Pre-feasibility Study for the Ruhuhu Irrigation Project Update

Presentation to Stakeholders

Landmark Hotel, Ubungo, Dar es Salaam

12\textsuperscript{th} September 2014
An Introduction to the Climate Resilient Infrastructure Development Facility
What is CRIDF

- DFID-funded water infrastructure programme for southern Africa
- Aimed at catalysing delivery of sustainable small-scale infrastructure
- Working through local networks and integrating into regional decision making
- Mainstreaming climate resilience into infrastructure planning
- Leaving behind sustainable solutions
The CRIDF Logical Framework

Output
- Prepare small scale water infrastructure projects
- Facilitate access to finance for the implementation of these projects
- Engaging with river basin organisation and national stakeholders
- Using CRIDF principles to ensure that investments align with strategic objectives

Outcome
- Poor people will benefit from climate resilient water infrastructure
- Conditions for cooperation between stakeholders in shared river basins will be improved

Impact
- Contribution to peaceful, climate resilient and sustainable planning and management of shared waters in SADC for current and future benefits to the poor.
What Are the CRIDF Countries?

- Working in 11 mainland SADC countries
- Focusing on DFID countries: Malawi, Mozambique, South Africa, Tanzania, Zambia and Zimbabwe
- With special attention on the low income countries: Malawi, Mozambique, Tanzania and Zimbabwe
Demand Driven and within a Climate Change Context

- Working with SADC and RBOs to respond to demand for investments
- Differentiating between well watered (northern) basins and water stressed (southern) basins
- Pursuing a specific strategy in each basin – different means of improving climate resilience according to context
Support to a Range of Investments and Activities

- **Entry Projects (Quick Wins)** to engage with key stakeholders, deliver on the ground and demonstrate specific concepts more widely

- **Focal Projects** to deliver climate resilient investments to Bankability and Implementation

- **Strategic Projects**, engaging in longer-term concepts that last beyond the CRIDF timeframe

- **Stakeholder Engagement** (TA) to assist RBOs and widen as well as deepen Project influence
How Does the ‘Facility’ Work?

- One-stop shop, linking to all the components necessary to deliver sustainable, climate resilient infrastructure
- Initial screening to determine eligibility (consistency with CRIDF mandate)
- Secure financing (could be from CRIDF); and
- Deliver infrastructure
The Ruhuhu Irrigation Scheme
Introduction

- Project initiated in 2006 by the Ministry of Agriculture, Food Security and Fisheries.
- Identified as a SADC Regional priority project, under the SADC Regional Indicative Development Development Masterplan.
CRIDF Eligibility Assessment
Regional and Trans-boundary Context

- Project identified from the RIDMP (Maseru 23); adopted as a priority irrigation project (scope expanded after CRIDF intervention)
- Can significantly contribute towards clean energy supply to the region
- May foster cooperation in national water infrastructure development in a transboundary basin
Lake Nyasa Sub-basin Characteristics

- Tanzania – 44% (27,623km²)
- Malawi – 46% (62,906km²)
- Mozambique – 10% (8,182km²)
Climate Change Resilience Context

- Possible climate change impacts identified:
  - Increased occurrence of floods and droughts
  - High projected population growth will increase demand for food
  - Intensification and Diversification of crop production: higher temps may favour some crops eg rice

- Possible mitigation
  - Increase productivity per ha; per m3
  - Rain-fed converted to irrigation (vulnerability to drought is shifted to a regional issues) Farmers become less vulnerable.
  - Exploitation of underground water. After hydro-geological studies
  - Reservoirs for hydropower production store more flood water for an even power production and flood control
  - Irrigation designs should cater for possible increase in irrigation peak requirements.

- Need to diversify sources of livelihoods for households in the project area through provision of energy
Project Components
Component Descriptions

- **Irrigation development:** About 3,200ha of irrigation on the left and right banks of the Ruhuhu River in the Manda and Lituhi Wards.

- **Transportation link across the Ruhuhu River:** The construction of a bridge across the Ruhuhu River, to serve the left and right bank communities in the Njombe and Ruvuma Regions.

- **Water supply and sanitation:** The provision of safe and reliable domestic water supply and sanitation for about 12,000 inhabitants in the Manda (now Ruhuhu and Manda) and Lituhi Wards.

- **Hydropower generation and distribution:** The generation of electricity (medium- to large-scale for feeding into the national grid, or small-scale for local use).

- **Flood control on the Ruhuhu delta:** The management of high-water flows, to help protect the communities and fields on the Ruhuhu delta from floods from the Ruhuhu River.
Status of each component

<table>
<thead>
<tr>
<th>Component</th>
<th>Stage in Development Cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydropower generation and distribution</td>
<td>Reconnaissance study for the proposed Kikonge Hydropower Project</td>
</tr>
<tr>
<td>Water Supply and Sanitation</td>
<td>Reconnaissance stage but will only proceed if the irrigation component is developed</td>
</tr>
<tr>
<td>Transportation link across the Ruhuhu River</td>
<td>Dropped from CRIDF funding</td>
</tr>
<tr>
<td>Flood control on the Ruhuhu delta</td>
<td>To included in the development of the dam for hydropower</td>
</tr>
<tr>
<td>Irrigation development</td>
<td>Prefeasibility stage – subject of today’s workshop.</td>
</tr>
</tbody>
</table>
Irrigation Development Component
Ruhuhu Irrigation Project Results Chain

**Main tasks - by CRIDF**

- **Agriculture and Irrigation**
  - Desk study and literature review; Reconnaissance study for project identification and assess eligibility; Prefeasibility study or preliminary viability assessment; Feasibility analysis to assess viability, sustainability & bankability; Source implementation funding and close financing deal; Prepare detailed designs and BoQ; Procure contractors; Supervise construction (CRIDF with MoAFS); Construction works (CRIDF with MoAFS); and Commissioning the scheme and handover (CRIDF with MoAFS)
  - **Agricultural Marketing**
  - Conduct market feasibility study
  - Feasibility analysis to assess viability, sustainability and bankability; Source implementation funding and close financing deal (CRIDF with REA); Prepare detailed designs and BoQs (CRIDF with REA); Procure contractors (CRIDF with REA); Supervise Construction (CRIDF with REA); Construction of works (CRIDF with REA); and Commissioning the plant and handover (CRIDF with REA)

**Main Tasks - by others**

- **Agricultural Support**
  - Facilitate the development and implementation of farm business (MoAFS)
  - Capacity building of farmers to implement farm business plan (MoAFS)
  - Developing institutions for irrigation scheme maintenance (MoAFS)

- **Agricultural Marketing**
  - Develop agro-processing industry (MoAFS)
  - Link farmers to existing value chains (MoAFS & Pvt Sector)

- **Institutional Development**
  - Developing institutions for operation and maintenance of irrigation scheme (MoAFS & Pvt Sector)
  - Capacity building and resourcing of extension staff and other service providers at all levels (MoAFS)
  - Developing institutions for mini hydropower generation operation and maintenance (REA & Pvt Sector)
  - Developing institutions for operation and maintenance of water supply

**Output 1**
- Irrigation infrastructure for targeted smallholder farmers in the Ruhuhu and Lituhi wards developed (CRIDF, GoT and Pvt Sector)

**Output 2**
- Markets for crops produced by targeted smallholder farmers developed (CRIDF, GoT and Pvt Sector)

**Output 3**
- Capacity of private and public institutions supporting the irrigation schemes improved (CRIDF, GoT & Pvt Sector)

**Output 4**
- Mini-hydropower infrastructure developed (CRIDF, TANESCO, Pvt Sector & REA)

**Output 6**
- Production and Productivity of targeted crops under smallholder farming improved (GoT)

**Project Outcome 1**
- Improved irrigation water management practices adopted by smallholder farmers in the irrigable areas of Lituhi and Ruhuhu wards

**Project Outcome 2**
- Increased agricultural production and productivity for participating farmers in the Lituhi and Ruhuhu wards

**Project Outcome 3**
- Access to clean electricity for the rural community in the Lituhi ward improved
Ruhuhu Valley Irrigation Project
Results of the Prefeasibility Study
Methodology

- Hydrological and sedimentation study
- Geological and geo-technical investigations (not yet done)
- Irrigation study
  - Engineering
  - Soils
  - Agronomy
- Project cost estimation and economic analysis
- Climate resilience assessment (not yet done)
- Environmental and social scoping
- Project Evaluation
- Training in notification requirements (not done – notification advisory prepared)
Siting of Intake Structure

- The ferry site rejected as dam and intake site
- Intake site selected 15km upstream of ferry site.
  - Narrow river bed width, about 100m
  - Substantial exposure to rock
  - Allow command of greater potential irrigable area
  - Diversion works impoundment will not result in displacement of people
  - Potential for development of a mini-hydropower of up to 500kW capacity.
Intake Sites for the Irrigation Scheme
Ruhuhu Irrigation and Hydropower Dam Sites
Hydrology and Sedimentation

- 100 - 80% dependability flow at the intake site is about 20 – 26m$^3$/s.
- The flow potentially available for irrigation is about 16m$^3$/s (60% of 80% dependable flow)
- No sedimentation studies carried out for the weir.
- Recommendations
  - Detailed hydrological data, including reliable rainfall data, required for further analysis
  - Full understanding of existing and planned water abstraction licences.
  - Assess potential impact of climate change
Minimum Daily Mean Flow at the Proposed Intake Site
Soil Analysis
Land Use Classes (FAO)
Map of Potential Irrigable Soils

NYMU – 2100ha
• profile is deep, moderately well drained non calcareous with very dark grey-brown (10YR4/2) sand clay loam in topsoil and light brownish grey (10YR6/2) clay loam in sub soil. When moist the soil is firm in top soil to extremely firm in sub soil, while when wet the consistence is slightly sticky and non-plastic in top soil.

LUDMU – 1690ha
# Land Suitability for Upland Crops and Paddy

<table>
<thead>
<tr>
<th>Land quality/characteristics</th>
<th>Mapping units</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NYMU</td>
</tr>
<tr>
<td>Infiltration/permeability (i)</td>
<td>1</td>
</tr>
<tr>
<td>Capacity to maintain surface water (c)</td>
<td>1</td>
</tr>
<tr>
<td>Possibility for mechanization (m)</td>
<td>1</td>
</tr>
<tr>
<td>Soil workability (s)</td>
<td>1</td>
</tr>
<tr>
<td>Drainage (d)</td>
<td>1</td>
</tr>
<tr>
<td>Soil fertility (f)</td>
<td>3</td>
</tr>
<tr>
<td>Sodicity/Salinity (a)</td>
<td>1</td>
</tr>
<tr>
<td>Suitability class</td>
<td>S2f</td>
</tr>
</tbody>
</table>
Soil Analysis Results

- All the mapping units NYMU (2,117.13ha) and LUDMU (1,695.41ha) were rated as moderately suitable for paddy, maize and vegetables (tomatoes).
- If the soil fertility \((f)\) is corrected, decantation basin (NYMU) will be highly suitable \((S1)\) for the production of irrigated upland crops.
- Sodicity may pose a threat to irrigated crops, especially to maize and legume crops, which have low tolerance to the effect of sodium and high soil pH (FAO, 1986). Thus adequate provision of farm drainage to keep the sodicity condition below the root zone is recommended.
- The potential area for irrigation agriculture is estimated to be greater than 5,947.7ha. However the area which this soil survey has covered is only about 3,812.54ha.
Marketing and Agronomic Studies
Current Crops, with Typical 1ha Cropping Model

- In dry season, cassava is the main crop >60%, using residual soil moisture
- In wet season rice is the main crop.
- Other crops: maize and leafy vegetables.

<table>
<thead>
<tr>
<th>Crop type</th>
<th>Rain season</th>
<th>Dry season</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>% area cropped</td>
<td>% area cropped</td>
</tr>
<tr>
<td>Paddy</td>
<td>50</td>
<td>-</td>
</tr>
<tr>
<td>Maize</td>
<td>10</td>
<td>2</td>
</tr>
<tr>
<td>Cassava</td>
<td>-</td>
<td>60</td>
</tr>
<tr>
<td>Vegetable</td>
<td>10</td>
<td>3</td>
</tr>
<tr>
<td>Fallow</td>
<td>30</td>
<td>35</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>
## Typical Irrigated cropping 1ha model

<table>
<thead>
<tr>
<th>Crop type</th>
<th>Rainy season (% area covered)</th>
<th>Dry season (% area covered)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paddy</td>
<td>80</td>
<td>50</td>
</tr>
<tr>
<td>Maize</td>
<td>10</td>
<td>15</td>
</tr>
<tr>
<td>Vegetable/tomatoes</td>
<td>10</td>
<td>15</td>
</tr>
<tr>
<td>Cassava</td>
<td>-</td>
<td>20</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>
Marketing

- Explore the following:
  - Establishment of warehouses
  - Links to SACOGT
- More needs to be done to understand marketing for the new irrigation scheme.
Crop Water Requirements

- The peak net monthly irrigation requirement for the mapping unit NYMU is 1,736m³/ha occurring in the month of August. The peak net irrigation duty requirement for the same mapping unit is 1.78l/s/ha, occurring in September.

- The peak net monthly irrigation requirement for the mapping unit LUDMU is 1,823m³/ha occurring in the month of August. The peak net irrigation duty requirement for the same mapping unit is 1.86l/s/ha, occurring in September.
Irrigation Systems
Schematic layout of the Ruhuhu Multi-purpose Project

200km 400kVA line to Makambako

Ludewa District, Njombe Region

Ruhuhu Block: 800ha

Lake Malawi/Nyasa

Litahi Block: 2000ha

Nyasa Region, Ruvuma Region
Component Descriptions

- Irrigation development:
  - Area: Approx. 4000ha
  - No. potential direct beneficiaries: 4,000 hh (20,000 pax)
  - Indirect beneficiaries: 6,000 hh
  - Cost: GBP21 million
  - Main crops: Rice, vegetables, maize

- Kikonge Hydropower Plant
  - Dam height: 120m
  - Potential installed capacity: 330 MW
  - No. beneficiaries: National
  - Potential Cost: GBP400 million
  - Main advantage: Year round electricity production
Irrigation Headworks and Main Canals

- Diversion weir:
  - Mass concrete
  - Height: 10m
  - Width: 15m
  - Control gate: 1.5 x 1.5m

- Main canal:
  - Trapezoidal section
  - Length: 10km
Schematic Layout of Irrigation Blocks – Flood Irrigation

Ruhuhu River

Intake weir

Ruhuhu and Manda Wards

BLOCK A
6 x 100ha

Manda Ward

BLOCK D
10 x 100ha

BLOCK E
3 x 125ha

BLOCK B
5 x 135ha

BLOCK C
15 x 100ha

Lituhi Ward

Mini Hydropower

Balancing Reservoir (Max. 36hr storage)
Schematic Layout of Irrigation Blocks – Pumped Option

- **Sub-blocks D9&10**
  - 211ha

- **Sub-block D8**
  - 100ha

- **Sub-block D7**
  - 100ha

- **Sub-block D6**
  - 100ha

- **Sub-block D5**
  - 100ha

- **Sub-block D4**
  - 100ha

- **Sub-block D3**
  - 100ha

- **Sub-blocks D1&2**
  - 200ha

- **BLOCK E**
  - 277ha
  - Ruhuhu and Manda Wards

- **Diversion works**

- **BLOCK A**
  - 6 x 100ha

- **BLOCK B**
  - 5 x 135ha

- **BLOCK C**
  - 15 x 100ha

- **MHS**

- **Balancing Reservoir**

- **36 HRS**

- **Pump station 2**

- **Lituhi Ward**
Cost Estimates

- Flood irrigation option: USD14,350,000 (3,590/ha)
- Pumped irrigation scheme: USD28,925,000 (7,230/ha)
# Economic Analysis

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>EIRR - Economic Internal rate of Return (%)</td>
<td>13.3</td>
</tr>
<tr>
<td>NPV – Net Present Value (million US$)</td>
<td>3.846</td>
</tr>
<tr>
<td>B/C – Benefit Cost ratio</td>
<td>1.16</td>
</tr>
<tr>
<td>Average water Unit Cost (US$/ m3)</td>
<td>0.150</td>
</tr>
</tbody>
</table>
Conclusion

- The scheme is viable from an economic point of view
Way forward

- Develop scenarios for possible multiplier impacts from irrigation scheme
- Decision from CRIDF and DFID on funding of feasibility study
- If approved, develop terms of reference for the feasibility study, with DITS.
- Consider possibility to seek funding to develop a masterplan for the Ruhuhu Valley, so as to better integrate irrigation development with other developments, especially mining activities.
## Kikonge Hydropower Project

<table>
<thead>
<tr>
<th>Dam Height</th>
<th>FSL (masl)</th>
<th>NMOL (masl)</th>
<th>TWL (masl)</th>
<th>Ave Head (m)</th>
<th>Ave Storage (MCM)</th>
<th>Ave Annual Dam inflow (m³/s)</th>
<th>Ave Storage/inflow (vol/vol)</th>
<th>Station Capacity (MW)</th>
<th>Capacity Factor (%)</th>
<th>Spill (%)</th>
<th>Annual Generation (GWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>140</td>
<td>680</td>
<td>640</td>
<td>520</td>
<td>140</td>
<td>11000</td>
<td>120</td>
<td>2.90</td>
<td>285</td>
<td>0.5</td>
<td>5%</td>
<td>1187</td>
</tr>
<tr>
<td>120</td>
<td>660</td>
<td>620</td>
<td>520</td>
<td>120</td>
<td>6200</td>
<td>120</td>
<td>1.64</td>
<td>240</td>
<td>0.5</td>
<td>10%</td>
<td>947</td>
</tr>
<tr>
<td>100</td>
<td>640</td>
<td>610</td>
<td>520</td>
<td>105</td>
<td>3000</td>
<td>120</td>
<td>0.79</td>
<td>210</td>
<td>0.5</td>
<td>15%</td>
<td>782</td>
</tr>
</tbody>
</table>
Advantages of Kikonge Hydropower Project

- Large storage – high energy security year round
- Can be flexibly dispatched to meet seasonal or peaking requirements of the system
- Cost of supply likely to be highly competitive with alternatives
Component description: Water supply and sanitation

- No. of households: 12,000
- Possible Cost: GBP530,000
- Project area: Ruhuhu, Manda and Lituhi wards in Tanzania
- Immediate response
  - Utilise potential ground water sources with simple technology
- Medium term response
  - Rehabilitate existing water systems (e.g. Lituhi water scheme) to determine requirements to improve services