nutrient cycling.

New evidence from REFRESH

We found profound changes in fish assemblage composition, size and age structure during recent decades and a shift towards higher dominance of eurythermal species and small individuals. This shift has occurred despite an overall reduction in nutrient loading that should have benefited the fish species typically inhabiting cold-water low-nutrient lakes and larger-sized individuals. The response of fish to the warming in recent decades has been surprisingly strong, making them ideal sentinels for detecting and documenting climate-induced modifications of freshwater ecosystems.

Weaker control over phytoplankton growth

We can expect cascading effect of the fish down through the food-web, leading to greater abundance of phytoplankton and cyanobacteria (the latter further stimulated by higher temperatures) and, in deep lakes, more stable and longer stratification. In addition, macrophytes will provide less refuge for zooplankton, further reducing the grazing capacity of zooplankton on phytoplankton.

Zooplankton, which is the main consumer of phytoplankton, remains under double pressure in warmer conditions: the increasing dominance of poorly-grazed colonial and/or toxic cyanobacteria impairs zooplankton food resources, whereas the increased occurrence of small-sized omnivorous fishes inhabiting the littoral zone, besides exerting direct feeding pressure, abridges zooplankton of the macrophyte refuge. We strongly suggest including zooplankton among mandatory biological quality elements for lakes.

Measures suggested by REFRESH

A review of more than 450 climate change adaptation measures related to water carried out by the REFRESH has pin-pointed a number of best agricultural practices and other measures which contribute to reduction of nutrient losses to surface waters. To avoid excessive leaching of N to aquifers and surface waters, it becomes necessary to reduce intensive tillage in autumn and extend the period of active crop growth, either by growing catch crops, cover crops or longer duration crops. A key measure is to enhance the retention time of water which will lead to higher N loss by denitrification. This can be achieved by re-meandering of channelized streams, (re-)establishment of wetlands, including also constructed wetlands in the farmland areas, reduction of P loading to improve lake water clarity and thereby enhance the N loss in lakes, and maintenance of a reduced abundance of cyprinids in lakes. To reduce the risk of eutrophication and lowering of the water table of shallow lakes in Southern Europe, restrictions on the human use of water are needed. Since more than 80% of the freshwater abstraction in most Mediterranean countries is used for irrigated agriculture, this will imply less use of irrigation water, more effective irrigation and water distribution systems, and improved recycling of water, including wastewater, within catchments.

In Northern Europe eutrophication risk can be tackled best by measures reducing nutrient leakage from fields whereas more efficient water use is required in Southern Europe

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http://www.refresh.ucl.ac.uk/

Additional scientific information

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