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DESIGN AND MANAGEMENT OF PILOT SMALL SCALE SUPPLEMENTARY IRRIGATION SCHEMES IN OTUKE DISTRICT-UGANDA "PREFEASIBILITY CASE STUDY"

Dr. Gamal Elkassar[1]

[1] Water Management and Irrigation Advisor, Ministry of Water and Environment MWE-Kampala-Uganda; Tel: (+256 779830853), Assistant Professor-National Water Research Center-Egypt

ABSTRACT

Uganda is blessed with abundant water resources relative to most countries in Africa, especially those in sub-Saharan Africa. The agricultural production in Uganda is over dependent on rain. This conventional rain-fed agricultural production is presently threatened by climatic changes resulting in poor crop and livestock production and productivity and reduces livelihood revenues accruing from the agricultural sector.

The objective of the introduced pilot scheme could be to maximize the value of production of unit of water or unit of land' also to mitigate the impacts of climate change on rain-fed agriculture in such particular site as a case study in Uganda. This technical paper is to provide information to enable policy-makers make informed decisions for investment in Water for Production WfP infrastructures in the selected study area of Akwera Site in Otuke District as pilot study case for supplementary irrigation techniques with its management mechanism to be disseminated as references for any irrigation projects and to ensure its sustainability.

The Researcher commissioned a comprehensive technical study to undertake the required Capacity Needs Assessment for the Water for Production (WfP) Water for Crops Sub-sector component. These initiatives were targeted to reinforce the water sector to undertake the expected responsibilities for the current efforts to change into irrigated agricultural practices. This applicable prefeasibility study in Otuke District is to introduce such new initiatives for depending on supplementary irrigation practices to change from the current rain-fed agricultural.

The decision about water delivery; this can be described as the frequency, rate and duration of water deliveries at all levels of an irrigation system, these issues were taken into consideration in this prefeasibility research work and the proposed scheme's management and related capacity building strategy were also included to ensure its sustainability.

The overall policy goal of such pilot projects is sustainable social and economic development, which maintains or enhances the sustainable utilization of water resources, without put at risk or compromising the ability of future generations to meet their own needs. Also to introduce

affordable (i.e. technical and financial) techniques to be implemented using the current Ministry of Water and Environment MWE in-house resources under the supervision of the Researcher.

The Research aims to introduce technical paper that illustrates complete mission and components for the preparation of a new irrigation scheme's design with its management and Operation technique that could assess other water/irrigation researchers for such initiative either for research or consultancy purposes.

Key Words: Irrigation, Scheme, Management, Operation and Maintenance, Capacity Building, Sustainability.

1. INTRODUCTION

Uganda is considered fairly well gifted with water resources, estimated at approximately 65x109 m3 of water giving a 2,171 m3 per capita per year (2008) with open water covering close to 12% of total land area; however these water resources exhibit both seasonal and spatial variability. There is a mismatch between the location of the water and the location of demand, together with highly fluctuating seasons make Uganda vulnerable and has implications on the water security of the country.

Over the years the agricultural production has been fluctuating. These fluctuations are attributed to over dependence on rain-fed agriculture. The current climatic change and variability is threatening the conventional rain-fed agricultural production and distorting growing seasons resulting in poor crop and livestock production and productivity; there by reducing livelihood revenues accruing from the sector. It is increasingly being recognized that reliance on this erratic rainfall alone can no longer sustain reasonable agricultural production.

The configuration of a supplementary irrigation system is obviously determined by the relation of water and land resources, beneficiaries and the economic considerations. The design should incorporate as much as possible features that facilitate operation and provide flexible irrigation services. Sustainability of the introduced a supplementary irrigation system is a must, so securing the needed water for irrigation is essential mainly in the dry season. Water resources and their variability are the critical elements in the determination of the irrigable areas. Studies on the balance of water supply and demand form the main part of the conventional feasibility studies of irrigation projects; in the meantime, identify responsibilities of the users and building the capacity of the society' management team is required to ensure sustainability.

The researcher carried out an inventory of the existing water sources in the project's area, indentified the potential for irrigation at specific project sites and established demand of water for agricultural production and made recommendations for its sustainable use, management, economic valuations, coordination, monitoring and evaluation mechanism.

2. TRENT OF IRRIGATED AGRICULTURE IN UGANDA

Climatic challenges to the agricultural production and productivity are happening despite Uganda's great endowment with abundant water resources relative to most countries in the sub-Saharan Africa. There is great potential to harness this water to increase production and productivity to supplement current dependence on rain-fed agriculture.The variability and intensity of rainfall require flexibility in the operation of irrigation systems to achieve overall efficiency.

The system should be able to respond quickly to a sudden fall in demand of irrigation water. Yet despite the fact that improved irrigation can mitigate climate change risk; facilitate the concentration of support services (and hence reduce the unit costs of improved service provision); and prevent the apparent risks of diversified or intensified farming, only some 14,420 ha is understood to have been equipped for formal irrigation.

Irrigation also introduces challenges of its own, which include the need for development of local institutions, skills, market access, environmental management, etc. Given these challenges and the limited extent of Uganda's irrigation potential as currently estima ted, there has to be a goodreason to invest in irrigation.

3. CONCEPT OF CONSTRUCTION OF LARGE DAMS

The MWE is building dams for medium sized reservoirs, the water of which is to be used for livestock and/or irrigation schemes to be developed at a later stage. Another supposed objective of the reservoirs is as a strategic reserve during times of severe drought. Thef ollowing figure illustrates the case of Akwera Dam in Otuke District (previously Lira) -Uganda

Figure 1.General Layout for Akwera Dam Site at Otuke District

These larger dams are in some cases rehabilitated dams from the colonial era. In other cases they are designed and built in development areas designated by the Government of Uganda GoU. Maintenance of the dams is delegated to a dam management committee which usually consists of beneficiaries that live close to the dam.

The irrigation potential of most of the areas around these dams has not been fully assessed. Th ere is no irrigation infrastructure, and potential beneficiaries are not familiar with irrigation techniques and related agricultural aspects. They also need to be included into the integrated planning approach for such irrigation schemes; the following questions should be considered:

1. What is the projected water demand for the reservoir (in other words, what are key activities planned and the related water volumes required)?
2. Is there sufficient capacity for the implementation of the activities planned (e.g. for irrigation,
3. Is there knowledge about irrigated agriculture, market demand for crops, timings, maintenance, collection of monies, etc.)?
4. Are there plans and funding for extension services to farmers for O&M and proposed use of the water?

Through a projects that specifically targets implementation of water/irrigation facilities on the basis of the Integrated Water Resources Management IWRM principles, coordination and joint implementation mechanisms can be tested. It is therefore also proposed that a pilot project within the WfP be included as best alternative use of the available water.

4. RATIONAL FOR THE PAPER

As stated before; The Ministry of Water and Environment (MWE, 2012) with the assistance of its technical and Irrigation Adviser (the Researcher) commissioned a comprehensive technical study to undertake the required Capacity Needs Assessment, Curriculum and Training Modules for Water for Production (WfP) Water for Crops Sub-sector component.

These initiatives were targeted to reinforce the water sector within WfP-MWE to undertake the expected responsibilities for the current efforts to change into irrigated agricultural practices. The goal of Water for Crop Sub-sector within WfP can be summarized as "to sustainably provide access to adequate quantity and quality of water and ensure effective utilization of water resources for increased crop production while reducing dependency on rain fed agriculture".

The overall Objective of this assignment and technical study is to carry-out a prefeasibility study and Design of Irrigation schemes for a WfP facilities in the selected site of Akwera Dam by undertaking the following:

- Establish and examine the existing potential water for irrigation purposes and the appropriate systems to be used and related design's concepts.
- Review the Water Resources Potential
- Design Cost-Effective irrigation schemes upstream and downstream, to ensure efficiency and Value for Money and to ensure their Sustainability.
- Design the required Capacity Building and needs assessment for such pilot irrigation scheme.

Effective community mobilization is important to ensure adequate and effective participation of the beneficiaries in the development of schemes, and proper legally constituted organization is essential for beneficiary operation and management of irrigation schemes. Stakeholder's participation at all stages is mandatory, and formation of, and capacity building of beneficiaries organizations such as Cooperative Society is an essential element to prepare the beneficiaries for self-operation and management of the schemes.

There are potential to supplementary irrigate and cultivate areas in the right hand site of the area in the upstream portion of the dam to get benefits from the available water in the dam by pumping during the dry-season. In the meantime, it is proposed to supplementary irrigate areas in the downstream areas using the available water from the 2 pipes by gravity. The reason for selecting these areas is that the users are ready to start these activities. The community groups and their willingness to start, supervise and cover all responsibilities for these activities are strongly required.

The next diagram presents summary outline and locations of the proposed pilot irrigation schemes and alternatives of water use in AkweraDam.

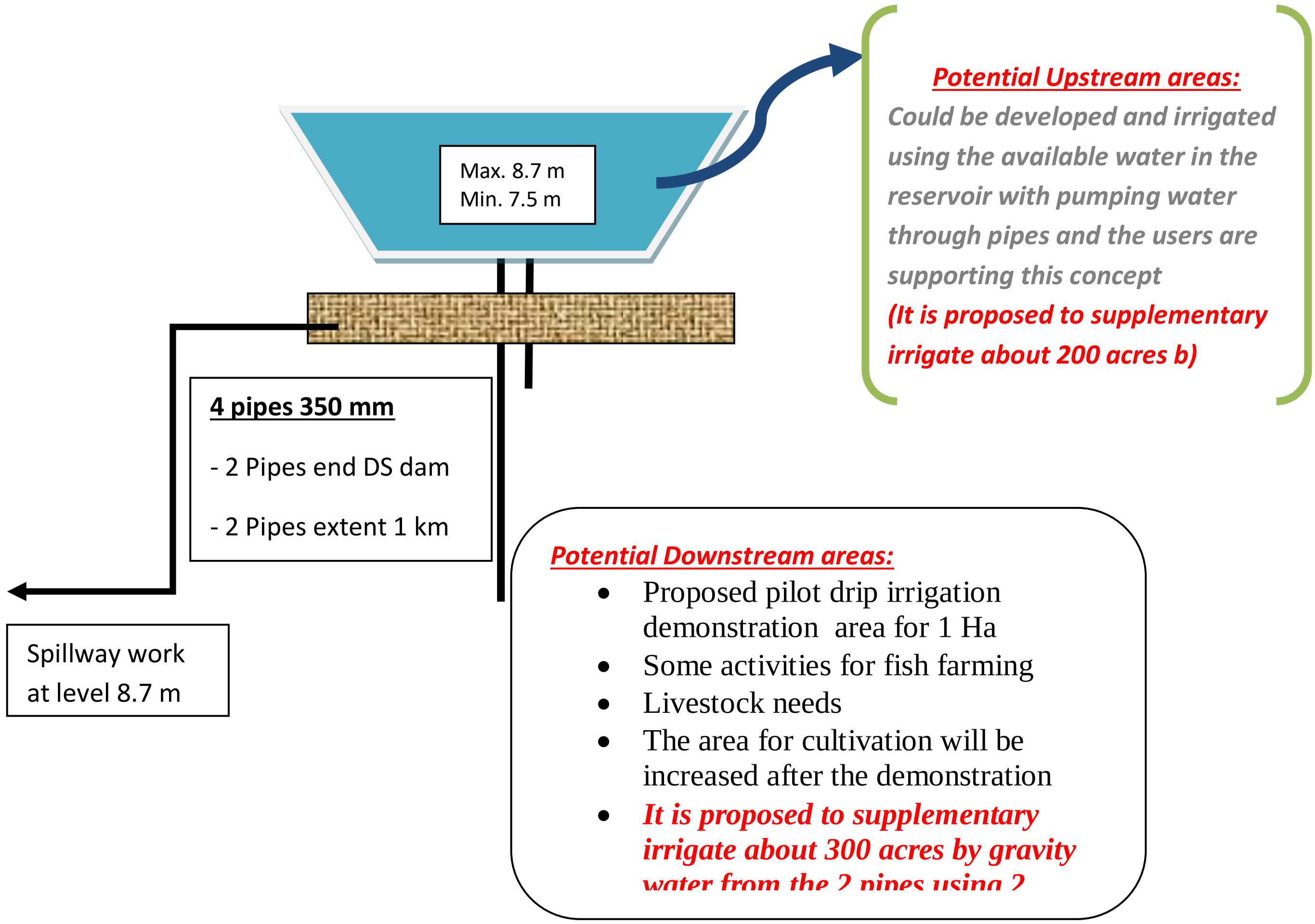


Figure 2.Outline and locations of the proposed pilot irrigation schemes

5. PROJECT AREA (AS IMPLEMENTED CASE STUDY)

5.1. General

Irrigation schemes depend on the supply of water from the source throughout the irrigation season. The reliability of that supply is an essential factor in the success of the irrigation scheme. Thus, once the "gross scheme irrigation need" of a scheme has been estimated, the flow of the river and the reliability of that flow during the irrigation season must be ascertained.

Table 1. Akwera Site Coordinates (U/S and D/S of the Dam)

	N	E		N	E
1	02 26 15.4	33 14 51.6	**10**	02 24 31.27	00 13 27.12
2	02 26 0 9.9	33 15 8.6	**11**	02 25 53.15	33 14 38.66
3	02 26 00.9	33 14 50.2	**12**	02 25 54.83	33 14 46.96
4	02 25 44.14	33 14 14.31	**13**	02 25 50.43	33 14 34.24
5	02 25 26.3	33 14 0.3	**14**	02 25 44.76	33 14 25.64
6	02 25 12.88	33 14 14.31	**15**	02 25 39.53	33 14 04.0
7	02 25 05.1	33 13 59.6	**16**	02 25 49.17	33 14 00.3
8	02 24 41.4	33 13 41.76	**17**	02 25 40.36	33 13 38.2
9	02 25 35.56	33 13 10.9	**18**	02 24 54.02	33 13 45.1

5.2. Dam Site Design Data

- The approximate width of the dam is about 1.0 km and the length is about 400 meters
- The Water sources with adequate amounts are available all-over the year for the dam
- The designed maximum water level at the dam is 8.7 meter
- The drop of water level during dry season in Mid February is 1.2 meter
- The minimum water level is 7.5 meter according to existing and history measurements and then the dam start to receive water again.
- At the intake chamber, the water level is at the 8.70 meter mark and some water is flowing to the D/S through the Spillway to Moroto River
- The site faces two dry periods, the long one from Mid November until March, and the second from Mid June until Mid July*(see the related figure in the crop water demand section)*
- As investigated with the leader of the farmer group, the MWE constructed four pipes; two of them end just D/S the Dam and the other two pipes flow for about 1 km in the D/S valley, the pipes are 40 cm in diameters. The lower pipe was placed at a height 1 m from the bottom level of the dam; the other is constructed at a height 6 m from the bottom to ensure receiving water in different water levels at the dam.
- The spillway, embankment, the intake chamber and the bridge are in excellent structural conditions.
- The Dam is about 1.3 MCMdesign capacity; *(this amount should be enough for the planned areas to be supplementary irrigated during the drought periods for about 3 months).*

6. RESEARCH METHODOLOGY

The design of a project configuration and the selection of an irrigation strategy and of control equipment to meet that strategy depends on a number of physical, social, managerial and economic considerations. No control strategy and no equipment are ideal for all situations found in irrigation projects. The delivery service should be as much as possible user leaning. Reliability and equity of water delivery are the basic features of irrigation service. However, providing some form of flexibility in duration, flow and interval of irrigation should be considered during the planning stage.

A basic qualitative survey was used to collect information on socio-economic characteristics in the project areas required for the design of this pilot irrigation schemes. The preparation phase of the study included identifying all stakeholders and working out a list of all required data.The methods used to gather the information included a series of interviews, discussions and consultations with selected representatives of the community members. Information and data was also obtained through secondary sources and by direct observation.

The development of the resource allocation strategy then follows these steps:

1. Clearly define the objectives of the supplementary irrigation activities.
2. Lay out the different elements of the resource strategy in terms of initial allocation and mechanisms for future operation.
3. Plan technical layout of irrigation system, irrigation organization and support structures for project implementation in tune with the resource allocation strategy.
4. Clarify the principles to be respected while pursuing these objectives (using the consensus-oriented approach involving all major stakeholders in the development of the proposal to ensure sustainability).

Emphasis was placed on reviewing relevant documents and reports, assessment of water potential and existing facilities, irrigation water demands, socio-economic reviews and design of appropriate irrigation water systems with the requirements of its management strategy and operation and maintenance of the provided schemes. The researcher used a participatory approach in executing the assignment. Community mobilization and development of effective farmer-based organization has been seen as a key element in the sustainability of irrigation development .Many Field visits were conducted in the target site project district.

7. HYDROLOGICAL ANALYSIS

7.1. General

As presented in the Feasibility Study Report-Central Region (WFP/MWE, 2012). The Hydrological Analysis of Catchment at the Dam's Site is presented. Akwera dam site is located on River Ipor. Land Ownership is Communal. The Site has a moderate catchment and is suitable for damming. Akwera Dam’s Catchment Area was delineated using a Digital Elevation Model.

The Catchment Area was calculated at 31.95 km2 with an Average Catchment Slope of less than 10%. River Ipor feeds Akwera Dam and is 10.7 km long as shown in the following figure.

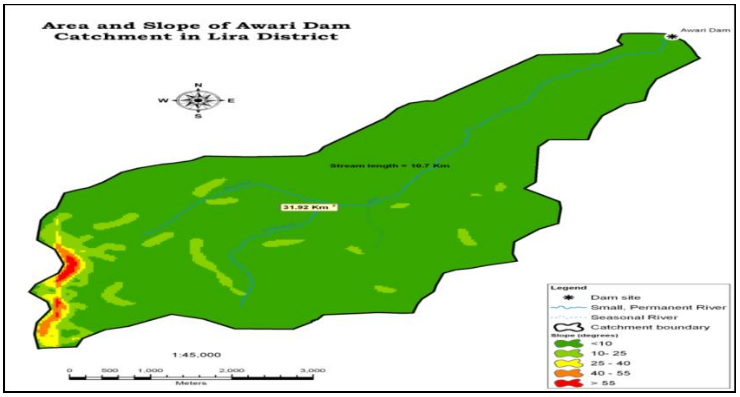


Figure 3. Catchment Delineation Akwera Dam

7.2. Climate data

Computing the water demand of crops requires commonly available climatic, water, soil and crop data. The climatic information was collected and crop water requirement is calculated with pen man- monteith method(CROPWAT8.0 software). The available climatic information was of more than 15 years, which enables to compute the probability of dependability. The climatic in formation was:

1. Temperature(minimum and maximum)
2. Wind speed mean
3. Mean sunshine hours
4. Mean relative humidity
5. Rainfall

The information on climate, the data on rain fall, temperature, wind speed, sunshine hours and solar radiation were collected from Meteorological stations in and around the project area. The data on natural resources were collected from Ministries of Agriculture/Water& Environment and National Forest Academy, Uganda.

7.3. Rainfall

The monthly rain fall received at Central Region was similar to that received at Akwera Site. The rainfall in most of the month sis more than 100mm per month.

Table 2. Mean Rainfall at Scheme's Site (average 22 years)

Jan	Feb	March	April	May	June	July	Aug	Sep	Oct	Nov	Dec	TOTAL
29.01	31.74	109.03	156.66	145.31	85.72	107.83	150.57	145.09	186.41	130.59	64.9	**1343**

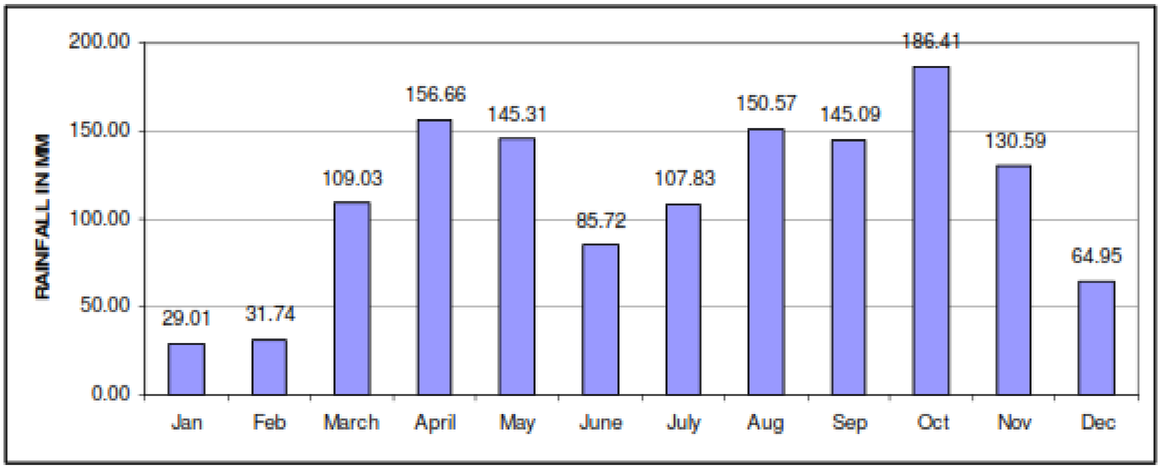


Figure 4. Rainfall at Scheme's Site

8. PILOT SCHEMES WATER REQUIREMENT

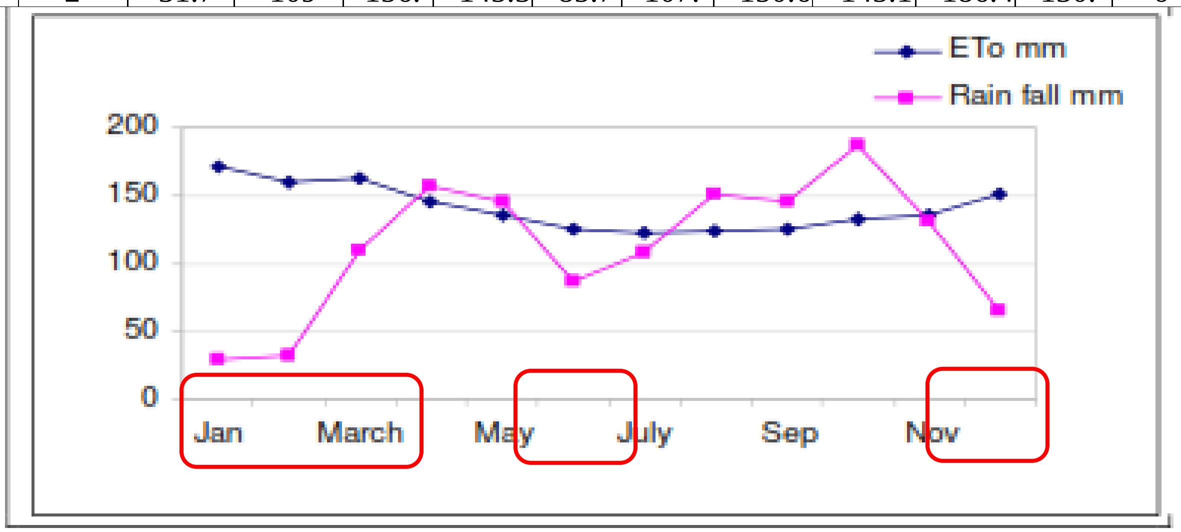
8.1. Crop Evapo transpiration

As there is still a considerable lack of information for different crops, the Penman-Monteith method is used for the estimation of the Reference evapo transpiration (ETo). Experimentally determined ratios of ETc/ETo, called crop coefficient (Kc),are used to relate ETcto ETo, there for ewe can express crop evapo transpiration as ETc= Kc * ETo. This is known as the crop coefficient approach to calculate crop evapotranspiration. Therefore, the Kc values for the paddy Rice was taken from FAO irrigation and drainage paper number 56 “Yield response to water".
The amount of water required to compensate the evapotranspiration loss from the cropped field is defined as crop water requirement. Al though the values for crop evapotranspiration under standard conditions(ETc) and crop water requirement are identical, crop water requirement refers to the amount of water that needs to be supplied, while crop evapotranspiration refers to the amount of water that is lost through evapotranspiration.

Detailed calculations were carried out and the values of ETo are given blow and compared with the expected amount of rainfall, so we can detect the areas and periods of dry spills to be covered by supplementary irrigation.

Table3. Mean Rainfall and Water Demand at Scheme's Site

	Ja	Feb	March	Apri	May	June	July	Au	Se	Oc	Nov	De	**Total**
ETo	171.4	159.3	163.0	145.	135.4	125.	122.7	124.3	125.7	132.3	13	151.5	**1691.**
Rainfall	2	31.7	109	156.	145.3	85.7	107.	150.6	145.1	186.4	130.	6	**1342.**



Draught Periods (to be covered by Supplementary Irrigation)

Figure 5. Comparison of available rain water and scheme's water demand

8.2. Scheme Water Requirement Determination

Scheme water requirement deals with the irrigation water need of an entire irrigation area. The supply of irrigation water to the entire irrigation area is the continuous flow of water required for good crop production during the irrigation season. In other words, it is the flow of water actually applied to the irrigation area, continuously after taking the operational criteria into account. There is always some water stored on the field (in case of paddy rice).

Therefore, scheme water requirement can be supplied continuously without affecting crop production. Thus for the proposed project the scheme water requirement is determined based on the proposed cropping pattern and the following detailed soil water characteristics.

8.3. Gross Irrigation Requirements (GIR)

For the gross irrigation requirement,70% of the field irrigation efficiency was considered. The GIR for irrigation of 500 acres found to be about 0.850 MCM; the following assumptions were considered for the supplementary irrigation needs:

- ✓ Average Supplementary water needs : 0.75L/S/Acre (Rice crop) including losses
- ✓ Application period : 12 hours,
- ✓ Application Supplementary amount per Acre : 32.4 m^3/day including all losses
- ✓ irrigation frequency (duration) : 2 times/week for a design crop as Rice
- ✓ Maximum draught periods : 3months (13 weeks)
- ✓ Total water needs for the 2 schemes (500 Acres) : about 0.85MCM (available stored water in dam's lake about 1.3 MCM).
- ✓ *As a conclusion the DIR for these pilot schemes are available during the dry periods.*

9. DESIGNED BUILDING CAPACITY AND IMPLEMENTATION PHASES

9.1. Framework for developing the Capacity Building Strategy.

The diagram below provides a simple framework for developing a plan for building capacity was used to run the introduced pilot supplementary irrigation scheme in Akwera and can be used for such similar small scheme irrigation project in WfP-MWE:

9.2. Phase 1: Determining nature of the 'gap'

The first phase was an assessment process to define the present capacity within the local and national stakeholders of Water for Production both at Technical and managerial level. This established the baseline and addressed the basic question - (*where are we now?)*. In determining the nature of the gap, the District and Community Field Visits method was used.

9.3. Phase 2: Deciding on overall strategy

The purpose of this phase was to decide on the broad strategy and to determine which area or areas should receive emphasis; *(Where do we want to go?).*

9.4. Phase 3: Determining priorities and set timeframes

With a choice of a broad strategy in hand, establishing a set of priorities and specific objectives as well as a timeline for meeting these was established. Proper sequencing of related activities was essential to the smooth implementation of the strategy.

It was agreed that some goals must be met before others can begin because of reasons like the need to test the training and constraints in finances and human resources; *(How do we get there?).*

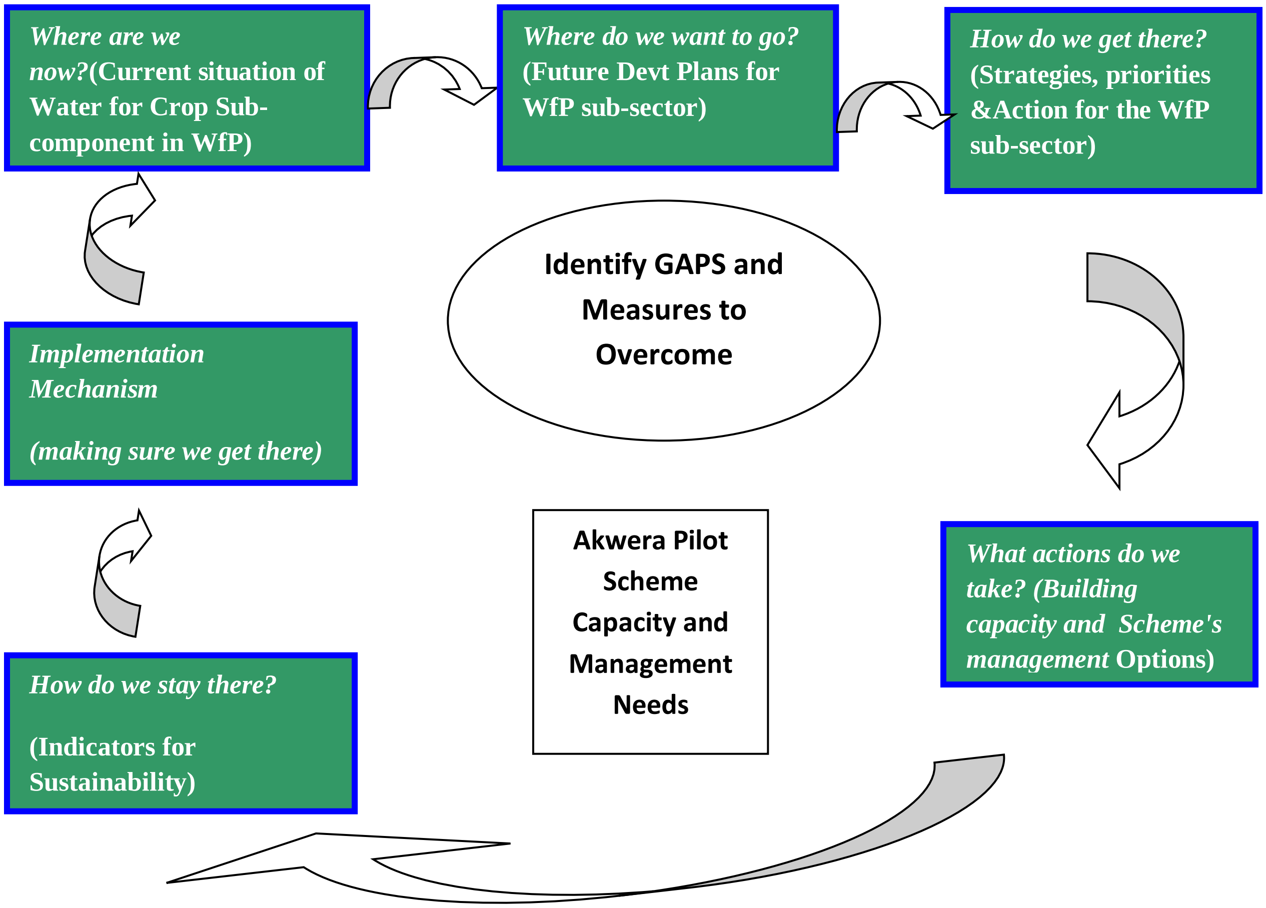


Figure 6. Design of Capacity Building diagram for Scheme's management

9.5. Phase 4: Matching the need to appropriate capacity-building techniques

This Phase identified the most appropriate techniques that were to be followed in the implementation. It is a combination of People-Oriented Approaches (on the job-training, short courses, skill development etc) and Organization-Oriented Approaches (e.g. use of consultants to conduct organizational development reviews). the options to secure project's *management and sustainability* were covered.

10. OUTCOMES AND RESULTS

10.1. General

The stated objective of such prefeasibility study is to obtain equity through simplicity of design. The frequency and sometimes the duration of irrigation are adjustable. In the preparation of this new design procedures and standards, an important distinction is to be made between the design of new projects and the rehabilitation and modernization of existing ones. The modernization of existing structures is aiming to use of existing facility, minimizing the costs, improving performance, and changing the quality of service.

Main Impacts of the proposed Irrigation communities in Akwere Site:

- Improve the lively hoods of the communities in near by Villages by enabling them achieve household food security (rice cultivation), and incomes through the production and selling of horticultural crops;
- Promote farming of short cycle crops which are also moderately suitable;
- Provide employment opportunity to some members of the local community;
- Provide an opportunity for training local people on operation and maintenance the improved irrigation scheme

10.2. Designed Irrigation Scheme Upstream The Dam and Tentative Implementation cost

The following figures represent sample potential area for the proposed pilot supplementary irrigation project the area is about 200 acres, other areas could be available for possible extensions, the users in the area are willing to support the operation of this pilot project.

The proposed design for the irrigation system is given, it is planned to pump water from the lake of the dam to the area through a pipe system. The layout of the designed irrigation networks (main, branch and field) levels with its required diameters are calculated. The prefeasibility study is given with the tentative cost estimates for the required system's component using the exiting local prices (1US dollar about 3400 UGX-Uganda Shilling).

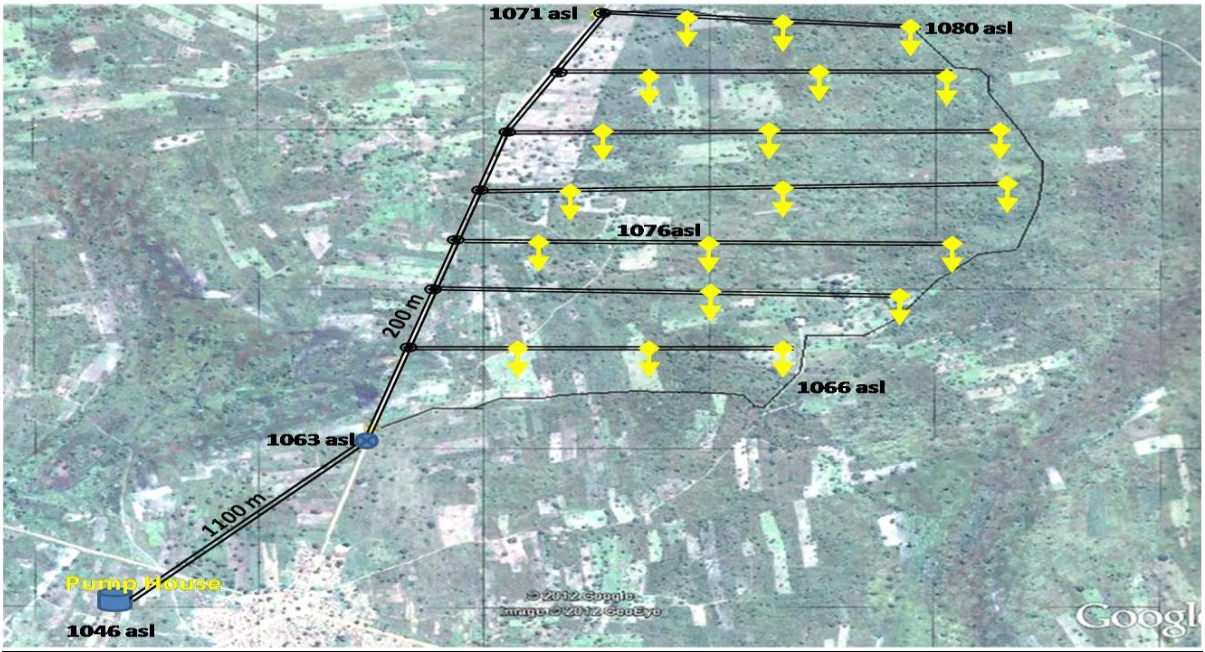


Figure 6. Proposed Layout and design of the supplementary irrigation system for the pilot scheme

Table 4.Tentative Estimate for Bill of Quantities for Establishment of irrigation distribution system (200 acres US Akwera Dam) 1 $ (US Dollar) = 3500 UGX (Uganda-Shelling)

Item	diameter (mm)	Unit	Number	Unit cost UGX	Cost UGX
Intake from the reservoir	600 mm	m	50	156,000	7,800,000
Diesel pump	50 L/sec , lifting head 50 meters	pc	4	30,000,000	120,000,000
Pump house	3x3x3.5 m	pc	1	6,000,000	6,000,000
UPVC pipe PN10	250	6m	460	662,160	304,593,600
UPVC pipe PN10	160	6m	1000	335,400	335,400,000
Control valve	200	pc	12	21,600	259,200
Control valve	160	pc	64	140,400	8,985,600
Air release valve	32	pc	9	162,000	1,458,000
Elbow PE 90	250	pc	2	120,000	240,000
T connector	200/160	pc	11	102,000	1,122,000
T connectors	160/160	pc	64	84,000	5,376,000
Flange	200	pc	8	60,000	480,000
Flange	160	pc	128	42,000	5,376,000
Bush	200	pc	8	78,000	624,000
Bush	160	pc	128	66,000	8,448,000
Suction pipe	160	m	40	84,000	3,360,000
Super Glue	PVC type	kg	15	18,000	270,000
Bush clearing and leveling		acre	200	240,000	48,000,000
Drains networks		m	2500	156,000	390,000,000
Road constructions		m	6,000	24,000	144,000,000
Sub Total cost					1,391,792,400
Allow 15 % physical contingency					208,768,860
Allow 25% Labour Costs, fuel and Supervision					347,948,100
Grand Total UGX					1,948,509,360

10.3. Designed Irrigation Scheme D/S The Dam and Tentative Implementation cost

One of the main steps in detailed design is to reconcile the flows and times with the total flow and its duration allocated to the field from the water supply. On small fields, the total supply may provide asat is factory coverage when used to irrigate the whole field simultaneously. However, the general situation is that fields must be broken into' sets' and irrigated basin by basin.

The se sub division sor'sets 'must match the field and its water supply. Thus, with the sub divisions established, the final land levelling is under taken. Once the field dimensions and flow parameters have been formulated, the surface irrigation system must be described structurally. To apply the water, pipes or ditches with associated control elements must be sized for the field. The following diagram presents the proposed design for the irrigation scheme D/S of Akwera

Dam using the existing water supplied by the piped system with gravity surface water system for an area about 300 Acres in the first phase.

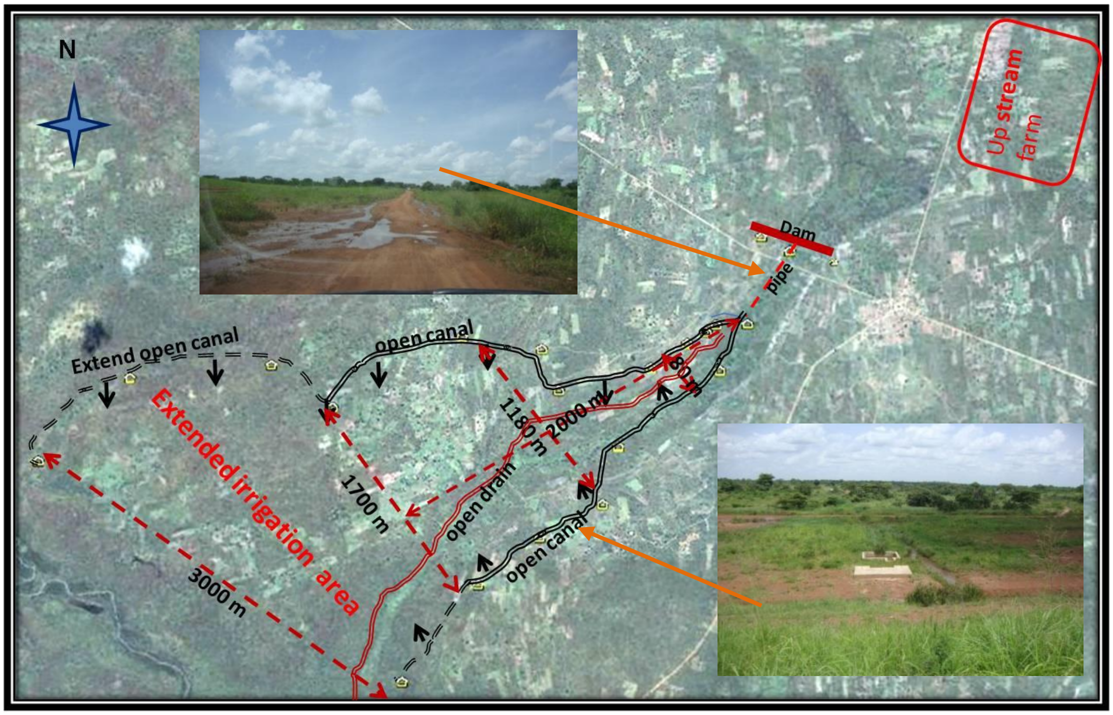


Figure 7. Proposed Layout and design of the supplementary irrigation system for the pilot scheme

The previous figure represent sample potential area for the proposed pilot supplementary irrigation project downstream the dam , the area is about 300 acres, other areas are be available for possible extensions, the users in the area are willing to support the operation of this pilot project. The proposed design for the irrigation system is given, it is planned to use water from the available two pipe DS the dam and direct it by gravity into two open canals in the outer-side of the land and use the current stream in the middle as main drain system. The prefeasibility study is given with the tentative cost estimates.

Table. 5. Tentative Estimate Bill of Quantities for Establishment of irrigation infrastructures distribution system (gravity flood plain) - (300 acres D/S Akwera Dam)

Item	unit	quantity	cost unit UGX	Total cost UGX
Bush clearing and land preparation	acre	300	240,000	72,000,000
Open canals excavation	m	3500	120,000	420,000,000
open drain excavation	m	3000	156,000	468,000,000
Control gates	pc	50	720,000	36,000,000
Check gates	pc	30	840,000	25,200,000
Roads constructions	m	10,000	24,000	240,000,000
Sub total				**1,261,200,000**
Allow 15 % physical contingency				189,180,000
Allow 25% Labour Costs, fuel and Supervision				315,300,000

11. PROPOSED SCHEME MANAGEMENT AND NEEDS ASSESSMENT

11.1. General

Participatory approach is an effective tool for resolving water delivery and distribution problems and for developing service agreements and accountability mechanisms. Considering the need for sustainable management of structures and systems, the proposed model to be adopted should of necessity be a business model. The business model will ensure delivery benefits/rewards to the most efficient members and allocate costs depending on quantified inputs used those members, while maintenance of common infrastructure for access to water for production must be guaranteed.

Capacity development will not yield fruitful results unless there is an adequate organizational environment to facilitate training and performance. This calls for provision of equipment, tools, time and space to facilitate the process for this pilot schemes and other similar small scale irrigation project in MWE. All activities should be aligned with the roles and responsibilities of the various stakeholders as clearly spelt out in the prepared water management and its Training Manual (ElKassar, 2012).

Acquirement and gaining of critical skills for lowest possible management groups at user level is very critical in management and sustainability of water for production facilities. Community management of WfP facilities involves mobilizing community members to take responsibility of operation and maintenance. This will only be achieved through continuous capacity building training especially to the Water User Committees WUCs and users who are responsible for water service sources. Optimal scheme management is achieved by having a technically fully functional irrigation system and by planning of crop cultivation and planting dates including harvesting time before the growing season. The diagram below presents the scheme level structural organization and governance flow of authority.

SCHEME GOVERNANCE STRUCTURE

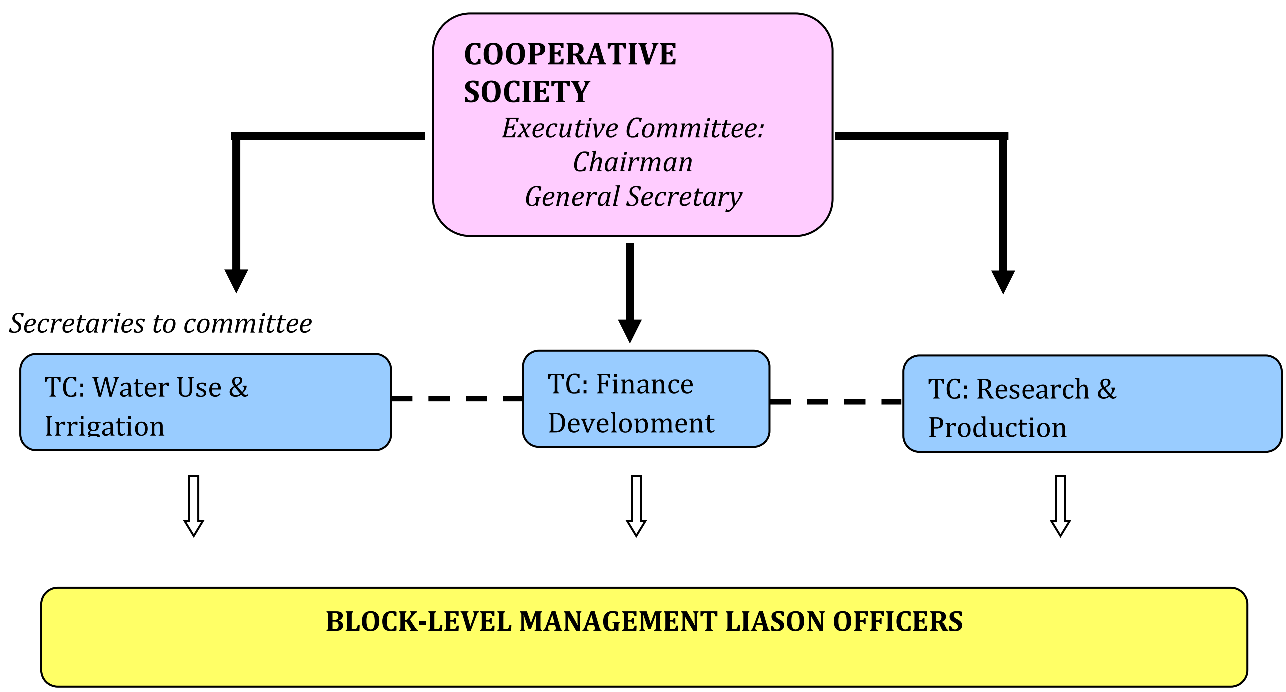


Figure 8. Designed Structure for Pilot Irrigation Scheme's management

The proposed Cooperative Society will draw its authority from the membership – General Assembly, which will elect offices – Executive Committee. The Executive Committee will then be mandated to hire technical staff headed by and answerable to the General Secretary. The technical officers so appointed will also act as secretaries to the relevant committees.

11.2. Scheme's Technical Committees TCs

There may be three mandatory technical committees although the individual cooperative societies can be allowed influence to form any number of committees deemed necessary for proper functioning of the operations of the schemes. Staff and technical committee members shall be rewarded in accordance with terms and conditions agreed by the General Assembly and approved by the Chief of Cooperatives.

The functions of the three Technical Committees TC cold be illustrated as follows:

11.2.1. TC – Water Use & Irrigation

This committee will primarily be responsible for water use planning, management and regulation within the scheme. It will also be charged with ensuring compliance with the abstraction permit conditions and will be the advisory committee to the Executive Committee and cooperative society on matters of water use and irrigation.

Other functions may include;

- Execution of different activities with cooperative society-assigned funds, as required,
- Supervise maintenance of scheme's channels at the end of each rainy seasons,
- Regulation of the use of water among the various blocks; under its scheme of influence,
- Ensuring equity of water distribution.

The above functions are only indicative and may be adjusted from time to time according to the interests of the respective cooperative societies.

11.2.2. TC – Finance & Business Development Services

This TC will be responsible for compiling operation and management expenses, computing and recommending membership rates and fees, developing draft budgets and monitoring budget performance. Additionally, the committee will develop mechanisms and procedures for collection of membership contributions for O&M and ensure value for money on expenditure outlays.

11.2.3. TC – Research & Production

This TC will be responsible for all tangible and intangible inputs and support processes for improved production, productivity and quality. The committee will liaise with research agencies as mandated, but may not enter into any contractual relationships with external parties except where expressly authorized in accordance with the Act.

The following training modules were prepared and covered with the stakeholders in the project's area:-

a) Operation and Maintenance of Water for Production (WfP) facilities
b) Project Cycle Management for water for Production
c) Roles and responsibilities of stakeholders and communication
d) Procurement and contract management for Water for Production (WfP)

12. CONCLUSIONS AND RECOMMENDATIONS

- A complete prefeasibility study for the implementation of two pilot supplementary irrigation schemes were designed. The proposed capacity building and required operational management structure were presented, also The tentative implementation costs were estimated.
- The introduced study presents the layout designs of the suitable supplementary irrigation systems for two pilot schemes as follows:
  - An area of about 200 acres in the upstream area using lifting water from the dam's lake
  - An area of about 300 acres in the downstream area of the dam using the available water from the 2 pipes to the designed two open canals.

- One of the major outputs of the study was the designed management structure and related capacity building techniques for the needs assessment for scheme's sustainability at Akwera Dam in Otuke District-Uganda.

- The community groups and their willingness to start, supervise and cover all responsibilities for these activities are strongly required.This factor is essential for the success of these pilot supplementary irrigation schemes.

- The Individual's Willingness to Pay in Monetary Value ; the majority of people say they are willing to pay for O&M of the pilot supplementary irrigation systems and the Water for Production Facilities.

- Detailed study that will cover all design elements to ensure a smooth way for implementations will be required, a team from WfP/MWE under the supervision of the Irrigation Adviser (Researcher) can lead such study and possibility of implementation of such pilot schemes in-house within the MWE to form a team that could manage and supervise similar project. In this feasibility study a detailed land survey and soil analysis for exact water requirement calculation will be needed for the selected areas and possible extension portions during later operation stages.

- A preliminary policy debate needs to be held in order to determine whether the MWE is willing and able to sustain a policy of "best alternative use" and water use efficiency on the basis of the IWRM concept and planning water allocations on the best of economic values.

13. REFERENCES

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