CHAPTER 3
METHODOLOGY FOR BASELINE ASSESSMENT

As a part of any environmental and social impact assessment study it is imperative to determine the baseline levels of appropriate environmental parameters, which are likely to be affected as result of construction and operation of the proposed project. Thus, collection of the baseline data of study area is a key step to understand the anticipated environmental impacts that are expected to accrue as a result of the proposed project is essential.

This chapter provides an overall description of the methods and practices used for studying the ambient status of each environmental parameter in the study area while, result of the study for specific environmental parameter and assessment of various impact on them are discussed subsequently under Physical Environment, Biological Environment and Social Environment chapters. Studies were undertaken to generate baseline data on various parameters of environment viz. land, water, air, noise, flora, fauna and socio-economics. All the methods were structured for collection and organization of environmental baseline data and identification of environmental impacts.

3.1 STUDY AREA

Determining the area of study area is a very important step in performing an impact assessment. The IFC's Performance Standard 1 (April 30, 2006) also specifies that risks and impacts associated with a project should be analyzed in the context of the project's area of Influence. The area of influence is often, if not always, variable and dependent on the impacting factor (both direct and indirect) and the affected resource. It is generally complex and is rarely limited to the some set distance from the project area. Accordingly, for the purpose of ESIA for the proposed Karuma HPP, study area was defined as follows:

- Submergence area (area within the FRL of the weir).
- Area within 2 km of the periphery of the project appurtenances including the area required for project construction, where the impacts can possibly be visualized.

The sampling of physical parameters like air, water, noise and traffic etc. and field survey for the ecological study has been conducted during the dry seasons i.e. in the month of May and June. Sampling location of each environmental parameter is discussed in their respective chapters. Review of available data, literature with various institutions and above all interaction with local people/stakeholders and also with various govt. departments was undertaken. The survey was conducted after consultation with the authorities and field officers while, sampling of data was done as per the specific requirements of the parameter studied.

3.2 LAND ENVIRONMENT

3.2.1 Geology, Topography, Seismicity and Catchment area

The data regarding Geology, Topography and Seismicity of the project area and Catchment area of River Kyoga Nile up to the Project site has been taken from the Detailed Engineering Report of Karuma HPP.

3.2.2 Hydro-Meteorology

Hydrology of the project has been also taken from the engineering Report of Karuma HPP and contains the source of database and detail methodology adopted for deriving i) environmental flow, ii) Ecological Demand Estimation iii) Sediment Flow etc. Data on rainfall, temperature and climatic condition has been taken from the meteorological stations that are closest to the project site.

3.2.3 Land use-Land Cover Classification

The land use land cover data has been procured from NFA (National Forest Authority) Kampala, Uganda. NFA has carried out Land use \ land cover classification using Landsat data of the year 1995. Land use describes how a patch of land is used (e.g. for agriculture, settlement, forest), where as land cover describes the material (such as vegetation, rocks or buildings) that are present on the surface. Accurate land use and land cover identification is the key to most of the planning processes. Further processing of data is done with project area of Influence of Karuma HEP using Arc GIS software package.

3.2.4 Soil Classification

Soil resource mapping of the proposed project area was prepared from the basic data/map of soil obtained from the Makerere University, Uganda.

3.3 AIR QUALITY

Sampling of the ambient air quality was made at four locations viz., Dam site, Power house site, Karuma Bridge and Karuma village of the project area during June, 2010. Measurement of the air borne particulate matter of size with diameter less than 10 μm was done using a Respirable Dust Sampler whereas Draeger air sampler and tubes measurement device CHP-71 designed for the chemical surveillance was used to analyse the gaseous pollutant (Carbon dioxide and Carbon monoxide, Sulphur dioxide (SO2), Nitrogen oxides (NOx). These tubes were exposed on-site so that the target gas diffused along the tube to an absorbent substance fixed at the sealed end of the tube. The tubes were closed at the end of the sampling period and the subsequent laboratory analyses determined the average concentration of the pollutant during the sampling period.

3.4 NOISE AND TRAFFIC DENSITY

The existing noise conditions were measured using Precision Integrating Sound Level Meter Type: 4 in one Digital Sound Level Meter, Model CEM DT 8820. The instrument recorded noise (range 35 – 130 dBA), temperature (-20 – 750 ^oC), relative humidity (25% - 95%) and light intensity (0 – 20000 LUX). The sampling was conducted near the residential area of Karuma Village and in the close vicinity of the project component area of the proposed Karuma HPP. The traffic data was taken at Karuma Bridge only during morning and evening hours and traffic density was calculated using number and types of vehicles plying on the National Kampala -Gulu Highway (at Karuma Bridge).

3.5 WATER QUALITY

Water samples assessed for baseline physical, chemical and bacteriological quality were collected at 12 predetermined sampling locations (six on each bank) on both the banks of the river Kyoga Nile. Dissolved oxygen (mg L^{-1}), temperature (^oC), pH and water conductivity (μs cm^{-1}) were measured *in situ* at 0.5 m below water surface using Multiprobe (Hach HQ40d). For other parameters, water samples were transported in a cool-box on ice to the laboratory for the analysis. Ammonia-nitrogen and nitrate-nitrogen were determined using Hach DR 2010 Spectrophotometer. Calcium, fluoride, total alkalinity, ortho-phosphate, total phosphate (TP), total nitrogen (TN), biological oxygen demand (BOD), oil and grease and were determined using various standard methods as set out in APHA (1995). Coliform count was done by membrane filtration technique using Laurel sulphate broth as the incubating media. Briefly, 100 mL of unfiltered sample was passed through a cellulose esters membrane filter. The filter was then incubated at 35°C for 12 hours and the yellow colonies counted as total coliform.

3.6 BIOLOGICAL ENVIRONMENT

3.6.1 Terrestrial Fauna Assessments

In order to collect the baseline information on the fauna, field surveys were conducted for birds, mammals, reptiles, amphibians and butterflies to record species by laying transect on below mentioned sites in the project area of Influence.

- The access route over the tail race tunnel
- The area over two of the adits (Adit 1 and Adit 2), and
- Two areas on the north and south bank of the River Nile at the point of the intake.

The information was also collected to identify critical habitats for the species and/or other attributes in the area that may be important for their continued survival. As TRT component of the project is located within the Karuma Wildlife Reserve and in the vicinity of Murchinson National Park, great emphasis was laid to cover these protected area through survey especially the part of Karuma Wildlife Reserve. For cross referencing and interpretation of the data, secondary sources were also referred. Methodology of primary data collection for different faunal component is described in details as follows:

3.6.1.1 Butterflies

The butterfly fauna in the proposed road, the ADIT routes, dam site, and the lagoon area were sampled through the systematic use of sweep. Sweep netting was done randomly within the areas that involved combing through the area, and catching every species encountered. Weather conditions were mainly favorable on most days except for one day when there was a slight drizzle and the day remained partly cloudy. All species of butterflies recorded were assigned to their specific ecological preferences as described by Davenport (1996).

3.6.1.2 Herpetofauna

Species sightings and important habitats encounters methods were adopted for collecting primary information on the amphibians and reptiles which were also geo-referenced using a GPS (Garmin GPS map 60Cx). Consultations with members of the local community and forest officials were also done. The sampling strategy was stratified to cover the important amphibian and reptilian habitats. The critical habitats identified for either taxon were marked (geo-positioned) for more intensive searching using the Visual Encounter Survey (VES) method. VES is similar to the Timed Constrained Count (TCC) method described by Heyer *et al*. (1994) and is effective in most habitats and for most species that tend to breed in lentic habitats. The method generates encounter rates of species in their habitats in a unit hour and involves moving through a habitat very slowly, watching the foliage above the ground carefully, turning logs or stones, inspecting retreats and watching out for surface-active species. The data gathered using this procedure provides information on species richness of the habitats. In addition, opportunistic recordings were also done. Opportunistic records are those made outside the sampling points but occurred in the surrounding area to be impacted by the project and the environs. It helps complete the checklist of the animals as much as possible. Amphibians and reptiles are mobile and can therefore be encountered outside their critical habitats. Identification of herpetofauna followed Channing and Howell (2006) and Spawls *et al*. (2002, 2006).

3.6.1.3 Mammals

The surveys of mammals involved a general walk over through the project area observing for mammal presence, mammal signs, tracks and faecal material and wallow areas. Simple measure of presence or absence was used. Major sample points were placed 1 km apart along the area to be traversed by the access road at which observations were made to record mammal data (presence/absence or signs), habitat characteristics (e.g. nature of vegetation, presence of wallow or water). Standard trapping methodology was also used to survey small mammal diversity.

3.6.1.4 Birds

Intensive bird surveys were conducted covering various project component i.e., Dam Site, Tunnel, Weir construction area, Head Race Tunnel (HRT) opening, Tail Race Tunnel (TRT) opening, Access road, Adits, Muck dumping ground and downstream area of the river stretch which is likely to have reduced flow during operation of the Project. Method used for gathering data on bird was point centered counts lasting 30 minutes at intervals placed 1 km apart along the access route and the general project area. Identification of species was based on (Stevenson and Fanshawe, 2002) and the taxonomy as per Carswell *et al.* (2005).

3.6.2 Aquatic Ecosystem

Aquatic ecosystem assessment covered baseline water quality, phytoplankton composition, distribution and relative abundance, species composition and spatial distribution of zooplankton, taxonomic composition, distribution and relative abundance of macro benthos, as well as species composition and distribution of fishes, and the fishery. Specific methods used in the assessment of particular environmental aspects and biodiversity groups included consultative engagement with relevant stakeholders in the aquatic resources management domain; literature search and desk review; as well as field surveys and experimental sampling are detailed as below:

3.6.2.1 Stakeholder consultation and literature review

Stakeholders were consulted to discuss the tasks proposed for the assessment, seek additional input and obtain literature. The stakeholders contacted included National Freshwater Fisheries Resources Research Institute (NaFIRRI), Department of Fisheries Resources and the Uganda Wildlife Authority (UWA). Consultations with fisher folk was vital to the collection of data on fish catch composition, species relative abundance, and migratory behavior. Desk literature review was undertaken to identify available relevant information and streamline plans for field studies.

3.6.2.2 Sampling

The main zones where the KHP would exert indirect influence on the ecosystem of the river are the sections of the river immediately upstream of the inundation zone, and that the tunnel outflow downstream. Apac/Masindi Port transect across River Nile was more or less arbitrarily selected as the furthest possible extent of impact upstream by the KHP and the most upstream sampling transect was located here. The most downstream transect was located below Chobe Lodge complex (just upstream of the big bay popular with hippos). Three transects were sampled above and below the point of water inflow in the tunnel.

Field samples were collected for phytoplankton, zooplankton and macro-benthos at selected sites from both the south and north bank (where accessible) in the inundation zone, draw-down zone and the re-fill zone below the canal outflow. The inshore sites were located about 10 m from land. Collection of midstream samples was abandoned due to very strong river currents and threatening the presence of hippos especially in the wildlife reserve sector of the river. Information for assessment of fish diversity and the fishery was collected from interviews with fishers on site and examination of landed catches. Indirect sources were used in the park and wildlife reserve where commercial fishing was prohibited. For example information on fish landed by poachers at Kampala beach transect deep in Karuma Wildlife Reserve, was obtained from rangers who impound the catch during regular checks. At Chobe information on fishes and their preferred habitats was compiled from discussions with one of the staff at the Lodge, an experienced sport angler.

3.6.2.3 Assessment of baseline phytoplankton composition, distribution and abundance

Water samples for assessment of the baseline status of phytoplankton were collected 10 m from the shore at the north and south shores of the transects at Apac/Masindi, Atura/Mutunda, Nora/Awoo (upstream) and Nora/Awoo (downstream) of the proposed Tunnel inflow, Kampala Beach (only at south shore), the north shore across from the Tunnel outflow, and from both shores at a transect downstream of the main Chobe Lodge building. At each site 20 ml of water drawn at 0.5 m depth was fixed with Lugol´s solution (Utermöhl 1958) and kept shielded from light (Wetzel and Likens 2000). The sedimentation method of Utermöhl (1958) was used for counting the phytoplankton under the inverted microscope (Leica DM IL). Taxonomic identification was made with the help of standard literature (John et al. 2002; Komarek and Anagnostidis 1999). Species counts were made at a magnification of 400 times. For each sampling site two transects in the sedimentation chamber were counted and the average recorded. *Planktolyngbya* and *Spirogyra* were counted as filaments and their total length and width measured using the micrometer scale inserted into the eyepiece (1 unit in the scale = 2.5 μm). Other species like *Anabaena*, *Chroococcus*, *Merismopedia* and *Microcystis* were counted as single cells. Cell lengths and width were determined for biovolume calculation. 20 randomly selected specimens from the dominant species were measured and the volumes calculated by assuming a geometric shape, i.e. for *Microcystis*, $\pi d^3/6$ was used where d equals cell diameter (Hillebrand et al 1999; Wetzel and Likens 2000). The biovolume was then calculated by multiplying the mean cell volume with cell density.

3.6.2.4 Assessment of zooplankton

Zooplankton samples were taken from various sampling sites along the River Nile both in the upstream as well as downstream of the proposed dam site. The water depth range of the sites sampled was two to three metres. Zooplankton samples were taken using conical plankton net of 60 μm mesh and 0.25 cm mouth opening, harnessed with a sample bucket and a towing rope marked in metre intervals. The net bucket had a sample concentration window of the same mesh size as the sampling net. Most of the sites sampled had water flow rates that made it impossible to make vertical hauls through the water column. Therefore, sample collection was done by holding the net into the water current for a few seconds. This method rendered quantification of the results difficult. The net also intercepted a lot of fine organic material present in the river during the entire period of the survey. The particles made it extremely difficult to concentrate the samples in the field and subsequently to sort out all the zooplankton in the laboratory.

3.6.2.5 Assessment of macro-benthos

Triplicate bottom sediment samples for benthic macro-invertebrates were collected from each station. Ponar grab (Jaw area =238.0 cm^2, inner depth =8.0 cm) was used to collect the sediment samples, as spelt out in standard methods (APHA, 1992). Water depth (m) was estimated by measuring the vertical distance covered through water by the rope attached to the ponar grab, during sampling. The sediment samples were emptied into plastic basins, their physical characteristics noted e.g. sandy, rocky, etc, and subjected to further processing procedures (APHA, 1992; Ferraro and Cole, 1992 and Ochieng *et al*., 2006 and 2008) in order to attain the sorting, identification and quantification of the macro-invertebrates. They were identified using guides to fresh water aquatic macro-invertebrates (Pennak, 1953; Mandal-Barth, 1954; Mellanby, 1963; Sholtz and Holm, 1985; Stehr, 1991; Kellog, 1994 and Merrit and Cummins, 1996). Other observations made during sampling also included the nature of water flow and background vegetation. All data from each transect was combined to determine the total number of taxa and mean number of individuals per area (m^2). Data was processed using MS excel program.

3.6.2.6 Major habitat types, fishes and the fishery

The major habitat types were characterized mainly from information gathered at sampling transects in the inundation, drawdown and re-fill zones of the project. Features considered included general riverbed topography, bottom types, flow rates, fringing vegetation and presence of river mouths of permanent inflowing rivers. Information on the fishes includes a checklist of commonly encountered fish species, their distribution and relative importance in the fisheries of various habitat zones; as well as the conservation status of vulnerable fish species. Migratory fish species especially in relation to breeding behavior are identified. Fishing practices are outlined.

3.6.3 Terrestrial Floral Assessment

Stratified random sampling was used to collect plant species data within 1 ha belt-transects (1000 m x 10 m) in the project area of influence. The belt transects were located along the proposed tunnel length of 12 km (Kent & Coker, 1994) on the southern bank and along existing footpaths and animal tracks within the wildlife reserve, which often will be the only means of effectively entering the forest interiors.

1-km belt-transects were established to enumerate the tree species in 10 X 10 m subplots although effort was also made to record shrubs, herbaceous vegetation and graminoids using nested plots of 3 x 3 m. Voucher specimens of unidentified species in the field were brought to Makerere University Herbarium for identification.

The phyto-sociological characteristics of the plant communities were assessed for consistence as used by Braun-Blanquet (1965), frequency as used by Singh & Singh (2010), species associations and abundance per plot on the belt transect. Nomenclature will follow Eggeling and Dale (1952); Polhill, (1952); Hamilton (1974), and Howard et al., (1996). Documents reviewed in preparation of this report include IUCN redlist of species, Langdale-Brown et al. (1964), Hamilton (1981), and the previous NORPAK Environment and Social Impact Statement (ESIS) for the Karuma dam.

Conservation status of the species was also identified using IUCN threat categories. Sensitive habitats within the proposed project area were also identified and recommendations made for appropriate conservation measures. Deliberate effort was also made to document any traditional/local uses of plants (e.g. firewood) in the area to determine if there will be any major impacts as a result of the proposed project on plant resources availability. Sampling locations were also recorded using the Global Positioning System (GPS).

3.7 SOCIO ECONOMIC ENVIRONMENT

The methodology used for the socio-economic assessment was that of mixed approach, integrating both quantitative and qualitative approaches. It included a review of related literature on policies, a socio-economic survey that is used to determine the vulnerability context of community members that are translated into negative or positive impacts as well as strategies that are proposed to help them cope or adapt to the negative impacts in order to improve their livelihood outcomes. The qualitative aspects of this assessment include meetings, in-depth interviews with key informants and community meetings. The study was undertaken in four main phases i.e. Planning and Review of Secondary data, Fieldwork, Data Analysis and Synthesis and Report Writing.

3.7.1 Planning and Review of Secondary data

This phase included the desk study and development of field instruments. The literature that was reviewed included policy documents, district development plans of Masindi (for Kriyandongo) and Oyam districts as well as other related literature. A structured questionnaire was developed and presented for accuracy as well as interview guides that were to be used for the key informant interviews **(Annexure 3.1)**. Four research assistants were selected from the four affected villages and trained for a period of two days.

3.7.2 Fieldwork

The fieldwork was undertaken between the months of May and June 2010 in the affected villages from where land is to be acquired for the use of project i.e., village Karuma, Awoo, Nora and Akuridia for discussing the socio-economic profile of these villages. Information and data on Project affected households was taken from Resettlement Action Plan (RAP) team. Semi structured interviews were also conducted with communities and stakeholders to ascertain their perceptions and generate information on the impact of the proposed project on special groups like women, people with disabilities, elderly and people with HIV/AIDS. Gender Analysis was done to understand and document the differences in gender roles, activities, needs and opportunities for the communities involved in the proposed project.

3.7.3 Village Meetings

Village Meetings were undertaken to allow local people describe problems and their priorities and aspirations under the proposed project. These meetings helped in initiating collaborative planning, sharing and verifying information gathered from fieldwork.

3.7.4 Data Processing and Report Writing

The processing of the socio-economic data began soon after the start of fieldwork, completed questionnaires were returned periodically from the field to a data processing center, first in Karuma where they were checked for consistency and check for response errors. The data was then entered into SPSS statistical software, coded and cleaned to in Kampala. The data entry ended in June and data analysis was completed in July 2010. The response rates were high as all questionnaires were completed.

3.8 CULTURAL AND ARCHAEOLOGICAL ASSESSMENTS

The baseline studies for the cultural and archaeological assessments were carried out using the following methods;

Desktop Survey: Literature review of the project and other similar development in the country as well as studies on archaeology, paleontology, and socio-cultural aspect of the region in question.

Site Survey**:** Field personnel walked across the project area for collecting data. The methods of data collection included; observations, recording, photographing, and documenting all identified cultural materials, and other environmental features likely to be impacted by the project.

Inventory**:** Forms for new finds were filled and the data analysed.

Ethno-archaeological Study**:** Meetings and interviews with stakeholders and the local people were the major source of information about the impact of the project on the current socio-cultural lives of the people living in and around the area.

Test Excavation: Test pits were sank in areas found appropriate; this depended on records from the field survey. The aim of the test excavation was to gather cultural materials in situ, which were then used for studying the cultural profile of the area.

Data Analysis: The team sorted out and studied the types of diagnostic cultural materials; these included the ceramics, fossils and stone tools in numbers and types in line with stratigraphic layers.

Consultations and Interviews: Consultations with area local community and cultural institutions, and with the Ministry of Tourism Trade and Industry on sites of archaeological importance and cultural heritage.

Documentation: A report, was prepared and the site map showing the sampling sites was plotted using Arc GIS from the GPS coordinates of the area.

3.9 IMPACT PREDICTION

Prediction of impacts has been based on a broad matrix group 'ecosystem' constituted by physical, biological and social components. The vulnerability of an ecosystem to various impacts resulting from an activity or multiple activities were identified and accordingly impacts are predicted. The main theme of the ecosystem approach in visualizing impacts on various sets of environmental data revolves around the idea that natural processes and patterns are likely to be affected under impacts of a developmental activity. In natural ecosystems, the impacts would surely change the existing state of equilibrium. In managed ecosystems and human societies impacts could be of positive as well as negative consequence. Similarly, in the case of natural ecosystems, likelihood of negative impacts could be seen in terms of direct and/or indirect, temporary or permanent impacts. However, baseline data could be of great importance to understanding actual post-project impacts but, the predictive impacts is said to have a limitation due to absence of long-term data availability on various environmental variables and also the paucity of studies on their likely responses to changes under developmental activities. It is therefore difficult to predict impacts with a high degree of exactness and certainty.