**THE UNITED REPUBLIC OF TANZANIA**
**MINISTRY OF WATER AND IRRIGATION**

# WAMI/RUVU BASIN WATER OFFICE

***Draft Report on Situation Analysis of Kizinga sub basin***


**by**

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## Executive Summary

The objective of the study was to establish the status of the Kizinga sub basin , threats negatively impacting on the sub basin and recommend intervention measures to arrest the situation. Furthermore to come out with a preliminary catchment management scenario

The survey reviewed relevant literature on the subject, interviewed key stakeholders in the sub basin and analyzed all information collected.

The survey has noted the level of environmental degradation in Pugu and Kazimzumbwi forest caused by illegal harvesting of timber, charcoal making, bush fires and sand mining. The later has greatly negatively impacted on the recharge of Kizinga river. Climate analysis has shown that rainfall has decreased over the years and temperature has increased considerably, the two factors has negatively impacted on water resources in the sub basin. Ground water is the major water source in the sub basin there tempering with environmental pollution will cause hazard in the sub basin.

Apparently Kinyamwezi dump site has been located in the neighborhood of Kinyamwezi tributary with support of an EIA report. However, it is a major polluting source as the whole city is dumping all the waste there. Apparently the geology and soil characteristics are sandy with ground water within 20-70m so pollution can easily be transferred through percolation.

Key drivers which are major challenges include, high urbanization rate in the sub basin without adequate planning. This is expected to negatively impact lead to poor sanitation due to un planned settlement and poor solid waste management. Other major challenge is irrigated farming of mostly vegetable inside the wetlands thus mining the recharge centre of Kizinga river particularly during the dry season. Irrigation of vegetable goes with fertilizers which lead to increased treatment cost to DAWASCO.

It was observed that during the survey in September which is the driest period Kizinga was not flowing from Kisarawe forest rather many springs within Kitunda area were responsible for the dry seasonal flow into Mtoni. Therefore protection of such wetlands areas is of prime importance.

All key challenges may be summarized as follows:

**A. Poor Governance**

**(a)** ***Weak Governance on Water and Natural resources within Kizinga sub basin***

Institutions mandated to oversee sustainable management of water and natural resources in the sub basin had not established a full time system for managing, monitoring and developments/threats that may alter negatively the ecosystem of Kizinga sub basin.

***(b) Weak enforcement of laws***

The environmental laws provides that the water catchments areas should be protected therefore the laws provide that 60 meters from the river bank should be conserved but contrary to that the residents residing 60 meters from Kizinga river **were given 2 year residential licenses since 2006.**

**B. Expanding Urbanization Without Adequate Planning**

(a) Un planned settlement encroaching Kizinga river into 60 m wetlands boundary

(b) Expanding population without adequate planning on **sanitation** and sold waste management which may threaten water resources

(c) Kinyamwezi dump site is within Kizinga sub basin although an EIA has positively approved it

**C. Expanding Irrigated Agriculture Within Kizinga Wetlands**

**( a)** ***Cultivation in swamps and river banks***

The river banks and swamps are heavily cultivated and water is used for irrigating the vegetables grown. It is claimed that about 30-40% of vegetable sold in Dar es Salaam are cultivated from the river banks and swamps of Kitunda

ward**.** The river banks and swamps have been deprived of their natural vegetation and left exposed facilitating loss of water through evaporation.

(b) Encroachment and degradation of important spring sources which are the recharge sources of suppliers of Kizinga during the dry season.
(c) Inefficient irrigation systems promotes high evaporation looses thus deplete water supply to Kizinga river.
(d) Heavy irrigation promote siltation which clog water treating costs at Mtoni treatment plant
(e) High fertilizers usage in the vegetable farming leads into increased costs in the treatment of water at Mtoni DAWASCO station

**D. Encroachment of Pugu and Kazimzumbwi Forests**

a) Encroachment of Pugu-Kazimzumbwi forest reserves for timber, charcoal making bush fires which all negatively impact recharging of Kizinga river
b) Sand mining in the Pugu Hills which leads into siltation of reservoirs and Mtoni pumping station

**E. Climate Change**

Rainfall analysis in Kiserawe and DIA has shown that rainfall has decreased in the recent years and that is coupled with increase in temperature as evidenced at DIA station. The result of the two variable is a negative impact on water resources . Minaki reservoir has decreased considerably

**Recommendations**

**A. Governance**

1. Establishment of a participatory Institution Framework comprising of all stakeholders enforce EMA and Water Act.

Key stakeholders include DAWASCO, City Council, Municipalities of Temeke, Ilala and Kisarawe District Council, Offices of the respective Wards in the Kizinga sub basin

including respective village governments(Mitaa). Others include NGOs (WCS, CARE WWF etc) , Kazimzumbwi and Pugu Catchment Forest

2. Enforce coordination of various authorities including lands, water and forest harmonise conflicting authorizations e.g giving 2 years licenses to settle in wetland boundary or issuing plots within wetlands

3. Undertake immediate action as invasion into the wetland is continuing at fast speed uncontrolled.

**B. Unregulated Urbanisation**

**1.** Promote urban Planning within the sub basin with sanitation and solid waste management

**C. Irrigated Agriculture**

1. Provide education on negative impacts of wetland encroachment and its implication to water resources and also to future irrigation
2. Explore for efficient irrigation techniques without destroying wetlands resources for water supply and improve economic wellbeing
3. Prohibit irrigated agriculture and negotiate for alternative income generating activities

**D. Conservation of Pugu and Kazimzumbwi Forests**

1. Enforce existing laws and promote participatory forest management including restriction on sand mining in the forest

**F. Hydrological Data Collection**

Strengthen data collection on stream flow and water quality which is not systematically recorded for sustainable management of Kizinga sub basin

**Compensation of human settlements within wetlands**

First of all settling in a wetlands within 60m is not allowed by EMA(2004) . However, people who may have settled within the wetlands before putting the beacons may require consideration. But people who settled after putting the wetland boundary (if records can prove that ) may not be considered at all. Therefore we can only talk of values of houses within the wetlands but who deserves the compensation is another matter requiring visitation to the existing laws.

**Compensation of agricultural land**

Agricultural land inside a wetland area within 60 m is difficult to consider for compensation but rather we can talk of economic values in the irrigated agriculture. So may be consideration of assisting in providing efficient irrigation systems outside the wetland to improve livelihoods. However, farmers in the Kitunda were arguing that water resources in Kizinga is not meant for Temeke people only but for all the residents. So Temeke residents may as well use ground water like them and let others utilize the waters as they wish. Temeke can also engage in vegetable farming downstream while using ground water source and not necessarily Kizinga river water.

**Benefit-cost implications**

The first outcome from the proposed management plan is change in agricultural output. The primary data and discussion with communities gives a clear picture on the decrease in agricultural output after implementation of watershed management plan. If farming within 60m will be banned, there would be reduce crop land by households in the catchment. Total ban from cropping would generate costs to communities who are currently deriving their income from livelihoods within 60 m area. Also, the ban would result to additional cost to Ministry of water from compensation for crops to those affected households.

In addition, the ban would result to reduced supply of crops to the community and this would lead to increased market price and also food insecurity. Some businesses in town are supplied with crops from Kizinga catchment, the ban would affect negatively these businesses in terms of supplies and they would have to look for alternative source of same products elsewhere, these would cause addition costs.

**Preliminary Catchment Management Scenarios**

1. Management scenario which will embrace all key stakeholders with implementation of the various recommendations mentioned above.

   Key stakeholders include DAWASCO, City Council, Municipalities of Temeke, Ilala and Kisarawe District Council, Offices of the respective Wards in the Kizinga sub basin including respective village governments(Mitaa). Others include NGOs (WCS, CARE WWF etc) , Kazimzumbwi and Pugu Catchment Forest

2. DAWASCO to seek alternative water supply for Temeke Municipality instead of Kizinga river due to its complexity and expected management costs. Explore the option of ground water in the area to provide service to the Temeke community at least equivalent to of 150,000 $m^3$/month which is what is supplied by DAWASCO during the dry season.

   Stakeholders upstream argue that may the Kizinga sources built since 1950 has outlived its life span due to the recent developments within the sub basin has rendered the original rationale redundant!

**Acknowledgement**

The research team would like to thank the various stakeholders who supplied various information as literature for reviewing, interviews undertaken and discussion held. Special thanks goes to WRBWO office in Dra es Slaam who worked hand in hand with the team throughout. Secondly, Manager DAWASCO Mtoni, Temeke Municipality, Kisarawe District Council , Manager Kazimzumbwi and Pugu forest Catchment Forest . Further the Chairmen of the various local government leaders within Kizinga sub basin in Temeke, Ilala and Kisarawe. We also acknowledge the irrigators in the sub basin particularly those in Azimio, , Makangarawe and Kitunda for accompanying the team in various activities.

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# SITUATION ANALYSIS OF KIZINGA SUB BASIN

# 1 INTRODUCTION

## 1.1 Background

The Government of the United Republic of Tanzania has proposed projects for priority investment in Wami/Ruvu Basin Water Office (WRBWO) within the framework of Water Resources Management Component of the Water Sector Development Programme (WSDP). The programme has an objective of developing a sound water resources management and development framework in the basin, optimising the utilisation of the water resources in a sustainable manner for various competing uses, and promoting good governance of water resources (URT, 2007).

In line with these objectives, WRBWO intends to implement a priority investment project namely protection of Kizinga catchment which is one of the important sources of water for residents of Temeke Municipality in Dar es Salaam Region. The project implementation will involve the following two phases: Situation Analysis and Catchment Management Strategy Formulation and Implementation of the Strategy.

## 1.2 Challenges in Water Resources Management

According to the National Water Policy 2002, the key water resources management challenges facing all basins is water resources depletion and rising demands. Extensive irrigation practices during dry season dry up rivers, thus disturbing ecosystems. This coupled with inefficiencies in water uses and leakages from domestic water supplies which have been estimated to cause significant water losses, contribute to reduction in water availability (URT, 2002).

Kizinga catchment has been facing degradation problems due to encroachments of the upstream Kazimzumbwi forests and agricultural activities along the river flood plan. As a result, serious deterioration in water quantity and quality has been recorded since 1990 (WRBWO, 2005).

## 1.3 Justification

Residents in the southern part of Dar es Salaam city (Temeke Municipality) rely mainly on groundwater because of the unreliable supply of water from Mtoni Treatment Plant drawing water from Kizinga River. Human activities along Kizinga River valley have reduced water flow, increased water pollution and environmental degradation. Formerly the supply of water from Kizinga River was 9,000 $m^3$/day against the current supply of about 1,500 $m^3$/day (WRBWO, 2005).

Some interventions have been carried out, initiated by WRBWO in collaboration with DAWASA. Concrete pillars have been installed in some parts along the river banks to stop human activities and further degradation. This project intends to manage the sub catchment for a sustainable use of the resources.

## 1.4 Integrated Water Resource Management (IWRM)

Integrated Water Resource Management (IWRM) is an approach that promotes coordinated development and management of water, land and related resources, in order to maximise the resultant economic and social welfare in an equitable manner without compromising the sustainability of the vital ecosystems (GWP, 2000). It integrates water use basin wide for sustainable livelihoods. The enabling environment for IWRM to function is policy and legislation whereby an overview of governance and institutional structures are clearly stipulated to ensure stakeholders participation.

Major challenges which have confronted the water sector in Tanzania have been increasing population and its related water needs, severe land degradation leading into high pollution in river. Sectoral planning has been uncoordinated which has lead to water use conflicts among upstream and downstream users. There is weak stakeholder participation in the governance of water resources in most of the basins in Tanzania.

In order to address the above challenges the government of Tanzania decided to adopt IWRM approach in managing water resources .Currently, basins across the country are developing IWRM plans. The approach involves integration of various attributes as follows:

- Integration of freshwater management and the coastal zones management. Fresh water managers should consider the requirements of coastal zones when managing water resources.
- Integration of land and water management. Land use developments and vegetation cover influence the physical distribution and quality of water and must be considered in the overall planning and management of water resources. Good catchment and river basin management is important.
- Integration of surface water and groundwater management. The widespread use of agro-chemicals and pollution from non-point sources pose significant threats to groundwater quality and force managers to consider the linkage between surface and groundwater.
- Integration of quantity and quality in water resources management. Water resources management entails the development of appropriate quantities of water with adequate quality
- Integration of upstream and downstream water related interests. Consumptive losses upstream will reduce river flows. The pollution loads discharged upstream will degrade river quality.
- Land use changes upstream may alter groundwater recharge and river flow seasonality.
- Flood control upstream may threaten flood dependent livelihoods downstream.

## 1.5 An Overview of Kizinga sub basin

### 1.5.1 Location of the study area

The Kizinga sub-catchment is within the Wami/Ruvu Basin. The sub catchment is located within three districts which are Kisarawe (Coastal region), Ilala (Ilala Municipal Council), and Temeke (Temeke Municipal Council). The sub catchment covers partly in Dar es Salaam region and Coastal region.Wami/Ruvu Basin where Kizinga sub catchment is located.

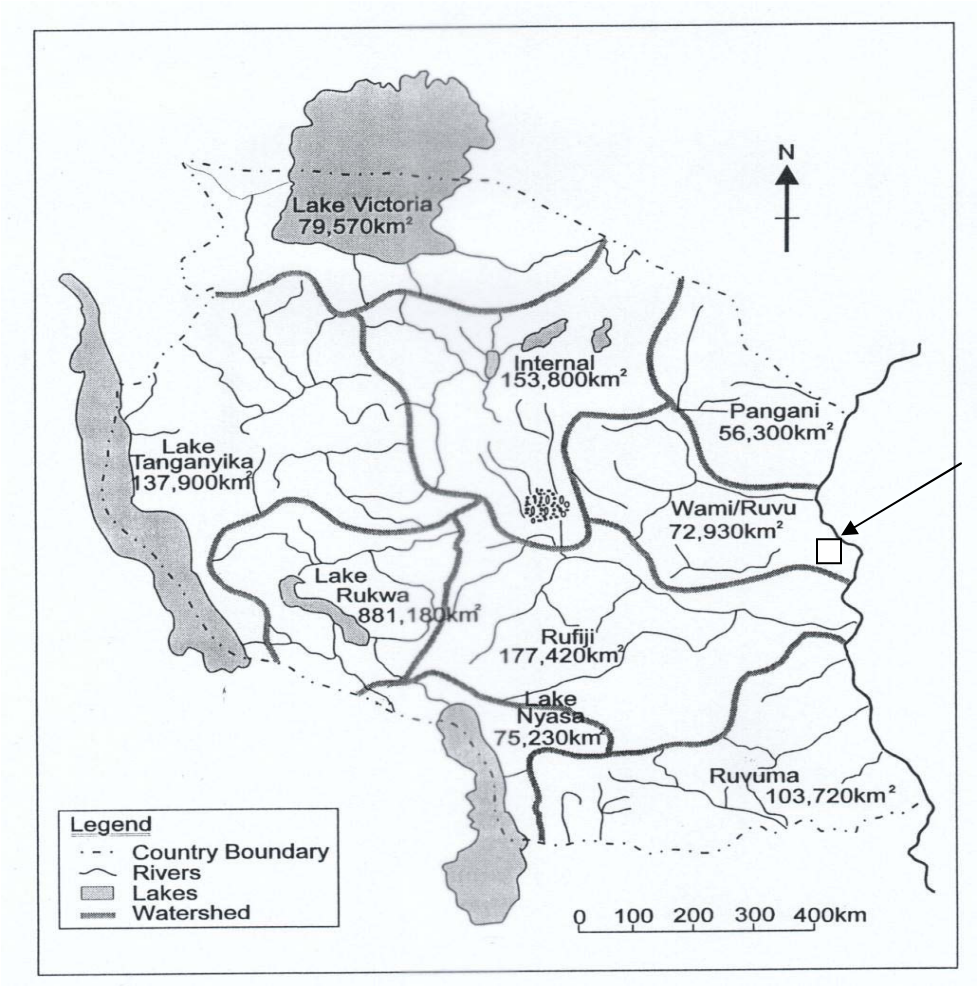



**Fig 1.1 Location of Kizinga sub basin in Tanzania**

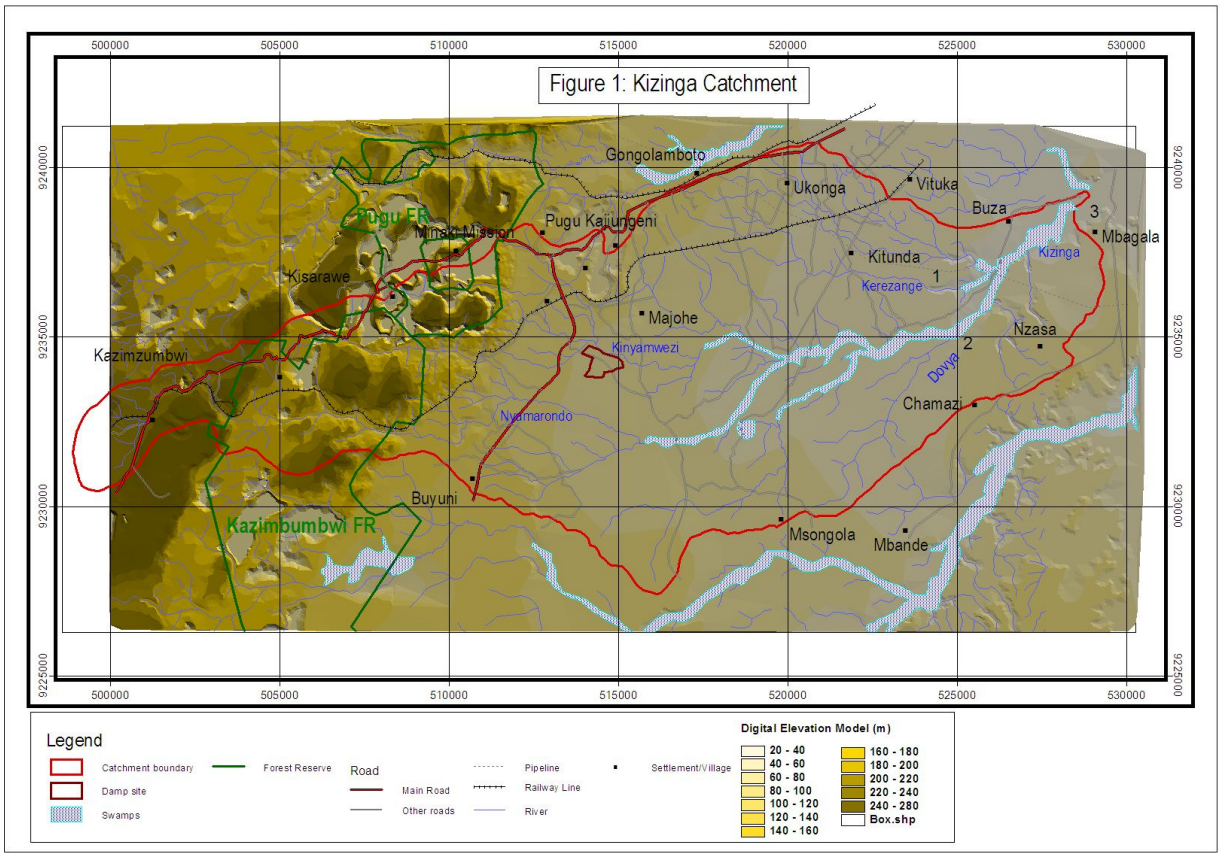



**Fig 1.2 Map of Kizinga sub basin**

### 1.5.1 Climate

Kizinga sub basin has an area of about 198 km$^2$ (Map 1 ) draining from the highlands of Pugu and Kazimzumbwi forests to the lowlands in Ilala and Temeke Districts as it empties to the Indian Ocean. Rainfall variation in Kizinga sub basin can be represented by rainfall patterns in Kisarawe in the highlands of Pugu and Kazimzumbwi while Dar es Salaam International Airport(DIA) represents the lowlands.

The annual rainfall in DIA range between about 800 mm to about 1600 mm with year to year variation while that of Kisarawe range between 800mm to about 2400 mm. There is year to year variation and there are periods of wet and dry patterns in all stations. The mean annual rainfall in the sub basin shows to range between 1000-1200 mm.

### 1.5.2 Geology and Hydrogeology

The study area comprise of largely Neogene formation which consist of interbedded sandy clays and clayey sands with minor lenses of pure sand or clay (Fig 5 ), (Temple, 1970). The gravel mostly quartz, some feldspar and some Precambrian gneiss is scattered throughout still clays in a clay matrix. The aquifer is a fractured aquifer and flows are dominantly in fissures, fracture zone and other geological discontinuities (JICA, 1994).

The typical bedrock underlying some areas of the sub catchment is sandstone and limestone, whereby, the former occupies about three-quarters of the area (Mato, 2002). The overburden consists of residual as well as transported soils. Generally, the soils within the sub catchment vary from gravel to sands, silts and clays. The residual soils are widespread on uplands with thickness up to 5m, while transported soils are found in the creeks with thickness up to 7m (Mato, 2002).

The limestone is mainly of coralliferous and is found along a narrow coastal belt. Kaolinitic sandstone consisting of fine to medium grained quartz sand and sandstone occur at the Pugu hills. The sub catchment also lies within an area that is traversed by swarms of lineaments and faults (Mato, 2002).

The area is plain, relatively flat, gentle sloping with a small surface gradient. Surface water flows following gradients of the areas according to the topography setup. The sub catchment consists of two main forest reserves namely Pugu Forest Reserve and Kazimzumbwi Forest Reserve where the Kizinga River and its tributaries start. Drainage of the area follows the major topographical features of the catchment. Drainage occurs from the upstream forest reserves to the lowland areas.

The area is characterized by low-lying terrain with increasing altitude of between 60 m to 280 m above sea level at Pugu and Kazimzumbwi, respectively. There are two main geological formations within the area:

(i) Quaternary rocks; These consist of alluvial deposits, coastal plain deposits, and limestone and (2) Negene deposits; The deposits from the Miocene to Pliocene

period and are of two types: i) Undifferentiated deposits; these occurs in the upper reaches of Kizinga catchment, Mostly consists of interbedded sandy clay and clayey sand and ii) Pugu Hills Kaolinitic sandstone; these consist of fine to medium quartz sands which are rich in Kaolin and sometimes feldspar. These occupy mostly highland areas of the study site. Moreover, the sub catchment has the following characteristics as indicated in table 1.1 below.

**Table 1.1 Catchment characteristics**

| Catchment's Characteristics | Kizinga River cathment |
|---|---|
| Area ($km^2$) | 191 |
| Mean annual rainfall (mm) | 1050 |
| Mean annual runoff (mm) | 85.8 |
| Mean annual runoff ($m^3/d$) | 45.0 |
| 95% reliable runoff (mm) | 10.1 |
| 95% reliable runoff ($m^3/d$) | 11.5 |
| Average Recharge ($10^6m^3/yr$) | 37.46 |
| Minimum Recharge ($10^6m^3/yr$) | 9.6 |
| Maximum Recharge ($10^6m^3/yr$) | 66.65 |

**Source:ERC, 2004**

### 1.5.5 General Objective of the project

The overall objective of the project is to lay a foundation for sustainable management of water and other resources in the Kizinga sub catchment.

Specific objectives of the project are as follows:

- To increase river flows
- To restore the natural environment of the entire River catchment
- To develop a comprehensive groundwater and surface water management programme for the Kizinga River Sub catchment
- To involve the neighboring communities in the catchment protection

**Scope of work**

The scope of work for the situation analysis includes assessing the situation of surface and groundwater development in the catchment, activities carried out in the catchment and the nature of forests.

The scope of work should include gathering information on the following:

- Water resources (surface and ground) of the catchment.
- Other natural resources related to water
- Challenges facing the catchment
- Key stakeholders who may be important in implementing the catchment management strategy

### 1.6 Summary of data and information sources

Data and information was derived from literature review and complemented with interviews carried out with key stakeholders in the Kizinga sub basin (see Annex 1) as well as observation from the physical visit. The interviews were aimed to determine activities as well as challenges and opportunities in hot spot areas of the sub basin (See Annex 2)

### 1.7 Structure of the Report

The Report presents an Introduction in Chapter one giving perspectives of challnges of water resources management in Tanzania and in Kizinga sub basin in Particular.
Chapter 2 is the Methodology whereby an approach used is presented. Annex 3 indicates the general checklist used to capture key issues , interventions undertaken and recommendations from various stakeholders.

Chapter 3 presents the results of the study in various components i.e water, and environmental pollution and other natural resources. Challenges are presented in Chapter 4 and Key stakeholders are summarizes in Chapter 5. Preliminary Catchment Scenarios appears in Chapter 6 while Conclusions and Recommendations are contained in Chapters 7and 8 respectively.

## 2. METHODOLOGY

The Team was multidisciplinary comprising of water resources, environmental engineer, land use expert, economist and an expert in Valuation. Therefore an integrated approach was used to capture cross cutting issues but analysis was disciplinary with a common

target of establishing ways to bring back the Kizinga sub basin into its former healthy ecosystem.

Cross cutting approaches included literature review on each subject matter, data collection from relevant institutions, physical visit of the study area including stakeholders interviews in the sub basin. (Annex 1 indicates institutions consulted and Annex 2 a general checklist of issues probed in the study ).

# 3. RESULTS

## 3.1 Water Resources

### 3.1.1 Surface Water Resources

#### 3.1.1.1 Climate Analysis

Climate in the study area shows that the minimum temperature evolved around $21^0$C while the maximum temperature has been slightly lower than $31^0$C. Minimum temperature shows to have increased over time while the max temperature has relatively remained almost constant (refer to Fig 3.1 below) . Annual rainfall in DIA (Fig 3.1 and and Kisarawe (Fig 3,2 ) shows that it has fluctuated up and down over the years with a general rainfall decline in DIA with a small increasing trend in Kisarawe.

However examining the annual rainfall in the two stations for the period 1990-2008 ( Figs 3.3 and 3.4 ) it is observed that rainfall has been decreasing quite considerably over time.

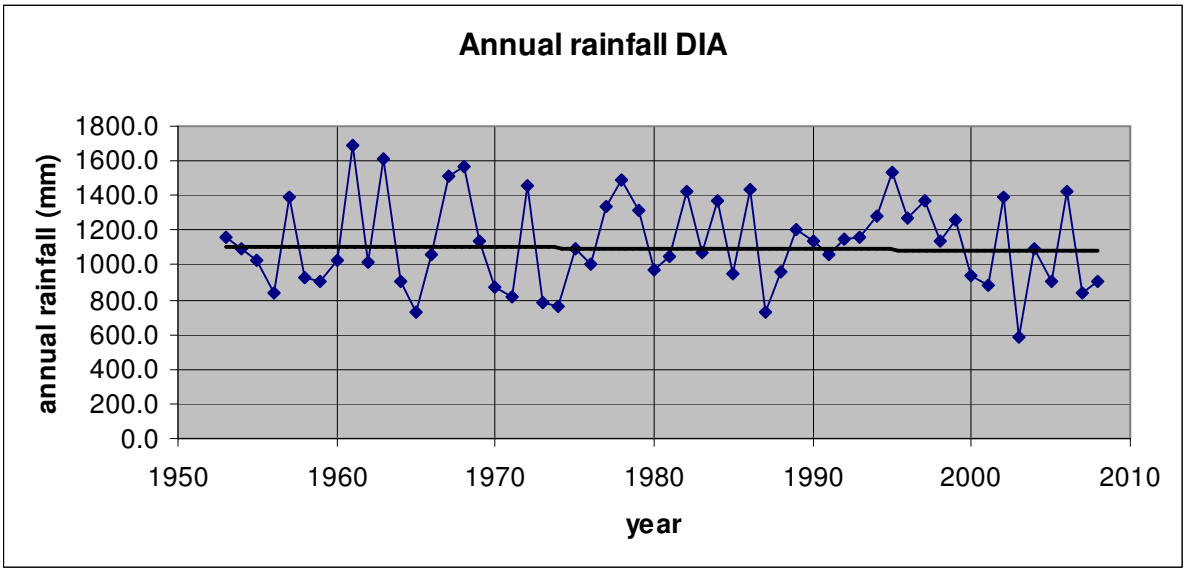



**Fig 3.1 DIA annual rainfall variation**

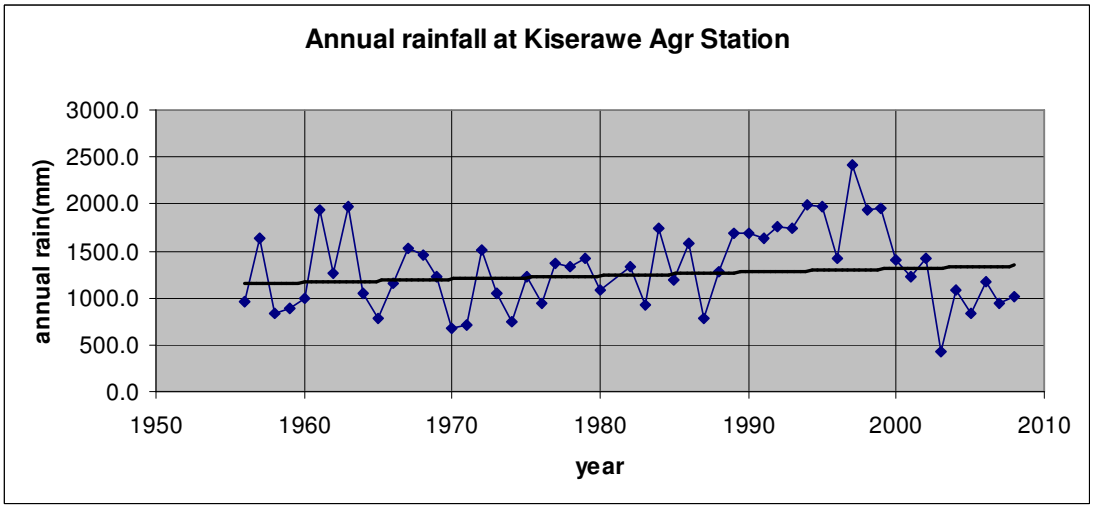



**Fig 3.2 Kisarawe annual rainfall variation**

### 3.1.1.2 Impact of Climate change on Water Resources

It has been shown above that annual rainfall has been decreasing in both locations DIA and Kisarawe stations between 1990-2008. Examining the temperature variation at DIA its is observed that the Maximum temperature has not increased but the minimum temperature has increased. This means that if the rainfall has been recently decreasing and temperature (global warming has increased) then evapotranspiration will have increased also impacting negatively on the water resources in the sub basin (Refer to Fig on Minaki Reservoir shrinking due to extended droughts and increased temperature).

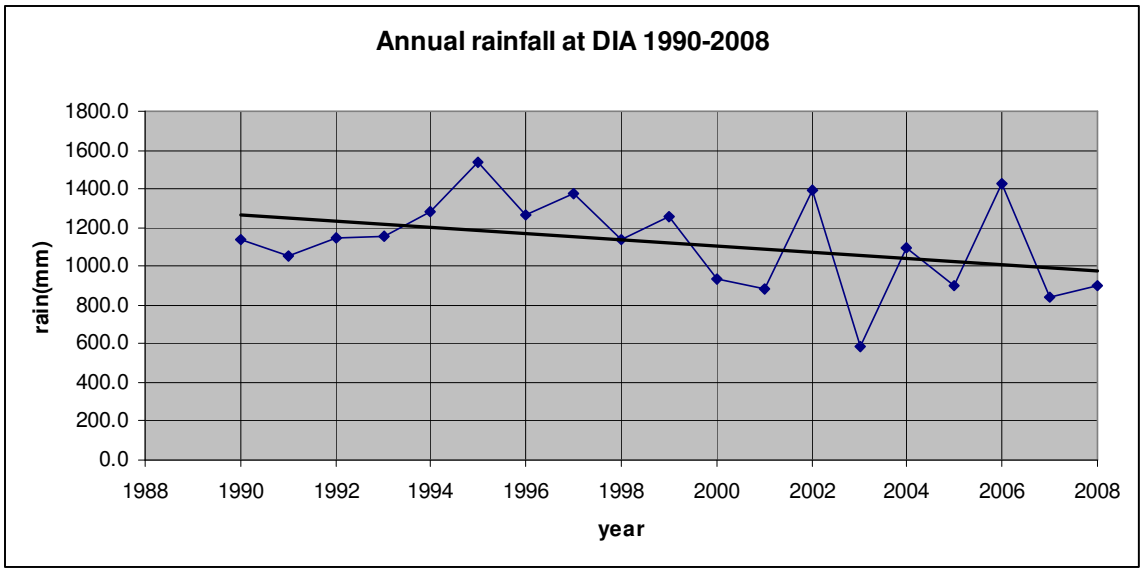



**Fig 3.3 Annual rainfall at DIA 1990-2008**

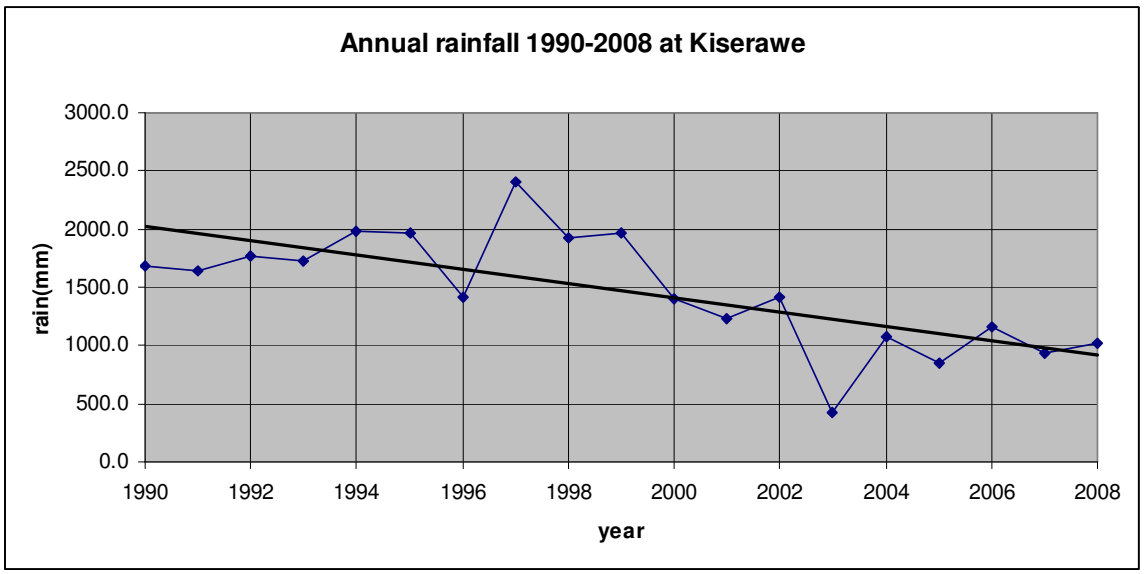



**Fig 3.4 Annual rainfall at Kisarawe 1990-2008**

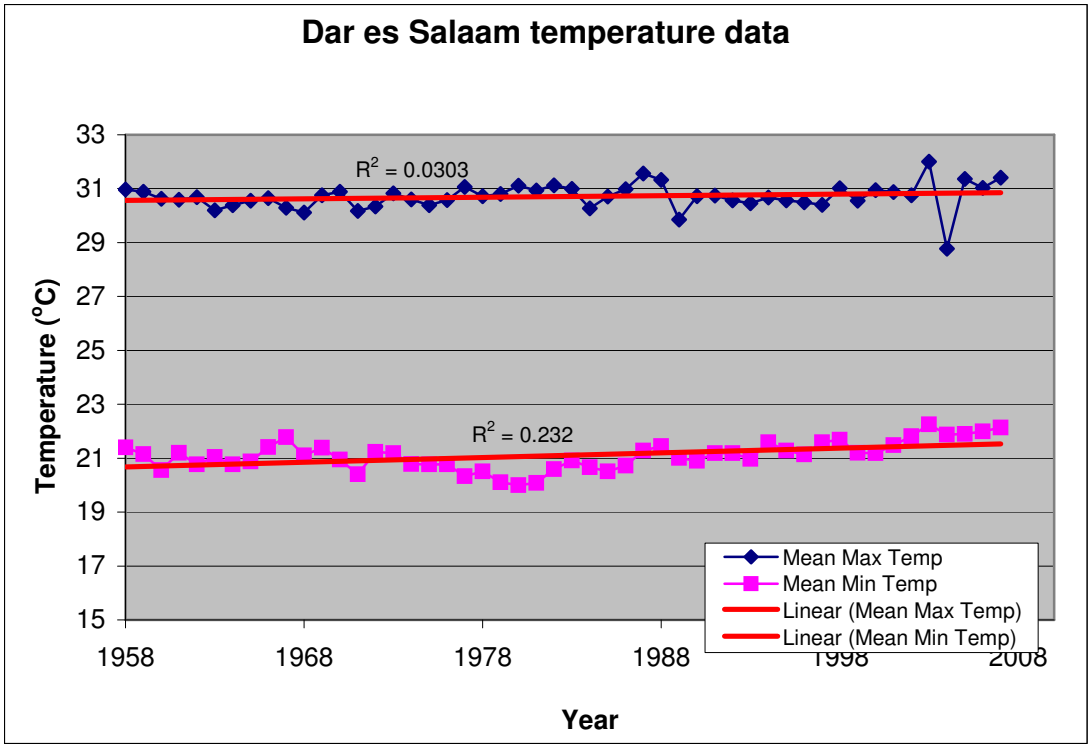



**Fig 3.5 Max and Min Temperature at DIA**

**Fig 3. 6 Minaki reservoir shrinking possibly due to extended drought and global warming**

### 3.1.1.3 Sources of Surface Water in dry season

It was observed during the dry season in September 2009 that there was no flow coming down from Kisarawe forest and yet Kizinga was flowing. Physical survey in the sub basin showed that many springs exist in the lowlands of Kizinga sub basin with considerable flow which is used extensively in the irrigated farming. (Fig 3.7-3.10). Irrigation is done on the spongy wetlands where several springs originate (Fig 3.8)

**Fig. 3.7 Spring in Kitunda valley water oozing out from a recharge sand unconfined aquifer**

**Fig 3.8 Irrigated agriculture ON a wetland  leading to highevaporation**

**Fig 3.9. Extensive Irrigation of vegetables at Mukerezange in Kitunda ward**

**Fig 3.10Kizinga river at Mtoni intake with low flow in September 2009**

### 3.1.1.4 Trends of Dry season flows

**Trend of Mean annual flow**

Mean annual flows of Kizinga was analyzed for the period 1967-2004 (Fig 3.11) and it is seen that the flows has ranged around 2-5 m3/sec with mostly ranging around 3 m3/sec. In order to capture the trends in recent years based on available data (1990-2004) it is seen that the annual flows has been steadily decreasing over years (Fig 3.12).

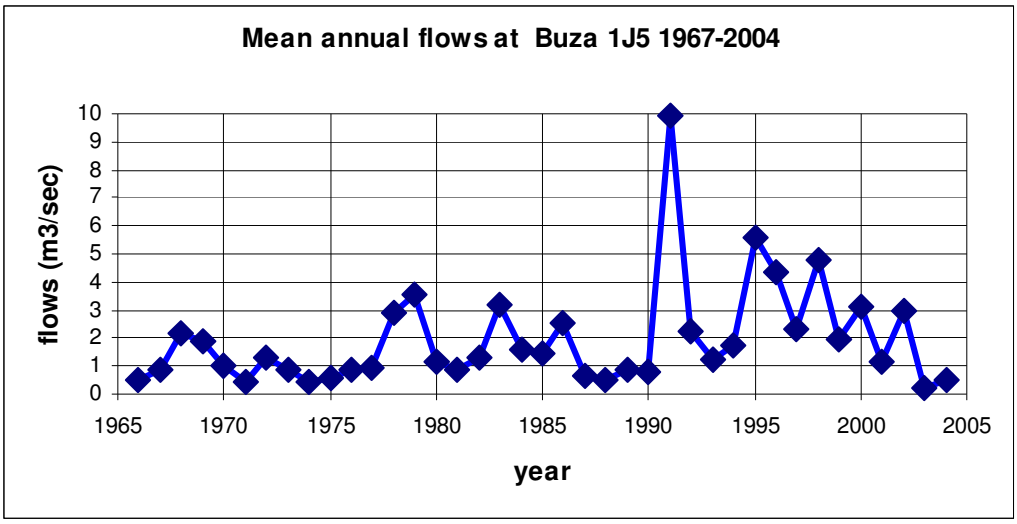



**Fig 3.11 Mean Annual flows in Buza 1967-2004**

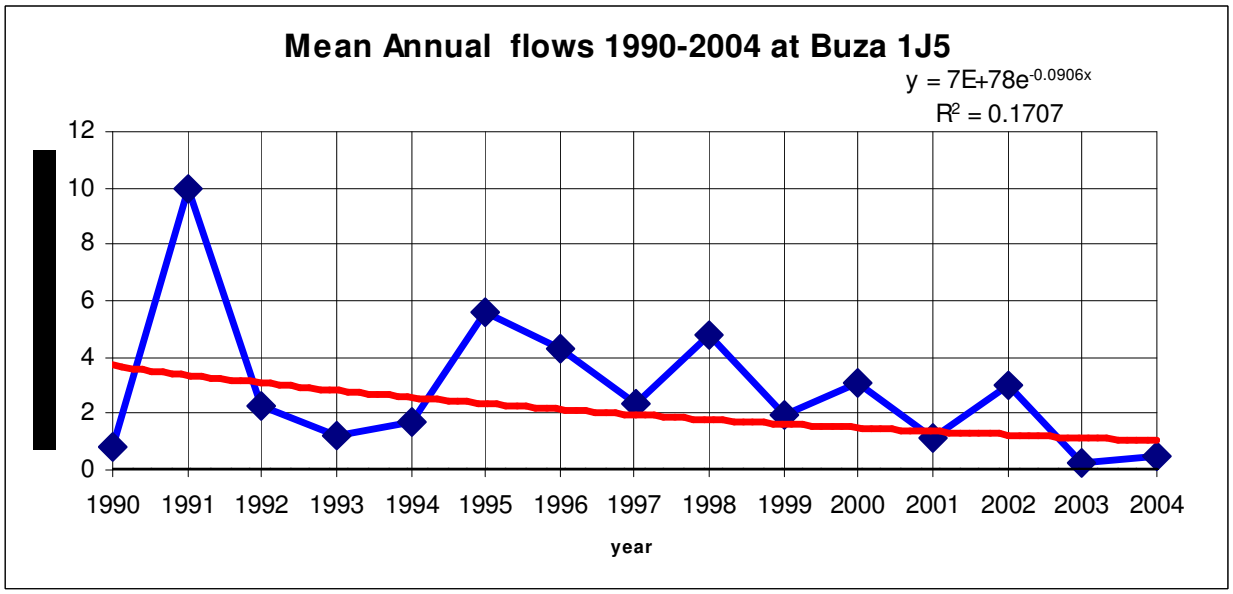



**Fig 3.12 Mean annual flows in Buza 1967-2004**

### 3.1.1.5 Trend of Flows during Dry season

Further analysis of the flows in the dry season months July, August, September, October and Nov for the past period : 1966, 1967, 1968 and 1969 and current period: 2000,2001,2002,2003, and 2004 (Fig 3.13). It is seen that flows in the past years has been much higher than those of current indicating a decree in flow magnitude in the river

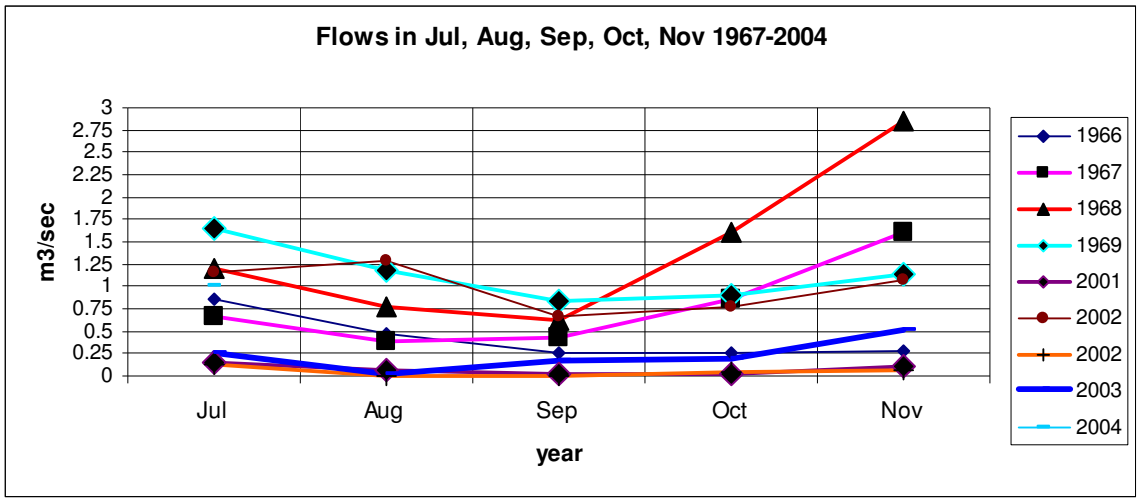



**Fig 3.13 Flows in Buza during dry season in for July, August , Sept, Oct and Nov 1967-2004**

**Trend Analysis of October flows and spot measurement October 2009**

Stream flows of Kizinga in October was analyzed and it is seen that it has fluctuated around 0- 2m3/sec with most flows ranging around 1.5 m3/sec.(Fig 3.14).

Trend analysis of October flows is shown in Fig 3.15 for the current period 1989-2004 shows that the flows has been decreasing exponentially . Spot measurement of flows in October 2009 shows that the flow was 0.4m3/sec which falls within the decreasing margin.

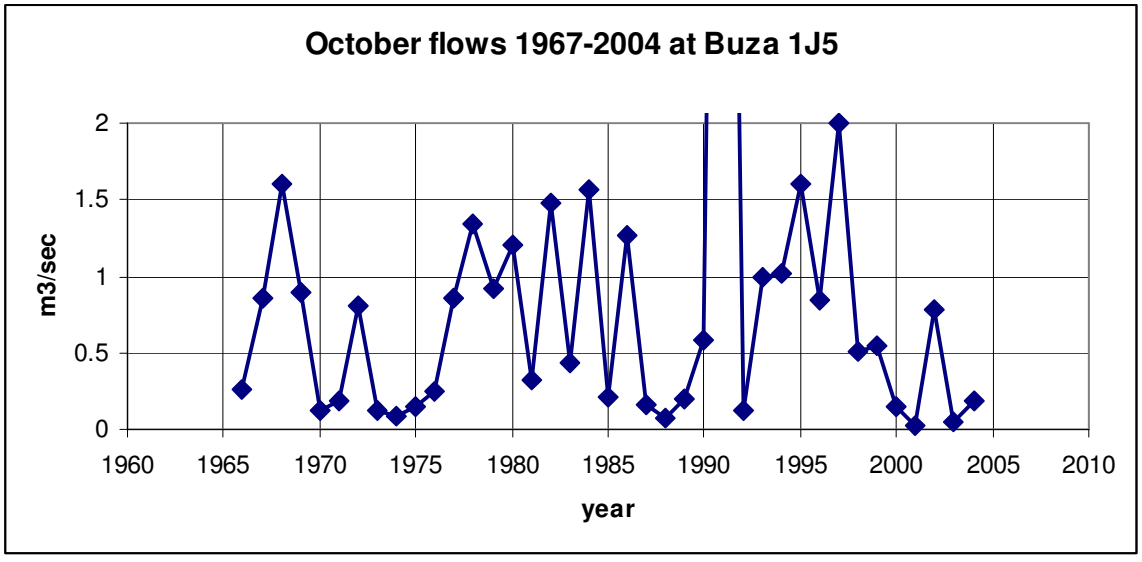



**Fig 3.14 October Flows in 1967-2004**

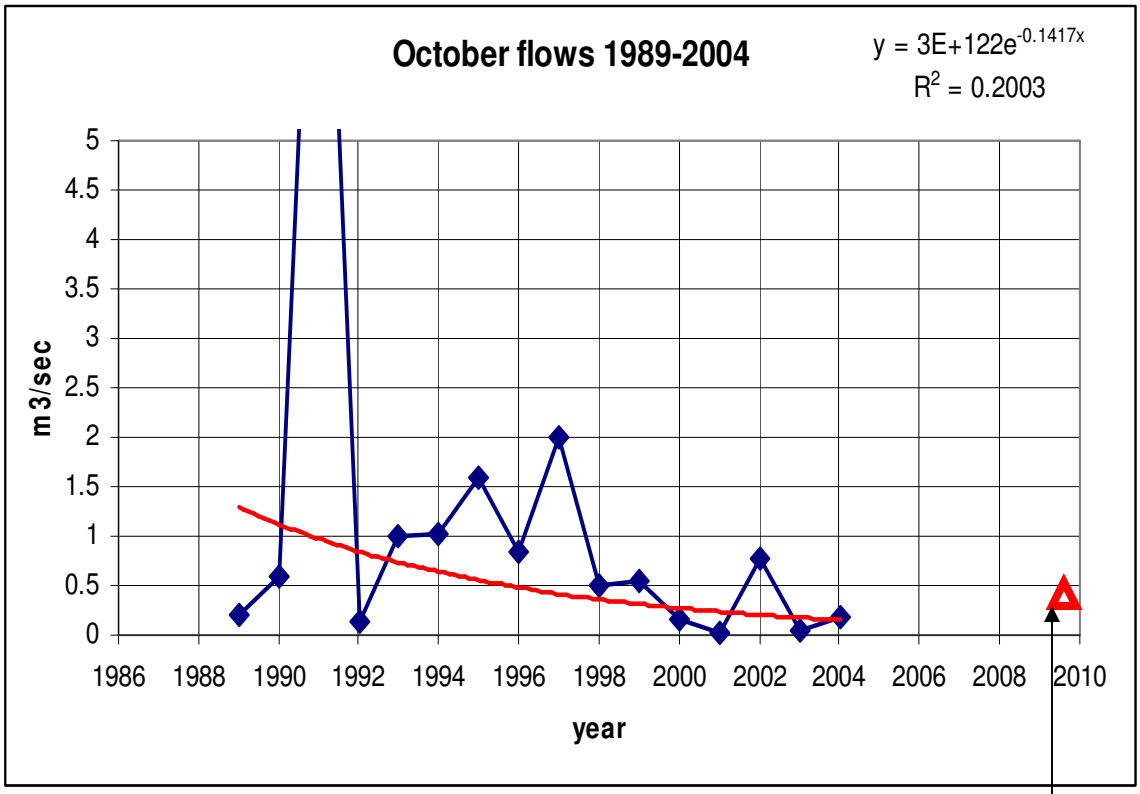



**Fig 3.15 October flows 1989-2004 (recent flows)**

**Spot measurement Oct 2009 as 0.4 m3/sec**

### 3.1.2 Ground Water Resources

#### 3.1.2.1 Ground Water Potential

Fig 3.13 (a) shows that the eastern edge towards the Ocean within Mbagala the Production of Ground water is relatively higher than the upstream part of the sub basin. Similarly in Fig 3.13(b) evaluation of the ground water is far better in the downstream end of the sub basin than in the upper part which is fairly good.(JICA, 1994).

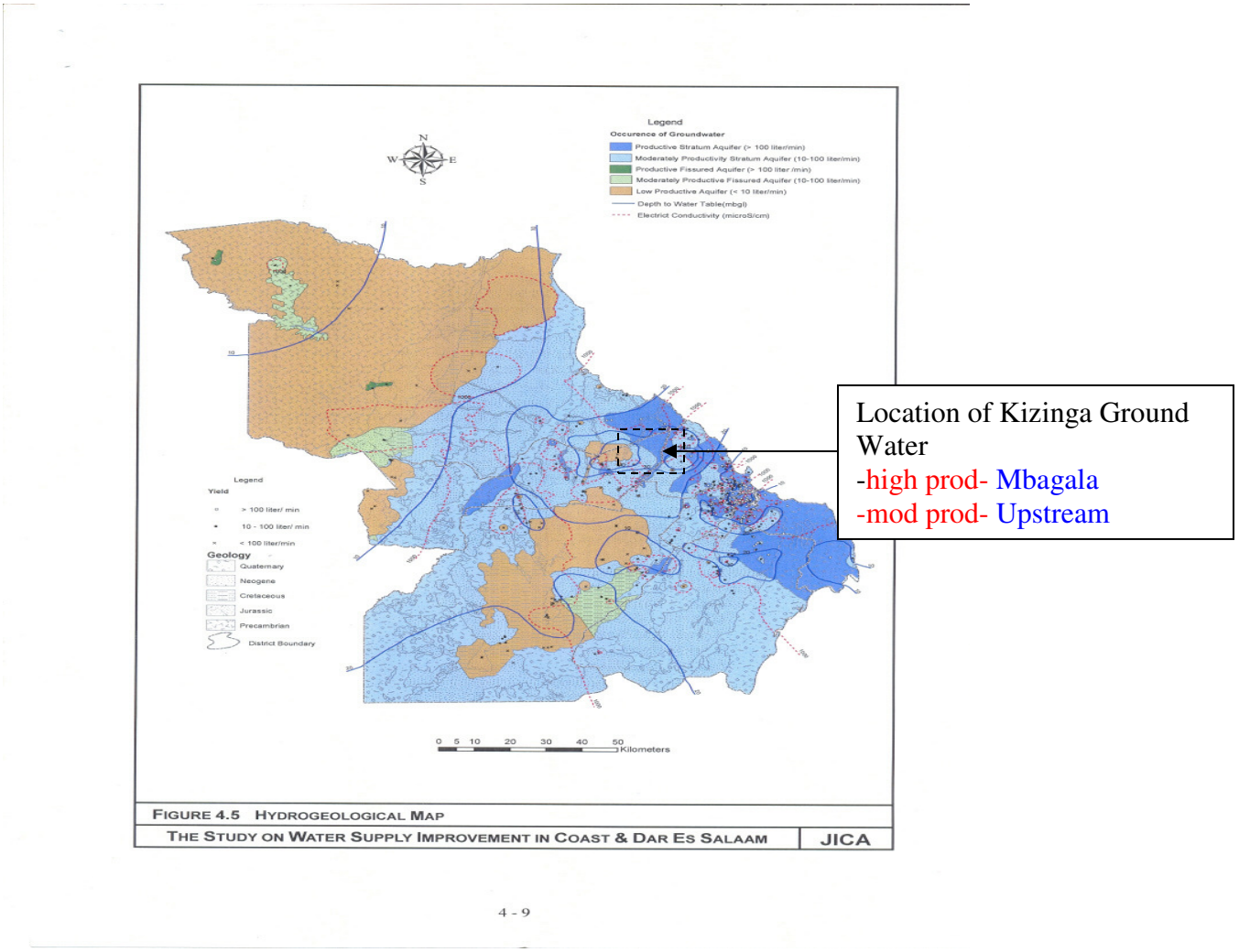
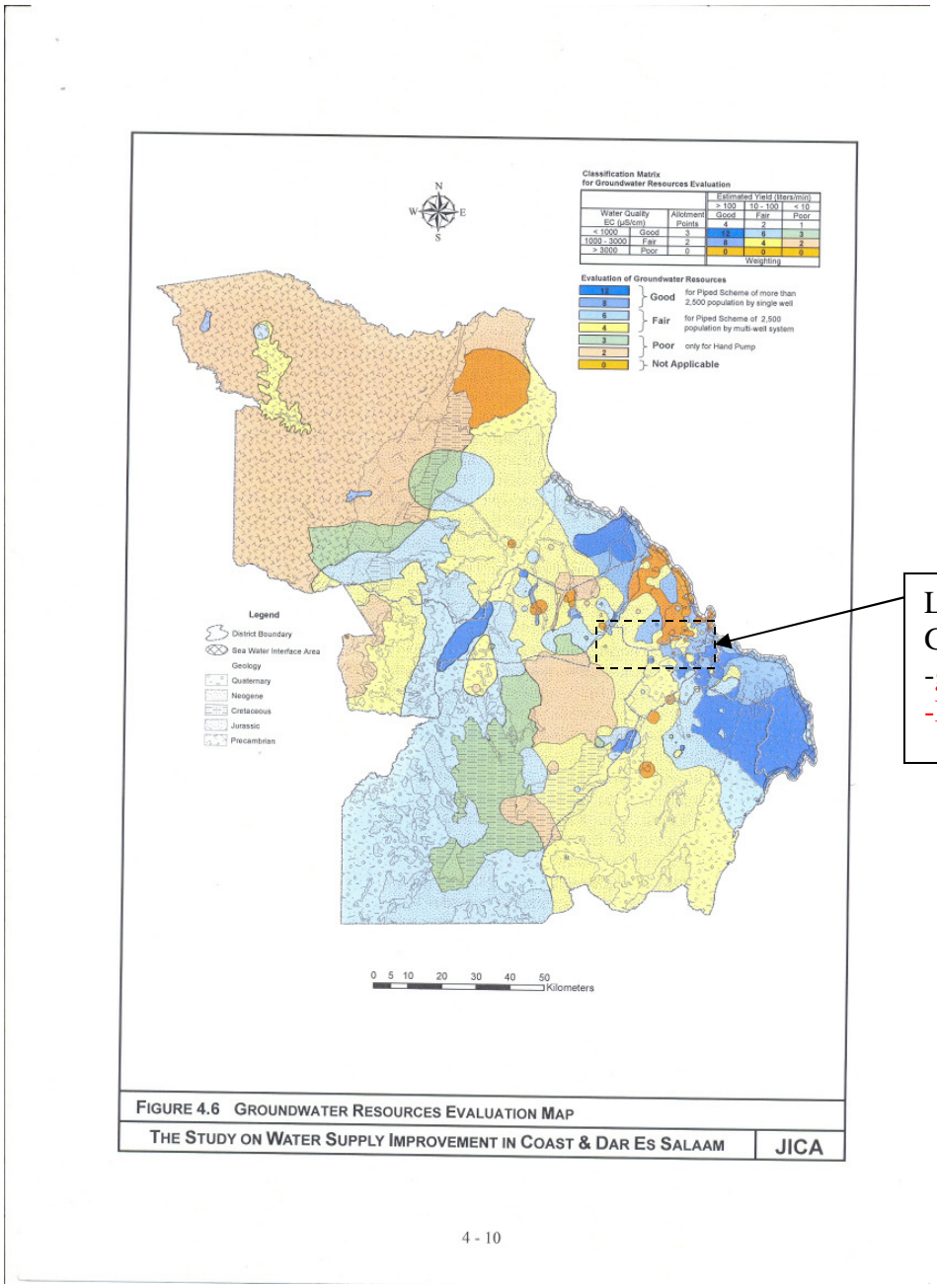



**Fig 3.16 Hydrogeology map of Dr es Salaam region**




Location of Kizinga Ground Water
-good quality - Mbagala
-Fair quality - Upstream

**Fig.3.17 Ground Water Resources Evaluation map (JICA,1994)**

### 3.1.3 Yield and Borehole Depth

Mjemah (2008) and Mato (2002) note that there is a certain pattern of yield and borehole depth. It is observed in Fig 3.14 that borehole depths are concentrated between about 20 m – 70m with a yield ranging between about 0-20 $m^3$/hr.

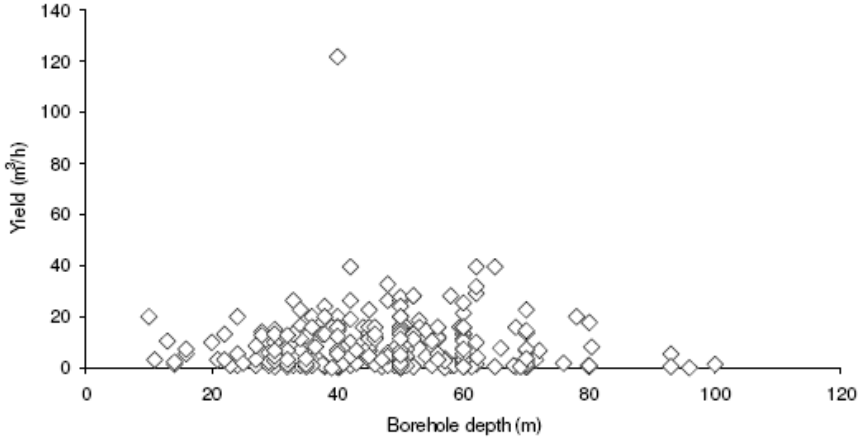


Fig. 3 Relationship between yield and borehole depth

**Fig 3.18 Borehole Depth and Yield in Study area ( Mjemah ,2007)**

There are three types of aquifer in Dar es Salaam, which include; an upper unconfined aquifer (1-15m thick); the upper confined aquifer (most productive zone, 5-50m thick) and multiplayer aquifer (normally separated from each other by alternating layers of clay) (Mato, 2002). The regional groundwater flow pattern towards the north is inferred from the general tilt of the geological blocks (Mato, 2002). The groundwater recharge is considered to be of both distant and in-situ types. The distant recharge areas are the surrounding hills of Pugu (Kisarawe District). However, the in-situ source considered to be the major contributor, mainly due to the sand soil nature of Dar es Salaam City. Within the alluvial sands, terrace sandstones and reefs areas, which have unconfined and to a lesser extent perched aquifer conditions, riverbank infiltration into the aquifers is possibly the predominant recharge mechanism (Mato 2002). The groundwater flow is considered to be towards the Indian Ocean as inferred from the piezometric heads.

### 4.1.4 Sources of pollution

**Pollution sources in the basin and threats**

There are two main classes/sources of pollution observed in Kizinga River Basin. These are Non point sources and point sources of pollution.

a) **Non-point sources of pollution**

Nonpoint sources of pollution introduce contaminants to the environment across areas that are large compared to point sources, or nonpoint sources may consist of multiple, closely spaced point sources. Pollution from agricultural activities mainly associated with application of fertilizers and agrochemicals such as pesticides is one of a nonpoint source of contamination that is also observed in the Kizinga Basin and affects large area.

**b) Point sources of pollution**

Contaminants from point sources discharge either into groundwater or surface water through an area that is small relative to the area or volume of the receiving water body. Examples of point sources include discharge from sewage-treatment plants, leakage from gasoline storage tanks, and seepage from landfills, sewage discharge, etc.

These types of pollution exist in Kizinga river catchment affecting both surface and ground water. The increase of pollution in Kizinga river catchment is highly contributed by growth of anthropogenic activities along with encroachment within the river valley beyond allowable 60m (Source: EMA, 2004) from the highest water mark.

### 3.1.5 Pollution of Water Resources

Groundwater is an important part of the water cycle. The water cycle begins with precipitation falling on the earth's surface. A portion of that water runs off into lakes and streams. The remaining water is absorbed into the soil layer where it is taken up by plants or penetrates deeper into the soil. The water that reaches the saturated zone is known as recharge water. Contaminants, including lawn and garden chemicals such as fertilizers and pesticides, enter the groundwater in several ways. The contaminants can be carried by rainwater into a stream as runoff and eventually reach the water table through surface water - groundwater interaction at some points. Another mechanism of groundwater contamination is leaching, which is the downward movement of a substance through the soil. Shallow aquifers can cross-contaminate deeper aquifers through penetration of an intervening aquitard, via sandy intervals in the aquitard, along well casings, across long well screens, or around aquitard pinchouts (Santi *et al*., 2005).

The proposed Kinyamwezi dumpsite is located between two streams. To the north of the site is Kinyamwezi stream and to the south is Nyamaronda, which is a bit farther from the site than Kinyamwezi stream is. These two streams receive water from upstream of Pugu Forest Reserve and Kazimzumbwi Forest Reserve. Drainage of the area follows the major topographical features of the catchment. Drainage occurs from the upstream forest reserves to the lowland areas in the northeastern side of the site. Pugu and the site reside in the catchment known as the Kizinga River Catchment.

Groundwater is used by local residents of Kinyamwezi for domestic and irrigation purposes. Pugu has a 7m depth to the water table and the direction of flow is northeast (ERC, 2004). Currently, the only borehole within the Kinyamwezi landfill area is located at the Amurt Foundation Nursery School. The depth of the borehole is 47 m. Also around the dumpsite are four dug wells used by the community. Along the main road to Chanika there are three boreholes used by the nearby communities for drinking.

The key challenge on ground water quality in Kizinga sub catchment is threatened by lack of sewerage system in most places of the sub catchment. Most of people depend on on-site sanitation facilities mainly pit latrines. Consultation with local people in Kitunda revealed that, in other places such as Kitunda water table range from 5m to 7m. Vulnerability to groundwater pollution is high since the pit latrines are locally constructed without any sealing to avoid contamination to ground water. In urban areas it is common that the upper soil zone is removed and thus it is not active in groundwater protection. One of the most common groundwater contamination sources in urban areas is the leakage from underground storage tanks and seepage from septic tanks, where the natural defense is partly removed. Also if the contaminant is released below the groundwater table, the natural barrier is bypassed and the groundwater is directly contaminated and vulnerability can be said to be 100% (Lindstrom and Scharp, 1995).

Another key challenge may result from Kinyamwezi dump since Landfills, open dump, or refuse piles are major sources of groundwater contamination. Landfills are supposed to

have a protective bottom layer to prevent contaminants from getting into the water. However, if there is no layer or it is cracked, contaminants from the landfill (car battery acid, paint, domestic wastes, *etc*.) can make their way down into the groundwater. There fore there is a possibility of rainwater to infiltrate through solid waste in Kinyamwezi dump forming leachate. Leachate extracts dissolved or suspended materials (often toxic) and transports them down to the ground water reservoir. Leachate poses potential threats for contamination of groundwater resource. It is assumed that any amount of leachate generated is potentially harmful. The most common impacts with regard to ground water quality from leachate pollution is an increase in COD, BOD, ammonia-nitrogen, pH, iron, lead, chromium, and cadmium depending on the type of waste deposited.

**(a) Pollution through Solid waste management**

Surface water in Kizinga River is also threatened by poor solid waste management within the Kizinga River Catchment. Most places within the catchment such Kitunda, Chamazi, Charambe, Majohe, Makangarawe and others have no proper solid waste management. Lack of proper designated waste collection points, transfer stations, transportation to the disposal site has contributed haphazard waste disposal. Common practices in villages and sub-urban areas within the catchment include burning of wastes, burying and crude dumping in the environment and sometimes into water streams. For example, consultation with municipal engineer in charge of Kinyamwezi dump revealed that, waste production in Dar es Salaam is about 3841 tones per day while waste collection is about 1805 tones per day. The remaining 2036 tones per day are neither collected nor transported to the dumpsite for disposal. This indicates that, a significant amount of waste is left in the environment. During the rain season most of these wastes from different areas are washed away by rainfall runoff into the Rivers including Kizinga River. The cumulative effect of these wastes results into poor quality of surface water.

The main designated dumpsite for Dar es Salaam city is now located at Pugu-Kinyamwezi in Pugu ward-Ilala, which is within the Kizinga River Catchment. The site is approximately 25 km from Dar es Salaam City Centre and lies at 39°08´ East and 06°56´ South. There are two main dumpsites currently operating, which are Kinyamwezi

and Kigogo Dumpsites. The Kigogo Dump receives more wastes than Kinyamwezi Dump. However, it is planned that on 1st of October 2009 the Kigogo dumpsite will be closed and all the wastes will be taken to Kinyamwezi dump. Therefore the situation in Kinyamwezi dump may become worse compare to the current situation. Although, efforts to monitor groundwater pollution alongside the dumpsite are undertaken through monitoring wells drilled at the sides of the dumpsite but the potential for surface and ground water pollution resulting from this dump still remains to be substantial.

**Fig 3.19 : Kinyamwezi Dump**

**Fig 3.20 Kigogo Dump**

Among the main identified negative impacts from Pugu-Kinyamwezi dump are: leachate, waste exposure and hydrological disruption such as decreased infiltration, increased runoff and changes in water courses are all possibilities due to this dump.

**(b) Pollution through Agricultural activities**

The Kizinga River during the dry season is extensively used for agricultural activities along with application of fertilizers. The main crops grown are mainly green vegetables, paddy, and to a small extent maize. The main types of fertilizers used are organic fertilizers originating from local poultry projects as well as cow dung's. Application of these fertilizers has profound effect in increasing the organic loading in surface water. The type of fertilizer used increases organic matter contents whereby in turn results into

high organic load in the surface water. According to the field survey undertaken inorganic fertilizer are not commonly used.

Fig 3.21 Irrigation within Kizinga

Fig 3.22 Agricultural activities at the confluence of Dovya tributary and kizinga river

### 3.1.6 Turbidity

Adequate data on turbidity was not available to run a trend analaysis. However data fro the period 2005-2009 shows that turbidity varies with time with high levels shown in the rain season and low turbidity in the dry season.

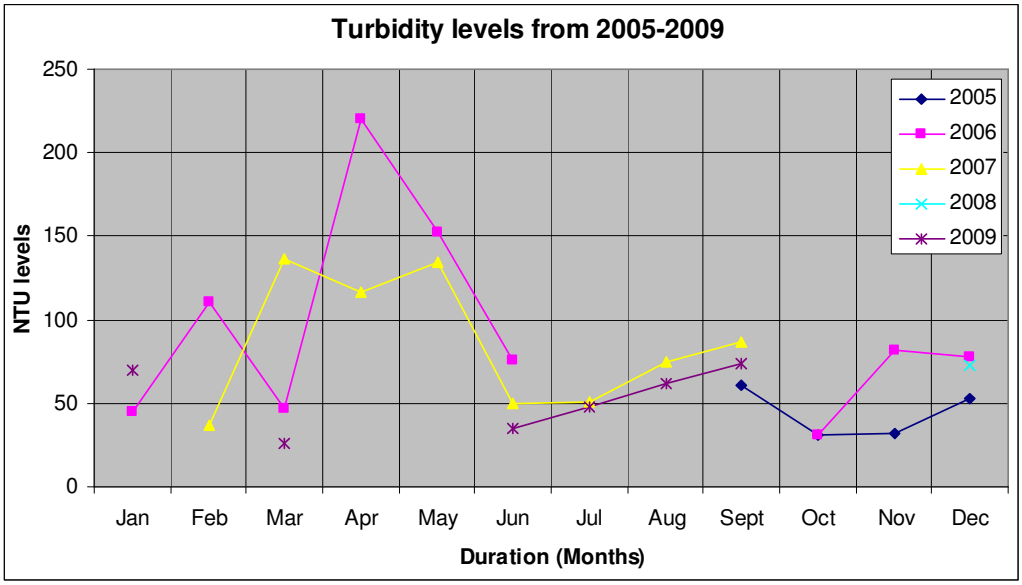



**Fig 3.23 Turbidity variation 2005-2009**

# 4.0 OTHER NATURAL RESOURCES

## 4.1 Data sources

Data sources used to determine land use/cover changes and derive the boundary of the catchment included namely:

***Topographic maps at 1:50,000***

These were used to demarcate or derive the catchment boundary, digitize rivers, streams and contours for the purpose of generating a digital elevation model (DEM). Since the topographic maps are based on aerial photographs, they also constituted a source of land use/cover depending on the year on which the source aerial photographs were taken.

***Landsat images (1994/95)***

Land use/cover was obtained from the satellite images through interpretation and image analysis. The combination of the above data sources provided four sets for land use/cover change analysis that are considered enough to provide reliable results as follows:1953 and 1981 – topographic maps from aerial photographs, 1995 – Landsat images thematic Mapper and 2002 – Quick bird images with a good resolution (2 – 5m) were used to get the most current status of land use/cover.

## 4.2 Data analysis

Satellite image interpretation and analysis was done using remote sensing software (Erdas Imagen), while data analysis was done using GIS software (ArcGIS) and a spread sheet (Microsoft Excel)

### 4.2.1 Land use / cover changes

Changes in land use/cover within the Kizinga Catchment are summarized in the following Table 4.1.

**Table 4.1 Land cover changes: 1986 and 1995**

| Land Use / Cover | 1986 | | 1995 | |
|---|---|---|---|---|
| | **km$^2$** | **%** | **km$^2$** | **%** |
| Build Up Areas | 4.5 | **2.3** | 6.4 | **3.2** |
| Mangrove Swamp | 0.1 | 0.0 | 0.1 | 0.1 |
| Natural Forest/plantation | 5.5 | 2.8 | 27.2 | 13.7 |

| | | | | |
|---|---|---|---|---|
| Permanent Swamp | 5.7 | 2.9 | 0.0 | **0.0** |
| Scrub and Scattered Trees | 173.4 | **87.5** | 35.1 | **17.7** |
| Cultivated Land | 9.0 | 4.6 | 129.2 | **65.2** |
| | 198.1 | 100.0 | 198.1 | 100.0 |

Land use/cover of 1986 is based on aerial photographs while that of 1995 is based on Landsat images. Though the resolution of the two datasets is different with that of 1986 being better, we can still appreciate the changes that have taken place between the two periods. There is a slight increase in Urban or built up areas from 2.3 to 3.2 %. Scrubs and scattered trees have gone down from 87.5 to 17.7 % in line with the increment in cultivated land from 4.6 to 65%.

Key informants in Kitunda ward had noted that intensive agriculture started in Kitunda in 1990s. Most of the rural settlements where houses are part of the farms, are implied in cultivated land use type. The absence of permanent swamps in 1995 is due conversion to agriculture on one hand, and the resolution of the Landsat images (30 x 30m) that might underestimate the normally narrow strips of swamps.

The Quickbird images of 2002 have a far better resolution (approximately 2- 5m) and can not be compared directly with the other datasets. It's obvious however that urban areas have increased significantly as evidenced by population increase.

Taking advantage of the better resolution of the Quickbird images, total visible area within the river banks is estimated to be 7.2 $km^2$ (720 hectares). Other river bank areas are no longer visible/ identifiable. There are houses and they now form part of the settlements. Most of the visible river banks and swamps, constituting 3.6 percent of the entire catchment area, are under cultivation (Figure 2). Cultivation in the river banks and swamps has deprived them of their natural capacity of holding water and act as reservoirs that would release water into river after the rain season.

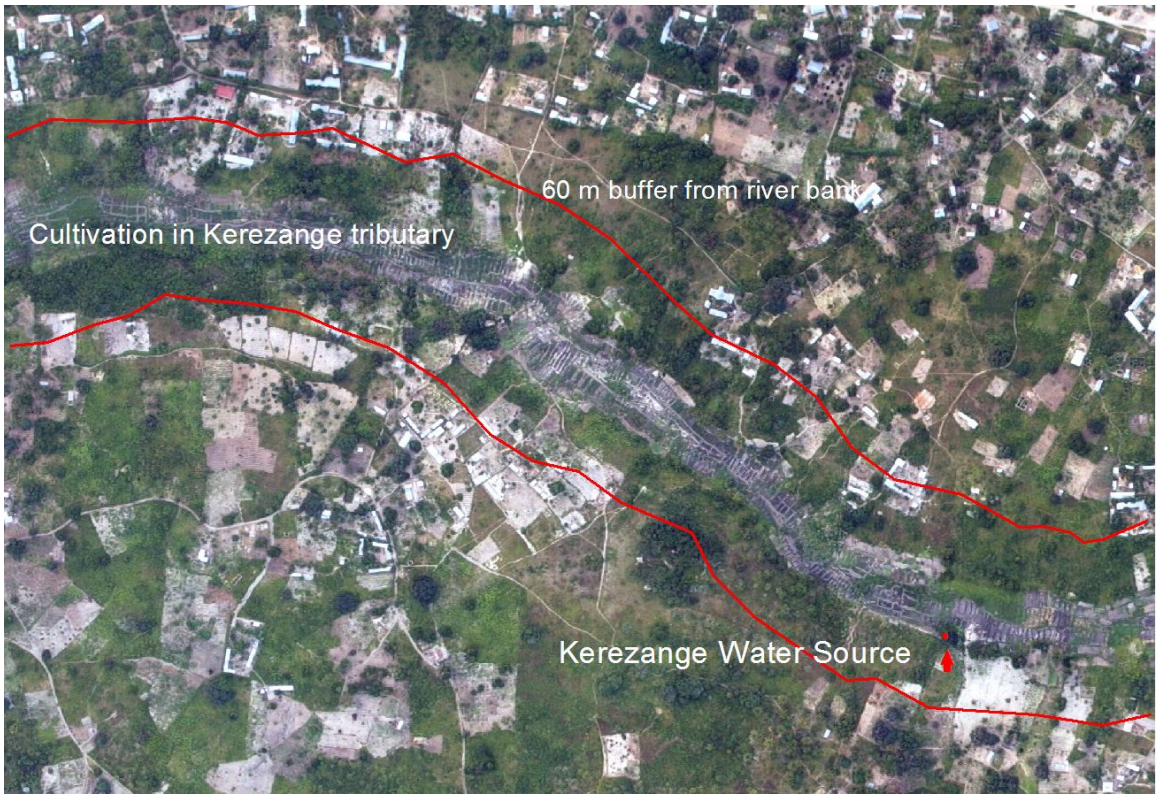



**Fig 4.1. Land use patterns in 2002 using Quickbird images**

## 4.3 Biodiversity of Kizinga Catchment

### 4.3.1 Flora

Large area of Kizinga sub catchment such as Pugu area lies in the Zanzibar-Inhambane vegetation mosaic, a diverse type ranging from dry coastal forest made up of Miombo with some moist and riverine components (Hawthorne, 1984). Most of the literature available with regard to vegetation analyses conducted in the Kizinga sub catchment focus on the nearby Pugu- Kazimzumbwi forest and little has been done in the communities surrounding the forest. Thus vegetation literature specific for the whole sub catchment is lacking. However, there is an overlap in species composition between the forest areas and other areas of the sub catchment, thus information documented from the forest can be used to reflect on the land use activities and vegetation changes in other areas within the sub catchment such as Pugu, Chanika, Kisarawe, Kitunda, and Charambe areas as a whole (Clarke and Dickson, 1995).

The Pugu Kinyamwezi area, Kitunda, Charambe and Chanika has low woody species diversity, and it is composed largely of open woodlands. There are seasonal rivers mainly Kizinga river tributaries that flow directly through these areas. The vegetation along the Kizinga River and other smaller streams in the area host marsh type vegetation that is dominated by sedges. The marshes are largely fed by ground water and to a lesser extent seasonal rainfall. Tiny pockets of riverine vegetation can be found around some water holes as seen on a couple of farms.

Some areas such as Pugu comprise patches of extensive relatively secondary miombo woodland that was noted as a source of fuel wood for the local communities. There is no obvious woodland community that appears to offer immediate protection from run-off into the Kizinga River. The main woodland is that of Pugu-Kazimzumbwi Forests which is the most significant where Kizinga River starts from these forests.

### 4.3.2 Fauna

There are few animals found in the sub catchment. This situation is attributed by degraded vegetation communities in the sub catchment which have been greatly disturbed by anthropogenic activities. However, invertebrates are the dominant group of indigenous fauna in the sub catchment. A number of migrant birds were observed in the forest areas, riverrine vegetation, agricultural fields, etc. Due to the lack of a constant water source in Kizinga River and other adjoining tributaries, fishing is not commonly found in the sub catchment. It is envisioned that during the rainy season there is a significant population of amphibians in the area.

### 4.3.3 Biodiversity of Pugu and Kazimbuzwi Forest Reserves

Southern Pugu and northern Kazimzumbwi forest reserves are one of the major sources of water for the two main tributaries (Kinyamwezi and Nyamarongo) that merge to from Kizinga River. Anything affecting the two forests in terms of water retention/flow will ultimately affects the flow of water to Kizinga and the thus the supply to DAWASCO at Mtoni water intake.

During July and August of 2001, The Frontier-Tanzania Forest Research programme conducted a biodiversity survey within the reserve, including an assessment of forest disturbance. Species richness was found to be high within all groups, with species records of 172 plants, 32 mammals, 28 reptiles 19 amphibians and 140 butterflies. The habitats and species of Kazimzumbwi Forest Reserve were found to be under pressure from pole and timber extraction, charcoal production, fire, animal trapping, cultivation and the presence of footpaths. Certain tree species appear to have been targeted for pole and timber extraction, charcoal production and makonde carving. Important species such as Milicia excelsa and Dalbergia melanoxylon are now considered rare within the reserve. (Staddon et al, 2001). Bushfires were also observed to be a problem within the reserves, particularly for easily combustible shrubs and herbs. A newly appointed manager to the forest reserves has indicated that fire outbreaks has been a major problem for the past three years.

### 4.3.4 Previous efforts to conserve the forests

There were efforts to arrest the situation as a review report by Prepared for CARE Tanzania by Kathryn Doody in 2004 reveals. The report shows that under the auspices of Misitu Yetu Project the following has been accomplished:

a) all 8 of the pilot villages adjacent to Pugu/Kazizumbwi FR
b) and 9 pilot villages adjacent to Ruvu South had received information and training regarding the Joint Forest Management process.
c) 21 Village Environmental Committees had been formed and trained in their roles and responsibilities (8 Pugu/Kazimzumbwi, 8 Ruvu South and 5 Pande).
d) 18 kms of the reserve boundary of Ruvu South have been cleared and missing beacons replaced.
e) Village forest management areas had been defined and demarcated in Pugu, Kazimzumbwi and Ruvu South.
f) The next stage in the process was to develop management plans that could be approved by Forest and Beekeeping Division.

*The report also reveals that, at Pugu/Kazimzumbwi there has been the problem of a 'power vacuum' where-by the central government forest reserve was being 'informally' managed (no written agreements) by the local authorities. It was found that both parties were thinking that the other party would deal with any issues arising regarding management planning of the reserves.*

*The project could not go beyond 2006 due to lack of funding. At that stage some villages had already produced by laws that were yet to be approved by the district council.*

### 4.3.5 Recent Forest encroachment

Field verification of the current studying September 2009, has clearly shown that the forest reserves are experiencing the same problems and probably to a greater extent. Fires are frequent, charcoal burning is still rampant and Kazimzumbwi is heavily encroached with people staying in the forest reserve (photos 1 and 2).

**Fig 4.2 : A large portion of Kazimzumbwi recently encroached : Clearing, pole harvesting and charcoal burning inside Kazimbumbwi Forest Reserve**

### 4.3.6 Planned efforts to conserve Pugu/Kazimzumbwi

The Wildlife Conservation Society of Tanzania is currently developing a Proposal to be submitted under the REDD Program for funding as a pilot project that could be eligible for funding under Norway' International Climate and Forest Initiative. The purpose of the

project is to pilot the REDD concept in Pugu and Kazimzumbwi National Forest Reserves through the application of Participatory Forest Management Regime (PFM).

The main objective of the project will therefore be maximizing the carbon stocks of the two National Forest Reserves while at the same time improving the livelihoods of the forest adjacent communities. The project intends to revive the previous Participatory Forest Management initiatives rather than starting afresh. The project also proposes two major interventions as a prerequisite for the success of the REDD pilot project:

a) Securing the integrity of the boundary that has been interfered by communities including felling of border tress, removal of beacons and destruction of directional trenches.
b) Evicting all illegal farmers from the two forest reserves.

# 5. ENVIRONMENTAL DEGRADATION

## 5.1 Sources of degradation

A number of activities are currently conducted in the Kizinga sub catchment which are main sources of environmental degradation. These are largely by local communities although activity like sand mining is done by immigrants from Dar es Salaam city. Most plots used for sand mining belong to individuals who in most cases are not residents of those areas. Access to the sand mining pits traverses through disturbed woodland and the river valleys that flow across the pits.

Seasonal farming is another activity that prevails in the area. This is carried out mainly by women seeking to improve their household incomes. A variety of vegetation types have been cleared to allow cultivation of the various crop species. The marsh area along the river beds is the one most impacted by this activity. Paddy and vegetables that require moist clay soils appear to be the principal agricultural products within the sub catchment. This could be for a number of reasons one being that the local population has very little farm land of their own and the marsh areas are not in use for sand mining. A second possibility is that the land surrounding the marsh areas has been exhausted from over cropping. More importantly, the main carbohydrate source for the sub catchment is rice and cassava (Source: EIA report for Kinyamwezi dump). Table 1 below provides a list of crops grown in the sub catchment.

**Fig 5.1 Irrigated agriculture**

**Table 5. 1 Crops Grown within the Kizinga sub catchment**

| Crop species | Use | Season | Vegetation type cleared for cultivation |
|---|---|---|---|
| Cucumber | D & C | Perennial | Marsh |
| Water melon | D & C | Perennial | Marsh |
| Rice | D | Perennial | Marsh |
| Coconut | D | Perennial | Grassland |
| Sweet potato | D | Perennial | Upper marsh |
| Cassava | D | Annual | Open grassland |
| Oranges | D & C | Annual | Open grassland |
| Lemons | D & C | Annual | Open grassland |
| Irish potato | D | Perennial | Marsh |
| Sugar cane | D | Annual | Riverine |
| Passion fruit | D | Annual | Riverine |
| Papaya | D | Annual | Open woodland |
| Aubergine | D & C | Perennial | Upper Marsh |
| Pineapple | D & C | Perennial | Open grassland |

Note: D = Domestic use; C = Commercial use.
**Source: ERC, 2004**

Other activities observed in the sub catchment is grazing but due to rapid urbanization animal keeping such as cattle is decreasing. Other animals kept are mainly pigs and chicken especially for commercial purposes saving as the source of income to the local

people. Animal keeping is commonly practiced in Kitunda, Chanika, Charambe, Majohe, Kisarawe and other areas within the sub catchment.

## 5.2 Key environmental challenges

Human activities within the Kizinga River sub catchment contributed much in the destruction of environment as well as water sources. These activities include;

a) Encroachment and degradation of important watersheds and groundwater recharge areas. Farming along the river banks, springs and steep slopes in the basin due to dependence on river water for irrigation during the dry seasons resulting into reduced minimum flows.
b) Urbanization attributed by rapid population growth.
c) Soil erosion due to cultivation and sand mining in river basins and forest areas, in turn cause siltation of watercourse thus water scarcity deterioration of water quality. Growing contamination on water sources from agriculture, industries, and mining

**5.2 Sand mining near Pugu forest**

d) Uncontrolled tree cutting and bush fire in the Pugu-Kazimzumbwi forest reserves and other village forests affecting recharge areas for rivers. Consultation with forest manager of these forests revealed that fires are commonly due to human activities around these forests as well as illegal charcoal making. Sometimes these fires spread

to the adjacent area or grassland and bush, and if uncontrolled poses threat to the forest reserve and human settlement surrounding these forests.

**Fig 5.3 : Charcoal making in Pugu**

**Fig 5.4 Tree cutting problems**

**Forest**

Uncontrolled groundwater abstraction which could lead to over- pumping, and thus damage to important aquifers

f)Inadequate waste management (solid and liquid waste) within the sub catchment. The existing waste management does not collect all wastes generated. Also there no sewerage system in the area and most of pit latrines are locally constructed causing interference of groundwater with pollution from these pit latrines.

# 6. VALUATION

## 6.1 Introduction

Valuation is the art or science of ascertaining the monetary worth of an asset at a particular point in time for a specific purpose. There are a number of human activities conducted within the Kizinga wetland; these include human settlements and agriculture activities which reduces Kizinga River's water availability. Valuation was carried out to ascertain the value of properties that are in the catchment's area and also to ascertain the values of assets that fall within it in two scenarios that is; properties that are 30 meters from the river bank and properties that are 60 meters from the river bank, the aim being to establish the cost that would be incurred if the residents are to be resettled.

**Valuation Approach**

A participatory approach was used which involved Chairmen of village governments in respective Wards.

The properties were divided into 3 major groups, where as at least 3 samples from each group were taken to represent the others. Valuation was conducted and an average value was adopted to represent the others, then the value arrived at was multiplied to the number of properties within a particular group. Counting the properties was made possible with the help of the local leaders and the maps that were used in issuing residential licenses.

## 6.2 Valuation of houses

The valuation assessment was done in accordance with the law which provides the following compensetable items to be included in assessing valuation for compensation:

(f) Accommodation allowance;

(g) Loss of profit;

(h) Disturbance allowance;

(i) Transport allowance; and

(j) Loss of interest or value for unexhausted improvements.

**Compensation for the above is calculated as follows:-**

a) ***Accommodation Allowance***,

the market rent of the building shall be multiplied by thirty six (36) months to arrive at accommodation allowance payable.

b) ***Loss of Profit,***

the net monthly profit of the business carried out on the land shall be assessed (as evidenced by audited accounts where necessary and applicable) and multiplied by thirty six (36) months to arrive at the Compensation. This is applied only for people who were doing business within their premises.

c) ***Disturbance Allowance,***

the land value shall be multiplied by the average interest rates offered by commercial banks on fixed deposits for a period of twelve (12) months at the time of loss of interest in land. Disturbance allowance has been calculated at the rate of 5 % of the value of land, value of buildings and value of crops as most Bank borrowers give a maximum of 5% although they may pay more but for very special customers.

***d) Transport Allowance,***

This shall be the actual cost of transporting twelve and half (12.5) tons of luggage (i.e. households- furniture and crockery) by rail or road (whichever available at cheaper cost) within twenty (20) km from the point of displacement. Since the amount of goods for transportation may differ including the distance, we have adopted the figure of Tshs. 100,000 as maximum for transport for each household.

***e) Loss of interest or value for unexhausted improvements***

Replacement cost method was adopted in the valuation of unexhausted improvements The Replacement Method of Valuation, sometimes known as the Cost Method of Valuation is generally used to value those types of assets, which do not change hands in the market very often and for which there would be no evidence of comparable sales.

In this method, the cost of an asset is determined by reference to its replacement cost or the cost of reinstating it (as new) or that of its substitute at the date of valuation. The replacement cost so obtained is reduced by an appropriate factor to reflect its obsolescence that the asset has suffered. It is in this line that we get the Depreciated Replacement Cost, which is equivalent to the Market Value.

**Valuation**

| | |
|---|---|
| Total Reduced Floor Area | X |
| Multiply by: Construction cost per sq. meters Tshs | Y |
| Replacement cost | XY |
| Less: Depreciation | D |
| Market Value Tshs. | XY-D |

The construction rate per meter squared adopted was between **Tsh 200,000 to 250,000 per meter squared,** this is the rate currently used by Temeke municipality in valuation assessment.

### 6.3 Valuation of agricultural land

The valuation of crops was done in accordance with the crop compensation schedule which is normally prepared at Regional level for this case **the Dar es Salaam crop compensation schedule was used**. Under this seasonal crops are valued per acre while the perennial crops are valued by counting the number of stems or trees.

#### 6.3.1 Land Value Approach

This method relates to establishment of land value and potentials. The potentials include those for crop production, soil fertility of the affected lands, climate, accessibility, transport network, alternative uses to which the subject land may be put, comparability of similar land in the neighbourhood and recent sales of neighbouring land. However, constraints in terms of time, lack of reliable data and other logistical problems would render the method difficult to invoke. The calculation for land values along the Kizinga

wetland has been based on Tshs. **3,000,000 per acre**. This is because the land is in urban areas provided with infrastructure.

**Human Settlement within the Kizinga Wetland (60m, 30m):**

The research observed an increased human settlement within the Kizinga wetland which results into deterioration of the water quality and water quantity. The areas with extensive encroachment of human settlements include the following

- Mashine ya maji – Makangarawe ward (Temeke Municipality).
- Buza- Makangarawe ward (Temeke Municipality).
- Tambukareli –Azimio ward (Temeke Municipality).
- Mbuyuni -Azimio ward (Temeke Municipality).

The following image shows human settlement encroachment within 60 m from the river bank

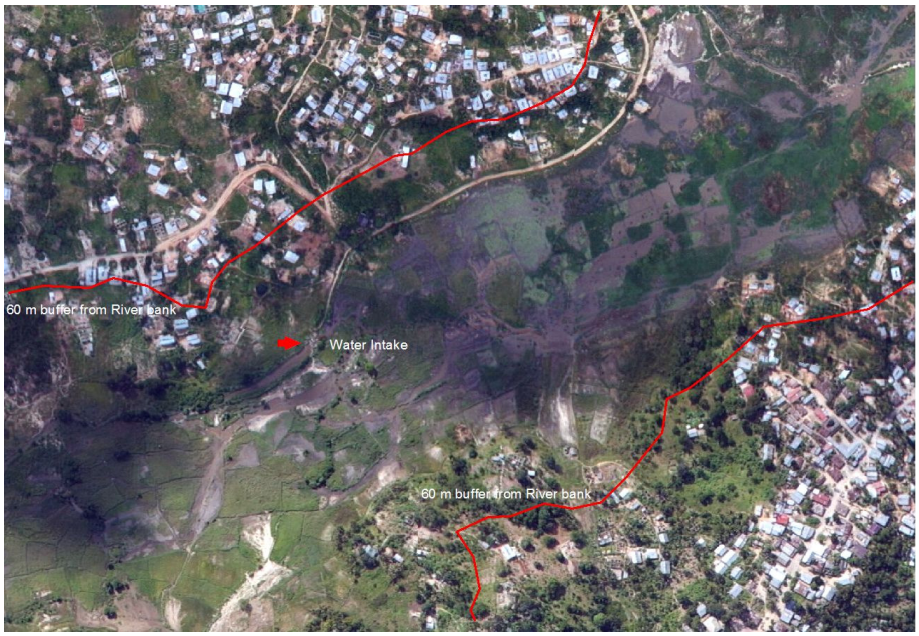



**Fig 6. 1 Human settlement encroachment within 60 m from the river bank**

From the interview conducted with the local leaders and the observation from the areas it is evident that the rate of encroachment is increasing at a high rate. It has been observed that there are still more houses under construction which will worsen the existing

situation. We have been able to identify the number of houses that fall within 60 meters from the river bank; and also tried to capture the number of houses that fall within 30.

**Table 6. 1 Number of Properties (Houses ) in various Localities (*Mitaas*)**

| **Location** | **Number of properties** | |
|---|---|---|
| | 60m | 30m |
| Mashine Maji | 113 | 83 |
| Buza | 20 | 7 |
| Tambukareli | 150 | 90 |
| Mbuyuni | 70 | 40 |
| **Total** | **353** | **220** |

There are a total of 353 houses that are within the Kizinga wetland that is 60 meters from the river bank and 220 houses that fall within 30 meters from the river bank. The table below shows in summary the number of properties in each ward that falls within 60 and 30 meters from the river bank.

### 6.3.2 Crop Value Approach

Valuation for compensation was previously being undertaken using total number of plants/clusters/stems regardless of crop husbandry being employed and historical performance of the relevant farm. We have, in this exercise, made consideration on the level of maturity of a particular crop, standard and maintenance of the crop.

**Agriculture within the Kizinga Wetland**

There is also agriculture activities conducted at the Kizinga wetland; areas with extensive agriculture activities are Kerezange, Kitunda and Nyanwandu. The total cultivated area is about 7.2 $km^2$ (1780acres ) and there are a total of about 800 farmers (PREM,2005). It is estimated that each farmer has at least 1 acre. Types of crops grown are mostly seasonal crops they include tomatoes, spinach and other green vegetables.

The following image shows cultivation at Mukerezange

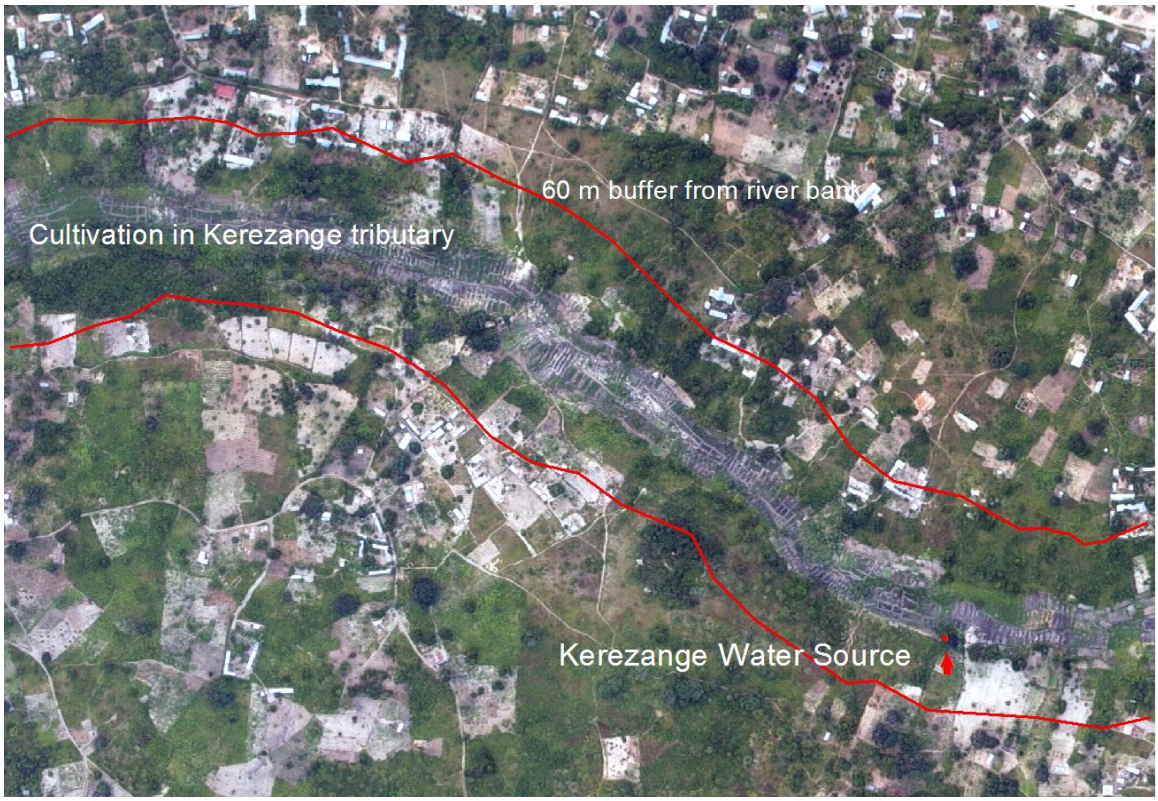



**Fig 6.2. Agriculture within Kizinga riverine in Mukerezange in Kitunda Ward**

**Value of agricultural land**

The value of agricultural land that fall within the wetland is (1780 acres x 3,000,000 Tsh ) = **Tsh 5,340,000,000** (Five billion three hundred and forty million only).

### 6.3.3 Compensation of agricultural land

Agricultural land inside a wetland area within 60 m is difficult to consider for compensation but rather we can talk of economic values in the irrigated agriculture. So may be consideration of assisting in providing efficient irrigation systems outside the wetland to improve livelihoods.

However, farmers in the Kitunda were arguing that water resources in Kizinga is not meant for Temeke people only but for all the residents. So Temeke residents may as well use ground water like them and let others utilize the waters as they wish. Temeke can

also engage in vegetable farming downstream while using ground water source and not necessarily Kizinga river water.

**Valuation of properties for possible Compensation.**

Valuation of properties was carried out for the properties that fall within the 60 meters and 30 meters from the river bank. The valued properties were categorized into 3 major groups as follows:

**Category 1**

Properties that bear pitched roofs covered with corrugated iron sheets on timber members with a hardboard ceiling. The walls are of sand cement blocks well plastered, rendered and painted internally and Tyrolean rendered externally with at least 3 bedrooms. A total of 100 properties fall under this category

**Fig 6.3 House of category 1**

**Category 2**

Properties that bear pitched roofs covered with corrugated iron sheets on timber members with a hardboard ceiling. The walls are of sand cement blocks **not plastered** with at least 3 bedrooms. A total of 210 properties fall under this category.

**Fig 6.4 House of Category 2**

**Category 3**

Properties **under construction**, the walls are of sand cement blocks. A total of 43 properties fall under this category.

**Fig 6.5 House of category 3**

**Values of houses**

The opinions of values are reported in two different scenarios, that is the values of houses that falls within 60metres and 30 meters from the river bank. The total value of houses that fall **within 60 meters** from the river bank is **Tsh 7,130,000,000** (seven billion one hundred and thirty million only) and the value of houses that fall **within 30 meters** from the river bank is **5,300,000,000** (five billion three hundred million only).

- **Compensation of human settlements within wetlands**

First of all settling in a wetlands is not allowed by EMA(2004) within 60m. However, people who may have settled within the wetlands before putting the beacons may require consideration.

But people who settled after putting the wetland boundary (if records can prove that ) may not be considered at all. Therefore we can only talk of values of houses within the wetlands but who deserves the compensation is another matter requiring visitation to the existing laws.

Reasons for increased encroachment in the basin:

1) ***Non enforcement of laws***

The environmental laws provide that the water catchments areas should be protected whereby 60 meters from the river bank should be conserved. But contrary to that the residents residing within 60 meters from Kizinga river were **given 2 years renewable residential licenses from year 2006.**

2) ***Overlapping of powers***

The local leaders revealed that they are aware that the Kizinga wetland has to be conserved, and they are ready to cooperate in the conservation exercise, but the problem is that there is a lot of politics in the whole issue. For example there is an instance where the local leader tried to stop a development on the wetland but the developer continued, the local leader reported the case to the Municipality but no action was taken as a result the property is still under construction.

**Fig 6.6 Construction going on within Kizinga wetland.**

### 3) Wetland Boundary definition

The river bank definition is also a reason for increased encroachment, some residents are not aware of where the river bank is because the beacons demarcating where the river bank is have only been recently kept in some areas like Mashine Maji and Buza. The exercise is not complete as there are areas with no beacons such as Tambukareli.

The following picture shows the beacon kept by DAWASCO to indicate 60 meters from the river bank that has to be conserved.

**Fig 6.7 A house built inside the 60 m Beacon mark**

## 6.4 Challenges

### 1) Encroachment of human settlements within the river wetland

There is an increase in encroachment of human settlements within the wetland, currently more houses are being constructed and more people are purchasing land within the wetland for construction of more houses.

2) **Vandalism**

Officials from DAWASCO in collaboration with the local leaders are trying to place some beacons 60 meters from the river bank to indicate that the area is a conserved area and no activities should be conducted but the residents are attempting to destroy and remove the beacons.

3) **Non enforcement of laws**

The environmental laws provides that the water catchments areas should be protected therefore the laws provide that 60 meters from the river bank should be conserved but contrary to that the residents residing 60 meters from Kizinga river **were given 2 year** residential licenses in year 2006.

4) **Inadequate communication between authorities at Ward and Municipalities**

5) **Conflicting laws**

Issuing 2 years licenses to communities to live within the 60 m is a mistake because repeatedly communities take it for granted that the area is theirs and decide to settle permanently. Similarly approving plots for human settlements by Ministry of Lands in areas within 60 m without consultations with other water/environmental authorities is a problem.

**Recommendations**

**(a) Enforcement of laws**

The laws such as the environmental Act, land Acts, water Act are very clear on the question of conservation of water catchment's areas , the problem is that the laws are not enforced that's why a lot of problems occur.

**(b) Banning of encroachment of Kizinga wetland areas**

The present situation at the kizinga wetland is not good as there is high encroachment of human activities such as settlements and agricultural activities; the rate of encroachment is increasing at a very high rate which calls for an immediate intervention.

**(c) Community participation in conservation**

There is need for the local community to be involved in conservation of the Kizinga wetland; the local people are the ones who benefit from the river therefore if they are well educated on different environmental laws, land law, they could be in a better position to protect the wetland.

**(d) Improve coordination among authorities at Ward and Municipalities**

The ministry of lands, water and environment needs to communicate at **Ward level and Municipalities** in order to avoid conflicting decisions /authorization on shared resources e.g land and water

# 7. BENEFIT COST ANALYSIS

## 7.1 Methodology and approaches

Social cost benefit appraisal is based on primary and secondary data collected in Kizinga catchment and using the net present value (NPV), Benefit –Cost Ratio and Sensitivity analysis. The study uses primary data and secondary data collected from various sources. Primary data collection involves household randomly selected from the list of farmers along the catchment, those who practices livelihood within 60m buffer zone and the hot spots identified by hydrological factors.

We establish social economic profiles of communities and households living in the study area. The profile is based on household survey, focus group discussion and visits to the areas. We undertook critical assessment of the social economic and environmental aspects of the target area for intervention. CBA for instituting changes in land use in the study area is undertaken. Information from CBA provides clear understanding of what are the likely costs of instituting the eviction management plan and the economic feasibility of the management plan.

The household were asked on general information on main occupation, land holdings, income, expenditure, savings, agricultural output, and other demographic characteristics such as age, gender, migration issues, education level and marital status. Also, information on input used for crop production such as type and quantity of fertilizers, quantity of water used for irrigation and domestic purposes, harvesting and use of forests products. Memory recall method was adopted to record the past experience of respondents about their cultivation practices, income, expenditure, water use, harvesting and use of forest products. The assessment of opportunity cost for the communities to undertake alternative income generating activities was done. This was achieved through answering the following questions:

- What are the main crops grown by farmers in the study area
- How much of each crop was produced in the last season

- What input were used in the production process of the major crops
- What value of each crop of each input that was used in the production process of major crops in the last season
- How much rent was charged for hiring land
- What is the projections of farm costs and benefits in the area
- What is the net present value of projected crop production in the study area.

Secondary data were collected from different sources such as DAWASCO, WRBWO, Ministry of natural Resources, Ministry of water, National Bureau of Statistics, Ministry of Agriculture, Ministry of Land and settlement development, research institutions (REPOA, ESRF, UDSM, SUA etc).

## 7.2 Demographic characteristics of respondents

A preliminary result indicates that, in general, the household size in the study area revealed to have about 9 members per household. The figure is relatively above the national average which stands at 6 members per household. (NBS, 2002). The maximum and minimum number of household members estimated to about 29 and 4 respectively. The distribution by sex shows that, majority respondents are male. These results are not surprising given the natural setup of Tanzanians when it comes to household matters. That is, most of households in the country areas are headed by male. See Table 7.1.

**Table 7.1: Household size and gender**

| | Minimum | Maximum | Average |
|---|---|---|---|
| Male | 1 | 10 | 4.4 |
| Female | 1 | 19 | 4.6 |
| Household size | 4 | 29 | 9.0 |

Analysis of the age structure of respondents in this study indicates that an average age of 48 years old, with majority of the respondents (50%) being the age group of 20 and 50 year old. Where as 45.8% is between 51 and 70 years and 4.2% are those with age above 71 years old. See Table 7.2 for details

**Table7.2: Age Composition of the respondents**

| **Age group** | **% respondents** |
|---|---|
| **20 – 50** | 50.0 |
| **51 – 70** | 45.8 |
| **71 +** | 4.2 |
| **Total** | 100.0 |

**Education level**

Respondents are grouped into three education categories namely none, primary and secondary. It is shown that, majority has attained up to standard seven, few have at least secondary education, and Table 7.3 summarizes the main results.

**Table7. 3: Education categories of the respondents**

| Category | % respondents |
|---|---|
| None | 12.5 |
| Primary | 79 |
| Secondary | 8.3 |

## 7.3 Main occupation of respondents

Together with field observation, respondents where asked to report their main occupation and later were also asked to rank the best two important occupation's source of income, the results are that, farming, livestock, causal work, businesses and wage employment identify as the min source of income in the study area (Table 7.4). The dominant economic activity by local community is cultivation of vegetables to the large extend and cereal crops in small quntities. Vegetbles include Ocra, Mchicha, Spinachi, chines, matembele, kunde, mnavu etc. Other crops include maize, banana, rice, and sweet potatoes. Majority of these farming and all vegetable farming depends on the water from the Kizinga catchment. Suggesting that the household rely heavily on the availability of water from this catchment.

**Table 7. 4: Main occupation of the respondents**

| Occupation | % respondents |
|---|---|
| Farming | 100 |
| Livestock | 87 |
| Causal labourer | 83 |
| Petty businesses | 67 |
| Wage employment | 66 |

### 7.4 Respondent's monthly Gross income[1]

In this study, we establish and analyze the monthly income of respondents. From Figure 1, the average monthly gross income ranges between TZS 20,000 and TZS 900,000 per month with an average of about TZS 200,000 per month. Income level distribution is analyzed against education of respondents. It is shown that, monthly income level correlates with education level. The higher the education levels of the respondent, the higher the average monthly income and vice versa (Figure 7.1).

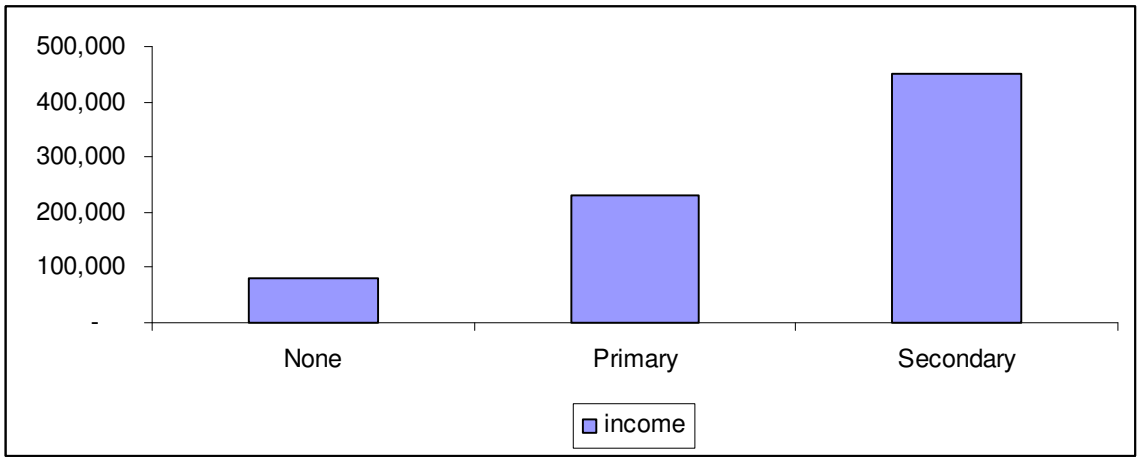



**Figure 7. 1: Respondents Monthly Gross Income**

The distribution of income by gender shows that female respondents have relatively small monthly income (TZS 140,000) than male with average of TZS 210,000. On average, employment (both wage and causal) offer low average income relative to average

[1] Few of the respondents were able to estimate their costs, therefore we decided to discuss the gross income

monthly income for farming, livestock and business (Table 7.5). The implication is that, river environment form a significant contribution to income of respondents in the study area. Non environment related occupation such as wage employment is having smaller contribution to respondents' income. This could be attributed by the low level of education reached by most respondents in the study area.

**Table 7. 5: Occupation and level of income per month**

| **Occupation** | **Monthly income** |
|---|---|
| Poultry | 360,000 |
| Farming | 202,500 |
| Petty Business | 127,000 |
| Causal labour | 79,000 |
| Employment | 45,000 |

## 7.5 The extent of water use in the area

We estimate the quantity of water use for irrigation in the study. Respondents were asked to recall frequency of irrigation on daily and weekly basis. Further more, they were asked on quantity of water (number of buckets) per single session of irrigation. Table below summarizes the proportion of respondents who irrigate and the frequency of irrigation. It is important to note that, irrigation is done for every day.

**Table 7. 6: The extent of Water use in the surveyed area**

| | |
|---|---|
| Respondent who irrigate | 62.0% |
| Respondents who irrigate once per day | 6.3% |
| Respondents who irrigate twice per day | 93.7% |
| | |

**Fig 7. 2 Irrigation in Kitunda area (Field visit 2009)**

### 7.6 Quantity of water use

We estimated quantity of water used for irrigation by asking respondents on number of 20lt bucket used per day. This amount was related with frequency of irrigation in Table 6. On average, about 940 litre of water is used for irrigation per day. The minimum and maximum quantity of water use is estimated to be 120 liter and 4,000 liters respectively.

The estimated area under cultivation using available satellite image of 2002, was found to be about 7.2 square kilometer or 1,780 acres being under cultivation. We use the average water quantity used per acre of 940lt/d to estimate the quantity of water used in irrigation farming in the catchment to be 1.7 million lt/d. According to PREM (2005), within the Kizinga watershed, there are about 800 households conducting irrigation farming and number were expected to increase with increasing migration of farmers from other regions of Tanzania. Irrigation in Kizinga Catchment is done through the use traditional means into which buckets and flooding is dominant.

**Fig 7. 3 Irrigated farming in the centre of spring in Kitunda area (Source: Field visit 2009)**

Water for domestic use[2] shows that, on average, households use an average of 256 lt/d The minimum and maximum quantity of water use for domestic purposes is 80 liters and 400 liters respectively. The main sources of water reported to be tap (39%) and well/springs (61%) these results are similar with PREM (2005) reported that 55% of water for domestic use is mainly collected from public wells in Kizinga. See Table 7.7 for details.

**Table 7.7: Household water use for Irrigation and domestic purposes**

| Indicator | Irrigation (lt/day) | Domestic (lt/day) |
|---|---|---|
| Minimum | 120 | 80 |
| Maximum | 4,000 | 400 |
| Average | 940 | 256 |

A comparison of mean income of respondents who irrigate and those who do not irrigate shows that, on average, those who irrigate have higher mean income than those who do not irrigate. While the mean income from irrigators is found to about TZS 250,000, that

[2] For some households, domestic use include water for poultry.

of those who do not irrigate is only TZS 70,000. This would imply that, irrigation water play a significant role in influencing respondents income. This due to fact that, crops irrigated are the most generators of income to most respondents in the area.

## 7.7 Monetary valuation of the benefits and costs

In this study, the unity measure of benefits and costs are in three levels: communities or households and institutions directly and/ or indirectly practicing livelihood in the catchment. The third level is the aggregated benefit or cost for both households and institutions. The setting of the valuation framework is that, current benefits are accruing to both households and institutions, however, the impact of household posses costs again to institutions. On the other hand, the implementation of management plan would generate benefits to institutions and costs (loss) to households. Benefit – Cost ratio is estimated for household, institution and for the aggregate values.

Water in the basin produces both use-related benefits and environmental benefits. The proposed water management centers on the measurement of economic efficiency effects of the proposed water decision. Our analysis accounts for efficiency impacts and the change in total economic value by computing four important kinds of benefits and associated costs for location where economic benefits from water occur. In this case, we calculate [1] use - related benefits,[2] use – related costs [3]environmental benefits and [4] environmental costs.

### 7.7.1 Benefits

Benefit values are obtained from households and institutions and is composed of benefits from crop production, income from livestock and income from water sales. Total net benefit in a single period is its total benefits minus total costs. Here total benefits equal the sum of [1] and [3] above. We quantify total benefits from the activities practiced in the catchment (within 60m from maximum river flood area. In this case, total benefit is estimated from activity output in equation (1).

**Total Benefit = $BX_1$+ $BX_2$…….+$BX_p$……..(1)**

Where

$X_1$ represent the variable (item/activity) at the current period

$BX_1, BX_2, \ldots BX_p$ represent output for item/activity 1 to p

The total benefit in real term is converted in values by multiplying with the respective farm get prices as shown in equation (2)

**($BX_1$ x $PX_1$)+ ($BX_2$ x $PX_2$)+…….+ ($BX_p$ x $PX_p$) = $VX_1$+ $VX_2$ + …+ $VX_p$…. (2)**

Where

$PX_1$, $PX_2$,….$PX_p$ represents price of output $X_1$, $X_2$ ……$X_p$

Note that, equation (2) estimates benefit value of activities by one household. For the entire households in the survey, the value of benefits is obtained by adding value of benefits in the RHS of (2) for all households in the study area. That is

**Benefit value = $VX_1$+ VX2 + ……+ $VX_p$ (H1)+ $VX_1$+ $VX_2$ + ……+ $VX_p$ (H2) +……..+ $VX_1$+ VX2 + .. ……+ $VX_p$ (Hn) …….(3)**

Where $H_1$, $H_2$, ....$H_n$ represent household 1, 2,..n

### 7.7.2 Benefit values of crops to households

In this study, we asked respondents to report on the crops grown, area planted, quantity harvested per season and the average farm get price. The identified crops grown are vegetables and cereal crops. For the vegetables, six different types are analyzed for each respondent. Table 7.8 indicates crop and benefit value per year per acre using equations 1,2 and 3.

**Table7.8: Benefit values from crop production in the Kizinga catchment**

| CROP | Benefit Value (TZS) | Average(TZS) | Contribution to income [3](%) |
|---|---|---|---|
| Tomato | 24,000 – 4,800,000 | 794,333 | 66.19 |
| Leaves of sweet potatoes(Tembele) | 84,000 – 2,160,000 | 618,727 | 51.56 |
| Green leaf vegetable (Mchicha) | 24,000 – 1,400,000 | 313,000 | 26.08 |
| Bean leaf (Kunde) | 40,000 – 787,500 | 312,786 | 26.07 |
| Lady's finger (Bamia) | 10,000 – 900,000 | 211,875 | 17.66 |
| Spinachi | 60,000 – 400,000 | 196,500 | 16.38 |

The average benefit value from vegetables ranges between TZS 200,000 and 800,000 per year per acre (See Figure 7.2). Tomato and Matembele are found to contribute more with about 66% and 52% of average income of respondents for the period of six months (vegetable growing period).

**Table 7.9: Acre and income of respondents**

| | **Minimum** | **Maximum** | **Average** |
|---|---|---|---|
| Plot size (Acre) | 0.25 | 6 | 1 |
| Monthly income(TZS) | 20,000 | 900,000 | 194,000 |
| Vegetable values/y/acre (TZS) | 10,000 | 4,800,000 | 407,000 |
| Rice per season | 19,000 | 1,04,000 | 343,800 |

[3] Calculated as percent of income ( from crops) on monthly income for the period of six months only.

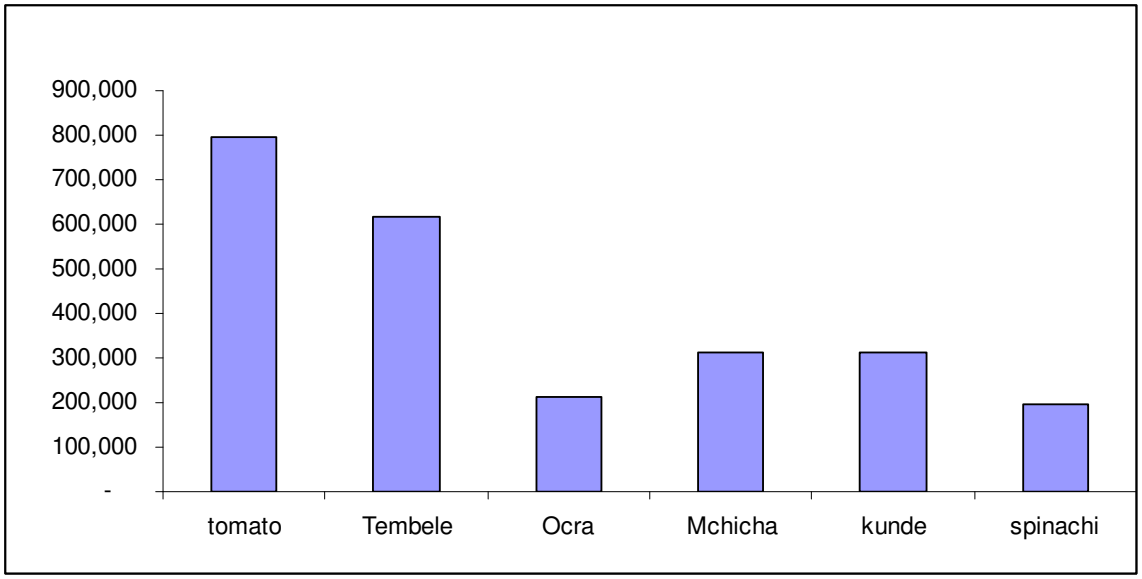



**Figure 7.4 : Values of Vegetables grown**

Analysis of monthly average income of respondents reveals that, on average, the six types vegetable contribute up to about 34% of the respondents' income. The value of cereal crop like rice is also significant and form an important component of food to respondents as mostly cultivate for home use.

Vegetables are traded within study area and outside in the bigger markets such as Ilala, Kariakoo, Temeke. There is chain of stakeholders involved in vegetable business from the farmer to the middlemen and the final consumers. The chain has also important implication on the price and general contribution of farming activity in the basin to the livelihood of different people. This is an indication that, vegetable cultivation along the Kizinga catchments plays a significant role in influencing people's welfare. The implication is that, any management plan to be imposed upon management of Kizinga river valley would have direct significant impact to peoples' welfare.

### 7.7.3 Sources of costs

Secondary data from DAWASCO provide information on cost on water treatment costs, maintenance cost, cost of abstracting water from other sources such as borehole, electricity costs, water right, water loss (delivery loss), and security. Whereas catchment management costs such as fire fighting, tree planting, awareness/training, patrol,

boundary demarcation, were obtained from Ministry of Natural Resources, DAWASCO, WRBWO and literature.

On the other hand, the cost of the project in different heads for the Kizinga watershed project will include cost of community organization, training, administration, treatment, electricity charges (due water interruption), costs of well or boreholes constructed to supplement water flow, catchment management (tree planting, boundary demarcation, fire fighting, patrol etc). The cost of the project is derived from secondary source.

### 7.7.4 Catchment management costs

Kizinga catchment has two reserves with water catchment potential and have an area totaling 196 square kilometer. For sustained production of water catchment services, the forests need to be properly managed. The management activities include (i) boundary survey and demarcation, which includes boundary clearing and planting of tree species, (ii) forest enrichment which includes gap identification, and planting, climber and brambles cutting on coppice and root suckers (iii) conducting regular patrols and fighting fire outbreaks. Kulindwa et al; (2006) estimated the catchment management costs of about Tshs 0.6 million per square km per year, using this fact, the management cost for Kizinga catchment of 198square km is bout Tsh 117.6 million per year. Note that, the figure is expected to be higher than this estimate given the fact that, catchment management activities in urban related environment could be higher/different from management activities in rural environment.

### 7.7.5 Water related Cost by DAWASCO

For the period between 2005/06 and 2008/09 water production in Mtoni plant has remained below plant capacity of 3.7million cubic metre per year (Table10). The average plant production of raw water stood at about 3 million cubic metres. The actual water production is about 2.3 million cubic metres. The implication is that, Mtoni plant have been incurring loss of water due to treatment and cleaning from about 17% and 30% per annum. Of recent years there has been some improvement such that water losses has been declining (See Figure 3). This translates costs to the plant in terms of treatment and sourcing alternative water which is only from wells.

**Table 7. 10: Water production by Mtoni Plan for 2005/06, 2007/08 and 2008/09**

| Year | Raw water | Actual production | Loss | %loss |
|---|---|---|---|---|
| 2005/06 | 3,777,750 | 2,614,196 | (1,163,554) | -30.8002 |
| 2007/08 | 2,801,564 | 2,089,897 | (711,667) | -25.4025 |
| 2008/09 | 2,562,138 | 2,116,010 | (446,128) | -17.4123 |
| Average | 3,047,151 | 2,273,368 | -773,783 | -24.5383 |

**Source: DAWASCO and Authors' estimation**

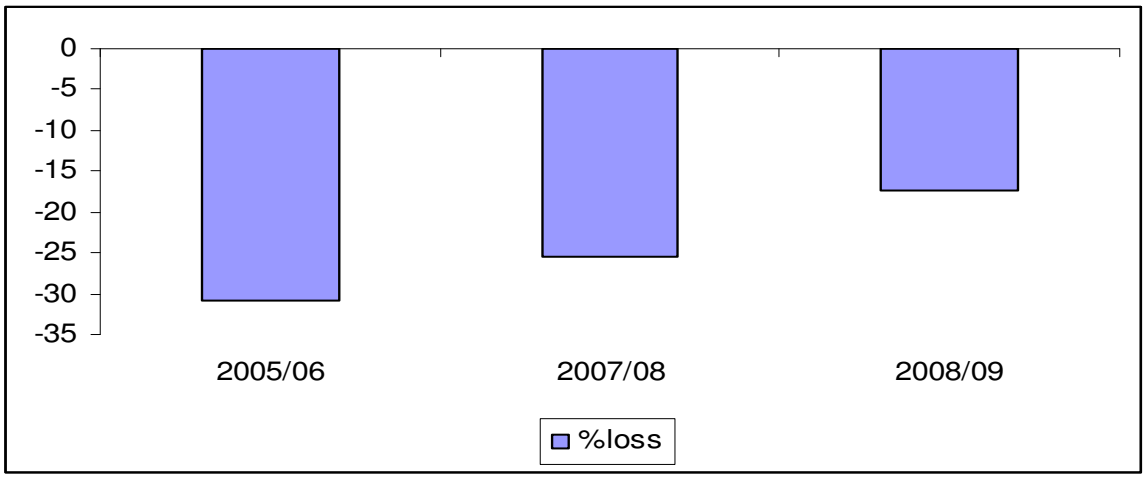



**Figure 7.5 Proportion of water loss due to treatment**

Analysis of monthly data indicates that, Mtoni Plant is faced with declining water quantity over time. It is clearly seen that, both raw water and treated water quantity is declining over time. Analysis of the difference between raw water and actual production is significantly higher for the period of April – October period.

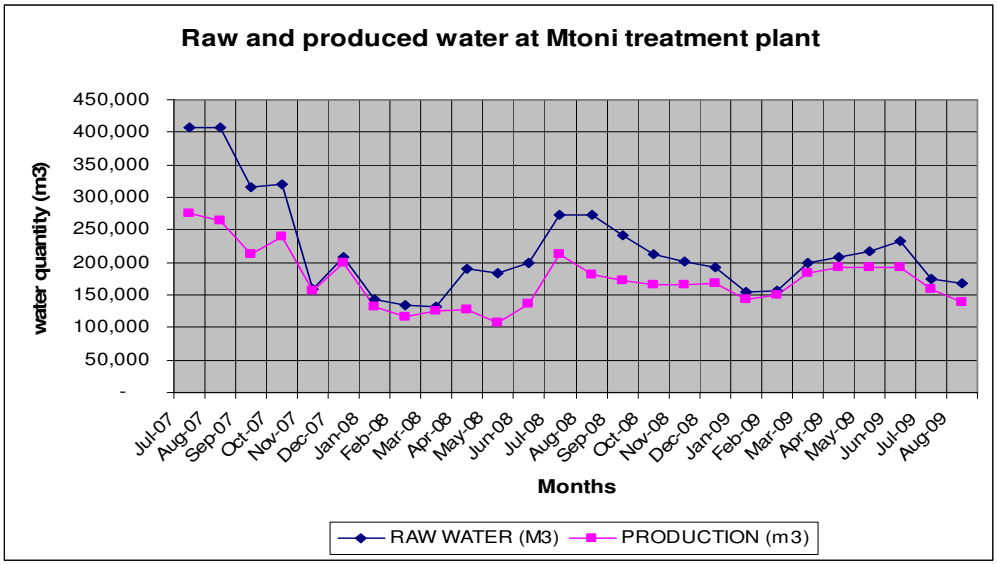



**Figure 7.6 Raw water and production in Mtoni Plant for July 2007 and august 2009**

This implies that, the plant is faced with higher costs (treatment) during dry season, where water supply is lower. It is this period where there are significant household activities such as cultivation of vegetables along and nearby river flowing area resulting to increased siltation. The plant in this case is faced with two problems of reduced water supply (quantity) and poor quality of water. As water quantity decreases, the plant is also faced with increased costs due to electricity. It is seen that, power consumption in the plant is increasing with decreasing water quantity at the intake.

In addition, the plant is faced with increased cost of treatment during wet period the difference between raw water and production is very small which imply low cost of treatment by the plant. During dry period, the plant is faced with higher cost of treatment and also low water supply as much of water is lost through treatment processes

This implies that, the plant is faced with higher costs (treatment) during dry season, where water supply is lower. It is this period where there are significant household activities such as cultivation of vegetables along and nearby river flowing area resulting to increased siltation. The plant in this case is faced with two problems of reduced water supply (quantity) and poor quality of water. As water quantity decreases, the plant is also

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In addition, the plant is faced with increased cost of treatment during wet period the difference between raw water and production is very small which imply low cost of treatment by the plant. During dry period, the plant is faced with higher cost of treatment and also low water supply as much of water is lost through treatment processes.

### 7.7.6 Implication from watershed protection

The first outcome from the proposed management plan is change in agricultural output. The primary data and discussion with communities gives a clear picture on the decrease in agricultural output after implementation of watershed management plan. If farming within 60m will be banned, there would be reduce crop land by households in the catchment. Total ban from cropping would generate costs to communities who are currently deriving their income from livelihoods within 60 m area. Below is an indicative opportunity costs to community as a result of loss of agricultural land

**Table 7.11 Estimation of opportunity cost due to loss of farmland in the Kizinga sub basin per acre**

| CROP | Benefit Value (TZS) | Average(TZS) | Weights | Opportunity cost per acre | | |
|---|---|---|---|---|---|---|
| | | | | lower limit | Upper limit | average |
| Tomato | 24,000 – 4,800,000 | 794,333 | 0.16 | 3,789 | 757,895 | 125,421 |
| Leves of sweet potatoes(Tembele) | 84,000 – 2,160,000 | 618,727 | 0.19 | 16,211 | 416,842 | 119,403 |
| Green leaf vegetable (Mchicha) | 24,000 – 1,400,000 | 313,000 | 0.14 | 3,368 | 196,491 | 43,930 |
| Bean leaf (Kunde) | 40,000 – 787,500 | 312,786 | 0.12 | 4,912 | 96,711 | 38,412 |
| Lady's finger (Bamia) | 10,000 – 900,000 | 211,875 | 0.28 | 2,807 | 252,632 | 59,474 |
| Spinachi | 60,000 – 400,000 | 196,500 | 0.11 | 6,316 | 42,105 | 20,684 |
| Total | | | 1.00 | 37,404 | 1,762,675 | 407,324 |

**Source: Field survey 2009 and author's estimation**

Note:

(i) Weights used were derived from the average number of farmers for the six crops grown in the catchment as identified during the survey.

(ii) Estimate of lower and upper bound is done by multiplying the lover/upper value with the weight of each crop. The values from six crops are added together to get the aggregate crop value per household.

Using benefit value from six crops (Table 7.11 ) the estimated loss of benefit is between 37,400 and 1,762,675 per household. For the estimated 800 farmers in the basin, this would translate a loss of about Tshs 29.9 million and Tshs 1,410.1 million as lower and upper bound respectively. Note that, these values are indicative of what is likely to be lost per season (dry season) and the value will increase or decrease based on the actual number of farmers of each crop in the basin.

In addition, the ban would result to reduced supply of crops to the community and this would lead to increased market price and also food insecurity. Some businesses in town are supplied with crops from Kizinga catchment, the ban would affect negatively these businesses in terms of supplies and they would have to look for alternative source of same products elsewhere, these would cause addition costs.

# 8. KEY ISSUES AND CHALLENGES

## 8.1 Poor Governance

There are a number of issues within the governance area as shown below:

**(a)** ***Weak Governance on Water and Natural resources within Kizinga sub basin***

Institutions mandated to oversee sustainable management of water and natural resources in the sub basin had not established a full time system for managing, monitoring and developments/threats that may alter negatively the ecosystem of Kizinga sub basin.

***(b) Weak enforcement of laws***

The environmental laws provides that the water catchments areas should be protected therefore the laws provide that 60 meters from the river bank should be conserved but contrary to that the residents residing 60 meters from Kizinga river **were given 2 year residential licenses since 2006.**

## 8.2 Expanding urbanization without adequate planning

a. Un planned settlement encroaching Kizinga river into 60 m wetlands boundary
b. Expanding population without adequate planning on **sanitation** and sold waste management which may threaten water resources

## 8.3 Expanding irrigated agriculture within kizinga wetlands

**( a)** ***Cultivation in swamps and river banks***

The river banks and swamps are heavily cultivated and water is used for irrigating the vegetables grown. It is claimed that about 30-40% of vegetable sold in Dar es Salaam are cultivated from the river banks and swamps of Kitunda ward**.** The river banks and swamps have been deprived of their natural vegetation and left exposed facilitating loss of water through evaporation.

c. Encroachment and degradation of important spring sources which are the recharge sources of suppliers of Kizinga during the dry season.

d. Inefficient irrigation systems promotes high evaporation looses thus deplete water supply to Kizinga river.
e. Heavy irrigation promote siltation which clog water treating costs at Mtoni treatment plant
f. High fertilizers usage in the vegetable farming leads into increased costs in the treatment of water at Mtoni DAWASCO station

### 8.4 Encroachment of Pugu and Kazimzumbwi Forests

c) Encroachment of Pugu-Kazimzumbwi forest reserves for timber, charcoal making bush fires which all negatively impact recharging of Kizinga river
d) Sand mining in the Pugu Hills which leads into siltation of reservoirs and Mtoni pumping station

### 8.5 Climate Change

Rainfall analysis in Kisarawe and DIA has shown that rainfall has decreased in the recent years and that is coupled with increase in temperature as evidenced at DIA station. The result of the two variable is a negative impact on water resources. Minaki reservoir has decreased considerably

# 9. RECOMMENDATIONS

## a) Ban encroachment of human activities such as settlements and agricultural activities

(i) To achieve that objective, **all destructive activities** (fires, encroachment, and charcoal burning) **must cease in the forests** while swamps and river banks are restored to their natural state to increase their ability to hold water and gradually release it into the river.

(ii) Restoring swamps and river banks to their natural state will mainly involve ceasing agriculture activities.

## b. Enforcement of laws

The laws such as the environmental Act, land Acts, water Act are very clear on the question of conservation of water catchment's areas , the problem is that the laws are not enforced that's why a lot of problems occur.

## c. Promote Community participation in conservation

There is need for the local community to be involved in conservation of the kizinga wetland; the local people are the ones who benefit from the river therefore if they are well educated on different environmental laws, land law, they could be in a better position to protect the wetland.

## (d) Benefit-cost implications

The first outcome from the proposed management plan is change in agricultural output. The primary data and discussion with communities gives a clear picture on the decrease in agricultural output after implementation of watershed management plan. If farming within 60m will be banned, there would be reduce crop land by households in the catchment. Total ban from cropping would generate costs to communities who are currently deriving their income from livelihoods within 60 m area. Also, the ban would

result to additional cost to Ministry of water from compensation for crops to those affected households.

In addition, the ban would result to reduced supply of crops to the community and this would lead to increased market price and also food insecurity. Some businesses in town are supplied with crops from Kizinga catchment, the ban would affect negatively these businesses in terms of supplies and they would have to look for alternative source of same products elsewhere, these would cause addition costs.

(e) Establishment of a participatory Institution Framework comprising of all stakeholders

1. WRBWO
2. DAWASCO
3. Local Government Institution
    a. Municipal Councils : Ilala and Temeke
    b. City Council
    c. Kiserawe District Council
4. Local government at grass rot level
    a. Wards
    b. Village Government
5. Pugu –Kazimzumbwi Catchment Forest Project
6. NGOs
    a. WCS
    b. CARE
    c. WWF
    d. TFCG

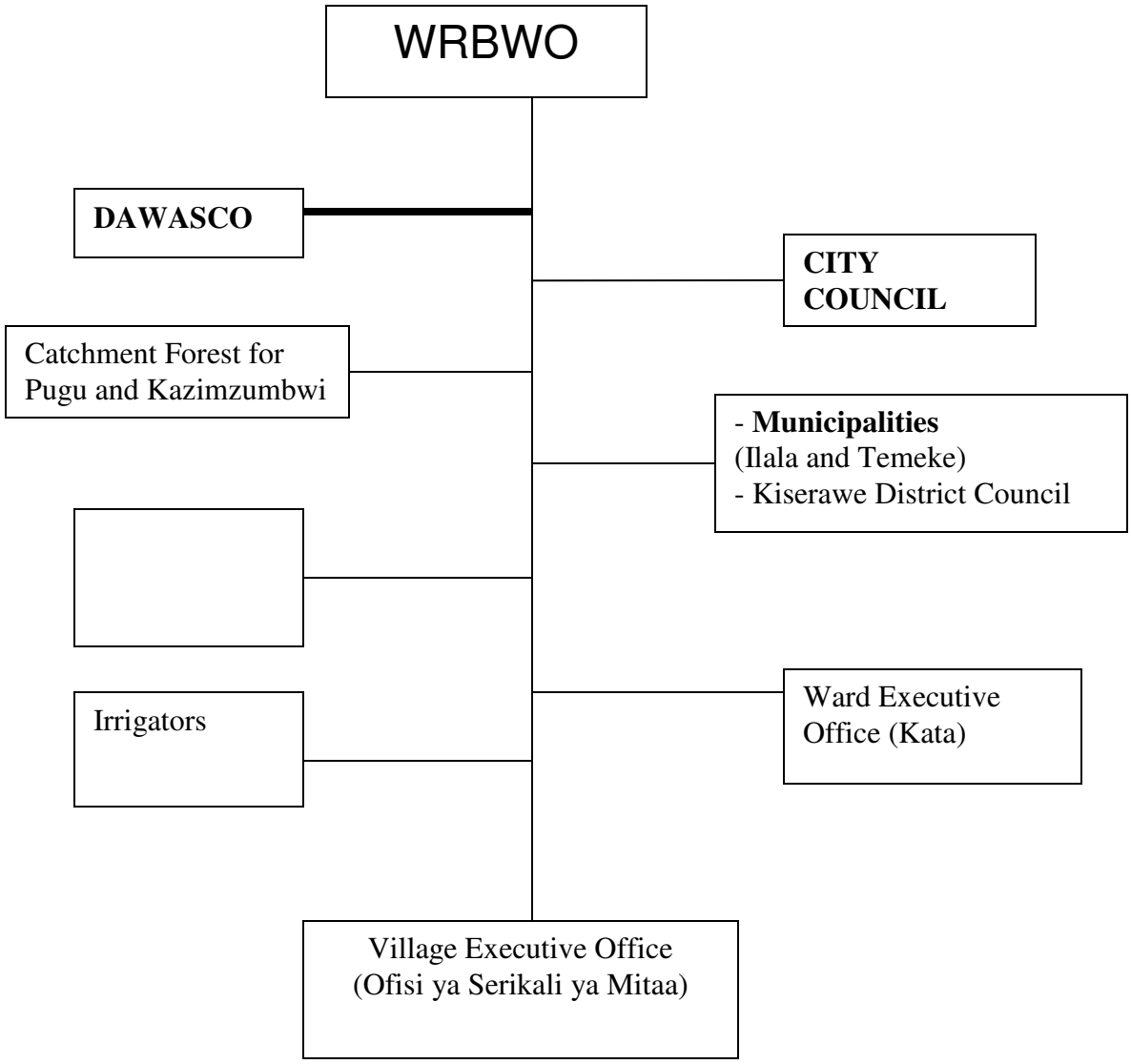
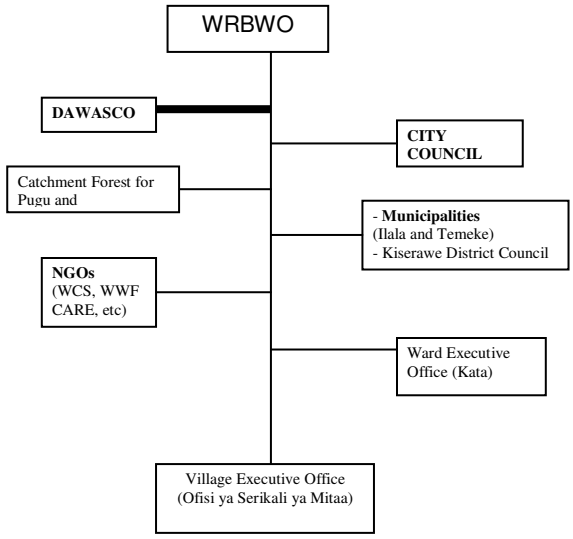



**Fig 8 Proposed Kizinga sub basin Management Framework**

# 10. PRELIMINARY CATCHMENT MANAGEMENT SCENARIOS

1. Management scenario which will embrace all key stakeholders implementing various Actions in the Recommendations




**Proposed Kizinga sub basin Management Framework**

2. DAWASCO to seek alternative water supply for Temeke Municipality instead of Kizinga river due to its complexity and expected management costs. Explore the option of ground water in the area to provide service to the community at least equivalent to of 150,000 $m^3$/month

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## Annex 1 Stakeholders consulted

1. WRBWO
2. DAWASCO
3. Municipalities : Ilala and Temeke
4. Kisarawe District Council
5. Dar City Council/Kinyamezi Damp Management Office
6. Ward and Village Governments in key Wards :
    1. Azimio,
    2. Makangarawe,
    3. Kitunda
    4. Kisarawe
7. Ministry of Natural Resources
8. Catchment Forestry in Pugu and Kazimzumbwi
9. Ministry of Water and Irrigation
10. TMA

Annex 2 Checklist of issues in Stakeholder Consultations

1. What is the history of Kizinga sub basin in as far as environmental and water resources was concerned?
2. What changes have occurred over time and what drivers brought about such changes?
3. Specifically what were the constraints with the previous catchment management system. What structure did it have ?, What were the successes ?
4. How could it be strengthened, and what would be the role of each player.
5. Finally what would be the recommendations in order to bring back the basin natural ecosystem
6. What information is available which is relevant on Kizinga ??