WHY MONITORING IS NECESSARY ?

AFRICAN GREAT LAKES ARE THREATENED

The major African Great Lakes (Albert, Edward, Kivu, Malawi/Niassa/Nyasa, Tanganyika, Turkana, Victoria) and their basins provide invaluable resources for the 10 countries sharing the lake basins with fastly growing population of more than 52 million. Those lakes are also globally significant for their exceptional biodiversity (e.g > 1450 fish species) and as a world reservoir (28%) of surface freshwater.

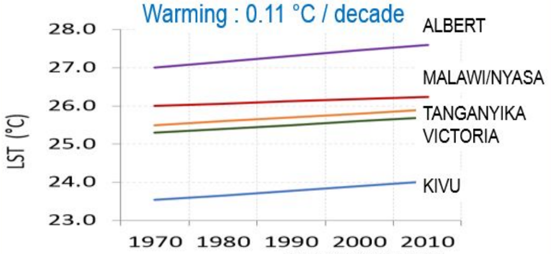
Various threats on AGL have been described in the last 3 decades: overfishing, climate change, eutrophication, loss of fish biodiversity, massive algal blooms, water hyacinth infestation, oxygen depletion, fish kills, excessive sediment from intensive agriculture/deforestation, localized pollution.

A long-term monitoring at a regional level is highly advisable as a tool for lake managers toward the sustainability of ecosystems services provides by the great lakes (Odada et al., 2003). The present multi-lake monitoring is in direct agreement with the African Great Lakes Conference resolution of Entebbe (>300 participants) recognizing the need for timely information, robust data, and continual monitoring to guide policy for conservation and management of the resources of the African Great Lakes region (AGL, 2017).

LINK To REFERENCES

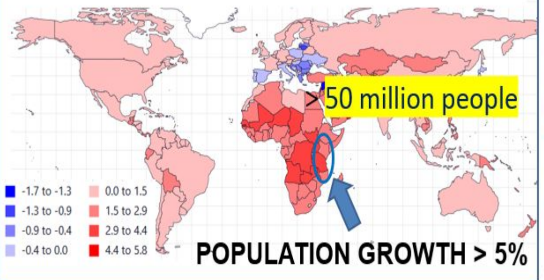
THREATS

CLIMATE CHANGE



After data from Katsev et al., 2014

ANTHROPOGENIC PRESSURE



FISH CATCHES DECREASE

Overfishing ? Climate change ?

INVASIVE SPECIES

POLLUTION

ALGAL BLOOMS

EROSION

Sedimentation

Photo: Pierre-Denis Plisnier

Photo: Olivier Dewitte

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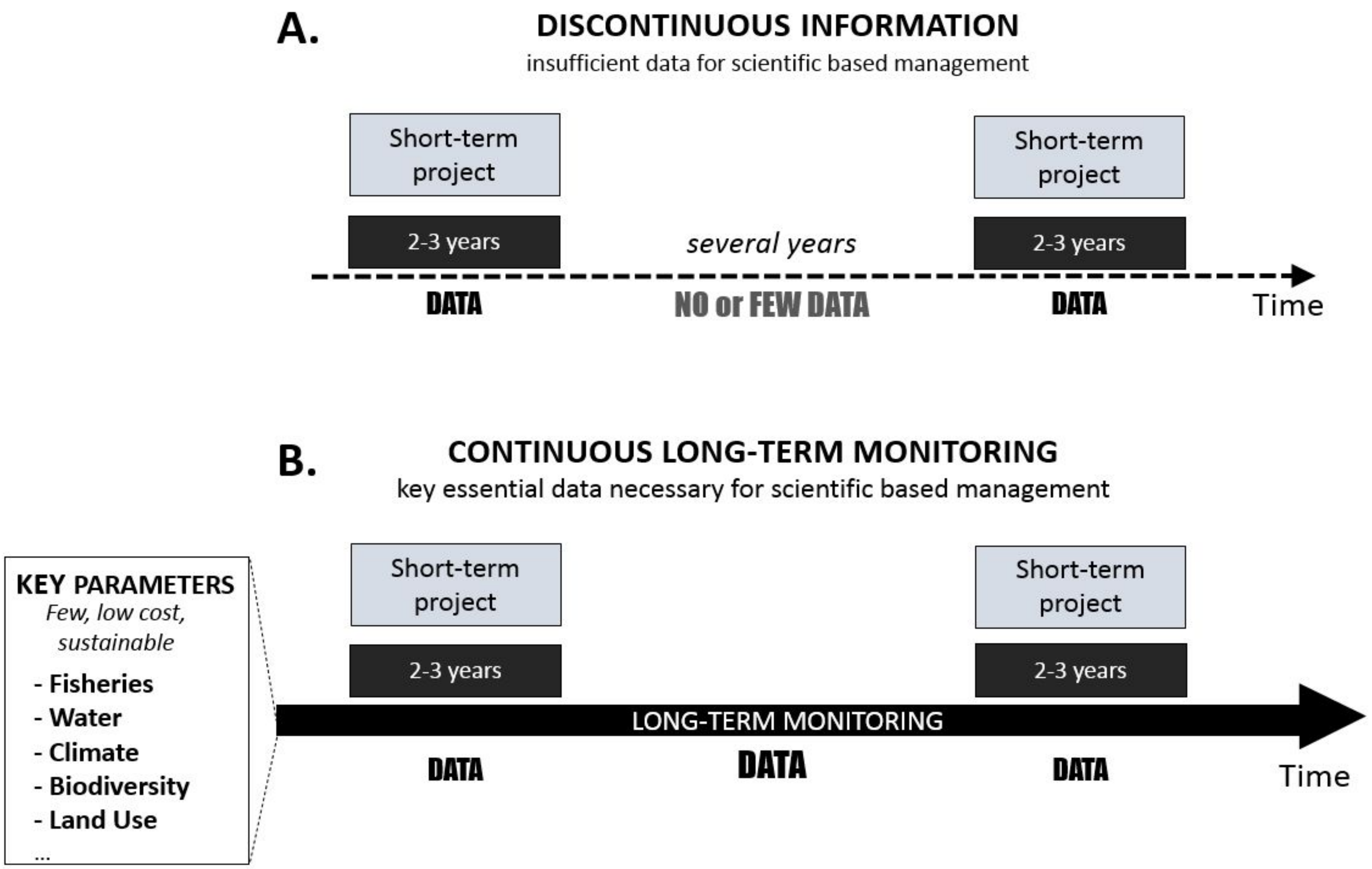
CONTINUOUS SCIENTIFIC DATA ARE NEEDED

Management of large lakes needs to be based on permanently collected observations and scientific data. Without good information, decisions can only be based on guesses which are unlikely to address threats optimally. Presently, in many sites, there are long periods when key data on fisheries, water parameters etc… are not monitored although many data are sometimes collected in the frame of short-term projects. The objective of a long-term monitoring is to insure a continuous acquisition of key data. However, to insure the long-term sustainability of such a monitoring, collected data need to be based on a few key parameters that may provide useful information at a low cost as the capacities of each research station allow. Essential key parameters have been identified previously with many lake managers and researchers in the frame of workshops and with various managers and the network of researchers gathered by ACARE-IISD.


A.
DISCONTINUOUS INFORMATION
insufficient data for scientific based management
Short-term project
2-3 years
several years
Short-term project
2-3 years
DATA
NO or FEW DATA
DATA
Time
B.
CONTINUOUS LONG-TERM MONITORING
key essential data necessary for scientific based management
KEY PARAMETERS
Few, low cost, sustainable
- Fisheries
- Water
- Climate
- Biodiversity
- Land Use
...
Short-term project
2-3 years
Short-term project
2-3 years
LONG-TERM MONITORING
DATA
DATA
DATA
Time

MONITORING THEMES

The multi-lake monitoring is targeting an “ecosystem approach” based on the multidisciplinarity.

Six main themes are considered:

- Water (limnology: physico-chemistry, hydrodynamics, planktonic abundance)
- Fisheries (catches and efforts targeting main species of fish)
- Meteorology (main parameters essential to all themes)
- Biodiversity (risks of invasive species and environmental changes)
- Land use (erosion, sedimentation, eutrophication, pollution..)
- Socio-economic indicators (fisheries and other lake activities)

Two methodological aspects will address various themes and provide common services for all the partners:

- Remote sensing (lake parameters, land-use, meteorology)
- Database

WHY A MULTI-LAKE MONITORING ?

There is an added value to monitor African Great Lakes using a multi-lakes approach: acquired experience from one Lake may have a levering effect for a better understanding of other lakes:

-The various limnological cycles show strong similarities because they are impact by similar climate patterns linked particularly to winds and rainfalls. For example, lake levels show similar changes at the different lakes.

-Similar types of anthropogenic pressure are observed at the different lakes (overfishing, deforestation, increased sedimentation, pollution, even if some differences are well known (such as related to different depths). However, the intensity of the anthropic pressure is different between lakes: the multi-lake monitoring provides thus a great opportunity to compare the lakes issues and better identify probable causes of changes (natural or anthropic). A better understanding of limnological and fisheries cycles is also expected (annual, ENSO, Indian Ocean related, trend…).

The multi-lake monitoring and the network of AGL are also expected to be beneficial for the whole community and for each Great Lake individually

MULTILAKE MONITORING

Fisheries, limnology, biodiversity, erosion

CLIMATE vs ANTHROPENIC IMPACTS ?

LAKE TURKANA MONITORING

LAKE ALBERT MONITORING

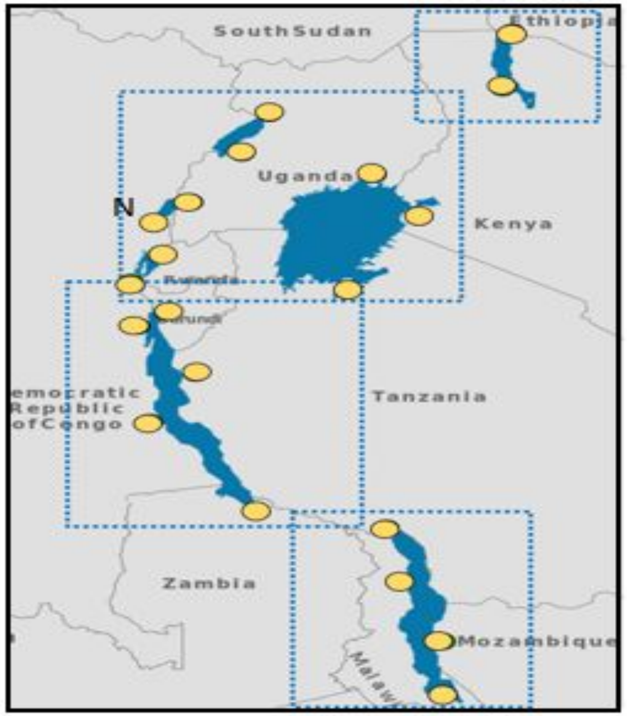
LAKE EDWARD MONITORING

LAKE KIVU MONITORING

LAKE VICTORIA MONITORING

LAKE TANGANYIKA MONITORING

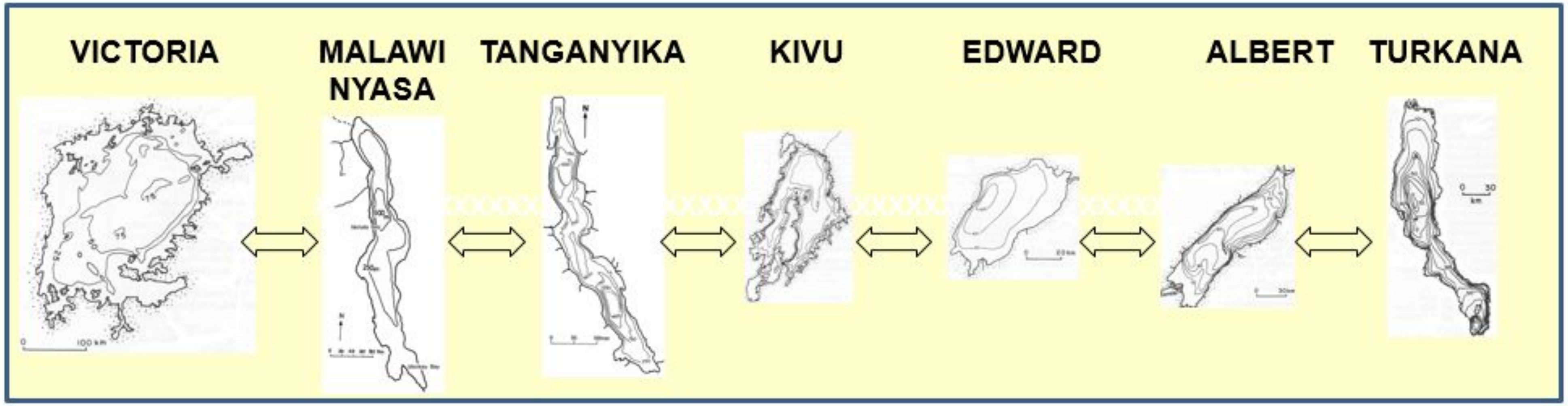
LAKE MALAWI-NYASA-NIASSA MONITORING



CONTINOUS MONITORING
COMPARABLE INDICATORS
CONTINUOUS TIME SERIES
INCREASED UNDERSTANDING
NETWORKING
EXPERIENCE SHARING

CLIMATE IMPACT → **ADAPTATION**

ANTHROPIC IMPACT → **MANAGEMENT**


VICTORIA
MALAWI
NYASA
TANGANYIKA
KIVU
EDWARD
ALBERT
TURKANA

MAIN PRINCIPLES OF THE MULTI-LAKE MONITORING

The long-term monitoring is **different from short-term intensive monitoring**.

The long-term monitoring plan is based mainly on a few key field parameters. This is to insure the long-term sustainability by all stations at the 7 lakes. The parameters are thus chosen on the basis of their great interest, ease of implementation and "low cost". This should allow the sustainability and a rather high frequency of measurement. The goal is the acquisition of time series data presenting "no gaps" and in a harmonized standard way at the 7 lakes to allow comparisons. More measurements could be possible in stations that are able to insure a continuous presence of qualified staff for correct calibration of instruments and the quality data acquisition. The objective is to insure a sustainable and high-quality data collection. The multi-lake monitoring requires comparable methods of monitoring (fisheries, water quality, biodiversity…) taking into account as much as possible the present methodologies in application at lakes where a monitoring is presently done.

Remote sensing will extend the spatial scale of investigation for the whole region. This is detailed further in this document.

Automatic buoys with various sensors could provide a good source of data. The secure installation of automatic buoys is however necessary for the long-term use and cost efficiency. The priority would be given for sites at the northern and southern ends of lake in relation with the trade winds impact on the hydrodynamics.

NB: Short term projects will increase the number of measurements and parameters from time to time. More intense monitoring depends of each short-term research projects. They are not included in the present plan. It is advised that short term projects take place simultaneously at more than one lake to increase possible comparisons between lakes.

PROCESS FACILITATION FOR THE LONG-TERM MONITORING

The proposed multi-lake monitoring setup is being facilitated by the African Center for Aquatic Research and Education (ACARE) and the International Institute for Sustainable Development (IISD). IISD-ACARE is proposing to serve to facilitate communication, to implement the setting up of the long-term monitoring and to assist with finding appropriate research and financial partners. The objectives are to strengthen research and management and to develop an international network between the region of AGL and the global large lakes community. The present ideas have been discussed during various meetings facilitated by ACARE-IISD.

MULTI-LAKE MONITORING SET UP STEPS

The setting up of a long-term multi-lake monitoring is a process involving many partners (people and institutions).

(1) **Survey 1** "**Who is doing what and where**". Various information concerning the present activities taking place at the AGL need to be collected. This survey aims to identify better persons and institutions. It is important also to identify the institutions that do have a mandate in relation with the lakes and their basin for the various themes indicated above. In addition, other institutions, groups and associations…whose activities are related to the great lakes need to be identified also as the long-term monitoring will need specialists at various stages of the monitoring (specific information, training, data interpretation…). **LINK to survey 1**

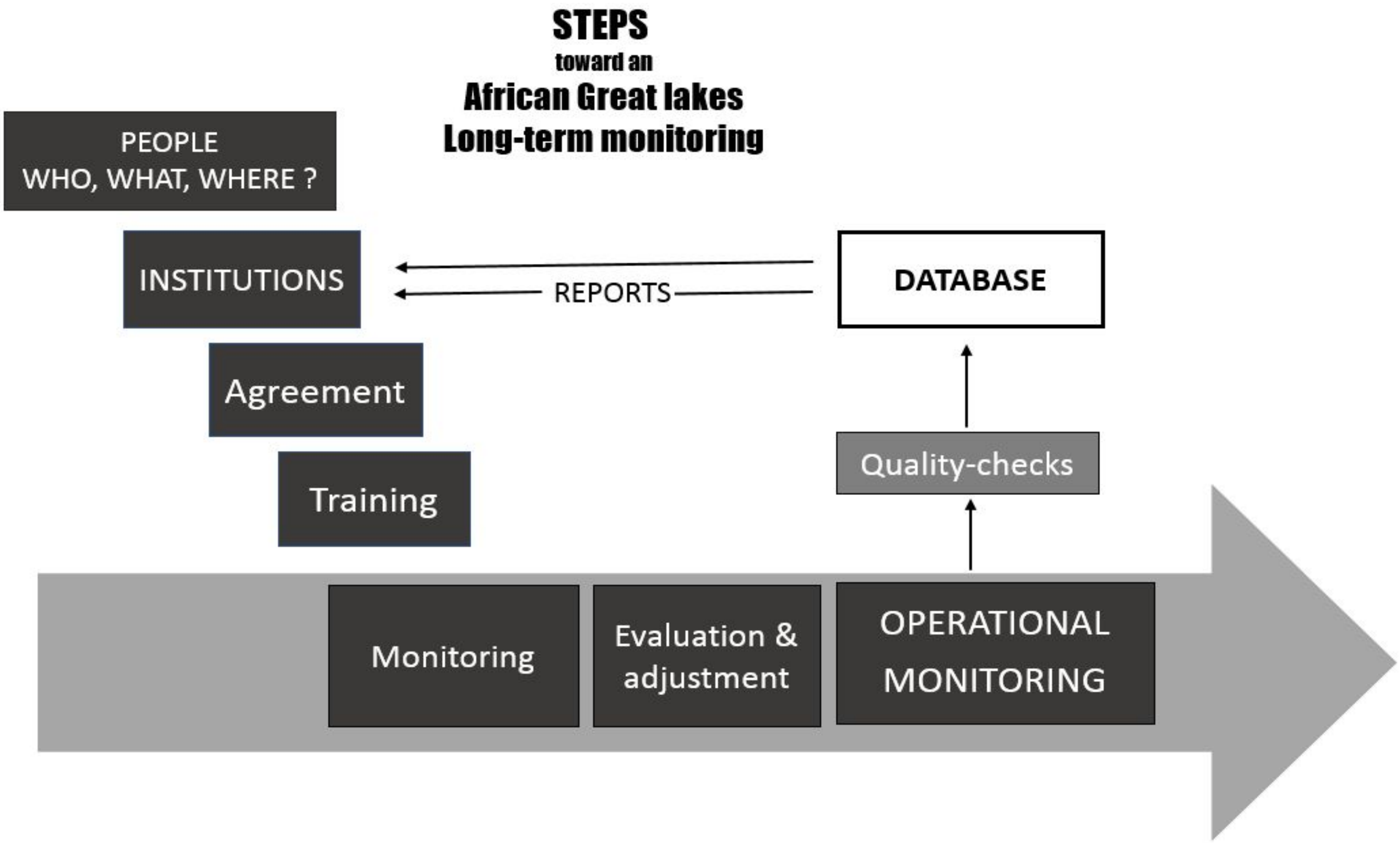
(2) **Survey 2** "**Institution capacities and present monitoring activities**". In a second steps, more information on monitoring capacities are necessary in relation with research stations, staff and methods that are used if monitoring activities are presently done (tools, method, frequency) This will help to propose a unified and comparable monitoring of the AGL in addition to possible capacities building (particularly training and main instruments). **Future LINK to survey 2**

(3) **Contacts with institutions** that have been identified as possible partners will be contacted to present the proposed long-term monitoring and arrange possible meeting with them.

(4) If an institution agrees to join the network of multi-lake monitoring, an agreement of collaboration such as "**memorandum of understanding**" to participate to the network of long-term monitoring of African Great Lakes and their basin.

(5) **Training** and **capactity buiding** will then be organized with the staff that will be indicated in each institution for the long-term monitoring harmonization (field manual, instruments, methodology, procedure for reporting, database access, quality check procedure, reporting…). In situ training and additional meeting to comfort methods harmonization will be detailed later on.

Multi-lakes monitoring of African Great Lakes



PARAMETERS OF THE MULTI-LAKES MONITORING

WATER

Water temperature (WT) is an essential parameter related to various aspects and particularly to the physical stability and mixing of the lakes. Its monitoring could help to understand better nutrient accessibility in euphotic layers and thus possible changes of lake productivity.

Secchi disk transparency (SD). The SD is a very useful parameter, in many lakes where it was shown to be generally well correlated to phytoplanktonic concentration. Since nutrients are quickly used for primary production in tropical waters, the measurement of SD is an ideal proxy indirectly linked to nutrients (their concentration may thus be measured less often, in the frame of short-term project for example). Since a SD is cheap to build and operate, it is an ideal parameter for a long-term monitoring.

Planktonic bloom observation (required)

The occurrence of each observed planktonic bloom should be noted in a log book (date and location)

Planktonic bloom sample (optional)

Sampling and conservation of phytoplankton and zooplankton from important blooms events. This needs confirmation according to species determination possibilities.

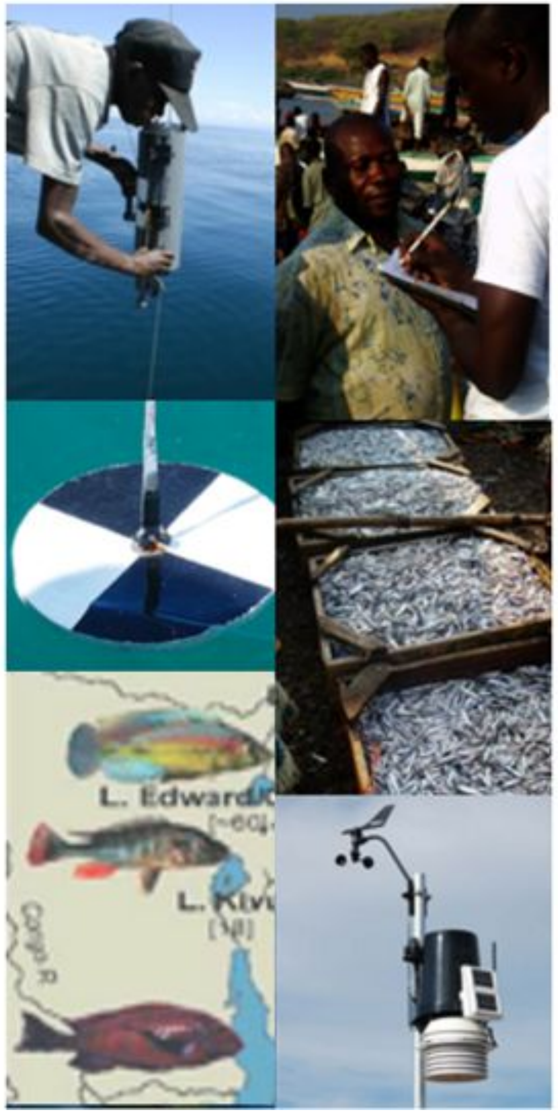
Water sample (optional)

In case of polluted waters, a sample could be kept for analysis by a specialized laboratory (those need to be identified including their capacities).

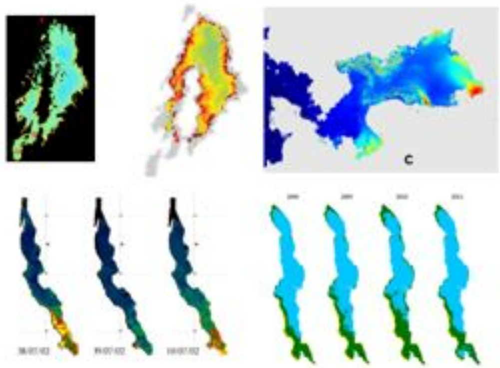
pH, dissolved oxygen, turbidity (optional)

Those parameters could be included in the long-term monitoring only if a continuous correct calibration of instruments can be insured on a continuous basis (no gaps). The presence of qualitied staff in a station is essential to insure that only quality data are collected. If this can not be insured on the long term, it is preferable to not include those parameters or to “flag” them correctly with the name of person in charge of calibration and comments.

Various other parameters (optional) could be measured but too many of them and a too high of frequency of measurement could decrease the successful long-term implementation of the monitoring. It is preferable to start with few parameters and increase their number according to sustainable capacities to allow the high-quality data monitoring.

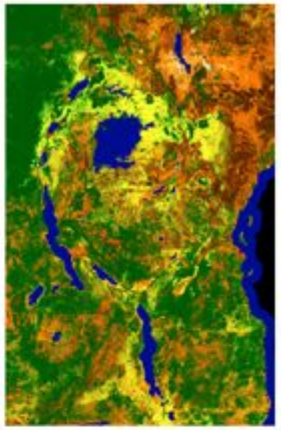


WATER



METEOROLOGY

LAND USE



PARAMETERS OF THE MULTI-LAKES MONITORING

FISHERIES

-Catch assessment survey (CAS) (required)

It is essential to monitor catches per unit of effort (CPUE) data for the main fish species and most important fishing techniques. Catch assessment surveys could take place yearly or every 2 years. This will need more information from discussions with implementing institutions.

-Monthly catches per unit of effort (CPUE) (optional)

In addition to CAS, the monthly monitoring of a number of fishing units near the research stations is advisable to increase knowledge on fish and environmental variability relationships.

- Frame surveys (FS) (required)

A frame survey of boats and fishing gears is advised every 2 to 5 years. Field investigation could be comforted by satellite images.

- Other fisheries studies (optional)

-biological analysis of main species
-fish cohort studies
-gear selectivity
-biomass/stock assessments.

PARAMETERS OF THE MULTI-LAKES MONITORING

METEOROLOGY

-**Automatic meteorological stations (AWS)** (required)

The monitoring of meteorological conditions is essential. AWS are becoming cheaper and of better quality. The site of recording should be as close from the lake as possible and optimally from stations situated on floating platforms or buoys. In each case, the security of the AWS is important to consider also. The main parameters to record include air temperature (maximum and minimum), rainfall, rain intensity, wind speed and direction, humidity, solar radiation and atmospheric pressure. Remote sensing may also comfort the regular acquisition of meteorological data for the whole of the AGL region including their basins. The official meteorological network remains the official reference. Data exchanges with the official network is strongly encouraged. In addition to the AWS, meteorological information may be expanded spatially from the use of remote sensing data (see below).

PARAMETERS OF THE MULTI-LAKES MONITORING

REMOTE SENSING

RS data with the appropriate spatial, spectral, and temporal scales are freely available for the AGL and can provide important long-term consistent data over a wide surface area. Currently operating sensors include MODIS, VIIRS, Landsat 8, and Sentinel 1, 2, and 3. New satellite sensors and sensor constellations are continually being added to the list of potential resources.

Key data include **chlorophyll a concentration**, indicators of **cyanobacteria blooms**, **surface temperature** and **light penetration depth**. Other data products derived from RS include physical variables such as **wind, waves, precipitation, solar insolation** and **cloud cover.** Biogeochemical variables such as **surface layer suspended solids concentration** and **dissolved colored organic matter concentration** could also be measured.

Creating data products for the AGL requires validation of existing algorithms or development of lake-specific algorithms. There needs to be a regional capacity to process remote sensing data and to provide adequate measurements to validate data products. Lake specific remote sensing algorithms require data for development and validation. While limnological field data plays a key role, various sensing systems on buoys can provide a link between field and satellite data for more rapid development and validation of algorithms. These sensors include the capacity to measure light spectra of lake water absorption, scattering, reflectance, and fluorescence. A capacity to measure atmospheric properties for good atmospheric compensation of the satellite signals is also very useful.

PARAMETERS OF THE MULTI-LAKES MONITORING

BIODIVERSITY

The African Great Lakes present and exceptional biodiversity. However, this biodiversity is at risk of loss from competition with invasive species, overexploitation, pollution. It is important to detect significant changes sufficiently early to insure conservation measures.

Three types of surveys for biodiversity monitoring are considered. Only one of those surveys belongs to the long-term monitoring while the two others are based on short-term projects as indicated below:

-**Baseline survey** (short-term survey only; needed at the beginning)

In case that historical data are not sufficient, a baseline survey is needed. It could be organized with national and international experts focusing on a wide range of taxa.

-**Changes from the baseline** (required; part of the multi-lake monitoring)

The occurrence of key taxa is indicative of habitat. It includes key taxa easily identifiable by para-taxonomists (trained staff) and also easily sampled (for instance using dipnets, snorkeling, or fishing gears). Some key fish species and possibly plants will be monitored once or twice per year with attention to possible introduced species.

-**Intermittent surveys** (short-term surveys only)

Those surveys are related to short term project and are done when possibility arise (e.g. funding). Those updated of biodiversity requires to be done by specialists/taxonomists.

PARAMETERS OF THE MULTI-LAKES MONITORING

LAND USE

Land use has an impact on lakes such as from erosion and increased sedimentation, use of fertilizer in agriculture and eutrophication, use of pesticides and pollution etc…

The monitoring of land use includes remote sensing analysis and field verifications every 2 or 3 years. The following information is targeted:

- **Land use maps** (required)
- **Surface use for agriculture, forest, pasture, savanna** (required)
- **Surface used on exposed soil by categories of slope** (required)
- **Erosion hazard risk assessment** (required)
- **Population and its distribution** (required)

In some lakes, land use will be more specifically oriented on some aspects such as erosion or agriculture. More information from each lake is necessary to precise the needs in this theme. The above list is only preliminary

PARAMETERS OF THE MULTI-LAKES MONITORING

SOCIO-ECONOMIC INDICATORS

Various socio-economic indicator will be gathered from the national institution in charge of collecting this information. It is important for managers to be informed of the changes of **population density**, **number of fishermen** in relation with different type of **fishing and human activities** related to the lakes.

MONITORING SITES

Because of the North-South orientation of most lakes and the important impact of trade winds (SE and NE) on lake hydrodynamics it is advised to monitor at least two sites in each lake (if possible: northern and southern ends). Additional main monitoring sites are advised according to lake size (Total: 2 to 4 sites per lake).

DATABASE

A common platform/database will be accessible for all partners. It will allow partner to upload information and also retrieve information. Uploaded information will be checked for quality before being fully integrated into the database. A priority of publication will be insured during 3 years for the teams that produce data. Direct information will be insured for the partners of the network. Other institutions, researchers and general public will have some access to information according to modalities that will be discussed with partners.

Beside the multi-lake monitoring database, other databases such a contacts names of the network researchers, possibilities of training, groups interested in developing short term projects on some topics, historical data and bibliographic references could be developed.

AGL ADVISORY GROUPS

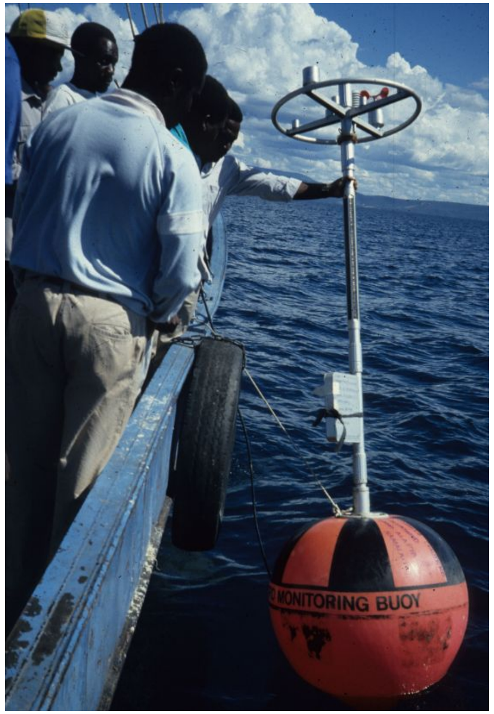
The African Great Lakes Advisory Groups are groups of experts knowing well each lake and their various issues. They exchange information on their lake to increase the collaboration for research and management. Experts in those groups could be involved in the long-term monitoring in various way (implementation, training, quality check, data processing and reporting).

Multilakes monitoring

INTERNATIONAL CONSORTIUM

A Great lakes Consortium involving various national, regional and international institutions or individuals could support the long-term monitoring. This could be based on period of 5 or 10 years for institutions and shorter periods for individuals. The interest of setting up such a Consortium is to ensure continuity in partnerships for the long term, even when no short-term projects are in place. Partners and short-term project do change but a consortium (possibly called "Friends of the African Great Lakes”) would be a long-term association in relation with the long-term goal of monitoring. It could be also an important partner for securing other funding (for specific projects and capacity building. ACARE-IISD could initiate contacts for setting up such an international consortium.

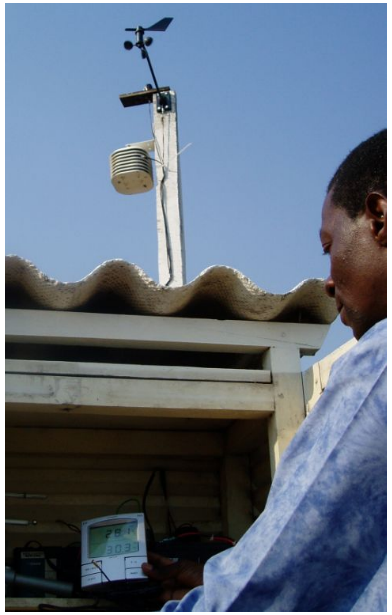
Multi-lakes monitoring of African Great Lakes

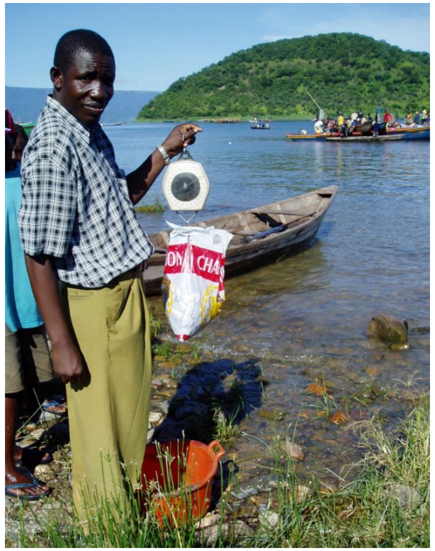


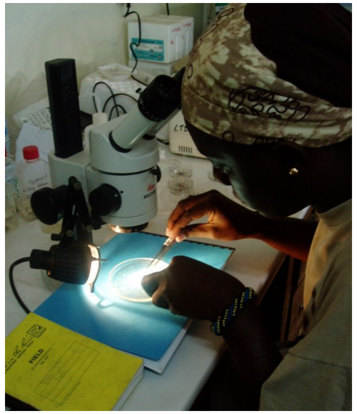












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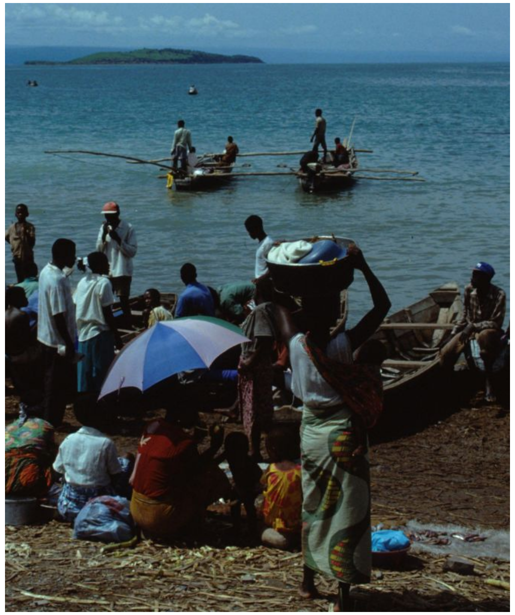


Photo: P.-D. Plisnier