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NINA Report

Environmental Monitoring Programme for the Albertine Graben, Uganda

Results from an ecosystem indicator scoping workshop in Kasese, Uganda, April 2011

Jørn Thomassen
Reidar Hindrum

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Lake Albert in Albertine Graben. Photo: Jørn Thomassen.

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Uganda, Rift Valley, Albertine Graben, oil and gas development, scoping, ecosystem indicators, monitoring

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Abstract

Thomassen, J. & Hindrum, R. 2011. Environmental Monitoring Programme for the Albertine Graben, Uganda. Results from an ecosystem indicator scoping workshop in Kasese, Uganda, April 2011. - NINA Report 706. 118 pp.

Uganda plan to start oil and gas exploration and development in the Albertine Graben in the Rift Valley. The area is a global biodiversity hot spot, and the oil and gas development activities can potentially have severe impacts on the ecosystem and the society. As part of management actions in connection with the planned activities, Uganda will establish an environmental monitoring programme in the Albertine Graben covering ecological and societal issues.

Funded by the Norwegian Government under the environment pillar of the Uganda *oil for development program*, a participatory process has been initiated to build up a monitoring program with indicators. One important step in this process was to arrange a scoping workshop attended by various major stakeholders. The workshop was conducted in Kasese, Uganda from 11th to 14th April 2011. The Norwegian Institute for Nature Research (NINA) was contracted by the Directorate for Nature Management, Norway, to facilitate the workshop. The National Environment Management Authority (NEMA) in Uganda is the lead agency in developing and managing the monitoring program, including the process of establishing it.

The main objectives of the Kasese scoping workshop was to identify focused measurable indicators to be used in the environmental monitoring programme for the Albertine Graben. This report summarizes the process at and the results from the Kasese workshop.

Several lectures were given to clarify the oil and gas development plans, the status of the biodiversity and sensitivity in the Albertine Graben and the workshop process (see appendix). The Adaptive Environmental Assessment and Management (AEAM) method was used as a working approach to the scoping. The AEAM is a systematic step by step scoping process where the participants work in groups identifying and prioritizing main focal issues (Valued Ecosystem Components (VECs)), the major associated drivers (impact factors from the oil and gas development), cause–effect charts where VECs and drivers are seen in a context, impact hypotheses, and monitoring recommendations including measurable indicators.

Five major themes were identified prior to the workshop, namely 1. Aquatic ecological issues: 2. Terrestrial ecological issues; 3. Physical/chemical issues; 4. Society issues; and 5. Management and business issues. A total of 42 VECs and 78 drivers were identified, 31 cause – effect charts were constructed and 46 Indicator Fact Sheets were produced at the workshop.

According to the workshop results the ecosystem indicators will be concentrated around wetlands and water, fish, flagship mammals and birds, flagship wetland animal species and flagship floral ecosystem components. Focus was also put on indicators on diversity below ground, physical and chemical indicators on water, air, soil and micro climate. Society indicator recommendations include settlements, food, water and sanitation, health, energy, infrastructure, education, culture and archeological sites. Recommendations concerning management and business issues were given on tourism, fisheries, agriculture and forestry, transport and construction materials.

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Sammendrag

Thomassen, J. & Hindrum, R. 2011. Miljøovervåkingsprogram for Albertine Graben, Uganda. Resultater fra et arbeidsseminar om økosystem indikatorer i Kasese, Uganda, april 2011. - NINA Rapport 706. 118 s.

Uganda planlegger å starte med utvinning av olje og gass i Albertine Graben som ligger i Rift Valley. Området er et globalt "hot spot" når det gjelder biologisk mangfold og olje/gass-utvinning kan potensielt ha store negative effekter på økosystemet og samfunnet. Som en del av områdeforvaltningen vil Uganda etablere et miljøovervåkingsprogram for Albertine Graben som skal dekke økologiske og samfunnsmessige forhold.

Med økonomiske midler fra det norske Olje for utvikling-programmet er det satt i gang en deltakende prosess for å bygge opp overvåkingsprogrammet med indikatorer. Et viktig trinn i denne prosessen var å arrangere et målfokuseringsseminar (scoping) med deltakere fra ulike interessentgrupper. Seminaret ble arrangert i Kasese, Uganda fra 11. til 14. april 2011. Norsk institutt for naturforskning hadde fått i oppdrag fra Direktoratet for naturforvaltning å fasilitere seminaret. National Environment Management Authority (NEMA) i Uganda er ansvarlig for å utvikle og drive overvåkingsprogrammet, inklusive prosessen med å etablere det.

Hovedformålet med seminaret i Kasese var å identifisere fokuserte og målbare miljøindikatorer til bruk i miljøovervåkingsprogrammet for Albertine Graben. Denne rapporten oppsummerer prosess og resultater fra Kasese-seminaret.

Flere foredrag om olje- og gassutvinningsplanene, om biologisk mangfold og sårbarhet i Albertine Graben og om seminarprosessen ble holdt ved starten av seminaret (se vedlegg). Adaptive Environmental Assessment and Management (AEAM)-metoden ble benyttet som arbeidsform på seminaret. AEAM er en systematisk trinn for trinn-prosess hvor deltakerne arbeider i grupper og hvor de skal identifisere hovedkomponenter i overvåkingsprogrammet (verdsatte økosystemkomponenter (VØKer)), de viktigste driverne (påvirkningsfaktorer fra olje- og gass-utviklingsaktivitetene), koble VØK-er og drivere i årsak–virkningskart, formulere påvirkningshypoteser, og foreslå overvåkingaktiviteter inklusive målbare indikatorer.

Fem hovedtema var identifisert i forkant av seminaret: 1. Akvatisk økologiske tema; 2. Terrestrisk økologiske tema; 3. Fysisk/kjemiske tema; 4. Samfunnsmessige tema; og 5. Forvaltning og forretningsmessige tema. Tilsammen ble 42 VØK-er og 78 drivere identifisert, 31 årsak–virkningskart ble laget og 46 indikator-faktaark ble produsert på seminaret.

Resultatene og anbefalingene fra seminaret viser at økosystem indikatorene vil bli konsentrert omkring våtmarker og vann, fisk flaggskip arter hos pattedyr og fugler, våtmarksarter og viktige økologiske vegetasjonstyper. Det ble også fokusert på biologisk mangfold under bakken, fysiske og kjemiske indikatorer i vann, luft, jord og mikroklima. Indikatorer som omfatter samfunnet inkluderer bosetting, mat, vann og hygiene, helse, energi, infrastruktur, utdannelse, kultur og arkeologi. Anbefalinger innenfor næringsliv ble også gitt innenfor turisme, fiskerier, jord- og skogbruk, transport og bygningsmaterialer.

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Contents

List of acronyms

AEAM	Adaptive Environmental Assessment and Management
BGBD	Below Ground Biodiversity
CSO	Civil Society Organisations
DFR	Department of Fisheries Resources
DLGs	District Local Governments
DN	Directorate for Nature Management
DoM	Department of Meteorology
DWRM	Directorate for Water Resources Management
EA	Exploration Area
EIA	Environmental Impact Assessment
GIS	Geographic Information System
GOV	Government
IH	Impact Hypothesis
LC1	Local Council 1
M&E	Monitoring & Evaluation
M&R	Monitoring & Research
MAAIF	Ministry of Agriculture, Animal Industry and Fisheries
MDA	Mission Doctors Association (?)
MEMD	Ministry of Energy and Mineral Development
MFCA	Murchinson Falls Conservation Authority
MFNP	Murchinson Falls National Park
MGLSD	Ministry of Gender, Labour and Social Development
MIST	Management Information System Technology
MoES	Ministry of Education and Sports
MoH	Ministry of Health
MoWT	Ministry of Works and Transport
MTTI	Ministry of Tourism, Trade and Industry
MUIENR	Makerere University, Institute of Environment and Natural Resources
MWE	Ministry of Water and Environment
NaFIRRI	National Fisheries Resources Research Institute
NARL	National Agricultural Research Laboratories
NARO	National Agricultural Research Organization
NEMA	National Environment Management Authority
NFA	National Forestry Authority
NGO	Non Governmental Organisation
NINA	Norwegian Institute for Nature Research
NP	National Park
OSH	Occupational Safety and Health
PA	Protected Area
PEPD	Petroleum Exploration and Production Department
QECA	Queen Elisabeth Conservation Areas
QENP	Queen Elisabeth National Park
QEPA	Queen Elisabeth Protected Area
RBDC	Resource Based District Centre
SEA	Strategic Environmental Assessment
ToR	Terms of Reference

UBoS	Uganda Bureau of Statistics
UBOS-ED	Uganda Bureau of Statistics EdData
UNRA	Uganda National Roads Authority
UWA	Uganda Wildlife Authority
VEC	Valued Ecosystem Component
WCS	Wildlife Conservation Society
WR	Wildlife Reserve
WWF	World Wildlife Fund

Landscape at the shores of Lake Albert in Albertine Graben. Photo: Reidar Hindrum.

Foreword

Uganda has plans for oil and gas development in the Albertine Graben in the Rift Valley in Africa. The National Environment Management Authority (NEMA) in Uganda is responsible for establishing an environmental monitoring system for the Albertine Graben, with clear and agreed indicators. The Norwegian Government under the Environment Pillar of the Uganda Oil for Development Program is assisting NEMA in this process. A scoping workshop was initiated with the aim to make a fundament for this process.

The Environment Pillar program is administrated by the Directorate for Nature Management (DN) in Norway in close cooperation with NEMA. To secure involvement by major stakeholders in the development of the monitoring program a participatory scoping workshop was conducted in Kasese, Uganda from 11th to 14th April 2011. The Norwegian Institute for Nature Research (NINA) was contracted by DN to facilitate the workshop. This report summarizes the process at and the results from the Kasese workshop.

2nd May 2011

Jørn Thomassen (NINA)

1 Part I: Background and challenges

From the foreword in the Environmental Sensitivity Atlas for the Albertine Graben (NEMA 2010):

Oil exploration has been has been ongoing in the Albertine Graben since the 1920's. Currently there is confirmation of commercially viable oil deposits in this area with early production scheduled to begin 2009. Oil spills can have severe and long term ecological and socio-economic adverse impacts if not properly planned for and addressed. While it is not possible to predict the impacts of an oil spill with certainty it is possible to evaluate the vulnerability of an area to a defined spill scenario based on the environmental resources present in the area.

An environmental oil spill sensitivity atlas has been prepared to provide environmental planners with tools to identify resources at risk, establish protection priorities and identify timely appropriate response and clean-up strategies. The atlas enables oil companies and authorities to incorporate environmental consideration into exploration and contingency plans. It also provides an overview of such aspects as the occurrence of biological resources, human resource use (fishing and hunting) and archaeological sites that are particularly sensitive to oil spill. Furthermore it contains information regarding the physical environment, lake shore and bathymetry of Lake Albert and the climate of the area.

The Albertine Graben is known for its high biodiversity spots at the same time it is now an oil rich region. Oil is a non-renewable resource meaning that at one time it will be exhausted. Therefore, care has to be taken to ensure that exploitation of oil resources is done without compromising the quality and quantity of environmental resources. The oil for development strategy should improve services such as conservation of natural resources, infrastructure, energy, education etc.

Following the plans for oil and gas development in the Albertine Graben it is necessary to establish an environmental monitoring program. Funded by the Norwegian Government under the environment pillar of the Uganda oil for development program, a process has been initiated to build up a monitoring program with indicators.

1.1 Workshop objectives

The main objectives of the Kasese scoping workshop was to identify focused measurable indicators to be used in the environmental monitoring programme for the Albertine Graben.

1.2 What is scoping?

Scoping refers to the process of identifying, from a broad range of potential problems, a number of priority issues to be addressed by an EIA (Beanlands 1988).

In connection with the establishment of the environmental monitoring programme for the Albertine Graben in Uganda, scoping refers to the process of identifying a limited number of issues to be addressed in the monitoring programme with the aim to measure (indicators) the existing quality and potential future changes of the environment and the society (ecosystem approach)

The design of a monitoring programme must consider the final use of the data before monitoring starts.

1.3 Indicators

Indicators are purpose dependent which means that they should be used for reporting potential changes in the ecosystem as a consequence of the oil/gas development, and as a basis for decisions on mitigating measures or other management actions. Consequently, it is important to determine the purpose of the indicator and the end users. Successful indicators are actually used to support policy and decision making.

An indicator can provide information on several issues and there are some basic criteria for selecting indicators (box 1).

1. Policy relevance
   - in accordance with policy documents and objectives in Uganda
2. Available and routinely collected data
   - secure regularly update of indicator data which should be simple, but accurate to measure and cover both lower and higher trophic levels
3. Spatial and temporal coverage of data
   - secure that the defined monitoring area will be covered over time and that the indicators are sensitive to ecosystem change caused by natural and anthropogenic drivers
4. Existing monitoring data series should be continued
   - good long term qualitative data series are essential to measure trends, and the value of such datasets only increases over time
5. Representativeness
   - secure that most aspects of the ecosystem are covered, both physical aspects, biological components and the society, and cover common species of public concern (e.g. red listed species) and of importance to local communities
6. Methodologically well founded
   - through a clear description of the methodology to be used when measuring the indicators
7. Understandability
   - secure that the indicators are clearly defined and understood by the stakeholders and end users (i.e. local community, decision makers, global public)
8. Agreed indicators
   - indicators mutually accepted by the stakeholders and end users

Box 1. Basic criteria for selecting indicators (after EEA 2005 and Background paper (NEMA 2011)).

The monitoring programme with its indicators must cover all phases of the oil/gas development and also consider direct, indirect, and cumulative impacts

1. Exploration (potential environmental impacts from exploration activities)
2. Drilling/Development (potential environmental impacts from drilling and oil or gas field development activities)
3. Production (potential environmental impacts from production activities)
4. Decommissioning/Reclamation (potential environmental impacts from decommissioning and reclamation activities)

1.4 Methodological approach - indicator scoping

1.4.1 Oil/gas development description

To make a fundament for the scoping, detailed descriptions of the oil/gas development plans should be given. In the case of oil/gas development in the Albertine Graben, Petroleum Explo-

ration and Production Department (PEPD) gave an overview of existing activities and of future plans at the start of the workshop. The development plans are also described in 2 documents:

- The basin wide development concept for the Albertine Graben for consideration during strategic environment assessment development. Ministry of Energy and Mineral Development, Petroleum Exploration and Production Department (PEPD), (December 2010)
- Background paper for Development of indicators for monitoring environmental changes in the Albertine Graben. Compiled by an editorial group lead by Dr Kitutu K. Mary Goretti, National Environment Management Authority (NEMA), (March 2011).

1.4.2 Baseline studies

Another important basis for the scoping process is to give a status and access of the ecosystem baseline information available. Ecosystem baseline information refers to the background information on the environment and socio-economic setting for a proposed development project. For the Albertine Graben area NEMA has published a Sensitive Atlas covering ecological and societal issues. NEMA presented the Sensitivity Atlas at the start of the workshop:

- Environmental Sensitivity Atlas for the Albertine Graben, second edition (Kitutu 2010)

1.4.3 The Adaptive Environmental Assessment and Management (AEAM)

One major challenge in an M&E programme is to identify a limited number of indicators. This process is called scoping, and will normally include considerations of impact factors and potential impacts, decision makers, stakeholders, alternatives, access of baseline information, time schedule and also economic frames. The scoping phase in an M&E programme (as well as in a Strategic Environmental Assessment for the Albertine Graben and later in exploration area specific Environmental Impact Assessments) is furthermore critical for an optimal use of limited resources in the perspective of personnel, time and economy, and should be accomplished as early as possible in the process.

One approach is to use an adjusted form of the Adaptive Environmental Assessment and Management (AEAM) concept (Holling 1978, Hansson et al. 1990, Indian and Northern Affairs Canada 1992a, 1992b, 1993, Thomassen et al. 1996, 1998, 2003). As an M&E normally shall cover various subjects concerning environment, natural resources and society, different actors and stakeholders will be involved in different phases of the process. Obviously, communication between decision makers, authorities, management, NGOs, public, consultants and scientists should be accomplished in a very early stage in the development of an M&E, with the objective to scope on important issues. AEAM is a participatory process, based on workshops attended by different stakeholder and project holders.

In AEAM the impact predictions and significance includes:

1. The selection and prioritization of a limited number of Valued Ecosystem Components (VECs), which are focal issues potentially affected by the oil/gas development activities;
2. The identification of major drivers (impact factors from the oil/gas development);
3. Assess major linkages between the different VECs and the drivers by constructing cause-effect charts with linkage explanations;
4. Describe potential impacts through impact hypotheses and finally;
5. Give recommendations on further needs for research, investigations and management actions including M&E programme with indicators.

Key statements in every scientific work, as well as in an M&E programme, should be the transparency and possibilities to document and control the process and the choices done. It should be obvious that an open and well-documented process is essential when numerous subjects are rejected as not important enough.

Step 1. Valued Ecosystem Components (VECs)

A *Valued Ecosystem Component* is defined as *a resource or environmental feature that: is important (not only economically) to a local human population, or has a national or international profile, or if altered from its existing status, will be important for the evaluation of environmental impacts of industrial developments, and the focusing of administrative efforts* (Hansson et al. 1990).

The selection of VECs is probably the most important and at the same time the most difficult step in the process of selection and focusing in the development of an M&E programme. The critical point is to focus on decision-making, and the VEC concept therefore also should include social, political and economical qualities. Moreover, there are only rooms for a limited number of VECs, which in turn call for high critical sense in the selection process.

How to proceed:

1. *Make a list of Valued Ecosystem Components (VECs) for the 4 phases: 1. Exploration; 2. Development; 3. Production and 4. Decommissioning*
2. *Rank the VECs according to importance for the areas affected by the oil/gas development*
3. *Assess and rank the most important associated drivers from group work 2*
4. *The monitoring programme with indicators will be anchored in the VECs*

Step 2. Drivers

Drivers are impact factors or driving forces which can affect the ecosystem and/or the society in one way or another.Based on the activity description of the proposed oil/gas development in the Albertine Graben, a number of drivers (or impact factors) can be identified.

How to proceed:

1. *Make a list of drivers in the 2 categories: From oil/gas development and others*
2. *Rank the drivers*
   - *Overall rank (1, 2, 3...n), and*
   - *Rank in each phase (Exploration; Drilling; Production and Decommissioning) in category 1-3 where 1 is least important and 3 is most important*

Step 3. Cause - effect charts: Linking Valued Ecosystem Components and drivers

A Cause – effect chart is a diagram of boxes and arrows indicating in which context each of the VECs appears, i.e. which type of driver from the proposed activity can affect the VEC and how. Each linkage shall be explained in a brief text following the chart. Hansson et al. (1990) described the content of the flow chart to include the main categories of the physical, biological and possibly also social and political factors influencing the VEC.

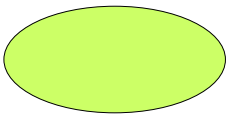
If all the connections between each VEC and the different components on primary, secondary, tertiary.... level should be included in the flow chart, a more or less chaotic picture would occur. Each flow chart, therefore, should only comprise the components that are in direct contact with the VEC. The flow chart will form the basis for formulating Impact Hypotheses.

How to proceed

1. *Select VEC*
2. *Select main associated drivers*
3. *Start constructing cause - effect chart with linkage explanations*

When building up the flow chart we use the following symbols:

Development - drivers



Valued Ecosystem Component (VEC)

System component: Natural factor of importance to the VEC

Linkage, number refer to the explanations

Step 4 and 5. Impact Hypotheses (IHs) and recommendations

An *Impact Hypothesis* is a hypothesis for testing the possible impact from the activity on the VEC. The impact hypothesis is based on the schematic flow chart and shall be explained and described preferably in scientific terms. The IHs are also the basis for recommendations concerning further research, investigations and management actions including mitigating measures and, in the case of Albertine Graben, an M&E programme with indicators.

The flow charts and the linkages indicate which activities will influence the VEC directly or indirectly via the system components. By means of the linkages a series of impact hypotheses can be prepared for each VEC. All IHs shall normally be scientific documented if possible. Several IHs will normally be formulated for each VEC.

After the preparation of the IHs, an evaluation procedure is accomplished for each IH, putting them into one of the following categories (box 2):

A. The hypothesis is assumed not to be valid.
B. The hypothesis is valid and already verified. Research to validate or invalidate the hypothesis is not required. Surveys, monitoring, and/or management measures can possible be recommended.
C. The hypothesis is assumed to be valid. Research, monitoring or surveys is recommended to validate or invalidate the hypothesis. Mitigating measures can be recommended if the hypothesis is proved to be valid.
D. The hypothesis may be valid, but is not worth testing for professional, logistic, economic or ethical reasons, or because it is assumed to be of minor environmental influence only or of insignificant value for decision making.

Box 2. Evaluation categories for the assessment of impact hypotheses.

In the assessment system, only IHs placed in category B, C and sometimes D are brought forward to the assessment of impacts. Normally, the category C - hypotheses will be tested through research, monitoring or surveys.

As a consequence of the evaluation of the impact hypotheses, several recommendations are normally given.

To validate or invalidate the IHs, research, monitoring and/or surveying may be necessary.

The needs for management actions, mitigating measures and monitoring programme. A natural part of an EIA will be to give recommendations concerning management actions and mitigating measures with respect to the proposed oil/gas activities. Based on previous steps in the scoping process several recommendations on an M&E programme, including indicators will be given. In section II of this publication results from the Kasese scoping workshop are given.

Exploratory drillings have been conducted in the Albertine Graben, this site is located in the Mputa 2 field at the shores of Lake Albert. Photo: Jørn Thomassen.

2 Part II: The Kasese scoping workshop

The Kasese scoping workshop consisted of two parts, day 1 was allocated to various presentations on core issues like existing baseline information (Background Paper), descriptions of the planned oil and gas development in the area, introduction to the methodological approach at the workshop and a more detailed step by step introduction to the process (see appendix 4.2).

2.1 Workshop participants

Participants from several stakeholders attended the scoping workshop (table 1).

Table 1. *Participants and institutional belonging at the Kasese scoping workshop in April 2011.*

Name	Institution	Name	Institution
Arinaitwe Topher	MWE	Kayondo Kenneth	NEMA
Bakunda Aventino	DFR	Khanzila Prossy	NEMA
Bbosa David Lwanga	NPA	Kiiza David	MWE
Beatrice Adimola	NEMA	Lwasa James	NARO
Bright Richard Kimuli	UBOS	Magezi Akiiki	Meteorology
Byaruhanga Jane M	PEPD	Margeret Driciru	UWA
David Mugisa	DSH/MGLSD	Mari Lise Sjong	DN-Norway
Edith Kateme Kasajja	NPA	Mbabazi Dismas	NaFIRRI - NARO
Edward Mbabazi	NEMA	Mpabulungi Firipo	NEMA
Eng. Ronald Kasozi	DWD	Mugisha Louis	DWRM
Erima Godwin	MUIENR	Mugume Evelyn	Kasese DLG
Festus Bagoora	NEMA	Muramira Telly	NEMA
Goretti Kitutu	NEMA	Nakalyango Caroline	DWRM
Grace Nangendo	WCS	Nurudin Njabire	PEPD
Guma Gerald	Geology Dept	Nyangoma Joseline	Hoima DLG
Hasahya Moses	NEMA	Perry I Kiza	NEMA
Hudson Basyomusi	EIA	Philip K. Ngangaha	Biliisa DLG
Ingunn Limstrand	DN-Norway	Reidar Hindrum	DN-Norway
Isabirye Moses	Busitema University	Robert Ddamulira	WWF Uganda
John Diisi	NFA	Rukundo Tom	NFA
Jørn Thomassen	NINA-Norway	Stephen Sekiranda	NaFIRRI - NARO
Justine Namara	UWA	Tiberindwa John	Geology Dept, Makerere
Kateregga Joseph	NEMA		

2.2 Workshop process

Five main thematic issues were defined prior to the workshop, namely:

1. Aquatic ecological issues
2. Terrestrial ecological issues
3. Physical/chemical issues
4. Society issues
5. Management and business issues

2.2.1 Group composition

The participants were divided into five groups, each group worked with one of the main thematic issues (see above) (table 2).

Table 2. *Group composition at the Kasese scoping workshop in April 2011. Participants in red chaired their group.*

Main thematic issues	Group member	Institution
1. Aquatic ecological issues	Mbabazi Dismas	NaFIRRI-NARO
	Bakunda Aventino	DFR
	Steven Sekiranda	NaFIRRI-NARO
	Mugume Evelyn	Kasese DLG
	Nyangoma Joseline	Hoima DLG
	Philip K. Ngangaha	Biliisa DLG
	Khanzila Prossy	NEMA
2. Terrestrial ecological issues	John Diisi	NFA
	Grace Nangendo	WCS
	Isabirye Moses	Busitema University
	Arinaitwe Topher	MWE
	Rukundo Tom	NFA
	Margeret Driciru	UWA
	Robert Ddamulira	WWF Uganda
3. Physical/chemical issues	Nakalyango Caroline	DWRM
	Lwasa James	NARO
	Mugisha Louis	DWRM
	Festus Bagoora	NEMA
	David Mugisa	DSH/MGLSD
	Magezi Akiiki	Meteorology
4. Society issues	Bright Richard Kimuli	UBOS
	Erima Godwin	MUIENR
	Mpabulungi Firipo	NEMA
	Goretti Kitutu	NEMA
	Byaruhanga Jane M.	PEPD
	Edith Kateme Kasajja	NPA
5. Management and business issues	Tiberindwa John	Geology Dept, Makerere
	Justine Namara	UWA
	Nurudin Njabire	PEPD
	Eng. Ronald Kasozi	DWD
	Muramira Telly	NEMA

2.3 Organisation of the scoping results

The results from the indicator scoping workshop in Kasese have been organised according to the main thematic issue, such that it is easier to follow the logical development of the indicators. Under each main thematic issue the results are organised as the stepwise work:

1. Identification and prioritization of Valued Ecosystem Components
2. Identification and prioritization of drivers
3. Construction of cause – effect charts
4. Assessing and filling in the Indicator Fact Sheets, i.e. impact hypotheses and recommendations

Table 3 summarizes the numbers of VECs, drivers, cause – effect charts and Indicator Fact Sheets produced in each group at the Kasese workshop. The numbers are the total and some of the VECs and especially the drivers will appear in several of the main thematic issues.

Table 3. *The numbers of VECs, drivers, cause – effect charts and Indicator Fact Sheets produced in each group at the Kasese workshop.*

Main thematic issues	VECs	Drivers	Cause-effect charts	Indicator Fact Sheets
1. Aquatic ecological issues	7	6	4	4
2. Terrestrial ecological issues	13	23	5	15
3. Physical/chemical issues	5	25	5	6
4. Society issues	11	12	11	11
5. Management and business issues	6	12	6	10
Total	42	78	31	46

The results are presented as appeared at the workshop, and due to restricted time in the group works some information may lack.

From the group works at the Margherita hotel in Kasese. Photo: Jørn Thomassen.

2.4 Aquatic ecological issues

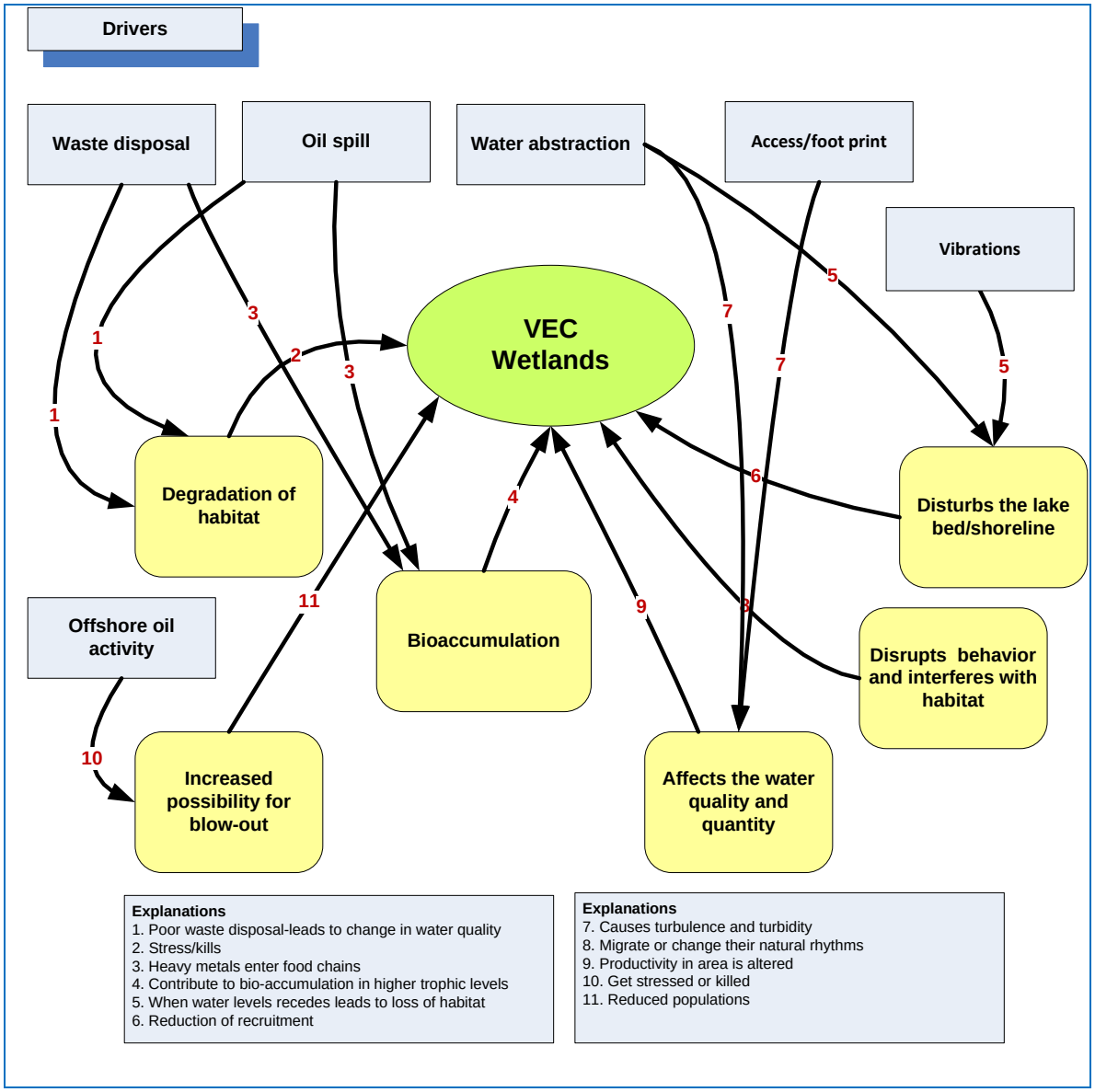
2.4.1 Valued Ecosystem Components

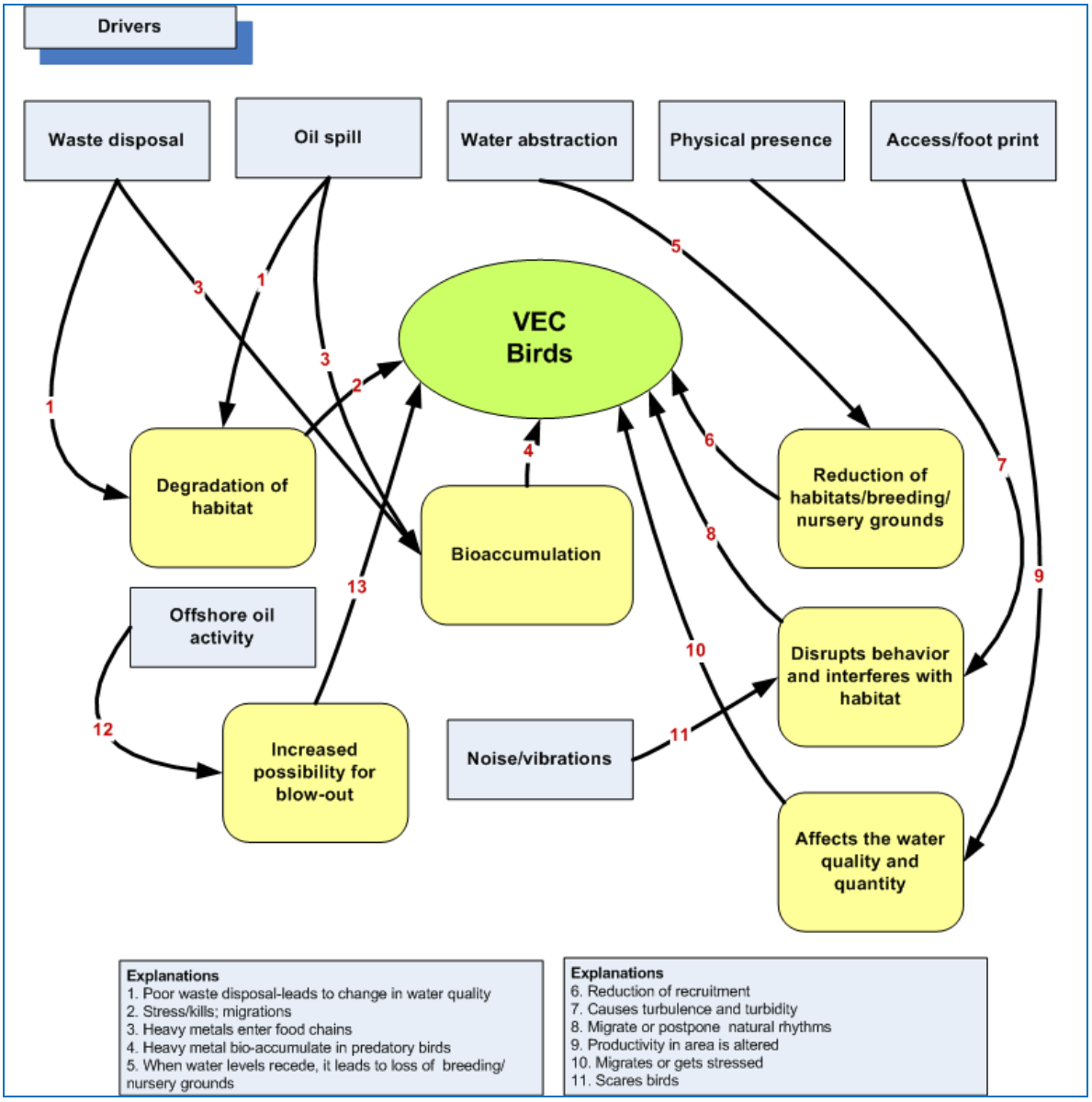
Group no:	1	Issue:	Aquatic ecosystem		
Valued Ecosystem Components, ranked			**Associated drivers, ranked (after group work 2)**	**Phase**	**Comments**
VEC 1 Fish			1.Waste disposal	3,2,1	
			2.Oil spill	3,2	
			3.Water abstraction	3,2	
			3.Physical presence	3,1,2,4	
			4.Noise/vibrations	1,2,4,3	
			5.Access/foot print	1,2,4,3	
			6.Water abstraction	3,2	
VEC 2 Macro-invertebrate			1.Waste disposal	3,2,1	
			2.Oil spill	3,2	
			3. Water abstraction	3,2	
			4.Access/foot print	1,2,4,3	
VEC 3 Algal communities			1.Waste disposal	3,2,1	
			2.Oil spill	3,2	
			3.Water abstraction	3,2	
			4.Access/foot print	1,2,4,3	
VEC 4 (wetlands)			1.Waste disposal	3,2,1	
			2.Oil spill	3,2	
			3.Water abstraction	3,2	
			3.Physical presence	3,1,2,4	
			4.Noise/vibrations	1,2,4,3	
			5.Access/foot print	1,2,4,3	
			6.Water abstraction	3,2	
VEC 5 (mammals/reptiles)			1.Waste disposal	3,2,1	
			2.Oil spill	3,2	
			3.Water abstraction	3,2	
			4.Access/foot print	1,2,4,3	
VEC 6 (birds)			1.Waste disposal	3,2,1	
			2.Oil spill	3,2	
			3.Water abstraction	3,2	
			3.Physical presence	3,1,2,4	
			4.Noise/vibrations	1,2,4,3	
			5.Access/foot print	1,2,4,3	
			6.Water abstraction	3,2	
VEC 7 (amphibians)			1.Waste disposal	3,2,1	
			2.Oil spill	3,2	
			3.Water abstraction	3,2	
			4.Access/foot print	1,2,4,3	

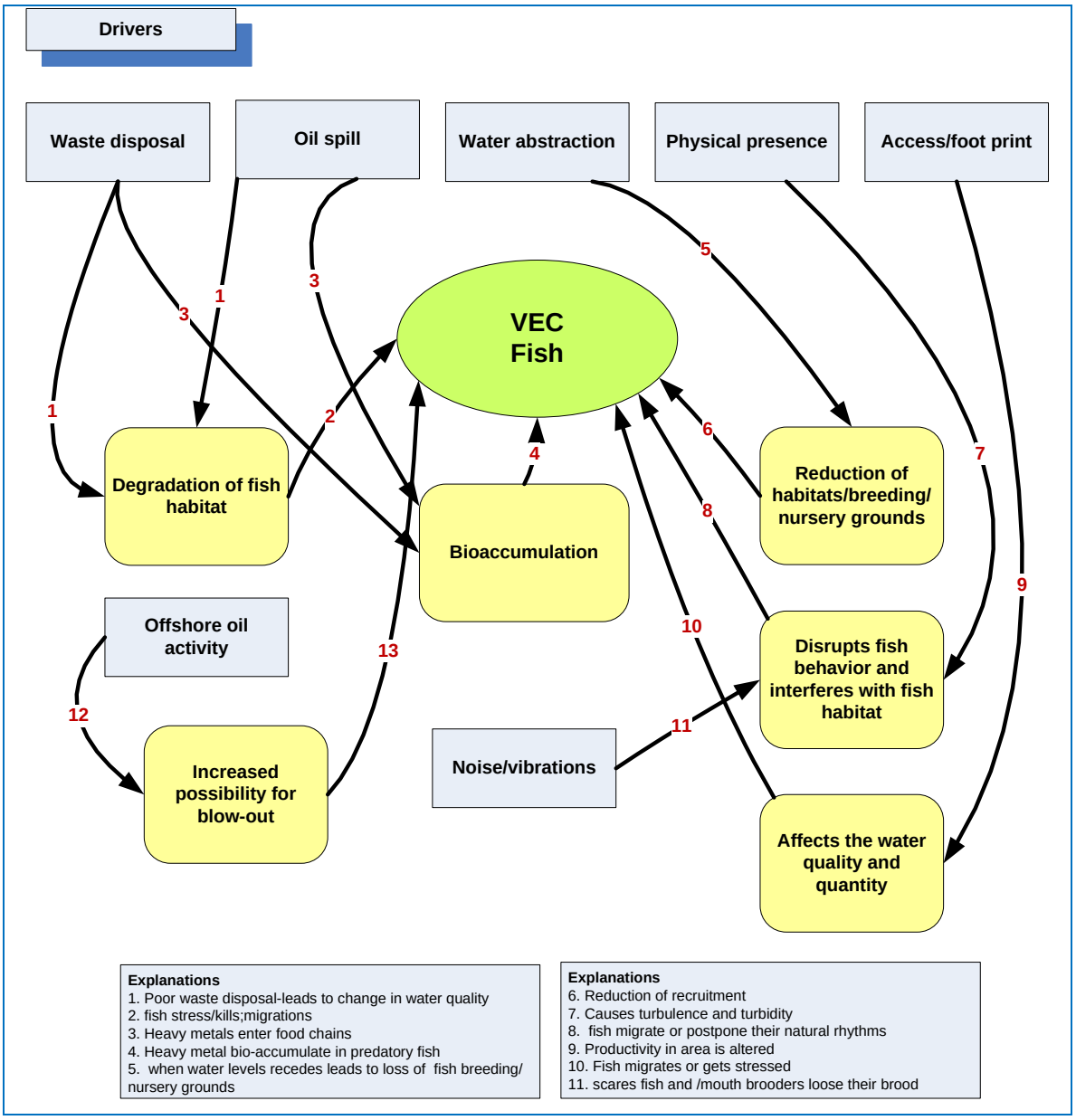
2.4.2 Drivers

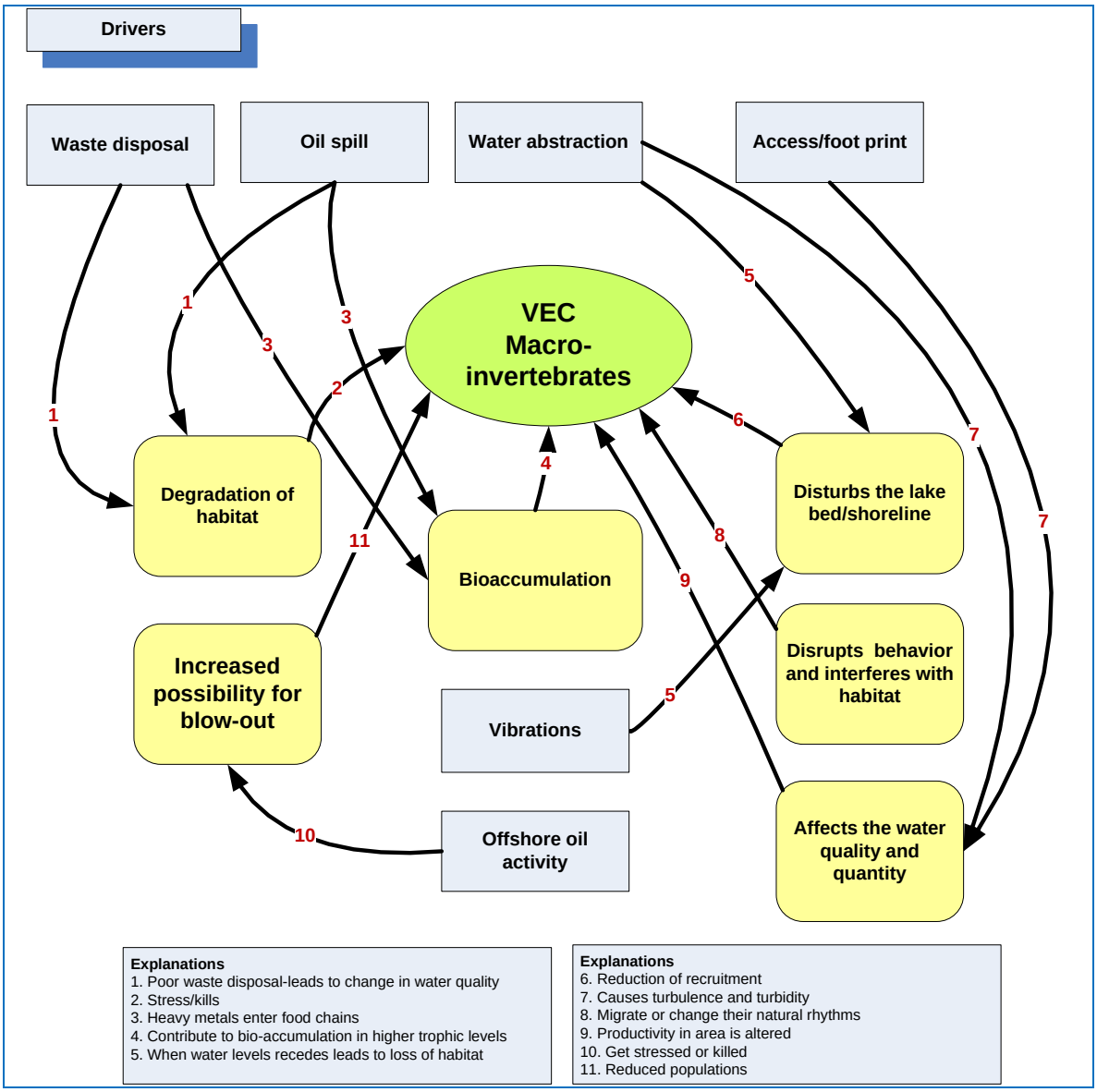
Group no:	1	Issue:	Aquatic ecosystem			
Overall rank	**Drivers\phase → ↓**	**Explo-ration**	**Develop-ment**	**Produc-tion**	**Decom-missioning**	**Others**
1	Waste disposal	2	3	3	3	
2	Oil spill	1	2	3	1	
3	Physical presence	3	3	2	2	
4	Noise/vibrations	3	3	2	1	
5	Access/foot print	2	2	3	1	
6	Water abstraction	1	1	3	1	

2.4.3 Cause – effect charts, aquatic ecosystem




Drivers
Waste disposal
Oil spill
Water abstraction
Physical presence
Access/foot print
VEC
Birds
Degradation of habitat
Bioaccumulation
Reduction of habitats/breeding/ nursery grounds
Offshore oil activity
Disrupts behavior and interferes with habitat
Increased possibility for blow-out
Noise/vibrations
Affects the water quality and quantity
1
2
3
4
5
6
7
8
9
10
11
12
13
Explanations
1. Poor waste disposal-leads to change in water quality
2. Stress/kills; migrations
3. Heavy metals enter food chains
4. Heavy metal bio-accumulate in predatory birds
5. When water levels recede, it leads to loss of breeding/ nursery grounds
Explanations
6. Reduction of recruitment
7. Causes turbulence and turbidity
8. Migrate or postpone natural rhythms
9. Productivity in area is altered
10. Migrates or gets stressed
11. Scares birds


Drivers
Waste disposal
Oil spill
Water abstraction
Physical presence
Access/foot print
VEC
Fish
Degradation of fish habitat
Bioaccumulation
Reduction of habitats/breeding/ nursery grounds
Offshore oil activity
Disrupts fish behavior and interferes with fish habitat
Increased possibility for blow-out
Noise/vibrations
Affects the water quality and quantity
1
2
3
4
5
6
7
8
9
10
11
12
13
Explanations
1. Poor waste disposal-leads to change in water quality
2. fish stress/kills;migrations
3. Heavy metals enter food chains
4. Heavy metal bio-accumulate in predatory fish
5. when water levels recedes leads to loss of fish breeding/ nursery grounds
Explanations
6. Reduction of recruitment
7. Causes turbulence and turbidity
8. fish migrate or postpone their natural rhythms
9. Productivity in area is altered
10. Fish migrates or gets stressed
11. scares fish and /mouth brooders loose their brood


Drivers
Waste disposal
Oil spill
Water abstraction
Access/foot print
VEC
Macro-
invertebrates
Degradation of habitat
Bioaccumulation
Disturbs the lake bed/shoreline
Disrupts behavior and interferes with habitat
Increased possibility for blow-out
Vibrations
Offshore oil activity
Affects the water quality and quantity
1
2
3
3
4
5
6
7
7
8
9
5
10
11
Explanations
1. Poor waste disposal-leads to change in water quality
2. Stress/kills
3. Heavy metals enter food chains
4. Contribute to bio-accumulation in higher trophic levels
5. When water levels recedes leads to loss of habitat
Explanations
6. Reduction of recruitment
7. Causes turbulence and turbidity
8. Migrate or change their natural rhythms
9. Productivity in area is altered
10. Get stressed or killed
11. Reduced populations

2.4.4 Indicator Fact Sheets, aquatic ecosystem

Aquatic ecosystem			
Group no:	1	**INDICATOR FACT SHEET**	
VEC: **Wetlands**		IH no:	2
Impact Hypothesis**:** Oil spills lead to negative change in ecosystem functions and services of wetland and loss of associated biodiversity		Driver: Oil spills	
Explanation: Oil spills affect respiratory systems of organisms often resulting into death, make the environmental conditions anoxic			
Evaluation in category A, B, C or D:	C*		
Rationale for category: The impacts of the oil spills are unknown but the potential for direct and indirect environmental damage to wetlands ecosystem services are extra ordinary			
Recommended research: Baseline study on wetland ecosystems in the Albertine Graben			
Recommended management actions: Ensure existing management regulation/policies are enforced			
Recommended monitoring:			
Measurable indicator name (what): Key water quality indicators(DO,Chl-a, P, N, pH etc), Plant species richness & composition		Order 1, 2 or 3	1
Existing	Existing monitoring *(relevant ongoing monitoring or available data sets)*: Wetland inventory available		
	Area covered (*by ongoing monitoring or available data sets)*: No ongoing monitoring		
	Data storage *(format and place where data sets are stored)*:		
	Responsibility *(institution and person currently responsible for existing monitoring data sets)*: Department of Wetland Management		
Why (*key question(s) which the indicator helps to answer*):Evaluation of status and tracking of changes			
Current trend (*upward, stable or downward)*: Not known			
How (*method, sampling and analysis, quality assurance*):): Key water quality indicators – Water sampling Plant species richness & composition - Surveys at selected geo-referenced sites as below			
Where (*location, geo-referenced)*: albertine graben – wetlands close to oil activities			
When (*frequency*): Baseline and quarterly surveys			
By whom *(which institution will collect the indicator data)*: District Natural Resources department			
Lead agency *(institution and person responsible for calculating and communicating the indicator)*: Department of Wetlands Management			
Presentation *(most effective forms of presentation: graphs, maps, narratives etc.)*: Maps, graphs, quarterly briefs, survey reports			
End user(s) *(who will use the indicator for what purpose)*: Policy makers, resource managers, academia and communities			
Financial assessment *(approximate costs from data collection to indicator)*:			
Comments:			
Literature: Albertine Graben Sensitivity atlas, National state of environment Report			

*A. The hypothesis is assumed not to be valid.
B. The hypothesis is valid and already verified. Research to validate or invalidate the hypothesis is not required. Surveys, monitoring, and/or management measures can possible be recommended.
C. The hypothesis is assumed to be valid. Research, monitoring or surveys is recommended to validate or invalidate the hypothesis. Mitigating measures can be recommended if the hypothesis is proved to be valid.
D. The hypothesis may be valid, but is not worth testing for professional, logistic, economic or ethical reasons, or because it is assumed to be of minor environmental influence only or of insignificant value for decision making.

Aquatic ecosystem			
Group no:	1	**INDICATOR FACT SHEET**	
VEC: **Wetlands**		IH no:	3
Impact Hypothesis: Wetland reclamation for infrastructure development leads to alteration of natural properties of wetlands		Driver: Access/footprint	
Explanation: Oil and gas developments will require establishing infrastructures in wetlands resulting into siltation, flooding, lowering of the water table			
Evaluation in category A, B, C or D:	C*		
Rationale for category: Experience in Uganda has shown that a lot of wetlands have been degraded through reclamation and encroachment			
Recommended research: Baseline study be done on current state of wetlands			
Recommended management actions: Ensure existing management policies and laws are enforced			
Recommended monitoring: Quarterly monitoring			
Measurable indicator name (what): Vegetation cover, flow, Key water quality indicators(DO,Chl-a, P,N, pH etc), Plant species richness & composition		Order 1, 2 or 3	1
Existing	Existing monitoring *(relevant ongoing monitoring or available data sets)*: Wetland inventory (10 years ago)		
	Area covered (*by ongoing monitoring or available data sets)*: Entire country		
	Data storage *(format and place where data sets are stored)*:Department of Wetland Management		
	Responsibility *(institution and person currently responsible for existing monitoring data sets)*: As above		
Why (*key question(s) which the indicator helps to answer*): For assessing status and track change			
Current trend (*upward, stable or downward)*: downward			
How (*method, sampling and analysis, quality assurance*): Vegetation cover-satellite images/aerial photos;flow-(to be assessed); Key water quality indicator-Water sampling at selected geo-referenced sites as below; Plant species richness & composition-Surveys at selected geo-referenced sites as below			
Where (*location, geo-referenced)*: Wetlands in the Albertine Graben with a focus on areas where infrastructure is likely to take place			
When (*frequency*): Baseline and then quarterly			
By whom *(which institution will collect the indicator data)*:District Natural Resource department			
Lead agency *(institution and person responsible for calculating and communicating the indicator)*: Department of Wetland Management			
Presentation *(most effective forms of presentation: graphs, maps, narratives etc.)*: Maps, graphs, pictures, satellite images			
End user(s) *(who will use the indicator for what purpose)*: Policy makers , oil companies, Resource Managers, academia			
Financial assessment *(approximate costs from data collection to indicator)*:			
Comments:			
Literature:			

*A. The hypothesis is assumed not to be valid.

B. The hypothesis is valid and already verified. Research to validate or invalidate the hypothesis is not required. Surveys, monitoring, and/or management measures can possible be recommended.

C. The hypothesis is assumed to be valid. Research, monitoring or surveys is recommended to validate or invalidate the hypothesis. Mitigating measures can be recommended if the hypothesis is proved to be valid.

D. The hypothesis may be valid, but is not worth testing for professional, logistic, economic or ethical reasons, or because it is assumed to be of minor environmental influence only or of insignificant value for decision making.

Aquatic ecosystem			
Group no:	1	**INDICATOR FACT SHEET**	
VEC: **Fish**		IH no:	1
Impact Hypothesis: Poor waste disposal-leads to change in water quality that results into degradation of habitat, leading to fish stress/kills and migrations		Driver: Waste disposal	
Explanation: Contaminated water bodies have been shown not to support fish in Europe, USA, Japan			
Evaluation in category A, B, C or D:	C*		
Rationale for category: No research has been done in Albertine Graben based lakes			

Recommended research: Baseline on environmental factors of key fish habitats	
Recommended management actions:	
Recommended monitoring: Quarterly monitoring	
Measurable indicator name (what): Water quality (DO, P, N, Chl-a, PHCs, Transparency, conductivity)	Order 1, 2 or 3
Existing	Existing monitoring *(relevant ongoing monitoring or available data sets)*: Baseline 2007-09
	Area covered (*by ongoing monitoring or available data sets)*: Ngasa, Kyehoro, Kaiso-Tonya, Sebagoro to Bugoma
	Data storage *(format and place where data sets are stored)*: Excel at NaFIRRI
	Responsibility *(institution and person currently responsible for existing monitoring data sets)*: NaFIRRI
Why (*key question(s) which the indicator helps to answer*): Assess status and track changes as the oil industry grows	
Current trend (*upward, stable or downward)*: Stable	
How (*method, sampling and analysis, quality assurance*): Water quality (DO, P, N, Chl-a, PHCs, Transparency, conductivity)- Water sampling in identified fish habitat	
Where (*location, geo-referenced)*: Identified fish habitat areas close to oil development enterprises	
When (*frequency*): Quarterly	
By whom *(which institution will collect the indicator data)*: NaFIRRI	
Lead agency *(institution and person responsible for calculating and communicating the indicator)*: NaFIRRI	
Presentation *(most effective forms of presentation: graphs, maps, narratives etc.)*: maps, graphs, quarterly briefs	
End user(s) *(who will use the indicator for what purpose)*: Policy makers, Department of Fisheries Management, Oil companies, NEMA, communities	
Financial assessment *(approximate costs from data collection to indicator)*:	
Comments:	
Literature: National state of environment Report, 2007-09 Baseline survey reports	

*A. The hypothesis is assumed not to be valid.

B. The hypothesis is valid and already verified. Research to validate or invalidate the hypothesis is not required. Surveys, monitoring, and/or management measures can possible be recommended.

C. The hypothesis is assumed to be valid. Research, monitoring or surveys is recommended to validate or invalidate the hypothesis. Mitigating measures can be recommended if the hypothesis is proved to be valid.

D. The hypothesis may be valid, but is not worth testing for professional, logistic, economic or ethical reasons, or because it is assumed to be of minor environmental influence only or of insignificant value for decision making.

Aquatic ecosystem			
Group no:	1	**INDICATOR FACT SHEET**	
VEC: **Fish**		IH no:	5
Impact Hypothesis: Offshore activity is likely to increase the possibility of a blowout which could lead to an oil spill that could lead to loss of aquatic life		Driver: Offshore oil activity	
Explanation: Offshore activities in the Gulf of Mexico in 2010 resulted into an oil spill that was blown out and led to enormous kills of sharks and whales			
Evaluation in category A, B, C or D:	B*		
Rationale for category: Oil spill causes a thick layer on water surface which affect air circulation and leads to anoxic conditions			

Recommended research: Baseline studies on relevant aquatic ecosystem components (e.g. fish, macro-invertebrates and benthos etc)		
Recommended management actions: Develop and implement oil spill contingency plan; acquire relevant oil/chemical spill response equipment.		
Recommended monitoring: water quality, spill size, spread, prevalent weather, biological aquatic components (e.g. fish, plankton etc)		
Measurable indicator name (what): Water quality (BOD, COD, pH, PHCs etc)	Order 1, 2 or 3	1
Existing	Existing monitoring *(relevant ongoing monitoring or available data sets)*: water quality parameters; fish distribution; fish breeding areas; fish catch; benthos etc	
	Area covered (*by ongoing monitoring or available data sets)*: L. Albert, Edward, Albert Nile shoreline and offshore	
	Data storage *(format and place where data sets are stored)*: NaFFRI and DFR (Excel files, spatial, narrative reports)	
	Responsibility *(institution and person currently responsible for existing monitoring data sets)*: NaFFRI and DFR	
Why (*key question(s) which the indicator helps to answer*): How do oil spills affect aquatic ecosystem health?		
Current trend (*upward, stable or downward)*: Unknown		
How (*method, sampling and analysis, quality assurance*): Frame surveys; *sampling and analysis,*		
Where (*location, geo-referenced)*: L. Albert, Edward, Albert Nile shoreline and offshore		
When (*frequency*): Annually		
By whom *(which institution will collect the indicator data)*: NaFFRI and DFR		
Lead agency *(institution and person responsible for calculating and communicating the indicator)*: DFR		
Presentation *(most effective forms of presentation: graphs, maps, narratives etc.)*: graphs, maps, narratives.		
End user(s) *(who will use the indicator for what purpose)*: Government, private sector, local communities, CSOs and trans-boundary partners.		
Financial assessment *(approximate costs from data collection to indicator)*:		
Comments:		
Literature:		

*A. The hypothesis is assumed not to be valid.

B. The hypothesis is valid and already verified. Research to validate or invalidate the hypothesis is not required. Surveys, monitoring, and/or management measures can possible be recommended.

C. The hypothesis is assumed to be valid. Research, monitoring or surveys is recommended to validate or invalidate the hypothesis. Mitigating measures can be recommended if the hypothesis is proved to be valid.

D. The hypothesis may be valid, but is not worth testing for professional, logistic, economic or ethical reasons, or because it is assumed to be of minor environmental influence only or of insignificant value for decision making.

The group work also resulted in some unfinished Indicator Fact Sheets. For documentation purpose the Impact hypotheses are listed below.

Group no:	1	INDICATOR FACT SHEET	
VEC: Wetlands			IH no: 1
Impact Hypothesis: Poor waste disposal-leads to change in water quality that results into degradation of wetland and loss of biodiversity			Driver: Waste disposal
Explanation: Degraded wetlands don't support a rich diversity of organisms and don't provide their natural functions and services.			
Evaluation in category A, B, C or D:	B		
Rationale for category: Facts exist on impacts of waste disposal and wetlands performance			

Group no:	1	INDICATOR FACT SHEET	
VEC: Fish			IH no: 2
Impact Hypothesis: Oil contains toxic chemicals and if spills occur in the environment, this may lead to bioaccumulation in the food web which affects the well-being of all organisms			Driver: Oil spill
Explanation: Presence of toxic chemicals in the water environmental have been reported to show deformities in some organisms e.g. midge lake fly larvae (Ocheing 2008)			
Evaluation in category A, B, C or D:	C		
Rationale for category: No major oil spills have occurred in Albertine Graben			

Group no:	1	INDICATOR FACT SHEET	
VEC: Fish			IH no: 3
Impact Hypothesis: Unregulated water abstraction lead to reduction in water levels, resulting into loss of breeding/nursery habitat			Driver: Water abstraction
Explanation: Drop in water levels in Lakes Victoria, Wamala, Naivasha (Verschuren *et al* 2000) and Chad have led to tremendous decline of fish stocks of species that live and breed in shoreline waters			
Evaluation in category A, B, C or D:	B		
Rationale for category: Need to establish effects of water level drop on fish stocks in lakes in the Albertine Graben			

Group no:	1	INDICATOR FACT SHEET	
VEC: Fish			IH no: 4
Impact Hypothesis: Physical presence causes turbulence and turbidity thus interfering with natural rhythms			Driver: Physical presence
Explanation: Fish naturally responds by escape behavior to unfamiliar object s, sound and light.			
Evaluation in category A, B, C or D:	B		
Rationale for category: Some of the offshore activities generate artificial noise, sound, vibrations and light which s likely to scare away fish			

Group no:	1	INDICATOR FACT SHEET	
VEC: Benthic macro-invertebrates			IH no: 1
Impact Hypothesis: Offshore activity is likely to increase the possibility of a blowout which could lead to an oil spill that could lead to loss of aquatic life			Driver: Offshore oil activity

Explanation: Oil spill causes a thick layer on water surface which affect air circulation and leads to anoxic conditions. The macro-invertebrates are likely to be impacted strongly because they are sedentary. Offshore activities in the Gulf of Mexico in 2010 resulted into an oil spill that was blown out and led to enormous kills of sharks and whales.
Evaluation in category A, B, C or D: B
Rationale for category: Scientific facts on effects of oil spill are known and experience from regions that have had this occurrence e.g. Gulf of Mexico in 2010 and Lake Nkugute in Rubirizi District in 2008 can be adapted

Group no:	1	INDICATOR FACT SHEET	
VEC: Benthic macro-invertebrates			IH no: 2
Impact Hypothesis: Poor waste disposal-leads to change in water quality that results into degradation of habitat, leading stress and/ or death		Driver: Waste disposal	
Explanation: Contaminated water bodies have been shown not to support viable macroinverte-brates populations in Europe, USA, Japan, China			
Evaluation in category A, B, C or D: C			
Rationale for category: No research has been done in Albertine Graben based lakes			

Hippos live in both the terrestrial and the aquatic environment. Photo: Reidar Hindrum.

2.5 Terrestrial ecological issues

Elephants in Murchison Falls National Park. Photo: Reidar Hindrum.

2.5.1 Valued Ecosystem Components

Group no:	2	Issue:	Terrestrial ecosystem		
Valued Ecosystem Components, ranked			**Associated drivers, ranked (after group work 2)**	**Phase**	**Comments**
VEC 1 Elephant			1. Roads		
			2. Seismic lines		
			3. Poaching		
			3. Human influx		
			4. Pipelines		
VEC 2 Lions			1. Human influx		
			2. Poaching		
			3. Hazardous waste		
			4. Roads		
			5. Vehicle traffic		
VEC 3 Uganda Kob			Camps		
			Drill sites		
			Poaching		
			Hazardous waste		
			Airstrips/pads		
			Roads		
VEC 4 African fish eagle			Hazardous waste		

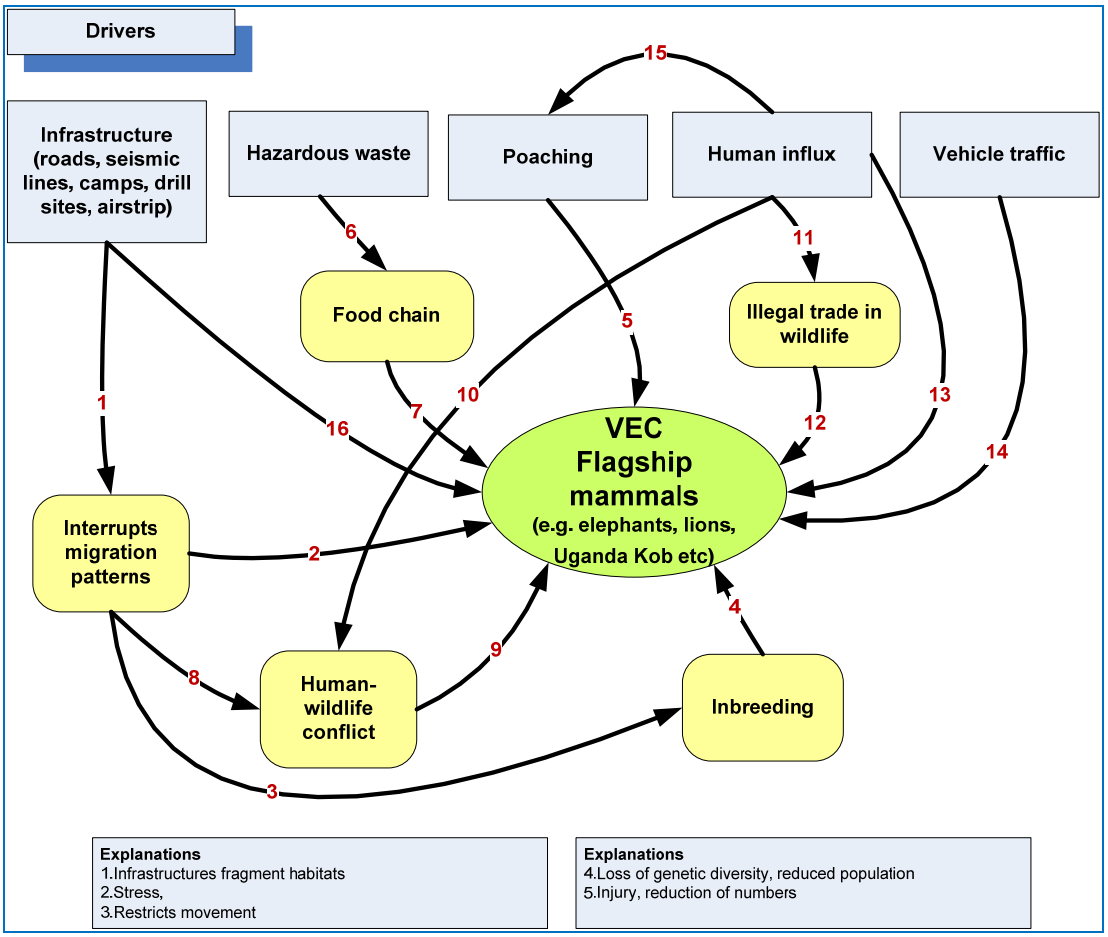
	Roads		
	Camps		
VEC 5 Vultures	Hazardous waste		
	Domestic waste		
VEC 6 Forest raptors	Refinery plant		
	Burrow pit		
	Power plant		
	Drill sites		
	Human influx		
VEC 7 Frog	Hazardous waste		
	Oil spills		
	Jetty sites		
	Refinery		
	Roads		
VEC 8 Butterflies	Lighting		
	Hazardous waste		
	Camps		
	Oil spills		
VEC 9 Earthworms (BGBD)	Oil spills		
	Hazardous waste		
	Roads		
	Seismic lines		
	Burrow pits		
VEC 10 Tropical High Forest	Roads		
	Seismic lines		
	Hazardous waste		
	Oil spill		
	Pipeline		
	Human influx		
	Illegal activities		
VEC 11 Savannah	Roads		
	Seismic lines		
	Hazardous waste		
	Oil spill		
	Pipeline		
	Human influx		
	Illegal activities		
VEC 12 Woodland	Roads		
	Seismic lines		
	Hazardous waste		
	Oil spill		
	Pipeline		
	Human influx		
	Illegal activities		
VEC 13 Agriculture landscapes	Roads		
	Seismic lines		
	Hazardous waste		
	Oil spill		
	Pipeline		
	Human influx		
	Re-injection		

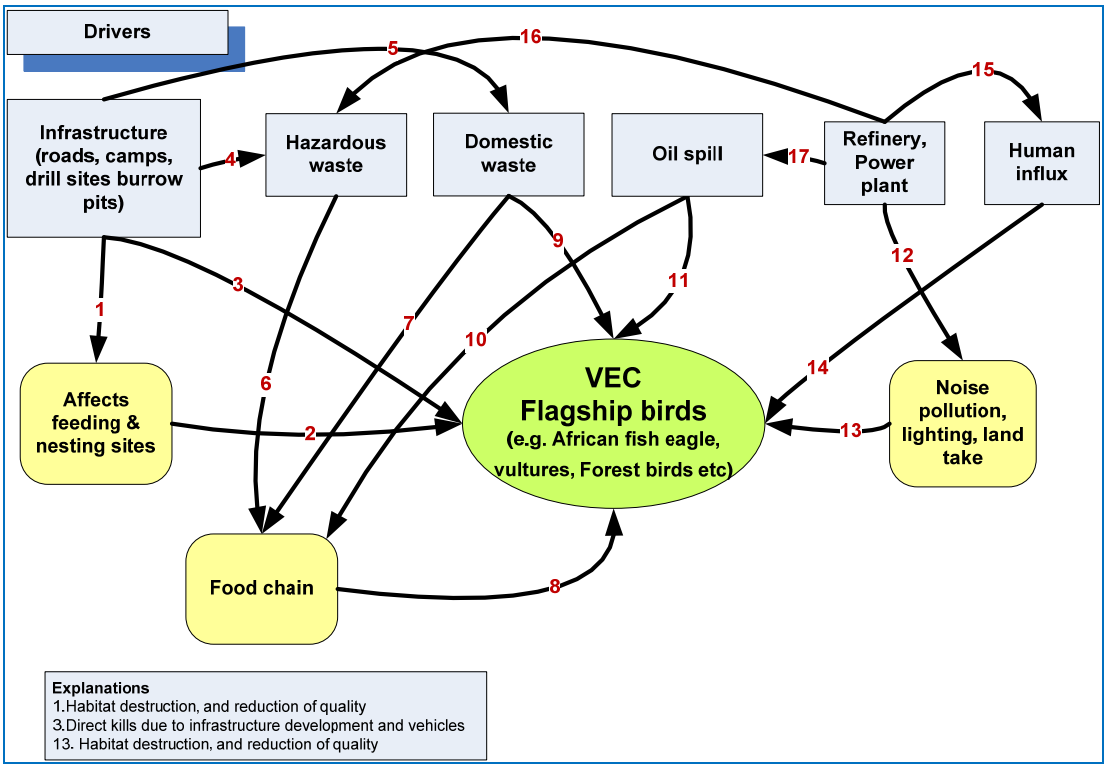
2.5.2 Drivers

Group no:	2	Issue:	Terrestrial ecosystem				
Overall rank	**Drivers\phase → ↓**		**Explo-ration**	**Develop-ment**	**Produc-tion**	**Decom-missioning**	**Others**
	Seismic lines		3	2			
	Camps		3	3	3	1	
	Blasts		3	2			
	Roads		3	3	3		
	Pipelines			2	3		
	Drill sites		3	3	2		
	Vehicle traffic		3	3	3	2	
	Human influx		3	3	2	1	
	Poaching		3	3	2	1	
	Spills		1	1	3	1	
	Hazardous waste		3	1	3	1	
	Domestic waste		3	3	3	1	
	Flaring		3		3		
	Lighting at facilities		3	1	2	1	
	Refinery plant			2	3	3	
	Burrow pits		3	3	2	1	
	Power plant			2	3		
	Oil storage facilities		1	1	3	1	
	Airstrips/pads		2	3	3	1	
	Jetty sites		3	2	2		
	Explosives magazines		3	2			
	Re-injection		2		3		
	Illegal activities						

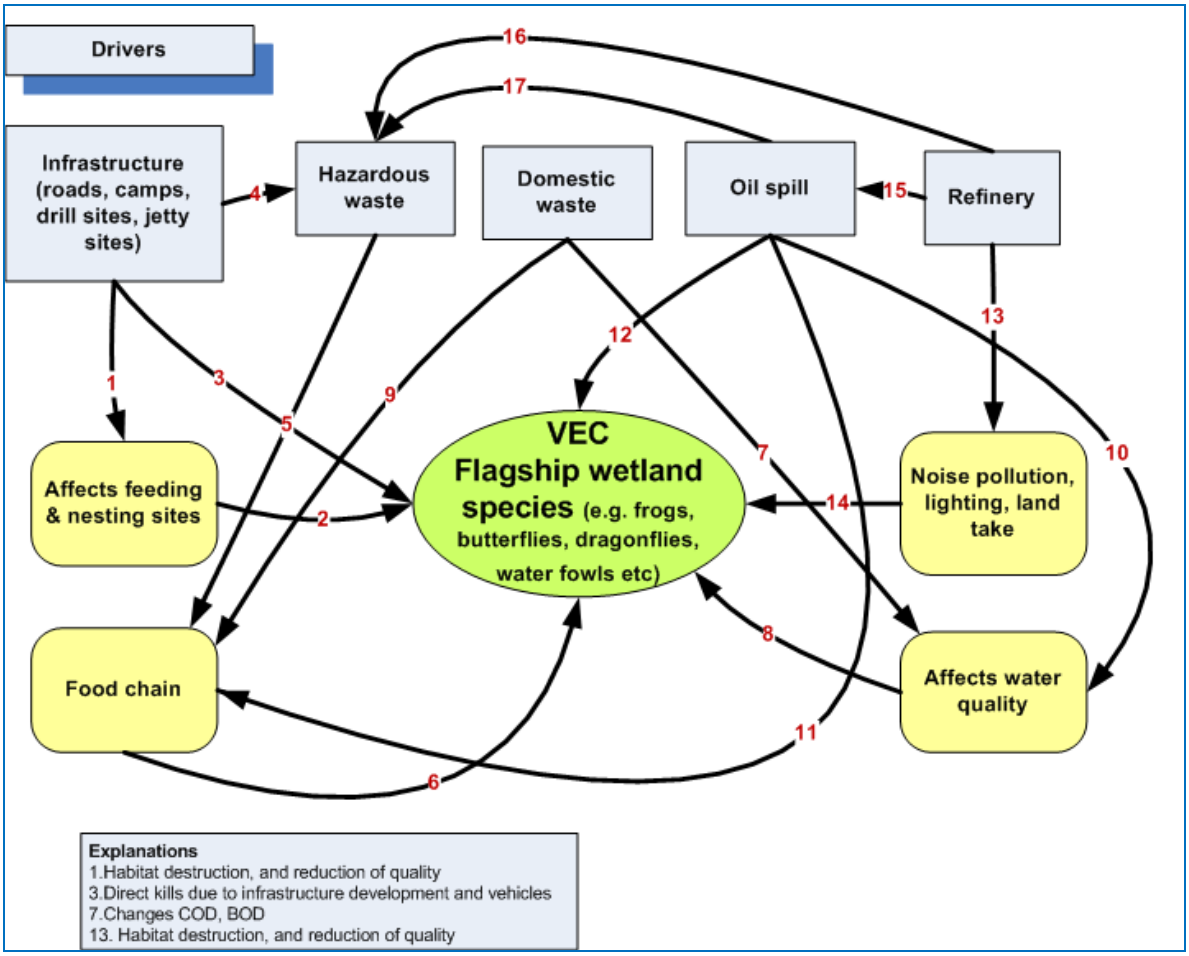
Antelopes are numerous on the Nile river bank in Murchison Falls National Park. *Photo: Jørn Thomassen.*

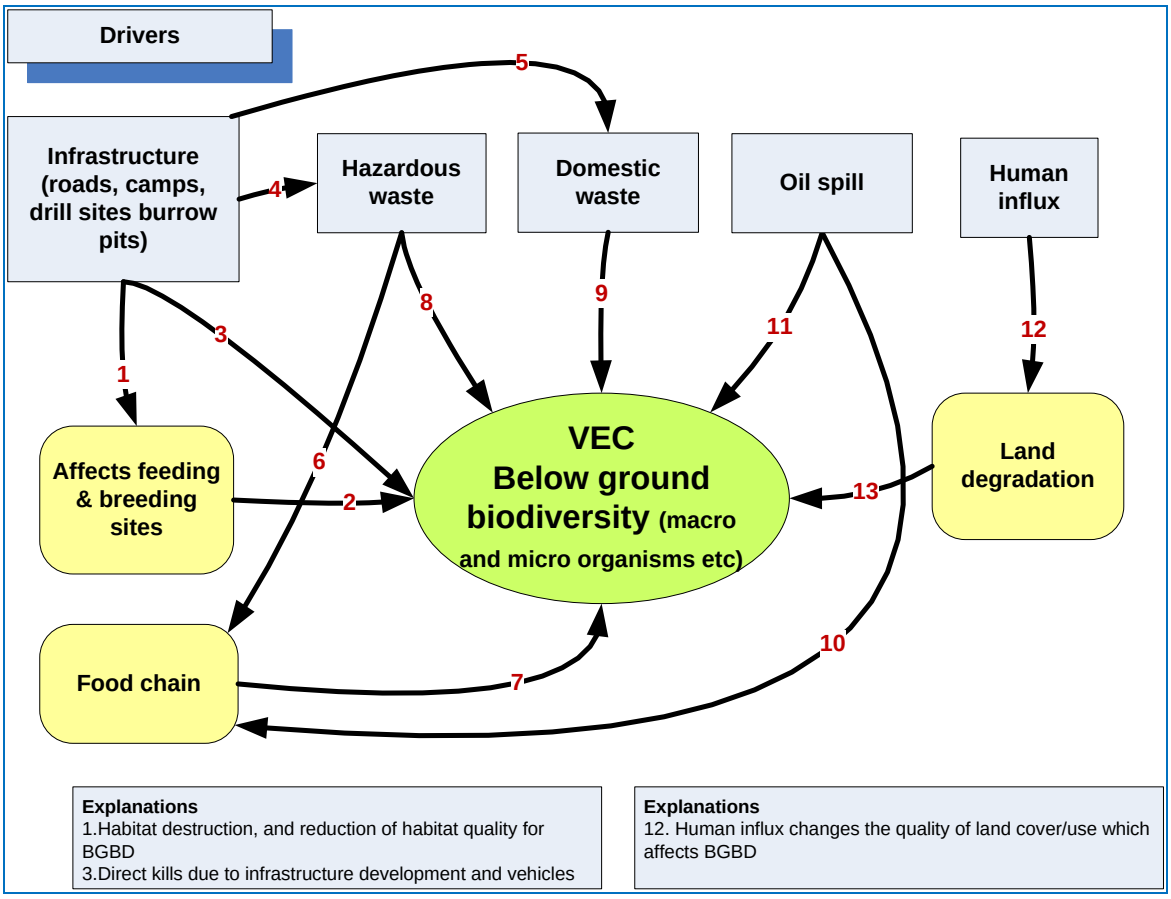
2.5.3 Cause – effect charts, terrestrial ecosystem

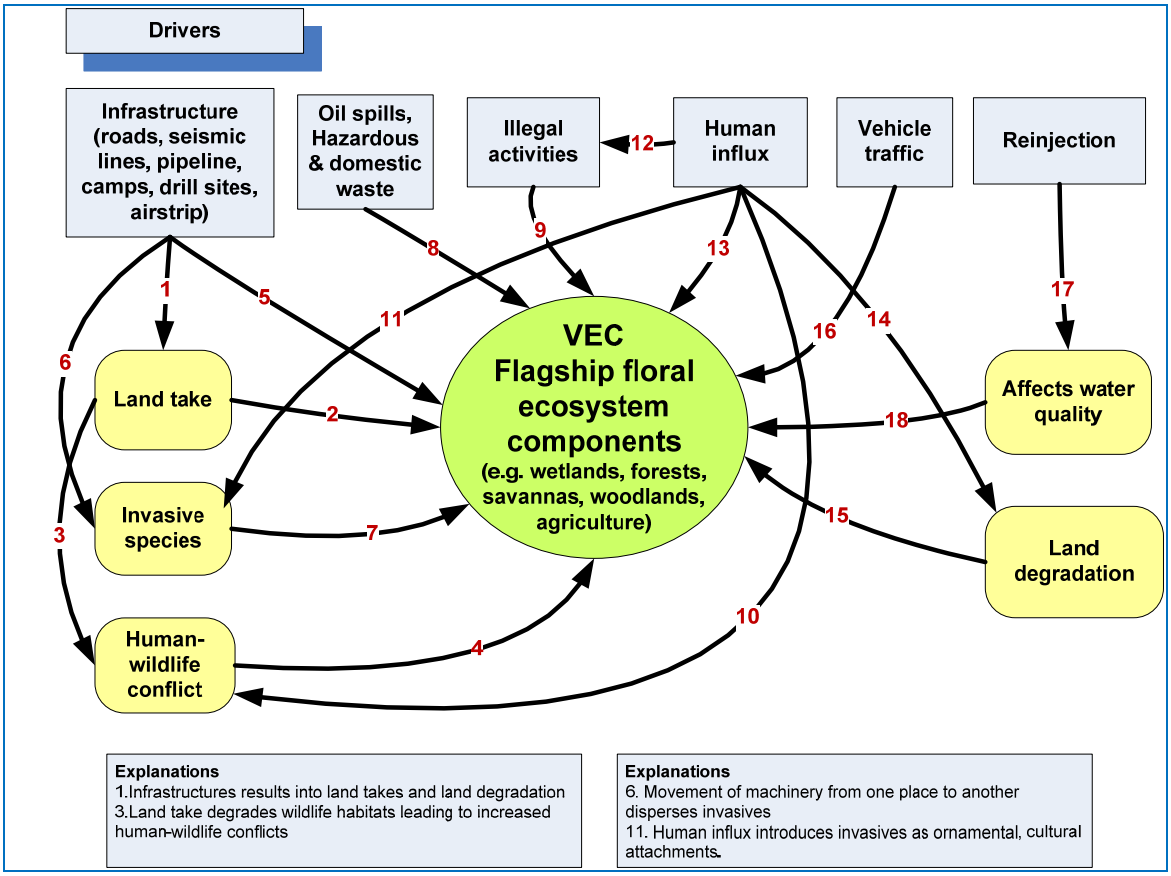




African fish eagles are common in the area. Photo: Reidar Hindrum.




Drivers
Infrastructure (roads, camps, drill sites burrow pits)
Hazardous waste
Domestic waste
Oil spill
Human influx
Affects feeding & breeding sites
VEC
Below ground biodiversity (macro and micro organisms etc)
Land degradation
Food chain
1
2
3
4
5
6
7
8
9
10
11
12
13
Explanations
1.Habitat destruction, and reduction of habitat quality for BGBD
3.Direct kills due to infrastructure development and vehicles
Explanations
12. Human influx changes the quality of land cover/use which affects BGBD


Drivers
Infrastructure (roads, seismic lines, pipeline, camps, drill sites, airstrip)
Oil spills, Hazardous & domestic waste
Illegal activities
Human influx
Vehicle traffic
Reinjection
Land take
VEC
Flagship floral ecosystem components
(e.g. wetlands, forests, savannas, woodlands, agriculture)
Affects water quality
Invasive species
Land degradation
Human-wildlife conflict
1
2
3
4
5
6
7
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9
10
11
12
13
14
15
16
17
18
Explanations
1.Infrastructures results into land takes and land degradation
3.Land take degrades wildlife habitats leading to increased human-wildlife conflicts
Explanations
6. Movement of machinery from one place to another disperses invasives
11. Human influx introduces invasives as ornamental, cultural attachments.

2.5.4 Indicator Fact Sheets

Terrestrial ecosystem			
Group no:	2	**INDICATOR FACT SHEET**	
VEC: **Flagship mammals (e.g. elephants, lions, Uganda Kob etc)**		IH no:	1
Impact Hypothesis: Impact Hypothesis: Infrastructural development fragments wildlife habitats that interrupts migration patterns, increasing human-wildlife conflicts, animal stress, inbreeding and other behavioral changes that eventually lead to reduced wildlife productivity		Driver: Infrastructure (roads, seismic lines, camps, drill sites, airstrip)	
Explanation: Five wells in Kabwoya WR are within a diameter of about 5Km and there is a dense road network			
Evaluation in category A, B, C or D:	C*		
Rationale for category: This is expected to happen but there is no comprehensive data to validate it yet. Research has been carried out on elephants and lions' ranging patterns but no research on stress. There is data on genetic variability in Kobs, giant forest hogs and elephants in the late 1990s.			
Recommended research: Research on range utilization and migration patterns of flagship species e.g. through collaring, research on genetic diversity, stress hormon levels of mammals especially Kobs			
Recommended management actions: Prepare a park specific sensitivity atlas focusing on animal issues e.g. breeding sites and sensitive ecosystems, prepare management plan, operational guidelines,			
Recommended monitoring: Monitor trends of conflicts, range utilization, mammal populations, infrastructure density changes. All items proposed for research should be monitored,			
Measurable indicator name (what): mammal numbers and diversity, mammal ranges (area), infrastructure density, gene diversity, stress hormon levels		Order 1, 2 or 3	1
Existing	Existing monitoring *(relevant ongoing monitoring or available data sets)*: Mist database since 2000, elephant and lion collaring		
	Area covered (*by ongoing monitoring or available data sets)*: All protected areas		
	Data storage *(format and place where data sets are stored)*: Database (MIST, MUIENR data bank)		
	Responsibility *(institution and person currently responsible for existing monitoring data sets)*: UWA		
Why (*key question(s) which the indicator helps to answer*): Does infrastructural development have impact on large mammals?			
Current trend (*upward, stable or downward)*: Upwards and area specific			
How (*method, sampling and analysis, quality assurance*): RBDC, radio collaring, ground and aerial counts, spatial analysis, genetic coding, stress hormonal analysis etc			
Where (*location, geo-referenced)*: Impacted ecosystems in the Albertine Graben			
When (*frequency*): Data collection as per specific research requirement. Data compilation -Annually			
By whom *(which institution will collect the indicator data)*: UWA and other research institutions			
Lead agency *(institution and person responsible for calculating and communicating the indicator)*: UWA			
Presentation *(most effective forms of presentation: graphs, maps, narratives etc.)*: Graphs, maps, narrative			
End user(s) *(who will use the indicator for what purpose)*: Relevant stakeholders			
Financial assessment *(approximate costs from data collection to indicator)*:			
Comments:			
Literature:			

Terrestrial ecosystem			
Group no:	2	**INDICATOR FACT SHEET**	
VEC: **Flagship mammals (e.g. elephants, lions, Uganda Kob etc)**		IH no:	2
Impact Hypothesis: Mammals can be affected by hazardous waste through food chain		Driver: Hazardous waste	
Explanation: Plants accumulate heavy metals from the environment and the plants are eaten by herbivores which are in turn preyed by carnivorous mammals			
Evaluation in category A, B, C or D:	B*		
Rationale for category: It is an established fact in literature and experience elsewhere that hazardous substances affect animal and human health.			

Recommended research: No primary research is required.			
Recommended management actions: Develop capacity for hazardous waste management. Minimize generation of hazardous material use; reuse and recycle hazardous material; proper storage, transfer and disposal of hazardous waste material. Formulation of relevant hazardous waste management regulations, readiness to respond to hazardous waste spills			
Recommended monitoring: Heavy metal analysis in the food chain, sampling of primary raw material inputs, Oil and chemical spills, water quality for traces of heavy metals			
Measurable indicator name (what): Number of spill incidences, heavy metal levels in the food chain, presence and level of heavy metals in water and soils		Order 1, 2 or 3	1
Existing	Existing monitoring *(relevant ongoing monitoring or available data sets)*: NEMA, DWRM		
	Area covered (*by ongoing monitoring or available data sets)*: ??		
	Data storage *(format and place where data sets are stored)*: NEMA, DWD		
	Responsibility *(institution and person currently responsible for existing monitoring data sets)*: NEMA, UWA, DWRM, NARO, DLGs		
Why (*key question(s) which the indicator helps to answer*): Where and in what quantities are the hazardous substances contamination in mammals?			
Current trend (*upward, stable or downward)*: Unknown			
How (*method, sampling and analysis, quality assurance*): Analysis of hazardous substances in animal and plant tissue, water, and soil.			
Where (*location, geo-referenced)*: Albertine Graben			
When (*frequency*): Quarterly			
By whom *(which institution will collect the indicator data)*: NEMA, UWA, DWRM, NARO, DLGs			
Lead agency *(institution and person responsible for calculating and communicating the indicator)*: NEMA			
Presentation *(most effective forms of presentation: graphs, maps, narratives etc.)*: Graphs, maps, narratives			
End user(s) *(who will use the indicator for what purpose)*: All stakeholders			
Financial assessment *(approximate costs from data collection to indicator)*:			
Comments:			
Literature:			

Terrestrial ecosystem			
Group no:	2	**INDICATOR FACT SHEET**	
VEC: **Flagship mammals (e.g. elephants, lions, Uganda Kob etc)**		IH no:	3
Impact Hypothesis: Poaching reduces animal populations and may cause species extinctions		Driver: Poaching	
Explanation: Black and White rhinos were extapted in MFCA, Ajai WR and Kidepo NP mainly due to poaching			
Evaluation in category A, B, C or D:	B*		
Rationale for category: There is already enough evidence through research that poaching reduces animal populatons			
Recommended research: N/A			
Recommended management actions: Enhanced security, strengthening of community initiatives, public awareness			
Recommended monitoring: Recording the number of snares, number of animals poached, poachers apprehended			
Measurable indicator name (what): Number of snares, poached animals, apprehended poachers, number of public awareness meetings		Order 1, 2 or 3	1
Existing	Existing monitoring (relevant ongoing monitoring or available data sets): Ranger based monitoring,		
	Area covered (by ongoing monitoring or available data sets): All protected areas		
	Data storage (format and place where data sets are stored): MIST		
	Responsibility (institution and person currently responsible for existing monitoring data sets): UWA		
Why (*key question(s) which the indicator helps to answer*): N/A			
Current trend (*upward, stable or downward)*: Upward			
How (*method, sampling and analysis, quality assurance*): Ranger patrols			
Where (*location, geo-referenced)*: All protected areas in the graben			
When (*frequency*): Daily			
By whom *(which institution will collect the indicator data)*: UWA			
Lead agency *(institution and person responsible for calculating and communicating the indicator)*: UWA			
Presentation *(most effective forms of presentation: graphs, maps, narratives etc.)*: Graphs, maps, narratives			
End user(s) *(who will use the indicator for what purpose)*: All relevant stakeholders			
Financial assessment *(approximate costs from data collection to indicator)*:			
Comments:			
Literature:			

Terrestrial ecosystem			
Group no:	2	**INDICATOR FACT SHEET**	
VEC: **Flagship mammals (e.g. elephants, lions, Uganda Kob etc)**		IH no:	4
Impact Hypothesis: Human influx increases human-wildlife conflicts, poaching and illegal trade in wildlife and wildlife products		Driver: Human influx	
Explanation: People have bought land around several petroleum development areas e.g. around Kabwoya WR, QEPA prospecting to be compensated at the time of petroleum production. Many people come to the petroleum areas seeking for gainful employment.			
Evaluation in category A, B, C or D:	C*		
Rationale for category: Human presence is linked to illegal activities that have often contributed to wildlife population reduction			

Recommended research: Human population, animal population, incidences of poaching,		
Recommended management actions: Enhanced security , strengthening of community initiatives, sensitization		
Recommended monitoring: Human and animal population changes, number of snares, number of animals poached, poachers apprehended		
Measurable indicator name (what): Human and animal demography, number of snares, number of animals poached, poachers apprehended, number of human-wildlife conflicts reported	Order 1, 2 or 3	
Existing	Existing monitoring *(relevant ongoing monitoring or available data sets)*: QENP, Kabwoya WR	
	Area covered (*by ongoing monitoring or available data sets)*: QENP, Kabwoya WR	
	Data storage *(format and place where data sets are stored)*: MIST, UWA, WCS	
	Responsibility *(institution and person currently responsible for existing monitoring data sets)*: UWA	
Why (*key question(s) which the indicator helps to answer*): Does human influx increase poaching of wildlife, trade in wildlife products, human-wildlife conflicts and enchroachment on the park?		
Current trend (*upward, stable or downward)*: Upward		
How (*method, sampling and analysis, quality assurance*): Population census in and around protected areas, evaluation of rield reports and MIST data		
Where (*location, geo-referenced)*: PAs in the Albertine graben		
When (*frequency*): Bi-annual		
By whom *(which institution will collect the indicator data)*: LC1, UWA, UBOS		
Lead agency *(institution and person responsible for calculating and communicating the indicator)*: UBOS		
Presentation *(most effective forms of presentation: graphs, maps, narratives etc.)*: Graphs, maps, narratives		
End user(s) *(who will use the indicator for what purpose)*: UBOS, UWA, Researchers, Police and other interested institutions		
Financial assessment *(approximate costs from data collection to indicator)*:		
Comments:		
Literature:		

Terrestrial ecosystem			
Group no:	2	**INDICATOR FACT SHEET**	
VEC: **Flagship mammals (e.g. elephants, lions, Uganda Kob etc)**		IH no:	5
Impact Hypothesis: Increases in vehicular traffic lead to increased wildlife kills and injury which affects animal behavior, ranging pattern and population		Driver: Vehicle traffic	
Explanation: Increased reports or road kills in MFCA. Currently in QECA road kills have risen to rank 2 in major wildlife mortalities.			
Evaluation in category A, B, C or D:	C*		
Rationale for category: Vehicles kill and disrupt animal behavior e.g. noise. Kills have been observed in QENP			

Recommended research: Stress hormone levels, animals killed by vehicles			
Recommended management actions: Speed controls in protected areas, road signs warning of animal crossing			
Recommended monitoring: Changed in number of kills or injuries, Frequency of vehicles			
Measurable indicator name (what): Number of kills or injuries, vehicles		Order 1, 2 or 3	1
Existing	Existing monitoring *(relevant ongoing monitoring or available data sets)*: QENP, MFNP		
	Area covered (*by ongoing monitoring or available data sets)*: QENP, MFNP		
	Data storage *(format and place where data sets are stored)*: MIST		
	Responsibility *(institution and person currently responsible for existing monitoring data sets)*: UWA		
Why (*key question(s) which the indicator helps to answer*): Does increase in vehicular traffic have an impact on animal behavior and population			
Current trend (*upward, stable or downward)*: Upward			
How (*method, sampling and analysis, quality assurance*): Vehicle count, animal kills, stress hormone levels			
Where (*location, geo-referenced)*: All protected areas			
When (*frequency*): Annually			
By whom *(which institution will collect the indicator data)*: UWA			
Lead agency *(institution and person responsible for calculating and communicating the indicator)*: UWA			
Presentation *(most effective forms of presentation: graphs, maps, narratives etc.)*: Graphs, maps, narratives			
End user(s) *(who will use the indicator for what purpose)*: UWA, Oil companies, researchers			
Financial assessment *(approximate costs from data collection to indicator)*:			
Comments:			
Literature:			

Terrestrial ecosystem			
Group no:	2	**INDICATOR FACT SHEET**	
VEC: **Flagship birds (e.g. African fish eagle, vultures, forest birds etc)**		IH no:	1
Impact Hypothesis: Infrastructural development in sensitive ecosystems disrupts the feeding and nesting behaviors of avian species. It also directly destroys their habitats and increases mortality.		Driver: Infrastructure (roads, seismic lines, camps, drill sites, airstrip)	
Explanation: Eggs, chicks and nests of birds are known to be destroyed during the construction of several infrastructure			
Evaluation in category A, B, C or D:	C*		
Rationale for category: This is expected to happen but there is no comprehensive data to validate it yet.			

Recommended research: Research on range utilization and migration patterns of flagship species e.g. through collaring, research on genetic diversity, stress hormon levels			
Recommended management actions: Prepare a park specific sensitivity atlas focusing on birds issues e.g.breeding sites and sensitive ecosystems, prepare management plan, operational guidelines			
Recommended monitoring: Monitor range utilization, birds populations, infrastructure density changes. All items proposed for research should be monitored			
Measurable indicator name (what): Birds numbers and diversity, ranges (area), infrastructure density, gene diversity, stress hormone levels		Order 1, 2 or 3	1
Existing	Existing monitoring *(relevant ongoing monitoring or available data sets)*: QENP, Kabwoya, Drilling sites in MFNP		
	Area covered (*by ongoing monitoring or available data sets)*: QENP, Kabwoya, Drilling sites in MFNP		
	Data storage *(format and place where data sets are stored)*: UWA, MUIENR, WCS		
	Responsibility *(institution and person currently responsible for existing monitoring data sets)*: UWA		
Why (*key question(s) which the indicator helps to answer*): Does infrastructural development have impact on birds population and behavior?			
Current trend (*upward, stable or downward)*: Unknown			
How (*method, sampling and analysis, quality assurance*): Collaring, mist netting, ringing, radio transmitters, counts			
Where (*location, geo-referenced)*: Whole Graben			
When (*frequency*): Twice a year			
By whom *(which institution will collect the indicator data)*: UWA			
Lead agency *(institution and person responsible for calculating and communicating the indicator)*: UWA			
Presentation *(most effective forms of presentation: graphs, maps, narratives etc.)*: Graphs, maps, narratives			
End user(s) *(who will use the indicator for what purpose)*: UWA, Oil companies, Academia			
Financial assessment *(approximate costs from data collection to indicator)*:			
Comments:			
Literature:			

Terrestrial ecosystem			
Group no:	2	**INDICATOR FACT SHEET**	
VEC: **Flagship birds (e.g. African fish eagle, vultures, Forest birds etc)**		IH no:	2
Impact Hypothesis: Hazardous subsistences contain toxic and/or bioaccumulative elects which enter the food chain and leads to increased bird mortalities and public health consequences.		Driver: Hazardous waste and oil spill	
Explanation: There have been instances where birds have been found in drill waste pits e.g. Hammerkop, lapwigs, Egyptian geese and various species of migrant birds. Locally it is known that some birds e.g. Egyptian geese, Guinea Fowls are eaten by people. Elsewhere (e.g. USWFS) research has indicated the hazardous impacts of petroleum related hazardous waste on migratory and non-migratory bird species			
Evaluation in category A, B, C or D:	B*		
Rationale for category: It is an established fact in literature and experience elsewhere that hazardous substances affect birds health			
Recommended research: No primary research is required			
Recommended management actions: Develop capacity for hazardous waste management. Minimize generation of hazardous material use; reuse and recycle hazardous material; proper storage, transfer and disposal of hazardous waste material. Formulation of relevant hazardous waste management regulations, readiness to respond to hazardous waste spills			
Recommended monitoring: Heavy metal analysis in the food chain, sampling of primary raw material inputs, Oil and chemical spills, water quality for traces of heavy metals			
Measurable indicator name (what): Number of spill incidences, heavy metal levels in the food chain, presence and level of heavy metals in water and soils		Order 1, 2 or 3	1
Existing	Existing monitoring *(relevant ongoing monitoring or available data sets)*: Birds counts and distribution		
	Area covered (*by ongoing monitoring or available data sets)*: MFNP, QENP		
	Data storage *(format and place where data sets are stored)*: UWA, MUIENR, WCS		
	Responsibility *(institution and person currently responsible for existing monitoring data sets)*: UWA		
Why (*key question(s) which the indicator helps to answer*):			
Current trend (*upward, stable or downward)*: Unknown			
How (*method, sampling and analysis, quality assurance*): Analysis of hazardous substances in birds and plant tissue, water, and soil.			
Where (*location, geo-referenced)*: Whole Graben			
When (*frequency*): Annual			
By whom *(which institution will collect the indicator data)*: UWA			
Lead agency *(institution and person responsible for calculating and communicating the indicator)*: UWA			
Presentation *(most effective forms of presentation: graphs, maps, narratives etc.)*: Graphs, maps, narratives			
End user(s) *(who will use the indicator for what purpose)*: UWA, Academia, oil companies and other stakeholders			
Financial assessment *(approximate costs from data collection to indicator)*:			
Comments:			
Literature:			

Terrestrial ecosystem			
Group no:	2	**INDICATOR FACT SHEET**	
VEC: **Flagship birds (e.g. African fish eagle, vultures, Forest birds etc)**		IH no:	3
Impact Hypothesis: Domestic wastes enhance the risk of human-wildlife-livestock disease transmission which invariably affects avian species through their food chains		Driver: Domestic waste	
Explanation: Domestic waste congregate birds at disposal points which increases the risk of poaching and disease transmission. At several drill camps weaver birds and malabou stocks have been observed to congregate around domestic organic waste disposal pits (e.g. at Ngege and the former Kyehoro camps)			
Evaluation in category A, B, C or D:	C*		
Rationale for category: This is expected to happen but there is no comprehensive data to validate it yet			

Recommended research: Baseline survey for birds that visit waste pits	
Recommended management actions: Proper disposal of domestic waste, sensitization of communities in the graben, inspections to ensure compliance	
Recommended monitoring: Changes in birds population around waste dumps, behavior change in birds	
Measurable indicator name (what): Birds demography, disease among birds communities	Order 1, 2 or 3: 1
Existing	Existing monitoring *(relevant ongoing monitoring or available data sets)*: None
	Area covered (*by ongoing monitoring or available data sets)*:
	Data storage *(format and place where data sets are stored)*:
	Responsibility *(institution and person currently responsible for existing monitoring data sets)*:
Why (*key question(s) which the indicator helps to answer*): Does domestic wastes enhance the risk of human-wildlife-livestock disease transmission?	
Current trend (*upward, stable or downward)*: Unknown	
How (*method, sampling and analysis, quality assurance*): Collaring, mist netting, ringing, radio transmitters, counts	
Where (*location, geo-referenced)*: Whole Graben	
When (*frequency*): Twice a year	
By whom *(which institution will collect the indicator data)*: UWA	
Lead agency *(institution and person responsible for calculating and communicating the indicator)*: UWA	
Presentation *(most effective forms of presentation: graphs, maps, narratives etc.)*: Graphs, maps, narratives	
End user(s) *(who will use the indicator for what purpose)*: UWA, Academia, oil companies, ministry of health and other stakeholders	
Financial assessment *(approximate costs from data collection to indicator)*:	
Comments:	
Literature:	

Terrestrial ecosystem			
Group no:	2	**INDICATOR FACT SHEET**	
VEC: **Flagship birds (e.g. African fish eagle, vultures, Forest birds etc)**			IH no:
Impact Hypothesis: Refinery and power plant facilities and associated activities generate hazardous wastes, take land, increase ambient noise and night lighting that negatively affects bird habitats directly and indirectly reducing bird populations.			Driver: Refinery and power plants
Explanation: It has been observed in Port Gentil Gabon where a refinery covered several square kilometers of land thereby reducing available habitat and habitat quality for bird species.			
Evaluation in category A, B, C or D:	C*		
Rationale for category: This is expected to happen but there is yet no comprehensive data to validate it yet. Research has been carried out on by Nature Uganda and MUIENR.			
Recommended research: Baselines on birds count and behavior within and around areas proposed for the location of the facilities			
Recommended management actions: Acoustic regulators should be installed on noise sources, Monitoring of nesting/feeding/roosting sites and migratory routes. Installation of appropriate lighting systems e.g. amber light			
Recommended monitoring: Noise levels, light intensity, bird diversity and demography, migratory patterns			
Measurable indicator name (what):		Order 1, 2 or 3	2
Existing	Existing monitoring *(relevant ongoing monitoring or available data sets)*: None		
	Area covered (*by ongoing monitoring or available data sets)*:		
	Data storage *(format and place where data sets are stored)*:		
	Responsibility *(institution and person currently responsible for existing monitoring data sets)*: UWA, NEMA		
Why (*key question(s) which the indicator helps to answer*): What are the impacts of the refinery/power plant facilities and associated activities on avian communities?			
Current trend (*upward, stable or downward)*: N/A			
How (*method, sampling and analysis, quality assurance*): Collaring, mist netting, ringing, radio transmitters, counts			
Where (*location, geo-referenced)*: In and around the refinery			
When (*frequency*): Twice a year			
By whom *(which institution will collect the indicator data)*: UWA			
Lead agency *(institution and person responsible for calculating and communicating the indicator)*: UWA			
Presentation *(most effective forms of presentation: graphs, maps, narratives etc.)*: Graphs, maps, narratives			
End user(s) *(who will use the indicator for what purpose)*: UWA, Oil companies, Academia			
Financial assessment *(approximate costs from data collection to indicator)*:			
Comments:			
Literature:			

Terrestrial ecosystem			
Group no:	2	**INDICATOR FACT SHEET**	
VEC: **Flagship wetland species (e.g. Frogs, butterflies, dragonflies, water fowls etc)**		IH no:	1
Impact Hypothesis: Infrastructural development fragments wetland species' habitats affects feeding and breeding sites leading to reduced productivity. It also leads to direct kills of the species		Driver: Infrastructure (roads, camps, drill sites, jetty sites)	
Explanation: Five wells in Kabwoya WR are within a diameter of about 5Km and there is a dense road network			
Evaluation in category A, B, C or D:	C*		
Rationale for category: This is expected to happen but there is no comprehensive data to validate it yet			

Recommended research: Research on range utilization and migration patterns of flagship species			
Recommended management actions: Prepare a park specific sensitivity atlas focusing on wetland species' issues e.g.breeding sites, prepare management plan, operational guidelines			
Recommended monitoring: Wetland species populations, infrastructure density changes			
Measurable indicator name (what): Wetland species numbers and diversity, ranges (area) and infrastructure density		Order 1, 2 or 3	1
Existing	Existing monitoring *(relevant ongoing monitoring or available data sets)*: None		
	Area covered (*by ongoing monitoring or available data sets)*:		
	Data storage *(format and place where data sets are stored)*:		
	Responsibility *(institution and person currently responsible for existing monitoring data sets)*:		
Why (*key question(s) which the indicator helps to answer*): Does infrastructural development have impact on wetland species population and behavior?			
Current trend (*upward, stable or downward)*: Unknown			
How (*method, sampling and analysis, quality assurance*): Mist netting and counts			
Where (*location, geo-referenced)*: Whole Graben			
When (*frequency*): Twice a year			
By whom *(which institution will collect the indicator data)*: UWA?			
Lead agency *(institution and person responsible for calculating and communicating the indicator)*: UWA?			
Presentation *(most effective forms of presentation: graphs, maps, narratives etc.)*: Graphs, maps, narratives			
End user(s) *(who will use the indicator for what purpose)*: All			
Financial assessment *(approximate costs from data collection to indicator)*:			
Comments:			
Literature:			

Terrestrial ecosystem			
Group no:	2	**INDICATOR FACT SHEET**	
VEC: **Flagship floral ecosystem components (e.g. wetlands, forests, savannas, woodlands, agriculture)**		IH no:	1
Impact Hypothesis: Infrastructural development takes a lot of land, increases the spread of invasive species, habitat destruction and exaverbates human-wildlife conflicts thus affecting the floral eco-system components.		Driver: Infrastructure (roads, seismic lines, camps, drill sites, pipelines airstrip)	
Explanation: Invasive species currently cover nearly 30%of QEPA (particularly Lantana Camara, spear grass etc). Petroleum developments may increase the spread of these species through vehicular movements, land take and decommissioning of facilities.			
Evaluation in category A, B, C or D:	B*		
Rationale for category: Infrastructural development takes geographical space and replaces native vegetation causing competition for the remaining space			
Recommended research:			
Recommended management actions: Approved construction plans, quarantine on new species introduction into the park, adhare to park management plans			
Recommended monitoring: Habitat mapping, invasive species monitoring, human-wildlife conflicts, land cover change analysis			
Measurable indicator name (what): Number and coverage of invasive species, areas that have changed from one cover type to another, number of conflicts reported		Order 1, 2 or 3	1
Existing	Existing monitoring *(relevant ongoing monitoring or available data sets)*: Whole Graben		
	Area covered (*by ongoing monitoring or available data sets)*: Graben		
	Data storage *(format and place where data sets are stored)*: NFA, UWA		
	Responsibility *(institution and person currently responsible for existing monitoring data sets)*: NFA		
Why (*key question(s) which the indicator helps to answer*):			
Current trend (*upward, stable or downward)*: Upward - habitat destruction			
How (*method, sampling and analysis, quality assurance*): Mapping, ground surveys/sampling, evaluating records of conflicts			
Where (*location, geo-referenced)*: Whole Graben			
When (*frequency*): Land cover - 3 years, invasive species - 5 years, Conflicts - annual			
By whom *(which institution will collect the indicator data)*: NFA, UWA, DWM			
Lead agency *(institution and person responsible for calculating and communicating the indicator)*: NFA, UWA,			
Presentation *(most effective forms of presentation: graphs, maps, narratives etc.)*: Graphs, maps, narratives			
End user(s) *(who will use the indicator for what purpose)*: All interested parties			
Financial assessment *(approximate costs from data collection to indicator)*:			
Comments:			
Literature:			

Terrestrial ecosystem			
Group no:	2	**INDICATOR FACT SHEET**	
VEC: **Flagship floral ecosystem components (e.g. wetlands, forests, savannas, woodlands, agriculture)**		IH no:	2
Impact Hypothesis: Human influx can cause land degradation which in turn causes deterioration of floral communities, and increases the spread of invasive species		Driver: Human influx	
Explanation: Opuntia vulgaris (prickly pear) was introduced in QENP as an ornamental plant and as a fencing material for cattle kraals and this plant spread widely. Management is spending a lot of money on its eradication			
Evaluation in category A, B, C or D:	C*		
Rationale for category: Humans convert native veggetation allowing invasive species to take up land. Humans are also agent of invasive species dispesal			

Recommended research: Species diversity, land take by humans			
Recommended management actions: Approved settlement plans, quarantine on new species introduction, Increase security for protected areas, restoration of degraded areas			
Recommended monitoring: Human demography, land cover and biomass			
Measurable indicator name (what): Area of land cover types, biomass stocking including regeneration, biodiversity, trade in timber and non-timber forest products,		Order 1, 2 or 3	2
Existing	Existing monitoring *(relevant ongoing monitoring or available data sets)*: Land cover mapping and biomass monitoring at NFA, biodiversity monitoring by WCS		
	Area covered (*by ongoing monitoring or available data sets)*: Graben		
	Data storage *(format and place where data sets are stored)*: NFA, WCS, MUIENR		
	Responsibility *(institution and person currently responsible for existing monitoring data sets)*: NFA, UWA		
Why (*key question(s) which the indicator helps to answer*): Does human influx have impact on flora?			
Current trend (*upward, stable or downward)*: Upward			
How (*method, sampling and analysis, quality assurance*): Mapping, field surveys			
Where (*location, geo-referenced)*: Whole graben			
When (*frequency*): Every 3 years			
By whom *(which institution will collect the indicator data)*: NFA, UWA			
Lead agency *(institution and person responsible for calculating and communicating the indicator)*: NFA, UWA			
Presentation *(most effective forms of presentation: graphs, maps, narratives etc.)*: Graphs, maps, narratives			
End user(s) *(who will use the indicator for what purpose)*: Government, researchers, oil companies			
Financial assessment *(approximate costs from data collection to indicator)*:			
Comments:			
Literature:			

Terrestrial ecosystem			
Group no:	2	**INDICATOR FACT SHEET**	
VEC: **Flagship floral ecosystem components (e.g. wetlands, forests, savannas, woodlands, agriculture)**		IH no:	3
Impact Hypothesis: Oil spills will directly affect plant survival through blocking their respiratory and food absorption systems. Plants will bioaccumulate heavy metals in their tissues thus affecting the health of herbivores.		Driver: Oil spills, Hazardous & domestic waste	
Explanation: The wash down from the pyrate stock piles that drain down to QENP have been observed to kill vegetation and heavy metals found in the plant tissues and it is known that wildlife graze, browse and water/drink in that area.			
Evaluation in category A, B, C or D:	B*		
Rationale for category:			

Recommended research: Adequate capacity to respond quickly to oil spills promptly (both human and resource), adherence to established construction plans and safety standards, strengthen legislation concerning pollution and oil spills			
Recommended management actions:			
Recommended monitoring: Regular inspecion of oil infrastructure			
Measurable indicator name (what): Number and quantity of spills, spatial coverage of spill, response time to spills		Order 1, 2 or 3	1
Existing	Existing monitoring *(relevant ongoing monitoring or available data sets)*: None		
	Area covered (*by ongoing monitoring or available data sets)*: N/A		
	Data storage *(format and place where data sets are stored)*: N/A		
	Responsibility *(institution and person currently responsible for existing monitoring data sets)*: PEPD		
Why (*key question(s) which the indicator helps to answer*):			
Current trend (*upward, stable or downward)*: Stable			
How (*method, sampling and analysis, quality assurance*): Inspection reports			
Where (*location, geo-referenced)*: Whole Graben			
When (*frequency*): Where oil activities are taking place			
By whom *(which institution will collect the indicator data)*: PEPD, NEMA			
Lead agency *(institution and person responsible for calculating and communicating the indicator)*: NEMA			
Presentation *(most effective forms of presentation: graphs, maps, narratives etc.)*: Graphs, maps, narratives			
End user(s) *(who will use the indicator for what purpose)*: Government, oil companies, UWA and other stakeholders			
Financial assessment *(approximate costs from data collection to indicator)*:			
Comments:			
Literature:			

Terrestrial ecosystem			
Group no:	2	**INDICATOR FACT SHEET**	
VEC: **Below ground biodiversity (macro and micro organisms etc)**		IH no:	1
Impact Hypothesis: Infrastructural development and human influx affects the feeding and breeding sites of BGBD species. It also directly destroys their habitats and increases mortality.		Driver: Infrastructure (roads, camps, drill sites burrow pits) and human influx	
Explanation: Infrastructure and human influx affect the feeding and breeding sites of BGBD species.			
Evaluation in category A, B, C or D:	C*		
Rationale for category: There is limited knowledge on the impact of infrastucture and human influx on BGBD			

Recommended research: Impact of human disturbance on the species count and diversity of BGBD.			
Recommended management actions: Sensitization soil manament practices that conserve BGBD species			
Recommended monitoring: Counts of soil BGBD e.g. earth worm and beetles			
Measurable indicator name (what): Counts and diversity		Order 1, 2 or 3	1
Existing	Existing monitoring *(relevant ongoing monitoring or available data sets)*: None		
	Area covered (*by ongoing monitoring or available data sets)*:		
	Data storage *(format and place where data sets are stored)*:		
	Responsibility *(institution and person currently responsible for existing monitoring data sets)*:		
Why (*key question(s) which the indicator helps to answer*): Does infrastructural development and human influx affects the feeding and breeding sites of BGBD species?			
Current trend (*upward, stable or downward)*: Unknown			
How (*method, sampling and analysis, quality assurance*): Counts			
Where (*location, geo-referenced)*: All Graben			
When (*frequency*): 4 times in a year			
By whom *(which institution will collect the indicator data)*: NARL			
Lead agency *(institution and person responsible for calculating and communicating the indicator)*: NARO			
Presentation *(most effective forms of presentation: graphs, maps, narratives etc.)*: Graphs, maps, narratives			
End user(s) *(who will use the indicator for what purpose)*: All			
Financial assessment *(approximate costs from data collection to indicator)*:			
Comments:			
Literature:			

Terrestrial ecosystem			
Group no:	2	**INDICATOR FACT SHEET**	
VEC: **Below ground biodiversity (macro and micro organisms etc)**		IH no:	2
Impact Hypothesis: BGBD can either be directly affected by hazardous waste or through food chain. Direct effects may result in increased mortality		Driver: Hazardous waste, domestic waste, oil spill	
Explanation: BGBD accumulates contaminants from wastes and oil. The BGBD is eaten by omnivores which are in turn preyed by carnivorous mammals			
Evaluation in category A, B, C or D:	C*		
Rationale for category: There is limited knowledge on the impact of wastes and oil spills on BGBD			

Recommended research: Impact of waste and oil spill on the species count and diversity of BGBD	
Recommended management actions: Sensitization waste manament practices that conserve BGBD species. Develop capacity for hazardous waste management. Minimize generation of hazardous material use, proper storage, transfer and disposal of hazardous waste material. Formulation of relevant waste management regulations, readiness to respond to hazardous waste and oil spills	
Recommended monitoring: Counts of soil BGBD at representative waste disposal or oil spill sites	
Measurable indicator name (what): Counts and diversity	Order 1, 2 or 3: 1
Existing	Existing monitoring *(relevant ongoing monitoring or available data sets)*: None
	Area covered (*by ongoing monitoring or available data sets)*:
	Data storage *(format and place where data sets are stored)*:
	Responsibility *(institution and person currently responsible for existing monitoring data sets)*:
Why (*key question(s) which the indicator helps to answer*): Does waste and oil spill affect BGBD?	
Current trend (*upward, stable or downward)*: Unknown	
How (*method, sampling and analysis, quality assurance*): Counts	
Where (*location, geo-referenced)*: Whole graben	
When (*frequency*): 4 times a year	
By whom *(which institution will collect the indicator data)*: NARL	
Lead agency *(institution and person responsible for calculating and communicating the indicator)*: NARO	
Presentation *(most effective forms of presentation: graphs, maps, narratives etc.)*: Graphs, maps, narratives	
End user(s) *(who will use the indicator for what purpose)*: All	
Financial assessment *(approximate costs from data collection to indicator)*:	
Comments:	
Literature:	

The group work also resulted in some unfinished Indicator Fact Sheets. For documentation purpose the Impact hypotheses are listed below.

Group no:	2	**INDICATOR FACT SHEET**	
VEC: **Flagship wetland species (e.g. frogs, butterflies, dragonflies, water fowls etc)**			IH no:
Impact Hypothesis: Wetland species can be affected by hazardous waste through food chain and direct kill when they fall into the waste e.g. into pits.			Driver: Hazardous waste
Explanation:			
Evaluation in category A, B, C or D:	B		
Rationale for category:			

Group no:	2	**INDICATOR FACT SHEET**	
VEC: **Flagship wetland species (e.g. frogs, butterflies, dragonflies, water fowls etc)**			IH no:
Impact Hypothesis: Domestic wastes affect wetland species through their food chain and through causing changes in water quality.			Driver: Domestic waste
Explanation:			
Evaluation in category A, B, C or D:	B		
Rationale for category:			

Group no:	2	**INDICATOR FACT SHEET**	
VEC: **Flagship wetland species (e.g. frogs, butterflies, dragonflies, water fowls etc)**			IH no:
Impact Hypothesis: Oil spills negatively affect wetland species' bio-physical and physiological abilities either directly or indirectly through the food chain and through reducing water quality. This increase bird mortality.			Driver: Oil spill
Explanation:			
Evaluation in category A, B, C or D:	B		
Rationale for category:			

Group no:	2	**INDICATOR FACT SHEET**	
VEC: **Flagship wetland species (e.g. frogs, butterflies, dragonflies, water fowls etc)**			IH no:
Impact Hypothesis: A refinery and associated activities generate hazardous wastes, take land, and increase night lighting that negatively affects wetland species habitats directly and indirectly reducing their population.			Driver: Refinery
Explanation:			
Evaluation in category A, B, C or D:	B		
Rationale for category:			

2.6 Physical/chemical issues

2.6.1 Valued Ecosystem Components

Group no:	3	Issue:	Physical and Chemical issues		
Valued Ecosystem Components, ranked		**Associated drivers, ranked (after group work 2)**		**Phase**	**Comments**
VEC 1 Water Surface Water Quality Ground Water Quality Surface Water Quantity Ground Water Quantity		1D1: Waste Disposals			
		1D2: Oil Spills			
		1D3: Large water abstraction			
		1D4: Vegatation Clearance			
VEC 2 Air Air Quality		2D1: Seismic tests, vehicles and machinery, construction			
		2D2: Oil development and production			
VEC 3 Soil Soil Pollution Soil Quality Soil Biota		3D1: Oil Spills			
		3D2: Waste Disposal			
		3D3: Vegetation clearance for settlements, infrastructure development and agriculture			
VEC 4 Micro Climate Wind Temperature Humidity		4D1: Heat generation from vehicles, oil rifinery			
		4D2: Vegetation clearance			
VEC 5 Physical landscape Surface landscape Ground Structural stability including vibration		5D1: Seismic tests, vehicle and machine operations			
		5D2: Excavations, construction, settlements and other land use practices			

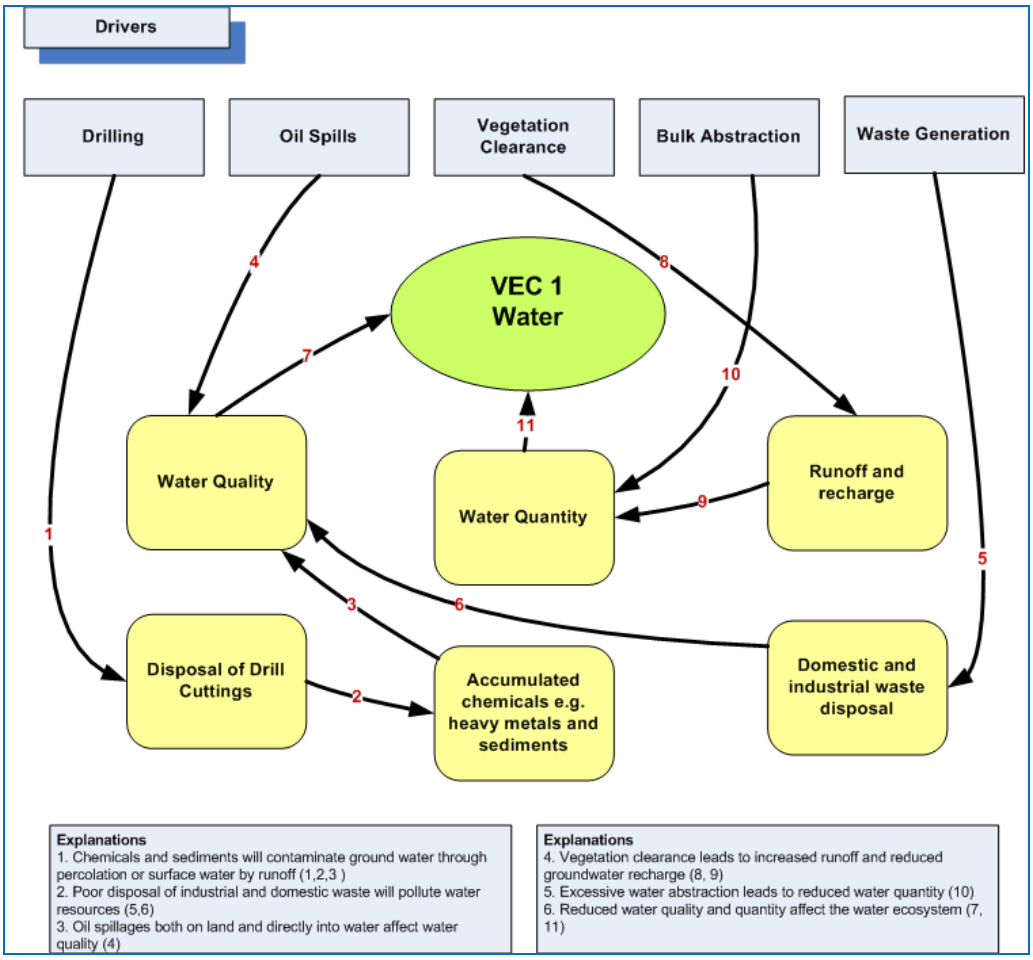
2.6.2 Drivers

Group no:	3	Issue:	Physical and Chemical issues				
Overall rank	**Drivers\phase → ↓**		**Exploration**	**Development**	**Production**	**Decommissioning**	**Others**
9	Waste Discharge		2	3	3	1	
7	Sediment Pollution		1	2	3	1	
6	Waste generation		1	1	3	1	
6	Pollution by Seepage into aquifer		1	3	1	1	
5	Aquifer mining		1	1	2	1	
4	Precipitation		1	1	1	1	
5	Evaporation		1	1	2	1	
6	Large Water abstruction		1	1	3	1	
6	Groundwater Recharge		1	1	3	1	
7	Air chemical pollutants		1	2	3	1	
7	Air Particulate pollutants		1	2	3	1	
5	Air Temperature		1	1	2	1	

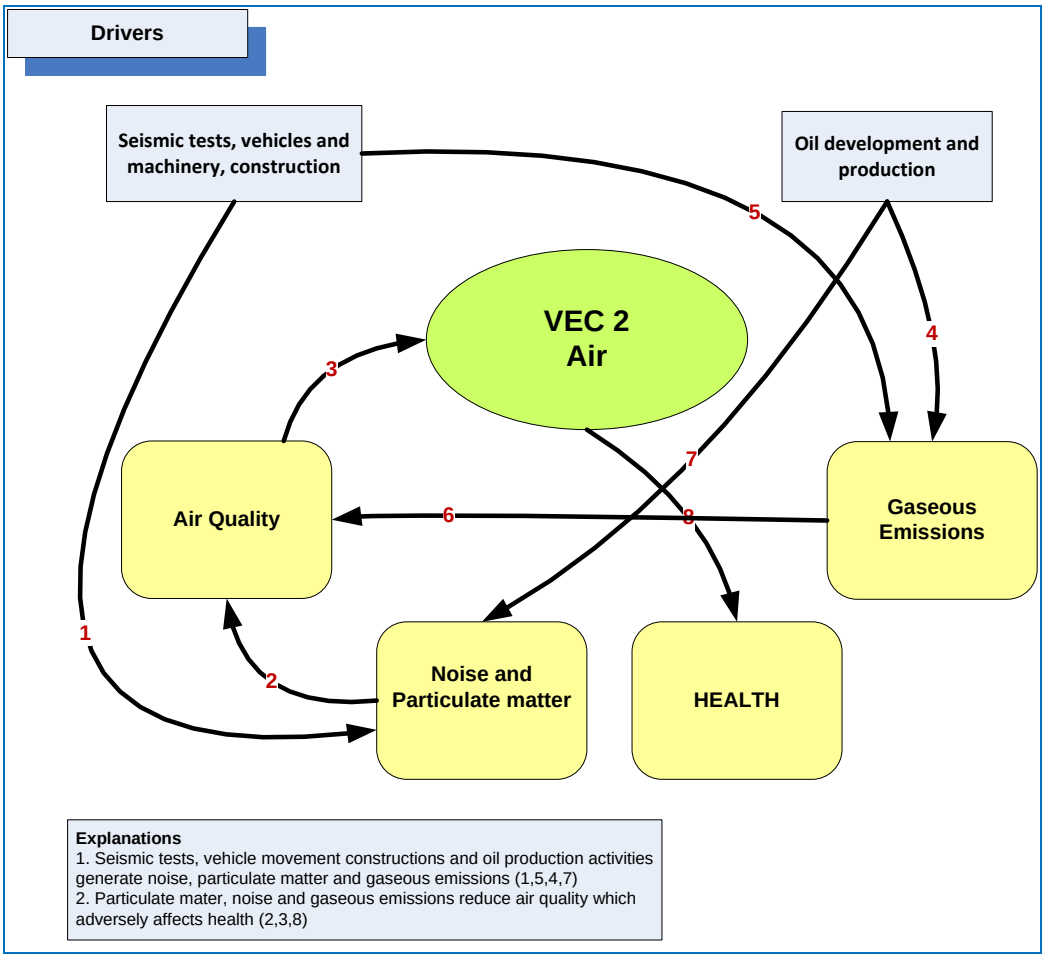
11	Noise	2	3	3	3	
8	Soil Chemical pollution	1	3	3	1	
6	Soil productivity	1	1	3	1	
7	Soil erosion	1	2	3	1	
7	Soil permeability	1	2	3	1	
5	Soil temperature	1	1	2	1	
6	Changes in Soil Biota	1	1	3	1	
4	Changes in Rainfall amount and distribution	1	1	1	1	
5	Change in Wind Speed and Direction	1	1	2	1	
5	Change in Mean Temperature	1	1	2	1	
5	Change in Humidity	1	1	2	1	
6	Landscape degradation and distortions through land use practices	1	1	3	1	
7	Vibrations in ground structures	3	2	1	1	
Comments: 1,2,3 (increasing importance from 1 to 3)						

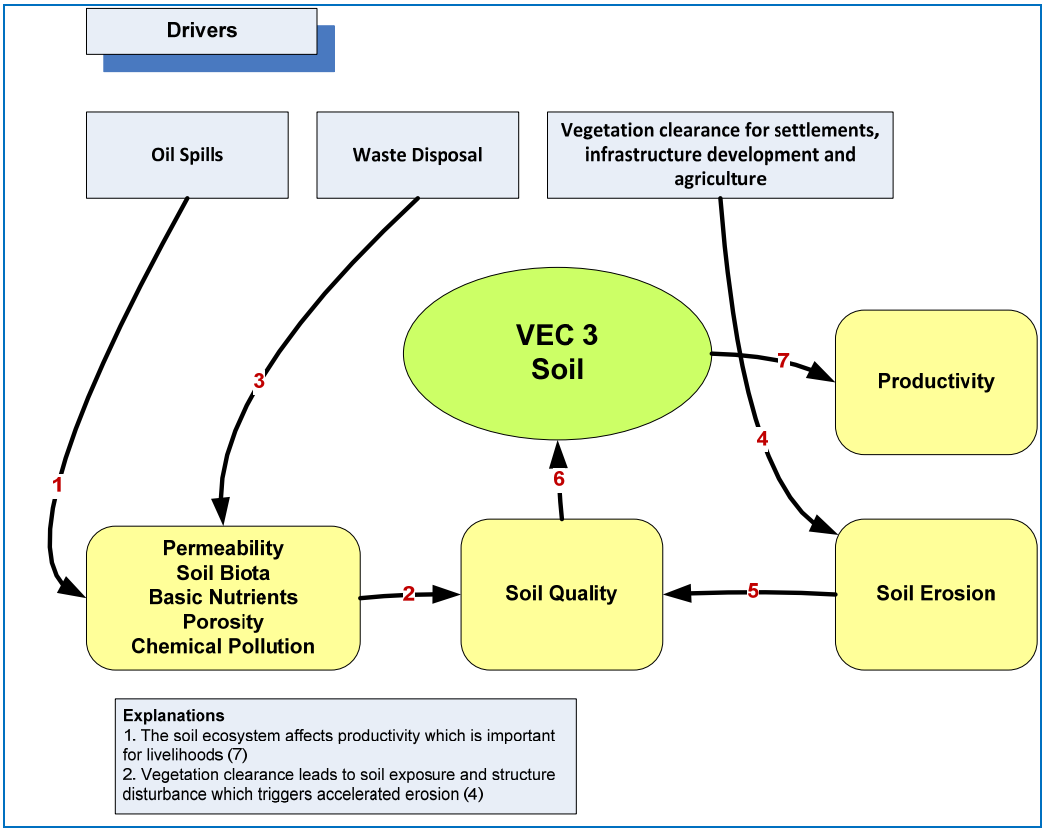
Surface water quality and quantity will probably be monitored. Nile river. Photo: Jørn Thomassen.

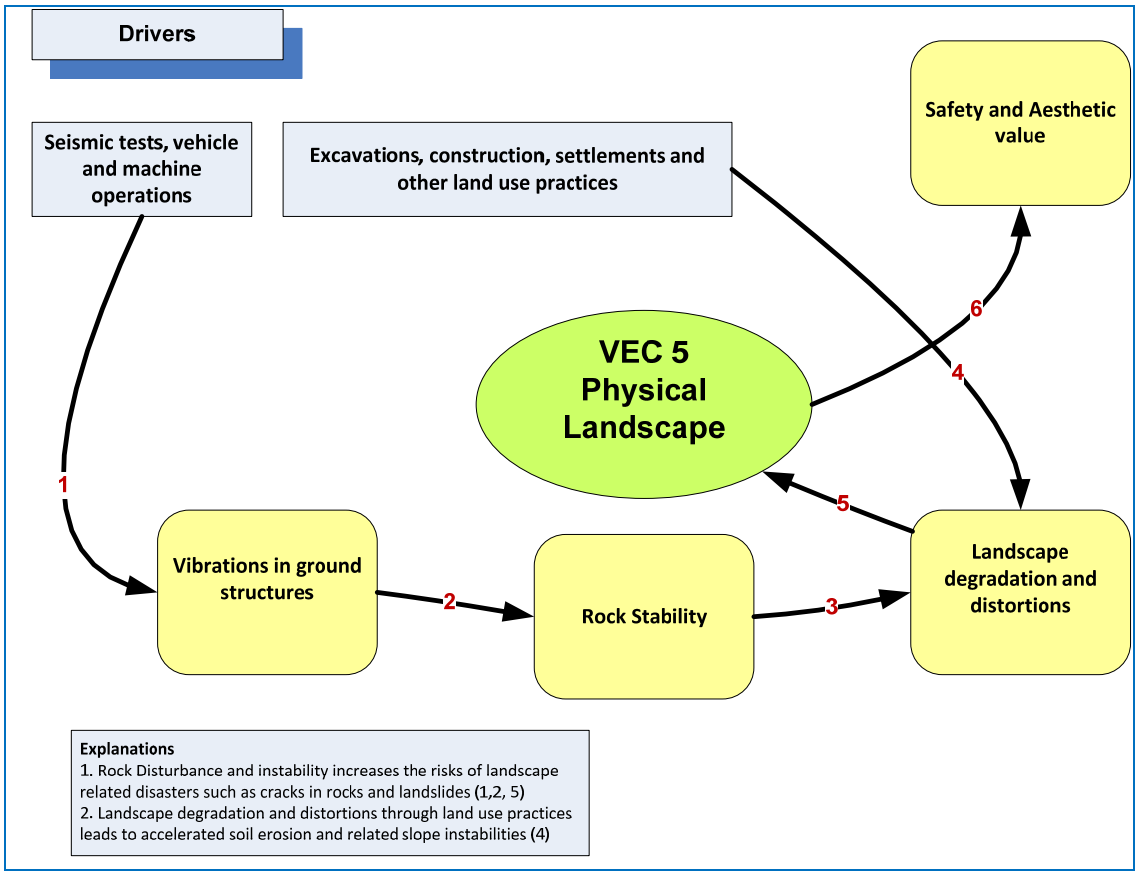
2.6.3 Cause – effect charts, physical/chemical

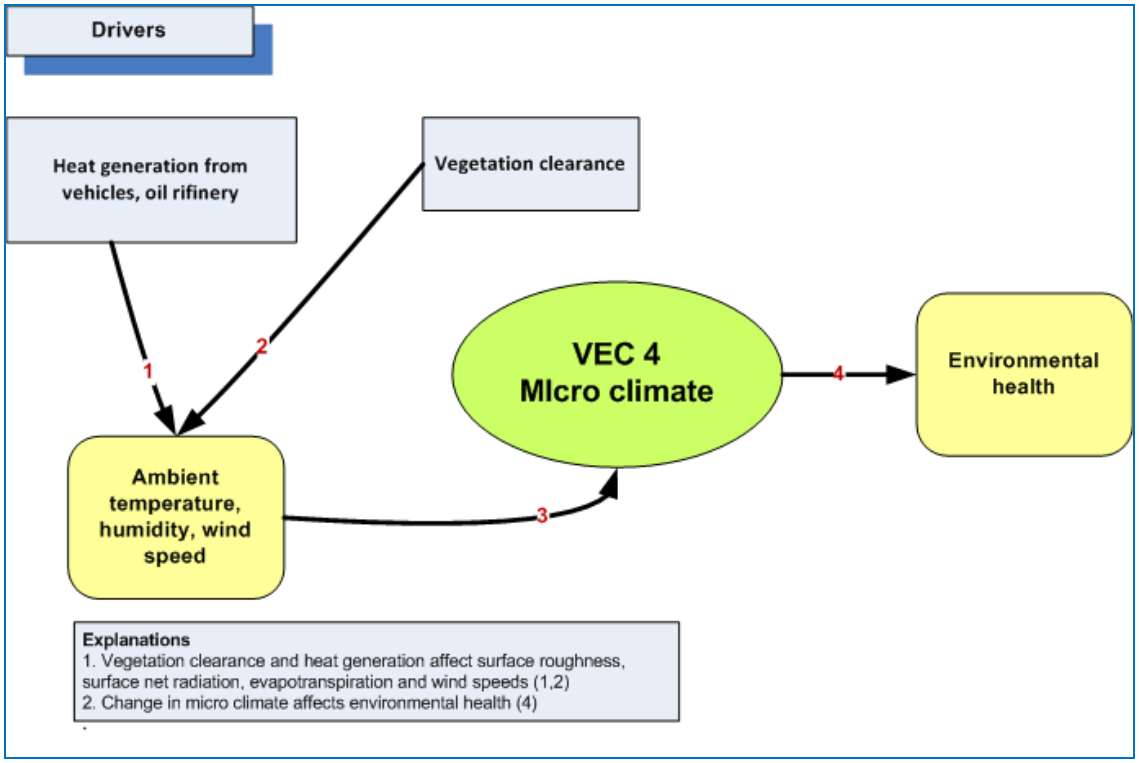


Water is crucial for several bird species like the Great white egret and the Spur-winged plover. Photo: Jørn Thomassen.


Drivers
Seismic tests, vehicles and machinery, construction
Oil development and production
VEC 2
Air
Air Quality
Gaseous Emissions
Noise and Particulate matter
HEALTH
1
2
3
4
5
6
7
8
Explanations
1. Seismic tests, vehicle movement constructions and oil production activities generate noise, particulate matter and gaseous emissions (1,5,4,7)
2. Particulate mater, noise and gaseous emissions reduce air quality which adversely affects health (2,3,8)


Drivers
Oil Spills
Waste Disposal
Vegetation clearance for settlements, infrastructure development and agriculture
VEC 3
Soil
Productivity
Permeability
Soil Biota
Basic Nutrients
Porosity
Chemical Pollution
Soil Quality
Soil Erosion
1
2
3
4
5
6
7
Explanations
1. The soil ecosystem affects productivity which is important for livelihoods (7)
2. Vegetation clearance leads to soil exposure and structure disturbance which triggers accelerated erosion (4)


Drivers
Seismic tests, vehicle and machine operations
Excavations, construction, settlements and other land use practices
Safety and Aesthetic value
VEC 5 Physical Landscape
Vibrations in ground structures
Rock Stability
Landscape degradation and distortions
1
2
3
4
5
6
Explanations
1. Rock Disturbance and instability increases the risks of landscape related disasters such as cracks in rocks and landslides (1,2, 5)
2. Landscape degradation and distortions through land use practices leads to accelerated soil erosion and related slope instabilities (4)


Drivers
Heat generation from vehicles, oil rifinery
Vegetation clearance
VEC 4 Micro climate
Environmental health
Ambient temperature, humidity, wind speed
1
2
3
4
Explanations
1. Vegetation clearance and heat generation affect surface roughness, surface net radiation, evapotranspiration and wind speeds (1,2)
2. Change in micro climate affects environmental health (4)

2.6.4 Indicator Fact Sheets

Physical/chemical			
Group no:	3	**INDICATOR FACT SHEET**	
VEC 1: **Water**		IH no:	1
Impact Hypothesis: Drill Cuttings will contaminate ground water through percolation and surface water by runoff		Driver: Drilling	
Explanation: Drill cuttings contain heavy metals and other chemicals that can cause pollution of the water			
Evaluation in category A, B, C or D:	B		
Rationale for category: Sufficient evidence from earlier drilling activities has shown this.			

Recommended research: Not for validating the hypothesis			
Recommended management actions:			
Recommended monitoring:			
Measurable indicator name (what): Site samples analysed for heavy metals		Order 1, 2 or 3	1
Existing	Existing monitoring *(relevant ongoing monitoring or available data sets)*: No		
	Area covered (*by ongoing monitoring or available data sets)*: None		
	Data storage *(format and place where data sets are stored)*:		
	Responsibility *(institution and person currently responsible for existing monitoring data sets)*:		
Why (*key question(s) which the indicator helps to answer*): Will drill cuttings contaminate surface and groundwater?			
Current trend (*upward, stable or downward)*: Not applicable			
How (*method, sampling and analysis, quality assurance*): Heavy metal sampling (using standard methods) and samples analysed in GOV'T and other gazette LABS			
Where (*location, geo-referenced)*: Specific sites where heavy metals are likely to contaminate water (yet to be decided)			
When (*frequency*): Quarterly (start before drilling activities to get the baseline)			
By whom *(which institution will collect the indicator data)*: DWRM and Oil companies, to be coordinated by NEMA			
Lead agency *(institution and person responsible for calculating and communicating the indicator)*: DWRM			
Presentation *(most effective forms of presentation: graphs, maps, narratives etc.)*: Graphs, Maps			
End user(s) *(who will use the indicator for what purpose)*: Management and response actions will be taken by Government, communities, other key stakeholders and oil companies.			
Financial assessment *(approximate costs from data collection to indicator)*: To be done later			
Comments:			
Literature:			

A. The hypothesis is assumed not to be valid.
B. The hypothesis is valid and already verified. Research to validate or invalidate the hypothesis is not required. Surveys, monitoring, and/or management measures can possible be recommended.
C. The hypothesis is assumed to be valid. Research, monitoring or surveys is recommended to validate or invalidate the hypothesis. Mitigating measures can be recommended if the hypothesis is proved to be valid.
D. The hypothesis may be valid, but is not worth testing for professional, logistic, economic or ethical reasons, or because it is assumed to be of minor environmental influence only or of insignificant value for decision making.

Physical/chemical			
Group no:	3	**INDICATOR FACT SHEET**	
VEC 1: **Water**		IH no:	2
Impact Hypothesis: Excessive water abstraction will lead to reduced water quantity		Driver: Bulk water abstraction	
Explanation: Oil production and processing will require large volumes of water			
Evaluation in category A, B, C or D:	C		
Rationale for category: Insufficient information on the water budget for the graben			
Recommended research: Carrying out water balance studies for the graben and downstream			
Recommended management actions:			
Recommended monitoring: Amount of water abstracted, recharge rates, reservoir levels			
Measurable indicator name (what): River discharge, lake levels, groundwater levels and rainfall		Order 1, 2 or 3	1
Existing	Existing monitoring *(relevant ongoing monitoring or available data sets)*: Yes, but inadequate		
	Area covered (*by ongoing monitoring or available data sets)*: Significant area covered but requires review in view of the expected use in oil production		
	Data storage *(format and place where data sets are stored)*: Microsoft Access sheets, DWRM		
	Responsibility *(institution and person currently responsible for existing monitoring data sets)*: DWRM		
Why (*key question(s) which the indicator helps to answer*): Will the expected large scale water abstraction significantly affect water quantity?			
Current trend (*upward, stable or downward)*: Insignificant			
How (*method, sampling and analysis, quality assurance*): Conventional hydrological techniques			
Where (*location, geo-referenced)*: To be determined after network review			
When (*frequency*): Daily			
By whom *(which institution will collect the indicator data)*: DWRM and Oil companies, to be coordinated by NEMA			
Lead agency *(institution and person responsible for calculating and communicating the indicator)*: DWRM			
Presentation *(most effective forms of presentation: graphs, maps, narratives etc.)*: Graphs, Maps			
End user(s) *(who will use the indicator for what purpose)*: Management actions will be taken by Government and implemented by Oil companies			
Financial assessment *(approximate costs from data collection to indicator)*: To be done later			
Comments:			
Literature:			

A. The hypothesis is assumed not to be valid.
B. The hypothesis is valid and already verified. Research to validate or invalidate the hypothesis is not required. Surveys, monitoring, and/or management measures can possible be recommended.
C. The hypothesis is assumed to be valid. Research, monitoring or surveys is recommended to validate or invalidate the hypothesis. Mitigating measures can be recommended if the hypothesis is proved to be valid.
D. The hypothesis may be valid, but is not worth testing for professional, logistic, economic or ethical reasons, or because it is assumed to be of minor environmental influence only or of insignificant value for decision making.

Physical/chemical			
Group no:	3	**INDICATOR FACT SHEET**	
VEC 1: **Water**		IH no:	3
Impact Hypothesis: Poor disposal of industrial and domestic waste will pollute water resources which may affect aquatic life		Driver: Waste	
Explanation: Waste generated from domestic and industrial activities contain pollutants that will pollute water			
Evaluation in category A, B, C or D:	B		
Rationale for category: Sufficient evidence is available			

Recommended research: Baseline on environmental factors of key fish habitats		
Recommended management actions: Develop and implement a waste management plan and risk management		
Recommended monitoring: Effluent, Water bodies, Leachate , Sediments, Fish tissue		
Measurable indicator name (what): Waste water, biological indicators, leachate parameters, heavy metals, PHCs and nutrient loads	Order 1, 2 or 3	
Existing	Existing monitoring *(relevant ongoing monitoring or available data sets)*: Baseline 2007 -2009	
	Area covered (*by ongoing monitoring or available data sets)*: Ngasa, Kyehoro, Kaiso-Tonya, Sabagoro to Bugoma	
	Data storage *(format and place where data sets are stored)*: Microsoft Excel	
	Responsibility *(institution and person currently responsible for existing monitoring data sets)*: NaFIRRI	
Why (*key question(s) which the indicator helps to answer*): Will poor waste disposal contaminate water?		
Current trend (*upward, stable or downward)*: Not applicable		
How (*method, sampling and analysis, quality assurance*): Measurements to be undertaken using standard methods		
Where (*location, geo-referenced)*: Specific sites where waste will be generated and disposed of		
When (*frequency*): Monthly but with risk evidence instant checks and compliance monitoring (start before drilling activities to get the baseline)		
By whom *(which institution will collect the indicator data)*: DWRM, NAFIRRI/DFR and Oil companies, to be coordinated by NEMA		
Lead agency *(institution and person responsible for calculating and communicating the indicator)*: DWRM and NAFIRRI/DFR		
Presentation *(most effective forms of presentation: graphs, maps, narratives etc.)*: Tables, Graphs, Maps		
End user(s) *(who will use the indicator for what purpose)*: Management and response actions will be taken by Government, other key stakeholders and oil companies		
Financial assessment *(approximate costs from data collection to indicator)*: To be done later		
Comments:		
Literature:		

A. The hypothesis is assumed not to be valid.
B. The hypothesis is valid and already verified. Research to validate or invalidate the hypothesis is not required. Surveys, monitoring, and/or management measures can possible be recommended.
C. The hypothesis is assumed to be valid. Research, monitoring or surveys is recommended to validate or invalidate the hypothesis. Mitigating measures can be recommended if the hypothesis is proved to be valid.
D. The hypothesis may be valid, but is not worth testing for professional, logistic, economic or ethical reasons, or because it is assumed to be of minor environmental influence only or of insignificant value for decision making.

Physical/chemical			
Group no:	3	**INDICATOR FACT SHEET**	
VEC 2: **Air**		IH no:	1
Impact Hypothesis: Seismic tests, vehicle movement constructions and oil production activities will generate noise, particulate matter and gaseous emissions that will affect air quality		Driver: Seismic tests, vehicles and machinery, construction	
Explanation: Oil production and processing use equipment that generate noise, particulate mater and gaseous emissions.			
Evaluation in category A, B, C or D:	B		
Rationale for category: Information and evidence is available			
Recommended research: None			
Recommended management actions: Need to develop standard methods for monitoring the impact			
Recommended monitoring: Noise levels, particulate matter and gaseous concentrations			
Measurable indicator name (what): Noise levels, vibrations, concentrates of gases and particulate matter		Order 1, 2 or 3	
Existing	Existing monitoring *(relevant ongoing monitoring or available data sets)*: None		
	Area covered (*by ongoing monitoring or available data sets)*: Not applicable		
	Data storage *(format and place where data sets are stored)*: None		
	Responsibility *(institution and person currently responsible for existing monitoring data sets)*: None at the moment		
Why (*key question(s) which the indicator helps to answer*): Will gaseous emissions, particulate matter and noise significantly affect health and environment?			
Current trend (*upward, stable or downward)*: Not applicable			
How (*method, sampling and analysis, quality assurance*): Standard methods and procedures			
Where (*location, geo-referenced)*: To be determined later			
When (*frequency*): Daily			
By whom *(which institution will collect the indicator data)*: OSH,DOM and Oil companies coordinated by NEMA			
Lead agency *(institution and person responsible for calculating and communicating the indicator)*: OSH			
Presentation *(most effective forms of presentation: graphs, maps, narratives etc.)*: Graphs, Maps			
End user(s) *(who will use the indicator for what purpose)*: Management actions will be taken by Government and implemented by Oil companies			
Financial assessment *(approximate costs from data collection to indicator)*: To be done later			
Comments:			
Literature:			

A. The hypothesis is assumed not to be valid.
B. The hypothesis is valid and already verified. Research to validate or invalidate the hypothesis is not required. Surveys, monitoring, and/or management measures can possible be recommended.
C. The hypothesis is assumed to be valid. Research, monitoring or surveys is recommended to validate or invalidate the hypothesis. Mitigating measures can be recommended if the hypothesis is proved to be valid.
D. The hypothesis may be valid, but is not worth testing for professional, logistic, economic or ethical reasons, or because it is assumed to be of minor environmental influence only or of insignificant value for decision making.

Physical/chemical			
Group no:	3	**INDICATOR FACT SHEET**	
VEC 3: **Soil**		IH no:	1
Impact Hypothesis: Oil spills will alter soil permeability, Soil Biota, Basic Nutrients, Porosity which will significantly affect soil quality hence reducing soil productivity		Driver: Oil Spills	
Explanation: The hydrophobic characteristic of oil obstructs water movement in the soil. Oil also contains chemicals that pollute the soil and hence affecting basic soil nutrients and soil biota. All these lead to reduced soil productivity.			
Evaluation in category A, B, C or D:	B		
Rationale for category: Information and evidence is available from scientific research			

Recommended research: None	
Recommended management actions: Develop oil spill monitoring protocols (including surveillance and emergency response)	
Recommended monitoring: Visual observations, Standard Laboratory tests	
Measurable indicator name (what): Area covered by the spill, Magnitude and extent of oil traces, results from laboratory tests for hydrocarbons and heavy metals	Order 1, 2 or 3
Existing	Existing monitoring *(relevant ongoing monitoring or available data sets)*: None
	Area covered (*by ongoing monitoring or available data sets)*: Not applicable
	Data storage *(format and place where data sets are stored)*: None
	Responsibility *(institution and person currently responsible for existing monitoring data sets)*: None at the moment
Why (*key question(s) which the indicator helps to answer*): Will oil spills have an impact on the soil ecosystem?	
Current trend (*upward, stable or downward)*: Not applicable	
How (*method, sampling and analysis, quality assurance*): Standard methods and procedures	
Where (*location, geo-referenced)*: To be determined later	
When (*frequency*): Continuously	
By whom *(which institution will collect the indicator data)*: Oil companies, NARO – NARL, coordinated by NEMA	
Lead agency *(institution and person responsible for calculating and communicating the indicator)*: NARO - NARL	
Presentation *(most effective forms of presentation: graphs, maps, narratives etc.)*: Graphs, Maps	
End user(s) *(who will use the indicator for what purpose)*: Management and response actions will be taken by Government, communities, other key stakeholders and oil companies.	
Financial assessment *(approximate costs from data collection to indicator)*: To be done later	
Comments:	
Literature:	

A. The hypothesis is assumed not to be valid.
B. The hypothesis is valid and already verified. Research to validate or invalidate the hypothesis is not required. Surveys, monitoring, and/or management measures can possible be recommended.
C. The hypothesis is assumed to be valid. Research, monitoring or surveys is recommended to validate or invalidate the hypothesis. Mitigating measures can be recommended if the hypothesis is proved to be valid.
D. The hypothesis may be valid, but is not worth testing for professional, logistic, economic or ethical reasons, or because it is assumed to be of minor environmental influence only or of insignificant value for decision making.

Physical/chemical			
Group no:	3	**INDICATOR FACT SHEET**	
VEC 4: **Micro Climate**		IH no:	1
Impact Hypothesis: Heat generated from vehicles and oil refinery will change the micro climate of the area		Driver: Heat generation from vehicles, oil refinery	
Explanation: Operation of oil refineries and vehicular movements are known to generate significant amounts of heat which affect the temperature and wind speed of the area			
Evaluation in category A, B, C or D:	B		
Rationale for category: Sufficient evidence from earlier research			

Recommended research: Site based research needed	
Recommended management actions: Design and implement a framework for installation of an optimum network	
Recommended monitoring: Rainfall, wind, temperature, pressure, evapo-transpiration and solar radiation	
Measurable indicator name (what): Changes in; rainfall, wind, temperature, pressure, evapo-transpiration and solar radiation	Order 1, 2 or 3
Existing	Existing monitoring *(relevant ongoing monitoring or available data sets)*: Yes, but needs improvement
	Area covered (*by ongoing monitoring or available data sets)*: Insignificant area covered
	Data storage *(format and place where data sets are stored)*: DOM
	Responsibility *(institution and person currently responsible for existing monitoring data sets)*: DOM
Why (*key question(s) which the indicator helps to answer*): Will the operations of the oil refinery alter the micro climate of the graben?	
Current trend (*upward, stable or downward)*: Not applicable	
How (*method, sampling and analysis, quality assurance*): Observations using standard instruments	
Where (*location, geo-referenced)*: Specific sites to be decided later	
When (*frequency*): Daily (start before drilling activities to get the baseline)	
By whom *(which institution will collect the indicator data)*: DOM, DWRM and Oil companies	
Lead agency *(institution and person responsible for calculating and communicating the indicator)*: DOM	
Presentation *(most effective forms of presentation: graphs, maps, narratives etc.)*: Data tables, Graphs, Maps and Advisories	
End user(s) *(who will use the indicator for what purpose)*: Management and response actions will be taken by Government, communities, other key stakeholders and oil companies.	
Financial assessment *(approximate costs from data collection to indicator)*: To be done later	
Comments:	
Literature:	

A. The hypothesis is assumed not to be valid.
B. The hypothesis is valid and already verified. Research to validate or invalidate the hypothesis is not required. Surveys, monitoring, and/or management measures can possible be recommended.
C. The hypothesis is assumed to be valid. Research, monitoring or surveys is recommended to validate or invalidate the hypothesis. Mitigating measures can be recommended if the hypothesis is proved to be valid.
D. The hypothesis may be valid, but is not worth testing for professional, logistic, economic or ethical reasons, or because it is assumed to be of minor environmental influence only or of insignificant value for decision making.

2.7 Society issues

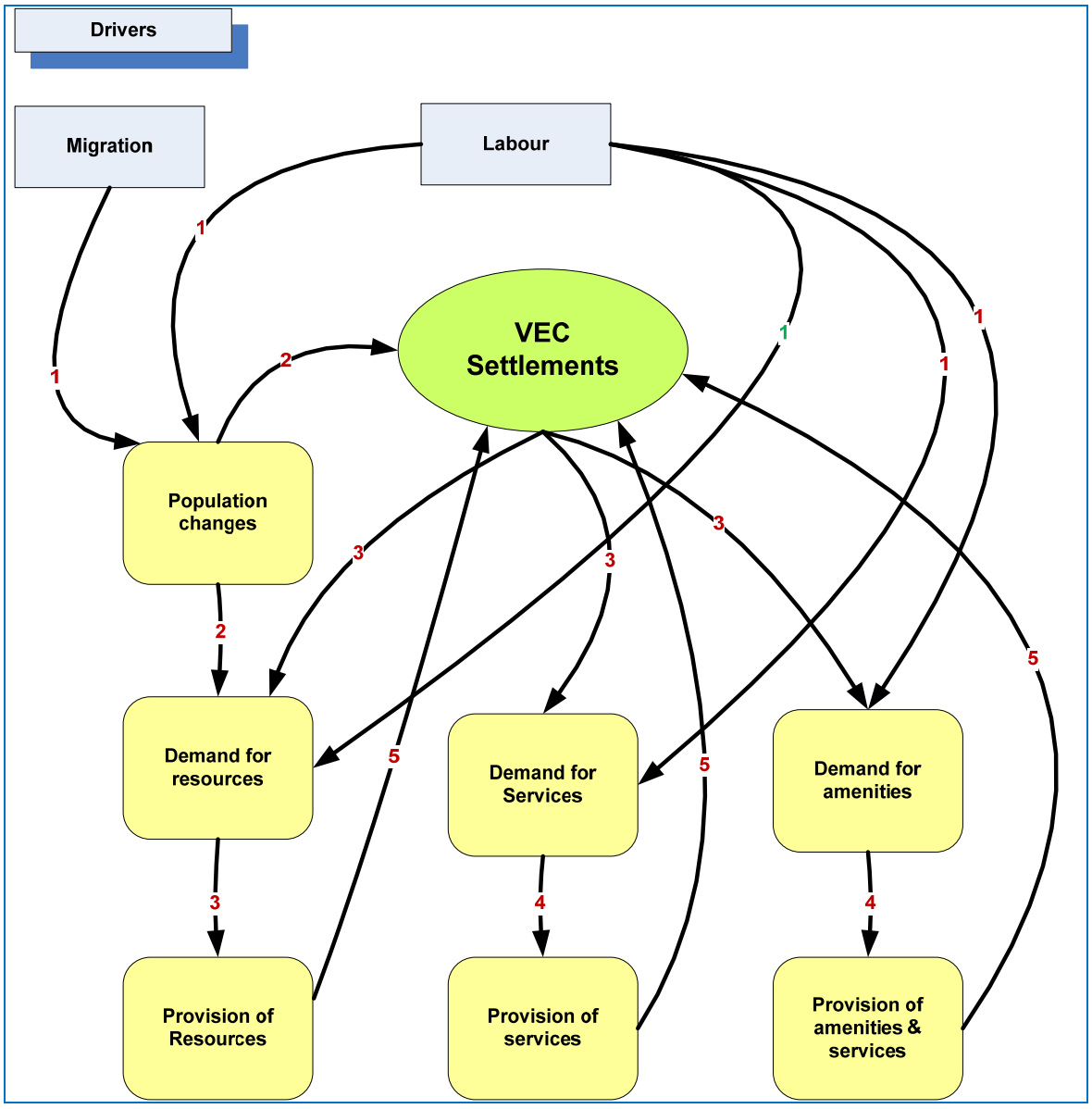
2.7.1 Valued Ecosystem Components

Group no:	4	Issue:	Society issues		
Valued Ecosystem Components, ranked			**Associated drivers, ranked (after group work 2)**	**Phase**	**Comments**
VEC 1 Settlements			Migration		
			Labour		
VEC 2 Food			Production		
			Storage		
			Infrastructure development		
VEC 3 Water and sanitation			Population		
			Infrastructure development		
VEC 4 Health			Population		
			Pollution		
			Infrastructure development		
VEC 5 Infrastructure			Population		
			Mineral development		
VEC 6 Energy			Population		
			Infrastructure development		
VEC 7 Education			Population		
			Infrastructure development		
VEC 8 Culture			Migration		
			Economic development		
			Education		
VEC 9 Archeological sites			Population		
			Infrastructure development		
VEC 10 Disaster			Settlement		
			Infrastructure development		
VEC 11 Governance			Population		
			Infrastructure development		

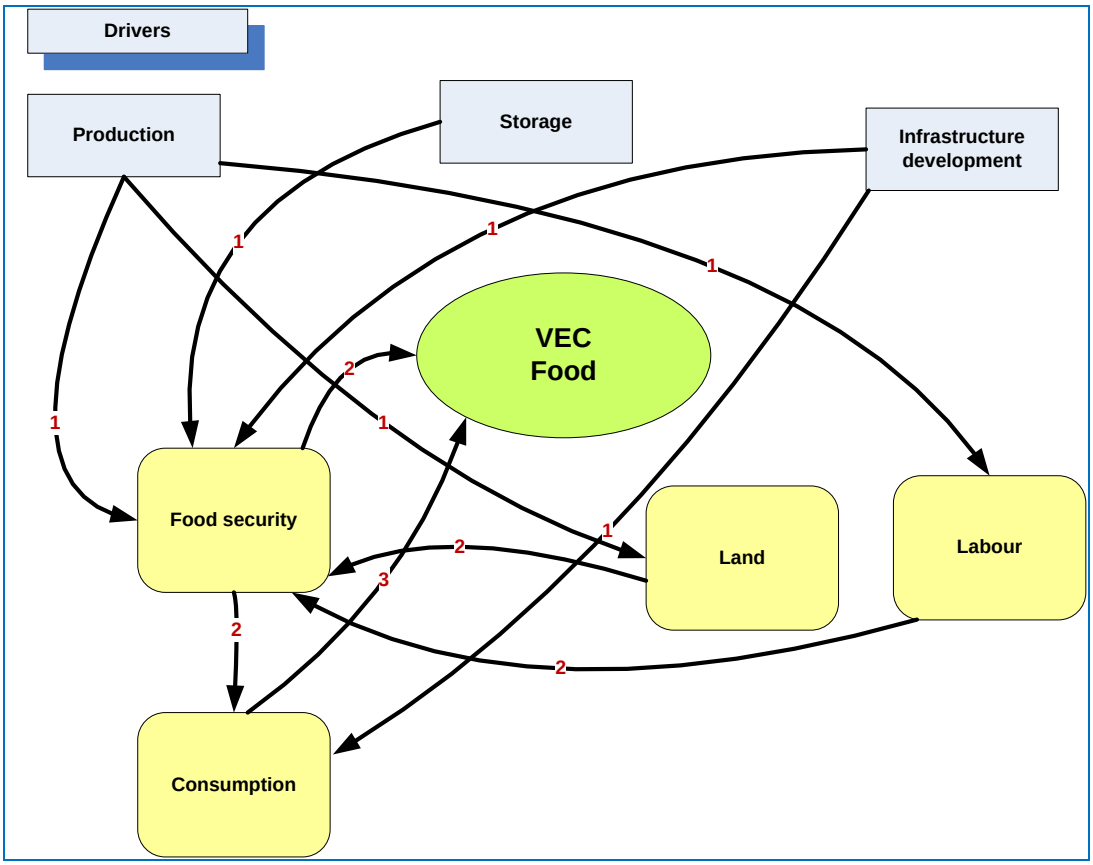
2.7.2 Drivers

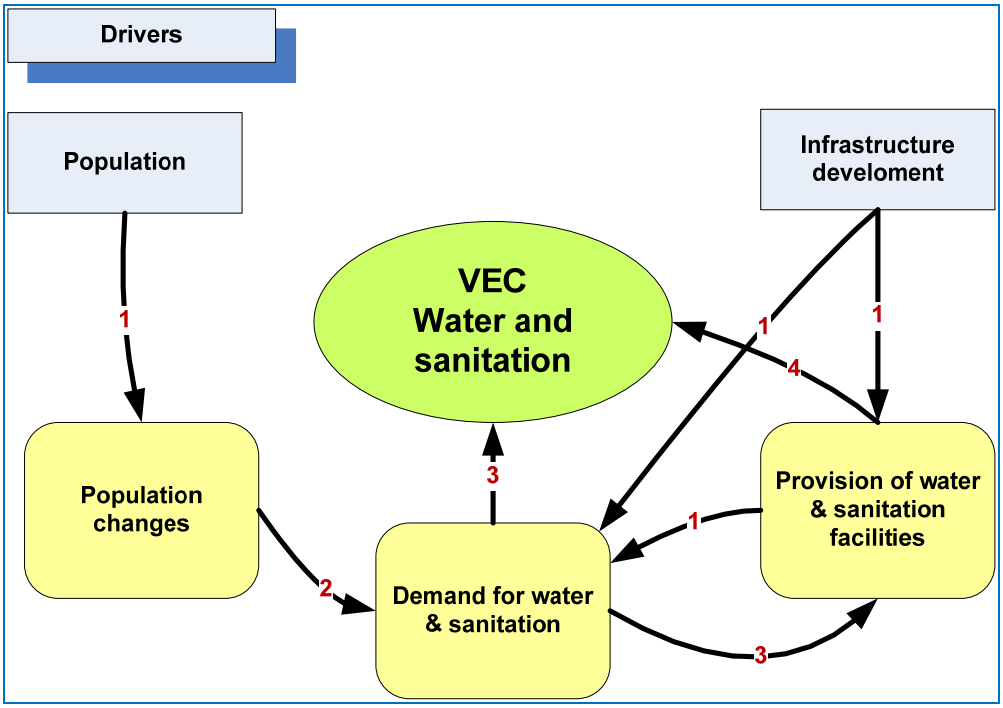
Group no:	4	Issue:	Society				
Overall rank	**Drivers\phase → ↓**		**Explo-ration**	**Develop-ment**	**Produc-tion**	**Decom-missioning**	**Others**
	Consumption (Food)		1	1	3	2	
	Economic devt			1	3	1	
	Education		1	1	1	1	
	Infrastructure devt		1	3	2	1	
	Labour		1	3	3	1	
	Migration		1	1	2	2	
	Mineral development		1	1	3	3	
	Pollution		1	1	1		
	Population		1	1	1	1	
	Production (Food)		1	2	3	1	
	Settlements		1	1	3	1	
	Storage (Food)				1	1	

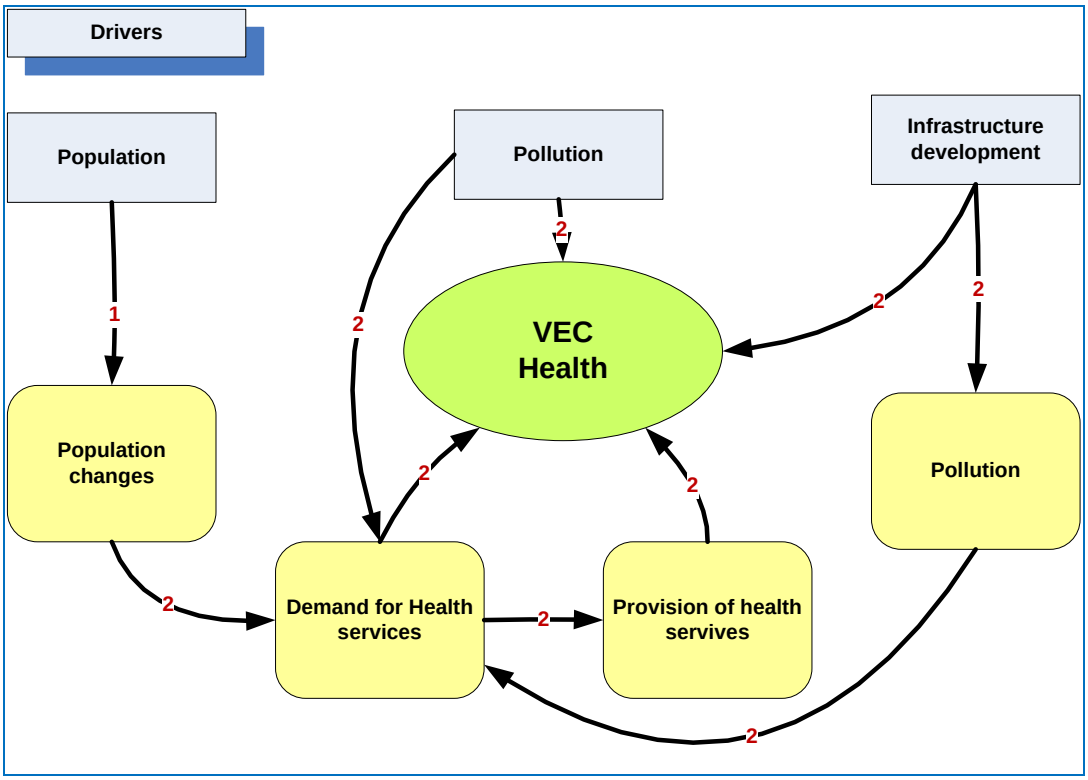
2.7.3 Cause – effect charts, society

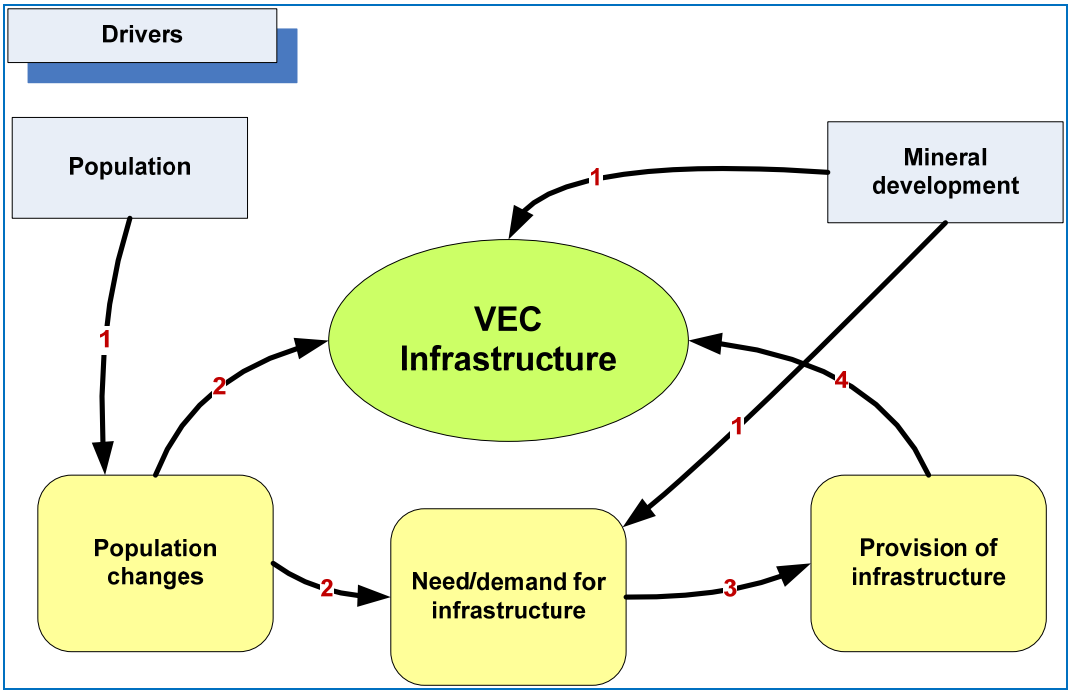


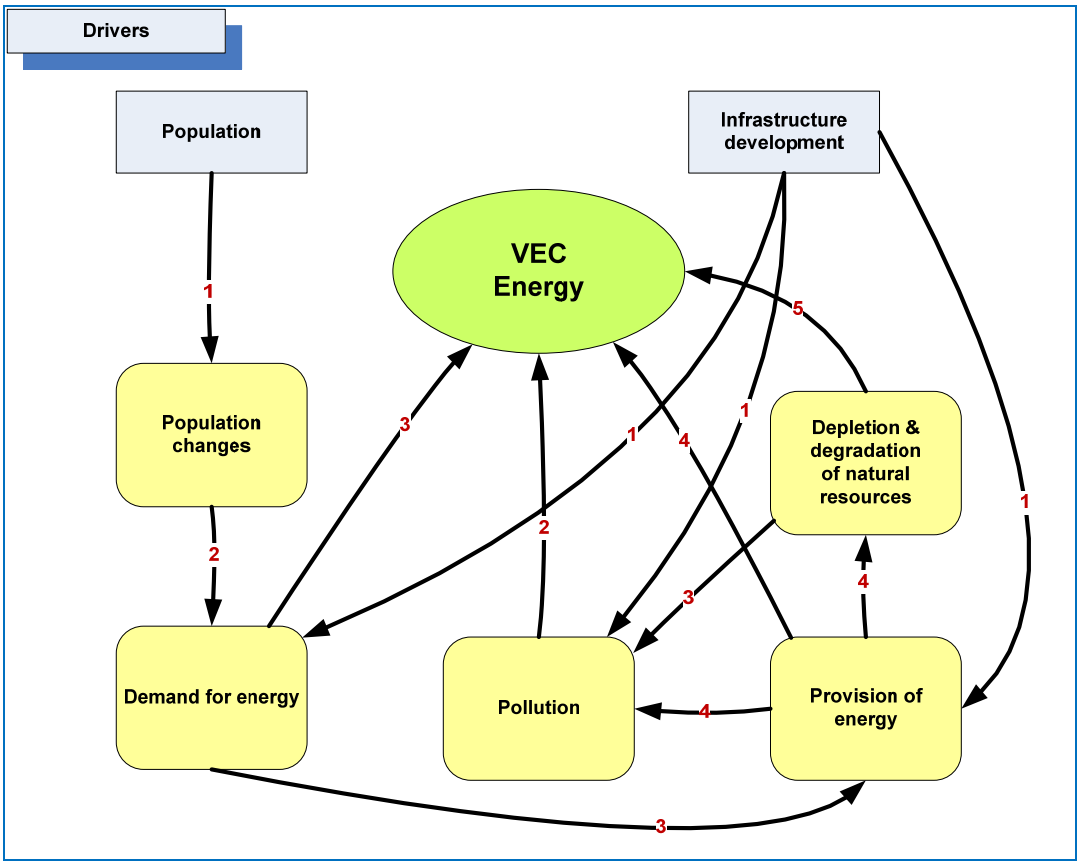
Society and settlements will be included in the monitoring program. Photo: Jørn Thomassen.


Drivers
Production
Storage
Infrastructure development
VEC Food
Food security
Land
Labour
Consumption
1
2
3

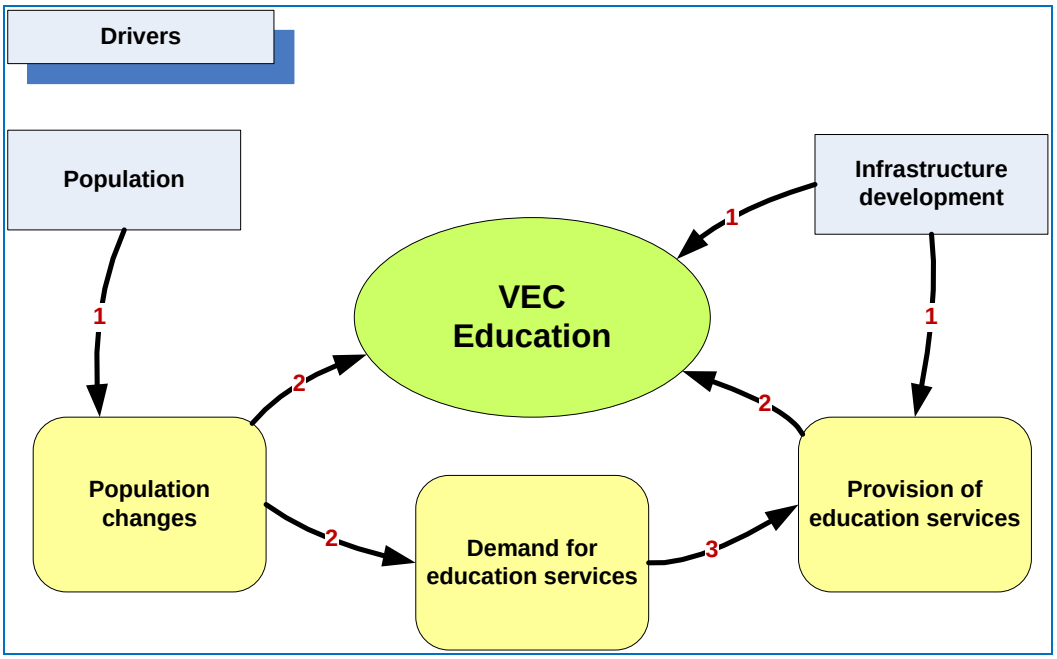

Drivers
Population
Infrastructure develoment
VEC Water and sanitation
Population changes
Demand for water & sanitation
Provision of water & sanitation facilities
1
2
3
4

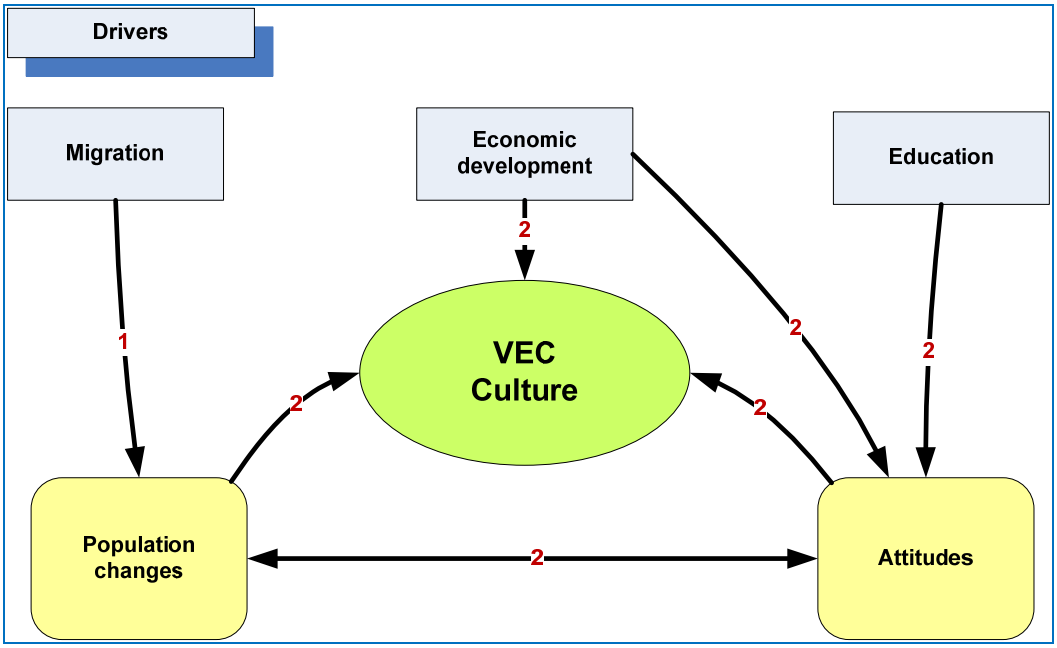

Drivers
Population
Pollution
Infrastructure development
VEC Health
Population changes
Pollution
Demand for Health services
Provision of health servives
1
2
2
2
2
2
2
2
2
2

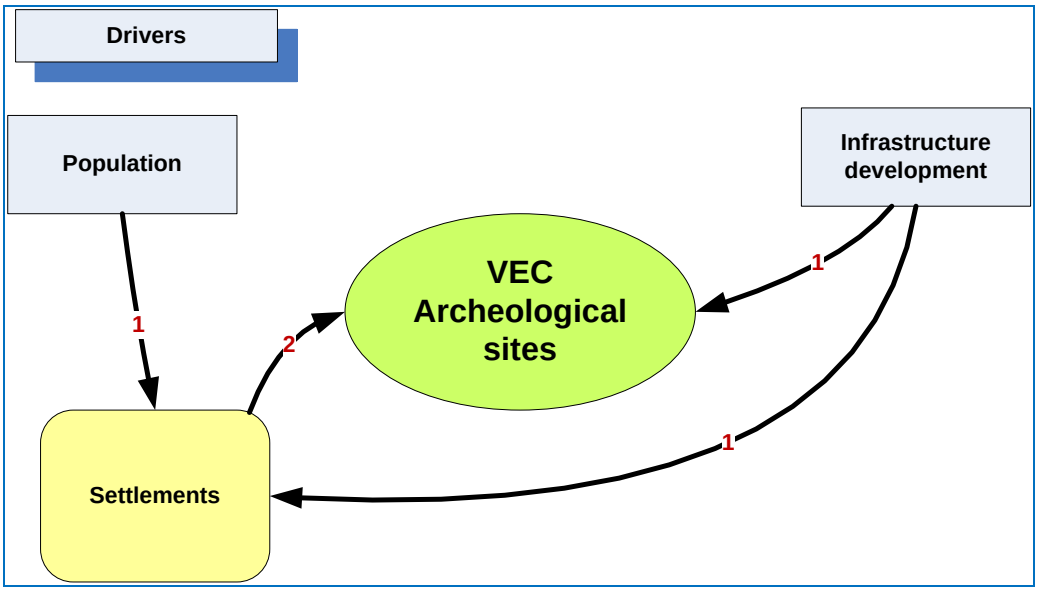

Drivers
Population
Mineral development
VEC Infrastructure
Population changes
Need/demand for infrastructure
Provision of infrastructure
1
1
2
4
1
2
3

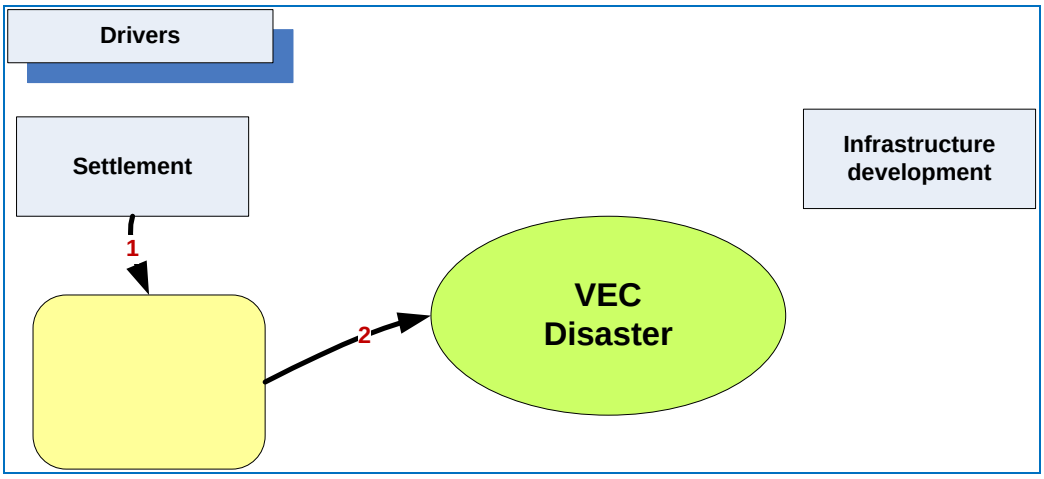


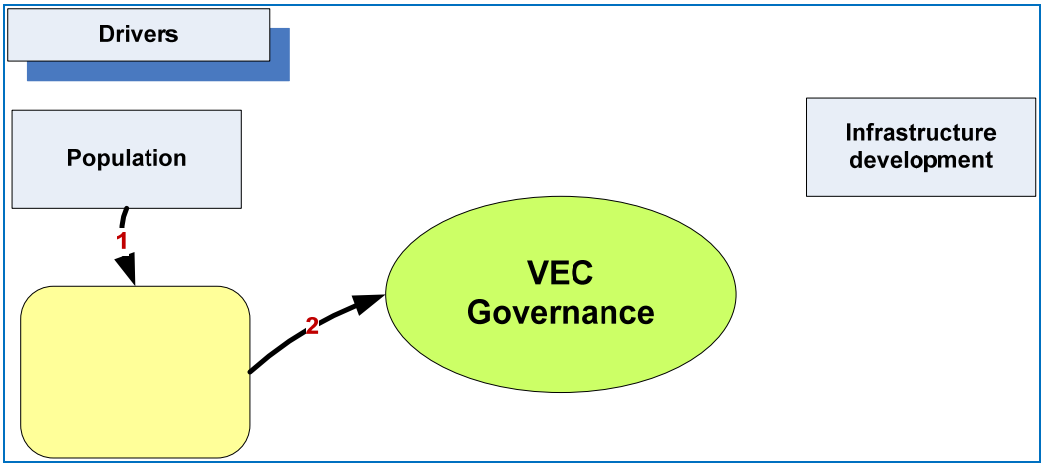
Pipelines are already on site. Photo: Jørn Thomassen.


Drivers
Population
Infrastructure development
VEC Education
Population changes
Demand for education services
Provision of education services
1
1
1
2
2
2
3


Drivers
Migration
Economic development
Education
VEC Culture
Population changes
Attitudes
1
2
2
2
2
2
2


Drivers
Population
Infrastructure development
VEC Archeological sites
Settlements
1
2
1
1


Drivers
Settlement
Infrastructure development
VEC Disaster
1
2


Drivers
Population
Infrastructure development
VEC Governance
1
2

2.7.4 Indicator Fact Sheets

Society			
Group no:	4	**INDICATOR FACT SHEET**	
VEC: **Settlements**		IH no:	1a
Impact Hypothesis: Migration leads to changes in population density that change settlements		Driver: Migration	
Explanation: influx of people (labour, service providers, family, etc) will require housing facilities among others			
Evaluation in category A, B, C or D:	C		
Rationale for category: No data and influx of people is not yet			

Recommended research: carry out baseline survey	
Recommended management actions: Commission a baseline survey	
Recommended monitoring: Regular	
Measurable indicator name (what): 1. Number of people 2. Number of settlements 3. Size of settlements	Order 1, 2 or 3
Existing	Existing monitoring *(relevant ongoing monitoring or available data sets)*: Uganda National Population and Housing Census, UNHS
	Area covered (*by ongoing monitoring or available data sets)*: Uganda
	Data storage *(format and place where data sets are stored)*: Uganda Bureau of Statistics
	Responsibility *(institution and person currently responsible for existing monitoring data sets)*: Uganda Bureau of Statistics
Why (*key question(s) which the indicator helps to answer*): To know the migration and settlement patterns	
Current trend (*upward, stable or downward)*: upward	
How (*method, sampling and analysis, quality assurance*): As advised by Uganda Bureau of Statistics	
Where (*location, geo-referenced)*: Albertine Graben	
When (*frequency*): every five years	
By whom *(which institution will collect the indicator data)*: Uganda Bureau of Statistics	
Lead agency *(institution and person responsible for calculating and communicating the indicator)*: Uganda Bureau of Statistics	
Presentation *(most effective forms of presentation: graphs, maps, narratives etc.)*: Graphs, tables, maps and narratives	
End user(s) *(who will use the indicator for what purpose)*: All relevant stakeholders (MDA, CSO, International Organisations, Investors, private sector, etc)	
Financial assessment *(approximate costs from data collection to indicator)*:	
Comments:	
Literature:	

A. The hypothesis is assumed not to be valid.
B. The hypothesis is valid and already verified. Research to validate or invalidate the hypothesis is not required. Surveys, monitoring, and/or management measures can possible be recommended.
C. The hypothesis is assumed to be valid. Research, monitoring or surveys is recommended to validate or invalidate the hypothesis. Mitigating measures can be recommended if the hypothesis is proved to be valid.
D. The hypothesis may be valid, but is not worth testing for professional, logistic, economic or ethical reasons, or because it is assumed to be of minor environmental influence only or of insignificant value for decision making.

Society			
Group no:	4	**INDICATOR FACT SHEET**	
VEC: **Settlements**		IH no:	1b
Impact Hypothesis: Influx of labour leads to demand of resources		Driver: Labour	
Explanation: influx of labour will require housing facilities among others			
Evaluation in category A, B, C or D:	B		
Rationale for category: influx of people is not yet significant			

Recommended research: Regular monitoring		
Recommended management actions: physical planning		
Recommended monitoring: population density, resources demand		
Measurable indicator name (what): 1. Size and composition of labour force 2. Number of people employed by sector and occupation	Order 1, 2 or 3	
Existing	Existing monitoring *(relevant ongoing monitoring or available data sets)*: Uganda National Household Survey reports	
	Area covered (*by ongoing monitoring or available data sets)*: Albertine Graben	
	Data storage *(format and place where data sets are stored)*: Uganda Bureau of Statistics (UBoS)	
	Responsibility *(institution and person currently responsible for existing monitoring data sets)*: Uganda Bureau of Statistics	
Why (*key question(s) which the indicator helps to answer*): To assess the impact of petroleum development on the labour market		
Current trend (*upward, stable or downward)*: upward		
How (*method, sampling and analysis, quality assurance*): As advised by Uganda Bureau of Statistics		
Where (*location, geo-referenced)*: Albertine Graben		
When (*frequency*): every five years		
By whom *(which institution will collect the indicator data)*: Uganda Bureau of Statistics		
Lead agency *(institution and person responsible for calculating and communicating the indicator)*: Uganda Bureau of Statistics		
Presentation *(most effective forms of presentation: graphs, maps, narratives etc.)*: Graphs, tables, maps and narratives		
End user(s) *(who will use the indicator for what purpose)*: All relevant stakeholders (Government, Civil Society Organizations (CSOs), International Organisations, Investors, private sector, etc)		
Financial assessment *(approximate costs from data collection to indicator)*:		
Comments:		
Literature:		

A. The hypothesis is assumed not to be valid.
B. The hypothesis is valid and already verified. Research to validate or invalidate the hypothesis is not required. Surveys, monitoring, and/or management measures can possible be recommended.
C. The hypothesis is assumed to be valid. Research, monitoring or surveys is recommended to validate or invalidate the hypothesis. Mitigating measures can be recommended if the hypothesis is proved to be valid.
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Society			
Group no:	4	**INDICATOR FACT SHEET**	
VEC: **Food**		IH no:	2a
Impact Hypothesis: Improved food production and storage enhances food security.		Driver: Food production and storage	
Explanation: due to influx of people the demand for food will increase hence creating markets for food			
Evaluation in category A, B, C or D:	B		
Rationale for category: Empirical knowledge			
Recommended research: Updated data required			
Recommended management actions: Agricultural extension services			
Recommended monitoring: Annual			
Measurable indicator name (what): 1. Acreage of land under food production 2. Food price index 3. Food availability in the region 4. Household incomes 5. Number of food storage facilities.		Order 1, 2 or 3	
Existing	Existing monitoring *(relevant ongoing monitoring or available data sets)*: Uganda Census of Agriculture		
	Area covered (*by ongoing monitoring or available data sets)*: Uganda		
	Data storage *(format and place where data sets are stored)*: Uganda Bureau of Statistics, Ministry of Agriculture, Animal Industry and Fisheries (MAAIF)		
	Responsibility *(institution and person currently responsible for existing monitoring data sets)*: Uganda Bureau of Statistics/ MAAIF		
Why (*key question(s) which the indicator helps to answer*): Food availability within the region			
Current trend (*upward, stable or downward)*: downward			
How (*method, sampling and analysis, quality assurance*): As advised by Uganda Bureau of Statistics/ MAAIF			
Where (*location, geo-referenced)*: Albertine Graben			
When (*frequency*): Annually			
By whom *(which institution will collect the indicator data)*: Uganda Bureau of Statistics/MAAIF			
Lead agency *(institution and person responsible for calculating and communicating the indicator)*: Uganda Bureau of Statistics/MAAIF			
Presentation *(most effective forms of presentation: graphs, maps, narratives etc.)*: Graphs, tables, maps and narratives			
End user(s) *(who will use the indicator for what purpose)*: All relevant stakeholders (MDA, CSO, International Organisations, Investors, private sector, etc)			
Financial assessment *(approximate costs from data collection to indicator)*:			
Comments:			
Literature:			

A. The hypothesis is assumed not to be valid.
B. The hypothesis is valid and already verified. Research to validate or invalidate the hypothesis is not required. Surveys, monitoring, and/or management measures can possible be recommended.
C. The hypothesis is assumed to be valid. Research, monitoring or surveys is recommended to validate or invalidate the hypothesis. Mitigating measures can be recommended if the hypothesis is proved to be valid.
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Society			
Group no:	4	**INDICATOR FACT SHEET**	
VEC: **Food**		IH no:	2b
Impact Hypothesis: Increased food production improves food security		Driver: Production	
Explanation: due to influx of people the demand for food will increase hence creating markets for food			
Evaluation in category A, B, C or D:	C		
Rationale for category: No data and influx of people is not yet			

Recommended research: carry out baseline survey		
Recommended management actions: Commission a baseline survey		
Recommended monitoring: Regular		
Measurable indicator name (what): 1. Acreage of land under food production 2. Total food production in the country 3. Household incomes	Order 1, 2 or 3	
Existing	Existing monitoring *(relevant ongoing monitoring or available data sets)*: Uganda Census of Agriculture	
	Area covered (*by ongoing monitoring or available data sets)*: Uganda	
	Data storage *(format and place where data sets are stored)*: Uganda Bureau of Statistics	
	Responsibility *(institution and person currently responsible for existing monitoring data sets)*: Uganda Bureau of Statistics/ MAAIF	
Why (*key question(s) which the indicator helps to answer*): To know the food production levels		
Current trend (*upward, stable or downward)*: downward		
How (*method, sampling and analysis, quality assurance*): As advised by Uganda Bureau of Statistics/ MAAIF		
Where (*location, geo-referenced)*: Albertine Graben		
When (*frequency*): every three years		
By whom *(which institution will collect the indicator data)*: Uganda Bureau of Statistics/MAAIF		
Lead agency *(institution and person responsible for calculating and communicating the indicator)*: Uganda Bureau of Statistics/MAAIF		
Presentation *(most effective forms of presentation: graphs, maps, narratives etc.)*: Graphs, tables, maps and narratives		
End user(s) *(who will use the indicator for what purpose)*: All relevant stakeholders (MDA, CSO, International Organisations, Investors, private sector, etc)		
Financial assessment *(approximate costs from data collection to indicator)*:		
Comments:		
Literature:		

A. The hypothesis is assumed not to be valid.
B. The hypothesis is valid and already verified. Research to validate or invalidate the hypothesis is not required. Surveys, monitoring, and/or management measures can possible be recommended.
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Society			
Group no:	4	**INDICATOR FACT SHEET**	
VEC: **Water and Sanitation**		IH no:	3
Impact Hypothesis: influx of people (labour, service providers, family, etc) necessitates provision of additional water and sanitation facilities		Driver: Population	
Explanation: Increased population will lead to increased demand for water and sanitation facilities			
Evaluation in category A, B, C or D:	C		
Rationale for category: No data and influx of people is not yet happening			
Recommended research: Carry out baseline survey to establish existing water and sanitation facilities			
Recommended management actions: Commission a baseline survey to establish existing water and sanitation facilities			
Recommended monitoring: Regular			
Measurable indicator name (what): 1. Portable water coverage 2. Latrine coverage 3. Number of waste disposal facilities 4. Distance to nearest safe water source 5. Time taken to collect water from nearest water source 6. Number of cases due to water borne diseases		Order 1, 2 or 3	
Existing	Existing monitoring *(relevant ongoing monitoring or available data sets)*: MWE /UBoS		
	Area covered (*by ongoing monitoring or available data sets)*: Uganda		
	Data storage *(format and place where data sets are stored)*: MWE/UBoS		
	Responsibility *(institution and person currently responsible for existing monitoring data sets)*: MWE/Uganda Bureau of Statistics		
Why (*key question(s) which the indicator helps to answer*): To establish the status of the water and sanitation coverage			
Current trend (*upward, stable or downward)*: upward			
How (*method, sampling and analysis, quality assurance*): As advised by MWE/Uganda Bureau of Statistics			
Where (*location, geo-referenced)*: Albertine Graben			
When (*frequency*): Annually			
By whom *(which institution will collect the indicator data)*: MWE/Uganda Bureau of Statistics			
Lead agency *(institution and person responsible for calculating and communicating the indicator)*: MWE			
Presentation *(most effective forms of presentation: graphs, maps, narratives etc.)*: Graphs, tables, maps and narratives			
End user(s) *(who will use the indicator for what purpose)*: All relevant stakeholders (MDA, CSO, International Organisations, Investors, private sector, etc)			
Financial assessment *(approximate costs from data collection to indicator)*:			
Comments:			
Literature:			

A. The hypothesis is assumed not to be valid.
B. The hypothesis is valid and already verified. Research to validate or invalidate the hypothesis is not required. Surveys, monitoring, and/or management measures can possible be recommended.
C. The hypothesis is assumed to be valid. Research, monitoring or surveys is recommended to validate or invalidate the hypothesis. Mitigating measures can be recommended if the hypothesis is proved to be valid.
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Society			
Group no:	4	**INDICATOR FACT SHEET**	
VEC: **Health**		IH no:	4
Impact Hypothesis: influx of people (labour, service providers, family, etc) necessitates provision of additional health facilities		Driver: Population	
Explanation: Increased population will lead to increased demand for health facilities			
Evaluation in category A, B, C or D:	C		
Rationale for category: Inadequate data and influx of people is not yet happening			
Recommended research: Carry out baseline survey to establish existing health facilities			
Recommended management actions: Commission a baseline survey to establish existing health facilities			
Recommended monitoring: Regular			
Measurable indicator name (what): 1. Number of health facilities 2. Prevalence of diseases 3. Mortality rate 4. Number of deaths by cause		Order 1, 2 or 3	
Existing	Existing monitoring *(relevant ongoing monitoring or available data sets)*: MoH /UBoS		
	Area covered (*by ongoing monitoring or available data sets)*: Uganda		
	Data storage *(format and place where data sets are stored)*: MoH/UBoS		
	Responsibility *(institution and person currently responsible for existing monitoring data sets)*: MoH/Uganda Bureau of Statistics		
Why (*key question(s) which the indicator helps to answer*): To establish the coverage of health services			
Current trend (*upward, stable or downward)*: upward			
How (*method, sampling and analysis, quality assurance*): As advised by MoH/Uganda Bureau of Statistics			
Where (*location, geo-referenced)*: Albertine Graben			
When (*frequency*): Continuous			
By whom *(which institution will collect the indicator data)*: MoH/Uganda Bureau of Statistics			
Lead agency *(institution and person responsible for calculating and communicating the indicator)*: MoH			
Presentation *(most effective forms of presentation: graphs, maps, narratives etc.)*: Graphs, tables, maps and narratives			
End user(s) *(who will use the indicator for what purpose)*: All relevant stakeholders (MDA, CSO, International Organisations, Investors, private sector, etc)			
Financial assessment *(approximate costs from data collection to indicator)*:			
Comments:			
Literature:			

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B. The hypothesis is valid and already verified. Research to validate or invalidate the hypothesis is not required. Surveys, monitoring, and/or management measures can possible be recommended.
C. The hypothesis is assumed to be valid. Research, monitoring or surveys is recommended to validate or invalidate the hypothesis. Mitigating measures can be recommended if the hypothesis is proved to be valid.
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Society			
Group no:	4	**INDICATOR FACT SHEET**	
VEC: **Energy**		IH no:	5
Impact Hypothesis: Migration leads to changes in population density which result into increased demand for energy resources		Driver: Population	
Explanation: The influx of people (labour, service providers, family, etc) people will require energy to light, cook, transport etc			
Evaluation in category A, B, C or D:	C		
Rationale for category: No data and influx of people is not yet			

Recommended research: carry out baseline survey to establish the energy resource demand		
Recommended management actions: Commission a baseline survey		
Recommended monitoring: Regular		
Measurable indicator name (what): 1. Types of energy sources 2. Number of people using energy source by type and quantity	Order 1, 2 or 3	
Existing	Existing monitoring *(relevant ongoing monitoring or available data sets)*: UNHS, Bio-Mass study	
	Area covered (*by ongoing monitoring or available data sets)*: Uganda	
	Data storage *(format and place where data sets are stored)*: Uganda Bureau of Statistics	
	Responsibility *(institution and person currently responsible for existing monitoring data sets)*: Uganda Bureau of Statistics	
Why (*key question(s) which the indicator helps to answer*): To know energy availability & consumption patterns		
Current trend (*upward, stable or downward)*: upward		
How (*method, sampling and analysis, quality assurance*): As advised by Uganda Bureau of Statistics, NFA, MEMD		
Where (*location, geo-referenced)*: Albertine Graben		
When (*frequency*): every 1-2 year		
By whom *(which institution will collect the indicator data)*: Uganda Bureau of Statistics, NFA, MEMD		
Lead agency *(institution and person responsible for calculating and communicating the indicator)*: MEMD		
Presentation *(most effective forms of presentation: graphs, maps, narratives etc.)*: Graphs, tables, maps and narratives		
End user(s) *(who will use the indicator for what purpose)*: All relevant stakeholders (MDA, CSO, International Organizations, Investors, private sector, etc)		
Financial assessment *(approximate costs from data collection to indicator)*:		
Comments:		
Literature:		

A. The hypothesis is assumed not to be valid.
B. The hypothesis is valid and already verified. Research to validate or invalidate the hypothesis is not required. Surveys, monitoring, and/or management measures can possible be recommended.
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Society			
Group no:	4	**INDICATOR FACT SHEET**	
VEC: **Infrastructure**		IH no:	6
Impact Hypothesis: Mineral development necessitates development of a basic infrastructure		Driver: Mineral Development	
Explanation: in order to explore and develop minerals, a minimum infrastructure must be in place			
Evaluation in category A, B, C or D:	C		
Rationale for category: minerals not yet developed			
Recommended research: carry out exploration to determine the location and quantities of mineral resources.			
Recommended management actions: Commission exploration studies			
Recommended monitoring: Regular			
Measurable indicator name (what): 1. Quantity of mineral resources 2. Location of mineral resources 3. Available infrastructure		Order 1, 2 or 3	
Existing	Existing monitoring *(relevant ongoing monitoring or available data sets)*: MEMD, UNRA, MoWT, MoES, MoH, UBoS		
	Area covered (*by ongoing monitoring or available data sets)*: Uganda		
	Data storage *(format and place where data sets are stored)*: MEMD, UNRA, MoWT, MoES, MoH, UBoS		
	Responsibility *(institution and person currently responsible for existing monitoring data sets)*: MEMD, UNRA, MoW, MoES, MoH, UBoS		
Why (*key question(s) which the indicator helps to answer*): To know energy availability & consumption patterns			
Current trend (*upward, stable or downward)*: upward			
How (*method, sampling and analysis, quality assurance*): As advised by MEMD, UNRA, MoWT, MoES, MoH, UBoS			
Where (*location, geo-referenced)*: Albertine Graben			
When (*frequency*): Continuous			
By whom *(which institution will collect the indicator data)*: MEMD, UNRA, MoW, MoES, MoH, UBoS			
Lead agency *(institution and person responsible for calculating and communicating the indicator)*: UNRA, MoWT			
Presentation *(most effective forms of presentation: graphs, maps, narratives etc.)*: Graphs, tables, maps and narratives			
End user(s) *(who will use the indicator for what purpose)*: All relevant stakeholders (MDA, CSO, International Organizations, Investors, private sector, etc)			
Financial assessment *(approximate costs from data collection to indicator)*:			
Comments:			
Literature:			

A. The hypothesis is assumed not to be valid.
B. The hypothesis is valid and already verified. Research to validate or invalidate the hypothesis is not required. Surveys, monitoring, and/or management measures can possible be recommended.
C. The hypothesis is assumed to be valid. Research, monitoring or surveys is recommended to validate or invalidate the hypothesis. Mitigating measures can be recommended if the hypothesis is proved to be valid.
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Society			
Group no:	4	**INDICATOR FACT SHEET**	
VEC: **Education**		IH no:	7
Impact Hypothesis: influx of people (labour, service providers, family, etc) necessitates provision of additional education facilities		Driver: Population	
Explanation: Increased population will lead to increased demand for education facilities			
Evaluation in category A, B, C or D:	C		
Rationale for category: Inadequate data and influx of people is not yet happening			
Recommended research: Carry out baseline survey to establish existing education facilities			
Recommended management actions: Commission a baseline survey to establish existing education facilities			
Recommended monitoring: Regular			
Measurable indicator name (what): 1. Number of education facilities 2. Number of school-going age children 3. Literacy rate		Order 1, 2 or 3	
Existing	Existing monitoring *(relevant ongoing monitoring or available data sets)*: MoES /UBoS		
	Area covered (*by ongoing monitoring or available data sets)*: Uganda		
	Data storage *(format and place where data sets are stored)*: MoES/UBoS		
	Responsibility *(institution and person currently responsible for existing monitoring data sets)*: MoES/Uganda Bureau of Statistics		
Why (*key question(s) which the indicator helps to answer*): To establish the coverage of education services			
Current trend (*upward, stable or downward)*: upward			
How (*method, sampling and analysis, quality assurance*): As advised by MoES/Uganda Bureau of Statistics			
Where (*location, geo-referenced)*: Albertine Graben			
When (*frequency*): Annually			
By whom *(which institution will collect the indicator data)*: MoES/Uganda Bureau of Statistics			
Lead agency *(institution and person responsible for calculating and communicating the indicator)*: MoES			
Presentation *(most effective forms of presentation: graphs, maps, narratives etc.)*: Graphs, tables, maps and narratives			
End user(s) *(who will use the indicator for what purpose)*: All relevant stakeholders (MDA, CSO, International Organisations, Investors, private sector, etc)			
Financial assessment *(approximate costs from data collection to indicator)*:			
Comments:			
Literature:			

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Society			
Group no:	4	**INDICATOR FACT SHEET**	
VEC: **Culture**		IH no:	8
Impact Hypothesis: influx of people (labour, service providers, family, etc) result in culture mix and changes		Driver: Population	
Explanation: migration of people of different cultures results in culture transformation			
Evaluation in category A, B, C or D:	C		
Rationale for category: Inadequate data and influx of people is not yet happening			
Recommended research: Carry out baseline survey to establish existing cultural sites			
Recommended management actions: Commission a baseline survey to establish existing culture sites			
Recommended monitoring: Regular			
Measurable indicator name (what): 1. Number of cultural sites 2. Number of ethnic groups and languages		Order 1, 2 or 3	
Existing	Existing monitoring *(relevant ongoing monitoring or available data sets)*: MGLSD /UBoS		
	Area covered (*by ongoing monitoring or available data sets)*: Uganda		
	Data storage *(format and place where data sets are stored)*: MGLSD/UBoS		
	Responsibility *(institution and person currently responsible for existing monitoring data sets)*: MGLSD/Uganda Bureau of Statistics		
Why (*key question(s) which the indicator helps to answer*): To establish the number and status of cultural sites			
Current trend (*upward, stable or downward)*: Stable			
How (*method, sampling and analysis, quality assurance*): As advised by MGLSD/Uganda Bureau of Statistics			
Where (*location, geo-referenced)*: Albertine Graben			
When (*frequency*): Annually			
By whom *(which institution will collect the indicator data)*: MGLSD/Uganda Bureau of Statistics			
Lead agency *(institution and person responsible for calculating and communicating the indicator)*: MGLSD			
Presentation *(most effective forms of presentation: graphs, maps, narratives etc.)*: Graphs, tables, maps and narratives			
End user(s) *(who will use the indicator for what purpose)*: All relevant stakeholders (MDA, CSO, International Organisations, Investors, private sector, etc)			
Financial assessment *(approximate costs from data collection to indicator)*:			
Comments:			
Literature:			

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Society		
Group no:	4	**INDICATOR FACT SHEET**

VEC: **Archeological sites**	IH no:	9
Impact Hypothesis: infrastructure development will lead to destruction of archeological sites	Driver: Infrastructure development	
Explanation: in development of infrastructure development, archeological sites may be destroyed		
Evaluation in category A, B, C or D:	C	
Rationale for category: to update the data		

Recommended research: carry continuous studies to establish the status of the archeological sites		
Recommended management actions: Commission the continuous studies		
Recommended monitoring: Regular		
Measurable indicator name (what): 1. Number of the archeological sites 2. Location of archeological sites 3. Available infrastructure	Order 1, 2 or 3	
Existing	Existing monitoring *(relevant ongoing monitoring or available data sets)*: MoGSD, MTTI	
	Area covered (*by ongoing monitoring or available data sets)*: Uganda	
	Data storage *(format and place where data sets are stored)*: MoGSD, MTTI	
	Responsibility *(institution and person currently responsible for existing monitoring data sets)*: MoGSD, MTTI	
Why (*key question(s) which the indicator helps to answer*): To know the current status of the archeological sites and related infrastructure		
Current trend (*upward, stable or downward)*: upward		
How (*method, sampling and analysis, quality assurance*): As advised MoGSD, MTTI, UBoS		
Where (*location, geo-referenced)*: Albertine Graben		
When (*frequency*): Continuous		
By whom *(which institution will collect the indicator data)*: MoGSD, MTTI, UBoS		
Lead agency *(institution and person responsible for calculating and communicating the indicator)*: MoGSD, MTTI		
Presentation *(most effective forms of presentation: graphs, maps, narratives etc.)*: Graphs, tables, maps and narratives		
End user(s) *(who will use the indicator for what purpose)*: All relevant stakeholders (MDA, CSO, International Organizations, Investors, private sector, etc)		
Financial assessment *(approximate costs from data collection to indicator)*:		
Comments:		
Literature:		

A. The hypothesis is assumed not to be valid.
B. The hypothesis is valid and already verified. Research to validate or invalidate the hypothesis is not required. Surveys, monitoring, and/or management measures can possible be recommended.
C. The hypothesis is assumed to be valid. Research, monitoring or surveys is recommended to validate or invalidate the hypothesis. Mitigating measures can be recommended if the hypothesis is proved to be valid.
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2.8 Management and business issues

2.8.1 Valued Ecosystem Components

Group no:	5	Issue:	Management and business issues		
Valued Ecosystem Components, ranked			**Associated drivers, ranked (after group work 2)**	**Phase**	**Comments**
VEC 1 Tourism			Land take, borrow pits and roads		
			Noise and vibrations		
			Oil spills		
			Visual intrusion		
VEC 2 Fisheries			Oil spills and blowouts		
			Vibrations		
			Noise		
			Aquatic disturbance (platforms)		
VEC 3 Agriculture			Land take		
			Shifts in economic activity		
			Increased demand for food		
VEC 4 Transport			Traffic		
VEC 5 Forestry			Settlements and infrastructure development		
			Increased supply of oil and gas products		
VEC 6 Construction materials			Settlements and infrastructure development		
			Material source restrictions (e.g. sand)		

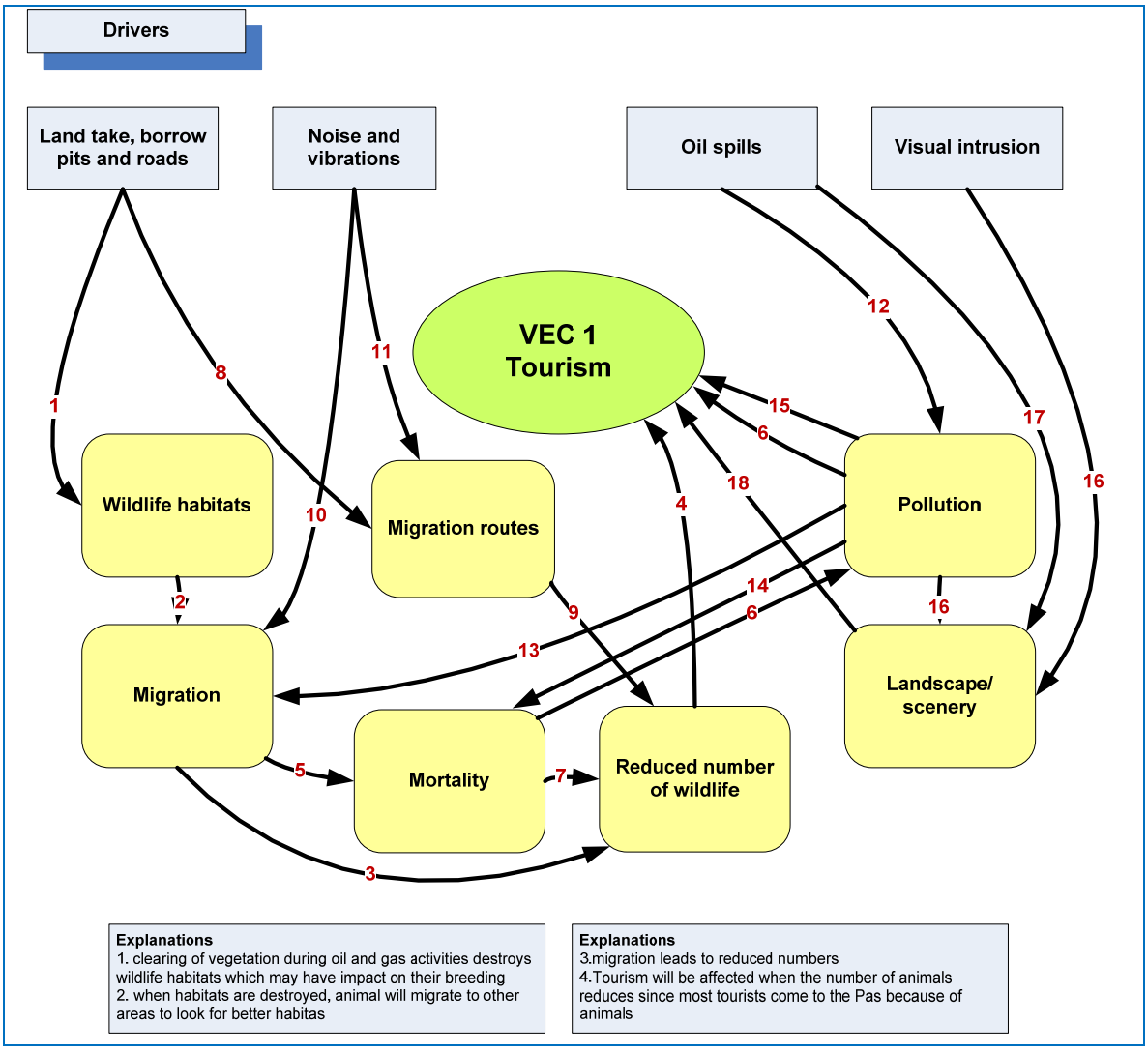
2.8.2 Drivers

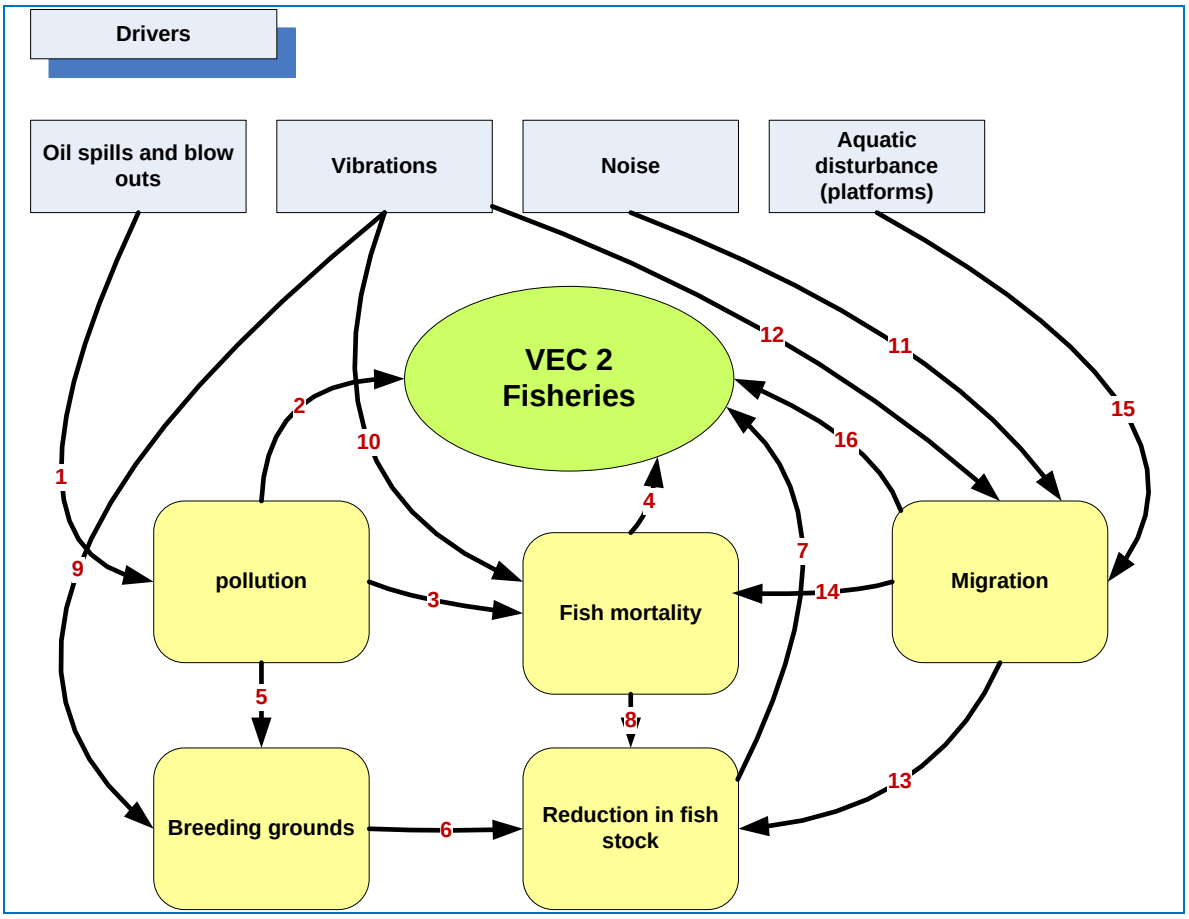
Group no:	5	Issue:	Management and business issues				
Overall rank	**Drivers\phase → ↓**		**Explo-ration**	**Develop-ment**	**Produc-tion**	**Decom-missioning**	**Others**
	Land take, borrow pits and roads						
	Noise and vibrations						
	Oil spills and blow outs						
	Visual intrusion						
	Aquatic disturbance (platforms)						
	Vibrations						
	Shifts in economic activity						
	Increased demand for food						
	Traffic						
	Settlements and infrastructure development						
	Increased supply of oil and gas products						
	Material source restrictions (e.g. sand)						

Albertine Graben is characterized as a biodiversity hotspot and attract thousands of tourists every year, for instance visiting Murchison Falls by boat on the Nile. Photo: Jørn Thomassen.

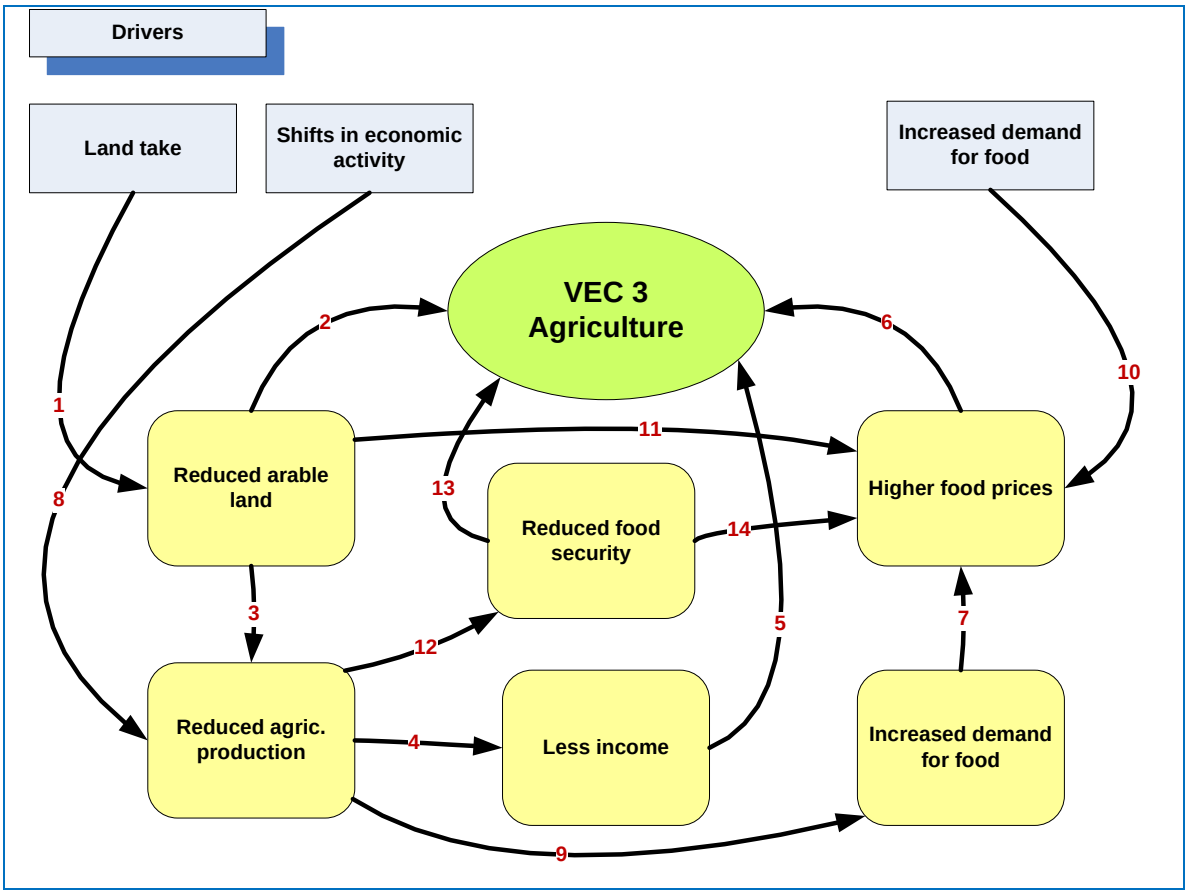
Ferry with tourist vehicles crossing the Nile. Photo: Jørn Thomassen.

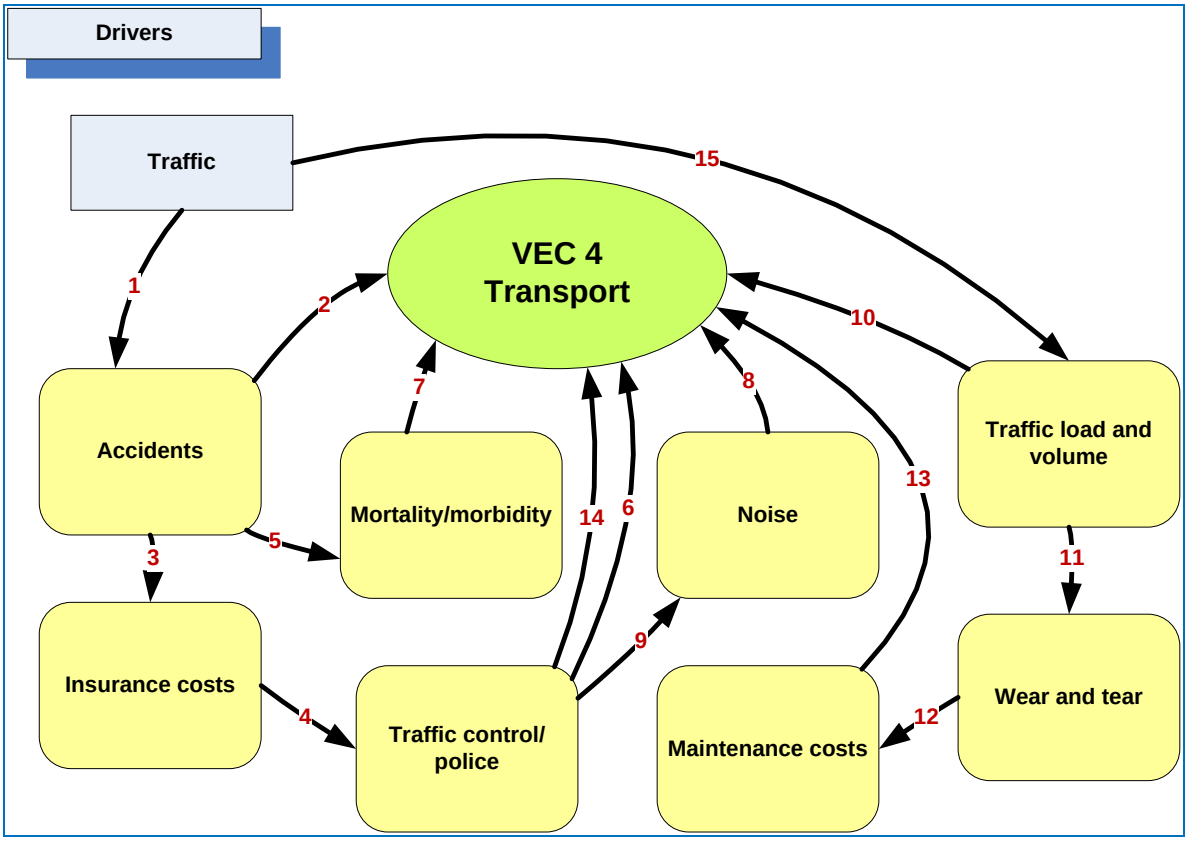
2.8.3 Cause – effect charts, management and business





Local fishermen at Lake Albert. Photo: Jørn Thomassen.


Drivers
Land take
Shifts in economic activity
Increased demand for food
VEC 3 Agriculture
Reduced arable land
Reduced food security
Higher food prices
Reduced agric. production
Less income
Increased demand for food
1
2
3
4
5
6
7
8
9
10
11
12
13
14


Drivers
Traffic
VEC 4 Transport
Accidents
Mortality/morbidity
Noise
Traffic load and volume
Insurance costs
Traffic control/ police
Maintenance costs
Wear and tear
1
2
3
4
5
6
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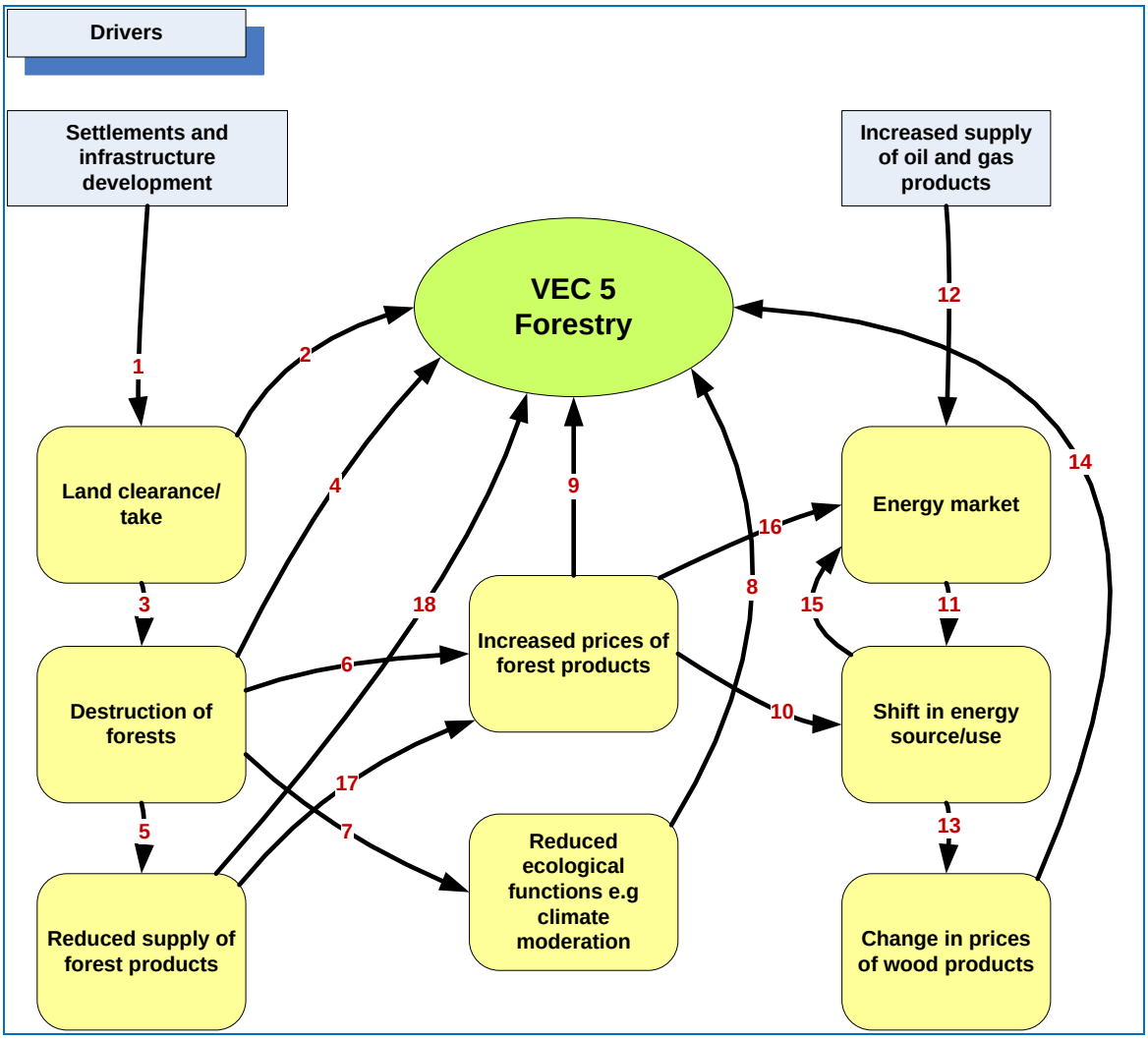
14
15


Drivers
Settlements and infrastructure development
Increased supply of oil and gas products
VEC 5 Forestry
Land clearance/ take
Energy market
Increased prices of forest products
Destruction of forests
Shift in energy source/use
Reduced ecological functions e.g climate moderation
Reduced supply of forest products
Change in prices of wood products
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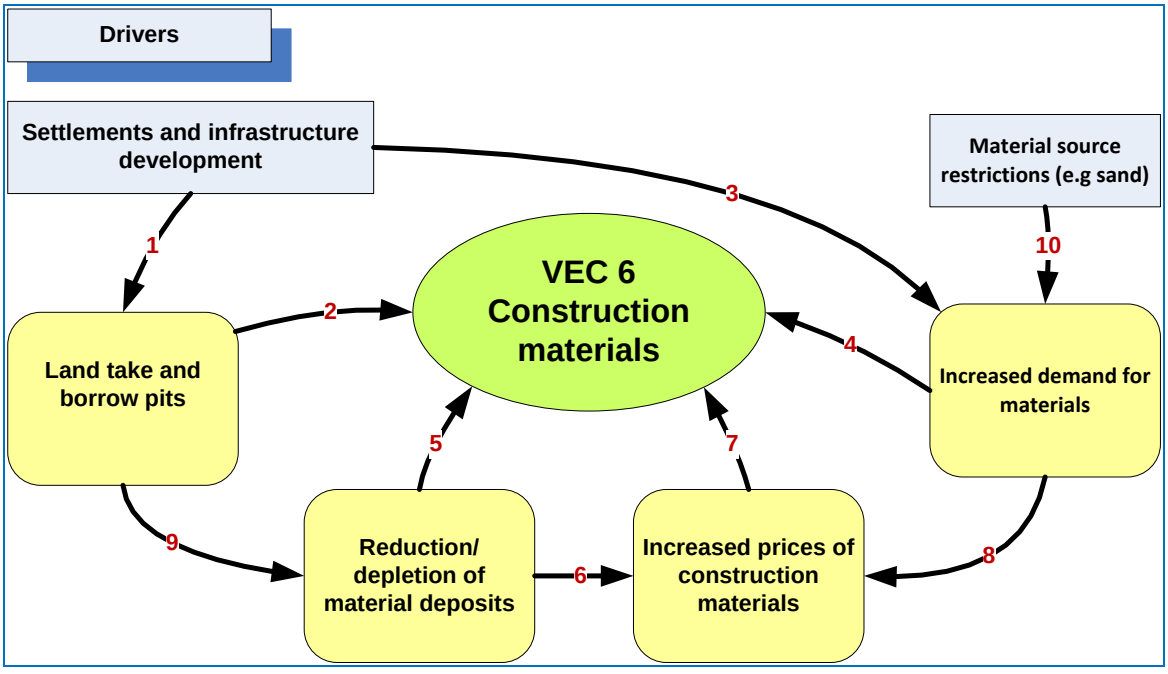
17
18


Drivers
Settlements and infrastructure development
Material source restrictions (e.g sand)
VEC 6 Construction materials
Land take and borrow pits
Increased demand for materials
Reduction/ depletion of material deposits
Increased prices of construction materials
1
2
3
4
5
6
7
8
9
10

2.8.4 Indicator Fact Sheets

Management and business			
Group no:	5	**INDICATOR FACT SHEET**	
VEC 1: **Tourism**		IH no:	1a
Impact Hypothesis: Land clearance within PAs for oil and gas activities will lead to wildlife migration reducing wildlife numbers		Driver: Land take/clearance	
Explanation: Land take will interfere with habitats leading to wildlife migration which will reduce the number of wildlife and negatively impact on tourism			
Evaluation in category A, B, C or D:	B		
Rationale for category: Empirical knowledge			

Recommended research: N/A to test the hypothesis	
Recommended management actions: Put in place a well equipped monitoring unit	
Recommended monitoring: YES	
Measurable indicator name (what): Number of species in a restricted area e.g Delta area MFNP	Order 1, 2 or 3
Existing	Existing monitoring *(relevant ongoing monitoring or available data sets)*: YES
	Area covered (*by ongoing monitoring or available data sets)*: PAs in the ALbertine Graben where oil and gas activities are taking place
	Data storage *(format and place where data sets are stored)*: MIST at UWA
	Responsibility *(institution and person currently responsible for existing monitoring data sets)*:UWA, M&R Unit
Why (*key question(s) which the indicator helps to answer*): there are exploratory sites which can potentially affect the animals and impact negatively on experience for tourists	
Current trend (*upward, stable or downward)*: Generally the animal population is increasing	
How (*method, sampling and analysis, quality assurance*): aerial surveys and ground counts	
Where (*location, geo-referenced)*: e.g delta area north of the Nile	
When (*frequency*): Monthly in phase 1,2 and quarterly in 3	
By whom *(which institution will collect the indicator data)*: UWA, WCS	
Lead agency *(institution and person responsible for calculating and communicating the indicator)*:UWA - ED	
Presentation *(most effective forms of presentation: graphs, maps, narratives etc.)*:Graphs, maps, tables, narratives	
End user(s) *(who will use the indicator for what purpose)*:Government for decision making and information and Companies	
Financial assessment *(approximate costs from data collection to indicator)*:	
Comments: Regularly review the indicator. Equipments needed to facilitate monitoring	
Literature:	

A. The hypothesis is assumed not to be valid.
B. The hypothesis is valid and already verified. Research to validate or invalidate the hypothesis is not required. Surveys, monitoring, and/or management measures can possible be recommended.
C. The hypothesis is assumed to be valid. Research, monitoring or surveys is recommended to validate or invalidate the hypothesis. Mitigating measures can be recommended if the hypothesis is proved to be valid.
D. The hypothesis may be valid, but is not worth testing for professional, logistic, economic or ethical reasons, or because it is assumed to be of minor environmental influence only or of insignificant value for decision making.

Management and business			
Group no:	5	**INDICATOR FACT SHEET**	
VEC 1: **Tourism**		IH no:	1b
Impact Hypothesis: Visual intrusion will impact on landscape/scenery which will reduce visitor experience hence reducing visitor numbers impacting on tourism		Driver: Visual intrusion	
Explanation:			
Evaluation in category A, B, C or D:	C		
Rationale for category:			

Recommended research: Tourism survey recommended to test the hypothesis	
Recommended management actions: strengthen collection of visitor statistics	
Recommended monitoring: YES	
Measurable indicator name (what): Number of tourists in Wildlife PAs	Order 1, 2 or 3
Existing	Existing monitoring *(relevant ongoing monitoring or available data sets)*: YES
	Area covered (*by ongoing monitoring or available data sets)*: All parks
	Data storage *(format and place where data sets are stored)*: Excel, UWA
	Responsibility *(institution and person currently responsible for existing monitoring data sets)*:UWA, Reservations Unit
Why (*key question(s) which the indicator helps to answer*): the different activities carried out during oil and gas exploration may result into visual intrusion which have a negative impact on visitor experience which may reduce tourist numbers	
Current trend (*upward, stable or downward)*: Generally tourist numbers increasing	
How (*method, sampling and analysis, quality assurance*): tourism survey	
Where (*location, geo-referenced)*:All parks	
When (*frequency*): Quarterly	
By whom *(which institution will collect the indicator data)*:UWA	
Lead agency *(institution and person responsible for calculating and communicating the indicator)*:UWA - ED	
Presentation *(most effective forms of presentation: graphs, maps, narratives etc.)*:Graphs, maps, tables, narratives	
End user(s) *(who will use the indicator for what purpose)*:Government for decision making and information and Companies	
Financial assessment *(approximate costs from data collection to indicator)*:	
Comments: Regularly review the indicator.	
Literature:	

A. The hypothesis is assumed not to be valid.
B. The hypothesis is valid and already verified. Research to validate or invalidate the hypothesis is not required. Surveys, monitoring, and/or management measures can possible be recommended.
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Management and business			
Group no:	5	**INDICATOR FACT SHEET**	
VEC 1: **Tourism**		IH no:	1c
Impact Hypothesis: Land take will lead to change in wildlife habitats which will lead to reduction in wildlife hence reducing visitor number hence negatively impacting on tourism		Driver: Land take, borrow pits and roads	
Explanation:			
Evaluation in category A, B, C or D:	B		
Rationale for category: Empirical evidence			
Recommended research: N/A			
Recommended management actions: avoiding sensitive areas			
Recommended monitoring: YES			
Measurable indicator name (what): Habitat attributes		Order 1, 2 or 3	
Existing	Existing monitoring *(relevant ongoing monitoring or available data sets)*: YES		
	Area covered (*by ongoing monitoring or available data sets)*: All parks		
	Data storage *(format and place where data sets are stored)*: MIST, UWA		
	Responsibility *(institution and person currently responsible for existing monitoring data sets)*:UWA, Monitoring Unit		
Why (*key question(s) which the indicator helps to answer*): the different activities carried out during oil and gas exploration may impact on the wildlife habitats and cause reduction in wildlife numbers negatively impacting on tourism business.			
Current trend (*upward, stable or downward)*: habitats have been interfered with because of oil and gas activities			
How (*method, sampling and analysis, quality assurance*): aerial surveys, satellite imagery, and ground truthing			
Where (*location, geo-referenced)*:All parks			
When (*frequency*): Quarterly			
By whom *(which institution will collect the indicator data)*:UWA			
Lead agency *(institution and person responsible for calculating and communicating the indicator)*:UWA - ED			
Presentation *(most effective forms of presentation: graphs, maps, narratives etc.)*:Graphs, maps, tables, narratives			
End user(s) *(who will use the indicator for what purpose)*:Government for decision making and information and Companies			
Financial assessment *(approximate costs from data collection to indicator)*:			
Comments: Regularly review the indicator.			
Literature:			

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Management and business			
Group no:	5	**INDICATOR FACT SHEET**	
VEC 1: **Tourism**		IH no:	1d
Impact Hypothesis: Land take will interfere with habitats leading to wildlife migration which will reduce the number of wildlife and negatively impact on tourism		Driver: Land take/clearance	
Explanation:			
Evaluation in category A, B, C or D:	B		
Rationale for category: Empirical knowledge			

Recommended research: N/A to test the hypothesis	
Recommended management actions:	
Recommended monitoring: YES	
Measurable indicator name (what): Number of species in a restricted area e.g Delta area MFNP	Order 1, 2 or 3
Existing	Existing monitoring *(relevant ongoing monitoring or available data sets)*: YES
	Area covered (*by ongoing monitoring or available data sets)*: The whole park
	Data storage *(format and place where data sets are stored)*: MIST at UWA
	Responsibility *(institution and person currently responsible for existing monitoring data sets)*:UWA, M&R Unit
Why (*key question(s) which the indicator helps to answer*): there are exploratory sites which can potentially affect the animals and impact negatively on experience for tourists	
Current trend (*upward, stable or downward)*: Generally the animal population is increasing	
How (*method, sampling and analysis, quality assurance*): aerial surveys and ground counts	
Where (*location, geo-referenced)*:Delta area north of the Nile	
When (*frequency*):Quarterly in phase 1,2,3	
By whom *(which institution will collect the indicator data)*:UWA, WCS, NEMA	
Lead agency *(institution and person responsible for calculating and communicating the indicator)*:UWA - ED	
Presentation *(most effective forms of presentation: graphs, maps, narratives etc.)*:Graphs, maps, tables, narratives	
End user(s) *(who will use the indicator for what purpose)*:Government for decision making and information and Companies	
Financial assessment *(approximate costs from data collection to indicator)*:	
Comments: Regularly review the indicator. Equipments needed to facilitate monitoring	
Literature:	

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Management and business			
Group no:	5	**INDICATOR FACT SHEET**	
VEC 2: **Fisheries**		IH no:	1a
Impact Hypothesis: Aquatic disturbance destroys breeding grounds leading to fish migration, and mortality causing reduction in fish stocks affecting the fisheries business		Driver: Aquatic disturbances	
Explanation: Empirical evidence			
Evaluation in category A, B, C or D:	B		
Rationale for category: Empirical knowledge			

Recommended research: Baseline research e.g Extent of disturbance, level of impact			
Recommended management actions: strengthen the monitoring within the graben			
Recommended monitoring: baseline information collection and regular monitoring			
Measurable indicator name (what): species richness and distribution in Lake Albert, George, Edward		Order 1, 2 or 3	
Existing	Existing monitoring *(relevant ongoing monitoring or available data sets)*: fish catch, bethos, water quality		
	Area covered (*by ongoing monitoring or available data sets)*: shoreline and offshore		
	Data storage *(format and place where data sets are stored)*: NaFIRRI, DFR		
	Responsibility *(institution and person currently responsible for existing monitoring data sets)*: DFR		
Why (*key question(s) which the indicator helps to answer*): can oil and gas activities in or near the lake affect fish stocks and water quality			
Current trend (*upward, stable or downward)*: fish stocks declining mainly because of poor methods of fishing and overfishing			
How (*method, sampling and analysis, quality assurance*): fish catch assessments, gill net surveys			
Where (*location, geo-referenced)*: at relevant sites, breeding sites, fishing grounds			
When (*frequency*): quarterly			
By whom *(which institution will collect the indicator data)*: NaFRRI, DFR			
Lead agency *(institution and person responsible for calculating and communicating the indicator)*: DFR-Commissioner			
Presentation *(most effective forms of presentation: graphs, maps, narratives etc.)*:Graphs, maps, tables, narratives			
End user(s) *(who will use the indicator for what purpose)*:Government for decision making and information and Companies, fishermen and local authorities			
Financial assessment *(approximate costs from data collection to indicator)*:			
Comments: Regularly review the indicator. Equipments needed to facilitate monitoring. Advance methods/techniques for monitoring fish stocks required			
Literature:			

A. The hypothesis is assumed not to be valid.
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C. The hypothesis is assumed to be valid. Research, monitoring or surveys is recommended to validate or invalidate the hypothesis. Mitigating measures can be recommended if the hypothesis is proved to be valid.
D. The hypothesis may be valid, but is not worth testing for professional, logistic, economic or ethical reasons, or because it is assumed to be of minor environmental influence only or of insignificant value for decision making.

Management and business			
Group no:	5	**INDICATOR FACT SHEET**	
VEC 2: **Fisheries**		IH no:	1b
Impact Hypothesis: oil spills and blow outs lead to water pollution which cause fish mortality reducing fish stocks hence affecting fisheries		Driver: Oil spills and blow outs	
Explanation: Experience from other countries			
Evaluation in category A, B, C or D:	B		
Rationale for category: Experience from other countries			

Recommended research: N/A to test the hypothesis	
Recommended management actions: Develop an oil spill contingency plan and procure relevant equipments	
Recommended monitoring: YES	
Measurable indicator name (what): water quality	Order 1, 2 or 3
Existing	Existing monitoring *(relevant ongoing monitoring or available data sets)*: YES
	Area covered (*by ongoing monitoring or available data sets)*: Water bodies in the Albertine Graben
	Data storage *(format and place where data sets are stored)*: NAFRRI, DFR
	Responsibility *(institution and person currently responsible for existing monitoring data sets)*: DFR-
Why (*key question(s) which the indicator helps to answer*): oil spills impact on fisheries resources	
Current trend (*upward, stable or downward)*: fish stocks declining	
How (*method, sampling and analysis, quality assurance*):	
Where (*location, geo-referenced)*:Lake Edward, George, Albert and other water bodies within the Albertine Graben	
When (*frequency*):when it happens	
By whom *(which institution will collect the indicator data)*: NAFRRI, DFR	
Lead agency *(institution and person responsible for calculating and communicating the indicator)*: DFR-Commissioner	
Presentation *(most effective forms of presentation: graphs, maps, narratives etc.)*:Graphs, maps, tables, narratives	
End user(s) *(who will use the indicator for what purpose)*:Government for decision making and information and Companies, fishermen and local authorities	
Financial assessment *(approximate costs from data collection to indicator)*:	
Comments: Regularly review the indicator.	
Literature:	

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B. The hypothesis is valid and already verified. Research to validate or invalidate the hypothesis is not required. Surveys, monitoring, and/or management measures can possible be recommended.
C. The hypothesis is assumed to be valid. Research, monitoring or surveys is recommended to validate or invalidate the hypothesis. Mitigating measures can be recommended if the hypothesis is proved to be valid.
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Management and business			
Group no:	5	**INDICATOR FACT SHEET**	
VEC 3: **Agriculture**		IH no:	1
Impact Hypothesis: The oil and gas activities will provide alternative economic activities causing shifts from agriculture resulting into reduced food production. This will reduce food security, cause escalation of food prices, affecting the agricultural business		Driver: shifts in economic activity	
Explanation: Experience of other oil producing sub Saharan countries			
Evaluation in category A, B, C or D:	B		
Rationale for category: Empirical knowledge			

Recommended research: N/A to test the hypothesis	
Recommended management actions: UBoS and MAAIF should strengthen monitoring and surveys	
Recommended monitoring: YES	
Measurable indicator name (what): sources and levels of income for households	Order 1, 2 or 3
Existing	Existing monitoring *(relevant ongoing monitoring or available data sets)*: YES
	Area covered (*by ongoing monitoring or available data sets)*: the Albertine Graben
	Data storage *(format and place where data sets are stored)*: UBoS and MAAIF
	Responsibility *(institution and person currently responsible for existing monitoring data sets)*: UBoS and MAAIF
Why (*key question(s) which the indicator helps to answer*): oil and gas activities taking place within the graben are anticipated to provide alternative employment that may affect food production and security	
Current trend (*upward, stable or downward)*: declining rate of food production	
How (*method, sampling and analysis, quality assurance*): surveys, analysis	
Where (*location, geo-referenced)*:Kanungu, Rukungiri, Arua, Amuru, Hoima	
When (*frequency*):Annually in phases 1,2,3 and 4	
By whom *(which institution will collect the indicator data)*: UBoS and MAAIF	
Lead agency *(institution and person responsible for calculating and communicating the indicator)*: UBoS-ED	
Presentation *(most effective forms of presentation: graphs, maps, narratives etc.)*: Graphs, maps, tables, narratives	
End user(s) *(who will use the indicator for what purpose)*:Government for decision making and information and Companies, Farmers and local authorities	
Financial assessment *(approximate costs from data collection to indicator)*:	
Comments: Regularly review the indicator. Create awareness and provide incentives to maintain agriculture as an attractive business	
Literature:	

A. The hypothesis is assumed not to be valid.
B. The hypothesis is valid and already verified. Research to validate or invalidate the hypothesis is not required. Surveys, monitoring, and/or management measures can possible be recommended.
C. The hypothesis is assumed to be valid. Research, monitoring or surveys is recommended to validate or invalidate the hypothesis. Mitigating measures can be recommended if the hypothesis is proved to be valid.
D. The hypothesis may be valid, but is not worth testing for professional, logistic, economic or ethical reasons, or because it is assumed to be of minor environmental influence only or of insignificant value for decision making.

Management and business			
Group no:	5	**INDICATOR FACT SHEET**	
VEC 4: **Transport**		IH no:	1
Impact Hypothesis: oil and gas activities will increase traffic load and volume likely to cause increase in accidents and maintenance costs that can affect the transport business		Driver: Traffic	
Explanation: ongoing activities have increased traffic volumes in the region			
Evaluation in category A, B, C or D:	B		
Rationale for category: Empirical knowledge			

Recommended research: traffic surveys to test the hypothesis	
Recommended management actions: Put in place traffic regulation mechanism	
Recommended monitoring: YES	
Measurable indicator name (what): traffic volumes and loads on selected priority roads.	Order 1, 2 or 3
Existing	Existing monitoring *(relevant ongoing monitoring or available data sets)*: YES
	Area covered (*by ongoing monitoring or available data sets)*: The Albertine Graben
	Data storage *(format and place where data sets are stored)*: UNRA
	Responsibility *(institution and person currently responsible for existing monitoring data sets)*:UNRA
Why (*key question(s) which the indicator helps to answer*): Oil and gas activities require road access infra-structure with significant traffic volumes and loads that will affect road conditions	
Current trend (*upward, stable or downward)*: low standard roads	
How (*method, sampling and analysis, quality assurance*): traffic surveys and road condition assessments	
Where (*location, geo-referenced)*: roads leading to Kaiso, buliisa, semuliki, Ishasha, and key bridges	
When (*frequency*): quarterly in 1,2 and 3	
By whom *(which institution will collect the indicator data)*:UNRA	
Lead agency *(institution and person responsible for calculating and communicating the indicator)*:UNRA - ED	
Presentation *(most effective forms of presentation: graphs, maps, narratives etc.)*:Graphs, maps, tables, narra-tives	
End user(s) *(who will use the indicator for what purpose)*:Government for decision making and information and Companies, transporters	
Financial assessment *(approximate costs from data collection to indicator)*:	
Comments: roads need upgrading and regular maintenance.	
Literature:	

A. The hypothesis is assumed not to be valid.
B. The hypothesis is valid and already verified. Research to validate or invalidate the hypothesis is not required. Surveys, monitoring, and/or management measures can possible be recommended.
C. The hypothesis is assumed to be valid. Research, monitoring or surveys is recommended to validate or invalidate the hypothesis. Mitigating measures can be recommended if the hypothesis is proved to be valid.
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Management and business			
Group no:	5	**INDICATOR FACT SHEET**	
VEC 5: **Forestry**		IH no:	1
Impact Hypothesis: oil and gas activities will involve settlements and infrastructure developments that may require land clearance/taking causing destruction of forests reducing the supply of forest products and ecological functions hence increasing prices.		Driver: Settlements and infrastructure development	
Explanation: ongoing activities are likely to reduce the forest cover			
Evaluation in category A, B, C or D:	B		
Rationale for category: Empirical knowledge			
Recommended research: N/A to test the hypothesis			
Recommended management actions: strengthen forest monitoring			
Recommended monitoring: YES			
Measurable indicator name (what): forest cover, prices and number of loggers within and surrounding areas of the graben.		Order 1, 2 or 3	
Existing	Existing monitoring *(relevant ongoing monitoring or available data sets)*: YES		
	Area covered (*by ongoing monitoring or available data sets)*: The Albertine Graben and surroundings		
	Data storage *(format and place where data sets are stored)*: NFA		
	Responsibility *(institution and person currently responsible for existing monitoring data sets)*: NFA		
Why (*key question(s) which the indicator helps to answer*): Oil and gas activities will attract settlements and infrastructure development that will affect the forest cover and availability of wood products			
Current trend (*upward, stable or downward)*: downward			
How (*method, sampling and analysis, quality assurance*): inventories, land cover assessments, satellite imagery and remote sensing			
Where (*location, geo-referenced)*: Forest reserves in and around the graben			
When (*frequency*): quarterly in 1,2 and 3			
By whom *(which institution will collect the indicator data)*: NFA and NEMA			
Lead agency *(institution and person responsible for calculating and communicating the indicator)*: NFA - ED			
Presentation *(most effective forms of presentation: graphs, maps, narratives etc.)*:Graphs, maps, tables, narratives			
End user(s) *(who will use the indicator for what purpose)*:Government for decision making and information and Companies			
Financial assessment *(approximate costs from data collection to indicator)*:			
Comments: people need to be encouraged to plant trees to increase forest cover and products			
Literature:			

A. The hypothesis is assumed not to be valid.
B. The hypothesis is valid and already verified. Research to validate or invalidate the hypothesis is not required. Surveys, monitoring, and/or management measures can possible be recommended.
C. The hypothesis is assumed to be valid. Research, monitoring or surveys is recommended to validate or invalidate the hypothesis. Mitigating measures can be recommended if the hypothesis is proved to be valid.
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Management and business			
Group no:	5	**INDICATOR FACT SHEET**	
VEC 6: **Construction materials**		IH no:	1
Impact Hypothesis: oil and gas activities will involve settlements and infrastructure developments that may require more building materials that will deplete or reduce the availability of these materials increasing the prices for these materials.		Driver: Settlements and infrastructure development	
Explanation: ongoing activities are likely to reduce the forest cover			
Evaluation in category A, B, C or D:	B		
Rationale for category: Empirical knowledge			
Recommended research: N/A to test the hypothesis			
Recommended management actions: strengthen forest monitoring			
Recommended monitoring: YES			
Measurable indicator name (what): forest cover, prices and number of loggers within and surrounding areas of the graben.		Order 1, 2 or 3	
Existing	Existing monitoring *(relevant ongoing monitoring or available data sets)*: YES		
	Area covered (*by ongoing monitoring or available data sets)*: The Albertine Graben and surroundings		
	Data storage *(format and place where data sets are stored)*: NFA		
	Responsibility *(institution and person currently responsible for existing monitoring data sets)*: NFA		
Why (*key question(s) which the indicator helps to answer*): Oil and gas activities will attract settlements and infrastructure development that will affect the forest cover and availability of wood products			
Current trend (*upward, stable or downward)*: downward			
How (*method, sampling and analysis, quality assurance*): inventories, land cover assessments, satellite imagery and remote sensing			
Where (*location, geo-referenced)*: Forest reserves in and around the graben			
When (*frequency*): quarterly in 1,2 and 3			
By whom *(which institution will collect the indicator data)*: NFA and NEMA			
Lead agency *(institution and person responsible for calculating and communicating the indicator)*: NFA - ED			
Presentation *(most effective forms of presentation: graphs, maps, narratives etc.)*:Graphs, maps, tables, narratives			
End user(s) *(who will use the indicator for what purpose)*:Government for decision making and information and Companies			
Financial assessment *(approximate costs from data collection to indicator)*:			
Comments: people need to be encouraged to plant trees to increase forest cover and products			
Literature:			

A. The hypothesis is assumed not to be valid.
B. The hypothesis is valid and already verified. Research to validate or invalidate the hypothesis is not required. Surveys, monitoring, and/or management measures can possible be recommended.
C. The hypothesis is assumed to be valid. Research, monitoring or surveys is recommended to validate or invalidate the hypothesis. Mitigating measures can be recommended if the hypothesis is proved to be valid.
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2.9 Summary of indicators

Category (VEC)	Measurable indicator name (what):	Order
Aquatic ecosystem		
Wetlands	Key water quality indicators(DO, Chl-a, P, N, pH etc), Plant species richness & composition	1
	Vegetation cover, flow, Key water quality indicators(DO, Chl-a, P, N, pH etc), plant species richness & composition	1
Fish	Water quality (DO, P, N, Chl-a, PHCs, Transparency, conductivity)	
	Water quality (BOD, COD, pH, PHCs etc)	1
Terrestrial ecosystem		
Flagship mammals (e.g. elephants, lions, Uganda Kob etc)	Mammal numbers and diversity, mammal ranges (area), infrastructure density, gene diversity, stress hormon levels	1
	Number of spill incidences, heavy metal levels in the food chain, presence and level of heavy metals in water and soils	1
	Number of snares, poached animals, apprehended poachers, number of public awareness meetings	1
	Human and animal demography, number of snares, number of animals poached, poachers apprehended, number of human-wildlife conflicts reported	
	Number of kills or injuries, vehicles	1
Flagship birds (e.g. African fish eagle, vultures, forest birds etc)	Birds numbers and diversity, ranges (area), infrastructure density, gene diversity, stress hormone levels	1
	Number of spill incidences, heavy metal levels in the food chain, presence and level of heavy metals in water and soils	1
	Birds demography, disease among birds communities	1
	Noise levels, light intensity, bird diversity and demography, migratory patterns	2
Flagship wetland species (e.g. Frogs, butterflies, dragonflies, water fowls etc)	Wetland species numbers and diversity, ranges (area) and infrastructure density	1
Flagship floral ecosystem components (e.g. wetlands, forests, savannas, woodlands, agriculture)	Number and coverage of invasive species, areas that have changed from one cover type to another, number of conflicts reported	1
	Area of land cover types, biomass stocking including regeneration, biodiversity, trade in timber and non-timber forest products	2
	Number and quantity of spills, spatial coverage of spill, response time to spills	1
Below ground biodiversity (macro and micro organisms etc)	Counts of soil BGBD e.g. earth worm and beetles	1
	Counts of soil BGBD at representative waste disposal or oil spill sites	1
Physical/chemical		
Water	Site samples analyzed for heavy metals	1
	River discharge, lake levels, groundwater levels and rainfall	1
	Waste water, biological indicators, leachate parameters, heavy metals, PHCs and nutrient loads	
Air	Noise levels, vibrations, concentrates of gases and particulate matter	
Soil	Area covered by the spill, Magnitude and extent of oil traces, results	

	from laboratory tests for hydrocarbons and heavy metals	
Micro climate	Changes in; rainfall, wind, temperature, pressure, evapo-transpiration and solar radiation	
Society		
Settlements	Number of people; Number of settlements; Size of settlements	
	Size and composition of labour force Number of people employed by sector and occupation	
Food	Acreage of land under food production; Food price index Food availability in the region; Household incomes Number of food storage facilities.	
	Acreage of land under food production; Total food production in the country; Household incomes	
Water and sanitation	Portable water coverage; Latrine coverage; Number of waste disposal facilities; Distance to nearest safe water source Time taken to collect water from nearest water source Number of cases due to water borne diseases	
Health	Number of health facilities; Prevalence of diseases; Mortality rate; Number of deaths by cause	
Energy	Types of energy sources Number of people using energy source by type and quantity	
Infrastructure	Quantity of mineral resources; Location of mineral resources; Available infrastructure	
Education	Number of education facilities; Number of school-going age children; Literacy rate	
Culture	Number of cultural sites; Number of ethnic groups and languages	
Archeological sites	Number of the archeological sites; Location of archeological sites; Available infrastructure	
Management and business		
Tourism	Number of species in a restricted area e.g Delta area MFNP	
	Number of tourists in Wildlife PAs	
	Habitat attributes	
	Number of species in a restricted area e.g Delta area MFNP	
Fisheries	Species richness and distribution in Lake Albert, George, Edward	
	Water quality	
Agriculture	Sources and levels of income for households	
Transport	Traffic volumes and loads on selected priority roads.	
Forestry	Forest cover, prices and number of loggers within and surrounding areas of the Albertine Graben	
Construction materials	Forest cover, prices and number of loggers within and surrounding areas of the Albertine Graben	

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4 Appendix

4.1 Workshop program

Monday 11 April

Time	Introduction and preparation	Who
09:00	Welcome	
09:10	Presentation of participants	all
10:00	Introduction	NEMA
10:20	Presentation of baseline information – Background Paper	NEMA/WCS
11:00	Coffee, tea	
11:30	Activity description – oil and gas development phases	PEPD
13:00	Lunch	
14:00	Introduction to the scoping process	Facilitator
14:30	Scoping process training: step by step instruction	Facilitators
15:30	Coffee, tea	
16:00	Group work, composition and tasks (organizing group leaders, reporters and participants)	Facilitators
16:30	Special preparation for groupwork reporters	Facilitators/Editorial Group
	End day 1 for main group of participants	

Tuesday 12 April

Time	Scoping process	Who/where
09:00	Group organizing	Facilitators
09:15	Group work 1: Selecting Valued Ecosystem Components (VECs)	Participants, group rooms
10:30	Coffee, tea	
11:00	Group work 2: Identification of drivers (impact factors)	Participants, group rooms
13:00	Lunch	
14:00	Plenary session 1: Presenting the results from group work 1 and 2	Plenary
15:30	Discussion, conclusions	
16:00	Group work 3: Linking drivers and VECs in cause-effect charts	Participants, group rooms
18:00	End day 2	

Wednesday 13 April

Time	Scoping process	Who/where
09:00	Group work 3: Continue from end of day 2	Participants, group rooms
11:00	Coffee, tea	
11:30	Plenary session 2: Presenting the results from group work 3	Plenary
13:00	Lunch	
14:00	Group work 4: Formulation ofImpact Hypotheses from VEC cause-effect charts,evaluation and prioritizing	Participants, group rooms
16:00	Coffee, tea	
16:30	Group work 4: continues	Participants, group rooms
18:00	End day 3	

Thursday 14 April

Time	Scoping process	Who/where
09:00	Plenary session 3: Presenting the results from group work 4	Plenary
10:30	Coffee, tea	
11:00	Group work 5: Recommendations	Participants, group rooms
13:00	Lunch	
14:00	Plenary session 4: Presenting the results from group work 5	Plenary
16:00	Coffee, tea	
16:30	Wrapping up the workshop	Facilitators
18:00	End of workshop	NEMA

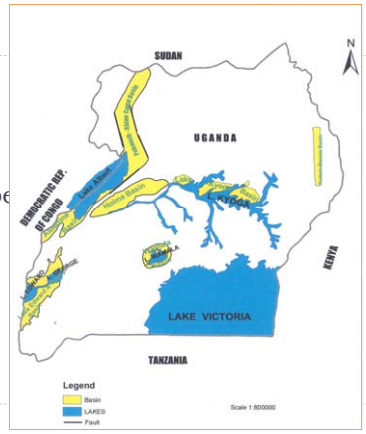
4.2 Presentations at the workshop

1. **Environmental sensitivity of the Albertine GrabenPresentation of baseline information – Background Paper**
2. **Activity description – oil and gas development phases**
3. **Introduction to the scoping process**

Environmental sensitivity of the Albertine Graben

Kitutu Kimono Mary Goretti (PhD)
Environment Information Systems Specialist
National Environment Management Authority.

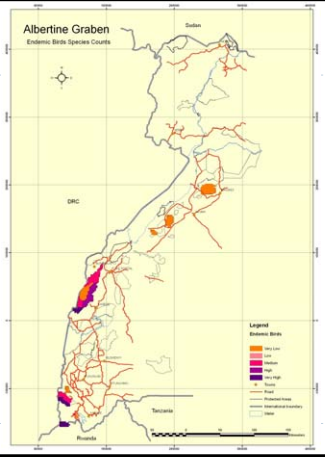
Albertine grabe

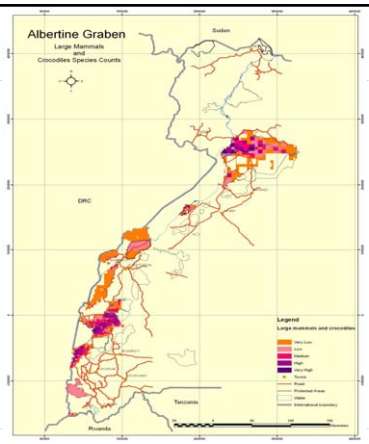


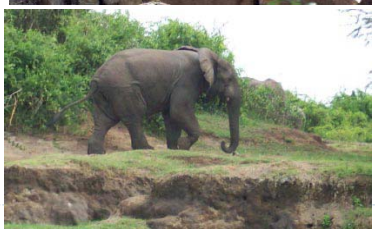
Biological Hot spot in Africa.

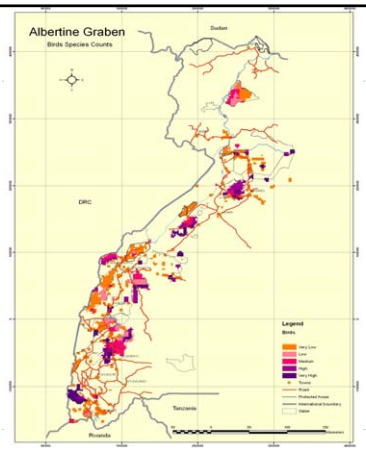
- The area has 14% of all African reptiles (175 species).
- 19% of Africa's amphibians (119 species).
- 35% of Africa's butterflies (1300 species).
- 52% of all African birds (1061 species).
- 39% of all African mammals (402 species of mammals), and about
- 128 species of fish.

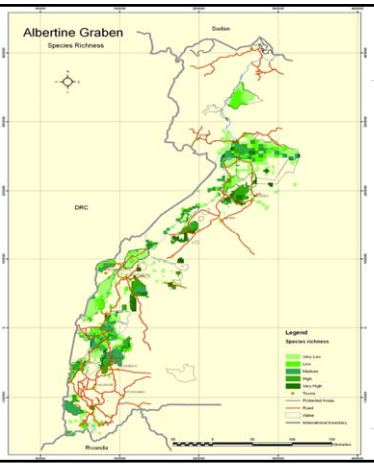
Biological sensitivity

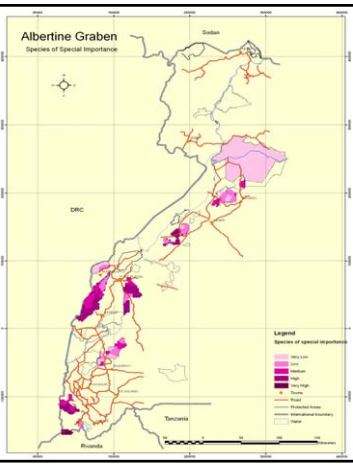


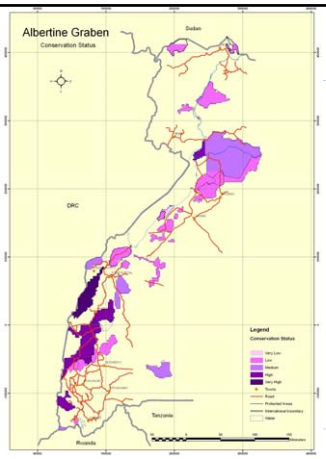


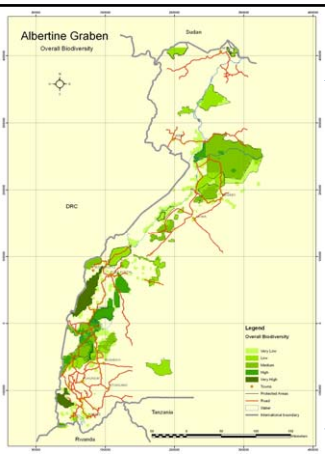



Albertine Graben
Birds Species Counts
Sudan
DRC
Tanzania
Rwanda
Legend
Birds


Albertine Graben
Species Richness
Sudan
DRC
Tanzania
Rwanda
Legend
Species richness


Albertine Graben
Species of Special Importance
Sudan
DRC
Tanzania
Rwanda
Legend

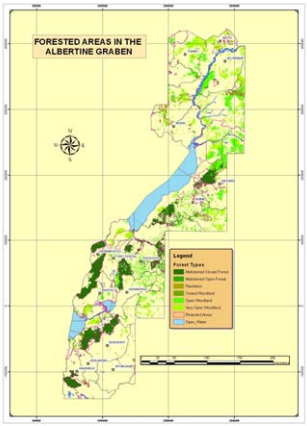


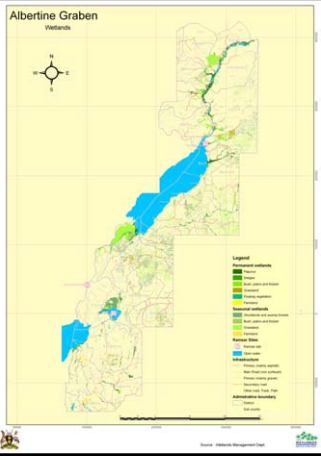


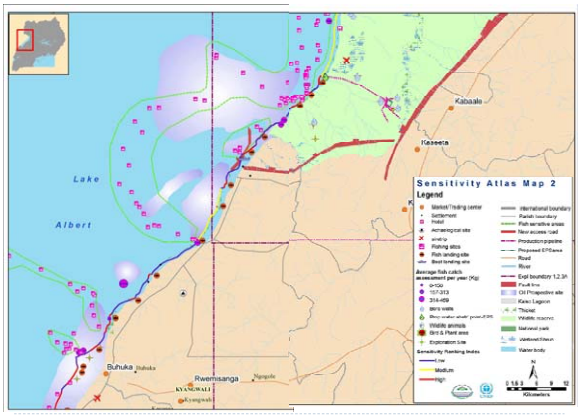
Murchison falls NP (River Nile)

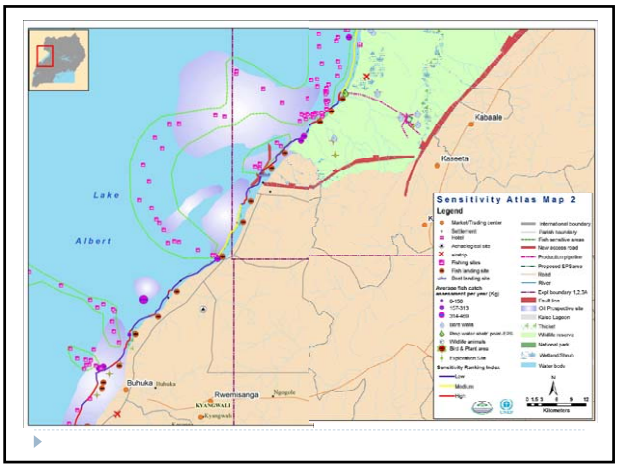
Kabwoya game reserve

Kabwoya Game Reserve








Lake
Albert
Kabaale
Kasneeta
Buhuka
Rwemisanga
Sensitivity Atlas Map 2
Legend

WORKSHOP FOR DEVELOPMENT OF ENVIRONMENTAL MONITORING INDICATORS

PRESENTED BY:
PEPD

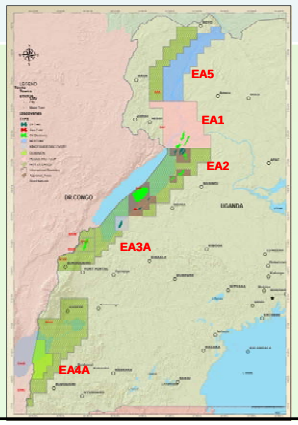
MARGERITA HOTEL, KASESE
11TH APRIL, 2011

PRESENTATION OUTLINE

1. Current status of licensing
2. Resource potential of Uganda's Albertine Graben
3. Investment in the upstream oil and gas sector
4. Petroleum Value Chain
5. Petroleum environment related challenges
6. Conclusion

2

STAND OF STATUS OF LICENSING IN UGANDA



Licensed EAs are:

EA1: Interim Operator is Tullow Partners to come in TOTAL and CNOOC

EA2: Operator is Tullow Partners to come in TOTAL and CNOOC

EA3A: Interim Operator is Tullow Partners to come in TOTAL and CNOOC

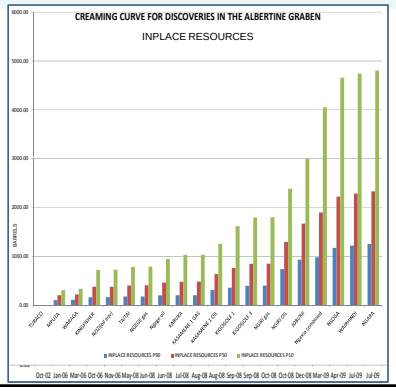
Operatorship of EA1, 2 and 3A is being evaluated by Government and after the full transfer of 33% of each of the shares in EA1, 2 and 3A, the Minister will write to Tullow, TOTAL and CNOOC giving operatorship for each of the area.

EA4A: Operator is Dominion (U) Ltd

EA5: Operator is Neptune Petroleum (U) Ltd

3

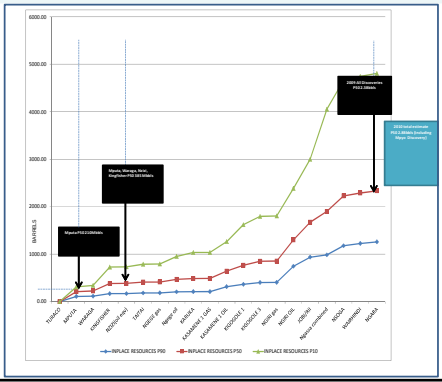
Resource potential



4

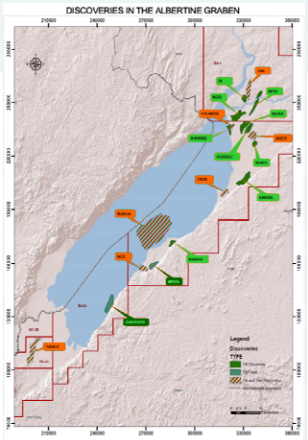
Resource potential

CREAMING CURVE FOR DISCOVERIES IN THE ALBERTINE GRABEN



5

Resource potential



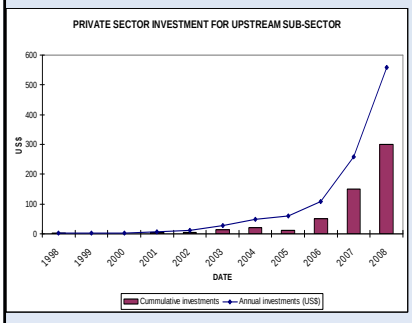
Resource Base at the end of 2010

Eighteen discoveries with total estimate of over two billion barrels of oil in place

6

INVESTMENT

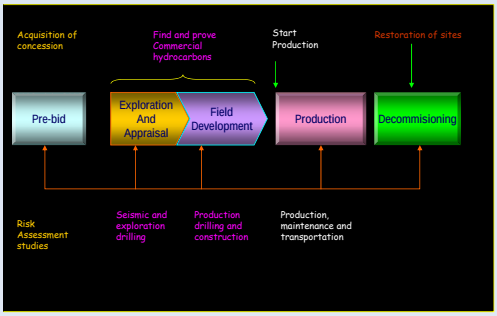
Foreign Direct Investments (FDI) to date



Cumulative Investment in oil and gas.

- Up to 2008: in excess of US$ 509 Million
- In 2009: in excess of US$ 900 Million
- In 2010: Up to US$ 1.4bn invested
- With the Oil and Gas giants showing interest in Uganda (e.g Total and CNOOC), this investment may double.

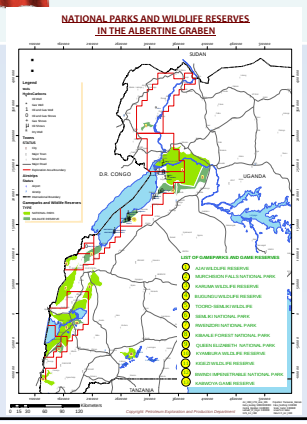
PETROLEUM VALUE CHAIN



PETROLEUM VALUE CHAIN

LICENSING EXPLORATION DEVELOPMENT PRODUCTION	UPSTREAM
TRANSPORTATION REFINING GAS PROCESSING	MIDSTREAM
DISTRIBUTION MARKETING SALES	DOWNSTREAM

Environment related challenges

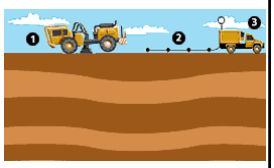


- Hydrocarbon prospective areas are the same areas of rich biodiversity
- Sustainable exploitation of Hydrocarbon implies conserving the Environment and biodiversity

Environment related challenges

UPSTREAM: Exploration and Development

- 1) Seismic equipment:
  - Noise/vibration
    - Shot-hole drilling: acoustic (explosives & vibrations)
    - Wildlife mortality: potential for straying animals
- 2) Line cutting
  - Access/footprint
    - Removal of vegetation, erosion, changes to surface hydrology & drainage, population influx, passage width for equipment, opens up access
    - Mainly short-term



Credit US Dept. of Energy

Line cutting can have different impact and different significance depending on sensitivity habitat

Environment related challenges

UPSTREAM: Exploration and Development

Impacts from drilling

- **Roads (access)**
  - **Primary:**
    - **Vegetation clearance: erosion, hydrology**
    - **Emissions, vibrations, noise from earth clearing**
    - **Disturbance local population & wildlife**
  - **Secondary:**
    - **Influx & conflict, settlement & carrying capacity, etc**

Source: PEPD

Environment related challenges

UPSTREAM: Exploration and Development

- **Site preparation & Camp**
  - **Footprint**
    - **Choice of location: loss of habitat, visual intrusion, disturbance to local population & wildlife, habitats, transport**
    - **Vegetation clearance: topsoil removal, erosion, hydrology impacts**
  - **Physical presence**
    - **Soil contamination, construction & drilling noise, emissions, discharges (sanitary, kitchen wastes, etc)**
    - **Water access & supply**
  - **Workforce**
    - **Choppers/barges, population influx, interactions, hunting/poaching, land-use conflicts**

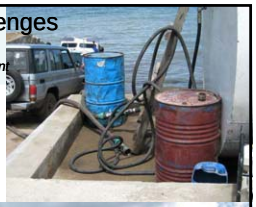
Source: PEPD

Short-term (---> long-term?)

Environment related challenges

UPSTREAM: Exploration and Development

- **Discharge, emissions, wastes**
  - **Muds re-use, then evaporation/ disposal**
    - **Water (seawater, fresh or brine) or oil (diesel) based muds**
    - **Chemical additives**
  - **Cuttings disposal**
    - **Land-spreading**
    - **Offshore dumping in piles**
  - **Waste water & Spills**
    - **Contamination**
    - **Containment (land vs water)**
  - **Waste disposal (hazardous?)**
- **Footprint & community**
- **Supply of water**
  - **Lake water**
  - **or shallow aquifer …reduces water available at boreholes for others?**



Source: PEPD

Environment related challenges

UPSTREAM

Drilling wastes

- Typically 1000-5000 m^3 waste per well
- Water-based muds (WBM) now most common
  - WBM have less toxic effect on the environment
    - ✓ Bentonite & clays chemically inert
- Oil based muds (OBM) usually on deviated wells due to increased drilling challenges

Environment related challenges

UPSTREAM: Chemicals used in drilling

- Weighting materials (major component)
  - ✓ e.g. barite (+ heavy metals traces, fine particles)
- Viscosifiers
  - ✓ e.g. bentonite, clays
- Fluid loss control agents
- Emulsifiers
- Brines
- Alkaline chemicals
- Lost circulation materials
- Shale control additives
- Lubricants & detergents

Impacts may include:

Toxicity
- Absence, to potentially lethal concentrations?
- Dilution, dispersion

Smothering
- Benthic & soil ecology

Respiration/ingestion
- Pelagic lake species
- Benthic lake bed

Disposal of waste hazardous substances
- Problem

Environment related challenges

UPSTREAM AND MIDSTREAM: Well testing/flaring

Impacts include:
- noise
- light
- Emissions (combustion of HC's)
- Non-combusted oil dropout

Flaring in kaiso-Tonya 2007 (Waraga well test)

Flaring in using the ever green burner- 2008 to date

Environment related challenges

UPSTREAM AND MIDSTREAM: Blowouts

Credit: API

- Uncontrolled flow of of oil/gas from a well, occurs when formation pressure exceeds the pressure applied to it by the column of drilling fluid
  - loss of containment = loss of control
- Incredible pressures in reservoir and well
  - Pressure and equipment viability is maintained through a closed system
  - Blow Out Preventer (BOP) hydraulic valves to shut-in well
- Risks to human safety and environment are huge if not managed effectively

Environment related challenges

UPSTREAM AND MIDSTREAM

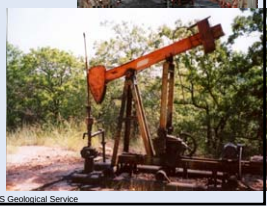
Impacts from production

- Longer term & increased potential for impacts
  - over producing field (25yrs+)
- Site selection is vital
  - Long-term habitat loss
- Volume, geographical & timeframe scales all increase:
  - footprint, construction, supply of materials, emissions/discharges, waste disposal, road access, product export infrastructure, …on & offsite

Credit: BP

Credit: Simon Pedersen BBOP

Onshore & offshore operations



Credit: US Geological Service

Environment related challenges

UPSTREAM AND MIDSTREAM

Impacts from production cont'd

- Camp & infrastructure
  - Footprint & discharges
    - Permanent addition to existing exploration footprint
      - Hydrology changes & soil erosion
      - Water supply, drainage, sewage
      - Soil & water contamination from spillage & leakage
      - Habitat & wildlife displacement
      - Community & land-use change
    - Expands for additional equipment and staff e.g.
      - Airstrip, roads & port facilities
      - Accommodation modules, storage & safe areas
      - Oil/gas/water separation equipment
      - Export & storage facilities


Nzizi-1 Camp


Nzizi-1 Camp


Explosives magazine at Bulissa


Main airstrip at Kaiso

Environment related challenges MIDSTREAM

Impacts from pipelines

- Construction & access
  - Potential for long linear scars
  - Possible barriers to wildlife movement
  - Possible access through previously closed 'safe' areas
  - Possible wildlife corridors & incursion by humans
- Long term occupation of land, above or sub-soil
  - Land leasing or occupation issues, compensation?
  - Conflict with land /sea users
- Security & safety issues e.g. Nigeria

Credit:Platform website (Remember Ken Sarowiwa)

Current mitigations

Drilling activities- mitigation of impacts

Drilling mud considerations for minimal harm to environment

•Selection of drilling fluid chemicals based on analysis of toxicity, biodegradation and bioaccumulation e. g use of inert inorganic chemicals and degradable organic compounds

•Use water based drilling fluid instead of oil based drilling fluid if possible.

•Reuse of drilling fluids

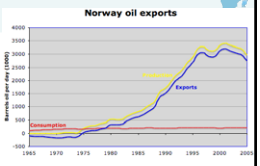
Current mitigations

Outline of Social and Environment strategies being implemented by Government:

- Strategic Environment Assessment (SEA)
- Environment Impact Assessment
- Environment Sensitivity Atlas
- Oil Spill Contingency plans
- Use of Blow Out Preventers
- Waste collection and proper disposal
- Collaboration with other Government institutions
- Sensitization and training

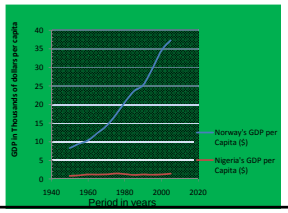
Turning Oil and Gas into an opportunity

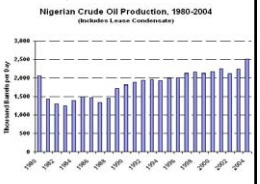
Examples of Countries with good Oil and Gas management practices



Norway is the best example of countries which have sustainably invested the O&G revenues

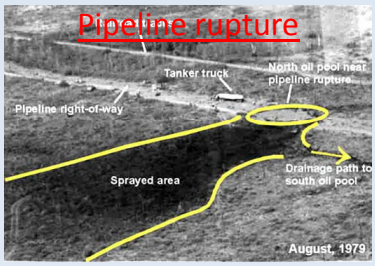
Both Nigeria and Norway produced 1.5-2mbpd between 1980 and 2005 but Norway's GDP per capita has been growing steadily to over $35,000 compared to Nigeria's (constantly at less than $5000)

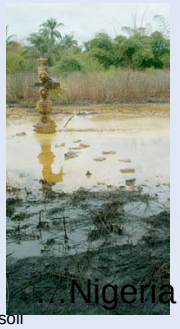




Turning Oil and Gas into an opportunity

Examples of cases of poor Oil and Gas management practices





- 1979 pipeline rupture Bemidji,Minnesota, US
- 10,700 bbls released, spray towards wetland
- After clean-up, 2,500 bbls crude oil remains in sub-soil

Turning Oil and Gas into an opportunity

Examples of Countries with poor Oil and Gas management practices

Angola produces more than 1 million barrels of oil per day. Valued at over US$50 million per day yet Angola is still a recipient of Foreign Aid.

Chad produces more than 160,000 barrels of oil per day yet public infrastructure are nearly nonexistent.

Oil in most of Africa is synonymous with greed, theft, mismanagement, conflict, corruption, poverty and misery in all its forms.

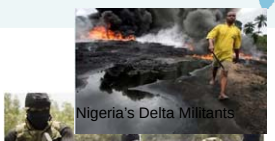
Have we learnt any lessons about what to avoid?

Turning Oil and Gas into an opportunity

Reasons for why oil curse had to occur in some countries

1. Lack of proper policies and legislation before exploitation of resources
2. Mismanagement of resources
3. Political instabilities e.g Angola

Uganda is lucky by putting up the necessary regulatory framework on management of O&G revenues and on protection of the environment ahead of production



Nigeria's Delta Militants

Turning Oil and Gas into an opportunity

1. Implementation of international best practices
2. Use of Oil and Gas revenues for sustainable development e.g supporting other sectors e.g Agriculture, Tourism, reduction of dependency on biomass for fuel, infrastructure and social development etc.

   Our Policy 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.*

3. In order to make it to the above goal among others, the National Oil and Gas Policy has guiding principles as:
   - *To use the finite resources to create lasting benefit to society*
   - *Efficient resource management*
   - *Transparency and accountability*
   - *Protection of the environment and conservation of biodiversity*

Conclusion

The way forward is co-existence between the rich biodiversity in the Albertine Graben and O-G related activities so that Ugandans can benefit from both resources

Environmental monitoring in Albertine Graben, Uganda

Scoping process - indicators

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NINA

Directorate for Nature Management

Workshop outputs

- Focused measurable indicators to be used in the environmental monitoring programme for the Albertine Graben
- Important input to the work with a Strategic Environmental Assessment for oil/gas development in the Albertine Graben (both scoping and M&E programme, ref. Pt. 9 in draft ToR)
- An ownership for the participants to the process of selecting indicators and to the process of oil/gas development in the Albertine Graben

What is scoping?

- *Scoping refers to the process of identifying, from a broad range of potential problems, a number of priority issues to be addressed by an EIA (Beanlands 1988)*
- In connection with the establishment of the environmental monitoring programme for the Albertine Graben in Uganda, scoping refers to the process of
  - *identifying a limited number of issues to be addressed in the monitoring programme with the aim to measure (indicators) the existing quality and potential future changes of the environment and the society (ecosystem approach)*
- Important: the design of a monitoring programme must consider the final use of the data before monitoring starts

Indicators

- Indicators are purpose dependent, i.e. monitoring the oil/gas development for reporting potential changes in the ecosystem as a basis for decisions on mitigating measures or other management actions
- Consequently, it is important to determine the purpose of the indicator and the end users
- Successful indicators are actually used to support policy and decision making
- Indicators provide data about more than itself (ex. human body temperature provide information about the persons health)
- An indicator can provide information on several issues

Indicator development must include

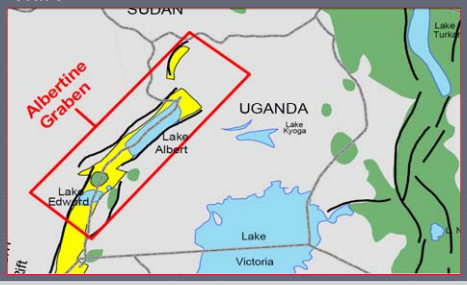
- A science based understanding of the focal issues
- An understanding of the scientific and statistical strengths and weaknesses of the collected indicator data
- Skills to develop valid scientific and statistical maps, graphs and narratives
- Skills and routines to communicate the indicator results to decision makers
- An understanding that active use of indicator results are an important tool for adaptive management and decision making

Approach

- The Adaptive Environmental Assessment and Management (AEAM)
- a systematic step–by–step scoping approach
- participatory workshop based process
- secure the interdisciplinarity and mutually share knowledge among scientists and other actors and stakeholders
- Aim: identify a limited number of issues to be addressed in the monitoring programme
- Issues: Valued Ecosystem Components, drivers (impact factors), impact hypotheses and measurable indicators

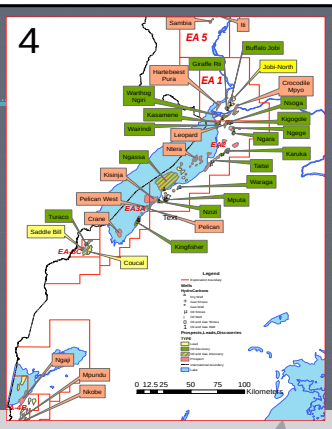
Basic information

Location



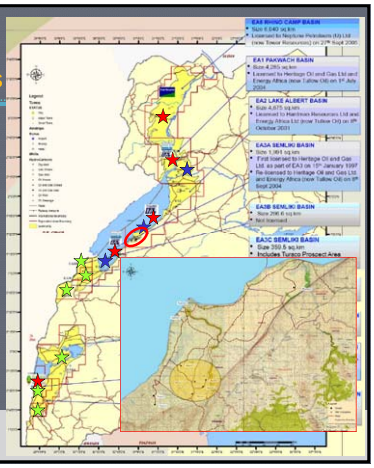
Basic information

- Development concept for the Albertine Graben
- Prospects, leads and discoveries
- Oil/gas development plans



Exploration areas

- 10 Exploration Areas
- 5 licenced
- Sensitivity Atlas cover all EA's
- Initial development will focus on EA 1, 2 and 3A
- Development plan starts with Mputa Field (EA2)
  - 35 production wells
  - 2 water disposal wells
  - Crude oil transportation (pipeline or tankers) to Kabale refinery
  - Power plant
  - Access roads



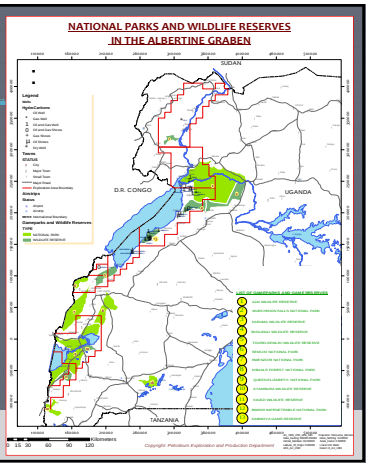
Basic information

- Sensitivity Atlas:
- Overall biodiversity sensitivity of the Albertine Graben
- Baseline information about the ecosystem, natural resources, climate, socio-economy, land use and tenure, geology …
- Sensitivity of biological resources and other natural resources

Basic information

Background information

- Protected areas
- Biodiversity in general
- Terrestrial ecosystem
- Aquatic ecosystem
- Ecosystem services
- Society
- Tourism and business
- Ecosystem approach
- National Environment Act



Basic criteria for selection of indicators

1. Policy relevance
   - in accordance with policy documents and objectives in Uganda
2. Available and routinely collected data
   - secure regularly update of indicator data which should be simple, but accurate to measure and cover both lower and higher trophic levels
3. Spatial and temporal coverage of data
   - secure that the defined monitoring area vil be covered over time and that the indicators are sensitive to ecosystem change caused by natural and anthropogenic drivers
4. Existing monitoring data series should be continued
   - good long term qualitative dataseries are essential to measure trends, and the value of such datasets only increases over time
5. Representativeness
   - secure that most aspects of the ecosystem are covered, both physical aspects, biological components and the society, and cover common species of public concern (e.g. red listed species) and of importance to local communities

Basic criteria for selection of indicators

6. Methodologically well founded
   - through a clear description of the methodology to be used when measuring the indicators
7. Understandability
   - secure that the indicators are clearly defined and understood by the stakeholders and end users (i.e. local community, decision makers, global public)
8. Agreed indicators
   - indicators mutually accepted by the stakeholders and end users

Source: Based on EEA core set of indicators + Background Paper

Scoping towards indicators

- Aim: what to measure how, when, where, why and by whom?
- Systematic step by step process (Adaptive Environmental Assessment and Management)
- Starting with a holistic picture, scoping towards the core set of indicators
- Group work and plenary sessions
- Groups interdisciplinary composed, seeking for an even distribution of gender and age

Information needs, baseline data

- Baseline existing information on the environment and on the society
- Activity description – oil and gas development phases:
  1. Exploration (potential environmental impacts from exploration activities)
  2. Drilling/Development (potential environmental impacts from drilling and oil or gas field development activities)
  3. Production (potential environmental impacts from production activities)
  4. Decommissioning/Reclamation (potential environmental impacts from decommissioning and reclamation activities)
- Potential environmental impacts associated with oil and gas production will vary by phase, and include direct, indirect, and cumulative impacts

What do we have?

- Sensitivity Atlas and Background paper: baseline existing information on the development plan, the environment and the society (NEMA)
- Oil/gas development concept: Basin wide development concept (PEPD)
- Background paper: framework for development of indicators, including Ecosystem monitoring framework (appendix 2)
  - Main categories
  - Parameters
  - Indicators
  - Methods
  - Frequency
  - Responsibility
  - Relevant ongoing monitoring or available databases
  - Areas covered by ongoing monitoring

Scoping process

- Most important Valued Ecosystem Components (VEC) – or focal resources or environmental features that:
  - are important (not only economically) to a local human population, or
  - has a national or international profile/value, or
  - if altered from its existing status, will be important for
    - the evaluation of environmental impacts arising from oil/gas development, and
    - the focussing of management actions like mitigating measures
  - Examples: biodiversity, large mammals, crocodiles, red list species, endemic species, wetlands, vegetation, PA's, local communities, fisheries, tourism etc.....

Scoping process

- Most important Drivers – or impact factors/driving forces which can affect the ecosystem and/or the society (the VECs) in on one way or another during exploration, drilling, production and decommissioning
- Examples: Access roads, noise, disturbance, pollution, waste, habitat fragmentation, land use changes, invasive species, influx of labours, socio-economic disturbance, poaching etc...
- Most important potential Impacts (described through impact hypotheses) when the drivers "hit" the VECs
- A set of sound Indicators – which are clear and agreed measuring points to be used in the environmental monitoring programme

Group work structure

- Group 1 & 2: Biological issues (ex. wildlife, fish, vegetation, habitats, forests, biodiversity.....). Group 1: Aquatic; Group 2: Terrestric)
- Group 3: Physical/chemical issues (ex. water, soil, climate, air.....)
- Group 4: Society issues: (ex. fisheries, agriculture, settlements, firewood, gender, poverty, health, diseases, economy, cultural heritage.....)
- Group 5: Management and business issues (ex. wildlife management, fisheries, landscape, NPs, poaching, tourism, cultural heritage.....)

Group work 1 – Valued Ecosystem Components

How to proceed:

1. Make a list of Valued Ecosystem Components (VECs) for the 4 phases:
   - 1. Exploration; 2. Drilling; 3. Production and 4. Decommissioning
2. Rank the VECs according to importance for the areas affected by the oil/gas development
3. Assess and rank the most important associated drivers from group work 2
4. The monitoring programme with indicators will be anchored in the VECs

Group work 1 & 2 – Reporting

Reporting VECs (drivers, to be filled in after group work 2)

Group no:		Issue:		
Valued Ecosystem Components, ranked		**Associated drivers, ranked (after group work 2)**	**Phase**	**Comments**
VEC 1 (name)		1D1: name		
		1D2: name		
		1D3: name		
VEC 2 (name)		2D1: name		
		2D2: name		
Comments:				

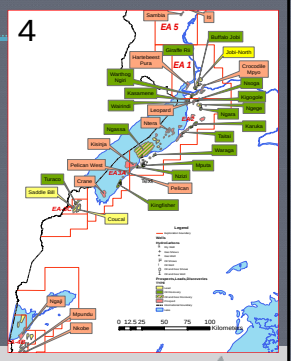
Group work 2 - Drivers

- Drivers are impact factors or driving forces which can affect the ecosystem and/or the society in one way or another
- Divide between drivers caused by the oil/gas activities and other drivers
- Examples:
  - From oil/gas development: noise, air quality, hazardous materials and waste, pollution, oil spill, land use, infrastructure, access roads, labour influx + +
  - Other drivers: climate change, economic development, financial crisis, business (ex. tourism), exploration of other natural resources + +
- Some of the drivers are more important than others and need to be identified

Group work 2 - Drivers

How to proceed:

1. Make a list of drivers in the 2 categories
   - From oil/gas development
   - Others
2. Rank the drivers
   1. Overall rank (1, 2, 3…n), and
   2. Rank in each phase (Exploration; Drilling; Production and Decommissioning) in category 1-3 where 1 is least important and 3 is most important
3. Report the results:



Drivers

Example:

Group no:		Issue:					
Overall rank	Drivers\phase → ↓	Explo-ration	Drilling	Produc-tion	Decom-missioning	Others
	Noise		3	1		
	Seismic activity					
	Drilling					
	Oil spills					
	Mud cuttings					
	Heavy equipment					
	Clearing of vegetation					
	Infrastructure					
	Labour influx	1	3	2	3	
	STD					
	+					
	+					
Comments:						

Group work 3 – Cause–effect charts

Linking Valued Ecosystem Components and drivers

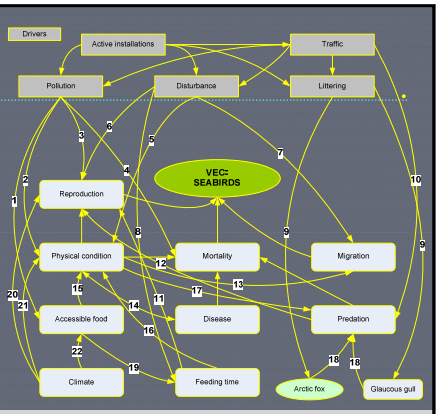
Task: Construct cause - effect charts

1. Select VEC
2. Select main associated drivers
3. Start constructing cause - effect chart with linkage explanations

Example:

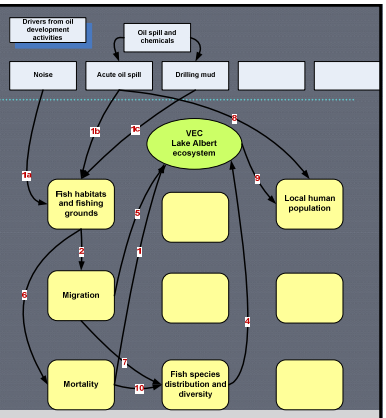
Example

1. Pollution may lead to reduced access to food by causing the destruction of food organisms.
2. Oil fouling causes increased energy expenditure, by impairing the insulation properties of the plumage.
3. Pollution can cause reduced reproduction, as eggs and chicks will be soiled by adult birds fouled by oil.



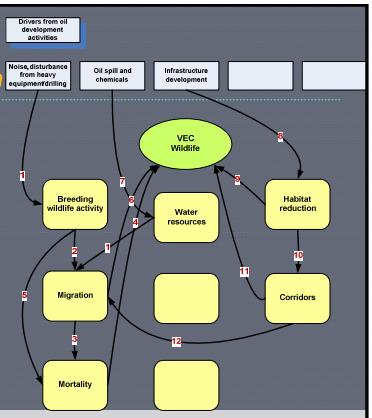
Example AG 1 *limnic system*

1a.Noise – e.g. offshore seismic shots, exploration drilling in fish habitats and fishing grounds
1b, c. Pollution – acute oil spills and pollution from hydrocarbon compounds and chemicals from mud cuttings
2. Migration
4. Negative effects on ecosystem
6. Death of fish
10. Secondary effects like change in fish species distribution, composition and diversity

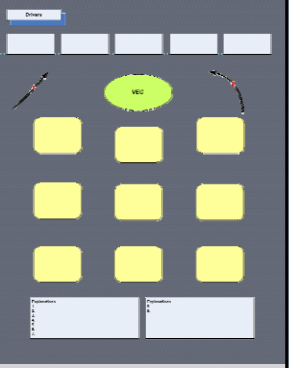


Example AG 2 *terrestrial system*

1. Disturbance will have an effect on wildlife breeding activity
2. Animals will move to other areas
3. Unsuitable habitats will lead to increased mortality
4. Wildlife population will decrease



Group work 3 – reporting



- How to use the reporting chart:
- Observations/case: [illegible]

Group work 4 – Impact Hypotheses

Task: formulate and evaluate Impact Hypotheses (IH)

- Based on cause - effect charts, with linkages and explanations
- Formulate IHs following the chain all the way to the VEC
- Start with the most important chain (threatening the VEC)
- Several IHs for each VEC
- Evaluate IHs by categorising in one out of four categories:

Group work 4 – Impact Hypotheses

Evaluate IHs using one of four categories

A. The hypothesis is assumed not to be valid.
B. The hypothesis is valid and already verified. Research to validate or invalidate the hypothesis is not required. Surveys, monitoring, and/or management measures can possible be recommended.
C. The hypothesis is assumed to be valid. Research, monitoring or surveys is recommended to validate or invalidate the hypothesis. Mitigating measures can be recommended if the hypothesis is proved to be valid.
D. The hypothesis may be valid, but is not worth testing for professional, logistic, economic or ethical reasons, or because it is assumed to be of minor environmental influence only or of insignificant value for decision making.

- Use reporting form (coming up)

Group work 5 – Recommendations

Give recommendations concerning
- Research
- Management actions
- Monitoring

Report ongoing monitoring

Assess and recommend measurable indicators
- What, Why, How, Where, When
- Current trend
- By whom
- Lead agency
- Responsibility
- Presentation
- End user(s)
- Financial assessments

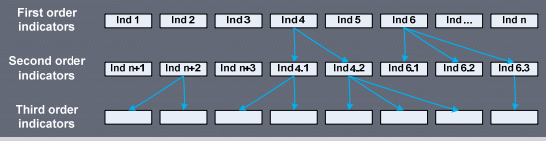
Remember:

1. Policy relevance
2. Available and routinely collected data
3. Spatial and temporal coverage of data
4. Existing monitoring data series should be continued
5. Representativeness
6. Methodologically well founded
7. Understandability
8. Agreed indicators

Group work 5 – Recommendations

Indicator options

- Limited resources may limit the monitoring programme, one option can be to divide the monitoring and the indicators into:
  1. First order indicators – few, but robust indicators that answer a specific highly relevant question or meet a clearly defined need
  2. Second order indicators – new, lesser important indicators or sub-indicators of first order indicators
  3. Third order indicators - sub-indicators of second order indicators



Reporting indicators

Group no:	INDICATOR FACT SHEET
VEC:	IH no:
Impact Hypothesis:	Driver:
Explanation:	
Evaluation in category A, B, C or D:	
Rationale for category:	
Recommended research:	
Recommended management actions:	
Recommended monitoring:	
Measurable indicator name (what):	Order 1, 2 or 3
Existing monitoring *(relevant ongoing monitoring or available data sets)*:	
Area covered *(by ongoing monitoring or available data sets)*:	
Data storage *(format and place where data sets are stored)*:	
Responsibility *(institution and person currently responsible for existing monitoring data sets)*:	
Why *(key question(s) which the indicator helps to answer)*:	
Current trend *(upward, stable or downward)*:	
How *(method, sampling and analysis, quality assurance)*:	
Where *(location, geo-referenced)*:	
When *(frequency)*:	
By whom *(which institution will collect the indicator data)*:	
Lead agency *(institution and person responsible for calculating and communicating the indicator)*:	
Presentation *(most effective forms of presentation: graphs, maps, narratives etc.)*:	
End user(s) *(who will use the indicator for what purpose)*:	
Financial assessment *(approximate costs from data collection to indicator)*:	
Comments:	
Literature:	

Tentative Programme

Tuesday 12 April

Time	Scoping process	Who/where
09:00	Group organizing	Facilitators
09:15	Group work 1: Selecting Valued Ecosystem Components (VECs)	Participants, group rooms
10:30	Coffee, tea	
11:00	Group work 2: Identification of drivers (impact factors)	Participants, group rooms
13:00	Lunch	
14:00	Plenary session 1: Presenting the results from group work 1 and 2	Plenary
15:30	Discussion, conclusions	
16:00	Group work 3: Linking drivers and VECs in cause-effect charts	Participants, group rooms
18:00	End day 2	

Wednesday 13 April

Time	Scoping process	Who/where
09:00	Group work 3: Continue from end of day 2	Participants, group rooms
11:00	Coffee, tea	
11:30	Plenary session 2: Presenting the results from group work 3	Plenary
13:00	Lunch	
14:00	Group work 4: Formulation ofImpact Hypotheses from VEC cause-effect charts,evaluation and prioritizing	Participants, group rooms
16:00	Coffee, tea	
16:30	Group work 4: continues	Participants, group rooms
18:00	End day 3	

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Tentative Programme

Thursday 14 April

Time	Scoping process	Who/where
09:00	Plenary session 3: Presenting the results from group work 4	Plenary
10:30	Coffee, tea	
11:00	Group work 5: Recommendations	Participants, group rooms
13:00	Lunch	
14:00	Plenary session 4: Presenting the results from group work 5	Plenary
16:00	Coffee, tea	
16:30	Wrapping up the workshop	Facilitators
18:00	End of workshop	NEMA

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NINA Report

The Norwegian Institute for Nature Research (NINA) is Norway's leading institution for applied ecological research.

NINA is responsible for long-term strategic research and commissioned applied research to facilitate the implementation of international conventions, decision-support systems and management tools, as well as to enhance public awareness and promote conflict resolution.

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