Advice of the Secretariat

To	Minister of State in charge of Energy, Mr. Albert Butare
Attn	Ms Augusta Umutoni
From	Mr Reinoud Post (The Netherlands Commission for Environmental Assessment)
Date	19 February 2008
Subject	Advise of the secretariat By: Johny Wüest (Expert on Lake Stratification) and Reinoud Post on behalf of the Secretariat of the Netherlands Commission for Environmental Assessment Advice 2008-001

Monitoring Strategy and Monitoring Action Plan for Lake Kivu Gas Extraction

1. INTRODUCTION

Construction of the KP1 methane extraction pilot station reaches completion and the Rwandan Ministry of Infrastructure anticipates operation of that station under the ministries responsibility in the month of April 2008.

Following-up on the March 2007 workshop on Kivu methane extraction monitoring, progress on establishing and instructing the structures for monitoring has been relatively slow. As operation of the first pilot plan is now imminent, the Ministry of Infrastructure is developing a monitoring strategy and a clear and fundable monitoring action plan. A source of funding for implementation of this plan is available through the World Bank.

2. THE REQUEST

Being in the stage of establishing a clear action plan (ready for funding) for the coming years, the Ministry of Infrastructure of Rwanda requested the NCEA to assist in formulating this action plan, that would have the following aspects:

- technical
- institutional
- financial
- timeframe
- roles/responsibilities.

Specifically, the ministry requested the NCEA to provide expertise to formulate the plan and to do the plan editing.

3. NCEA ASSISTANCE

The NCEA has responded positively to this request and composed a team of a technical secretary and an expert on lake stratification.

The publication of this Advice of the Secretariat is the material result of NCEAs response to the request.

4. CURRENT SITUATION AND GENERAL ADVICE

4.1 Current situation

4.1.1 Ongoing work

The following relevant work is ongoing:

- AEWAG, Switzerland and the university of Namur, Belgium are carrying out baseline surveys on lake Kivu (lake stratification and carbon fluxes). As a result of this work, no specific additional baseline survey is needed. Publication of the results of this work is foreseen for April 2008.
- AEWAG is developing a Methane Extraction planning tool. This tool will be available in April 2008 and will provide input data for providing each incremental methane extraction concession/ plant operation license.
- Work on the "Basic Principles, Mandatory Requirements and Guidelines etc."-document.

4.1.2 Decision making

For various reasons there is a very strong sense of urgency to start operating the first pilot plant for gas extraction.

There are, however, factors that call for caution in starting extraction activities with the pilot plant:

- As the Basic Principles, Mandatory requirements and Guidelines for the Concessioning, Design and Operation of Gas Extraction Plants are not yet complete, the knowledge base for licensing of the plant is incomplete.
- Without license the pilot plant seems to lack a legal base for functioning.
- Rwandan law requires that an EIA be done for the pilot plant and approved by REMA. However, an approved EIA for the extraction plant is currently not available.
- More importantly, the NCEA team has not been able to verify the safety aspects of the KP1 pilot plant design, operational routines and control systems, as such information was not available at the Ministry of infrastructure. A foreseen third party safety assessment for the KP1 pilot plant had not yet been commissioned.

4.2 General points of advice

4.2.1 Permitting start of extraction operations

On the scale foreseen for the KP1 pilot plant, gas extraction from lake Kivu is a new venture. The NCEA assumes that accidents with pilot plants are going to happen.

Although it is not likely that such accidents can trigger a major gas eruption, it is neither excluded that they will. The risk is for the authority that gives the KP1 plant the permission to start operations. The secretariat of the NCEA recommends that this authority fulfils all safety precautions and all legal requirements before giving such permission.

4.2.2 Establish an authority with adequate powers

The risk of accidents and disaster happening can be reduced by adequate monitoring and enforcement. The impact of disasters can be contained by immediate adequate action.

The NCEA has the opinion that the safety issues related to the presence of the gases and the risk and hazards related to the harvesting of methane warrant the permanent vigilance of an authority vested with such power and means that it can instantaneously take any measure or intervene in any way to avert risks and hazards. The fact that the lake is owned by two countries must not in any sense hamper the creation and functioning of such an authority[1].
In order to be able to perform adequately, this authority must have direct and immediate access to adequate and up-to-date information on safety-related issues. An important part of this information must be generated by monitoring.

The secretariat of the NCEA recommends that this authority be established as soon as possible. In the following pages, the NCEA secretariat refers to this authority as the 'Local Institute' (LI).

4.2.3 Speed of harvesting the Methane

Preliminary economic analysis of the methane reserves (see Annex 1, results to be confirmed) makes clear that at a discounting factor of 1, it is more profitable to harvest the methane reserves at high rates than at low rates. The current discount factor in Rwanda is higher than 10. From an economic view, rapid harvesting of the methane reserves seems economically most profitable.
As rapid harvesting of the reserves may affect the biozone of Lake Kivu through influx of nutrients, the secretariat of the NCEA recommends to let the speed of nutrient influx determine the maximum acceptable speed of methane harvesting.

5. GENERALITIES ON KIVU GAS EXTRACTION MONITORING

5.1 The goal of monitoring

The goals of monitoring can be summarised as follows[2]:

- assure the safety of personnel and public as well as the environmental safety at the plants;
- assure re-injection of the gas-depleted water (after methane extraction) according to the Mandatory Requirements and Guidelines and periodic adjustment of the re-injection depth range as proposed in the Mandatory Requirements and Guidelines;
- follow the development of lake stratification and ecology, and adjust periodically the re-injection depth range as proposed in the Mandatory Requirements and Guidelines;
- establish the possibility for revising the Mandatory Requirements and Guidelines upon unforeseen developments of the stratification and the lake ecology;
- follow the gas inventory in the lake for management, planning and concession purposes.

[1] Observation 11 of NCEA-advice "Advice on Harvesting the Methane Resource and Monitoring the Stratification of Lake Kivu, Rwanda", 7th of August 2007 / 072-060/ISBN 978-90-421-2182-9

[2] See "Advice on Harvesting the Methane Resource and Monitoring the Stratification of Lake Kivu, Rwanda", 7th of August 2007 / 072-060/ISBN 978-90-421-2182-9

5.2 Current and future potential of the monitoring – a vision

Currently there are not enough specialized personnel available in both riparian countries to perform the monitoring without international support[3]. Therefore, the NCEA secretariat advices to build-up an temporary fieldwork and analytical capacity as well as laboratory and boat facilities in such a way that lake monitoring tasks can in the long run be performed by local resources. A positive side effect of the temporary monitoring structure should be the capacity building, so that after three years the LI is fully functional and independent of external support. In addition the LI has the potential for:

- collaboration between Rwanda and DRC on a practical level;
- creating scientific (international) activity with the local universities (in addition to LI), involving local university academics and local training (Environmental Sciences / Engineering students) and feedback on monitoring from international scientists;
- generating revenue by renting the infrastructure and personnel to scientific parties.

5.3 Monitoring approach

5.3.1 Monitoring tasks

The NCEA secretariat advices that monitoring consists of the following four main tasks[4]:

- Inspecting the plant for safety and environment;
- Monitoring the on-plant operation;
- Monitoring the re-injection and re-stratification of the degassed deep water (reject water) as well as the wash-water;
- Monitoring the long-term development of the methane resources, the maintenance of the physio-geochemical stratification (safety) and of the ecological integrity of the lake water body. Kabuno Bay has to be included in the long-term monitoring for reasons of gas accumulation (safety).

5.3.2 Temporal sequence of the monitoring

The NCEA secretariat advices to distinguish three time scales for the build-up of the monitoring structures and the monitoring process per se:

(i) Bridge-over, until the monitoring group is formed and functional (up to 1/2 year)

NCEA advices to immediately hire external capacity on a temporary basis to perform the most urgent monitoring functions at KP1, including on-plant inspection and near-plant CTD work.

(ii) Initial phase (first three years)

1. *capacity building*

During this three-year period, NCEA advices to hire an experienced professional to build up the future monitoring group, to buy the necessary equipment, to train the personnel including the future coordinator. As the methane production will not yet run at full capacity, the work load will is limited during this initial phase, such that resources should be available to build up the facilities and to perform training.

2. *Baseline study on the biozone ecological functioning, including fish management*

The concept of the Mandatory Requirements and Guidelines does not allow taking dilution water from the biozone or water to be rejected into the biozone. Therefore, the authors do not expect any changes to the biozone within the next decade (later on the nutrient fluxes will increase due to the extraction / re-injection of the nutrient-rich deep water). This extraction concept allows performing a biological/ecological/fish monitoring which does not have to be rushed immediately but can be carried out, well-planned within a time scale of several years.

[3] At the moment, the groups at (i) ISP in Bukavu and (ii) the University of Rwanda in Butare are active in Lake Kivu research. Interest has been signalled from (iii) the department of Environmental Engineering at Kigali Institute of Technology and (iv) the GVO in Goma.

[4] See "Advice on Harvesting the Methane Resource and Monitoring the Stratification of Lake Kivu, Rwanda", 7th of August 2007 / 072-060/ISBN 978-90-421-2182-9

(iii) Monitoring parallel to the full-scale methane exploitation (long-term)
The competences and the group composition has already been established and is functioning. The ToR of the different functions need to be established during the build-up phase.

6. MONITORING PARAMETERS, FREQUENCY AND DATA FLOW[5]

According to the NCEA secretariat, the following would need to be done:

a) On-plant
Inspection - In the licensing process, the requirements with regard to design, operation and control and specifically the safety aspects of these need to be detailed. License requirements and conditions need to be inspected.

The operators must c**ontinuously monitoring** the **Water Flow** as well as **Temperature and Salinity** (conductivity) in the intake pipe, in the reject water pipe and in the washing water discharge pipe. One water sample from within these three pipes has to be collected weekly to calibrate and cross-check the online monitoring measurements *(sensor failure; drift, etc)* of the operators[6]. The LI can adjust the parameters (including size and form of the samples) that must be measured in those samples according to the needs and priorities.

Information transfer - The data to be transferred - on-line and continuously - consists of water flow as well as temperature and salinity (conductivity) of the water measured at the following points within the plant system:[7]

- in the intake pipe,
- in the reject water pipe
- in the washing water discharge pipe.

The goal is to detect deviations from the target operation (intake depth; water flow; injection depths of reject (degassed) water and washing water.

The operator must inform the coordinator (and other units according to the licence) immediately if the operation deviates from the licensed scheme or if dangerous conditions develop.

b) Near-plant
During the initial phase - until the full-scale plant is well established - the monitoring around the plant should be tuned to the experimentation program (lasting in total several months) of the plant operation. The monitoring needs to be coordinated with the testing activities. Once the full-scale plant operation is established, the survey around the plant can be reduced to once per month. The survey of the fate of the re-injected and restratifying water can be carried out by a CTD (parameters: temperature, salinity (conductivity), oxygen, particles (transmissivity) and pH). The parameters temperature and salinity need to be calibrated once per 1-2 years. The parameters oxygen, particles and pH need to be calibrated once per day of fieldwork.

The coordinator must inform the operators immediately if the operation deviates from the licensed scheme or if dangerous conditions develop.

[5] For an overview, see Annex 6
[6] The intake pipe, the reject water pipe and the washing water discharge pipe need to have outlets, such that water samples can be taken conveniently. The details of size and the form of the sample will be specified by the Institute and modified according the progress of the analytical capability and the needs of the Institute.
[7] these two parameters need to be measured continuously, as they identify the input depth and the re-stratification of the output depth and the re-stratification depth of the reject water and the scrubbing discharge water

c) lake-wide

The parameters that can be collected with the CTD (temperature, salinity (conductivity), oxygen, particles (transmissivity) and pH), as well as the basic chemical parameters (including the nutrients P, N and Si) should be surveyed at least once per year. The survey should be carried out as a transect of about 4 profiles (covering the entire deep part), including one profile at the deepest location of the lake. These surveys could ideally be done in cooperation with research projects.

The gas profiles should be measured once every 2 to 3 years depending on the rate of extraction.

The routine ecological monitoring will start (within the first decade), after a baseline ecological monitoring has been performed. It comprises parameters related to primary production, plankton and fishes. The details on the lake-wide long term monitoring will be worked out as a result of the baseline ecological monitoring (see below and Annex 2).

d) Baseline ecological monitoring

The geophysical and geochemical properties of the lake stratification will change very slowly and therefore a continuous monitoring in the long-run is more important than a baseline survey (see Annex 2 for available research).

What would be most urgently started is a baseline survey on (i) fishes and (ii) plankton:

(i) Fishes – the fragile diversity of endemic cichlid fish is sensitive to changing nutrient fluxes (see Lake Victoria; see historic disruptions in Lake Kivu during Holocene). Changes in the diversity of these fish can be taken as a sensitive indicator of changes. As only little information is currently available on diversity and distribution of these fishes, a base line study on endemic cichlid diversity and distribution in Lake Kivu is recommended.

(ii) Plankton - we recommend to perform a baseline study during the first few years at on a location in the north basin comprising parameters related to primary production, and phytoplankton and zooplankton composition.

7. INSTITUTIONAL STRUCTURES FOR LICENSING, MONITORING, INSPECTION AND DISASTER PREPAREDNESS AND RESPONSE

7.1 Local Institute

As it cannot be excluded that an accident related to methane extraction triggers a gas eruption, there is a strong necessity that there is an authority that has real-time oversight over every gas extraction activity on the lake and that has the authority to intervene on the plants and to set in motion evacuation and rescue operations without necessity of consulting authorities in distant capitals.

As indicated in its advisory report [8] and reiterated in § 4.2.2 of this advice, NCEA recommends to establish an authority vested with such power and means that it can instantaneously take any measure or intervene in any way to avert risks and hazards. To be able to live-up to its duties, this authority must have real-time insight in monitoring data.

[8] See "Advice on Harvesting the Methane Resource and Monitoring the Stratification of Lake Kivu, Rwanda", 7th of August 2007 / 072-060/ISBN 978-90-421-2182-9

This authority should (i) advice government agencies on planning resource use, concessioning and licensing, (ii) monitor and inspect installations, (iii) carry out near plant and whole lake monitoring, (iv) assure public safety and (v) administrate, communicate and report.

The NCEA-secretariat recommends that the legislator legally establishes the Local Institute. For suggested composition of the LI, its roles, responsibilities, powers and functioning see Annex 3.

7.2 Expert Advisory Group

At the moment there are not enough high-quality scientific personnel available in this domain in the two countries to perform the monitoring without strong international support. In general, the task of the Expert Advisory Group (EAG) should be capacity building and performing the backstopper function. For suggested composition of the EAG and roles, responsibilities, powers and functioning see Annex 3. Support mechanism could be: (i) exchange programs for young scientists with western universities; (ii) local formation by physical, chemical and biological limnologists and (iii) international cooperation research programs on Lake Kivu (and possibly other lakes in the region).

The NCEA secretariat suggests that while composing this group special attention is paid to the constructive an collaborative attitude of its members.

7.3 Developers

The developers should design, and build their extraction plants and gas ducts according to the specifications provided by the Regulatory Agency. They should operate their plants and gas ducts according to the specifications and conditions of the licence and they should monitor operation of their plants and gas ducts according the to proposed monitoring protocol. For details on developers roles and responsibilities related to monitoring see Annex 3.

7.4 RURA

RURA is the agency authorised to regulate technical, economic and legal aspects of the gas sub-sector. The NCEA-secretariat recommends that RURA takes up all its responsibilities as foreseen in the RURA law. As the suggested LI will host all required scientific and technical expertise on methane extraction and lake stability, the secretariat recommends that RURA uses LI-expertise for performing its regulatory functions. For the very same reason, the secretariat recommends that RURA delegates its powers to monitor, inspect and enforce the extraction plant and gas duct licences to the LI. For suggested roles and responsibilities for RURA in relation to regulation, monitoring, inspection and enforcement see Annex 3.

7.5 REMA

REMA is the agency that must approve ToR for EIA-studies for the extraction plants and the EIA-studies themselves. The NCEA-secretariat recommends that REMA takes up all its responsibilities as foreseen in the law. As the suggested LI will host all required scientific and technical expertise on methane extraction and lake stability, the secretariat recommends that REMA uses LI-expertise for performing its functions for ToR and EIA-report approval. For the very same reason, the secretariat recommends that REMA delegates its powers to monitor, inspect and enforce environmental aspects of the plant licences to the LI. For suggested roles and responsibilities for REMA in relation to EIA, environmental monitoring, inspection and enforcement see Annex 3.

8. ADVISORY SHORT TERM ACTION STRATEGY TO ESTABLISH CAPACITIES

If the above is acceptable to all parties involved, the secretariat of the NCEA recommends the following strategy for immediate action:

1. Finalizing the Basic Principles, Mandatory Requirements and Guidelines for the Concessioning, Design and Operation of Gas Extraction Plant document;
2. Commission, execute and validate consultant study on:
    a. describing the development of the most credible major disaster[9],
    b. contingency planning (including location specific evacuation planning)
    c. training programs for implementing contingency plans
3. Establish a compulsory monitoring protocol for extraction plants;
4. Legally enact the basic principles etc. document and the monitoring protocol in Rwanda and (if possible) the DRC;
5. Assuring that KP1 complies with Rwanda legislation
    a. Review and approve EIA report for KP1
    b. Commission, execute and validate an Independent third party assessment of installations (specialist team) and consecutive licensing KP1 (for licensing, assure assistance of a team of specialists)
6. Establish the monitoring requirements for government on lake status;
7. Provide for an operational intermediate monitoring function for near-plant monitoring (hire a specialist consultant for up to 6 months)

Seen the fact that the Ministry for Infrastructure plans to make the first extraction pilot plant operational in April 2008, the time-frame for implementation of the short term action strategy is before July 2008 (for details see advisory monitoring action plan in Annex 4)

9. ADVISORY MID AND LONG TERM STRATEGY AND ACTION PLAN

The action short term action strategy is recommended to be part of a medium and long term action plan:

8. Implement training program for contingency plans;
9. Commission and validate consultant study on establishing early warning system;
10. Establish early warning system;
11. Establish (also legally), equip, train and operate the Local Institute[10].
    a. hiring a coordinator for 3 years
    b. installation of infrastructure and analytical equipment
    c. hiring of additional personnel by the consultant
    d. implementation of a capacity building program
12. Establish (contract) the Expert Advisory Group[11]
13. Review[12], peer review, finalize, validate and enact the gas law
14. Build capacity on regulating, monitoring, and inspecting gas operations in RURA
15. Build capacity in Kigali Institute for Science and Technology (KIST) (or Butare University) and in Bukavu University[13] on:

[9] Although not likely, it cannot be excluded that accidents at (with) the extraction plants (accidents that will certainly take place) trigger a major gas eruption in the lake. According to the NCEA, knowledge on the character and scope of such a disaster and preparedness to cope with it is a 'must'.

[10] For roles, responsibilities and powers, see Advisory Monitoring Roles and responsibilities

[11] See observations in Advisory Monitoring Roles and Responsibilities under Expert Advisory Group

[12] eventually reformulate

e. gas operations in general,
f. research on
    i. lake limnology
    ii. Kivu methane reserves
g. methane exploitation operations in lake Kivu,

16. Build laboratory capacity in KIST (or Butare University) and Bukavu University[14] (for details on lab requirements, see monitoring programs)
17. Within the next 10 years implement the biological baseline study according to the proposed protocol that further must be specified
18. If nutrient fluxes into biozone tend to increase with 15%, identify relevant institution for biological monitoring (plankton and fish stocks) and build capacity on such monitoring. Raise funds, program and apply biological monitoring.

10. BUDGET ESTIMATES

In this chapter, the NCEA-secretariat provides some rough estimates of the necessary funding for the monitoring set-up.

NCEA estimates the investment budget (to be spent in the first 3 years of building the monitoring capacity) to be around 2 million US$.
Annual operating costs would be in the order of 0,5 million US$. This figure does not take into account possible revenues generated by provision of services by the Local Institute (e.g. lab. analyses) to the plant operators.

For more detail on both estimates, see Annex 5

[13] Bukavu university and KIST (or Butare University) to function as scientific back-stoppers for the Local Institute.. Local Institute to offer data and certain facilities to Bukavu and KIST (or Butare University) for training and scientific research.
[14] Laboratories of Bukavu and KIST (or Butare University) to function as reference and back-up laboratories for the lab of the Local Institute and as labs where gas analyses can be done.