Annex 1

Data Methane gas Kivu

	m3	MW equivalent	KWh	Present price (US$/KWh)	Annual value at present price (milion USD)	Target price in 2011 in US$/KWh	Annual value at target price 2011 (in US$)	Final target price (US$/KWh)	Annual value at final target price (in US$)	Number of years until complete resource consumption	Total discounted value at actual prices discount factor 1 (bilion US$)
Known reserves	6,00E+10										
Exploitable reserves	4,80E+10										
Annual increase / sustainable yield	3,00E+08	120	1051200000	0,22	231	0,11	116	0,05	53	400	23
Initially intended yield	1,00E+09	400	3504000000	0,22	771	0,11	385	0,05	175	69	39
presently intended yield	1,75E+09	700	6132000000	0,22	1.349	0,11	675	0,05	307	33	38

Annex 2

Lake-wide ecological monitoring

1. Expected ecological changes

The restacking of nutrient-rich deepwater within the vertical water column of the lake - as a result of the methane extraction - will drive ecological changes in the biozone in the upcoming decades. Although, according to the MR&, such changes should not become relevant and visible within the next decade, a minimum monitoring of ecological parameters is advised, given the expected nutrient flux changes in the next years as a result of the intense land use. Although the extent of the increase of nutrient concentration is not known, the result is an increased primary production, which may not be utilised by the consumers and merely provide more organic matter to heterotrophic bacteria, promoting oxygen consumption and driving the biozone, or part of it, to anoxic conditions. This disruption of its ecological functioning may lead to harmful consequences for the fisheries, which greatly contribute to the local food. Therefore, we strongly recommend sufficient ecological monitoring of Lake Kivu, based on acquisition of reference data before the pilot plant operation and follow-up of biota and ecological processes after plant start-up.

2. Current ecological knowledge

Reference data are available from studies, which started in 2002 at ISP-Bukavu, in collaboration with the laboratory of Freshwater Ecology, URBO, University of Namur, and from the ECOSYKI project (2004-2009), supported by Belgian cooperation funds and from the Swiss SNF/SDC-supported methane project (with ISP-Bukavu and University of Butare). Involved teams are from University of Butare, Rwanda (present coordination: Dr. L. Nyina-Wamwiza) and from ISP-Bukavu, RDC (coordination: Prof. B. Kaningini and Dr. P. Isumbisho). These data include meteorology, limnology, phytoplankton composition and biomass, zooplankton composition and biomass, and some fisheries statistics, from 2 sites, located in the southern and eastern basins of the lake. In addition nutrient data (phosphorus, nitrogen, silica) are available from tributaries, the biozone, sediment traps (gross sedimentation) and sediment cores (net sedimentation). These data allow establishing a current balance of the fluxes of nutrients and carbon. Most of the data - in addition to the listed publications - will be published in 2008/9.

Current reference publications on the lake ecology (to be completed)

Isumbisho M, Kaningini M, Descy JP, et al. 2004. Seasonal and diel variations in diet of the young stages of the fish Limnothrissa miodon in Lake Kivu, Eastern Africa. JOURNAL OF TROPICAL ECOLOGY 20: 73-83.

Schmid, M., M. Halbwachs, et al. (2005). "Weak mixing in Lake Kivu: new insights indicate increasing risk of uncontrolled gas eruption." Geochemistry, Geophysics, and Geosystems 6(7): Q07009, doi:10.1029/2004GC000892.

Isumbisho, M., Sarmento, H., Kaningini, B., Micha, J.-C., Descy, J.-P. 2006 Zooplankton of Lake Kivu, East Africa, half a century after the Tanganyika sardine introduction. Journal of Plankton Research 28 (11), pp. 971 - 989.

Sarmento H, Isumbisho M, Descy JP2006. Phytoplankton ecology of Lake Kivu (eastern Africa) JOURNAL OF PLANKTON RESEARCH 28 (9): 815 - 829

Sarmento, H., Leitao, M., Stoyneva, M., Compère, P., Couté, A., Isumbisho, M., Descy, J.-P. 2007 Species diversity of pelagic algae in Lake Kivu (East Africa) Cryptogamie, Algologie 28 (3): 246 - 269.

Villanueva, M.C.S., Isumbisho, M., Kaningini, B., Moreau, J., Micha, J.-C. 2007. Modeling trophic interactions in Lake Kivu: What roles do exotics play? Ecological Modelling, DOI: 10.1016/j.ecolmodel.2007.10.047

3. Parameters to be monitored for baseline survey (sites, frequency, parameter)

We recommend a baseline study during the first five years to perform a deep anchor point of the situation before the extraction (see attached Table). Phytoplankton production and sedimentation (system new production) are key parameters to be monitored. The phytoplankton production determines the ecosystem and fishery production, while its sedimentation is the driving force of CH_4 production in deep waters. Because of the low spatial heterogeneity of parameter values in Lake Kivu biozone, we recommend the follow-up along a single station located in the North Basin. We recommend the monthly survey the following parameters:

- continuous monitoring of Chl-a fluorescence and turbidity;
- nutrient concentrations (dissolved and particulate organic carbon, ammonium, nitrates, nitrites, soluble reactive phosphorus, dissolved reactive silica, total nitrogen and total phosphorus) every 10 meters until 60-m depth:
- phytoplankton biomass and composition: samples for HPLC pigment determination should be taken every 10 meters until 40-m depth:
- primary and bacterial productions on an epilimnion pool;
- organic matter sedimentation: a sediment trap must be located at 100-m depth along the permanent mooring and recovered every month. Particulate C, N and P contents must be estimated in the settled particles.

Fishery qualitative data must be collected from local representative fishermen. Data must include species relative abundances of fish caught, mean lengths and weights. Pelagic fish stocks must be quantified once a year by using hydro-acoustic methods along multiple transects covering the whole lake area. Natural annual variations of meteorological conditions must alter phytoplankton and fish productions. This is the reason why we recommend a 3-year initial study to estimate the amplitude of these annual variations.

Annex 3

Advisory Monitoring Roles, Responsibilities and Powers in relation to Lake Kivu Methane Extraction Transport and Processing

1. **Local Institute**
   - 1.1. Methane harvest planning
     - 1.1.1. master and use the methane tool for concession/extraction planning
     - 1.1.2. formulate the technical specifications for extraction plants for each new concession to be awarded
   - 1.2. Provide assistance to Government bodies
     - 1.2.1. Assist Regulatory bodies regulating gas operations and licensing gas extraction plants
     - 1.2.2. Assist authorities in charge of Environmental Impact Assessment in formulating guidelines / terms of reference for EIA's for extraction plants and gas ducts and in reviewing such EIA's
     - 1.2.3. Inspect and enforce compliant extraction plant construction and functioning in test phase and during operation (powers of Regulatory Bodies to be delegated to Local Institute). Inspections during the operational phase to be made at random and unexpected with a minimal frequency of twice a year
     - 1.2.4. Assist the authorities in defining the technical requirements for extraction plants of consecutive new concessions (results of planning tool use)
   - 1.3. Monitoring
     - 1.3.1. Carry out the near-plant monitoring program (see annex)
     - 1.3.2. Carry out lake-wide monitoring program (see annex)
   - 1.4. Assuring public safety
     - 1.4.1. Accidents and hazard for public safety, health and the environment
       - 1.4.1.1. Close down extraction plant operations in case of accidents and in case the Institute considers the extraction plant a hazard to public safety and/or health and/or the environment
       - 1.4.1.2. Conduct inquiries and establish reports on accidents and hazards
       - 1.4.1.3. Authorize restart of extraction plant operation if the Institute considers operation justified
     - 1.4.2. Run the early warning system on gas disasters
       - 1.4.2.1. Regularly test the early warning system
       - 1.4.2.2. Coordinate training of the emergency services on contingency plan execution
       - 1.4.2.3. Coordinate contingency-plan testing (evacuation plans population)
     - 1.4.3. Order and initiate execution of contingency plan (evacuation population)
   - 1.5. Administrate, communicate and report
     - 1.5.1. Set up a database of monitoring and inspection data and on lake status (archives)
     - 1.5.2. Develop Data and Information Communication Web Site on Methane Extraction monitoring and inspection and on Lake Status of Lake Kivu
     - 1.5.3. Document and (publicly, web-site) report on incidents and accidents
     - 1.5.4. Provide secretarial and management functions to the Expert Advisory Group

1.5.5. Chair, inform and consult the Expert Advisory Group
1.5.6. Relate with science and facilitate research and training

- The Local Institute to be in accordance with bilaterally agreed set-up
- The Local Institute to be composed of
  - Technical and scientific coordinator
    Communication, reporting, organization;
    Technical control of the plants, concessions, Requirements and Guidelines
    Cooperation with RURA
    Cooperation with expert group
  - Technical Logistics and infrastructure
    Boat maintenance and driving;
    Logistics: including maintenance and repair house; car maintenance, etc
  - Field technician
    Data collection in the field and
    Sample preparation
    Preparation of equipment and filed installations (such as moorings).
  - Laboratory technician for chemical analysis
  - Laboratory technician for biological analysis
  - Scientist or technician for IT and data
    Data analyses, presentation and storage
    Maintenance of computer and software
    Scientific collaboration
    Support for reporting
- The Local Institute to be legally established
- The Local Institute to legally be given the powers to:
  1. inspect the extraction plants and gas ducts to the shore;
  2. enforce compliant design, construction, functioning and decommissioning of the extraction plants and gas ducts to the shore (this power is to include the power to order closing-down and restart of operation of installations)
  3. require, receive, process and comment on on-plant monitoring information, either on-line or periodically
  4. implement the near plant monitoring program
  5. implement the whole-lake monitoring plant
  6. take any decision necessary to guarantee public safety (this power includes the power to start implementation of contingency and evacuation plans)
  7. publish monitoring and inspection data and their interpretation by the Local Institute
  8. call upon external expertise when judged necessary

2. Expert Advisory Group

2.1. Technical monitoring

2.1.1. advice on a set of standard operating conditions (already done)
2.1.2. advice on the monitoring protocol for extraction plants
2.1.3. advice on the government monitoring program
2.1.4. review the effectiveness of the monitoring program and the Local Institute and advice on improvements
2.1.5. review the effectiveness of the inspection an enforcement mechanisms and advice on improvements
2.1.6. review the impact of methane harvesting on the lake

2.2. Monitoring the adequacy of the harvest planning
   2.2.1. review the use of the planning and its results
   2.2.2. advice on updating the planning model according to new insights
   2.2.3. advice on updating the planning model on the basis of new lake data
2.3. Other monitoring functions
   2.3.1. advice on review of the basic principles, mandatory requirements and guidelines for extraction plants
   2.3.2. on an ad-hoc basis, the Local Institute may ask advice of (selected members of) the Expert Advisory Group to provide advise for a specific issue
   2.3.3. assure the input of international scientific networks in Lake Kivu monitoring by establishing the necessary links with these networks

- The Expert Advisory group to be composed of independent experts (not related to any commercial interest in Kivu Methane harvesting)
- The Expert Advisory group to function on the basis of a contract with the Local Institute, spelling out confidentiality regulations, publication rights and copyrights
- The Expert Advisory group to be composed of international experts in the field of physics/geochemistry, geochemistry/plankton, plankton/fisheries, safety issues (specific on gases) and on volcanology
- The Local Institute Coordinator to function as resource person for the Expert Advisory group. RURA and REMA representatives to function as resource persons on demand.
- The Expert Advisory Group to convene once a year (when results of the yearly monitoring campaign are available) and any moment, the coordinator of the Local Institute judges it opportune. If relevant, meetings with operators or other stakeholders
- The expert advisory group to function on basis of international consultancy conditions.

3. Developers

3.1. Monitor compliance of design, construction and testing of installations
3.2. Monitor functioning of extraction plants, gas ducts and on-shore gas processing installations according to the mandatory monitoring protocol
3.3. Provide monitoring data to the Local Institute as required per the Operating License and the mandatory monitoring protocol
3.4. Provide additional monitoring data as requested by the Local Institute within the timeframe indicated by the Local Institute
3.5. Provide unrestricted access to gas extraction plants and on-shore installations in any stage of their development and provide assistance to Local Institute staff members or their delegated representatives for monitoring and inspection purposes.

4. RURA

4.1. Regulate gas extraction plants and gas ducts;
4.2. License gas extraction plants and gas ducts;
4.3. Pursue delegation to the Local Institute its powers to monitor, inspect and enforce Lake Kivu gas operation licenses (extraction plants and gas ducts)

4.4. Perform all other monitoring, inspection and enforcement tasks under its mandate.

5. <u>REMA</u>

5.1. Review the ToRs for EIA reports and the EIA reports for gas extraction plants and gas ducts.

5.2. Delegate its powers to perform environmental monitoring, inspection and enforcement of Lake Kivu gas extraction plants and gas ducts to the Local Institute

Annex 4
Advisory cumulative action plan

Ref.	Component of the strategies	Action	Who	With whom	When	Costs	Indicators
1.	Finalizing the Basic Principles, Mandatory Requirements and Guidelines for Concessioning, Design and Operation of Gas Extraction Plants						
1.1.		check points to be settled amongs scientists	Johny Wuest		16 january 2008		
1.2.		Settle the points with question marks	John Boyle		February 2008		
1.3.		Complete the reviewers list (Congolese authorities)	John Boyle		February 2008		
1.4.		Organise and implement peer review	John Boyle		February 2008		
1.5.		Include reviewers comments and finalize document as advisory document to respective governments	John Boyle	peer reviewers	March 2008		
1.6		Validate and communicate the document in a workshop	RURA	UPEGAZ	March 2008		
2.	Commission, execute and validate a consultant study on: a) describing the development of the most credible major disaster b) contingency planning for such a disaster (including location specific evacuation planning) c) training programs for implementation of evacuation plans						
2.1.		Develop ToR for consultant study	Task Force		March 2008		
2.2.		Launch tender procedure	Task Force		March 2008		
2.3.		Select and contract the consultant	Task Force		April 2008		
2.4.		Validate and approve the study	Task Force		April 2008		
2.5.		Formally attribute resonsibilities for evacuation	MININFRA		April 2008		
3.	Establish a mandatory monitoring protocol for extraction plants						
3.1.		Develop the protocol	Task Force		done		
3.2.		Validate the protocol by submitting it to ????? for review	Task Force		February 2008		
3.3.		Finalize the protocol by processing reviewers comments	Task Force	NCEA	March 2008		
3.4.		attach the protocol to the Basic Principles etc. document	Task Force		March 2008		
4.	Legally enact the Basic Principles, Mandatory Requirements and Guidelines for Concessioning, Design and Operation of Gas Extraction Plants				April 2008		

4.1.		Translate the Basic Principles etc.document into legaly binding guidelines in Rwanda and DRC	Governments of Rwanda and DRC (Regulating Agencies)		Mai 2008		
4.2.		Publish the Basic Principles etc. in Rwanda and DRC	Governments of Rwanda and DRC (Regulating Agencies)		Mai 2008		
5.	Assuring that KP1 complies with Rwanda legislation						
5.1.		Review and approve KP1 EIA report	REMA		April 2008		
5.2.		Identify an institution or company that has the competence to do an independent third party safety assessment (suggested team: Gas installations construction engineer, risk assessment specialist and lake physicist)	RURA	MINIFRA	February 2008		
5.3.		develop ToR for third party independent safety assessment	RURA	MINIFRA and NCEA	February 2008		
5.4.		do the third party independent safety assessment	selected assessor team		March 2008		
5.5.		publish assessors team report	RURA		April 2008		
5.6.		act according to findings and recommendations of assessors team	MININFRA	RURA	April - Mai 2008		
4.7		License KP1 (including formulation of license conditions)	RURA	NCEA?	June 2008		
6.	Establish the monitoring requirements for govenment on lake status						
6.1.		Formulate the near-plant and the whole lake monitoring program (including biological monitoring)	Task Force	NCEA	done		
6.2.		organise and implement peer-review of the near-plant and the whole lake monitoring programs	Task Force	peer reviewers via John boyle	February 2008		
6.3.		Finalize the near-plant and whole lake monitoring programs by processing the reviewers comments	Task Force	NCEA	June 2008		
7.	Provide for an operational intermediate monitoring function for near-plant monitoring						
7.1.		develop ToR for a monitoring consultant	Task Force	NCEA	February 2008		
7.2.		Identify institutions or companies that have the competence to fulfill the ToR	Task Force	NCEA	February 2008		
7.3.		launch the tender	Task Force		March 2008		
7.4.		select and hire the consultant (for 6 months)	Task Force		Mai 2008		
7.5.		design/specify the transitional Local Institute housing and other facilities (Cap Rubona)	Task Force	NCEA?	February 2008		
7.6.		construct the transitional Local Institute according to design	Task Force		March - Mai 2008		
7.7.		decide specifications for lab, boat and CTD	Task Force	NCEA	March 2008		

7.8.		Hire boat as per 1 June 2008(+ captain and maintenance staff) and lease CTD	Task Force		March 2008		
7.9.		Allow for consultant to hire temporary 1 auxiliairy staff	Task Force		June 2008		
7.10.		Test-run monitoring station	Consultant		June 2008		
7.11.		Operate monitoring station	Consultant		As of KP1 functioning		
8.	Implement training program for evacuation plans						
8.1		Develop ToR for training consultant	Task Force				
8.2.		Contract training consultant	Task Force				
8.3.		Train responsible agencies	consultant				
8.4.		Plan evacuation rehearsals	consultant				
9.	Commission, execute and validate consultant study on early warning system on lake eruption						
9.1.		Develop ToR for consultant study	Task Force		April 2008		
9.2.		Launch tender procedure	Task Force		April 2008		
9.3.		Select and contract the consultant	Task Force		Mai 2008		
9.4.		Validate and approve the study	Task Force		June 2008		
9.5		Formally attribute resonsibilities for early warning	MININFRA		June 2008		
10.	Establish the early warning system						
10.1		Develop ToR for contract	resp. agency				
10.2.		Launch tender procedure	resp. agency				
10.3.		Select and contract the company establishing the system	resp. agency				
10.4.		Establish the system	company				
10.5.		Test-run and accept the system	resp. agency		July 2008????		
11.	Establish, equip and train the Local Institute						
11.1.		Develop ToR for Local Institute	Task Force				
11.2.		Define institutional setting for Local Institute	MININFRA				
11.3.		Draft law or bilateral agreement on the establishment of the Local Institute	MININFRA				
11.4.		Define requirments for Local Institute Home Base	Task Force				
11.5.		Study, propose and decide on location for establishment of Local Institute home base	Task Force				
11.6.		Design Local Institute Home Base	Task Force				
11.7.		Physically establish Local Institute Home Base	Task Force				
11.8.		Hire long term (3 years) coordinator	Task Force				
11.9.		Hire additional staff	Task Force				
11.10.		Train and phase in staff:					
		1. training 'On the job'	Coordinator	AEWAG????			
		2. supervision	KIST/Butare University/Bukavu University				
		3. Outside country training	AEWAG????				
12.	Establish the Expert Advisory Group						

		Develop ToR for EAG (composition, tasks, working routines)	Task Force				
		Develop contract for individual EAG-members	Task Force				
		Identification of potential EAG-members	Task Force				
		realisation of EAG	Task Force				
		Launch EAG					
13.	Review, peer-review, finalize, validate and enact the gas law						
			MININFRA	RURA?			
			MININFRA				
			MININFRA				
			MININFRA				
14.	Build capacity on regulating, monitoring and inspecting gas operations in RURA						
15.	Build capacity in KIST/Butare Univ./Bukavu University on gas operations in general, on research on lake limnology and Kivu methane reserves and on methane exploitation activities in Kivu.						
16.	Build laboratory capacity in KIST/Butare Univ. and Bukavu Univ.						
17.	Implement the biological base-line study		Local Institute				
18.	Implement biological monitoring						
			Local Institute				

Annex 5

Provisional Investment Budget

		Euros	Euros	Euros
1	**Investments**	**1.125.400**		
1.1	*Housing*		**300.000**	
1.1.1.	6 room (8 desks) office with conference room			
1.1.2.	10 m2 laboratory			
1.1.3.	storage room 10 m2			
1.1.4.	staging area			
1.1.4.	Boat House			
1.1.5.	Fuel storage			
1.1.6.	Car			
1.2.	*Equipment*		**825.400**	
1.2.1.	boat for sampling/CTD carrier			400.000
1.2.2.	Zodiac			5.000
	2 Niskin bottles			3.000
1.2.3.	CTD			60.000
	Air and water temperature sensors			
1.2.4	Wind sensors (2)			10.000
1.2.5	Analytical Analysis Investment			250.000
	Gas chromatograph			
	Photometer			
	Analysis balance			
	General Laboratory infrastructure (Pipettes, Burettes, Chemicals)			
	Filtration unit with pump			
	Oven (filter heating/drying)			
	Winkler Titration			
	Titrimate (Metrohm)			
	Microwave and Steam pot for digestion			

	Unforeseen equipment		20.000		
1.2.6.	laptop computers (2)		3.000		
1.2.8.	server computer (2)		3.000		
	network equipment (wireless router etc)		500		
1.2.9.	printers (3)		1.000		
1.2.10.	scanner/photocopier		1.500		
1.2.11.	desktop computers (8)		8.000		
1.2.12.	Computer software		8.000		
1.2.13.	laboratory furniture		50.000		
1.2.14.	desks (8)				
1.2.15.	conference table and 10 chairs				
1.2.16.	cupboards (4)				
1.2.17.	telephones		400		
1.2.18.	redundancy communication system (satellite system) (Thuraya, ASCOM)		500		
1.2.19.	generator (for ship and as back-up)		1.500		
2,	**Capacity development**	**38.500**			
2.1.	coordinator				on the job (see external expertise)
2.2.	scientist/technician		21.000	6	months
2.3.	lab technicians (2)		14.000	4	months
2.4.	field technician		3.500	1	months
2.5	driver/boat driver/handyman/maintainer				
3,	**external expertise (build-up phase)**	**980.000**			
3,1	coaches/trainers		900.000	36	months
3,2	bridge-over monitoring expert (hire for KP1)		80.000	6	months

Provisional Operational Budget

		Euros	Euros	Euros	
4.	**Running costs / revenues**	**519.250**			
4.1.	Office		**219.000**		
	Salaries			200.000	
4.1.1.	materials			2.000	
4.1.2.	communications (Internet, telephone)			1.000	
4.1.3.	electricity, water			1.000	
4.1.4.	fuels			3.000	
4.1.5.	car maintenance costs			2.000	
4.1.6.	Publications; information			10.000	
4.2.	Boat		**65.000**		
4.2.1.	fuels, oils and fats			10.000	
4.2.2.	regular maintenance costs			25.000	
4.2.3.	temporary boat hire (first 6 months)			30.000	
4.3.	Laboratory		**110.000**		
4.3.1.	Repair and maintenance			70.000	
4.3.2.	Chemicals for analysis			10.000	
4.3.3.	outsourced (external) analysis			20.000	(needs more thought)
4.3.4.	Unforeseen equipment			10.000	
4.4.	external advisory board		**125.250**		2 nationals + 5 expats meeting 3 days per year (tickets, DSA, Fees) (check is redesigned)

ANNEX 6. : Advisory Monitoring Programs

Mandatory protocol for on-plant inspection

Action		Periodicity	Location(s)	Method	Parameter	Parameter	Parameter	Parameter	Parameter
1	**Safety inspections**	continuous during testing; 2/yr under operation	entire plant	????	details spelled ot in licensing	specifically the valves to stop flow immediately			

Mandatory protocol for on-plant monitoring

Action		Periodicity	Location(s)	Method	Parameter	Parameter	Parameter	Parameter	Parameter
1	**Continuous measurements**	continuous data transmission	on-plant	electronic sensor	Wind speed and direction	Air temperature	water surface temperature		
2	**Continuous measurements**	continuous data transmission	intake pipe	electronic sensor	salinity	temperature	water flow		
3	**Continuous measurements**	continuous data transmission	reject water pipe	electronic sensor	salinity	temperature	water flow		
4	**Continuous measurements**	continuous data transmission	washing water discharge pipe	electronic sensor	salinity	temperature	water flow		
5	**Continuous measurements**	continuous data transmission	CO2 on plant (safety)	sensor	CO2				
6	**Gas measurements**	monthly reporting	on-plant	Gas budget (including venting)	CO2	CH4	(H2S test phase only)		
7	**Water sampling for cross-calibration**	1 per week	all three pipes (see above)	water sample	all CTD parameters	optional: gases	optional: nutrients	optional: other properties (deep on needs)	

8	**Check restratification depth (see details in prescription)**	continuous	data analysis laboratory	data analysis	salinity	temperature			

Near-plant monitoring

Action		Periodicity	location(s)	Method	parameter	parameter	parameter	parameter	parameter
1	**Measurements by CTD**	monthly (initial phase: parallel to tests and later in start-up phase: weekly)	near-plants in circles and transects	CTD profiles from ship (Yo-Yo style)	salinity	temperature	oxygen	particles	pH
2	**Water samples for calibration**	one per day in the field	near-plant	Niskin bottles on rope			oxygen (calibration)	particles (calibration)	pH (calibration)
3	**Check restratification depth (see details in prescription)**	continuous during test phase; 1 per months under operation	data analysis laboratory	data analysis	all CTD parameters				

Whole-lake monitoring

Action		Periodicity	location(s)	Method	parameter	parameter	parameter	parameter	parameter
1	**CTD parameters**	annual	Centre of the lake (min); optional: transect 4 stations	CTD from boat	salinity	temperature	oxygen	particles	pH
2	**Water samples for calibration**	annual	Centre of the lake	Niskin bottles on rope			oxygen (calibration)	particles (calibration)	pH (calibration)
3	**Water sampling and analysis of nutrients**	annual	Centre of the lake; laboratory	Niskin bottles on rope	Nitrogen (NO2, NO3, NH4)	Silica	Phosphorus (P-tot; SRP; P-part)	alkalinity	Ph

4	**Sampling for gases in Kivu**	annual	Centre of the lake	to be developed	CO2	CH4	H2S		
5	**Analysis of gas samples**	annual	Int. reputed laboratory		CO2	CH4	H2S		
6	**Sampling for CO2 in Kabuno Bay**	annual	deepest location	to be developed	CO2				
7	**analysis of samples**	annual	laboratory	from alkalinity (conductivity) and pH	CO2				
8	**Check for rate of changes of stratification; CH4; layering**	annual	data analysis laboratory	data analysis	all CTD parameters	all gases			

Biological monitoring whole-lake in case nutrient fluxes increase with 15% (not expected before 2020)
(program will be establish based on baseline results)

Action		Periodicity	location(s)	Method	parameter	parameter	parameter	parameter	parameter
1	**measurement of primary production related parameters**	continuously	open water	to be determined	Phytoplankton	Zooplankton			
2	**Monitoring of fish catches and stocks**	continuously	to be determined	acoustic survey; statistics	Limnothrissa miodon	seasonal distribution patterns			
3	**Intra and inter-specific relationships amongst species; data analysis**	annual reporting							

Calibration procedure

Action		Periodicity	location(s)	Method	parameter	parameter	parameter	parameter	parameter
1	**Calibration in-situ sampling**	1x per field day	representative profile (on choice)	sampling from bottles (crane from boat)			Oxygen (Winkler)	particles (filter weighing)	pH (with calibration solution)
2	**Laboratory calibration**	once every 1 - 2 years	laboratory	laboratory calibration	salinity	temperature			

Biological baseline monitoring (to be carried out within the next 10 years) **(not expected before 2020)**

Action		Periodicity	location(s)	Method	parameter	parameter	parameter	parameter	parameter
1	**Primary production; plankton composition; fish composition; plankton-fish interaction**	to be scientifically evaluated			Phytoplankton	Zooplankton	fish		