THE UNITED REPUBLIC OF TANZANIA

Dar es Salaam Water and Sewerage Authority

Environmental Impact Assessment (EIA) Statement for Kidunda Dam

Executive Summary

Final

March 2008

Norconsult

Environmental Impact Assessment (EIA) Statement for Kidunda Dam

Executive Summary

Dar es Salaam Water and Sewerage Authority - DAWASA

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Location:	Kidunda Village, Morogoro District, Tanzania.
Developer:	Dar es Salaam Water and Sewerage Authority (DAWASA).
Lead Consultants:	Norconsult As (Norway and Tanzania).
Consultant Contact Address and Phone:	Vestfjordgaten 4, NO-1338 Sandvika, Norway.
Report Designation:	Final Report f
Decision Making Authority:	National Environment Management Council (NEMC).
Date of Submission:	1.3.08

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3 INTRODUCTION

3.1 Background to the EIA

In the Tanzanian context of EIA's, the "Kidunda Water Supply Dam" (the Project) is classified as a "water resources development project", regulated under Section 82(1) and 230(2)(h) and (q) of the Environmental Management Act (EMA) No. 20 (2004). A development of this nature and magnitude is listed under "mandatory projects" for which it is obligatory to undergo an EIA. This EIA Statement for Kidunda Dam, follows the First Schedule of the "Regulations for the Environmental Impact Assessment and Audit", GN No. 349, of 2005, for "dams".

In response to the draft "Environmental Assessment Preliminary Report" (EAPR) and draft "EIA Scoping Report", submitted by DAWASA in October 2006, NEMC responded on 29.5.07 to confirm that a "full EIA" was necessary. This EIA Statement is therefore submitted to fulfil this requirement. The Executive Summary is in English, with a Swahili abstract, as required by the EIA Regulations. It is intended as a non-technical summary. The table attached further highlights key findings and mitigation measures, and is the basis for the Environmental Management Plan (EMP).

3.2 Objectives of the Executive Summary

This Executive Summary is a "stand-alone" document of the key findings. It highlights potential effects on people and natural resources, and describes issues and impacts, with suggested mitigation. It has taken into consideration stages of the Project from design, construction, operation and eventual decommissioning. Specifically, the EIA objectives were to:

i. Document the existing baseline of social economic conditions and natural resources around the dam, as well as upstream and downstream.
ii. Examine what may be affected by the change(s) in the landscape as a result of both the construction activities and the changes in river flow patterns and the inundation.
iii. Assess how, over time, the changes may either be beneficial, or may make life more difficult for people and nature, offering potential mitigation, with cost implications.

3.3 The Consultants Approach to the EIA Study

The study was organised in several thematic teams, as follows:

a. Land Use and Natural Resource Study Team.
b. Aquatic Biology Study Team.
c. Socio-Economic Study Team.
d. GIS and DEM Study Team.
e. Hydrology Study Team

The elaborated approach of each team was circulated to stakeholders in the "Inception Document". Subsequently modified, this was circulated to the public as an "Information Document".

The approach includes in-depth analysis of directly impacted areas, as listed, below, notably:

- 22 villages and lands of the JUKUMU WMA Society.
- The 4 directly impacted villages of Kidunda (1,131 ha) , Kiburumo (1,302 ha), Bwira Chini (111 ha) and Bwira Juu.
- The Mkulazi Forest Reserve (FR) .
- The Selous Game Reserve (GR).

- The Gonabis wetland set aside as JUKUMU WMA.
- The riverine forest of the Ruvu River.
- The in-situ fishery of the Ruvu System.
- The near downstream community.

Studies of those areas indirectly impacted, include:

- The river fishery above, and below the dam wall.
- The estuarine region and mangroves of the river mouth.
- The upland users and the effects of long term deforestation on the Uluguru catchment.

Table 1 below shows the proportional flooding impact on the various land categories as well as comparison with total flooded land as calculated from the area enclosed by the respective contours and a predictive curve at 2 m contour interval (e.g. see area volume curve in figure 1). The larger estimated reservoir area for the latter at 93.5 m results from extrapolation error.

Table 1. Overview of impact on adjacent protected areas (ha)

SI no	Description	90 m Total Inundation	92 m Seasonal Inundation	93.5 m 1/30 Year Inundation
1	Mkulazi Forest Reserve	981	1278.1	1514.6
2	Selous Game Reserve	189.8	389.8	487.7
3	Jukumu WMA/ Gonabis Wetland	48.72	139.44	207.24
4	Jukumu Farm & Fallow Land (Kidunda, Kiburumo etc.)	1 516.2	2 544.8	3 220.1
	Total	2 735.7	4 352.2	5 429.7
	Total incl. area of river calculated from area enclosed by contour curve	2 759.8	4 342.8	5 307.0
	Total estimated from predictive curve as shown in area volume curve	27.6	43.4	65.5

The EIA focus is on the Project as designed. Impacts that arise as a result of upstream and downstream consequences of the Dam, not part of the design nor content of this EIA, include:

Access Road: The main road from Ngerengere to Kidunda and Kidunda Station to Site may need to be upgraded as a consequence of the contractor requiring materials, equipment, supplies and staff movement. These developments need separate EIAs, beyond the frame of this Study.

Water Abstraction Up- and Downstream: The Wami/Ruvu Water Basin Office (WRWBO) has 90 registered user rights along the Ruvu River. This has been considered constant in the hydrological calculations and estimation of environmental flows and the design parameters for a "Water Release Strategy". The impacts of these abstractions, their control and management thereof have not been considered. Each abstraction point, in its own right, requires a separate EIA.

Improved Communications and Electrification: The contractor and DAWASA may cause new installations of cellphone communications and electrification in the area. These developments will require separate EIAs, beyond the scope of this Study.

Upgrade of the Dam to 92 m Contour: During the study, it became apparent that the accuracy of earlier site elevations were underestimated (See below). The re-calculated dam volume yields only 60 Mm3. To maintain the design storage capacity of 150 Mm3, the dam spillway would have to be raised from 90m to 92m. The dam area would increase from

27km2 to 43 km2. This EIA focus, however, is on the "original design specification". Any design upgrade, requires a new EIA.

3.4 Study Methodology

3.4.1 a. Land Use Natural Resource Study

The main aims of this study were to:

- Determine land use patterns, agricultural and natural resources
- Assess the terrestrial fauna and flora in the areas to be flooded
- Predict the potential impact of the new lake, and of dam construction

During field investigations, any unusual resources were sought out, to assess the potential loss of rare, threatened and/or endangered plant and animal species. Key informant interviews provided inputs on medicinal or edible plants, unusual animals observed while hunting or unique plants found when gathering natural resources.

A base map using Remote Sensing and GIS, was created of "Land System Zones" organised according to composite associations of vegetation, hydrology, soils and land use. The proportion of each land cover that would be lost to the dam were assessed. Particular attention was paid to the risk of losing critical habitat and endangering critical species. In all, 19 sites were surveyed.

Data collection (Flora): The field data was primarily gathered using nested transects of 5x5m, 10x10m, 25x25m and 50x50m. Plant specimens were collected and sent to the Tanzania Tree Seed Agency (TTCA) for scientific validation and verification by a specialist Plant Taxonomist.

Timber Inventory Data: Through conventional transects, a timber inventory was taken by counting large trees, estimating their sizes, in three height and diameter classes. Timber volumes were calculated, by species and linked to the estimated areas of land-systems and vegetation types.

Data Collection (Fauna): Field surveys and biological description of the fauna (avian, mammalian and reptile) upstream, in situ and immediate downstream of the proposed flood zone were carried out with a Bird/Mammal Specialist from the Wildlife Conservation Society of Tanzania (WCST). Checklists were made to verify available information on birds, mammals and reptiles, from the General Management Plan (GMP) of the Selous Game Reserve (GR). Transect walks and mist netting for birds, were carried out. Special attention was given to impacts on any endangered or threatened species, and wildlife migration routes.

Data Validation: At the request of the Consultative Workshop, the field data was validated in consultation with the Research Unit of the Selous GR, the Wildlife Division and lecturers from the University of Dar es Salaam (USDM). Tanzanian ornithologist, Neil Baker validated the bird list. The migration routes were re-examined by an on-going study by the Danish Hunters Association (DHA), looking at migration between JUKUMU and Wami Mbiki WMAs.

3.4.2 b. Aquatic Biology

A survey was undertaken of the aquatic species (fish, reptile, amphibian and micro-fauna/flora) in the river system (upstream, downstream and in-situ) and the current river fishery. Predictions were made of the potential of a new fishery in the dam, and of the likely impact on aquatic organisms. The study was done in conjunction with South Africa Institute of Aquatic Biology (SAIAB), Tanzania Fisheries Research Institute (TAFIRI) and University of Dar es Salaam (USDM).

Literature Review: Prior to the field work an extensive, on line, literature review was conducted.
Field Survey: To ensure complete coverage, 9 different sites were surveyed, equally spaced from the upper reaches of the Ruvu River estuary at Makurunge Village to the upper reaches of the Mgeta River at Mgeta Village. Aquatic sampling and fishermen surveys were conducted of a variety of habitats (floodplains, ponds and the main river channel), of techniques and markets. Water quality information, was obtained from DAWASA. For validation, specimens were preserved, TAFIRI consulted, and samples were sent to SAIAB for taxonomy work. Fish, macro-invertebrate, zooplankton and aquatic macrophytes, are described.

Socio-economic Fishery Survey: Information was obtained from interviews on the species composition of the fishery, its socio-economic characteristics and the attitudes of the local fishermen towards the dam. In all, 21 fishers from 7 villages and fish traders were asked about processing, pricing, markets, seasonality and species.

Data Analysis: Based on the species recorded, and current knowledge of their biology, hydrologists and other aquatic biologists, were consulted on the potential changes to the fish populations and the current fishery.

The potential fish yield of the new lake was estimated using fish production models of Morpho-edaphic Index (MRAG, 1992) and the Schlesinger and Regier (1982) global, temperature-adapted model. The species expected to dominate the new fishery were predicted from the situation in similar environments in the region based on current knowledge of the existing species found in the river. Proposed management strategies for the emerging fishery were developed based on the guidelines provided by the FAO Code of Conduct for Responsible Fisheries.

3.4.3 c. Socio-economic Study

This Study looked at the current socio-economic baseline of the communities around the proposed dam. Information was obtained on the current land use, agricultural production, natural resource uses, and economic status. Special emphasis was on those households that currently derive an income from the area to be inundated, and those whose land, businesses and homestead may be adversely impacted. The intent was to determine a “least impact, high water flood zone”.

Literature Review: An analysis of the earlier studies on Gonabis and JUKUMU WMA provided historical background and baseline data.

Community Consultations: Key informants, local leaders, policy makers, traditional leaders, elders, local traders, fishermen, livestock keepers, farmers and residents, were consulted in 7 villages. The community attitude and acceptance of the Project was explored, inviting comments, opinions and ideas for mitigation of those residing in the immediate vicinity, upstream and downstream of the Dam site. The survey included JUKUMU Society and local companies. Collectively, opinion was obtained from over 800 people.

At the household level the study examined the current baseline and estimated the likely extent of Project impact upon household income and livelihoods, access to natural resources, employment opportunities, education, water supply, health services, and other constraints.

JUKUMU WMA LUPs: Existing Land Use Plans (LUPs) of JUKUMU WMA, prepared by GTZ in 1991, formed the baseline for: homesteads, service centres, schools, medical services, beer shops, kiosks, agriculture, road network, grazing, village forest reserve, grassland, wildlife habitat areas, water bodies, economic activities and local structures. Morogoro District made available, updated maps and plans for the JUKUMU Society. The LUPs for 5 target villages were updated.

Local Government: Meetings, in each of 7 villages, were held with local leaders, village officials and elders. The meetings introduce the Project, identify key informants and allowed community consultations, misconceptions about the Project, were clarified and opinions obtained.

SWOT Analysis: A SWOT (Success, Weakness, Opportunity and Threats) analysis was conducted in groups, to assess the benefits, problems and possible opportunities of the dam in the 4 impacted villages. As a baseline, 3 other, non-impacted villages of JUKUMU Society were also surveyed.

Consultative Workshop: A broad, consultative stakeholder workshop was organized to present the EIA study results to 90 stakeholders. Contributions were incorporated into the final EIA, included feedback from local leaders, national ministries, district authorities, relevant NGOs and CBOs, JUKUMU WMA, community and ward officials.

Data Validation: Given the inherent inaccuracies in the GIS data (see below), a ground re-validation of the SE data was conducted, based on the true DEM. From the individual consultation of 780 households in 4 villages, involving the Village Executive Officers and village leaders, a more accurate picture was obtained of the inundated zone, affected people and assets.

Data Obtained: The main data obtained from the SE study, included:

a. Identifying and demarcating the direct impacted area and households.
b. Filling in missing secondary data in the LUPs.
c. Cross checking with the JUKUMU Society actual income/expenditure and revenue distribution to respective village members from the WMA.
d. Identifying downstream villages, impacted groups, social economic activities taking place, and associated impacts and mitigation measures.
e. Obtaining crop market prices, compared with villagers estimates to validate likely losses.
f. Identifying socio economic impacts, the affected communities and mitigation measures.
g. Assessing the needs for a resettlement action plan.
h. Reviewing Tanzania's legislation on resettlement and compensation, and social safeguards.
i. Taking a full census, documenting the status of the potentially affected population in-situ villages, including houses, land, trees fruits, graveyards, sacred sites and sources of livelihood.
j. A comprehensive study was made of inundation zones, of people's assets, incomes, cultural or religious networks or sites, other sources of support, and common property resources.

3.4.4 d. GIS and DEM Study

The GIS work was to produce SPOT imagery to develop GIS maps to allow analysis of different inundation scenarios, to assess impacts on people, vegetation, land use systems and infrastructure.

GIS Imagery: S. African expertise, GeoTerraImage (GTI) provided the GIS imagery. Field surveys by a Kenyan Company validated the SPOT heights through Digitally Enhanced Measurements (DEM) estimating the high water flood contours.

Data Validation: Given the inherent inaccuracy created by the coarse resolution of available satellite imagery (see below) distorting the low lying nature of the Gonabis, much time was spent in Norway, on re-validating the GIS data. This revealed some fundamental changes in design.

a. A map showing the larger JICA 250 km2 dam and the smaller 27km2 dam as designed.

b. A location map of the Kidunda Dam site, its tributary rivers, District boundaries, JUKUMU WMA, Selous GR, Mkulazi FR, Uluguru Mountains, existing roads and infrastructure.
c. A map of the 22 villages of the JUKUMU WMA, their boundaries relative to the Project.
d. A map of the land use plan (LUP) of the 5 key JUKUMU villages of: Kidunda, Kiburumo, Bwira Juu, Magogoni and Bwira Chini.
e. A table listing for each village, estimates of land cover (in ha) of: agricultural lands, settlement, Village Forest Reserves, Forest Reserves and WMA, and extent of impact of flooding on each.
f. A table of the JUKUMU Village Zone Areas (ha), comparing the LUPs by the District Lands Offices in Morogoro, and the GIS map provided by GTZ in 1991. The aim was to verify and correct the values of area of the 5 villages in the flood zone area.
g. A table of the proportions of each of the above natural resource systems that will be lost.
h. Using the DEM for 90, 92 and 93.5 m on the LUPs, ground-truth surveys by the SE Team estimated the impacted households in the flood zone, seasonal floods and 30 year peak flows.

3.4.5 e. Hydrology Study

This study assessed:

a. How the reservoir's flooding cycles will affect the upstream water levels and downstream environmental flow requirements.
b. How its regulation will have implications for water users, and the likelihood of salt intrusions in the estuarine area.
c. How it influences spillway design (length and overspill height), the impacts of sediment transport and least impact designs, for the Flow Release Strategy.

Literature Review: The study is based on historical flow records and secondary data collected as part of earlier assessments of Kidunda Dam (i.e. Nippon Koei and Sogreah, 1994) and more recent assessments and field studies (i.e. Norconsult 2005-07).

Back Flooding Risks: The sensitivity of length of dam spillway to water level elevations at 90, 92 and 93.5 m., for lengths of spillway of 10, 25, 50 and 100 meters was investigated.

Downstream Flows: The reservoir effect on the downstream flows in terms of its regulation effect on seasonal flows and the implications for salt intrusions, were investigated by simulation analysis.

Dam Filling: The filling scenario of the Reservoir was assessed by applying a water balance method and considering two likely inflow hydrographs from data for station 1H10, Ruvu at Mikula.

Sediment Loads: Sediment transport into the reservoir and sediment load downstream at Ngerengere were assessed on the basis of scanty data available at station 1H10, Ruvu at Mikula and station 1HA1, Ngerengere at Utari Bridge.

1/30 Year Flood Risks: An annual maximum discharge series was compiled from 9 gauging stations to carry out a Regional Flood Frequency Analysis (RFFA). Estimated were the 24 and 48-hr flood magnitude in 1/30 years to assess the least impact design of the spillway.

Data Validation: Following the realization that due to the low lying nature of the area, the dam, as designed would flood large areas of villages, the hydrology data was re-evaluated to arrive at suggestions for Flow Release Strategy, spillway design and use of outlets to achieve least impact.

Data outputs from the Kidunda Dam simulation study include:

i. Impact of the length of spillway on water levels upstream and outflow discharges downstream.
ii. Impacts of downstream flow volumes, by simulating the outflow and flow hydrograph at upper and lower Ruvu water intakes, the filling patterns of the reservoir, and the flows patterns downstream assuming there is water abstraction upstream of the dam.
iii. Estimation of sediment transport from upper catchment into the Dam and into the downstream river from Ngerengere catchment. The degradation rates in the upstream mountains have tripled over the past 10 years with implications for ecological functioning of the river and estuarine environment (e.g. shrimp).
iv. Review of 24-hr and estimation of 48-hr Design Floods for Kidunda Spillway.
v. Assessment of the significance of seasonal inundation on the upstream wetland areas.

3.4.6 f. Legal Steps Fulfilled While Conducting the EIA

1. Preliminary Project Registration: The Proponent, DAWASA in October 2006, filed the Environmental Assessment Preliminary Report (EAPR) with NEMC. A second, updated version was filed by the Consultant, on behalf of DAWASA, on 25th April 2007.
2. Project Scoping Report: The preliminary scoping submitted to NEMC also included the TORs for the EIA. NEMC approved this in June 2007, with the following requests:

- Highlight the background of the developer.
- Ensure detailed stakeholder consultations.
- Detail the phases of each stage of development.
- Detailed description of the environment to be impacted.
- Describe policy and institutional frameworks.
- State positive and negative impacts, focus on cumulative impacts, reversible or not.
- Analyse alternatives.
- Carry out cost benefit analysis.
- Recommend cost effective mitigation.
- Develop an environmental and social management plan.
- Ensure signatories to any public consultations.
- Ensure contents follow Regulations 18 and 19.
- Executive summary to follow Regulation 19 and 21.

3. Environment Impact Statement: This Report represents the final EIA Statement. A first draft EIA was submitted to DAWASA, end of May 2007, and an updated draft in August 2007.
4. Public Participation: Throughout, affected communities in the target zone, upstream and downstream have been consulted, over 800 people. A final, stakeholder consultative meeting of 90 people was held in August 2007, prior to submission of the final EIA to DAWASA.
5. Legal Documents Consulted: The Team looked at international, regional and national legislation, and provided a extensive review as relates to Kidunda, and its catchment. A key issues is Kidunda will influence Selous Game Reserve a World Heritage Site. This will mean DAWASA together with Wildlife Division, Antiquities Department and UNESCO will have to work out an intense Integrated Water Resource Management System (IWRMS) to accommodate that the Dam has no significant impact on the Selous.

3.4.7 g. Availability of Baseline Information: The EIA has drawn heavily on secondary data

1. Documentation from GTZ work on JUKUMU WMA, include:

- Land Use Plans and maps (1991).
- Baseline Survey of JUKUMU (WMA).
- Contribution of CBC to the Economy of the Local Community, JUKUMU WMA.
- What Kidunda Dam will destroy, Ecological and Socio-economic Value of Gonabis.
- Resource Management Plan, JUKUMU WMA.
- Selous Game Reserve GMP.

2. 1:50,000 Topographic maps were consulted as follows:

Ruvu 185/3, Kinyanguru 202/3, Bagamoyo 168/4, Mwana 202/2, Yombo 185/2, Dutumi 201/4, And Mlandizi 185/1

3. 1:125,000 Geological Maps were consulted as follows:

- Uluguru 201, Kidugallo 184, Bagamoyo 168, and
- Selous – in the Selous General Management Plan (GMP)

4. Hydrological Reports were consulted as follows:

- Future Water Source Studies
- Eastern Arc Mountains Reports
- Hydrological Inputs to WSCDMP
- Water Quality Report Ruvu River.

3.4.8 h. Study Constraints

The EIA Study encountered the following constraints:

- Delays in contract finalization meant that the study took place March and June 2007, during the peak of the floods. This delayed field surveys and access to the site was only by boat.
- The discovery of 6-9 new fish species, required additional specialist, and assistance had to be sourced from taxonomists from South Africa. However, the sample size had limitations, and although indicative for the purposes of this EIA, more in-depth analysis is called for.
- At the onset, the resolution of the GIS imagery provided, was too low to determine the depth of analysis anticipated. In addition, the actual contours of the site remained in doubt due to historical discrepancies identified during scoping. This meant the Consultant had to undertake more precise spot height surveys. This was delayed by poor access due to the rains. The right GIS imagery was only made available in Mid-June 2007, but, due to inconsistencies, had to be re-calibrated. Accurate DEM was only provided in November 2007. This delayed the estimation of flood impact zones on natural resources and the SE study of impacted households, and significantly delayed the final write-up of the EIA.
- The Stakeholders Workshop in August 2007 called for a more in-depth analysis of the impact on the Selous GR and animal migration. This was initially assigned to the Selous GR Research Team. However, due to conflict of interest, the assignment had to be re-assigned to an independent team from USDM and DHA, delaying the survey, until February 2008.
- Most information is in the public domain, and there was no constraint due to confidential data.

3.5 Limitations of the EIA

3.5.1 a. Accuracy of the Design Data

As mentioned the Team had serious difficulty obtaining accurate data of the elevation and contours. With due diligence, and the knowledge of DAWASA, the Consultant spent considerable time to secure more accurate GIS data. This required additional work to conduct on the ground, accurate GPS spot height verification. This uncovered the following, as a future design feature:

Verification of the Topographic Data

The original, available GIS data for the design of the 27 km2 Kidunda Dam is based on the Shuttle Radar Topography Mission (SRTM) 90 meter resolution Digital Terrain Model (DTM). This data has inherent limitations. The accuracy decreases significantly as the terrain gets flatter (i.e. it does not have sensitivity up to 10 meters in the vertical axis). In addition the spatial resolution of 90 meter squares is very coarse. The re-sampling to 30 m resolution and field verification performed in June 2007, gave a revised DEM, and formed the basis for the area/volume calculations.

Due to the low lying nature of the upper reaches, to maintain the original design storage capacity of 150 Mm3, the reservoir spillway level will need to be raised from 90 to 92 m (See table/graph below). Consequently, the permanent inundation area increases from 27 km2 to 43 km2 (i.e. by 60%), with dramatic impacts increasing from hundreds to thousands of households. At this stage the EIA has limited itself to assessment of impacts of the "original design", based on the 90 m contour, 27 km2 dam. However, it is now apparent that but due to the low lying topography, a reservoir of this dimension, may not have the prerequisite depth profile to maintain the required design 150 Mm3 water storage (i.e. it only has a volume of 60 Mm3, or 40% of requirement).

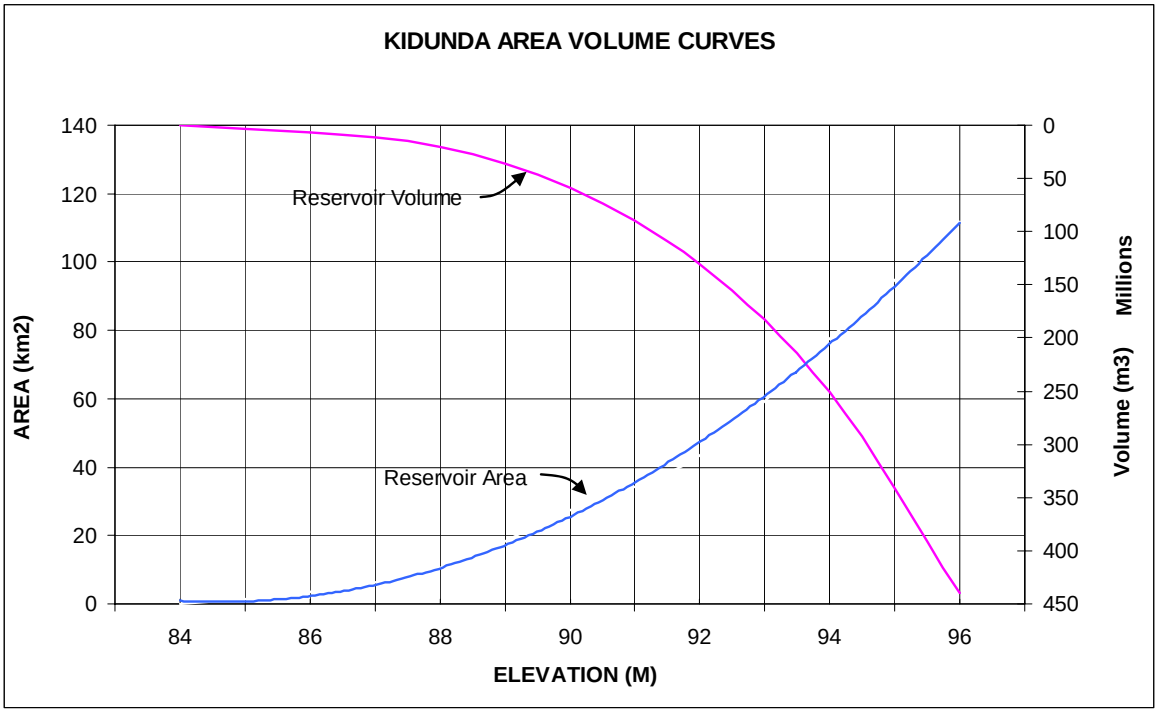

Figure 1. Dam flood curves by contour elevation

Anomalies in the Data:
The new GIS data allowed a comparison of the results as verified by GeoTerraImage (GTI). The higher estimates in the 90 m dataset results from the fact that figures are rounded up to the nearest integer, a product of approximations. The results appear comparable, although the Consultant's interpretation using the re-sampled terrain data at 30 m resolution is more conservative, and has become adopted as the basis for this Study.

Table 2. Comparison of calculated flooded areas

Dam Wall Elevation	Kidunda EIA This Report (SRTM 30 m)(Norconsult)		Kidunda EIA, Verification (SRTM 90)		Kidunda EIA, Verification (SRTM 30)(GTI)	
Contour (m)	Area (km^2)	Volume (Mm^3)	Area (km^2)	Volume (Mm^3)	Area (km^2)	Volume (Mm^3)
90	27.6	58.9	27.3	94.0	29.8	83.0
91			34.4	128.3	37.4	116.3
92	43.4	130.0	43.3	172.0	46.6	158.2
93			53.6	225.2	58.2	210.3

Dam Wall Elevation	Kidunda EIA This Report (SRTM 30 m)(Norconsult)		Kidunda EIA, Verification (SRTM 90)		Kidunda EIA, Verification (SRTM 30)(GTI)	
Contour (m)	Area (km^2)	Volume (Mm^3)	Area (km^2)	Volume (Mm^3)	Area (km^2)	Volume (Mm^3)
93.5			66.5	258.5	65.5	241.2
94	77.5	250.9				

Original maps show the reservoir stops in Kiburumo village. However, due to the lack of sensitivity of the available data to pick up the fine distinction, it must be noted, estimates predict there is a cut-off reservoir in the North West, in Bwira Chini village and the Gonabis flood plain, and similar uncertainty in the South West (encircled in red in Figure 2 below). Flooding may occur due to the low lying area.

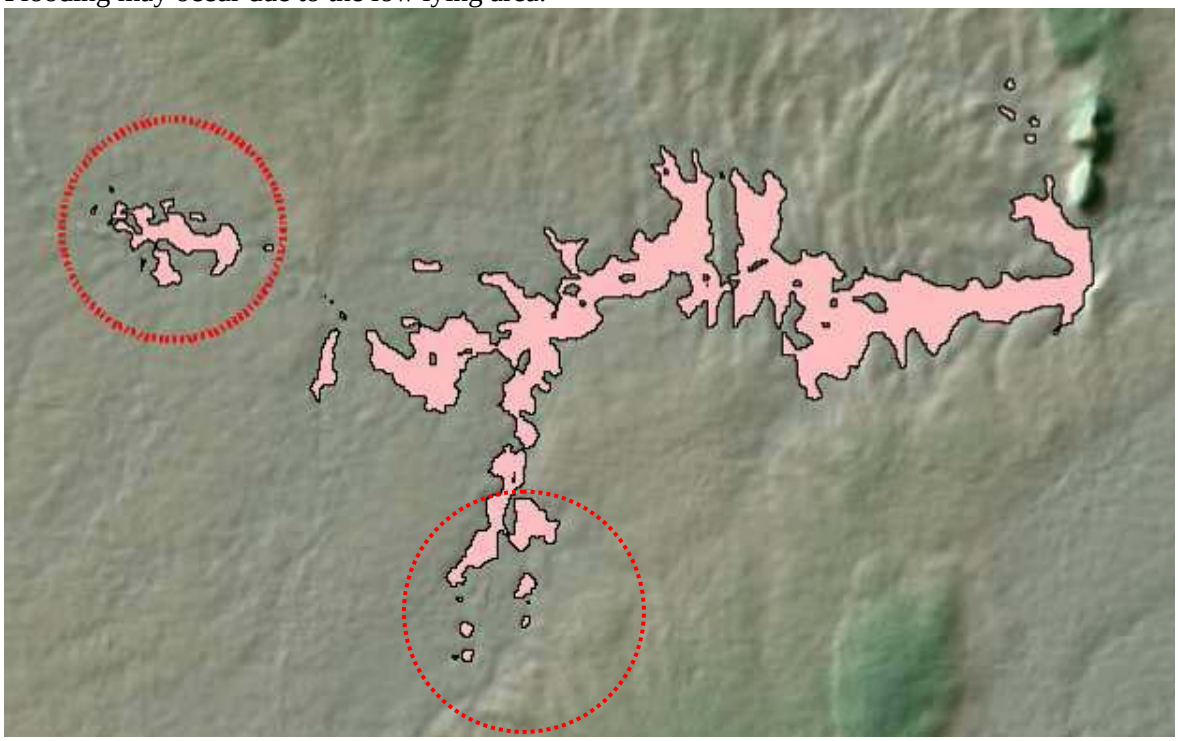

Figure 2. Reservoir at 90 meter, GTI Data (as of November 2007).

The Need for More Accurate Topographic Assessment

Given the low-lying nature of the terrain, and the inherent inaccuracy of available data to quantify the actual inundation zones and impacts on households and properties, land use and natural resources, it would be desirable, at design, to acquire and superimpose a higher resolution satellite image onto the existing maps. The cost is prohibitive for this Study (about USD 180 000), and would require a total re-survey on the ground.

The assessments and the information presented, therefore refer ONLY to the "original Project design". Whereas the data is adequate for this EIA, a more detailed mapping study, an aerial flyover using LIDAR technology should be part of the engineering design and build contract, notably:

i. To produce a Digital Terrain Model with a 15 cm pixel with 15 cm spot height.
ii. For orthophotography for accurate determination of dwellings, affected proprieties, infrastructure etc, can be determined from Spot 5 imagery with resolution down to 2.5 meters.

This will allow design decisions to be made based on a balance between the actual storage capacity of the dam, and a play-off against the least impact on human and natural resources.

3.5.2 b. Resettlement Action Plan (RAP):

As the contour datum was insufficiently accurate to allow exact location of impacted households, this EIA provides indicative estimates for the 90 m contour. Given, the high degree of tension in the area, to minimise stress and anxiety, a detailed house by house account was considered inappropriate at this time. A separate RAP undertaking will be required once the actual dimensions are decided. The process of a RAP was not a part of the Consultants TORs but should be done at design stage.

4 BRIEF OUTLINE AND JUSTIFICATION OF THE PROJECT:

4.1 Objectives of Project

The Project is a single purpose, water supply dam, flooding upto the 90 m contour, with a moderate storage facility of 27 km^2. It is designed to be operated only over a few months of the year (October to December), to augment the flows of the Ruvu River to cater for the dry season water needs for the next 30 years of the 2.8 million people of Dar es Salaam, Bagamoyo, Kibaha and surrounds. The Dam also maintains a reasonable downstream environmental flow to ensure environmental integrity with “limited” reserves for future water rights.

The Kidunda Dam is not to be confused with the earlier proposed, Multi-Purpose Project, a 270 km^2 water reservoir, intended for the longer term supply of the City’s growing needs in water supply, irrigation and hydro-electric power. This Dam is smaller. It is considered to be “the least environmentally impactful” of all recent design options. The Dam is just one of “several alternative options” currently under study as a measure to ensure water security, for Dar es Salaam. The two dam options are shown in Figure 3 below.

The proposed dam site is located 12 km down the Ruvu River from the site originally selected. The change in location and size has been made by DAWASA so as to minimise the flooding impact on people, the Selous GR, the Gonabis wetland and JUKUMU WMA.

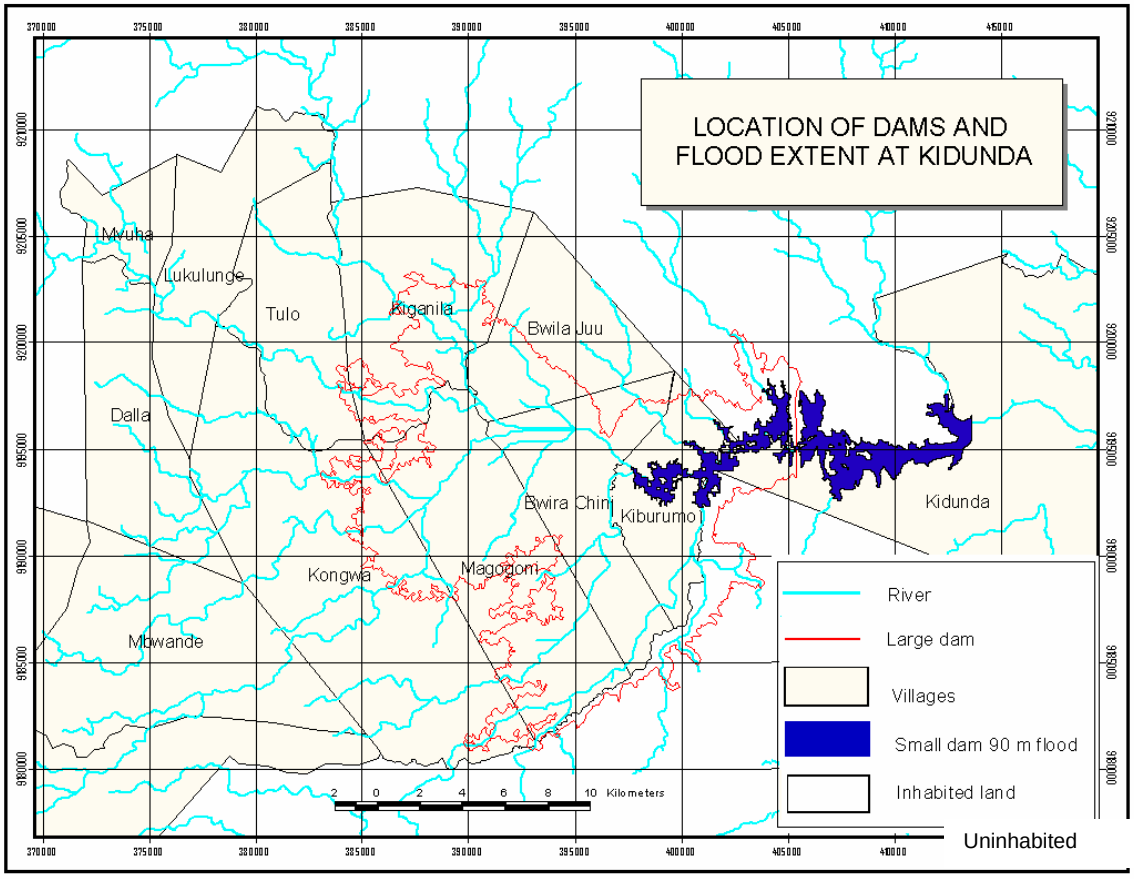

Figure 3. Location map with Kidunda Dam options.

4.2 Justification of the Project

The population of Dar es Salaam and surrounds (3 million people), currently derive most of their domestic and industrial water supply from direct pumping from two intake weirs on the Lower Reaches of the Ruvu River. Water supply to the intakes, is currently unregulated, and subject to seasonal shortages caused by climatic variation, upstream abstraction, competing water user needs (mainly for irrigation), inadequate size of purification plant and limited conveyance capacity. The Ruvu River dry season water flow decreases to the extent that very little can be drawn to meet the present Dar es Salaam water requirements. The City has therefore been experiencing frequent water shortages. The Ruvu River system is vulnerable to climate shocks as witnessed during recent droughts. This is exacerbated by catchment land use and excessive deforestation, changing run-off rates and seasonal flow patterns. Engineering studies suggest the Dar water situation can be improved through a nominal water storage facility of 150 Mm^3, to satisfy the year-round water demand for the next 30-years.

The Project has therefore been justified on the basis of the following:

To Provide Secure Water Supply for Dar es Salaam: The Dam will provide a secure domestic and industrial water supply, approximately 0.8-1.25 Mm^3/day, for 2-3 critical months. Over 3 million people will benefit from a drought buffer protection as well as other downstream human, economic and industrial uses. This has a high economic value and human well being significance.

The adverse impact of “no action” will leave 3 million people and the main centre of Tanzania’s multi-billion dollar industrial and economic sector with water scarcity for 2-3 months. The resultant and dire long term consequences will mean human suffering and environmental health disasters, a build up of sewage and industrial waste, and economic losses. This will far outweigh the immediate and long term impacts of the Dam.

The Consultant provides the following additional justification:

- **Maintain Ecological Integrity:** The Dam's "Flow Release Strategy" will mimic environmental flows, protecting ecological integrity of the Ruvu, its environment and estuary.
- **Fishery Development:** The Dam will provide in situ the development of a valuable 200-300t/yr fishery whose productivity may bolster food security and income in the area.
- **Buffering of Downstream Water Users:** The Dam will provide a buffer against climatic shocks for in-situ and downstream water users. It will cater not only for the target city of Dar, but also current and future irrigation, domestic and industrial needs, and the new bio-fuel plant.

4.3 Location of the Project

The Dam wall is located at approximately E37-413500 and N9196000, which is ~2km upstream of Kidunda Village, on the border between Morogoro and Kibaha Districts. The dam wall is located between Kidunda Hill and Makanga Hill (part of the Mwanga Hill Range), immediately downstream of the Mkulazi – Ruvu River confluence. The 27 km2 reservoir boundary lies on the Selous Game Reserve in the south and Mkulazi Forest Reserve on the north. The reservoir will flood back beyond the confluence of the Ruvu and Mgeta Rivers and will encompass a proportion of the Gonabis wetland, which is part of the JUKUMU Wildlife Management Area (WMA). Figure 4 shows the location Map of the Kidunda Dam and land cover flooded by the 27 km² reservoir at seasonal high flood with flood level upto the 92 m contour.

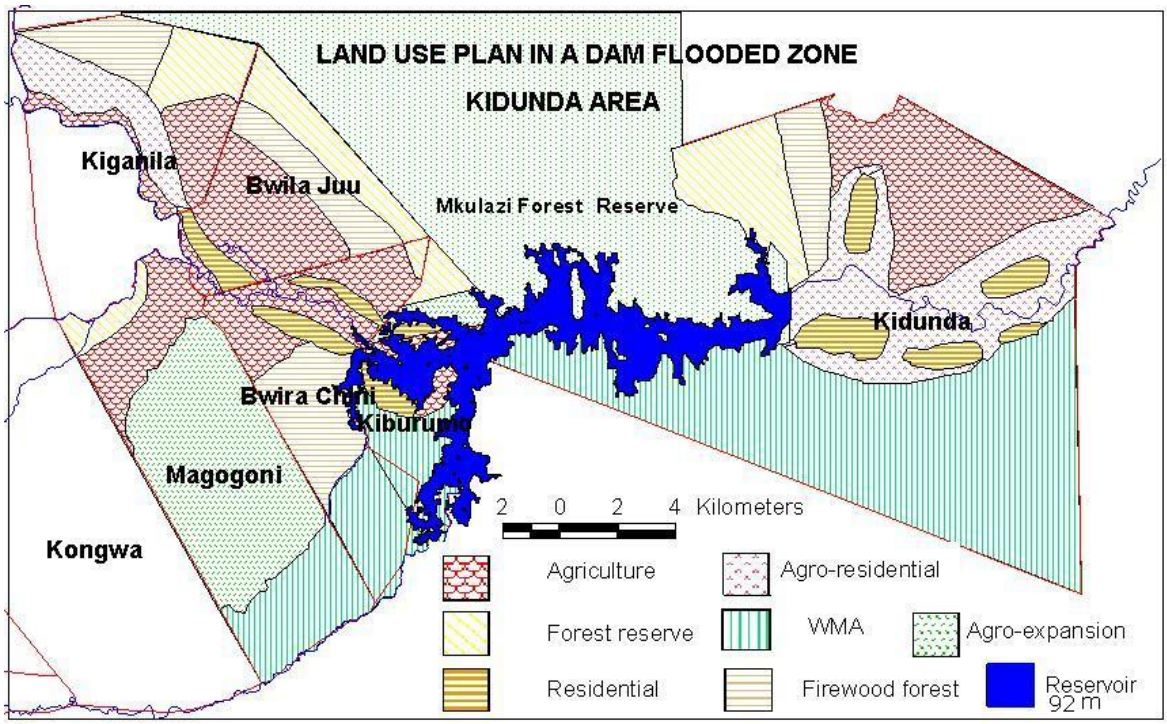

Figure 4. Location map with flooded cover.

4.4 Brief Project Description

The Kidunda Dam Project will have a number of operational stages in its life cycle, notably:

i. Design Stage (1 year)
ii. Construction Stage (1-2 years)
iii. Commissioning Stage (6-12 months)
iv. Operations Stage (30 years)

v. Decommissioning Stage (6-12 months)(or up-grade)

The EIA has taken the above into consideration and the environmental impacts of each stage:

Table 3. Overview of construction requirements.

STAFFING	
Number of permanent (operational stage) staff:	~5-10
Number of construction staff	~300
LAND TAKE	
Land take required for the reservoir	27km²
Land required for plant and works, materials stockpile and access tracks	~1.0 km²
Land required for housing and other accommodation, offices and workshops	~0.5 km² (but may not be located contiguously)
Road requirements	12 m wide gravel road
RESOURCE REQUIREMENTS	
Rock, gravel, sand & concrete works for dam construction	
Clay soils for dam wall core	160,000m³
Sand – for external compaction in the dam wall	54,000 m³
Gravel – for external compaction in the dam wall	54,000 m³
Rock – for external stabilisation in the dam wall	71,000 m³
Clay blanket fill material	54,000 m³
Concrete works	41,000 m³
Excavation Work – to be stockpiled & shaped	
Clearing & grubbing works	240,000 m³
Trees to be cleared/felled in the dam wall area	~3-4km²
Liquids & Lubricants, fuels, etc	
Fresh water for domestic use	23 m3/hour
Lubricants – during construction	145 litres per month
Diesel (earth moving machinery, generators etc)	200 l/hour
PRODUCTION	
Construction phase	
Fresh water- potable	50 m³/day
Fresh water – non-potable, for construction	100 m³/day
Operation phase	
Stabilised water release into downstream Ruvu	0.8-1.25 Mm³/day
BY PRODUCTS AND POLLUTANTS	
Construction phase – on-site water treatment and effluent, sanitation etc.	
Water treatment on site	0.5m³/day sludge and treatment plant by-products
Sewerage and solid waste effluent from camps, offices etc	30m³/day of water from ablutions
Machinery oils and lubricants from operations and servicing	5-10m³/day of polluted water
Solid waste generated	2-5m³/day of polluted water

The Dam wall will be of length 1,200m and maximum height of 25m. The base of the wall will be 130m wide, while the top (crest) will be 15m wide, with shoulder slope angle of 1:3.

The Spillway, made from reinforced concrete 100m in width and 20 m height, at the 90 m contour.

Percolation grout curtain will be 170m, extending ~85 m either side of the centre-line of the dam wall to reduce water percolation through the sandstone that forms the bedrock for the dam wall.

The centre core will be compacted clay soil materials ~20m wide at base narrowing to ~10m at the crest of the dam wall, extending as a flat bed under the reservoir, inward to a further ~90m.

Dam wall protection will be 30m (both sides) of crushed rock-fill, "rip-rap", to stabilise the dam wall against lateral water pressure and to prevent erosion of the dam wall, by wind and wave.

The intake tower (~35m height) and manual water release control mechanism will regulate water release back into the downstream section of the Ruvu River. As per Water Release Strategy, the design is to maintain a minimum environmental flow of 6 Mm3/year or 150 Mld. The outlet from the intake tower, will be a double box culvert, approximately 5m by 6m in cross-sectional dimension, extending from the dam wall into the reservoir and downstream side (total length =170m). It can maintain a maximum flow of ### Mm3 to dampen peak floods, when fully open.

The Access road may need upgrade to mobilise equipment. There may be need for provision of a power supply line, for the operations of the Dam, and on-site staff. Short link roads, mainly within the reservoir body, will connect the source of materials to the crusher site and the dam wall.

Infrastructure will include engineer and site offices, accommodation, labour camps, canteens, stores, fuel depots and garages, etc, plus water supply, toilets and sewerage disposal systems.

A stockpile site will also be required to store overburden from the dam wall excavations and grouting process. This will later be brought back to encourage grass cover in strategic erosion sites.

Clay Core: The origin of the clay core material will be alongside the main river channel. Clearing and grubbing will be required along the river bank.

4.5 Proposed Project Activities

The dam construction will comprise mobilisation, establishment of facilities and construction of the dam wall, off-take structures, commissioning, operation and decommissioning, notably:

a. Design: During design stage, the dam wall site will need to undergo soil and sub-stratum studies to determine rock structure to decide the design of the wall and foundations. Some vegetation clearance will be needed. The length of spillway to minimise the seasonal back-flooding needs engineering consideration, as does the design of a fishway. This EIA suggests that both structures need additional survey and studies. Most important, at design, is more accurate GIS and DEM data will be needed to confirm the final storage capacity and the extent of inundation impact.

b. Construction: Construction will take up to 2 years to complete. The main concrete works include the spillway and the water tower and release control system. Buildings will include DAWASA offices, accommodation, workshops, maintenance and storage facilities. Contractors, staff accommodation, clinic and canteen, ablution facilities, engineer's accommodation and offices.

About 1.5 km2 of land will be required for the construction site, rock and gravel crusher, excavated materials stockpiles, and offices, workshops and accommodation. Water supply for

construction will come from the existing river, as raw, untreated water. Water for human consumption will be either from local wells/boreholes, or from treated river water. Sewerage disposal will be through septic tanks and soak-away for the Contractor's camp, and workshops. An all-weather, heavy duty internal gravel road network (~12m wide), will be required within the reservoir basin to link excavations and materials sources and stockpile areas. Another, small road (~7-9m wide) will be required between the works site and the nearest main road at/near Kidunda Village, and/or to the railway line (approximately 12km away to the Kidunda Station). An offloading platform will be required for large machinery. The access road from Kidunda to the Morogoro - Dar es Salaam highway near Ngerengere will also need upgrading.

Vegetation clearing will take place at the dam construction site, access roads, stockpile areas, quarry areas, etc. Within the reservoir body, clearing may be needed where the vegetation may impact on water quality and fishing. Scope is explored that communities will do this controlled clearing so as to sell the timber, firewood and charcoal products to generate local income.

c. Commissioning: Once construction is completed, the dam will act as a passive structure, with manual regulation of water flow according to a pre-determined, simple Flow Release Strategy.

Prior to vacating the site, there will be a site rehabilitation phase and decommissioning of the Contractor's works site. All processing plant structures will be removed. All material stockpiles will be shaped and contoured to fit the local landscape, covered with topsoil, to enable natural vegetation to re-colonise the exposed earth surfaces. The Contractors offices and accommodation, could be left for DAWASA staff or could be given to JUKUMU WMA as a tourist lodge.

d. Operation: The Dam is anticipated to have a 30-year operation period. The operation process will be largely passive, with regulated seasonal release flows, to guarantee a daily water supply requirement of approximately 310Mld. There will be resident DAWASA staff.

e. Decommission: After 30 years, the fate of the Dam is uncertain. Water supply demands will rise and potentially the Dam would be upgraded, or at least maintained to cater for future needs. Alternatively, it could be demolished or reduced to a size which is not a future flood risk.

4.6 Duration of Construction and Life Span

The construction of the dam wall is likely to take 18-24 months from mobilization to commissioning, and will operate for at least 30 years.

5 BRIEF DESCRIPTION OF PROJECT ENVIRONMENT

5.1 Hydrological Environment

5.1.1 a. Geology, Topography and Landform

Located in Morogoro Region part of the Eastern Arc Mountains, the Uluguru Mountain catchment is the source of the Mgeta and Ruvu streams. This area is under threat from deforestation and agricultural encroachment, affecting 13% of the range. If left unchecked, these activities could drastically alter seasonal run-off rates, increasing erosion and silt deposition in the dam. The upper reaches of the reservoir is categorised by lowland areas, notably the extremely flat, Gonabis wetlands. This leads to the gently undulating plains of the Selous GR. The low lying nature of the area, results in seasonal flooding bringing alluvial soil richness and the area is popular for agriculture, and thus densely populated. The area

however, is prone to flooding, and therefore very sensitive to changes in seasonal flows. The Ruvu is dynamic, and has 4 features:

Hilly upstream reaches (220 - 270 km): The Ruvu originates in the Uluguru mountains, where small streams combine to form three main tributaries. The Mgeta and Ruvu, drain the south side and the Ngerengere drains the north. Characterized by high mountains, steeply sloping banks, a narrow channel, rocky substrate and frequent rapids, the steep gradient makes the current flows fast, less turbid and better oxygenated. The banks are lined with over-growth of trees and grasses. The top end of the Ngerengere has been dammed for water supply to Morogoro, resulting in the Midu dam. The EIA of this dam and its observed impacts on the lower Ruvu, were not available.

Upstream foothills (200 - 220 km upriver): As the Ruvu descends to the foothills, the gradient is reduced, the pools are larger, rapids less frequent, the substrate is sandier and the current slower.

Middle reaches (90 - 200 km upriver): The low gradient slows the flow and the channel is wider, relatively steep-sided. It is fringed with aquatic vegetation such as Vossia and Phragmites grass and reed beds, water lilies, with Ficus verruculosa, Syzigium and Albizia tree species Elephant Grass (Pennisetum spp), and various herbaceous annuals. Submerged vegetation is common. The river is characterized by large meanders and small islands. The substrate is finer and ranges from rock to silt with reed covered, in-stream sandbars. During the rains, the main river channel floods its banks and 4 extensive floodplains are formed: between the estuary and the village of Ruvu, around the Morogoro Bridge, one below Kidunda village and the fourth is the 250km2 Gonabis, between the confluence of the Mgeta and Ruvu. It is here that the floodplains are generally silt laden, and used for rice and maize farming, with oxbow lakes/pools used for fishing, livestock and household use.

Lower reaches/estuary (from the sea to 90 km upriver): The estuary is strongly influenced by the marine environment for about 23 km. The salinity fluctuates through the tidal cycle and seasons. The highest salinity is during the spring high tide, during the low rain season (October - November). During the rains, at low tide, salinity in the estuary is low. The substrate varies from sand to mud and categorised by 2,123 ha of mangroves, mainly Rhizophora mucronata, Sonneratia alba, Ceriops tagal and Heritiera littoralis. The latter is a riverine mangrove. About 100 ha of mangrove has been cleared on the southern bank for the construction of a solar salt works. In the dry season, the whole river is reduced to deep-water channels, ponds and oxbow lakes resulting in a concentration of crocodiles and hippos in lower and middle reaches.

During the rains, the river fills the main channel, overtops and flows onto the floodplains, floods the low-lying land. As a result, people live on the high ground, or levies between the oxbow lakes.

5.1.2 b. Climate

Morogoro Region experiences a bimodal rainfall from November and May with a dry spell in January and February. The rains vary from year to year in timing, amount, duration and intensity. The annual total rainfall varies between 600 mm and 1,800 mm. The high, mountainous nature of the Ulugurus forces the South East Trade winds, to precipitate on the windward, or eastern side. The resultant high rainfall amounts to 2,850 mm annually. As a result, the leeward side of these mountains are drier, receiving less than 600 mm per annum. In the Ruvu Plains-Morogoro Rural District, rainfall averages 900mm and 1,400mm per annum, and temperatures average 30° C.

5.1.3 c. Soils and Riverine Sediment

The river meanders through the alluvial floodplains, but from about 3km downstream of the Ruvu-Mgeta confluence to Kidunda Village there are several sharp bends caused by fissured

sandstone rock aligned at 90º to the flow. Rock outcrops are evident 3 km downstream of the proposed site. The dam site consists of upland hills on Miombo forest in deep to moderately deep sandy soils overlying sandstones. They slope gradually down to an old alluvial floodplain with dense, tall riverine fringing woodland. Valleys and basins are characterized by fertile alluvial soil, seasonally inundated, a loose sandy loam matrix overlying a hardpan layer, or soils with increasing clay.

5.1.4 d. Water Environment

Two major rivers, the Ruvu and Mgeta Rivers, with a third, smaller river, the Mkulazi, categorise the area. These are fed by smaller streams from the surrounding upland mountain catchment areas:

- Mvuha enters the Ruvu from the western (right bank) upstream end of Kiganila Village.
- A small river flows out of the Mkulazi forest, and enters the dam site from the northern (left bank) side, 5 km downstream from the Ruvu-Mgeta Rivers Confluence.
- A small channel enters the northern side of the Ruvu 1km downstream of the Ruvu-Mgeta confluence, arising from Vidwali-Kiburumo Village area

e. River Flow Patterns

Historical peak flows in the Ruvu at Kidunda have reached as high 400 m3/s with mean flow at about 50 m3/s. Low flows have occurred relatively frequently with probability of not meeting the stipulated Dar water demand of 1 in 4 years (Water Source Development Master Plan, April 2007).

f. Water quality

Available water quality data suggests the concentration of all characteristic parameters is generally higher in the Ngerengere. The higher conductivity suggests corrosive water and high content of TDS and salts. The content of chloride in the Ngerengere exceeds the WHO drinking water limits during the highest peaks. Analyses indicates a Na-Ca-Mg-Cl water type in the Ngerengere, Mg-Cl water type in the Lower Ruvu and Ca-Mg-Cl-SO4 in the Upper Ruvu River.

An analysis of heavy metals and pesticides did not reveal detectable concentrations of any analysed elements (list according to WHO). The water quality meets the drinking water guidelines in terms of heavy metals and pesticides. However, in dry periods, the guidelines are exceeded in the Ngerengere River, mainly due to high chloride and conductivity. These are not hazardous to health.

5.2 Terrestrial Environment (Flora)

5.2.1 a. General Description of Landscape and Visual Characteristics

The area, is categorised by a number of vegetation types:

Table 4. Overview of flooded land uses

Total Land Area Flooded by Kidunda Dam

Land Area Type/Category	AREA OF FLOODED LAND (Ha)		
	90 m	92 m	93.5 m
	Permanent Inundation	**Seasonal Inundation**	**1/30 Year Inundation**
Seasonaly innundated grassland-long term	156.4	282.0	344.8
Seasonaly innundated grassland-short term	26.4	42.3	65.2
Settlements and agriculture	20.8	23.1	24.0
Riverine forest	271.8	439.9	521.1
Miombo and associated hilly woodland	409.1	658.3	845.6
Savanna woody grassland	1137.5	1886.7	2337.9
Mbuga-dambo grassland savanna	543.8	778.8	917.8
Cleared land-highly disturbed	52.3	68.4	75.4
River/water area	141.7	163.2	175.0
Total	**2759.7**	**4342.7**	**5307.0**

The area upstream of the Ruvu-Mgeta confluence to the foothills is hundreds of square kilometres of alluvial floodplain. Here, 3 additional vegetation types occur. These are:

- The rocky hillsides are quite steep and vegetated by a close canopy, dry - deciduous woodland with dense under storey of shrubs and herbaceous weeds.
- The seasonally wet grasslands comprise tall moist grassland savanna with scattered trees and clumps of trees and shrubs around termite mounds, with species similar to those found on river fringes (on the lower slopes) and on rocky hillsides (on the higher lying ground)
- The permanently wet grasslands have scattered water holes, and are located on lying sections of the drainage lines flowing from the Miombo woodlands into the Ruvu drainage basin.

The the permanent inundation zone are categorised by dense, tall riverine forest and woodland.

5.2.2 b. Biodiversity and Endemism

The plants species in the site number over 160 woody plant species, which characterise the riverine, wetland and grassland conditions that typify the Miombo vegetation of the Selous GR and Mkulazi FR. Several aquatic macrophytes, 17 common herbaceous plant species, 10 liana/climber species, 56 woody shrub/small tree species, 97 species of large trees, 8 commonly occurring grass species, 9 dominant herbaceous annuals/perennials, 26 shrub species that grow to small trees, 1 tree fern species and 1 bamboo species, were surveyed.

There is no known incidence of plant endemism in the area. There is one tree species recorded that is documented on the IUCN Plant Species Red Data List, namely Baphia kirkii, found close to the Dam Wall site. One tree species appears as a new record of extension of the range, of the Genus Cynometra, a plant recently renamed as Brenaniodendron carvalhoi, which is more commonly found in Mozambique, with one record from Lake Utungu in the southern Selous Game Reserve.

The mammalian fauna in the Gonabis area are typical of the Selous GR, and is home to 1 of the 11 endangered species found in Tanzania, notably wild dogs. It is also a valuable habitat to 3 of the 27 vulnerable species found in the country, notably: lion, cheetah and elephant (Rustigi, 2005). The Selous GR has one of the highest concentrations of wild dogs in Africa, approx 1,500 of a total 4,600. It is uncertain if the Gonabis population is resident or migratory. Most sightings were reported in the dry season with pack sizes of 5-10 animals.

The Selous also supports Black Rhinos and the largest concentrations of Cape Buffalo in Africa, the latter migrate to the Gonabis during the dry season.

The survey was validated by a USDM fauna expert who concluded that there are no known unique or threatened endemic mammals, reptiles or amphibians.

The Bird Fauna: The Selous GR is also an Important Bird Area (IBA) with over 450 species (Baker, 2002). It is important for rare birds such as White-backed Night Herons, Saddle-billed Storks, Pel's Fishing Owls and African Skimmers. It is also seasonally important for many wetland habitat species, like Goliath Herons, and is the border of the coastal forest range of the endangered Spotted Ground Thrush. It is also, the northern breeding site of African Pitta, and habitat for the Lesser Seedcracker and Rock Pratincole. Vulnerable species include Lesser Kestrel, Corncrake, and Kilombero Weaver, and the near threatened Madagascar Squacco Heron, Pallid harrier, Stierlings Woodpecker and Basra Red Warbler. Baker (2002) reported that the Kidunda dam, while potentially destructive to habitat, is unlikely to have an impact on endemic, or threatened avifauna. The dam would probably favour water birds, as their dry season habitat is limited in extent.

Although the Grey Throated Flycatcher (Myioparus grisegaularis), was seen for the first time, and is not known to be within its normal range. The survey was validated by Tanzanian ornithologist, Neil Baker, who concluded that there are no known unique or threatened endemic birds.

5.2.3 c. Terrestrial Vegetation

Among the most frequently encountered timber species are Dalbergia melanoxylon, Acacia nigrescens and Tamarindus indica. Dalbergia melanoxylon (Ebony), known for its hard wood, are the dominant species, forming almost mono-species stands in some places. Other well-known, locally occurring timber trees are: Afzelia quanzensis, Pterocarpus angolensis, Combretum imberbe, Julbernardia globiflora, Syzygium quineense, Sterculia appendiculata, Tamarindus indica, and Albizia, Terminalia, and Diospyros species. Encountered in very limited numbers during field surveys, they are thought to have been illegally harvested in the past.

At least 7 different vegetation systems have been observed:

Hygrophyllous Riverine Forest: This fringing riverine forest are found on the high ground, where the soils are deep, dark brown to blackish-brown, freely to moderately freely draining sandy loams to sandy clay loams rich in humus. In places the forest has been cleared for cultivation.

The riverine vegetation consists of dense middle storey tree and shrub canopy (10-15m height) with very little undergrowth, but with occasional very tall trees emerging (16-22m+ height). The dominant tree species are Trichilia emetica, Kigelia africana, Syzigium and Ficus sycomorus, with extremely tall trees of Albizia species and Sterculia appendiculata. The under storey is dominated by lianas and scrambling shrubs such as Capparis tomentosa. Along the river, where exposed to sunlight, is often covered in mats of creeper, dominated by Ipomoea and Rhoicissus species. More open canopy occur in the riverine woodland, where large Ficus species (F.sycamorus), a large Palm tree (Borassus aethiopica) and the Doum Palm (Hyphaene compressa) commonly occur. This vegetation type is made up of a number of sub-systems:

- **Riverine forest along rocky cascades:** The vegetation resembles the dense riverine thicket found along the main Ruvu River channel, but occur where the streams are very narrow (mostly <15m wide and often only up to 5m wide), so the forest comprises a narrow band of tall dense thicket and trees up to ~20-30m wide at most.

- **Fringing forest (Mkulazi FR):** There are two types of fringing forest, with Miombo woodland on the upland areas, and a dry woodland savanna on the lower slopes adjacent to the moist Mbuga grassland areas.
- **Palm riverine thicket:** Fringing Hyphaene compressa occur in the fringing riverine forest along sections of the Ruvu, particularly between the Ruvu-Mgeta confluence and Kidunda Hill.
- **Open wooded savannah association:** This plant association covers the largest area to be inundated. The vegetation system is very common. The tall grassland areas have a low nutritional status during the wet season, and of low values to livestock and wildlife.

Deciduous Woodland (Selous GR): Comprises woodland thicket on hill footslopes of the sand ridges, where there is lateral moisture seepage from the deeper sandy soils up-slope. The vegetation forms dense thickets generally surrounded by seasonally wet, tall grassland savannah.
The dominant tree species are Spirostachys africana, Terminalia brownii, Adansonia digitata Acacia nigrescens, Markhamia lutea, and Sclerocarya birrea with shrub species Rhus, Commiphora, Gardenia, Grewia and Euclea. There are various climbing plants and lianas, including Landolphia, Coccinea, Dioscorea, and Ipomoea species. Small herbs are mainly of Sida, Corchorus, Abutilon, Hibiscus and Commelina species, while grasses are dominated by Panicum maximum, Panicum coloratum (probably), Sporobolus, Digitaria and Heteropogon contortus.

Secondary Vegetation: Riverine areas have been significantly modified by cultivation. Few trees remaining, replaced by exotic fruit trees such as Mango, Coconut, Banana, Jack Fruit, Guava, Oil Palm and Kapok. The low lying reed-bed areas either remain, or have been replaced with maize, sorghum, sugar cane, various household vegetables and wetland rice paddy. The higher lying alluvial floodplains are cultivated with Maize, Sorghum, Tobacco, Beans and Sim-Sim (Sesame).
Tall riverine grassland and reeds is dominant along sections of the river where the banks are low-lying and have not been undercut to expose sheer river bank faces. The dominant indigenous trees are Syzygium and Ficus species (eg F.verruculosa). The dominant grasses are Setaria and Vossia, with reeds and reed-like grasses dominated by Miscanthidium, Pennisetum and Phragmites. The island near the dam wall site that has been colonised by Bamboo.

Seasonally Inundated Grasslands/Wetlands: Seasonally wet tall grasslands savannah with scattered tall trees and thorn scrub, locally known as Mbuga, and regionally as Dambo occurs in low lying areas along drainage lines and on alluvial plains between riverine forest and the upland areas. The soils are seasonally inundated due to rainfall and to soil moisture. The grasslands are regularly subjected to very hot dry-season fires, resulting in few tree species.

The dominant tall trees are Acacia nigrescens, Sclerocarya birrea, Combretum imberbe, while shorter trees are predominantly Acacia drepanolobium (whistling thorn), Rhus (possibly R.natalensis), Combretum (possibly C.mossambicensis). Small herbs are mainly of Sida, Corchorus, Abutilon, Hibiscus and Commelina species, while grasses are dominated by Panicum maximum, Panicum coloratum, Sporobolus, Digitaria and Heteropogon contortus, with the addition of Hyperthelia and Cymbopogon species and sedges such as Kyllinga, Cyperus and Scirpus species.

Orchids, Ferns and Epiphytes: No orchids were observed. Epiphytes were observed in some of the trees mainly in the section downstream of the Ruvu-Mgeta River confluence. Encephalartos hildebrandtii, a tree fern was found in the dense thicket in footslopes of Kidunda hill.

5.3 Terrestrial Environment (Fauna) (And Migrants)

5.3.1 a. Mammals

There are migrant and resident species. The area is a transit route from the North Selous GR to Mkulazi FR and Mikumi/Uluguru Hills. DHA describe 5 major crossing points in the Project area. Larger herbivores (e.g. Elephant, Buffalo, Wildebeest, Hartebeest, Zebra and Giraffe) migrate in and out of the area, based on season availability of forage. They are followed by predators: Lion, Wild Dog, Hyena, and Cheetah. The Dam is unlikely to impede this migration as they can cross before the dam wall, or around the Jukumu WMA side, however, what was alarming from the field validation is that human ingression for farming in the Jukumu/Gonabis area, is destroying this habitat.

Miombo woodlands and upland (dry) grasslands: These upland woodland areas provide transient habitats for many of the large herbivores of the Northern Selous GR including Elephant, Black Rhinoceros (on the southern side of the Ruvu), Cape Buffalo, Giraffe, Hartebeest, Wildebeest, Zebra, Sable Antelope, Reedbuck, Eland, Impala, Kudu, and several lesser, more commonly resident mammals, such as Pangolins, Aardvark, Warthog, Bushpig, Common Duiker, Suni antelope, Oribi, Pangolins, Porcupine, Tree Hyrax and various species of hares, squirrels, bats, shrews, mice, rats, molerats and shrews. The larger carnivores include Lion, Leopard, Spotted Hyaena, and Wild Dog, while lesser carnivores include Jackal, Civet, Serval, Genet, Mongoose and Honey Badger/Ratel. Vervet Monkey and Yellow Baboon are also common.

Seasonally wet/inundated grasslands: This habitat contains mammals that move through the Miombo woodlands on seasonal basis, and/or as permanent residents, particularly on the fringes where habitats merge. This includes Bushbuck, Reedbuck, Waterbuck, Hippopotamus (mainly at night), Warthog, Otter, and various rodents, Cane and Giant Rats and Climbing Mice.

Agricultural lands areas: The agricultural lands provide habitat for many of the small mammals, mainly monkeys, rodents and the smaller carnivores. Larger mammals such as elephant and hippo pose serious problems to crop damage and by chasing and frightening people, particularly those land areas located close to migration routes (e.g. the Ruvu-Mgeta River confluence).

5.3.2 b. Herpetofauna (Reptiles and Amphibians)

Reptiles: The reptiles common in the area are the Nile crocodile, and Water Monitor, as well as turtles, tortoises and many species of lizards, skinks and geckoes, chameleons, and snakes.

Amphibians: Many amphibians were observed, dominated by the African clawed frog (Xenopus laevis), land toads, grass and reed frogs, and bullfrogs. Most reptiles will move away from the water body into adjacent /remnant habitat around the reservoir.

Avifauna: More than 90% of the bird species observed were common to river wetland habitat (e.g. Kingfishers, Ducks and Waders). None of the BirdLife (2007) listed birds falls under the current threatened list. Being a contiguous habitat of the Selous Game Reserve, the threatened birds found in Selous (Baldus and Siege, 2003; Baker, 2002) may also be using this habitat. Other species listed, especially Birds of prey, which have large home ranges, likely to be found in the proposed dam site, include Ruppel's Vulture Gyps rueppellii (Near Threatened), Lappet-faced Vulture Torgos tracheliotos (Vulnerable) and Pallid Harrier Circus macrourus (Near Threatened).

Insect Fauna: Very little is known about specific insects. Those of economic significance affecting human health, including mosquitoes, ticks, mites, fleas, flies, and Tsetse Fly (Glossina morsitans). Dragonflies, butterflies and moths are abundant in the forest and grassland areas, and agricultural lands. Ants, bees, hornets and wasps, have positive economic

significance due to a growing world market for decoration, for eco-tourism, and in some cases, as natural pest control agents. Termites are important to the ecology creating habitats for various plants, and in wetland areas, provide higher, drier land for woody plant and thickets, habitat for small animals.
The impacts of the reservoir are not expected to affect the habitats of the majority of insect species.

5.4 Aquatic Biota

Fish are the most important aquatic fauna in the Ruvu River. None of the aquatic biota found are listed as endangered or endemic. It is quite possible that as yet un-described species are in fact endemic to the river, and the discovery of 6-9 new fish species, suggests further studies are needed.

a. Phytoplankton and Zooplankton: The estuarine environment in the Ruvu River has diverse zooplankton fauna, mostly of Cycolpoides and Calanoides.

b. Aquatic Meiofauna: Easterly flowing rivers in East Africa support at least 4 species of freshwater prawns (Machrobranchium spp.).

c. Sediment fauna (Meiobenthos/molluscs): Diptera, Ephemeroptera and Odonata larvae dominate the insect fauna in the sediments. Snails (Gastropoda) are also found in the sediments.

5.4.1 d. Ichthyofauna

Ruvu River is typical of a tropical river and floodplain. It has a diverse fauna, an estimated 82 species of fish. 43 of the fish species are marine or estuary associated, mostly in the lower reaches. 39 freshwater species were found in the study from the lower to the upper reaches, notably:

- Up-stream: At least 35 species occur up-stream of the dam. Only four species are found exclusively up-stream of the site.
- In-Situ: At least 31 species are thought to occur at the site of the dam. These include all species that were found in the middle and throughout the Ruvu River.
- Downstream: The marine and estuarine influence in the area downstream of the dam means an estimated 74 species occur in this region.

5.4.2 e. Aquatic Ecology

Agricultural activities and capture fisheries have been operating for years in the area, and have already altered the biological river environment, increasing turbidity and nutrient status. Consequently, this environment favours species that have evolved physiological and behavioural mechanisms to cope with the resultant stress of the fluctuating environment, notably:

Life history: At least 43 species of fish are known to breed or live in the sea and migrate up through the estuary into the freshwater reaches of the Ruvu River, many only venture into the upper part of the estuary. Four mullet species, indo-pacific tarpon and Zambezi Shark are considered to be amphidromous, spending large amounts of time in the lower brackish/freshwater reaches for feeding. At least 42 species can live, breed and feed in freshwater, and includes predators, herbivores, insectivores, and phytoplanktivores.

Reproductive requirements of the species that breed in freshwater: Of the 42 freshwater species, at least 18 breed in floodplains, 3 prefer a rocky substrate and 19 have unknown breeding habits. Reproduction is normally timed to coincide with a seasonal abundance of food resources, shelter from predators and benign abiotic conditions. This normally coincides

with an increase in rainfall and flooding. Consequently, most riverine fishes in the Ruvu will spawn just prior to, or during periods of flooding. Spawning normally occurs on recently inundated vegetation when rivers break their banks, or on floodplains. Egg and juvenile survival is dependent on the maintenance of a consistent water level during the early stages. Rapidly receding water is known to leave eggs and juvenile fish stranded, reduce food availability and cause mass mortality.

Migratory species, swimming ability and seasonal timing: A number of fish migrate up and down the Ruvu River. Three are catadromous, 6 amphidromous and at least 14 potadromous.

The African Mottled, African Longfin and Shortfin eels are the only truly catadromous species (migrate from sea to freshwater to breed). Collectively, they are important to the local fishery, ranked 7th by fishermen. Eels are well known to migrate long distances up east coast rivers to feed and mature. Eels spawn at sea and after a planktonic larval stage, move into estuaries, where they metamorphose into glass eels. The glass eels begin a freshwater migration and change to elvers which migrate up to 500 km upriver and are capable of climbing moist rock faces and weirs. Eels spend many years (up to 15) in freshwater, undergo a second metamorphosis at maturity, change into silver eels. They migrate downstream to the sea to breed. The proposed dam is likely to pose a barrier, but not too severe a threat to the up and downstream migration of these species.

The four mullet species, indo-pacific tarpon and Zambezi shark are considered to be amphidromous (spending large amounts of time in the lower brackish/freshwater reaches for feeding). These fish are strong swimmers and capable of moving great distances upriver, but, it is unlikely they migrate high enough upriver to be severely affected by the proposed dam.

Potadromous species (migrate up river to breed), include the Clarias, Hydrocynus, Citharinus, Labeo and Barbus species. They make up half of the 10 most important fishery species. Tigerfish and Redeye Labeo can traverse small weirs and waterfalls, but will be hampered by the dam.

Reproductive minimum flow requirements: For the optimal functioning of a floodplain, seasons of low and high flow, are required. It is therefore essential to maintain minimum Environmental Flow Requirements for successful fish reproduction. Large daily fluctuations can leave fish stranded, altering spawning behaviour and egg and juvenile survival. Natural flood heights, intensities and timing must match the natural (pre-dam) conditions to avoid reproductive failure.

Gene pool status: The gentle gradient, lack of waterfalls or large rapids suggests that there are probably no natural barriers between the estuary and the upper reaches of the river. Consequently, the fish in the Ruvu River are capable of freely mixing genetically and there should be a large and healthy gene pool in the river, particularly for the migratory species. The dam may alter this.

Important wetlands: The 4 significant floodplains, described above are critical habitats and provide shelter, feeding and breeding habitat for many species of fish in the Ruvu River.

5.5 Socio-Economic Conditions

JUKUMU WMA has a considerable volume of published material describing the SE nature.

5.5.1 a. Community Description: Villages Formation/Registration

All villages within the Project area were formed under the 1974 Ujamaa Villagisation Program. Households were shifted to new settlements under various registered villages. They were provided with big enough plots to build their houses, and with reasonable sizes of farming areas in the virgin land within the flood plains and lowlands of the Ruvu River. Due

to this earlier displacement, the general consensus is one of dissatisfaction at the looming prospect of having to be displaced again.

Settlement pattern: Most of the houses in the project area are built along the high ground, to avoid flooding, especially Kiburumo village, Mvuha, Bwira Juu and Magogoni. They tend to prefer to be near the road or close to the Ruvu River. As a result, villages are densely populated, and houses condensed in a linear pattern on both sides of the road, a reflection of "Ujamaa village concept".

The majority are primarily farmers (94%), engaged in off-farm activities such as fishing (18%) and illegal hunting, and a few engage in honey harvesting. Some villagers (e.g. in Bwira Juu and Bwira Chini) carry out weaving, e.g. making mats. Few carry out petty trading and have kiosks or genge for selling seasonal fruits and tomatoes, and various processes goods. Most households are surrounded by farm crops, such as pawpaw, coconuts, bananas, and maize and mango trees. Cowpeas and cassava are also grown. House compounds tend to be overgrown and this poses a danger of snakes and other harmful reptiles and insects. Occasionally, the Ruvu and Mvuha Rivers have flooded residential areas affecting houses and properties for a period of 1 to 3 days.

Household size: 83% of the households in the project area are headed by male members. Female headed households comprise about 17% of the community households. This is not an uncommon feature in a predominantly Muslim community, where divorce is common. Women headed household have limited land, resulting in low income and subjected to more hardship.

Rustagi (2005), estimated the average household (hh) size is 3-5 people per household (37.5%) and 6-8 people per hh (~30%). This study shows 3-5 people (58.9%) and 29.1% of households consist of 6-10 people, suggesting a high population growth or influx.

Land conflicts: Migrant Maasai and Barabaig pastoralists are in conflict as a result of grazing animals in people's farms. Land Use Plans (LUPs) were made up as early as 1991, and revisions are underway but village governments do not use these plans. Mkulazi FR is a grazing area, but there is a tendency to move towards the village land to avoid the threat of tsetse flies. In the past, there have also been inter-clan and inter-village land disputes in the area. Bwira Juu farmers had reported land conflicts with their relatives in Magogoni.

5.5.2 b. Current Hazards, Threats and Floods

Floods: With a large number of households living near the river banks, many people experience flooding. This can be up to 0.5-0.6 m above the house foundations and has been a regular event, appearing to increase, of late. When floods occur, farming ceases and schools are closed, as nobody can cross the river. Problems arise from crocodiles, hippos, dangerous snakes and insect pests. Gastro-intestinal problems also increase due to water contamination due to flooding of pit latrines.

Vermin: High concentrations of vermin, notably monkeys, create losses to crops. Rodents damage/eat about 40% of the total production. Some bird species also pose a threat. A great deal of time is used to protect crops. People have opted not to farm certain areas because of the vermin.

Man-eating crocodiles: The threat of crocodiles to people's lives seems to be increasing. 21 cases of partial attacks, injury or death, were reported, between January and May 2007. This corroborates earlier studies. Attacks happen frequently during fishing or when fetching water from the river. The JUKUMU Society has a crocodile hunting licence to try to alleviate the situation.

Soil erosion: The Ruvu River meanders in the area, causing destruction to houses and farm land due to soil erosion. River banks are undermined and collapse. This is aggravated by local

farmers, who clear reeds, grasses and trees for cultivation, reducing the protection along the river banks.

5.5.3 c. Socio-Cultural Profile

Holy Sites/Shrines: There are areas set aside for special traditions, notably graveyards, rituals (locally called 'Kilemela'), sacred trees (include mbuyu, mgude, and mtamba) and areas for traditional training (mainly girls) known as mkole. Several burial sites, owned by clans are within the area to be flooded. Transfer of these spiritual heritage sites, prior to flooding, is welcomed under special requirements and traditional process that would cost around Tsh 300,000/- per site.

Ethnic Profile: The main indigenous ethnic group in the area is the Wakutu who form a big percentage that range from 95% to 98% of the total population in respective villages. The remaining 2-5% included Wazaramo, Wakwere, Matumbi and Walugulu, who come from several parts of Morogoro and other parts of Bagamoyo district. Most moved to the area in 1974 under Ujamaa, but others have since migrated into the area because of richer agricultural soils and other non-farm activities. They are Maasai, Chagga, and Barabaig. The dominant languages spoken in the project area are Kiswahili (100%), Kikutu (98%), Kizaramo (99%) and Kirugulu (66%).

Gender: Most of the women in the area are marginalised, although they are the main producers of crops and other economic products. They have less authority over decisions concerning family properties, farms and crops. Only the head of the family (usually a male) has the mandate to decide on domestic matters and household income. Women accept this as a cultural norm under Islam.

5.5.4 d. Domestic Organization

Water: Water is used for domestic and small-scale irrigation, from the rivers and shallow wells. Water availability is not a problem, but water quality is questionable. At Kiburumo, water is used for irrigating tobacco and brick making. The majority (75.3%) consume more than 2 buckets of water/day, 18.4% consume 2/day, and (5.3%) consume one or less/day.

About 77.2% have year-round access to water. The majority fetch water from hand-pumped wells, while others (21.5%) fetch water from the Ruvu River, and 1.3% live far from water. Most of the water infrastructure is currently not functioning. Water Committees are not active.

Food: Amongst the food crops grown in the area of study, beans constituted the highest (24%), maize (22%), cassava (15%), rice (13%), chick peas (9%), potatoes (9%) and (8%) soya beans. Bwira Chini and Bwira Juu produce bananas for both home use and cash earning.

Food purchase consumes most of the household income, especially November and February during the dry season. Food scarcity is due to farmers selling their food crops, often with little reserves for own consumption, giving rise to a high degree of food insecurity. Education is needed to highlight the importance of reserving food. The Dam offers opportunity for domestic vegetable production.

Firewood: Villagers obtain their firewood near to their residential area. Women are normally the main collectors of firewood, except around Kidunda where men collect firewood, and then sell it. A bundle of firewood is sold for Tsh. 300/-. There have been no attempts to establish woodlots in the area as indigenous trees are plentiful. Firewood is used for cooking. Women spend an estimated 7 hours/day, collecting wood. Charcoal, Tsh 3,500- 4,000/- per sack, is produced for re-sale.

Indoor lighting: Kerosene is the main source of lighting, 56% use oil lamps, 27% use firewood.

5.5.5 e. Fisheries practices and economic importance

Fishing is a significant activity. In the hilly upstream reaches, there are fewer fishers, mostly because of a lack of large fish and low species diversity. In the upstream foothills, individuals practice fishing as an occupation, while 13 % of males in the middle and lower reaches of the Ruvu River (the dam site) engage in fishing. In the wet season, there are many opportunistic fishers.

The major of the catch comes from gillnets of mesh sizes from 2 - 4" (50 -100mm), and between 10m and 100m long. Fish nets are usually set parallel to the river banks using dugout canoes. Gillnets set at night, and fish are removed regularly to prevent crocodiles from eating the fish or becoming tangled. Gillnets range in price from Tsh 2,500/- to Tsh 17,000/- with an average price of Tsh 10,500/- (± $8.40) per 100m. The seine nets that were observed were relatively small (<20m) with a mesh size of 2" (50mm), used mainly in the ponds and backwaters. Operated by two people during the daylight hours, seine nets cost Tsh 10,500/- per 10m, on average, Tsh 21,000/-.

Hook and line fishing is a common by opportunistic fishers. The bait includes maize, soap, small fish, earthworms, insects and boiled eggs. This gear is inexpensive. Hook prices ranging from 100 to 300 Tsh each and 10m of line costs 500 to 2,000Tsh. Long-line fishing is also conducted, with at least ten baited hooks attached to a long rope or line.

A variety of traditional fishing methods, include basket traps and reed traps. In one village, two fishers used paraffin lights to attract fish at night and caught them using scoop nets.

Fish are important for food security and for cash income. Most fish are sold or bartered to villagers, or to middlemen who transport the fish to the nearest market. Some fishers take their catch home to be processed (fried, dried or smoked) or eaten. Fish is a most important source of animal protein, and opportunistic fishers rely on fish as a source of food, when other proteins are lacking. On average during the dry season, fishers earn ~Tsh 22,000/- ($18.00) per day, and in the wet season ~Tsh 3,000/- ($2.50) per day. Fishing is done for 6.9 days/week in the 3 month, dry season and 4.5 days/week in the 9 month, wet season. The average annual earning per fisher is Tsh 2,600,000/- ($2,090). This indicates the importance of fish to livelihoods and the local economy.

5.5.6 f. House Construction

Almost all houses (90%) in the 7 villages surveyed (Bwira Juu and Bwira Chini, Kidunda, Kiburumo, Bonye, Mvuha and Magogoni) are of mud and poles, thatched with grass, and with an earthen floor. About 58% of the houses in the study area are of grass thatched, and 38% are roofed with corrugated iron sheets, and 4% have either mixed roofing materials (i.e. tin/thatch), or are roofless, under construction. 37% constitute mud and poles structures roofed with corrugated iron sheets, while 55% are built with reeds or sticks. Houses are not strong, and are easily destroyed by floods, fire and wind. Only 1 % are built either of concrete blocks or burnt bricks, roofed with iron sheets. The latter are normally for government, NGOs, schools, dispensaries, and worship centres (i.e. churches mosques etc). Very few individuals can afford such building materials.

5.5.7 g. Domestic Stability

On average, families were reported to be stable, though divorce is noted. Conflicts are caused by polygamy and unfair treatment from the husband. Some disliked to be married and share a single husband because of complexities related to administration, access (acquired) and sharing or control of resources. In Mvuha, 70% of the males practiced polygamy.

5.5.8 h. Population

Population profile by age, sex and marital status: Data from CSPD (2006) indicated the following key figures with regard to sex and age in the project area:

Age	Female	Percent	Males	Percent
Under 5 years:	395	9.8	278	7.2
6-13	263	6.8	290	7.5
14-44	659	17.1	648	16.8
45-60	445	11.5	430	11.1
Above 60	218	5.6	219	5.7

The high active, able-bodied age categories, suggests that out-migration is not an issue.

Births and deaths: Average 2006 birth rate in the ward was 4 children/village/month, or 20/ward.

Migration: In and out migration in the area is marginal, except in the upstream villages. In-migration is currently high, due to opportunities like mining, livestock keeping, different businesses and timber harvesting. Immigrants come from Kigoma, Tanga, Kilimanjaro, etc. The youth tend to migrate to urban centres looking for formal employment in industries, businesses and informal sector. The youth end up frustrated as there are no local employment opportunities in the villages. Young females tend to leave the area due to inter-clan marriages.

5.5.9 j. Local Government

The local government follows normal structures, represented by the Ward Executive Officer (WEO), supported by Village Executive Officer (VEO), and answerable to the District Council. The development planning procedures at the ward level are coordinated by Ward Development Committee (WDC). The plans are approved by the District Full Council supported by sectoral departments that are responsible to the District Executive Director (DED).

JUKUMU WMA Government: JUKUMU is a local association/society composed of 22 village members who participate in the management of the 750km2 Wildlife Management Area (WMA). It has a constitution, a steering body, and is registered as a CBO, making it legally recognized by government. The Executive Committee of the association constitutes of 10 members of which two are females. Each village is represented by three members for the annual/general meetings. These are selected by the general assembly, and of the three members, one must be female.

5.5.10 k. Education Status in the Project Area

Literacy: The illiteracy level is very high (33%). The majority (66%) have primary education while only 1% has secondary education. About 27.2 % cannot read or write.

Access to primary schools: The area has 6 primary schools, one under construction. 31.0% of students live within 5 to 10 km of a school, 23.4% live less than 5 km and 22.8%, more than 10 km.

Some primary school (eg Bwira Chini) infrastructures are poor and inadequate, unlike Dutumi-Bonye primary school which is in good condition. The primary school at Bwira Juu is under construction, but has stopped due to the Project. Most schools lack basic teaching aides and facilities. Enrolment is low as few parents value formal education. Girls are at a disadvantage because of traditions and customs. They are expected to marry, and raise children. Except for Kiburumo, women tend to have a lower standard of education than men. Problems include shortage of teachers (Bwira Chini = 4, Kiburumo = 4 and Kidunda = 3),

inadequate classrooms, few desks and teachers' houses, lack of motivation and few incentives for teachers.

Reasons for dropping out of school: 3/30 school girls were reported pregnant at Bwira Chini primary school. Boys are often expected to support their parents, take care of livestock. Often boys dropout after losing interest, due to poor performance and not being selected to join secondary schools. They engage in income generating activities (IGA) including illegal ones (e.g. hunting).

Secondary Schools: There are only two secondary schools at Magogoni and Dutumi for all twenty-two villages of the JUKUMU Society. There are no initiatives for adult education except for a programme introduced for youths known as Compulsory Basic Education in Tanzania (COBET).

5.5.11 I. Other Local Institutions and Infrastructure

NGOs (Non Governmental organizations): It was noted that there are no International or National/Civil/Non-Governmental Organizations in the area and none of the UN agencies were present. Only the Roman Catholic and Lutheran Churches are present in Magogoni and Mvuha villages, where there is TCRC (Tanzania Christian Refugee Services).

Churches and religious organizations: 98% of the people are Muslims. This has shaped the style of living and thinking. Christianity, mainly Lutheran, exists but its influence is small. Traditional belief (pagan) persists, dominated by strong and scaring witchcraft practices. Cutting across modern beliefs, this practice is probably behind the current level of under-development. People do not build modern houses or put on nice dresses/shirts, in fear of being bewitched by jealous neighbours. Many sacred sites and shrines exist in the forest and river woodland.

Transport and communication: Most complain of the poor transport system. Kidunda access is poor. It is difficult for middlemen and business interests to transport goods and people. The carrier bicycle is the main transport, costing ~ Tsh 12,000/- per route from Kidunda to Ngerengere and Mvuha, the major shopping centres. In Kiburumo, there are 52 bicycles, Bwira Juu 91 and Bwira Chini 178. From Kidunda it takes 2 days by bicycle to reach Dutumi.

5.6 Natural Resource Husbandry

Other than agriculture, land use encompasses forests, grasslands and wildlife habitat. Although LUPs exist, all of the land uses are not specifically planned, and are haphazard.

a. Access to land and land tenure: Land is acquired through 35% inheritance on clan basis, 3% rented or borrowed village land, allocations to needy people and purchase, and 34% self-allocation. The majority of in-situ villages have plenty of undeveloped fertile land. Only Mvuha, has no available land left, typical of the upstream villages. In Kiburumo, land can be rented at Tsh 200, 000/ha/year while Bwira Chini the rate was Tsh 10,000/ha/year. This gives an idea of land value.

The village government has also allocated 24% of land to applicants in need. A village government committee decides which part and how much of the land should be allocated and to whom. The process is easier for indigenous local residents, but harder and complicated for in-migrants. Any land inundated by the dam would have to follow local custom of procurement and compensation.

b. Land holding: 43% of people interviewed indicated that there was land scarcity, but varied from village to village. People would like more land for agriculture and other economic activities but land is not easily available. 22% indicated no land pressure, while 35% were uncertain.

c. Crop patterns: Agriculture in the area is typified by crops such as cotton, maize, tobacco, millet and a variety of fruits. Rice is grown in wetlands, a few kilometres from the homestead. Tobacco is grown along the river banks, for cash. Food crops include rice, sorghum, millet and simsim. Most of the farmers till the land using hand-hoes. No modern farm implements are used. Agriculture is small-scale subsistence, producing for home consumption and surplus for market to generate revenue to procure other, non-farm products. 93% practiced slash and burn.

Irrigation agriculture is not practiced. Farming depends on rain fed agriculture. Most crops (e.g. maize, watermelon) and some fruits, grown in the wetland areas, can be harvested twice a year due to good moisture and rich soils. There is little shortage of food in the area.

d. Land husbandry: 33% of the villagers practise monoculture farming. Mixed farming is about 65%, cowpeas, maize, and pawpaw are grown in the same farm. Fallow accounts for 2% of area.

e. Agriculture inputs: Agriculture is characterized by poor technology, hand hoe, limited inputs and shifting cultivation. Most farmers can physically cultivate 2–5 acres per household. The majority do not apply chemical pesticides, organic or chemical fertilizers. Inputs are not affordable and are generally not available. Farms rely on naturally fertile soils due to silt deposition during flooding. There is no financial institution for loan facilities. Muungano wa Vikundi vya Wakulima Tanzania (MVIWATA) was asked to become active in the area, and some villages had establish SACCOS through which communities could access credit and other, different facilities.

f. Cropping system: Shifting cultivation is practiced due to diminishing natural fertility after continuous use, as better yields come from newly cleared virgin land. In Bwira Chini and Kidunda villages, rice production goes up to 25 bags/acre in virgin lands, versus 8 bags if over-cultivated.

g. Agricultural storage: Most do not have modern storage facilities. Maize, millet, sorghum etc are kept in small bandas “Vihenga”. Paddy, simsim, groundnuts etc are stored inside the house for security. Cassava is sold fresh, the remainder is dried and kept in the backyard under thatched huts.

h. Animal husbandry: Very few people keep cattle, except immigrant Maasai and Barabaig. The indigenous Wakutu no longer practice a livestock tradition of the early 1930’s, abandoned due to tsetse flies. There are no reliable veterinary services. Few keep goats (average of 1 – 5/hh) for domestic use. Maasai cattle, goats and sheep provides milk, which they sell to buy grain. Cows are sold in open market to buy clothes, veterinary drugs, food and beer/local brews.

60% of people keep small scale poultry for domestic use. A few keep 60-150chickens or ducks, for commercial purposes. Prices fluctuate depending on the market and bargaining power, averaging Tsh 3,500/- to Tsh 6,000 Tsh/- per unit. The 2006 national out-break of Rift Valley Fever (RVF) contributed to the rise of chicken prices. Poultry diseases, are treated with local herbs.

i. Utilization of forest products (village and forest reserve): Forest products include timber, building poles, thatch, fuel wood, charcoal, fruits, mushrooms, traditional medicine, and beekeeping. Environmental degradation is evident in forested areas surrounding the villages. Timber harvest business is mainly at Mvuha (6 carpentry shops and several carpenters), Mbwade (6), and Bonye (10 in 2007 compared to 3 in 2003). Carpenters are in every village, highest in Gomero (10) and Kisaki (10), while other villages have either one or none. Bonye has a building pole business, larger than any other village. Many engage in brick making for own use and selling. Charcoal makers have increased in Bonye 6 (from 0 in 2003), Mvuha 30, Gomero 25, Kidunda 5.

j. Important plant species affected by project development: People are concerned that the dam will affect a number of plant species used for traditional medicines and ritual ceremonies, as well as tree species used for construction (notably: Ebony, Mkongowe, Mzizima, Mpungupungu, Mkula, Mikorosho, Mtambazi, Mguruka, Mkwambe, Mkunju, Mkilika, and Lufambo).

k. Lack of agricultural/livestock and forest extension services: The extension services are inadequate, with extension officers only allocated at ward level to serve 4 to 8 villages. Selembala Ward is most affected as it has no extension officers, except the Health Officer, based at Magogoni Dispensary. Extension staff are frustrated by lack of conducive working environment, lack of transport, meagre salaries, and poor incentives. Farmers therefore rely on indigenous knowledge and would benefit from assistance and modern technology, especially the new fishery.

5.7 Local Economy

a. Market access: Limited access to markets for farm produce is due to limited capital, lack of marketing or producer associations, and poor road conditions. Middlemen from Morogoro and Dar es Salaam, exploit low prices associated with the increase in supply immediately after the harvest in June to September. Farmers feel trapped by the situation, lacking market information to negotiate and sell if they urgently need cash. Better access could improve the situation.

Mvuha has a big market that serves 10 villages, once a week. The majority (67.7%) travel more than 10kms to sell their farm products and buy their requirements, and 13.9% travel 5-10kms, while 17.7% claim no market access and 15.2% are uncertain of the distance to market. People depend on the local, make-shift markets (Magenge) and kiosks for their domestic requirements.

b. Market price: Produce prices depend on the type of crop, demand and supply. Middlemen buy cheaply in the villages and sell higher in the urban areas to recover transport cost and risks. Maize or sorghum at Kidunda fetches Tsh. 15,000/bag. Some middlemen prepay farmers while crops are still in the fields (eg rice in Mvuha). Bwira Chini sell a bag of rice at Tsh 35,000/- to 40,000/-, simsim at Tsh 40,000/-, and maize at Tsh 28,000/100 kg bag.

c. Access to transport: Transportation to external markets due to poor roads results in low prices. Farmers pay Tsh 3,000 to 5,000/- for a return trip to Morogoro town and Tsh 2,000 to 3,000/100 kg bag of any farm produce.

d. Income generation: Most of the community engage in business activities, a small shop, brewing alcohol, farm/crop selling, food vending, restaurants, small-scale guest houses, and selling milk. The restaurants (mama lishe) are owned and controlled by women. Statistically, 18% fish for a livelihood, 54% produce livestock (chicken and ducks), while 2% produce handicrafts. Other economic activities include 4% as travelling traders, 4% local brewing, and pottery 14%. Shop traders and traditional healers make up 2%. Most people depend upon agriculture (98%).

e. Household income: Males are key income earners, assisted by wives, jointly growing food and cash crops. Women also own farms for their personal requirements to avoid matrimonial conflicts.

An average 5 person household expenditure, at Kidunda was Tsh 1,119,600/year, in Bonye, Tsh 1,093,000/year, Kiburumo and Bwira Chini was Tsh 1,800,000/year and Mvuha Tsh 720,000/year. The average for all 5 villages was Tsh 1,306,520/hh/year, higher than income. 64.6% noted annual income was more than Tsh 1,000,000/-, 17.1% ranged between Tsh 100,000 to 449,000/year, while 3.2% made less than Tsh 100,000/year. 3.8% did not want to reveal their income.

e. Wildlife management area: Income generated from the JUKUMU Society Wildlife Management Area (WMA), from 1997 to 2007, is significant, cited as the sole source of village's income/revenue, key to village development. Villages show different annual figures of money received from the WMA, due to the JUKUMU Committee favoured some villages. Kidunda reported Tsh 500,000/year, others received less or more, but none were not aware of the reasons for the variation. There is a need to assist in developing capacity in handling funds and record-keeping.

Without Authorised Association (AA) status, JUKUMU cannot earn much from investors. Sable Mountain lodge, provides Tsh 25 million/year, plus Intercon Safaris, Tsh 8 million/year. JUKUMU Society spends 50% on administration and 50% distributed equitably to 22 members. A new Committee was appointed in November 2006, and will need support from to administer the area.

f. Social services: Most villages lack necessary social services, especially clean water, and health services. There is no electricity and no chemists to supplement shortages of drugs in dispensaries.

g. Access to milling machines: The most important social service in the villages are milling machines, privately or publicly, owned. Only 3.8% live within a 5 km from a milling machine, 10.8% within 5 to 10 km and 41.1% live more than 10 km away, with 1.3% without such service.

5.8 Natural Resources with Socio-Economic Importance

Economically Valuable Timber: Survey estimates of the timber value to be lost to inundation, but which could be harvestable prior to flooding are substantial. Added to this, would be the remaining trees/off-cuts that could be used/sold as fuelwood or charcoal to generate local revenue. At USD 10-30/m3 timber values alone would total as much as USD 350 000 - 1 000 000.0.

- At 90 m (Permanently inundation): 35 500 m3
- At 92 m (Seasonally inundation): 56 200 m3
- At 93.5 m (1/30 year inundation): 67 800 m3

Wildlife management: The 22 villages of JUKUMU Society since 1991 have been mobilized to manage wildlife conservation in the WMA. Once it has AA status, the Society may lease to investors tourism, hunting and photographic operations.

Bushmeat: JUKUMU members enjoy an annual meat quota of 50 buffalo and 200 wildebeest. Sold at a cheap price of Tsh 250 - 400/kg (Kiburumo), prices differs from village to village but there are problems acquiring ammunition and hunters to help with the cull and distribution. However, illegal hunting for food persists, and poaching is a problem for the Society to manage.

Sport hunting: Safari hunting is done by one foreign company (Intercon) allocated their hunting license from Central Government. Part of their fee (25%) goes to JUKUMU society and Morogoro District to support community development affairs.

Fish: In JUKUMU, Dala has 26 fishermen (2003), Lukulunge 25 (2003), Bonye 20, Mvuha 20(down from 25 in 2003), and Kisaki has only 3. Availability of fish has declined over the past years, although some fishermen report earning up to Tsh 7 million per year.

Birds: There are several bird species identified by villagers tetele / hua, kiliku, shorwe, ninga, kanga, boe, kilopo, kikucha, mwalala, bata maji, kuzumbulu, kwale, nguya, mzingwi, sangalugemba, bundi, dudumizi and many others, consumed for food. Birds are also destructive of grain crops, mainly rice, finger millet and sorghum.

6 HUMAN HEALTH CONDITIONS

6.1 Background

Construction of a dispensary at Kiburumo was stopped due to the dam. Villagers therefore walk 14.5 km to reach health service at Magogoni. Kidunda has a dispensary with 3 health staff. Magogoni dispensary serves Bwira Chini, Magogoni, Bwira Juu, Kiburumo and Kiganila. Other health facilities include the Tulo Government Dispensary and the Mvuha Mission Dispensary.

6.2 Access to Clinic/ Health Facilities

Three health facilities (dispensaries) provide services in the area and ~40% of people travel for more than 10 km to attend health services, while 13.3% live within 5-10 km from the facility. Each household contributes Tsh 5,000/year for health services through a Community Health Fund (CHF) system. Non-members pay Tsh 1,500/visit. The majority prefer to pay on the spot at the Magogoni dispensary and the CHF has less than 123 members out of 1,206 households from 5 villages. Constraints include low motivation, low incentives for staff, lack of diagnosis equipment, poor conditions of buildings and lack of staff houses, plus untimely and inadequate supply of drugs.

The predominant local diseases include malaria (72%), tuberculosis (TB 18%), the remainder is from diarrhoea, skin rash, pneumonia, eye diseases and worms (hookworms and round worms). The high incidence level of malaria is mainly attributed to a low level of understanding on prevention. The Project will need to consider this as people fear the dam will increase the frequency of cases and increase the workload on the limited local health facilities. To reduce diarrhoea and other waterborne diseases, local water supplies need also to be improved.

6.3 HIV /AIDS in the Project Area

HIV/AIDS is becoming a threat to the villages. Victims tend to be people who having left the village, return when they are ill and infected. In Bonye - Dutumi, HIV/AIDS is a threat as the knowledge on HIV/AIDS transmission is still poor. The taboo and social stigma of having HIV, is a problem. It is not talked about and is feared as witchcraft. Few cases of HIV/AIDS are recorded as most of the local community are not aware of their status. They have no testing options. Education and awareness creation on HIV/AIDS is provided, but more work is required.

6.4 Sanitation

Most villagers use pit latrines, mainly semi-permanent or temporary and unreliable. During the rains, most collapse or flood and the sewerage flushed out, leads to water contamination (e.g. cholera). There are many households without sanitary facilities/latrines. This needs to be addressed, adn those pit latrines that will be flooded, needed to be treated and buried, before inundation.

7 INTERESTED AND AFFECTED PARTIES

7.1 Categories of Affected Groups

For the future Resettlement Action Plan (RAP) the categories of homesteads affected, are:

Category 1: Resident within the dam site, losing houses structures and all agricultural land
Category 2: Resident on the dam Site, or within the area and losing some agricultural land.

Category 3: Resident off the dam site, within related development, losing all agricultural land.
Category 4: Those who have structures within dam servitudes.
Category 5: Those residing either on or off the dam site, but losing forest resources.
Category 6: Fishers, formal and informal whose source of revenue was from Ruvu and Mkulazi.
Category 7: Residents near resettlement, whose infrastructure and/or resources will be disturbed.
Category 8: The community infrastructure that will be disturbed by the project activities.

7.2 Directly Impacted

Directly impacted, social and economic losses, due to involuntary loss of land and assets, include:

- Loss of homesteads and shelter.
- Loss of assets or access to assets, like fruit trees.
- Loss of income sources such as farm land or other means of livelihood.
- Restrictions or access to newly legally designated protected areas, may impact on livelihoods.
- Loss of historical, religious and socio cultural features such as cemeteries, sacred sites.
- Loss of community resources such as schools, clinics, wells, mosques and places of worship.
- Disruption to social networks and footpath access.
- Changes to safety and security, due to resettlement or influx of new people.
- Household and family disruption.
- Loss in community infrastructure services such as wells and access routes.
- Impact on the biological function of the Ruvu River will impact livelihoods, like fishing.
- Impact upstream of fishers due to possible reduction in the numbers of catadromous eels.
- Fishers in the reservoir zone can expect greatly enhanced catches.
- Fishers below the dam could experience reduced catches.
- Loss in revenue to JUKUMU Society due to loss in WMA land.

The severity of the impacts would however be dependent on the management of the Flow Release Strategy of the dam, as evidenced in the table below:

Table 5. Overview of socio-economic impacts

Description of Area Affected	Unit	90 m Total Inundation					92 m Seasonal Inundation					93 m 1/30 Years Inundation				
		Kidunda	Kiburumo	Bwira Chini	Bwira Juu	Total	Kidunda	Kiburumo	Bwira Chini	Bwira Juu	Total	Kidunda	Kiburumo	Bwira Chini	Bwira Juu	Total
Farmer Owned Land:																
a. Settled &/or cultivated	ha	10.6	294.8	864.4	0	1169.8	11	294.8	1645.2	0	1950.6	11	294.8	1696.4	59.2	2061
b. Fallow land	ha	2.2	154.4	525.6	0	682.2	2.2	154.4	692.4	0	849	2.2	154.4	726.4	93.6	976.6
Total:	**ha**	**12.8**	**449.2**	**1390**	**0**	**1852**	**13**	**449**	**2337.6**	**0**	**2799.6**	**13**	**449.2**	**2422.8**	**152.8**	**3037.6**
Fruit Trees:																
a. Permanent trees	nos	13	751	6999	0	7763	13	751	9991	0	10755	13	751	10646	2783	14193
b. Seasonal trees/crops	nos	42	6819	25183	0	32044	42	6819	39656	0	46517	42	6819	44035	12098	62994
Total:	**nos**	**42**	**6819**	**25183**	**0**	**32044**	**42**	**6819**	**39656**	**0**	**46517**	**42**	**6819**	**44035**	**12098**	**62994**
Households:																
a. Permanent houses	nos	0	32	49	0	81	0	32	71	0	103	0	32	77	26	135
b. Mud houses	nos	5	185	266	0	456	5	185	432		622	5	185	470	100	760
c. Households/Families	nos	6	166	320	0	492	6	166	466		638	6	166	503	101	776
d. People displaced	nos	31	604	1029	0	1664	31	604	1554		2189	31	604	1651	385	2671
Social/Religious Sites:																
a. Primary Schools	nos	0	1	1	0	2	0	1	1	0	2	0	1	1	0	2
b. Clinics/Dispensary	nos	0	1	0	0	1	0	1	0	0	1	0	1	0	1	2
c. Mosques/Churches	nos	0	1	3	0	4	0	1	3	0	4	0	1	3	1	5
d. Hand pumps/Wells	nos	0	0	7	0	7	0	0	7	0	7	0	0	7	3	10
e. Toilets	nos	0	6	8	0	14	0	6	8	0	14	0	6	8	1	15
f. Grave Sites	nos	1	2107	1857	0	3965	1	2107	2182	0	4290	1	2107	2422	830	5360
g. Milling Machines	nos	0	2	2	0	4	0	2	2	0	4	0	2	2	0	4
h. Village Offices	nos	0	1	1	0	2	0	1	1	0	2	0	1	1	1	3

NB. This data is based on actual field verification and may in some instances differ from the GIS data due to the inherent inaccuracies in the quality of resolution.

8 PROJECT STAKEHOLDERS AND INVOLVEMENT IN EIA

8.1 JUKUMU WMA

The dam and reservoir is located in the JUKUMU Wildlife Management Area (WMA). Created in 1991 to reduce poaching through CBC, and later a pilot project under the Wildlife Act (WMA Regulations) of 2003. The WMA is managed by a Community Based Organization (CBO) JUKUMU Society, made up of 22 villages, representing 47 000 people. Reported herein are interviews of 7 JUKUMU villages and JUKUMU Barasa with regards to the Project.

JUKUMU WMA is part of the larger conservation area, the Mgeta River Buffer Zone (MRBZ), 1,690km², the northern boundary of the Selous GR. The MRBZ covers three divisions within the Morogoro Rural District, notably Bwakira Chini, Mvuha and Ngerengere. The villages have directly-shared boundaries with the Selous GR and 40% of the area (710km²) ha is WMA.

The area includes the low-lying 250 km2 Gonabis floodplain, extends into the Uluguru Mountain foothills, and borders 3 protected areas: Mikumi National Park, Selous GR and Mkulazi FR. It is considered a major wildlife migratory corridor. Despite the area's moderate human population density (28 people/km²), a large proportion of the area (~60%) remains under natural vegetation. A more detailed description of the studies areas follows below. The areas in km2 refer to peak flooding at 92 m.

8.2 Villages of: Kidunda, Bwira Chini, Bwira Juu, Magogoni and Kiburumo (25 km^2).

All these villages were visited several times, structured group interviews were conducted and reported, and a in depth survey of the affected households were conducted. The data summarised above is for field validated data, given there was some uncertainty in the accuracy of the GIS data.

Kidunda village: The village is located downstream, and mostly Manyunywe sub village will be flooded. In all 895-1,132 ha will be affected seasonally by the dam. Other sub villages of Kidunda, that have farms in the Project area, will be affected, totalling 13 ha of farm/fallow land.

Bwira Chini: This in situ village, is low lying and will be moderately affected by flooding. Most of the houses and farms lie within the seasonally inundated area of the dam. In all, 2425 ha of farm and fallow land will be affected.

Bwira Juu: The major part of this village is located up-stream of the upper reaches of the dam and will not be much affected by flooding nor seasonal inundation. An estimated 150 ha farm/fallow land will be impacted.

Magogoni: Also in the upstream reaches, this village will not be affected at all by the dam.

Kiburumo: Vidwale sub village will be inundated, so will sub villages Mkoroshoni and Mbuyuni, remain as an island. Between 620 to 1,302 ha will be under seasonal inundation, and 450 ha of farm and fallow land will be impacted.

8.3 Mkulazi Forest Reserve (13 km^2)

Mkulazi Forest Reserve is approximately 6,750 km², and lies on the north side of the Ruvu River. Its north and eastern boundaries run along the Ngerengere River, and are marked by various access roads from Ngerengere through to Kidunda Village. The Game, Forestry and Natural Resources Offices in Morogoro and Ngerengere were consulted on the Project. It is recommended that DAWASA and MNRT/FBD jointly develop a management plan for the inundated area.

The FR is used for commercial timber. Abundance of wildlife occurs in the dry season. Elephant, buffalo, wildebeest and other large herbivores migrate from the Selous GR, across the Ruvu into the FR, returning at first rains. Residents and people from Morogoro hunt in the area. This migration route may be impacted by the dam, but animals can still cross below the dam wall.

The FR is also used for collecting non-timber forest products (NTFPs), such as honey, mushrooms, grass, edible and medicinal plants. Livestock is grazed, common along the western boundary, but the central area harbours Tsetse Fly (Glossina morsitans) and is avoided.

8.4 Gonabis Wetland (2 km2) (as part of JUKUMU WMA)

See above under JUKUMU.

8.5 Selous Game Reserve (4 km^2)

The northernmost portion of the Selous GR abuts the reservoir, and will be inundation with possible consequences on migration routes. A recent study by DHA shows.... The Selous Game Reserve officially gazetted in the late 1890's, the current boundaries were gazetted in 1974, is a World Heritage Site. The Project Manager, Wildlife Division and UDSM University were consulted in a validation follow-up of the EIA findings. Their conclusion indicated that no endangered species, special habitat or migration route, would be lost.

DAWASA and MNRT/FBD jointly with UNESCO and Antiquities need to develop a management plan for the inundated area

9 EXPLANATION ON WHY SOME IMPACTS ARE NOT ADDRESSED

As mentioned in Section 1.3.4., the following were considered beyond the scope of this EIA:

a. Access Road: The main access road from Ngerengere to Kidunda and the road from Kidunda Railway Station to site may need to be upgraded. For this a separate EIA is needed.

b. Water Abstraction Up-Downstream: The environmental flows of the Water Release Strategy takes into account 90 registered users, but their impacts would need a separate EIA.

c. Improved Communications and Electrification: The contractor and DAWASA may cause new installations of cellphone communication and electrification. Each will need separate EIA.

d. Dam Upgrade to 150 Mm3 Storage: As designed, the 27km2 reservoir, due to more accurate contour estimates, will only yield 60 Mm3. Any new design to attain 150 Mm3 needs a new EIA.

10 LIST OF DEVELOPER, CONSULTANT, LOCAL PLANNING AUTHORITY, PEOPLE AND ORGANIZATIONS CONSULTED.

10.1 Developer

The chief developer is DAWASA. They have been consulted through regular reports/meetings.

10.2 Consultant

This Report was prepared by NORCONSULT AS, Norway in association with NORCONSULT Tanzania consultants hired by DAWASA, and carried out by the following team structure:

a. Project Management: Project Manager (NORCONSULT representative): Quality Assurance and Chief Editor, EIA Team Leader. DAWASA Liaison: (Assistant NORCONSULT representative). Assistant Team Leader: CBNRM, Fisheries and Natural Resources Specialist, Local Logistics Support and Assistant Editor.

b. Natural Resource Team (Terrestrial): Ecologist: Agriculturist, Agronomist, Forestry and Land Use Team Leader. Forestry Economist (DHA Representative), Reptile, Bird and Mammals Specialist (WCST Representative), Plant Taxonomist (TSC representative), GIS Mapping Specialist (UCLAS), GIS DEM Specialist (Kenya), GIS Mapping Specialist (S. Africa), Assistant GIS Specialist, and Biodiversity Specialist (Selous GR representative).

c. Natural Resources Team (Aquatic): Fish and Aquatic Biologist (SAIAB Representative), Fish and Estuarine Biologist (UDSM Representative) and a Fish Taxonomist (TAFIRI Representative).

d. Socio-economic Team: Socio-Economist: SE Team Leader, Key Interviewer, Assistant Socio-Economist, Data Analyst, 3 Enumerators, and a Land Use Planner (Morogoro District).

10.3 Local Planning Authority, Organizations and People Consulted

Public consultations are key to this EIA included 800 individual participants in total. Minutes were kept of these meetings and people that attended were listed, in the EIA Report:

a. Public Information Document: A Public Information Document with Kiswahili abstract was widely circulated to each of the local government and executive offices in the 5 impacted villages, 17 villages of JUKUMU Society, Morogoro District Offices, Wami/Ruvu Water Board Office (WRWBO) and Bagamoyo District Offices.

b. Wami Ruvu Water Board Office (WRWBO): The WRWBO, in Morogoro, represent the local authority of the catchment. In May, 2007, they held a nation-wide consultation. The Board met and subsequently visited the site on 22nd June 2007. They solicited feedback by from: Vice President's Office - the Division of Environment; Ministry of Agriculture and Cooperatives; the Ministry of Livestock Development; the Ministry of Natural Resources and Tourism; the Ministry of Energy and Minerals; the Ministry of Water, Ministry of Trade and Industry; RAS, Dar es Salaam, RAS, Morogoro, RAS, Coast, NEMC, UDSM, IRA, Water Resources, and Sokoine University.

c. National Level: At central level, the Consultant met with NEMC, DAWASA, TAFIRI, the Division of Fisheries, UDSM, SUA and the Wetlands Unit/Wildlife Division.

d. District Level: At district level, the Consultant meet District Executive Director (DED) and staff in the Morogoro and Bagamoyo Regional and District Offices, Game, Fish and Planning Units.

e. Community Level: The Consultant meet with Council Secretary in Ngerengere, the Village Assemblies of impacted villages, Kidunda, Kiburumo, Magogoni, Bwira Chini and Bwira Juu several times. Villages of Mvuha and Dutumi, and representatives of the 22 villages of JUKUMU Society were briefed and interviewed, and the Village Executive Officer's kept informed.

Extensive community consultation took place during the field study listing of 600 permanently impacted households that were directly interviewed to gather data on assets and farm lands.

f. Consultative Stakeholder Workshop: A public meeting of all major stakeholders was held by DAWASA and WRWBO in Morogoro on 17.9.07 to discuss the draft EIA. This was attended by over 90 people to discuss the final results. Highlights are listed below.

g. Selous GR Special Study: Following the Stakeholder Workshop, a request was made for more accurate assessment of loss to any rare biodiversity and migration routes. Selous GR research team and UDSM University were extensively involved in a follow-up study.

11 RESULTS OF PUBLIC CONSULTATION

11.1 Community Opinions

A synopsis of community consultations follows:

(a) Positive Impacts Anticipated by Local People:

- An irrigation scheme could be established for all year round cultivation for food and income.
- Possibility of employment during the construction (e.g. mama lishe, youths, carpentry etc).
- Increase of fishermen with modern new fishing technology introduced.

- Rise of income due to influx of people, trade and several other commercial activities.
- Increase of people ready to buy local agricultural products will improve prices.
- Presence of electricity supply for small scale industries as well as domestic lighting purposes.
- Transport networks improved, reducing cost of transport to markets.
- Modern social services, dispensary, schools, water supply, market places, shopping centres etc.
- All destructive and wild animals will decrease due to an increase in human population.
- Social interaction changes people's behaviour, life style and improve vision for better future.
- Agriculture will be improved, due to modern technology, chemical fertilizer and insecticides.
- Communication and telecommunication network is likely to be improved.
- Fish that like stationary water (ie kamba, pelege, pete, kambale, etc). will probably increase.

(b) Negative Impacts Anticipated by People:

- Increased infectious diseases such as malaria, TB, HIV/AIDS, due to influx of people.
- The dam is likely to be the main cause of floods during heavy rain seasons.
- In-migration will bring different behaviour, sexual abuse, unsafe sex practice, HIV/AIDS, etc.
- Bandits and hooligans will migrate to the dam site, threatening people's security.
- Animals like crocodiles, hippos and snakes will increase, threatening people.
- Arable land will be under pressure by people establishing modern farming and irrigation.
- Silt rich agricultural land will be lost to inundation, creating shortage of land for cultivation
- Wildlife is often given priority over local people. There is a fear this conflict favouring wildlife protection and tourism purposes could compromise people's well being and displacement.
- The introduction of modern fishing technology will be guided by strict rules and regulations that are likely to be difficult for local fishermen to follow.
- Fish species like kange, swepe, kasa, fungu, ngogo, kibua, etc are likely to decrease as their breeding areas will be disturbed.
- Plant species and natural vegetation that grow within the wetland will die out.
- Some households will be totally displaced causing loss in income generating sources.
- Rich people (particularly new comers) are likely to disrupt matrimonial homes, courting people's wives, causing chaos and uncalled for misunderstandings.
- People will miss existing social services, including local brew, known as mnazi.
- Nobody is aware of who will be resettled. The suspense is causing stress and demoralization.
- Displacement of people is likely to increase poverty as they will be compelled to incur unnecessary expenses (e.g. buying fertilizers, food, contribution for social services etc.)
- People will be shifted far from current markets (Mvuha village) it will be difficult to sell crops.
- Personal properties and human lives will be insecure by being moved to undeveloped settlements, which have no infrastructure and poor social services.
- Many people will be frustrated by being moved, to start a new life and new economic activities.
- People will waste a lot of time on constructing new settlements and spare little time on agriculture, which will finally end up to shortage of food to many households.

(c) Mitigation Measures Proposed by People Interviewed:

- Health services should be improved, providing better health centres, ambulance vans, and qualified medical staff posted to the centres, with adequate equipments and drugs.

- Treated mosquito nets should be provided at subsidized prices.
- Building contractors should observe (dam) construction standards in order to avoid unforeseen destructions likely to be caused by an increase of seasonal floods.
- Health education to create general awareness about HIV/AIDS and its prevention measures should be provided to people, to discourage unsafe sex practices etc.
- Security measures should be intensified, building police posts and establishing constant patrols.
- Night movements should be minimized to control thefts that are likely to arise.
- Proper village LUPs should be instituted to avoid conflicts and land encroachment.
- Soil erosion should be controlled by planting permanent trees along the dam site.
- Displaced people should be compensated for their properties before starting construction.
- New settlements should be located in advance to avoid disturbances to livelihoods.
- Compensation packages to put into consideration the inflation rates before effecting payments.
- Employment opportunities on site construction should go first to local and affected people.
- Thorough research and survey on the type of soil in new settlements should be done in advance to enable people resettled to be aware of suitable type of crops and fertilizers to be applied.
- Improved social services (e.g. water supply, schools, health centres, roads etc) should be made available before shifting people to new settlements.
- Government to seriously consider the benefits and compensation package of affected people.

(d) Impacts Perceived by the JUKUMU Society:

JUKUMU society operations will be affected by the dam construction based on following:

- Some village members will be displaced hence decrease the number of members.
- The area under JUKUMU Management will decreased as a result of dam flooding.
- Members were worried that the dam will cause erosion
- Some wildlife species will migrate to areas outside the JUKUMU WMA, negatively affected the number of animals being hunted, and reducing meat distribution quotas in the WMA.
- Wildlife migration may also negatively affect potential income from tourism.

(e) Identified Weakness of JUKUMU Association to Manage the Area:

- Lack of modern equipment for their operations in managing wildlife areas including, fishing gears and storage facilities for fish for its individual members and villages in general.
- Lack of appropriate leadership skills among office bearers.
- Lack of enough game scouts responsible for guarding the protected area. The current number of game scouts (27) is not enough to cover the entire WMA and control illegal poaching.
- Lack of funds to run the Society/Association and employ enough staff for its operations.
- JUKUMU is not creative enough to generate revenues for its self sustainability.
- Lack of reliable transport for office use and patrolling, and to distribute quotas of meat.
- Lack of strategic vision and business plans for revenue collection.
- Poor coordination experienced from the past JUKUMU leadership.

(f) "Fears or threats" of JUKUMU Society leadership:

- Less assistance from district authorities has been a problem.
- The AA application has been delayed so JUKUMU has no legal status, even after 15 years.

- DAWASA is likely to threaten JUKUMU by instituting various policies/bye-laws, etc.
- The area is likely to fall under different authorities e.g. Selous, Fisheries, DAWASA, etc. JUKUMU Society is worried that it will lose control.
- DAWASA will have water and land rights. JUKUMU rights will no longer be recognized.
- JUKUMU is worried on access to the area. Experience shows that some investors do not allow villages to run their social activities in the areas under the ownership of foreign investors.
- JUKUMU has not had good relations with Intercon Safaris who have a contract directly through the District Wildlife Division.

(g) "Strengths" of JUKUMU Society:

- Presence of committed scouts and weapons for patrolling.
- The availability of water will attract wild animals and tourists.
- Existence of the association and its human resources.
- Society's is legal CBO and has a constitution.
- Presence of fishers (existing skills) who are members of the JUKUMU Society.
- Available weavers and porters within the area.
- Existing artisans/handicraft activities.

(h) "Opportunities" available to JUKUMU Society:

- Expansion of tourism in the area and more tourists to visit the area.
- Attraction will increase with dam and more tourists will come in to take pictures.
- Construction of lodge (guest) houses in the area.
- Development of a tiger fish sport fishery in the Dam could become a tourism attraction.
- Development of water transport to replace transport on foot and/or by bicycle.

(i) Other Emerging Issues:

JUKUMU has no autonomy over the WMA. To date it does not have title ownership of the area due to delays in Land Use Planning process. Four villages have failed to develop their village land use plans. Some villages have no shares (as they have no land in the WMA) but have been incorporated for anti-poaching security purposes. In addition, JUKUMU noted that Mkulazi FR is very important to the WMA and would like, in future, to include it as part of the WMA.JUKUMU requires capacity building and the Project may have to strengthen this aspect.

11.2 National/District Stakeholders

The issues raised by the District staff, fell into several categories:

a. Directly affecting people around the dam may have to be relocated. This will negatively impact on livelihoods. The process of relocation and compensation needs to be well planned.
b. Decision-making processes such as community development in some villages has been halted due to possible inundation (e.g. Kiburumo Community Clinic and Mkulazi Community Secondary School). There are economic implications since funds are accruing bank charges.
c. Changes in flooding patterns are likely to affect irrigation agriculture (rice, sugar cane).
d. The dam will affect wildlife distributions, with economic implications for community and resident hunting. Changes in migration pattern by the dam acting as a barrier, will changes wildlife in the Mkulazi FR, affecting Morogoro recreational and subsistence hunting
e. Opportunities and threats created by the Dam include:

(i) Opportunities:

- Fisheries development.
- Ecotourism development.
- Year-round water supply for crop irrigation.
- Available timber within the flooded area could be extracted for commercial purposes, before flooding. Communities could benefit from permits to extract the timber.
- Secondary benefit of this is reduction in the cost to the client for vegetation clearing.
- Waterborne transport developments

(ii) Threats:

- Reduced revenues from hunting due to changes in the Gonabis floodplain.
- Loss of irrigable land due to changes in river flows and sediment deposition.
- Loss of access to the Mkulazi Forest Reserve area for south bank Kidunda residents.
- Damage to the planned (and approved) Kidunda Community Forest Reserve.
- Accelerated secondary draw-down on natural resources around the reservoir, especially due to charcoal/wood harvesting, e.g. for smoking and/or curing fish.
- Pollution in the dam from sewerage and other waste materials.
- Pollution in the dam due to upstream mining activities.

(iii) Possible solutions:

- Construct of a pedestrian/road bridge across the dam wall.
- Engineering a flood protection bund around Mkulazi and Kiburumo Villages (and any others that may be threatened by flooding due to changes in river flow patterns).
- Minimise damage to Kidunda Community Forest Reserve area.
- Introduction of water supplies and sanitation. Construct waterproof septic tanks.

Potential Socio-Economic Impact of the Dam Construction

Discussions with the Morogoro District Officials raised the following issues:

a. In-migration: Dam construction will attract immigrants. Increased population will increase pressure on already stressed social services such as water, health, education facilities, including housing. Land scarcity might result into social conflicts between farmers and livestock keepers, wildlife and human activities, and between families. Therefore, the responsible authorities have to increase availability of these social amenities.

b. Opening up to the Outside: It should be noted that the project area is a closed society where interaction with outsiders is limited, due to remoteness and poor road access. The development of Kidunda dam will open up the area, due to improved infrastructure and road network. Influx of job seekers of all ages and subsequent crime poses a threat to security in the project area. There are chances of getting a great influx of jobless people (especially youths) of different characters including thieves and pickpockets resulting in increased crime.

c. Diseases: It is anticipated that with this dam project, there is a risk that a migrant labour (and job seekers) population may introduce/induce new behaviour in the communities that would lead to critical levels of the HIV/AIDS pandemic. Sexual networks between the mobile population in the project area and the neighbouring villages' communities might put the village population at high risk. The main threat diseases are HIV/AIDS, STDs and malaria.

d. Disturbance on Community Planned Programs: The community of Mkulazi has already planned to establish a Village Forest Reserve on the Western side. It has several hardwood species especially Miombo and Mninga. The construction of this dam will disturb this program.

e. Displacement: There is a fear of people being displaced from their usual settlements with the construction of the dam. The increased fear is in the villages of Kiburumo, Kidunda and Mkulazi.

f. Conflict of Interest: Communities in the project area are doubtful as to their economic benefit. They fear a loss in potential revenue from wildlife in the WMA. Needed is public consultations and dissemination of information to stakeholders, especially the scope to develop fishing.

g. Environmental Degradation: The potential influx of many people in the project area will lead into high demand for natural resources such as Miombo and Mninga trees for fuel wood, charcoal burning, construction and cultivation (intensive agriculture). This adds to the threats.

11.3 Consultative Workshop

Over 90 stakeholders representing 1 Deputy Minister, 3 delegates, 3 MPs, 12 government officers, 3 RAS, 1 donor, 17 village leaders, 15 institutions, 3 Steering Committee, 10 journalists and 8 consultants took part in the workshop held in Morogoro. They were informed, Kidunda dam was proposed for water security for DSM during drought periods. The EIA is of a re-designed from the original proposed 270km2 structure. A smaller Dam, to reduce impact. It was clarified that the EIA was undertaken on the original design of a Dam of 27 km2, but due to inaccurate topographic details, the actual dam to maintain 150 Mm3 storage would be 43 km2, flooding to 92 m.a.s.l. This EIA has not studied the expected impacts of this much larger dam.

Conclusions after presentations included:

Hydrological: At 90 m, the current design will cause 1/30 year back-flooding as high as 93.5 m, increasing the seasonal impact area to 65 km2, and at 92m, seasonal flooding to 43Km2. The spillway design needs to be as wide as 200m to reduce these flood levels. The Water Release Strategy design should consider ways to dampen the back-flooding. Opening all outlets at peak flood, would reduce back-flooding by 33%. Tthe environmental flow would need to be maintained at 6 Mm3/year, but the Water Release Strategy design would need to mimic seasonal flow patterns. In addition, the WRBWO would need to regulate downstream users to avoid overuse of water destined for DSM.

Aquatic: To reduce the barrier effect to fish migration, the Dam design would need to include a fishway. To maintain the floodplain fish ecology downstream, the Water Release Strategy design would need to mimic seasonal stream flow. To reduce the potential poor water quality from the outflow, the Dam outlet design needs to consider adequate mixing of surface and bottom waters. In addition, clearing lush vegetation (but not necessarily standing hard-woods) pre-impoundment would help reduce anoxic conditions. There would also be a need to reduce exotic aquatic weed development by putting a strategy in place to clear floating weed mats.

Anticipated is that for the 200-300 t/yr fishery to develop, this needs extension services as well as fishing, processing & market technology. Noted is that the 6 un-described fish and range extensions of 3 known species discovered, would need further follow-up study of impacts, at design.

Ecological: To ensure a long term sustainability of water supply, there is need to include a holistic, Integrated Water Resource Management System (IWRMS) in the Uluguru catchment.

Ecological impacts include loss of plants (e.g. medicinal) and riverine biodiversity, notably 1 tree species which is recorded beyond its normal range, and 1 tree species listed in the IUCN Red Data Book. In addition, fauna of uniqueness were noted as 1 bird species (Flycatcher), found beyond its normal range. To mitigate, there is a need to conserve a portion of the

riverine forest below the dam. A re-alignment to the Dam wall design is proposed in order to save ~100 ha of riverine forest.

Socio-economic: Noted is that the top end of the Dam is very low lying, and as a result, at 27 km2, 600-800 hh, nearly 5000 people will be affected, including 2 schools, 1 dispensary and 2 mosques, and 1000 cultural and burial sites, will be lost. 400 latrines will flood. In addition, due to raised water table, several more will contaminate the ground water with sewage, needing new designs to reduce leakages. Due to survey inaccuracies, to cater for 150 Mm3 storage, the new dam design will greatly increase the number of hh and farm land impacted. Higher resolution GIS is needed to re-assess this impact. Village developments in the area have been stalled due to these uncertainties.

The community then needs to be advised soonest on the decision whether to develop the dam, or not. The RAP should include replacement of social amenities, and respectfully follow protocol to re-locate sacred sites. To make up for the loss in rich agricultural land and grazing area, the RAP should identify resettlement area of acceptable soils/grazing.

The raised water will increase wildlife human conflict (e.g. crocodile attacks) and there will be a need to provide wells and safe water, and greater awareness on the danger. Transport roads and paths will be lost, and a water transport system will be needed for isolated villages. There will arise health/sanitation problems when the dam floods. Advised is to fill in pit latrines before inundation. Health centres will be needed, with bilharzia and malaria control programs.

Potential Conflicts: It is expected that DAWASA and other up and downstream water users will clash over water rights in dry and drought seasons. It is recommended therefore, that WRWBO should actively manage and control water abstractions. It is also noted that at the community level, livestock keepers and crop farmers will conflict in use of the reservoir and upstream river drawdown zones for crops or livestock. This should be dealt with through LUP processes. The Dam will attract in-migration and new cultures, and there will be a need to provide police centre and cultural awareness (also HIV/AIDS) to ensure equitable labour opportunities for local residents.

General Discussion: This EIA covers only the 27km2 reservoir flood zone. This does not dictate the final dam size. To ensure 150 Mm3, storage may require a new design to flood the 92 m contour, creating a 43 km2 lake, affecting thousands of additional people. Concerns on the new design were:

What if mitigating activities do not work? How will employment favour local labour? What emergency plans will be put in place (e.g. landslide/El Nino)? How will water pollutants be managed during construction and operation of the dam? How will malaria be managed? How will sanitation issues be managed? How will tourism and health be dealt with? The stakeholders consider safe water wells are essential, as are health dispensaries, and HIV/AIDS eradication. It was also recommended that the Selous GR Management should be consulted on anticipated impacts of the larger dam on wildlife in the area. The EMP checklist contained a total of 28 negative impacts vs 5 positive impacts. If the expenditure on dam construction is only projected over 30 years, what will happen after that period? If more villages are drowned, will they be compensated? Magogoni Village, where 52 house will be flooded if the higher dam wall is required by DAWASA.

12 DESCRIPTION OF MAJOR SIGNIFICANT IMPACTS

The major impacts of the Project are highlighted, according to stages in Project Implementation.

12.1 Upstream Concerns

Due diligence calls for the consideration of the consequences of upstream events in long term Dam management. It is strongly recommended that DAWASA and WRWBO should undertake an analysis of on-going watershed management actions in the Uluguru Mountains. Protection of the base flow will be an essential part of the Project, to ensure the life span of the reservoir, and control of sedimentation due to catchment degradation. A holistic, Integrated Water Resource Management System (IWRMS) is required at the design stage, for long term sustainability.

12.2 Altered flow regime, water quality and inundation induced impacts

The new dam and the changes in downstream flow and seasonal inundation patterns will impact on ecological systems (e.g. riverine forest but not on any rare and endangered species), may disrupt wildlife corridors, affect reproductive behaviour of aquatic organisms and nutrient supply to estuarine species, and impact negatively on other wetland habitats. Contact between humans and animals will increase (i.e. crocodile attacks), and re-routing of migration routes may cause wildlife intrusion on farm land and roads. The positive impacts for the Gonabis are wildlife will find secure water and grazing, but may compete with livestock. The farm land lost to inundation will increase pressure on adjacent areas. The dam will increase access to water downstream for irrigation and recharge to groundwater.

12.3 Impacts from construction, access roads and discharge from construction

Construction equipment will pollute the air, water and soils, create noise and vibrations, especially during dam core compaction. Impacts from road upgrading could increase soil run-off rates during the rainy season. Cultural impacts on local communities may result due to the influence of migrant labour, but also will bring economic opportunities, etc as described in Section 1.11.3, above.

12.4 Potential environmental hazards relating to the dam

There is minimal design risk of downstream flooding and associated damage, if the dam wall should over-top or fail. Fail safe spillway designs are in place. Direct impacts on downstream wetlands and associated fauna and flora could arise from changes in historical river flow patterns. The local hydrology around the reservoir could experience impacts of rising groundwater, which could increase faecal coliforms in water supply wells, due to flooding of pit latrines.

13 MAJOR POSITIVE AND NEGATIVE IMPACTS AND MITIGATION MEASURES

An overview and summary of identified and assessed impacts including mitigation are:

Terrestrial fauna and flora: Few rare or threatened animal species will be specifically/directly threatened by construction and operation of the Dam. There is a risk that some will be lost upon clearing riverine thicket and the Mkulazi FR. Noting this as a key habitat, it is recommended to consider realignment of the dam wall approximately 250 m upstream. This would protect ~100ha of tall dense riverine forest and thicket of the Kidunda Village FR. It could provide a potential local tourist attraction, visible at tree-top level from the dam wall. An estimated 35 500 m3 of economically valuable timber, could be harvested prior to construction, plus the remaining use for firewood and charcoal, could boost the local community economy by USD 350 000 – 1 000 000.

Aquatic fauna and flora: The most significant impact of the dam is as barrier to upstream and downstream migration of fish. This requires the installation of an appropriately designed fishway to mitigate these effects, particularly with regards to eels. Although, the dam will

probably cause a reduction in species diversity, at the same time it will increase the fish production, and contribute to a potential 200-300 t/yr fishery. Facilitation of access to markets, processing and preservation could doubling the value of the catch from an estimated USD$200,000 to 400,000.

To encourage fishery development as much of the standing trees should be left particularly in the drawdown zone. However to reduce deoxygenated conditions due to excessive decomposing material in the Dam, recommended is permits should be issued to local communities to extract wood, timber and charcoal from the inundation zone of the Dam, as a local IGA.

Hydrology: As described above, a short length spillway will impede the passing of floodwaters. The resultant backwater effect could give rise to a 2-3 m head, in 1/30 peak flood. To counter the potential seasonal risk of flood impact upstream, spillway design will need to be at least 200m.

To minimize severity of negative impacts due to altered flow and water quality downstream, it is important that the design of the Flow Release Strategy mimic historical flow patterns and allow mixing of the upper and lower water layers. Significant reductions in the downstream fishery could result due to changes in flow patterns and de-oxygenated water.

Maintenance of the Environmental Flow requirements can be regulated by the outlet towers. When reservoir levels are low, in the beginning of the rainy season, to avoid a delay in stream flow while the dam fills, water can be released through the outlets. Conversely, at peak flow, outlets if open, allow a 33% reduction in the build up of head waters during flood peak. Similarly, to reduce the threat of salt intrusion, required is maintenance of a minimum environmental flow of 200 mld.

Sedimentation in the Dam, estimated at 65 000 t/yr is not considered to be a problem. Significant amounts of sediment will settle in the low gradient, upper reaches of the reservoir. Annual sediment deposition is currently insignificant, and can be flushed from the system at 10 000 t/yr. However, a more detailed assessment of sedimentation and associated erosion rates should be considered as an integral task for developing of a watershed management plan. More data is needed.

Physical environment: The dam is not expected to contribute to the formation of green house gases (i.e. most of the inundated vegetation will be tropical hardwoods, which decompose slowly). Construction will, contribute to increased noise, dust and wastes. Degradation of soils due to earth- moving, opening up of the forest for greater access, and dam building, will increase turbidity and sediment rates downstream of the Dam. These impacts are localized and temporary and will be mitigated through the Environmental Management Plan of the final design.

Socio-economic: Whereas the majority welcomed the Project, few remained undecided and the rest opposed. There is much anxiety and stress over the uncertainty of the Dam and its consequences on existing livelihoods and property. Urgently, DAWASA, WRWBO and local leaders should explain the Project, and dispel fears and rumours. Direct and indirectly impacted are:

- Over 800 hh will be adversely impacted: Kidunda (5), Kiburumo (200) and Bwira Chini (635).
- Over 46 000 people will be indirectly affected, positively and negatively: 19 villages of JUKUMU Society.
- Over 3 million people will directly benefit: Population of Dar and surrounds.

Detailed positive/negative impacts of the Project and mitigation measures are outlined in the EMP.

14 ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

The EMP focuses on the schedule of works, and has been summarised as follows:

a. Design Site survey and final environmental assessment: Verification of the EIA findings and re-design of the Project to a 150 Mm3 storage may need an updated EIA to account for a much greater area of permanent impact, and greater need for resettlement.
   Construction works activities: The physical environmental impacts of the construction phase, earth moving, access road EIA, and construction activities.
b. Other construction phase impacts: These will be socio-economic, in terms of the direct and indirect impacts associated with the influx of contractor's workforce, and resettling people.
c. The operation phase: This will comprise management of the Water Release Strategy and minimising impacts associated with peak flooding and the settling of the lake environment.
d. The decommissioning phase: This will require carefully decision to decommission or upgrade. If decommissioned, controlled actions are needed to drain and re-establish vegetation.

14.1 Design Survey Phase Impacts

Protocols: Initial protocols will include an updated EIA if the Dam is re-designed. DAWASA will have to secure from WRBO and MNRT a joint management agreement, and a release gazettement arrangement for the flooding of Mkulazi FR and Selous GR. The latter will require special consultation with Department of Antiquities and UNESCO, as relates to a World Heritage Site. In addition, access roads, communications and any quarrying outside the site require separate, stand-alone EIAs. Prior to start, local authorities should be formally notified by DAWASA and WRBO.

Clearing lines of initial survey work: Vegetation clearing for the survey work should be undertaken without total clearing or cutting trees of diameter of greater than 10cm BH. Cut materials should be offered to local people to collect for construction timber and/or fuel-wood.
Drilling and Geo-Testing: The District Authorities should be notified in writing prior to Geo-testing and other drilling and exploratory work operations to minimise possible local dissent.

Mitigating Design Considerations: At the time of the final dam design, consideration should be made for design of the fishway, and a special study of the 6-9 previously unknown fish species, to look at their ecology. Other items required will be the validation of minimum impact spillway length, design of Flow Release Strategy, dam re-alignment to protect the forest, site geology, to certify no faults, design of RAP, etc.

14.2 Construction Phase Activities

Protocols: Initial protocols required prior to the start of works, include obtaining permits (quarrying, blasting and borrow pit excavations), and to notify local authorities.

Blasting: Explosives should be stored safely, protected against burglary or wild animals and from flooding, and have a blast protection embankment constructed around them. Notification of local people pre-blast is required to stop straying onto site, and no blasting at night. Control is needed to prevent danger of rock showers and safety procedures as set out in the Blasting Regulations.

Upgrading Access Roads: To transport people, equipment and materials may require upgrading of the pathway from the Kidunda Railway Siding to site, and the access roads from Ngerengere via Kiganila and Mkulazi FR, or the eastern route, closer to the Ruvu River. An

EIA is needed to reduce risks of: noise and air pollution, health and safety issues due to movement of heavy vehicles, permits to damage property and loss of crops, with compensation. Adequate side drainage will be necessary to prevent water build-up, erosion and run-off damage along the access road.

Road works will require initial survey work, bush clearing and borrow pits. Road alignments should avoid settlement disturbances and croplands, schools, clinics and other built-up areas for reasons of safety and health risk from dust and noise, and regularly wetted to reduce dust.

Borrow pits and quarrying: The main impacts are from excavations relate to blasting, and noise and dust created by heavy machinery. Site preparation at quarry and borrow pit site should begin with vegetation clearing. Encouraged should be to give permits to local communities to derive benefit by extracting valuable resources beforehand.

Housing areas: Negative impacts may arise from soil erosion from excavation during construction. Junior staff and non-local semi-skilled labour and canteen facilities will need temporary accommodation and mess facilities. This may be prefabricated, requiring land clearing, provision of water supply, ablutions/waste-water management, canteen/mess facilities rubbish collection, a kitchen, a supply store and cleaners facilities. Required is to ensure a clean and healthy living.

Land clearing: For works areas, as for quarries and borrows pit sites, risk of impacts would be localised. Up to 50 ha or more is required for stockpiling rock and crusher material. The impacts will be long-term and should therefore be located within the inundation zone.

The workshops, offices and storage facilities: Located for ease of access in the works areas mitigation is needed from risk of pollution from spillages of fuels and/or lubricants.

Sanitation: The impacts of wastes from site will be minimal if septic systems are used. Pollution risk should be localised. However, pollution from pit latrines in the flood zone are high risk and these would need to be buried before flooding commences.

Amenities include overhead/ground level lines and underground pipelines will be highly localised and short-term. The main risks are people, animals or vehicles falling into open trenching or tangled in overhead lines, with high risk associated with objects touching high voltage power lines.

Spoil Heaps: Land clearing for spoil heaps is same for borrow pit and quarry sites, including removal of vegetation and topsoil to the sides, for post-construction rehabilitation.

Vegetation Clearing: Parts of the Dam wall site and reservoir requiring vegetation clearing should be clearly demarcated 6 months prior to the construction works, and locally implemented.

14.3 Post Construction Rehabilitation Works Activities

Dismantling Buildings: Impacts of waste and negative visual aesthetic impacts should be diminished due to untidy workmanship, and the site fully rehabilitated once construction works have been completed. Some senior staff buildings of quality standard may remain and be used for offices or tourism lodges by JUKUMU Society.

Backfilling: All excavated areas should be rehabilitated to avoid erosion, risk of steep slopes to people, animals and vehicles or collapsing soils. Reshaping land and re-vegetating works areas applies to spoil heaps, quarries & borrow pits.

Closure of Solid Waste Disposal Facilities: These dump sites may be suitable for continued use by the local community and may remain. Impacts could be long-term, particularly where there is residual ground pollution from waste matter and care should be taken to separate

chemicals. Solid waste and sewerage facilities should be closed according to standard procedures

14.4 Decommissioning Phase Activities

In the event of decommissioning, at some time in the future, some infrastructure will be required to remain, such as access across the dam wall and spillway for local traffic and/or pedestrians. In the event the dam is no longer required, the spillway or dam wall may be opened to let normal river flow. At this time, a full socio-economic impact should be undertaken, as it is expected that local communities will rapidly adopt their livelihood patterns around the existence of the dam and reservoir (i.e. for irrigation, domestic and livestock water, etc). They may wish the dam to remain.

If emptied, there will be a large area of bare soil, prone to erosion from wind and rain. To prevent this, the reservoir should preferably be emptied in stages, to enable vegetation to re-establish. Once empty and river flow patterns resumed, soil sediments deposited at the head/inflow end of the reservoir will begin to be carried down the Ruvu River. This may have an undesirable impact, and need to be stabilised using embankments or by placing rock gabions.

However, if at this time, it is decided to upgrade the dam, to a larger storage capacity, this would require a whole new EIA undertaking.

14.5 Action Plan to Manage the Emerging Fishery

The emerging fishery is probably the single most important, long term economic gain to the area. DAWASA, WRBO and Morogoro District Council, in co-operation with the local authorities, should be proactive preparing local people for the new fishery. A co-management structure should be developed in cooperation with the JUKUMU Society. Create a fishers association through Beach Management Units (BMU). The Morogoro District Council should consider placement of an extension officer to ensure maximum sustainable yield and introduce new technologies. The Project should consider building a local market, storage and processing facility for fish, including smoking capacity to improve marketability and quality of the catch. The fishery should operate on a limited access licensing system open only to local people, operated by the District Fisheries Officer.

The potential for a recreational tourism fishery is worth evaluating by monitoring the relative abundance of the expected recreational target species (e.g. Hydrocynus vittatus).

DAWASA are responsible for the maintenance of the Flow Release Strategy and Environmental Flow and would be responsible for the effective operation of the fishway. This would require DAWASA to post senior staff trained to operate the dam off take, fishway and to benefit the downstream fishery through the mimicking of environmental flow patterns.

14.6 Socio-Economic Management Plan

The Social Management Plan (SMP) consists of mitigation, monitoring, and institutional measures to be taken during design, construction and operation of the Project, to minimise human impact. It entails funding resettlement and compensation based on a Resettlement Action Plan (RAP).

Due to the topographic anomalies described, the actual extent of human impacts are not exactly known. The 27 km2 of impact zone will affect 800 hh and drown 1,515 ha of village land, seasonally affect 2,544 ha. Listed are the losses of houses, fruit trees, crop lands, grazing lands and sacred areas, school, clinics, places of worship, and roads. However, as the design requirement is for a larger storage facility, a more detailed hh survey and accurate budget for the RAP for compensation would have to be prepared once the full extent of flooding is known.

15 PROPOSED MONITORING AND AUDITING

Environmental monitoring is required to ensure compliance with the EMP. It will be important to ensure that the levels of impact are not increasing beyond set criteria or standards of tolerance, and to determine the effectiveness of otherwise that mitigating measures are having. Monitoring will help to identify remedial action if the mitigation measures have not been effective.

15.1 Monitoring Natural Biota

Monitoring of the natural biota could follow a CBNRM Audit format. The JUKUMU Community has existing LUPs, trained Village Natural Resources Committees (VNRC) and Village Game Scouts (VGS) in place. In addition, as a WMA, JUKUMU Society is supposed to monitor and report to Wildlife Division on the state of the WMA. There are pre-designed formats for this covering: land systems, vegetation associations and habitats for flora and fauna, records of seasonal movements of large animals, seasonal flood levels (areas flooded and flood heights) and the impacts on agricultural and settlement areas. Proposed is that these existing formats would suffice for dam impact monitoring as the Dam falls within JUKUMU area of jurisdiction, as follows:

i. **Wildlife Changes:** Annual (or twice annual) records will show how wildlife populations move through the area , how their numbers may be affected by community hunting, human animal disturbance and the changes in habitat caused by the Dam and influence on migration.
ii. **Habitat Changes:** In Participatory Forest Management (PFM), such as the Mkulazi Village FR, tools exist for habitat monitoring at the community level (e.g. recording trees removed, by species and size, by habitat of origin). Through PFM, changes in plant communities because of flooding and/or timber removal can be monitored by simple record keeping.
iii. **Other Changes:** The species checklists generated by the EIA can function as monitoring tools of changes in vegetation/habitat, fish, birds, insects, reptiles and mammal.
iv. **Fishery Changes:** Through the BMU, the DFO can provide standardise government formats for monitoring the fishery, species composition, catch rates by gear and species, and generally monitor and assess the development. The BMU in collaboration with local fisheries staff and with assistance from staff from FAST at USDM would track changes in the fisheries over time as a result of impoundment, to refine the fishing, fishway and, Water Release Strategy.
v. **District/National Level:** To monitor river flow patterns and changes in hydrology requires continued river flow gauging is needed. Regular monitoring of Satellite Imagery can show patterns and changes in land encroachment, degradation associated with large-scale erosion, land-take for (slash and burn) cultivation, deforestation, and vegetation thicket development around the Dam. DAWASA could contract SUA in Morogoro, to assist with this monitoring.

15.2 Monitoring of Socio-Economic and Cultural Aspects

SE parameters of the Project will fit into the overall monitoring plan of the District Council Programme. In addition, the DAWASA Resident Engineer/Management, in addition to the above, will be required to keep all records of the progress and to submit regular SE monitoring reports. DAWASA HQs will verify, validate, and take action, as required. The SE monitoring system would include such indicators as the following:

- Number of grievances, time and quality of resolutions and contentious cases.
- The relationship between the Project/DAWASA and the communities.
- Percentage of individuals selecting cash and in-kind compensation, and use of payments.
- Outstanding village/individual compensation or resettlement contracts.

- Seasonal or inter-annual fluctuation of key food stuffs.
- Number of impacted locals employed by the civil works contractors.
- Training of affected people.
- Number of health issues arising.
- SE status of resettled people vs those unaffected.
- Number of human/animal conflicts or attacks.
- SE benefits of the fishery.

15.3 Monitoring by JUKUMU Society WMA

As the directly impacted stakeholder, JUKUMU Society will require special attention. Monitoring of the WMA will follow laid down formats against the EIA as a baseline to measure impacts.

For the fishery, a supplemental study has been suggested by the Consultants to be done at design stage to better understand the biology of the 6-9 previously undescribed species found during the field work phase ofor this EIA. In the longer term information will be needed on the in-situ increase in number of fishers, type, number and description of gears used and the estimated earnings, fish processors and fish sellers. The monitoring phase should include species composition and their relative abundance, length frequencies, reproductive cycles, changes to composition of fishermen's catches, gear types used and the price of fish and the earnings of fishermen, people processing the fish and the people marketing the fish. A cost-effective manner of obtaining these data is possible through DAWASA funding postgraduate students at SUA/USDM.

For the downstream fisheries, a similar monitoring program is needed so the data should be comparable with that from the Dam, to get an idea of the net economic value of the dam.

16 RESOURCE EVALUATION OR COST-BENEFIT ANALYSIS

The Project has the following economic benefits and costs:

16.1 Dar es Salaam Water Supply

The Project design is to ensure adequate buffering of dry season supply of water catering for 3 million people, and maintaining functional the existing multi-billion dollar industrial, economic and commercial infrastructure of the City. The intention is to cater for dry season demand for the next 30 years, and as the population grows, potentially to supply water for as much as 7.5 million people. Without the Dam (or any alternative), the cost in loss to commerce and industry, to human suffering, the environmental and health consequences, etc will be enormous.

16.2 JUKUMU Society WMA

Expected benefits to local communities include short-term labour opportunities during construction (but may be competitive with migrant labour), and gains from sales of timber products during the land clearing for the Dam, and for local entrepreneurs, providing supplies, groceries, fresh fruit, vegetables, domestic cleaning and cooking services, messenger services, and security.

In the longer term, the Dam will provide local water supply, grazing, irrigation and water transport. Indirectly, the dam would improve supplies and business opportunity due to the access road and better public transport and communications in the area. The Contractor's facilities may be used (post-construction) for accommodation and/or ecotourism linked business, the local communities, JUKUMU WMA, and/or Selous GR.

The fishery in the dam is expected to have a highly positive economic impact on people in the surrounding areas estimated to fetch between 200,000-300,000 USD/year, and may be doubled with participation in the processing and marketing.

The tigerfish (Hydrocynus vittatus), is extremely popular as a recreational fish and could create a tourist attraction, need for accommodation, guides, gillies, bait, and revenues from license fees.

16.3 Downstream Communities

The fish yield in the river and floodplain downstream of the dam, could be negatively affected by the dam, but would depend on the extent of effectiveness of the mitigation, floe release strategy and fishway. Currently, therefore it is not possible to evaluate the potential loss of income, if at all.

WRBO note over 90 registered water users downstream of the project and would benefit from the water security provided by the Water Release Strategy. The emerging bio-fuel plant in Bagamoyo and communities living along the river who derive water for domestic use, livestock and traditional irrigation. However, conversely, their activities could lead to pollution or contamination of the Ruvu with herbicides, pesticides, chemicals, etc and needs to be monitored.

16.4 Upstream Communities

The upstream fisheries may also be negatively influenced by the dam. In addition, mining, agriculture and deforestation activities in the catchment pose a threat to the Dam and to the lives of downstream populations and crop products (i.e. over 3 million people). Those persons whose livelihoods depend on these activities will be impacted by mitigation measures included in an IWRMS to be implemented by DAWASA and WRBO to ensure safe and sustainable water supply.

16.5 Comparison of Alternatives

A number of alternative scenarios to the Dam exist, notably:

a. The No Dam Option: The “no-dam option” will mean that Dar es Salaam would have to explore alternative, future water supply options. Current ground water exploration may meet the need more cost-effectively. However, if alternatives fail, Dar es Salaam and surrounds will face a major political, economic, ecological and health disaster. Over 3 million people would struggle to compete for adequate water, to keep industry safe, for sewage disposal and for domestic needs.

b. The Large 270 km² Dam Option: The large dam option will have some specific cost-benefit outcomes. The most important of these relate to the economic, social, political and human costs of displacing and re-settling almost half of the JUKUMU WMA Society. Some 20-30 000 people will be displaced from their fertile agricultural lands, and total income from the WMA will be lost! In addition, lost would be the unique biodiversity of the Gonabis wetland with adverse effects on wildlife migration patterns of the North Selous GR. This concept has already been rejected.

On the downstream side of the larger dam (in the future), associated opportunities for hydro-power, irrigation and the expansion of the biofuel industry, may economically, politically and environmentally when compared to the “no action scenario” (i.e. 3 million vs. 30,000 people) justify the creation of a large dam, and compensate for the displacement of 30 000 people and the loss of biodiversity.

c. A Series of Smaller Dams: Kidunda at 27 km2 is likely to hold 40% of the anticipated design water storage needs. This should suffice for the near term, and opens options for

similar, smaller water storage dams in upstream and downstream tributaries, although this may not be as cost-effective as a single large dam, environmental and human consequences will be reduced.

On the downside, this option, would increase the opportunity to develop intensive (irrigated) agriculture upstream of the DAWASA water supply intakes. Not only will this compete for water, but may have severe negative impacts, like accumulation of herbicides, pesticides, fertilisers etc. All of which will affect water quantity and quality, and require significant additional monitoring and chemical treatment to ensure that the water is potable for Dar es Salaam residents.

d. Realignment of the Dam Wall Site: The riverine forest and thicket vegetation along the proposed dam wall alignment has great aesthetic and biodiversity value. The Consultant proposes that the opportunity to preserve this habitat by relocating and realigned the Dam Wall approximately 175-250 m upstream be considered in greater detail regards associated techn-economic implications. A preliminary estimate suggests that such a re-alignment may add up to 10% (USD 5 million) to the cost of construction and compromise some 10% of water storage capacity (6 Mm3). But in ecological terms, the vegetation type represents a significant potential saving of 30% of the habitat, and approximately 7-10% of the total when combined with the similar habitat upstream of the Ruvu-Mgeta confluence, mainly along the Mgeta River.

17 DECOMMISSIONING

The Project design envisaged a functional life of 30 years. After this, anticipated is that the Dam will be de-commissioned in favour of a suitable alternative. Given that Dar es Salaam is growing at a rapid rate, in 30 years, the population is more than likely to have increased by 100-150 %, to between 6 and 7.5 million. The 30 year time frame anticipated that other alternative options currently under exploration by DAWASA, including ground water development, would fill future needs. Although, the basic engineering design should hold for 50-60 years or more, in the long term, a number of scenarios emerge for the fate of Kidunda Dam, notably:

a. The Dam will not be needed, and dismantled in such a way as to restore the environmental flow patterns, reducing the risk of excessive flooding or threats to downstream communities.
b. If the alternatives and ground water solutions fail to live up to expectations, then the Kidunda dam may be retained as a reserve, dry season buffer, ensuring security of supply. At this time, the structures would require maintenance and upgrade, and a minor EIA.
c. Given the current growth in water demand for domestic supply, industry, hydro-power and irrigation, it is likely that at some time in the future, political pressures may see the need to re-consider the idea of a larger Dam. At this time, an updated and extended EIA will be needed, to evaluate the environmental, health and economic cost of “not taking action”. The threat of water shortage to millions of lives, livelihoods, downstream health and economy due to a lack of water, would at the time have to be weighed up against the cost of re-settlement of the 10’s of thousands of people who would be inundated and the loss of Gonabis wetland.
d. In the long term, catchment damage will play a key role in future decisions. Un-impeded de-forestation, irrigation and mining in the Uluguru Mountains will result in a reduction in the life of the Dam. The resultant climate change, erosion and siltation, will reducing live storage. Changes in rainfall and run-off patterns, heavily loaded at the front end of the season, would increase high flood risks, diminish long term, seasonal stream flows, as sponge effects are lost.

18 ENVIRONMENTAL IMPACT STATEMENT

From an integrated evaluation of the impacts on bio-diversity, on livelihoods (both of in-situ, upstream, downstream and target communities) and the valuation of resources lost to inundation vs the environmental consequences and economic costs of "no-action", the Consultant finds:

The 27km2 Kidunda Dam, as a dry season supplement for the single purpose of water supply, if re-designed, while taking into consideration the mitigation measures proposed, is considered to be the "least impactful Dam solution" to the future domestic, economic and industrial water needs of the 3 million people of Dar es Salaam and its environs. Due diligence is however needed when taking the proposed Environmental Management Plans into consideration, and re-designing the Dam, notably:

a. To do an accurate elevation survey to confirm the area of high water and flood zone.
b. To widen the spillway to over 200 m, to reduce the seasonal back-flooding risks.
c. To add a pedestrian walk for public access across the spillway and dam wall.
d. To include a fishway to allow un-impeded fish migration.
e. To re-align the Dam wall to protect 100 ha of the unique riverine forest, downstream.
f. To design a Flow Release Strategy to mimic natural flow patterns, dampen peak floods and maintain water quality.
g. For DAWASA to engage in catchment management to ensure the functional life of the Dam.
h. To do an in-depth household survey of the estimated 800 persons to be displaced.
i. To design the RAP to carefully consider site selection, to relocate people and sacred sites.
j. To include extension services for the management of irrigation, fishery, WMA and FR.
k. Include social services to improve: water supply, health, sanitation, education and security.
l. For DAWASA, MNRT, WD, FBD, Antiquities and UNESCO to agree on management of flooding in Selous GR and Mkulazi FR, and an IWRMS.

This conclusion is only applicable to the original design concept of a Dam of 27km2. Inaccuracy in earlier topographic estimates, means the EIA did not, at this time, have sufficient data to evaluate the development of a larger dam area of 43 km2 required to cater for the 150 Mm3 storage requirement. The Consultant recommends that this larger Dam requires an upgrade of this EIA.

19 ACKOWLEDGEMENT

The Consultant is indebted to the support it has received from the government and the local government authorities, at district, ward and village level. We thank the many stakeholders, especially villagers, who freely contributed their time and resources to assist the study. The Consultant wishes to thank the 800 odd participants who were interviewed, who attended stakeholder meetings and workshops, to discuss this important Project.

Finally, Norconsult is indebted to its team who carried out the study and prepared the reports and drafts that made up this EIA Report.

Annex: Environmental Management Plan – Summary of Impacts and Mitigation Measures

Environmental Management Plan: The Likely Impacts with Proposed Mitigation Measures of a 27 km^2 Kidunda Dam Flooding to 90 m Contour and 1/30 flood at 93.5m.

Sl No	Actions Affection Environmental Resources and Values	Environmental and Social Impact	Environmental Impact						Recommended Feasible Protection and Mitigation Measures
			Positive			Nil	Negative		
			L	M	S	0	S	M	L	
A	**Consequences of Project Location**									
1	Inundation of settlement & land at 90m	- 8.9 Km^2 Kidunda Village will be flooded. - 6.2 Km^2 Kiburumo Village will be flooded. - 0.1 Km^2 of B. Chini Village will be flooded. - 0.2 km^2 of Bwira Juu Village will be flooded							1	- To be included in Re-settlement & Compensation Plan. - The Dam will create new employment and income opportunities, potentially compensating for loses.
		- 895 houses, 2671 people, 15 toilets, 10 wells, and associated home gardens will be affected.							1	- To be included in Re-settlement & Compensation Plan.
		- 776 households will lose 1852 ha of agricultural land and 1185 ha will flood at some time or other.							1	- To be included in Re-settlement & Compensation Plan.
		- 2 schools, 3 village offices, 2 clinics, 4 mills and several trading shops will be affected.						1		- Build new schools, clinics, trading centres in the Re-settlement & Compensation Plan.
2	Inundation of ecological sites	- 10 Km2 Mukulazi FR will be flooded.						1		- FR lost will need to be de-gazetted before project can start. - Timber of value is to be harvested for cash before flooding.
		- 2 km2 Selous GR will be flooded.						1		- GR lost will need to be de-gazetted before project can start. - The Dam could become a potential tourist venue
		- 13 Km2 of Gonabis/JUKUMU WMA will be flooded.						1		- WMA area lost will need to be de-gazetted from JUKUMU WMA, compensated and GMP adjusted, before Project start. - No loss of endangered animals or plants is envisaged.
		- 2.7 Km2 of Riparian forest will be flooded, mostly in the area of the dam wall.						1		- To maintain the eco-type, proposed is to set aside as a FR 100 ha of Riparian forest below the dam wall
3	Inundation of cultural sites	- 5360 grave sites & sacred shrines will be flooded						1		- To be re-located in a proper, traditional & ceremonial way.
		- 5 Mosques will be flooded or affected.						1		- Build new Mosques as part of the Re-settlement & Compensation Plan.
4	Watershed erosion & silt run-off	- 55 000 t/yr silt from catchment erosion & run-off will shorten the reservoir life.					1			- Project is to adopt Integrated Water Resource Management System (IWRMS) to control catchment land use.

Sl No	Actions Affection Environmental Resources and Values	Environmental and Social Impact	Environmental Impact							Recommended Feasible Protection and Mitigation Measures
			Positive			Nil	Negative			
			L	M	S	0	S	M	L	
		- Sediment retention by Dam and reduced flows, could affect the estuary and coastal beaches.					1			- Water Release Strategy to include seasonal silt flushing from the Dam.
		- 13% in 10 years deforestation rates in Uluguru's will adversely affect the seasonal run-off rates.						1		- Through the IWRMS, a forest management & reforestation plan should be included for the watershed.
5	Impairment of river navigation	- The Dam will hinder the local passage up and downstream by fishermen and transport canoes.			1					- The Project should consider to provide opportunity to develop a local water transportation system.
		- Part of Kiburumo Village may become isolated as an island in the Lake.						1		- Kiburumo may need construction of land bridges for access to schools, roads, other villages, etc.
6	Effects to groundwater hydrology	- Flooding of pit latrines during seasonal floods could contaminate local water supply.						1		- Resettlement and Compensation Plan to consider relocation of wells & high water latrines, and consider piped water.
		- Flooding of pit latrines by the Dam could create a health hazard.						1		- All existing pit latrines in the inundation zone to be filled in before flooding.
7	Affects fish migration	- 9 species of fish are potadromous, and will be adversely affected in seasonal migration.							1	- Dam design is to include an appropriate fishway and Flow Release Strategy in to accommodate fish migration patterns.
8	Inundation of mineral resources	- No know minerals are mined or are known to occur in the inundation site.				1				- No action needed.
		- Improper mineral extraction in the upstream river and catchment, will cause hazards.						1		- The Project will need to work with Ministry of Mines to establish a safer watershed mining management plan.
9	Environmental aesthetics lost	- The Project may cause loses to tourism value in the area.			1					- The Lake could become a tourist attraction, with scope for more lodges along the Selous GR and JUKUMU WMA.
10	Risk of seismic movement	- The Project site could be on a potential fault line with risk of Dam failure.						1		- Pre- design geo-surveys need to be undertaken to reduce the risk of seismic activity and Dam failure.
11	Community anxiety/trauma	- Community fear of displacement by the Dam is a threat that has stopped local development.					1			- There is a need for local political and community awareness about the Project to dispel any fears.
B	**Consequences of Project Design**									

Sl No	Actions Affection Environmental Resources and Values	Environmental and Social Impact	Environmental Impact							Recommended Feasible Protection and Mitigation Measures
			Positive			Nil	Negative			
			L	M	S	0	S	M	L	
1	Erosion due to upgrade of access road	- Site access road, if upgraded for Project could add to siltation & poor water quality.						1		- This is beyond the scope of this Project and would need a separate EIA and EMP for the access road.
		- The site road would increase access and could enhance deforestation due to illegal timber.						1		- The Project should establish Joint Forest Agreement under PFM for Mukulazi FR, to better manage resource extraction.
2	Reservoir site preparation	- Excavation for Dam, material site, office, etc would increase siltation and poor water quality.						1		- Silt traps to be developed to protect run-off during rains from excavation sites damaging downstream water quality.
		- Inundation area is full of vegetation which, if left, could deteriorate water quality.							1	- Woody plants in inundation site are to be cleared prior to flooding to avoid decomposition and anoxic conditions.
										- Avoid burning of woody plants as ash adds to nutrient loads. Trees should be cleared and sold as timber or charcoal.
										- The Flow Release Strategy is to maintain outflow of hypo-limnion water so as to discharge anoxic waters.
3	Water rights conflicts	- 90 water abstraction rights are registered on the Ruvu River system.						1		- The Flow Release Strategy design will have to cater for all user rights.
4	Seasonal back-flooding of settlement	- Temporary flooding due to 1.5-2 m rise to 92 m contour during peak floods, will include: - 11.3 Km2 Kidunda Village will be flooded. - 13.0 Km2 Kiburumo Village will be flooded. - 1.1 Km2 of B. Chini Village will be flooded.							1	- Dam design, larger spillway, larger outlets and Flow Release Strategy could reduce this risk of flooding.
		- Accumulation of silt could increase the degree of back-flooding.					1			- The Flow Release Strategy will have to cater for seasonal silt flushing of reservoir to reduce build-up.
5	Conflict in land use bordering dam	- Stream bank/lakeshore cultivation will increase siltation due to poor land husbandry					1			- The Project should provide extension services to ensure sustainable land husbandry as per Land Use Plans.
		- The seasonal draw-down zone could become prime agriculture land with conflicting interests.					1			- Husbandry of draw-down zone should be guided by Land Use Plans.
6	Scouring river bed below dam	- The Dam could change downstream flows & the 1/30 peak flood at 93.5 m would flood 65 km2 and could result in eroded banks					1			- The Flow Release Strategy and spillway design need to safeguard against this risk.

Sl No	Actions Affection Environmental Resources and Values	Environmental and Social Impact	Environmental Impact						Recommended Feasible Protection and Mitigation Measures
			Positive			Nil	Negative		
			L	M	S	0	S	M	L	
7	River fishery transformed	- 200-300 t/yr new capture fishery could potentially develop in the Lake.	1							- Include fishery development plan
		- 6 new fish species and 3 new range, were noted in the surveys of the Ruvu River.							1	- Before the Project commences, a more in-depth study of the fish taxa is proposed to ascertain impact (See Annex)
C	**Consequences of Construction Phase**									
1	Soil erosion and increased silt loads	- Excavation, earth moving and construction activities will cause excessive silt load in river. - Silt from construction could harm the downstream water users and the ecology.					1	1		- The Project needs careful location of borrow pits, etc and to manage that earth moving does not enter the main River. - The Contractor is to carefully manage soil movement and secure no spillage into River through a series of dykes.
2	Safety of workers	- Site workers face hazards due to accidents.					1			- The Contractor must ensure workers are provided with and wear safety gear & are trained in its use and in First Aid.
		- The Site will have risks of dust, odours, fumes, noise, etc harmful to workers.								- The Contractor must ensure workers are provided with and wear safety gear & are trained in its use and in First Aid.
		- The labour could spread the health hazards of HIV/AIDS & STDs to the local community.					1			- There will be a need to establish clinic, train community & workers in HIV/AIDS awareness, providing condoms.
		- The quarry site has risk hazards from blasting and hauling.					1			- The Contractor must ensure workers are provided with and wear safety gear & are trained in its use and in First Aid.
		- Site workers face a risk of poor water supply quality as there is no piped water in the area.					1			- The Contractor is to ensure a clean piped water system for the labour.
3	Sanitation of workers camps	- There are potential health hazards due to poor latrines and bathing areas for workers.					1			- The Contractor is to ensure adequate wash areas and toilets and safe waste disposal.
4	Safety of community	- The local community, especially children face hazards from straying onto site.					1			- The Contractor is to fence danger areas, and make aware the local community of the dangers of straying onto the Site.
		- There are potential hazards downstream from dumping of wastes, oils and fuel spillage.					1			- The Contractor should dyke all fuel & oil depots and ensure proper storage/disposal of wastes.
		- The may be a increase in crime & rape in the local community perpetuated by migrant labour.					1			- The Contractor is to provide security services to control staff behaviour. - District council may need to post a policeman to the area.
		- There may be conflict from local workers due to preferential employment of external labour.					1			- The Contractor is to be advised to treat equally labour rights for locals and set-up a labour office with Ward Executives.

Sl No	Actions Affection Environmental Resources and Values	Environmental and Social Impact	Environmental Impact						Recommended Feasible Protection and Mitigation Measures
			Positive			Nil	Negative		
			L	M	S	0	S	M	L	
		- The local trade with the labour camp is likely to distort markets and increase local prices.					1			- The Contractor should establish a central buying mechanism with local community, through Ward Executives.
5	Construction monitoring	- The quality of the Dam could be compromised if the Contractor uses inferior goods.					1			- The Client needs to ensure during construction that appropriate, adequate engineering controls are in place.
		- After the work, the Contractor is unlikely to meet obligations to rehabilitate the site.					1			- The Client needs to ensure that the Contractors obligations to rehabilitate are monitored.
		- The environmental consequences of the Dam could be high is Contractor ignores the EMP.								- The Client and the Contractors need to ensure to follow obligations as in the EMP are carried out & monitored.
6	Threat to local ecology	- The Contractor, staff and labour are likely to poach for bushmeat to supplement food needs.					1			- The Contractor, staff and labour are to be made aware not to hunt local animals without permits, and closely monitored.
		- The Contractor, staff and labour may cut trees for fuelwood or timber, or to resell.					1			- The Contractor, staff and labour are to be made aware not to cut local trees without permits, and closely monitored.
7	Dam commissioning	- The is a threat of people & livestock drowning once the dam begins to fill-up.					1			- The Client must ensure to issue advance warnings tot he local community before closure of the Dam for first time.
		- Wildlife, insects, reptiles, etc will be drowned as the Dam floods for the first time.					1			- Most large mammals will run away, but some wildlife rescue may be needed at the first flood.
		- During first flood, the floating vegetation will be in high quantity & can clog Dam outlets.					1			- The Client Staff will need to be prepared to clear blockages to the outflows and spillway.
D	**Consequences of Project Operations**									
1	Variations in downstream flows	- The Dam may interupt flows cause disturbance to downstream navigation & fishery.					1			- Flows will have to be regulate by Client through the Flow Release Strategy, to mimic natural flow patterns.
		- The Dam may disrupt the downstream and upstream floodplain fishery.					1			- Flows will have to be regulate by Client through the Flow Release Strategy, to mimic natural flow patterns for fish.
		- The Dam may affect downstream water quality due to flow restrictions.					1			- Flows will have to be regulate by Client through the Flow Release Strategy, to mimic flow patterns for water quality.
		- The reduced flow due to the Dam may cause disturbance to the estuary/mangrove area.					1			- Flows will have to be regulate by Client through the Flow Release Strategy, to mimic natural flow patterns.
		- The reduced flow may disturb downstream water users.					1			- Flows will have to be regulate by Client through the Flow Release Strategy, to cater for registered user rights.
		- The changing flows may potentially increase					1			- Flows will have to be regulate by Client through the Flow

Sl No	Actions Affection Environmental Resources and Values	Environmental and Social Impact	Environmental Impact						Recommended Feasible Protection and Mitigation Measures
			Positive			Nil	Negative		
			L	M	S	0	S	M	L	
		the downstream, in-stream erosion.								Release Strategy, to flush sediments.
		- Regulated flows downstream will improve agriculture, but compete for Dar water needs.		1						- Flows will have to be regulate by Client through the Flow Release Strategy, to reduce conflict between users.
		- Reduced flows could enhance salinization of floodplains/estuary.					1			- Flows will have to be regulate by Client through the Flow Release Strategy, to mimic natural flow patterns.
2	Social conflicts in reservoir uses	- Permanent water means scope for drawdown agriculture will increase.		1						- There is a need for the Project to engage in proper land use services in the Dam vicinity to reduce risks of erosion.
		- The drawdown area will also offer grazing & conflict between livestock & crop farmers.					1			- The drawdown zone should be include in the village LUPs to manage against conflicts.
		- There is a threat of toxins/pollution due to upstream activities (ie mining, agriculture, etc)						1		- Management of pollution threats in the catchments need to be include in IWRMS as it affects the population of Dar.
		- The resultant Lake will assist local navigation.		1						- To ensure hazard free navigation, it would be important to clear all tree hazards in the mainstream of the Lake.
		- The dam may re-route wildlife migration to areas in conflict with people.					1			- Wildlife migration and problem animals should be managed through JUKUMU WMA & Selous GR.
		- The displaced people are given inferior resettlement & experience social inequality.							1	- The Client must ensure fair and equitable treatment of displaced persons and re-settle them in good land/terms.
		- The Lake will improve community water supply in situ and downstream.		1						- The Project should include a reticulated piped water supply for the affected villages.
		- The scope to increase agriculture in the drawdown around the Dam increases erosion.					1			- There is a need to minimise lakeshore and stream bank cultivation through the LUP.
		- The Dam will attract in-migration, job seekers, new settlers, opportunity seekers, etc.					1			- Any new settlement should follow the LUPs.
		- The local DAWASA presence will improve telecoms (eg instalation of cellphone system).		1						- The Project should consider to include a local cellphone tower.
		- The local DAWASA presence may improve electricity supply for the staff camp.		1						- The Project should consider to include a local electric supply connection to the main grid.
		- The development of the access road during construction will improve access to markets.		1						- Anticipated is private enterprise will establish a local public transport system.
		- Human settlements/developments around the Dam, mainly agriculture, will increase erosion.					1			- The local land use shall be addresses through the village LUP.
		- High seasonal floods, due to low lying nature, will means crops are affected by waterlogging.				1				- Awareness of the 1/30 flood risk to the local community is needed, inclusive of protective dykes and improved drainage.

Sl No	Actions Affection Environmental Resources and Values	Environmental and Social Impact	Environmental Impact						Recommended Feasible Protection and Mitigation Measures
			Positive			Nil	Negative		
			L	M	S	0	S	M	L	
		- The Dam will increase the incidence of drowning of people and livestock.					1			- The Project needs to educate children in schools of the potential risks of the Lake.
		- The press on the Dam and opportunity seekers, may increased land values.			1					- The local community is to be made aware of the Village Land Act to protect their land rights from land grabbers.
3	Change in lake water quality	- Eutrophication may result in the Lake due to excessive nutrients from vegetation, etc.					1			- Before commissioning, it is important to ensure proper vegetation clearing.
		- There is a threat that aquatic weeds may encroach the Lake					1			- The Client needs to consider regulate weed control, should a notifiable weed become established.
		- If the lake goes annoxic, there is a threat to downstream water quality.					1			- The Flow Release Strategy should ensure flushing of bottom, de-oxygenated layers.
		- Wind and wave action may erode the fine silts of the Lake sides					1			- It is important to ensure reeds re-establish in the drawdown zone as wind & wave breakers.
		- If eutrophic, the Lake will releases GHG (methane/hydrogen sulphide).					1			- The Flow Release Strategy should ensure flushing of bottom, de-oxygenated layers.
4	Health and safety hazards increase	- The permanent water will mean insect vectors will increase that spread diseases (eg. malaria).						1		- The Project needs to include a Community Health Program in the EMP.
		- The permannent water will mean mollusc vectors will increase, spread bilharzia & worms.					1			- The Project needs to include a Community Health Program in the EMP.
		- The permanent waters will bring crocodiles closer to people increasing the threat on lives.					1			- More quota licences shall be issued so as to cull crocodiles for the skin trade.
5	Impact on fisheries	- Reduced flows may affect estuarine/marine fishery.					1			- The Flow Release Strategy should ensure that minimal environmental flows reach to River estuary.
		- The Dam wall will affect migratory fish species.							1	- The Project needs to include the design and regulated management of a suitable fishway.
		- 200-300 t/yr fishery enhancement will result from the new Lake.	1							- The Project should include establishment and equipping Beach Management Units and a local fish extension service.
		- 9 as yet undescribed by science, fish species, may be threatened.							1	- There is need for follow-up study to establish a management plan for these species.
		- The developing fishery will have problems of fish nets snagging on inundated trees.					1			- Clearing of trees should set aside areas as fish nursery, like “brush parks”.
		- The new fishery may be controlled by					1			- The Morogoro District needs to regulate the fishery and

Sl No	Actions Affection Environmental Resources and Values	Environmental and Social Impact	Environmental Impact						Recommended Feasible Protection and Mitigation Measures
			Positive			Nil	Negative		
			L	M	S	0	S	M	L	
		unscrupulous middlemen who control the trade.								provide an extension service.
		- Lack of presevative techniques, means increased fish smoking causes deforestation.					1			- Train and design is needed on more efficient fish smoking kilns.
6	Impact on local natural resources	- There is scope that some endangered flora or fuana is threatened by the inundation. - The opening of access to the site may put Mukulazi FR under threaten by illegal timber. - The opening of access to the Site may mean wildlife is threatened by illegal hunting. - The attraction of the Lake, adds additional recreational area for tourism. - The long nature of the Lake may impair wildlife migration north and south. - The loss in riparian trees may mean a loss in bird breeding/roosting.	1	1	1	1	1 1			- There have been no endemic Red Book entries found in the site that will be threatened by the Lake. - The Project should instil joint management of Mukulazi FR through PFM to manage illegal off takes. - The Project should instil joint management through JUKUMU WMA to regulate illegal activities. - The business development opportunities for the Lake are to be include in the Selous GR and JUKUMU GMP. - Wildlife are likely to walk around the Lake if migration routes are disturbed. This will increase problem animal incidents. - The Project should leave select, large trees in the Lake as roosting sites for birds. - There is scope to plant more trees on the periphery to enhance habitat.
7	External forces threaten dam	- Uncontrolled deforestation in Ulugurus due to timber & agriculture will increase silt loads.						1		- The Project must implement an IWRMS Plan.
		- Uncontrolled mining in the river upstream and catchment will increase the silt load.					1			- The Project must implement an IWRMS Plan.
		- Poor catchment land husbandry will increase local siltation.					1			- The Project must implement an IWRMS Plan.
		- Pollution from upstream human waste discharge will affect water quality.					1			- The Project must implement an IWRMS Plan and a improved upsteram sanitation progam.
8	Climate change influences flows	- 1/30 peak flood causes excessive run-off, drowns settlements, floods crops, etc.					1			- The Dam design, spillway design & outlets need to dampen the flood levels, and bunds may be needed in some villages.
		- 1/30 year drought dries dam, exacerbated by climate change.					1			- Flow Release Strategy should, in time of drought, cater for all users, with climate change plan in place.
		- If drought, the Lake could provide a lifeline for the local community.			1					- The Lake will be a buffer to aide local community and downstream users against the risks of drought.

Sl No	Actions Affection Environmental Resources and Values	Environmental and Social Impact	Environmental Impact						Recommended Feasible Protection and Mitigation Measures
			Positive			Nil	Negative		
			L	M	S	0	S	M	L	
E 1	**Consequenses of De-commissioning** Political pressure to maintain/upgrade	- If the long term vision is to increase dam size to cater for needs, this will inundate 1000s hh.							1	- It must be weighed up that the resettlment of a larger Dam will be costly due to little return in storage due to low lying nature of the topograhpy.
		- The political intention is that the Dam is a solution beyond the envisaged 30, years.		1						- If a longer life is the intention, the design needs to consider this in the engineering parameters.
2	Dam de-commissioned after 30 year	- At de-commissioning, the potential threat of flooding must be removed					1			- The spillway will need to be demolished to a lower, a safe level
		- The potential threat of erosion must be removed.					1			- There should be a reforestation of the riverine area.
		- The threat of stream bank cultivation, must be removed.					1			- There will be a need to rehabilitate and to limit LUPs in the drawdown areas.
3	DAWASA facilities re-used	- The staff quarters could become local tourist lodge.			1					- The facilities could be to JUKUMU WMA to benefit

Key:

1. The degree of impact is measured as L = large or significant, with cause for concern and need for mitigation, M = moderate, minor cause for concern, can be mitigated against, S = Small or of no real consequence, manageable by design or mitigation measures and, Nil = No impact, negligible or insignificant.