Netherlands Commission for
Environmental Assessment

Terms of Reference Advice for the Environmental Assessment for the Tullow/Heritage JVP Lake Drilling Project Lake Albert (Uganda)

Memorandum by the NCEA

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TERMS OF REFERENCE ADVICE FOR THE ENVIRONMENTAL ASSESSMENT FOR THE TULLOW/HERITAGE JVP LAKE DRILLING PROJECT

LAKE ALBERT (UGANDA)

1.1 Introduction

On the 6th of February 2009, the National Environment Management Authority (NEMA) of Uganda requested that the Netherlands Commission for Environmental Assessment provide advice on a Terms of Reference (ToR) for a Strategic Environmental Assessment (SEA) that NEMA had recently received. It concerns a SEA for an exploratory oil drilling programme in Lake Albert. The programme is proposed by a joint venture, Tullow/Heritage JVP, who have prepared the ToR for the SEA with the assistance of a Ugandan/Lebanese consultants team.

There is at present no regulatory framework for SEA in Uganda. Tullow/Heritage has suggested an SEA approach because it is proposing a range of activities that would normally require several separate EIAs, each for a separate for permitting procedure. The ToR explains that these activities have now been grouped in a programme, and will be assessed together in the SEA. It also states that the SEA will provide the basis for environmental management plans for the different activities. While there is a reference to SEA is the new National Oil and Gas Policy for Uganda (Ministry of Energy and Mineral Development, 2008), a specific SEA approach for this sector has not yet been developed. NEMA is processing the SEA ToR according to the procedural requirements set for EIA.

The activities that make up the programme of oil drilling that Tullow/Heritage proposes include:

- An exploration drilling campaign (also referred to as a tri-block exploration well programme, or the lake drilling project (LPD) in the ToR), which will include the construction and operation of an offshore drilling rig (barge and support vessels), of a barge/rig assembly base and an operations base, as well as infrastructural measures (road upgrading) to enable transportation to and from these bases.
- The construction and operation of an facility to produce oil and gas, and convert this into electrical power as well as kerosene and diesel, referred to as an Early Production System (EPS).

The proposed programme spans three exploration areas in the Albertine Graben: blocks 1, 2, and 3a, as indicated in the Map of Exploration areas in the
National Oil and Gas Policy for Uganda. These blocks cover the Uganda part of Lake Albert itself, as well as adjacent land. Lake Albert is recognized as sensitive area of international importance, but has no formal protection status as such. As far as NCEA is aware, there is no (joint Uganda/RDC or Ugandan side only) management plan for lake Albert.

The ToR had been reviewed by the Commission's secretariat, with the assistance of an expert in oil drilling impact analysis. The Commission was not able to undertake a site-visit to the location. The advice is based on the ToR document as proposed, not additional background information was available. As a result, the advice is more generic, than it is site-specific.

1.2 Main observations

The ToR is clearly structured and well written. It provides detailed information on the drilling methods and equipment, and sets out the associated impacts. The design of the required on-shore support facilities is clearly set out, with the exception of the EPS facility for processing of the oil, which is not further detailed. The description of the projected area that will be affected by the proposal, and the existing environmental and social conditions in this area is very limited. In particular, the ToR does not give an overview of the current uses of the lake and shore, for such activities as fishing and tourism. A more elabrorate description of current conditions is noted in the ToR as part of the assessment still to come.

The ToR devotes three chapters (4, 5 and 6) to an explanation of the SEA approach for the exploration drilling programme proposed. While these SEA sections are easily read and reflect SEA best practice principles well, they consist mostly of generic SEA 'textbook' text. Occasionally programme specific details have been added to the SEA activities set out, but by and large the SEA approach has not been tailored specifically to the exploration drilling programme proposed. In Addition, although the ToR indicate it to be part and parcel of the Lake Drilling Project (paragraph 3.3.), the ToR does not provide any information and guidelines for the proposed Early Production System (EPS) within the Kaiso-Tonya valley. Seen the further contents of the ToR, the NCEA questions whether the EPS is indeed intended to be part of the Lake Drilling Project.
The ToR has not yet elaborated key SEA elements such as an assessment framework (with objectives, indicators etc, see table 10 of the ToR), delineate the alternatives that will be developed and compared in SEA, or a consultation process that is specific to both the local stakeholders and the procedural requirements. As a result, it is difficult to judge, on the basis of this ToR, what the SEA will be able to deliver.

One reason that the ToR is not able to provide a more specific SEA design is that the formal decision-making framework for which the SEA will de prepared is not clear. The ToR states that the SEA will support decision-making by Tullow/Heritage and other decision-makers, but these decision-makers are not specified, nor are the specific decisions to be made listed. It will be necessary to define this decision-making framework before proceeding. The scope of the assessment, the range of relevant stakeholders as well as the procedural requirements all depend on the level of decision-making that is anticipated.

Main recommendations:

- Clarify in the ToR the decision-framework for the SEA. Which decision-making processes are to be based on the SEA findings, who is responsible for these decisions, and what are the associated procedural requirements?
- Depending on the above, reconsider if SEA is the most suitable approach. If decision-making is limited to a cluster of EIA level permitting decisions, it may be more appropriate to undertake parallel EIA procedures in which several activities are combined, such as the baseline study and consultations. For such an EIA approach, the proposed ToR forms a good first basis that could be further complemented.

- Depending on the above, clarify the scope of the assessment. Subsequently, ensure that all the elements of the proposed programme are described and assessed in equal detail.
- Supplement, the ToR with a description of the environmental and social conditions in the area that will be affected. Alternatively, add specific baseline information requirements for the environmental assessment report.
- Further clarify the consultation process.

In the text below, a more detailed explanation the possible role of SEA in the oil exploration and drilling decision-making is given. In addition, this document sets out detailed advice for separate elements of the ToR.

1.3 When to apply SEA?

SEA is a planning instrument that has been developed to mainstream sustainability concerns into policy and planning decisions. It is intended to support strategic decision-making at the level of policies, programmes and plans, and complements EIA, which is designed to support decision-making at project level.

SEA is applied to the higher, more strategic, decisions in the hierarchy of government decision-making, starting at the level of policies (for example, a national energy strategy) through to plans and programmes (such as a coastal management plan. At these levels decision-making addresses: what development is needed, and where, when and how this development should be realised.

Added value SEA to oil and gas planning

At policy level, SEA can help to reduce risks and ensure preparedness for the consequences of oil and gas development through:

- Identifying environmental and poverty-combating priorities and how these may be influenced by oil and gas development options and alternatives;
- Assessing the country's related institutional and economic capacity to deal with the identified negative consequences of oil and gas development;
- Where systems fail, recommend institutional and governance-strengthening measures.

At plan and program level, SEA can help to take environmentally sound decisions on e.g. which technologies will be used, and capacities and locations
of interventions.

Ideally then, when it comes to permitting individual projects, strategic choices have already been made, and the focus of decision-making and assessment is on how a specific proposal can best be realized in a specific location (EIA). In many SEA systems there is some grey area in between, where it is unclear whether SEA or EIA is a more suitable instrument. Most commonly, this question arises when a cluster of projects, each subject to EIA, is proposed.

In the ToR for the SEA for the Tullow/Heritage oil drilling programme seems to be such a case. Firstly, because the SEA seems to focus on operational alternatives, rather than address strategic level questions such as:

- desirability, extent and location of oil development, given existing vulnerabilities and other interests;
- Comparison of different exploration and exploitation technologies available;
- Infrastructural developments associated with refining and transport;
- The timing and pacing of development;
- Cross boundary co-ordination of oil development.

Secondly, the SEA is initiated by one operator. An assessment of the strategic questions above likely requires a wider debate, and is more suited to a government led planning process, rather than a private initiative.

Examples of SEA applied to oil and gas planning

The Norwegian Barents Sea Integrated Management Plan was prepared with the help of an SEA. The plan addresses "the impacts of fishing, aquaculture, oil operations and shipping. It will attempt to ensure that the accumulated effect on the ecosystem does not exceed the tolerance of the ecosystem, and that the strategic, integrated approach inherent to SEAs is adopted."
http://www.panda.org/what_we_do/where_we_work/caucasus/publications/?18031

In the UK a range of SEAs has been undertaken for separate oil and gas licensing rounds (both exploration and production) as "a means of striking a balance between promoting economic development of the UK's offshore oil and gas resources and effective environmental protection." The SEA supported decision-making on whether or not to offer blocks within each area for licensing, and if so, what kind of temporal and spatial restrictions to impose on the licensing area.
(http://www.offshore-sea.org.uk/site/scripts/documents_info.php?categoryID=39&documentID=5)

- The Commission concludes that the SEA proposed seems essentially misplaced in the decision-making hierarchy. It recommends to separate strategic planning and assessment from the Tullow/Heritage initiative. The Commission recommends that NEMA confer with the Ministry of Energy, and other relevant parties, on a suitable process to address the more strategic decisions to be made.

1.4 What to address in an SEA for oil and gas in Lake Albert

The past discoveries of oil and gas in the Lake Albert region have led to a program of hydrocarbon (HC) development activities and further exploration efforts both on- and offshore Lake Albert (National Oil and Gas Policy for Uganda, Feb. 2008, Min. of Energy and Mineral Development, Ch. 2: p. 3-4). Current reserve estimates range between 300 million barrels of oil estimated (not proven) to be in place (Kaiso-Tonya area) to an extrapolation of 1 billion barrels of potential oil reserves in the total Lake Albert concession area.

The geological conditions for HC accumulations are favorable with good source rock potential, the presence of porous and permeable sandstone reservoirs and adequate claystone seals. Structural traps for the hydrocarbons to migrate to, have been formed prior to maturation and mobilization of the HC whereas stratigraphic traps possibilities in the Half Graben settings are expected to be present as well. All in all, a favorable setting for more discoveries to be made.

In that light, it makes good sense to prepare an inventory for the future exploration activities in the offshore Lake Albert concessions, especially when the inventory is made on a regional scale, covering the majority of current activities and their impacts on the area (water, air, nature, wildlife, society, economy et cetera). In view of the successful exploration campaign onshore, the offshore campaign is likely to result in more discoveries to be made. It is therefore timely to address also the subsequent development (involving more seismic acquisition) and production campaign as well and the decommissioning phase. If still opportune, the NCEA recommends that such an SEA be done for a government plan (e.g. a management plan for Lake Albert; a joint plan of the two concerned governments or a plan for the Uganda share of the lake alone). This plan could harmonize the various interests that are at stake in the lake area (e.g. conservation, tourism, fisheries, oil sector, transport, others).

1.5 Environmental assessment for the Tullow/Heritage Lake Drilling Project

If decision-making is limited to a cluster of EIA level permitting decisions and it is decided that is appropriate to undertake parallel EIA procedures in which several activities are combined (such as the baseline study and consultations), NCEA recommends the following approach.

Activities that are related to the exploration drilling campaign expected to start mid 2010 (ToR, Strategic Environmental Assessment for the Tullow/Heritage JVP, Lake Drilling Project, Jan. 2009, Ch. 3.5) need to be listed, analyzed and described in detail. To arrive at a logical sequence of subsequent activities, it is advised to apply a Factor Train Analysis (´from start to finish´), an example of which is given below.

It is advised to address the following questions at each stage the Factor Train Analysis:
- Why: Is this development really necessary?
- Where: Is there a better or alternative route or location
- When: What is the least vulnerable time in the day, season or year

- How: Are there alternative methods or approaches that offer environmental/social advantages.

Examples of such an approach are reported in the EIA for the Waddenzee in the Netherlands where, in a similar (marine) shallow water environment with very high ecological values, a drilling campaign was planned in the early 90´s (see EIA Waddenzee -1995).

The `Why` question should be answered by the respective authorities and oil companies and should refer to the National Oil and Gas Policy for Uganda (published in February, 2008). This policy states that `The political goal is to use the country´s oil and gas resources to contribute to early achievement of poverty eradication and create lasting value to society`. The oil companies will supply the necessary economic arguments in support of the national policy on poverty eradication.

To use to Waddenzee example further, the key to answer the `Where` question was formed by the subsurface drilling target as mapped from seismic. From the optimum penetration point, a circle was drawn at surface with a radius of 3 to 4 kms from where a well could be spudded at a reasonable deviation angle for an exploration target, to reach the desired point of penetration of the prospect. Within this circle, the environment was analyzed in more detail than the surrounding area and based on a set of criteria (see below) a selection of the least damaging locations was made. The final Best Practicable Environmental Option (BPEO) was chosen on the basis of accessibility for the drilling rig, the tugboats and supply vessels, safety aspects, costs etc. Such exercises sometimes led to the decision to drill deviated wells from land, an alternative that can possibly apply here as well. The choice of the final location was reviewed by an independent panel of experts and all final choices were based on their positive advice.

The ´When` question of the drilling campaign was governed by the presence of migratory birds, their nesting period, the calving period of the seals and the tourist season. For each period the impact of the drilling activities an inventory was made, allowing comparison of the resulting impacts and making the choices often seem obvious.

The answers to the `How` question related to each activity in the Factor Train Analysis, are used to develop alternatives for the execution of the individual activities. In the Waddenzee it was decided to alter Transport routes so as to avoid sandbanks used by seals to rest. Ditch cuttings were taken ashore for disposal, Water Based Muds (WBM) was favoured over operationally more attractive Oil Based Muds (OBM), noise reducing screens were installed, drip/free Jack Up rigs were constructed, flaring was allowed only in daytime so as not to attract birds into the flames at night, green diesel was to be used to reduce air pollution, shallow draft supply vessels were hired, helicopter flights across the vulnerable areas were rerouted and minimized etc etc.

Mapping and GIS usage

Each operational activity will cause an effect on the environment (noise, lighting, presence, vibration) that may vary from negligible to serious. The effects of many of these disturbances will diminish with distance from the source (i.e. the drilling rig or construction yard). This gradient can be expressed in contoured intervals. It has been demonstrated in other EIA studies (Waddenzee EIA,1995, and North Sea Coastal Zone EIA 199?) that at a distance of some 3 km most impacts had diminished to negligible. It is strongly advised to enter all observations in a GIS database and use maps and tables as much as possible.

A second step will be to map the key parameters that characterize the various environments. These can vary from certain fish species that determine the ecological significance of the Lake Albert environment, to aquatic flora and/or wading bird communities. Each of these key parameters will have their specific suite of disturbance criteria. For birds and other wildlife living along the shoreline, this may be noise at a specific decibel level, for fish it may be certain noise and vibration levels, for humans it may be noise, vibration and horizon pollution. Once these key parameters of each environment/ecological niche have been mapped with their corresponding sensitivity levels, the GIS system can easily overlay the disturbance contours of the activities on the drilling rig (or transport routes etc) with the contours of zero disturbance of the key species, to create a tool to help minimize the impact of the drilling activities by choosing the best location within a given area from which the subsurface target can still be reached.

The development of alternatives and impact reducing measures can now to be addressed in such a transparent way that involved parties can understand the decision-making process and feel they can make a contribution to arrive at the desired Best Practicable Environmental Option (BPEO).

Factor Train Analysis

The guidelines here proposed, therefore include these 4 questions for each activity in the Factor Train. The Factor Train subdivides the activities that need to be addressed into obvious sequential phases. Without assuming to be complete the phases could include:

1. Exploration-Appraisal Phase with the following activities
    - Yard and Infrastructure construction,
    - Barge and rig assembly
    - Preparation of drilling locations and access routes
    - Towing of Barges and Rig
    - Drilling activity
        1. discharge of top hole cuttings not addressed as yet
        2. blow-out risk and impact on lake environment (ERP to address this issue and containment measures)
    - Cementing (discharge of excess cement)
    - Testing and Flaring
    - Abandonment or Suspension of the wells
    - Transport to next locations

2. Development Phase with the following activities
    - Seismic acquisition
    - Installation of production platforms
    - Laying of transport pipelines for oil and/or gas
    - Construction of Terminals, oil refineries, power stations onshore
    - Drilling of several production wells
    - Testing and flaring of wells
    - Hook up of pipelines
    - Commissioning
    - Production phase of several years

3. Decommissioning Phase with the following activities
   - Abandonment of production wells
   - Breakdown of terminals, pipelines and production platforms
   - Breakdown of other on-shore infrastructure (e.g. refineries)
   - Transport of same for destruction
   - Destruction of hardware
   - Refurbishment of vacated locations

For each of these activities, one can prepare an inventory of the impact on the environment. The impact on the environment should be described as much as possible in measurable units (decibels, volumes, duration (hrs-days-months-years)). The respective environment should be characterized by their key parameters and their respective vulnerability for disturbance and/or stress as expressed in disturbance contours. Extensive use of maps and tables is recommended.
An example may be wading birds along Lake Albert's shoreline that are disturbed by noise at so many decibels or human presence (progressive reactions may vary from heads up, run, take flight). If considered in a longer time span, these birds may not be present at all in a certain period of the year, or show adaptation behavior. Such an analysis has been worked out in the EIA for the Waddenzee in the Netherlands as described above and could serve as an example for this approach.

Cumulation of effects

As these activities are planned along the length of the Lake Albert shores, the cumulative aspects on the environment should be considered as well. Total volumes of discharged exhaust fumes and ditch cuttings, surplus cement, total duration of light and noise disturbance, horizon pollution (think of tourism), possible obstruction of artisanal fishing and spawning grounds, etc etc.

1.6 Terms of Reference prepared by Tullow/Heritage JVP

Some good descriptions and solutions (best practice) have already been suggested in the Tollow-Heritage ToR for this environmental assessment (Jan. 2009). These comprise amongst others, the use of WBM, the anti/wetting modules on the floaters and anti/pollution barriers on the barges, floating hoses made of flexible double carcass sections with butterfly valves and blind flanges and double closure petal type couplings. Operating procedures for many of these critical activities are planned to be analyzed in local EIA's and be incorporated in the Environmental / and Waste Management Plans.

Additional activities

One item that has not been addressed involves the medical facilities available on site and onshore. Distance, mode of transport in case of emergency, type of medical staff and equipment etc, have not been covered but should at least be addressed in the Emergency Response Plan.

1.7 Overview of the major potential impacts of hydrocarbon exploration and exploitation activities with respect to the bio-physical, social and economic environment

This paragraph provides a generic overview of main issues that the NCEA secretariat thinks Environmental Assessments for oil related projects in Lake Albert should address.

1.7.1 Bio-physical Impacts

Seismic Activities

If seismic surveys are planned, they will need to connect to the existing land surveys and therefore seismic acquisition will cover the shoreline and the lake proper. The seismic survey on the lake will make use of boats. The boat may be towing either one 3-6 km long cable (?) with hydrophones (similar to microphones) in case 2D data are collected or a series of 6-12 cables (?) in case 3D data are collected. The activity includes the use of compressed air which when released sends a signal to the subsurface that is reflected to the hydrophones at intervals dependent on the depth and travel time of the reflector and rock, respectively.

- The presence of the boat during the survey will affect wildlife in the water and along the shore but also concern fishing activities (if relevant) that would be temporarily excluded from a particular area for no more than a few days.

In the shallow near-shore area, the seismic survey will require more time and effort as several techniques will be needed to acquire the data. Shallow draft boats, vibroseis trucks for the beaches and dry sand flats, ocean bottom cables or shallow water passive streamers/cables are all possible techniques to be considered in this respect. The activity will result in some noise and visual disturbance. Their effects may be more significant than in the deeper water environment, although their duration will be short.

- Effects to be considered are for instance disturbance of wildlife (feeding birds, drinking wildlife) and scouring of the surface by the cables or anchors.

Drilling Activities

The drilling activities will follow after the seismic data have been processed and interpreted and a viable prospect has been identified. The type of drilling equipment to be used will depend on the water depth. In shallow waters as is the case in Lake Albert, a barge can be used. In the production phase, the shallow water development may take place from land using a land rig.
All of these types of drilling equipment will only stay in the area for the duration of the drilling period, whether during the Exploration, Appraisal or Production Phase. Drilling of 1 well will take some 30-40 days if all goes well. The impact of the presence of such equipment on the environment is likely to be more intense in the shallow, near shore waters than in the deeper waters. In case the prospect needs to be drilled from an area that is not reachable by boat a channel may need to be dredged. The impact on the environment may be severe. Alternatives involving drifting pontoons that connect the vessel to the barges may have to be developed. Additional effects will comprise noise, lighting, transport movements by supply boats and helicopters, accidental spills of chemicals or diesel, exhaust fumes. A detailed activity train will need to be described of the entire operation detailing their effects, risks and impact

on the environment. Alternatives need to be considered from which a “most environmentally attractive” alternative can be chosen.

- The effects of drilling activities and mitigating measures should be addressed in the respective EIA’s.

Another important aspect of drilling is safety. A detailed safety and evacuation plan will need to be drafted and approved before operations can start. Such a plan will detail all possible contingencies needed in case of personal accidents, environmental damage or failure of the safety equipment on board (blow-out, fire etc). A nearby base for First-Aid Treatment, if not onboard should be considered which can be reached by helicopter in emergencies or by boat in other circumstances. Firefighting equipment will need to be present on board the drilling rig or stand by boat as well as in a nearby harbor. The same is needed to fight possible hydrocarbon spills on the water surface.

- The production EIA should address these risks and their mitigating measures. The relevant drilling permits should require the relevant safety/emergency and evacuation plans to be in place. The Emergency Contingency Plan (ECP) also asks for this.

Testing

The SEA/ EIA should address the Testing Phase. Hydrocarbon discoveries need testing to obtain information on pressure, production rates, producible volumes, composition of the hydrocarbons in order to plan the next Production phase (number of production wells, number of platforms, capacity of installation etc). In the Production phase the producing wells will need to be tested on their performance before they are tied to the transport pipelines. The testing takes some 3-5 days per well. The hydrocarbons produced are burned at location by means of a boom, extending the flare well away from the rig. Care should be taken that no unburned liquids are spilled from the boom into the lake. Visibility of the flare at night may be some km’s. Birds are attracted by the flare during nighttime. This can be serious when birds migrate in large numbers. This may not be the case in this area however.

Mitigating measures (such as bird watcher on board with authority to stop flaring, closed in flares, no flaring at night) can be devised for such circumstances and hazards and should be addressed in respective EIA’s.

Production Phase

Platform and Pipeline Installation

The Production Phase starts with the installation of either a production platform or a subaquaceous completion at the lakebed in the deeper waters. The depth of water and the size of the discovery dictate the choice of completion design.
In the near shore shallow zone development from land needs serious consideration. This onshore option depends on the distance from shore of the discovery, the depth of the reservoir and the character of the structures that need to be drilled through. Recent developments in drilling techniques have enabled gas and oil fields to be developed from distances of over 10 km’s. The evacuation of the hydrocarbons from the onshore production wells is straightforward.. A pipeline will need to be constructed on land to tie in the

well head to the transport pipeline that will take the HC for treatment at a refinery or LNG terminal.
In case development from land is not possible, a small platform needs to be constructed on the lakebed. Various designs (e.g. Vlieland Production Platform in the Waddenzee, northern Netherlands) are possible that minimize visibility. The boxlike structure that is needed will only have a drilling rig over it during the drilling of the production wells (few months), after which the wells are tied in to the transport pipelines. The drilling rig will move off location and may never return. The production platform can be painted in unobtrusive colors, be entirely encased, unmanned and without a flare. The connecting transport pipelines will cross the shoreline and beach and will need to be buried.

- The impact of the trenching, the presence of the pipeline and the design of the platform should all be addressed in this SEA or future production EIA.
- The existing exploration and appraisal wells may be re-used as producing wells. Special equipment is needed to suspend a well temporarily so it can be re-opened and completed as a producing well. The reduction in drilled wells is financially attractive but also has obvious environmental advantages.
- Investigations into the possibilities to convert the exploration and appraisal wells into production wells, thereby reducing costs, risks and impact on the environment significantly, should be carried out. The results of such investigations should be incorporated in the EIA for the production phase.

Operations and maintenance

Once the fields are finally in production, the platforms and wells need to be operated and maintained. In case the operations are by remote control from shore for instance, the platforms will be unmanned. Maintenance activities have to take place however, so transport boats or helicopters will occasionally visit the sites. Their impact is probably minimal. After some years, some wells may show a declining production performance. In such cases a so-called work-over is needed to clean out and repair possible down-hole damage. This work normally takes a few weeks per well.

Subsidence

A potentially serious side effect of production of a subsurface reservoir is the subsidence of the overlying rock formations. The pressure in the reservoir declines during production, causing the sand grains of the sandstone reservoir to compact. This reduction in rock volume is transmitted to the surface by the sagging of the overburden. Some of the subsidence is reduced by the strength of the overlying rock. In some cases (e.g. the Dutch gas fields) subsidence amounts to 30-50 cm in the center of the field once the field has been produced completely. This process of subsidence takes place over the lifetime of the field (some 30 years) and may continue a short time after production and will then stop. The amount of subsidence is dependent on the size of the field, the rate and amount of pressure decline and the thickness and character/strength of the overlying rock formations. The subsidence pattern is more or less concentric following the outline of the field to some extent. The maximum subsidence takes place in the center of the saucer, diminishing towards the margins.

Subsidence in waters of over 50 meters will have no noticeable effect. In the hydro- and morphodynamic, shallow near shore system however, subsidence may have an effect. Much will depend on the rate of deposition and the rate of subsidence. If these are equal no visible effects will occur. If subsidence exceeds the rate of deposition, shoreline morphology may start to change; flats may become less exposed thereby limiting the foraging area for wading birds that seek their nourishments on these flats. Studies should be conducted to unravel the sensitivity of subsidence on the most characteristic parameters of this unique environment.

- It is recommended that the possibility of subsidence is anticipated by requesting the appropriate ministry to conduct (with the operators) a monitoring programme on the amount, extent and rate of subsidence that may take place. Independent experts should be part of the monitoring team. The results of such studies should be published.
- The effects of subsidence will be negligible in Lake Albert waters but may have some effects in the shallow near-shore. The results of the monitoring programme such as rate of subsidence and diameter of the "saucer" may give a good indication of what to expect in the near-shore coastal area. A study of the depositional processes in the coastal zone could be started in parallel with the monitoring.

Decommissioning

Once the fields' performance has declined to uneconomic levels, the operations will stop and the wells will be abandoned some few meters below seabed and the platform will probably be removed as circumstances may prescribe. A new purpose may be found for the structure and be given a new lease of live (radio beacon, lake research station etc). This aspect could also be incorporated in the Production EIA and the report will have covered the entire lifecycle of the project. The danger however is that the EIA will contain technically outdated data and not be a valid tool for decision making at the end of the project (some 30 years from now?).

The above description of the effects were mainly concerned with the bio-physical aspects (i.e. nature). Social and economic effects are summarized below.

1.7.2 Social Effects

The environments in which the activities of the oil company take place are shared by the local population. The presence of seismic vessels and their surveying activities will take place away from population centers and only be of short duration. Negative impacts on fishing grounds are minimal as they will only last for a few days. Along the shores however, the impact may be more severe and will need to be addressed in the respective EIA.

The longer term period of drilling (some 1-2 months per well) may infringe on traditional fishing grounds for some time. It may disturb their habitat by noise and lighting, spills and drill cuttings on the lake floor directly around the well. During testing, the light of the flare at night may have unwanted effects on the behavior of the fish (attracted to light), reducing the volume of fish they normally may expect.
During the longer term production phase (20-30 years) the presence of the platform(s) will infringe on the accessibility of the possible fishing grounds (1 km radius restriction around the platform).

- In view of the size of the lake available to the local fishermen, the impact is probably negligible. However, perceptions may be contrary and a suitable information campaign will take away many of the anxieties that may already exist.

1.7.3 Economic Effects

Economically the exploration and exploitation activities will be mainly neutral to positive. The development of local materiel depots, heliports (?), harbor facilities, centers for firefighting and hazard control, medical assistance etc will benefit local economies, if care is taken to employ (and train) local personnel.
The negative effects of reduced fishing grounds by the presence of a production platform and its exclusion zone is negligible.

The international seismic and drilling crews stay only in the area for the duration of their short term activities (few weeks to months) and will move elsewhere in the world to continue their activities.

If economic effects are meant to be more than financial, which are expected to be considerable if hydrocarbons are found in commercial quantities, care should be taken to train and employ local staff for long term activities that may be developed during the operational phase (some 30 years) of the Production Period.

Another aspect NCEA think Environmental Assessments should for the oil and gas sector should address is the direct and indirect contribution that such project make to poverty alleviation, nationally and locally.

1.7.4 Summary of main issues

The exploration and exploitation activities on Lake Albert pose potential biophysical and socio-economic risks. These are surface water pollution by a blow-out or accidental spills of waste material, drilling fluid and cement remains. Furthermore horizon pollution may take place by the presence of drilling rigs (short duration) or production platforms (30 years ?). Noise and lighting may spoil the characteristic nature values of the Lake as a sanctuary for wildlife above and below lake level. Traffic movements of helicopters (?), trucks and supply boats will affect the area.

Subsidence is a potential risk for the shallow lakeside environment.

Exclusion of the local populations from sharing in the oil and gas sector benefits can pose a serious thread to sector sustainability.

All of these risks should be addressed in the respective EA's. Alternatives from which the "most environmentally attractive" alternative can be chosen, can be developed for many of the activities .

The permitting procedure should assure these potential risks are reduced as reasonably as may be expected according to the most modern techniques used in the oil and gas industry at that time. In case no alternatives are available, mitigating measures should be prescribed in the permits.