AR/02

EAGLES

East African Great Lake Ecosystem Sensitivity to changes

DURATION OF THE PROJECT
01/12/2010 – 31/03/2015

BUDGET
799.781 €

KEYWORDS
Lake Kivu, environmental change, biogeochemistry, productivity, sediment archives, climate, modelling

CONTEXT

Large East African Rift lakes have been changing rapidly during the last decades. They typically have a relatively high productivity compared to large temperate lakes and have active fisheries providing local populations with a relatively cheap source of proteins. However, human-induced changes, including climate change, can have significant effects on primary production of these lakes, as shown for Lake Tanganyika. It is likely that these decreases in primary production have affected secondary producers and fisheries, but, before being able to predict the extent of the primary productivity changes and how they affect whole ecosystem production, an improved understanding of ecosystem function and food web processes is required.

PROJECT DESCRIPTION

Lake Kivu, located north of L. Tanganyika, has undergone recent changes induced by alien species introduction and possibly climate change, which have affected the lake's biodiversity, productivity and ecosystem resources. Future industrial methane harvesting additionally threatens future sustainable development of ecosystem resources. Lake Kivu may provide an adequate model for studying responses of large tropical lake to human-induced changes: indeed, despite its physical and geochemical peculiarities, the limnological and ecological processes in its pelagic waters are subjected to the same forcing as in other great lakes of the same region, as shown by studies conducted in recent years. In addition, the simple pelagic food web of the lake facilitates our understanding of ecosystem functioning and of human-induced alterations. Some past changes in the lake have been revealed by analyses of the sediments, which can be further improved by studies of an array of proxies, by development of new proxies and by inference from present ecological processes taking place in the mixolimnion.

Objectives

The general objective of the EAGLES project is to understand, monitor and forecast how the ecosystem of a large African lake, Lake Kivu, responds to human-induced changes, in order to predict the effects of ongoing and planned exploitation of its resources under different scenarios of climate change.

Methodology

In this project, we will exploit the important database acquired in the period 2002-2009. The existing data base includes limnological variables, plankton (diversity, biomass and production of phyto- and zooplankton), fish abundance and meteorological data. This data base will be completed by sediment archives (biogeochemical and biological proxies) and by remote sensing of phytoplankton biomass and surface hydrological features, for taking into account spatial and temporal heterogeneity.

New *in situ* studies will be conducted in order to extend the database and increase our present understanding of ecosystem biodiversity and functioning. Laboratory studies will be undertaken to determine ecophysiological requirements of key diatoms isolated from L. Kivu and for studying Si isotopic fractionation by different species, both in the water column and the sediments.

The final step will be devoted to data processing and modeling, in order to:

- link atmospheric forcing and the lake's physics: relation between atmospheric conditions and lake temperature and water column structure, aiming to understand/simulate the variability of seasonal mixing processes and forecast long term changes
- link physical processes with biological and ecological (e.g. nutrient availability) processes: diversity and biomass of plankton, fate of primary production in the planktonic food web, fish abundance and fisheries yield
- predict future changes of ecosystem processes and resources, as a result from fisheries management, exploitation of methane from the deep waters, and climate change (linking global climate to regional climate).

Finally, we will examine how the methodologies used and developed in the research project could be applied to other large African lakes, particularly Lake Tanganyika.

INTERACTION BETWEEN THE DIFFERENT PARTNERS

- Compilation and exploitation of the existing data-sets on Lake Kivu (P1, P2, P4, P5 and P8)
- Acquisition of new data, including : extension of the limnological and planktological data series (P1, SC1 and SC2), high frequency measurements on moorings (SC2, P4), remote sensing (P1, P6), surveys of fish stocks (SC1, SC2, P8), carbon pathways in the planktonic food web (P1, P3, P4), paleolimnological records (P1, P2, P3, P5).
- Improvement of key proxies of water column productivity by laboratory studies (P2, P5)
- Analysis of ecosystem responses over the 2002-2013 period, based on data-analysis (all) and modelling (P7, P4)
- Prediction of future changes by numerical modelling (P7, P4).

LINKS WITH INTERNATIONAL PROGRAMMES

- EAGLES will contribute to the EAGLO network (the East African Great Lakes Observatory) supported by ESPA (http://www.nerc.ac.uk/research/programmes/espa/)

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EXPECTED RESULTS AND/OR PRODUCTS

- Historical data-bases (acquired by some partners on other projects and from data mining/rescue) on water column and sediment chemistry and biology.
- New data-sets and data-bases on chemistry and biology of the water column and sediments, including paleo-reconstructions
- Remote sensing reconstructed time series (surface temperature, Chla and K490 raw)
- Statistics on fish stocks and fisheries (2011 to 2013)
- Coupled hydrodynamic-ecosystem Kivu model on present day functioning and analysis of future impacts (climate change, CH_4 extraction).
- Advice for sustainable management of fisheries and CH4 extraction in L. Kivu
- Web-site (http://www.eagles-kivu.be/)

PARTNERS

Activities

P1/C: LFE, a research group within the Research Unit in Environmental and Evolutionary Biology (URBE, University of Namur) has been involved for almost a decade in research projects on East African Great Lakes, related to climate variability and environmental change

P2: The Group of biogeochemistry of the Royal Museum for Central Africa has been involved for the last ten years in national and international research network projects on developing the Si isotopic tool in order to better constraint: (1) the diatom productivity in fresh and sea waters; (2) the various vectors of continental weathering; (3) the impact of land use on the Si cycle; (4) various recent and past silicification processes.

P3: The group from the division of Soil and Water Management, part of the Earth and Environmental Sciences Department of K.U. Leuven focuses on elucidating carbon sources and pathways in aquatic ecosystems, from coastal environments to river networks and lakes; and makes extensive use of both natural abundance stable isotope proxies and labeling experiments.

P4: The Chemical Oceanography Unit of University of Liège (COU-ULg) focuses on biogeochemical functioning across aquatic systems (from freshwaters, to coastal and open ocean) with an emphasis on community metabolism using mass balance integrative approaches and the exchange of greenhouse gases with the atmosphere (CO_2, CH_4 and N_2O).

P5 The Laboratory of Protistology and Aquatic Ecology (PAE) focuses on microalgae ecology and the study of sedimentary archives to reconstruct past changes in environmental conditions and climate variability.

P6: The Geomatics Unit of ULg has been involved since more than 20-years in several projects regarding very high to low spatial remote sensing

P7: The KULeuven Regional Climate Studies group has extensive expertise in regional climate modeling in different regions of the world with emphasis on land-atmosphere interactions. In addition, these models are used to develop regional climate scenarios.

P8: UMR-Carrtel: Dr J. Guillard is specialised fish stock estimations by hydroacoustic, specially in freshwater areas, as Alpine great lakes and tropical ecosystems. He is involved in the development of the CEN hydroacoustic standardization.

Follow-up Committee

For the complete and most up-to-date composition of the Follow-up Committee, please consult our Federal Research Actions Database (FEDRA) by visiting
http://www.belspo.be/fedra

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