Ruvu Basin

A Situation Analysis

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Report for the Wami/Ruvu Basin Water Office
Supported by IUCN

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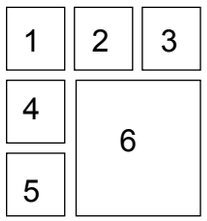

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Preface

The Wami/Ruvu Basin Water Office (WRBWO) with funding and technical support from the International Union for Conservation of Nature (IUCN), conducted field-work to produce situation analyses of natural resource management in the Wami, Ruvu and Coastal Rivers sub-basins in July 2008. Professor James Ngana from the University of Dar es Salaam was engaged as a consultant to carry out the field-work and draft the reports. Katharine Cross from IUCN and Florence Mahay from the WRBWO were recruited from within their respective organizations to take part in this work.

The Situation Analyses of the Wami and Ruvu (including coastal rivers) sub-basins were produced as separate analyses of the status, conditions and key issues affecting ecosystems in each basin using existing available information. The analyses provide information on natural resources (including water), socio-economic issues and the governance structure of water resource management. The purpose of each situation analysis is to provide an assessment that will be sufficiently adequate for priority themes or areas for actions to be developed in each basin according to the objectives of the National Water Sector Development Programme. This situation analysis will be used as background material for proposed project interventions.

Data and information were derived from literature review and interviews carried out with key stakeholders in the Wami and Ruvu basins. The interviews were semi-structured and aimed to determine activities as well as challenges and opportunities in hot spot areas of the sub-basin.

A first draft of the Situation Analysis for the Ruvu sub-basin was completed in late 2008 and distributed to stakeholders for review and comment. At a workshop hosted by the Wami/Ruvu Basin Water Office (WRBWO) and IUCN in Morogoro in December 2008, stakeholders gathered to comment on the Situation Analysis and suggest amendments. The workshop provided an opportunity to identify priority areas where the Basin Office should spend their time and resources, and identify mechanisms (activities) by which the priority areas for action can be implemented. A framework was also produced at the workshop to guide the staff of the WRBWO in producing a work-plan to implement priority areas of action.

Executive Summary

The Wami/Ruvu Basin Water Office (WRBWO) and Wami/Ruvu Basin Water Board (WRBWB) were established in July 2002. The vision of the WRBWO is to ensure basin water resources are sustainably managed for the socio-economic and environmental needs, interests and priorities of the basin population. The mission of the WRBWO includes facilitation of IWRM efficiently and effectively in order to address the resource needs, interests, and priorities of the Basin population while protecting and conserving the water resources (WRBWO 2008). This situation analysis concentrates on the Ruvu sub-basin; a separate report contains information on the Wami sub-basin.

The Ruvu sub-basin extends from Morogoro to the west of Dar es Salaam through the Coast and Dar es Salaam regions covering an area of about 18,000 square kilometres. Apart from the main Ruvu river system there are other small rivers draining the basin into the Indian Ocean. These rivers are Mkusa, Mpiji, Msimbazi on the southern part of the Ruvu River and Msimbazi, Kizinga, Mzinga, Mbezi and Luhute in the extreme south of the basin.

The Ruvu sub-basin is in mostly low lying areas, except for the Uluguru Mountains in the extreme West. The population of both the Wami and Ruvu basins combined is approximately 5.4 million. This includes Dar es Salaam (3 million) and the smaller cities of Morogoro, Kibaha and Dodoma. About 80% of the basin population lives in urban areas and 20% in rural areas, thus the population is very urbanized compared to the rest of the country which is 20% urban and 80% rural. Outside of major urban areas, approximately 75% of total household income in the basin is earned from agriculture.

Natural Resources in the Ruvu sub-basin including coastal rivers

The catchment forests within the Morogoro Region form part of the Eastern Arc Mountains which stretches through Tanzania and into Southern Kenya. These mountains (including the Ulugurus in the Ruvu sub-basin) protect and regulate water flow for the country's three major rivers namely - Rufiji (Kilombero and Ruaha), Ruvu and Wami. The Eastern Arc Mountains are renowned in Africa for high concentrations of endemic species of animals and plants. The importance of the Uluguru forest to securing water has been recognised since the colonial period. The German colonial power created the Uluguru South and North forest reserves.

Forest reserves have been subjected to degradation due to agricultural expansion, illegal tree cutting for timber, firewood, building poles and forest fires caused by farmers who use fire as a tool for land preparation for agriculture. Where the forests are disturbed by human activities there has been a reduction in the biodiversity values. Rare and endemic species are replaced by species found over a much greater portion of Africa. Forest utilisation therefore poses a threat to the conservation of biodiversity in the Eastern Arc. In response, the government is now promoting Joint Forest Management (JFM) to developing community management plans together with the Catchment Forestry department.

The Ruvu River is the source of surface water supply for domestic and industrial uses for about 3 million residents of Dar es Salaam City, Kibaha and Bagamoyo towns and also to the people residing along the pipeline. It is estimated that by the year 2020 the population of Dar es Salaam will reach about 6 million. This population together with increases in water demand for industrial production, domestic and irrigation will result in serious water shortages. Groundwater is one of the most important alternative sources of water for Dar es Salaam City and its peri-urban areas. Over 50% of Dar-es-Salaam residents rely on groundwater because of the unreliable supply of water from Ruvu River, which is the existing main source of water supply. This is due to vulnerability of the unregulated Ruvu River to adverse impacts of droughts and floods. However, waste disposal is inadequately disposed of, and consequently the quality of the groundwater resource and its future dependence for potable water supplies is unreliable. There have been a number of studies to identify future sources of water for Dar es Salaam including exploratory drilling for deep ground water in the Kimbiji and Mpiji aquifers and construction of a dam at Kidunda for water supply.

The Kidunda dam will result in changes in downstream flow and seasonal inundation. This in turn will have an impact on the ecology, disrupt wildlife corridors, affect reproductive behaviour of aquatic organisms and nutrient supply to estuarine species, as well as negatively impact other wetland habitats. On the other hand, wildlife will find secure water and grazing, but may compete with livestock. The dam will also increase access to water downstream for irrigation and recharge to groundwater. To reduce the severity of negative impacts as a result of an altered flow regime, Norconsult (2008) recommended that the Flow Release Strategy mimics historical flow patterns and allow mixing of the upper and lower water layers. Otherwise changes in flow patterns and de-oxygenated water could result in a significant reduction in the downstream fishery.

Conservation threats to the Ruvu sub-basin include pollution upstream urban areas. Other threats include fishing using poisons in the river as well as over fishing thus depleting the juveniles. Siltation from the Uluguru Mountains is also a hazard as this can destroy fish breeding habitats. Increasing livestock population will also add to the potential threat in the fishing stock due to increased soil erosion and heavy siltation. Furthermore, the disappearance of vegetal cover has lead to increased surface runoff and flash floods and reduced infiltration ultimately resulting in reduced base flows in rivers which contradicts the prediction above. In addition, although it is difficult to prove, circumstantial evidence indicates that cloud-bases have moved higher up the hills and hence the catchment values of the eastern Arc Mountains have probably declined.

Socio-economy in the Ruvu sub-basin including coastal rivers

Industries in the Ruvu sub-basin play an important role with regard to the status of the socio-economy. Most of the industries are concentrated around the Coastal Rivers in Dar es Salaam, which are so polluted by industrial effluents that the water is not for consumption, agricultural use, or even other industrial processes (WRBWO 2006). As a result, residents are drilling boreholes to obtain water.

Pollution by industrial activities in the sub basin is a significant management challenge for the WRBWO. No organisations have been prosecuted for exceedences. Fishing using pesticides is often cited as the cause of pollution and fish deaths but there needs to be more data and monitoring to prove this is the case. Polluted water means that more energy and financial resources need to de directed towards water treatment. It can also impact the productivity of farms.

The Mindu dam is one of the major water infrastructures in the Ruvu River system. First, there is pollution of the reservoir from land use activities such as agriculture, mining, and human settlement in the catchment area. Another problem associated with the construction of the dam is the change in flow regime of the Ngerengere River downstream of the dam, as it is has changed from perennial to seasonal and salinity levels increased. Other major infrastructures

in the Ruvu sub-basin are the lower and upper Ruvu intakes for the water supply to Dar es salaam City and villages along the pipeline (Bagamoyo, Mlandizi and Kibaha). In addition, as mentioned earlier, the Government of Tanzania intends to construct a dam that will control the Ruvu River at Kidunda and will be a significant source of water supply for Dar es Salaam.

The main problems in the rural water sector are pollution, inadequate water supplies, and weak management capacities in finance and organization. The status of rural water supply schemes in the Ruvu sub-basin depends on the altitude and geographical location of the area in respect to the river. Broadly, water sources in the highlands of Uluguru have a reliable supply and relatively cleaner water than villages in the lowlands with low rains and high evaporation. In all settings, it was observed that water committees have been established although they are weak particularly in the management of funds that has been generated from fees for water services.

Traditional irrigation is practiced in the Uluguru highlands particularly in the Mgeta area where rainfall is not adequate as it is on the eastern windward side of the Ulugurus. In the lowlands of the basin there are a number of irrigation schemes run by communities but many are not operational. The Irrigation National Master Plan initiated in 2002 and to be completed in 2017 will improve irrigation schemes, and develop further areas for irrigation. The current acreage is 246,000 hectares irrigated area for whole country, projected to 570,000 hectares in 2017.

Pastoralism is wide spread in the Ruvu sub-basin ranging from the lowlands of the basin in the Mvuha area, to Ngerengere down to Chalinze, Kiserawe and Bagamoyo Districts. Over the years a large migration has taken place into the Ruvu sub-basin due to the availability of good pasture and water for the livestock. Conflicts sometimes arise when cattle enter people's farms while trying to access water. These conflicts are generally resolved by discussion and negotiation, although some are solved in legal courts. Provision of livestock infrastructure and land use planning would contribute to resolving this long-standing conflict. However, planning for the water use of migrating groups is a challenge as they are not stationary and their abstractions tend to be seasonal.

In addition to farmer- pastoralist conflicts, there are also conflicts due to pollution. In the highlands, immediate downstream users complain of water being polluted because of upstream pollution from bathing and washing hence brings about pollution. Furthermore, some industries in the Morogoro Municipality upstream along the Ngerengere River are releasing effluents that are not complying with standards and polluting the river.

Water Resource Management in the Ruvu sub-basin and coastal rivers

The Water Utilization (Control and Regulation) Act No. 42 of 1974, with its subsequent amendments, previously governed water resources management in Tanzania. In 1989, by authority of this Act, the Minister for Water gazetted nine water basins for the purposes of water resources administration and management. The Basin Water Offices have been mandated with management of the water resources and implementation of the water law at the basin level.

The Water Resources Management Act, No. 11 of was passed in May 2009 and is operational as of July 2009. The Act provides for the institutional and legal framework for sustainable management and development of water resources and outlines principles of for water resources management. It also provides for the prevention and control of water pollution and for participation of stakeholders and the general public in implementing the

National Water Policy (NAWAPO) of 2002. Since water resources management and water supply and sanitation are multidisciplinary and multi-sectoral activities, the individual health, environmental, local government reform, rural development, land, settlement and forestry policies provide strategic linkages to the NAWAPO, and supplement the aims and objectives of NAWAPO as envisaged under this programme.

The government adopted the National Water Sector Development Strategy (NWSDS) to implement NAWAPO. Emphasis is on IWRM, which is also reflected in the Water Sector Development Programme (WSDP) 2006-2025. The WSDP provides a strategic background for the implementation of plans and interventions for the achievement of national targets and calls for development partners to actively engage and support the water policy/strategy.

According to the NAWAPO, water resources management in Tanzania should be organized around participatory and representative forums, starting at the national level and spreading to the basin and sub-basin level. The policy identifies five levels of basin management—national, basin, catchment, district and community or water association level. The institutional framework for water resources aims to integrate sectors at different levels, and this is formalized in the new water law. Each basin office is required to implement the decisions made by the board and carry out operations. At the catchment level, the aim is to have a catchment council that will provide integrated planning and district councils will participate fully in basin boards and catchment councils. Districts are also responsible for planning and developing water resources. The community level and Water Users Associations (WUAs) are responsible for local-level management of allocated water resources (IUCN Eastern Africa Programme 2003).

The Wami /Ruvu Basin Water Office, was established in 2001, and reports to the Wami / Ruvu Basin Water Board, which consists of seven to ten members appointed by the Minister of Water. The board meets at least twice a year and last year they met three times. A sub-committee of the board meets more frequently to discuss water rights. The WRBWO is the executive office of the Board and is headed by the Basin Water Officer. For daily technical work the Basin Officer reports to the Director of Water Resources. WRBWO has its headquarters in Morogoro and two sub-offices in DSM and Dodoma.

Communication between the district and WRBWO has been *ad hoc* and often at a personal level. However, recently, staff members from some of the district and municipality offices have received awareness and facilitation training from the basin office. The WUAs or Water User Groups (WUGs), which are the lowest level of management within the Tanzanian water management structure, aim to assist the WRBWO in managing water sources in the basin. Such associations are responsible for local level management of allocated water resources, mediation of disputes among users and between groups within their areas of jurisdiction, collection of data and information, participation in the preparation of water utilization plans, conservation and protecting water sources and catchment areas, efficient and effective water use and ensuring return flows, enforcement of the law and implementation of conditions of water rights, and control of pollution. In the future, WUAs will form sub-catchment committees and provide representatives on the Basin Board and Catchment Committees.

Opportunities and Constraints in the Ruvu sub-basin including coastal rivers

The main problems and issues in the Ruvu sub-basin can be broadly categorized into water resources, socio-economics and conflict, policy and law enforcement, and management and administration.

The main issues around water resources have to do with encroachment of water sources, increasing demand and impacts of water storage, and pollution. Protection of water intake areas is crucial to maintaining water sources. However, encroachment activities such as cultivation along the river-banks cause degradation. Many communities have environmental committees, which help to raise awareness about the protection of water sources, although their power and ability to influence is varied.

There is an increased demand for water in the sub-basin especially from the agricultural sector. Due to an increasing urban population and economic growth in the basin, the demand for irrigation for fertile agricultural land and fruit and vegetable products has increased, especially in the Ulugurus. Consequently, abstractions from the Ruvu River have increased water scarcity. Water is also scarce in the sub-basin during the dry season due to the Mindu Dam as the construction of the dam did not fully consider downstream users and the need for environmental flows.

Downstream communities in the basin are often affected by upstream pollution, including sedimentation from erosion as a result of deforestation and agricultural practices and contaminated water. This reduces access to safe drinking water and water for livestock and agriculture, and investment must be made in other water resources such as ground water. Contamination can come from industry, agriculture, fishers that use poison to catch fish and domestic sewage.

In regards to socio-economics and conflict, there are usually conflicts between upstream and downstream users regarding water quality and increasing conflicts between pastoralists and farmers over access to land and water. There are also conflicts over access to water in Dar es Salaam.

Under the area of policy and law enforcement, the main issues identified were around water permits and protection of sources, and water quality. The WRBWO reports low payment rates for water user fees, as it is often difficult to get users to register for water rights, especially if a community has been historically extracting water from the river without previously paying. Water usage without water rights impacts the operation of the Basin Office as they rely on the fees to manage the water resources. For example, protection of water resources is often inadequate, not because of the lack of laws and regulation, but due to limited enforcement from lack of capacity and financial resources within the WRBWO. This is compounded by a lack of awareness on the need to protect water sources within communities.

Issues around management and administration include weak stakeholder linkages, limitations on information gathering and coordination, and weak capacity to manage water resources. Firstly, the WRBWO is still becoming known and stakeholder involvement in the management of water resources in the sub-basin is weak. The basin would benefit from a stakeholder forum to discuss common issues impacting their activities as well as promote the sharing of information between institutions. Secondly, there is inadequate equipment to gather up-to-date information on the status of water resources, and transfer of information among departments at district, regional and national level is often limited. Finally, a challenge faced by many of the institutions in the Ruvu sub-basin is a lack of capacity. Many stakeholders generally lack awareness about water permits and the role of the Basin Office in issuing the permits.

On the basis of the key problems and issues the following priority areas of action were identified for the Ruvu sub-basin – strengthened stakeholder capacity and participation,

reliable information to support planning and management, resources efficiently planned and managed, strengthened regulation and compliance, and ensuring sustainable financing.

Strengthened stakeholder capacity and participation can be achieved through identification of stakeholders, investing in strengthening their capacity, and coordination and collaboration. The WRBWO needs to understand its stakeholders—from industrial to irrigation to domestic users—perhaps through stakeholder mapping or analysis. This could be coupled with strengthening capacity by distributing data and information on sources and monitoring of source capacity. However, this can only be achieved through improving communication between the basin office and key stakeholders such as the districts. Improved communication is a step in achieving effective coordination and collaboration among stakeholders. Through stakeholder platforms such as catchment forums to mange water resources, districts can assist in the formation of WUAs. The same platform can contribute towards conflict resolution using District Councils that have mandates over natural resource use in their districts.

Under the priority area of ensuring reliable information to support planning and management, there must also be an understanding of current and future water resources and information on water users and uses. The data collected by the WRBWO and partners provide information on the available water resources in the Basin. Thus it needs to be stored and processed for use in decision-making. There needs to be investment in the Basin Office's capacity for not only data collection, but also data management. The WRBWO must also ensure adequate instrumentation for both surface and ground water resources in the basin. Abstraction rates and water quality must be measured regularly, for surface and ground water resources, particularly in the Dar es Salaam area. Finally, the WRBWO needs to enhance co-operation and sharing of the collection and monitoring of ecosystems data on hydrology.

Resources can be efficiently planned and managed through effective planning, improving water used efficiently and conserving water quality. IWRM planning is essential at all levels from the basin to sub-catchment to streams. The WRBWO needs to understand how multiple users will access, use and manage the resource. This could mean designing structures for different users, such as livestock keepers and farmers, promoting conservation farming and exchanging information on how to resolve conflicts. Improving water use efficiency can include a range of activities such as improving existing infrastructure by, for example, lining irrigation canals to reduce leakage. In regard to conserving water quality, protection of the forests is vital for water management and can only be achieved through adequate monitoring and patrolling. This means a greater level of capacity in the Catchment Forest Project. In the case of ground water, improved protection of well fields can be achieved by demarcating and zoning the sub-catchment so that polluting activities are limited.

Strengthened regulation and compliance includes harmonizing laws and strengthening interagency cooperation and enforcement. There are cases of conflicting legislation, such as is the case of the distance allowed to build a structure from water source, so there is a need for harmonization and enforcement of all laws that improve catchment protection. WRBWO also needs to collaborate with other institutions to monitor effluent quality from industries in order to safeguard downstream users

Under the final priority area of ensuring sustainable financing, it was recommended that the Basin office should undertake research on the current water tariff and its rationale. Furthermore, it may wish to consult with SADC and neighboring countries on how financial sustainability can be achieved.

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Abbreviations

ASDP	Agriculture Sector Development Programme
BOD	Biological Oxygen Demand
CBO	Community Based Organization
COD	Chemical Oxygen Demand
CWB	Central Water Board
DAWASA	Dar es Salaam Water Supply Authority
DAWASCO	Dar es Salaam Water Supply Company
DDCA	Drilling and Dams Construction Agency
DGIS	Dutch Ministry of Foreign Affairs
DO	Dissolved Oxygen
DFT	District Facilitation Team
DSM	Dar es Salaam
DWSSP	Dar es Salaam Water Supply and Sanitation Project
EAMCEF	Eastern Arc Mountains Conservation Endowment Fund
EC	Electrical Conductivity
EIA	Environmental Impact Assessment
GDP	Gross Domestic Product
GWP	Global Water Partnership
IPCC	Intergovernmental Panel on Climate Change
IWRM	Integrated Water Resource Management
IUCN	The World Conservation Union
JFM	Joint Forest Management
JICA	Japanese International Co-operation Agency
KTM	Karibu Textile Mills
LGRP	Local Government Reform Programme
MasI	Metres above sea level
MDG	Millennium Development Goals
MORUWASA	Morogoro Urban Water Supply Authority
MoWI	Ministry of Water and Irrigation Development
MoWLD	Ministry of Water and Livestock Development

NAFCO	National Food Corporation
NAWAPO	National Water Policy
NEMC	National Environment Management Council
NGO	Non-Governmental Organization
NPRS	National Poverty Reduction Strategy
NWSDS	National Water Sector Development Strategy
PAH	Polyaromatic Hydrocarbons
PES	Payment for Ecosystem Services
RDPS	Rural Development Policy and Strategy
SWOT	Strength, Weakness, Opportunity, Threat
TBL	Tanzania Breweries Limited
TFCG	The Tanzania Forest Conservation Group
TLAI	Tanzania Leather and Associated Industries
TPDC	Tanzania Petroleum Development Corporation
TZS	Tanzania Shilling
UMADEP	Uluguru Mountain Agriculture Development project
UNESCO	United Nations Education and Scientific Organization
URT	United Republic of Tanzania
WANI	Water and Nature Initiative
WHO	World Health Organization
WSDP	Water Sector Development Programme
WRBWO	Wami /Ruvu Basin Water Office
WRBWB	Wami /Ruvu Basin Water Board
WCST	Wildlife Conservation Society of Tanzania
WUA	Water Users Associations
WUG	Water User Group

1 Introduction

In 1989, the Minister for Water gazetted nine water basins for the purposes of water resources administration and management through the Water Utilization (*Control and Regulation*) Act No. 42 of 1974, as amended by Act No. 10 of 1981. Figure 1.1 shows a map of all 9 river basins in Tanzania. Figure 1.2 shows the Wami Ruvu Basin with its sub catchments. This report concentrates on the Ruvu sub-basin.

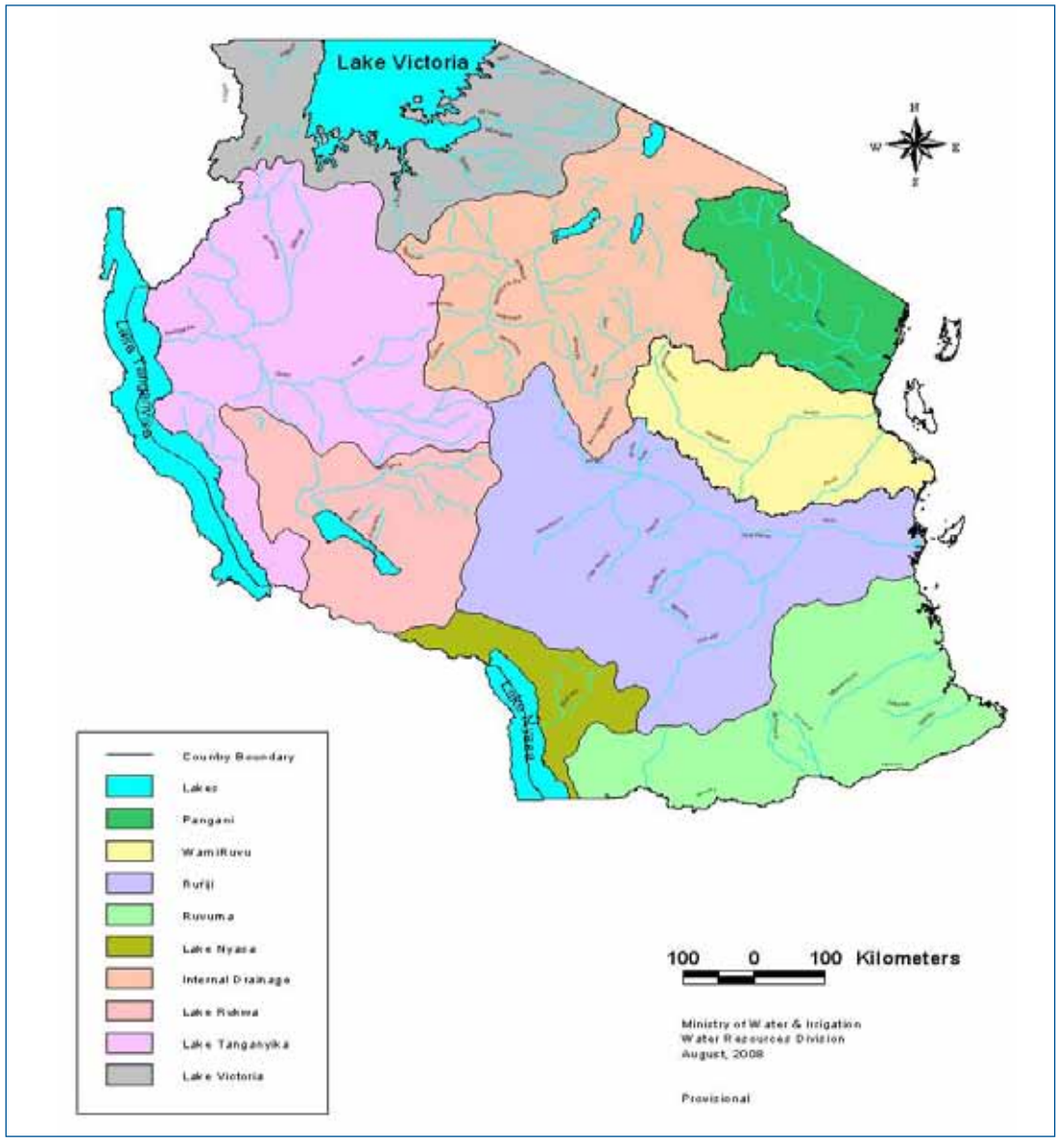

Figure 1.1. Map of Tanzanian River Basins

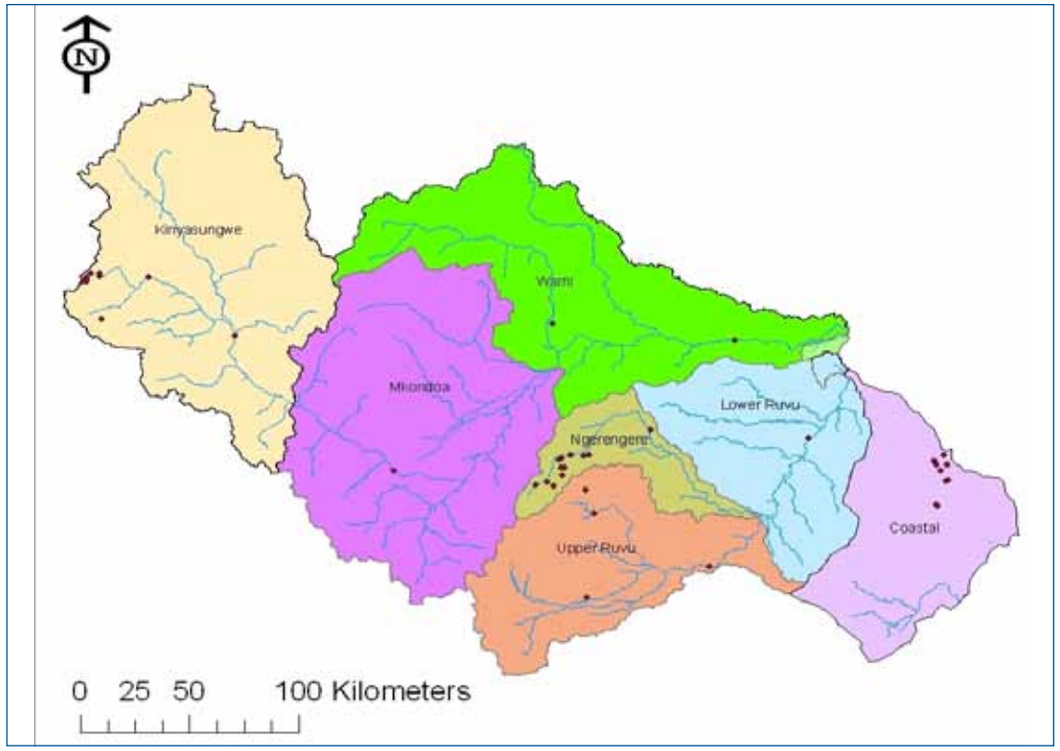

Figure 1.2. Map of Wami Ruvu Basin with water quality stations

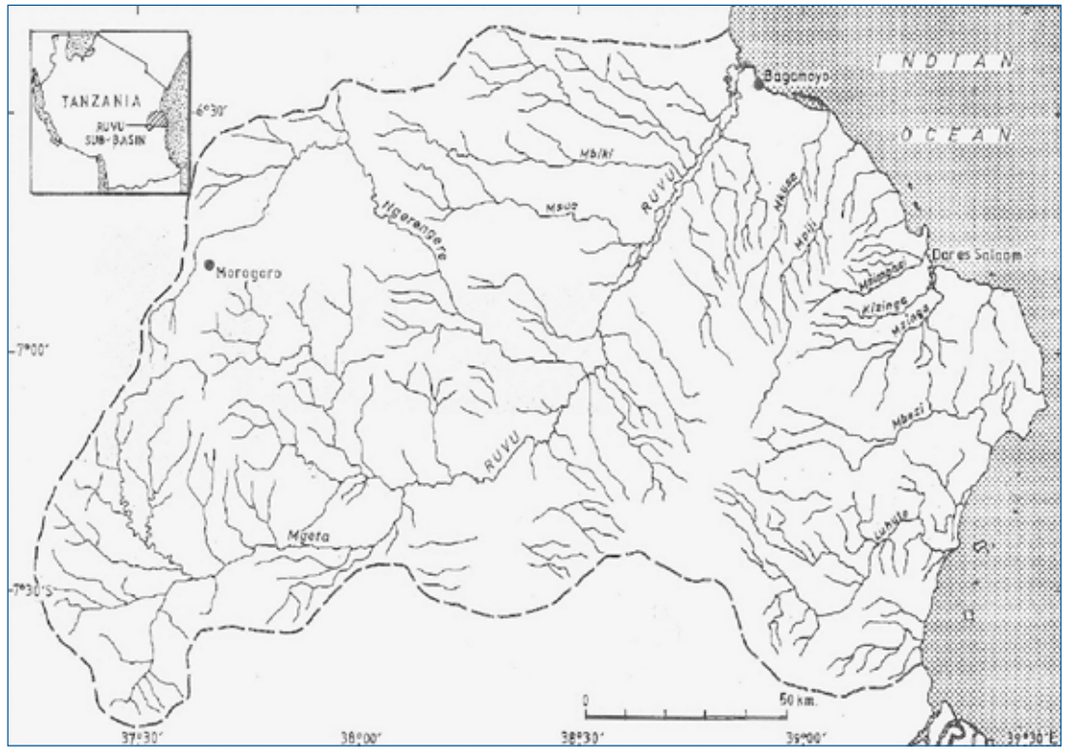

Figure 1.3. Map of the Ruvu sub-basin (JICA 1994).

1.1 An overview of the Ruvu (including the coastal rivers) sub-basin

The Ruvu sub-basin extends from Morogoro to the west of Dar es Salaam through the Coast and Dar es Salaam Regions, covering an area of about 18,000 km^2 of catchment which lies between latitudes 60° 05' and 70° 45' south and longitudes 37° 15' and 39° 00' east.

The Ruvu River basin can be subdivided into the following five main sub-catchments

- Mgeta, including Msoro,
- The Ngerengere
- Upper Ruvu
- Middle Ruvu
- Lower Ruvu.

Administratively, the Mgeta catchment and the Upper Ruvu fall in the Morogoro Region, while the Middle Ruvu and Lower Ruvu fall in the Coast Region extending southeastwards to cover the Dar es Salaam Region. Except for the Uluguru Mountains in the extreme west, which has an altitude of 2000 m above mean sea level, the basin is mostly composed of low-lying areas along the Ruvu River and a slightly elevated hilly area with moderate undulation, which extends from west to east around Morogoro town. Isolated rolling hills are in the middle reach of the Ruvu River. The lowermost part of the river is the extreme eastern edge of the Basin, where low-lying alluvial flood-plains about 5–10 km wide are found at an elevation below 10 m above mean sea level (JICA 1994).

1.1.1 Climate

The eastern slopes of the Uluguru Mountains have a mean annual rainfall in excess of 2500 mm while the western side of the mountains receives less (WRBWO 2008). Average monthly minimum and maximum temperatures are almost the same throughout the basin; the coldest month is August (about 18°C) and the hottest month is February (about 32°C). The annual average temperature is about 26°C.

1.1.2 Geology

The geology of the Ruvu sub-basin can be categorized into the following five major divisions: Precambrian, Karoo, Jurassic, Cretaceous, Tertiary and Quaternary rocks.

Precambrian rocks, which are mainly meta-sedimentary, occur mostly in the Uluguru Mountains and in the western part of the Ngerengere sub-basin and can be divided into three major lithological groups: acid gneisses, granulites and crystalline limestone, which seem to have been thrust and uplifted by the upward movement of the basic gneisses, thus giving rise to distinct fault zone in the rocks (JICA 1994).

The Karoo rocks that occupy the southeastern area of the Uluguru Mountains consist mainly of sandstone and shale, which was originally deposited in shallow fresh to brackish water. Their ages may vary from Permian to Triassic. Jurassic rocks occur in the eastern margin of

the Uluguru Mountains and elevated rolling hills between the Ruvu and Wami rivers. They consist of course sandstone, mudstone and oolitic limestone deposited under the marine environment. Cretaceous rocks, which lie on the elevated rolling hills, consist of clay, shale, calcareous sandstone, sandy limestone and mudstone. Sediments of Tertiary and Quaternary ages (youngest strata in the basin) occur in the catchment area of the Ngerengere River near Morogoro Municipality and in the elevated rolling hills and floodplains along the Ruvu River and extend up to Dar es Salaam. The Tertiary deposits consist of sandy clay, clayey sand with lenses of pure sand or clay, gravel and calcareous fragments. The Quaternary deposits were formed in the alluvial fan and are subject to swampy condition during the wet season; they consist of clay, silt, sand and rarely gravel (MoWLD 2005).

1.2 Definition of 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 maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of the vital ecosystems (GWP 2000). It integrates basin-wide water use 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.

Two major challenges that have confronted the water sector in Tanzania include increasing population and its related water needs and severe land degradation, which have contributed to high pollution in the 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 adopted the IWRM approach to managing water resources. Currently, basins across the country are developing IWRM plans that involve 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 ground water management. The widespread use of agro-chemicals and pollution from non-point sources pose significant threats to ground water quality and force managers to consider the linkage between surface and ground water
- 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 ground water recharge and river flow seasonality.
- Flood control upstream may threaten flood dependent livelihoods downstream.

1.3 Information on key partners funding the analysis (IUCN WANI, WRBWO)

1.3.1 IUCN Water and Nature Initiative

IUCN (International Union for Conservation of Nature) helps the world find pragmatic solutions to our most pressing environment and development challenges. IUCN supports scientific research, manages field projects all over the world and brings governments, non-governmental organizations (NGOs), United Nations agencies, companies and local communities together to develop and implement policy, laws and best practice.

IUCN is the world's oldest and largest global environmental network. It is a democratic membership union with more than 1,000 government organizations, NGO member organizations, and some 10,000 volunteer scientists in more than 160 countries. IUCN's work is supported by 1100 professional staff in 62 offices and hundreds of partners in public, NGO and private sectors around the world. The headquarters are located in Gland, near Geneva, in Switzerland (IUCN 2008).

In 2001, IUCN launched the Water and Nature Initiative (WANI)—an action-based programme that has worked with more than 80 partners in more than 30 countries—that works with mainstream environmental and social issues and water resources planning and management. The initiative uses ecosystem management as a strategy for integrated management of land, water, biodiversity and communities. WANI helps to solve the dilemma between fulfilling development options and conserving aquatic resources by resolving water conflicts, reviving rivers and spurring local economic development.

WANI develops and demonstrates practical approaches to the implementation of IWRM. It supports and catalyses national water reforms and builds needed capacities in local communities. The first phase of WANI took place in 12 river basins and in more than 30 countries from 2001 to 2008, with funding exceeding USD 40 million. The Dutch Ministry of Foreign Affairs (DGIS) provided core funding. WANI demonstration projects showed how to improve the well-being of both people and ecosystems using sustainable river basin management. WANI projects are partnerships of local communities, IUCN members, civil society and governments.

WANI helps to catalyse change by integrating into practice development priorities, ecosystem services, good water governance, stakeholder participation, sustainable financing, learning and leadership.

The first phase of WANI has worked extensively in the Pangani River Basin and the current situation analysis in the Wami/Ruvu Basin intends to build on the knowledge that has been developed in the Pangani region. A situation analysis that was conducted at the beginning of work in the Pangani laid a foundation for subsequent projects.

1.3.2 WRBWO

The Wami/Ruvu Basin Water Office (WRBWO) and Wami/Ruvu Basin Water Board (WRBWB) were established in July 2002. The vision of the WRBWO is to ensure that basin water resources are sustainably managed for the socio-economic and environmental needs, interests and priorities of the basin population. The mission, among other things, is to facilitate IWRM efficiently and effectively in order to address the resource needs, interests and priorities of the area's population while protecting and conserving the water resources (WRBWO, 2008).

The WRBWO has a strong commitment to the following:

- equitable and fair allocation of water that is socially desirable, economically viable and environmentally sustainable
- transparent and accountable service provision to all people in the Wami/Ruvu Basin
- promotion of integrated water resources management (IWRM) in the basin
- efficient and effective delivery of quality services to basin stakeholders
- being responsive to the basin stakeholders' needs and queries.

1.4 Objectives and outputs

The purpose of this situation analysis is to provide an assessment that will be sufficiently adequate for priority themes or areas for actions to be developed in the Ruvu sub-basin. The situation analysis provides a baseline of information that highlights the main challenges and opportunities in the Ruvu sub-basin, and will be used as background material for proposed project interventions.

A situation analysis of the Wami sub-basin has been produced in parallel with this analysis of the Ruvu sub-basin. Both documents provide analyses of the status, conditions, and key issues affecting ecosystems in each basin using existing available information. The analyses provide information on the socio-economic, natural resources (including water) and the environmental issues.

1.5 Summary of data and information sources

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

1.6 Structure of the report

Following the introduction, which has provided some background information on the basin and the organizations contributing to this study, the situation analysis gives an overview of the resources in the Basin that provides some information on the current status of these resources and some of the threats to conservation. Natural resources that are discussed include forests, water and wetland resources, ground water, environmental flows, water quality, protected areas, biodiversity, fisheries and soils. The third chapter examines the socio-economy of the Ruvu and identifies key stakeholders, their roles and responsibilities, interests and impact of their activities on the basin. Industry, water infrastructure, agriculture and irrigation, pastoralists, rural and urban interests, and NGO interventions are all examined. There is also a discussion on conflict issues. The fourth chapter focuses on natural resource management. This includes government management, legislation and policy at the institutional and organizational level, which focuses on the WRBWO and later on the district level. Economic issues refer to the viability of the institutional structure and future income generation. Also, gender issues are addressed, policies on other natural resources are summarized, and data collection and monitoring are reviewed in this chapter. The fifth chapter brings all the previous information together to examine the opportunities and constraints in the Ruvu sub-basin. Priority areas for action are identified. The final chapter provides conclusions and identifies any gaps in information.

2 Natural Resources in the Ruvu sub-basin including coastal rivers

This chapter documents the existing natural resource base and the current potential threats facing the sub-basin, featuring what needs to be done in order to minimize future environmental degradation.

The chapter also examines various types of resources in the sub-basin, namely, forests, wetlands, surface and ground water resources, water quality and flows. The existing protected areas and biodiversity are assessed in order to understand the ecosystem within the sub-basin. Fisheries, soils and the impact of climate change are also evaluated and how they may impact on resources in the sub-basin now and in future scenarios.

2.1 Sub-Basin forests

The catchment forests within the Morogoro Region form part of the Eastern Arc Mountains and protect and regulate water flow for the country's three major rivers: Rufiji (Kilombero and Ruaha), Ruvu and Wami. The flows in the Rufiji Basin are used to generate power at the hydropower stations of Kidatu and Kihansi. Large and small-scale irrigation schemes also depend on these rivers. Forests in the catchment are important for water, soil and biodiversity conservation as well as maintaining a climate that ensures reliable rainfall that favours continuous agricultural production. Also communities adjacent to the catchment depend on these forests to meet their daily wood and non-wood requirements (Catchment Forest Project Overview 2007).

The Eastern Arc Mountains are renowned in Africa for high concentrations of endemic species of animals and plants, being one of the 34 globally important 'hotspots' according to Conservation International (Burgess et al. 2007a; Schösler and Riddington 2006).

Thirteen separate mountain blocks comprise the Eastern Arc (see Figure 2.1), supporting around 3300 km^2 of sub-montane, montane and upper montane forest, less than 30% of the estimated original forested area (Burgess et. al. 2007a).

2.1.1 Uluguru Mountains

The Uluguru Mountains form the main water catchment area of the Wami/Ruvu Basin and are a part of the Eastern Arc Mountains, which stretch through Tanzania and into Southern Kenya. The Uluguru Mountains are within Morogoro Rural District (majority), Mvomero District and Morogoro

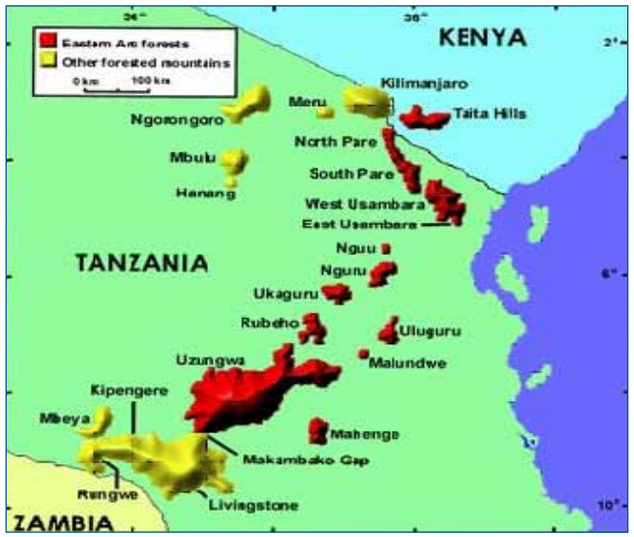

Figure 2.1 Map showing the extent of the Easter Arc Mountain Range (EAMCEF 2007).

Municipality—all within Morogoro Region. The Uluguru Mountains rise up to an altitude of 2630 m at their highest point (Eastern Arc Mountains Conservation Endowment Fund 2007). The forest within the Uluguru reserves mainly consists of tropical montane and upper montane forest. These forests represent a unique 'cloud forest' ecosystem (Schösler and Riddington 2006). Cloud forests capture mist from clouds and transfer it as water into streams. The Uluguru Mountains capture moisture passing inland from the Indian Ocean; the east facing slopes are especially wet, with rainfall estimated at over 3000 mm per annum, with some rain falling every month (African Conservation 2008). The remnant forests in the mountain range are considered crucial to securing the national water supply.

In the main Uluguru range, 50 villages touch the forest boundary and over 151,000 people live within the mountain area, often at increasing densities at higher altitudes up to the forest boundary (Eastern Arc Mountains Conservation Endowment Fund 2007). The importance of the Uluguru Forest to securing water has been recognised since the colonial period. The German colonial power created the Uluguru South and North Forest Reserves. These two reserves contain almost all of the remaining high altitude forest in the Ulugurus (Schösler and Riddington 2006). Currently, the Uluguru range contains seven forest reserves supporting Eastern Arc forest habitats within Morogoro Rural District (Uluguru North, Uluguru South, Kasanga, Mkangala, Mlaliwila, Ngambaula, Tongeni River) (Eastern Arc Mountains Conservation Endowment Fund 2007).

2.1.2 Ruvu South Forest Reserve

The Ruvu South Forest Reserve is one of the most extensive areas of coastal forest in Tanzania. The reserve, which covers 35,000 ha, was gazetted as a forest reserve in 1967 and is a Central Government Forest Reserve. Approximately 9800 ha of the reserve can be considered forest and the majority is riparian forest. The reserve is under extremely heavy pressure from charcoal production to supply the neighbouring city of Dar es Salaam, which lies 45 km to the north-east of the reserve (Tanzania Forest Conservation Group 2003). Kazimzumbi Catchment Forest is the source of Kizinga River area of Coastal River systems in Kisarawe District.

The Tanzania Forest Conservation Group (TFCG) is working with the Forestry and Beekeeping Division, local government and the communities surrounding the reserve to establish joint forest management group (Tanzania Forest Conservation Group 2003).

2.1.3 Joint Forest Management

Uluguru North and South are National Forest Reserves owned by the Central Government of Tanzania, and under the responsibility of the Catchment Forestry Department. It is technically illegal to enter the forest without a permit. However, without adequate enforcement and a lack of clear demarcation this is impossible to maintain, and communities use land and resources in the reserves. The government is now promoting Joint Forest Management (JFM), which involves establishing an environmental committee within each village that is responsible for developing management plans together with the Catchment Forestry Department. JFMs appear positive as they can potentially empower poor people by involving them in decision-making and management, and thus foster a sense of responsibility for maintaining natural resources. The JFM involves local people living adjacent to forest reserves in managing the forests. In addition to social benefits, in many cases a robust natural resource base will greatly increase the quality of life of communities dependent on these resources (Schösler and Riddington 2006). JFM has the potential for ensuring sustainable forest management and to improve livelihoods of the forest adjacent communities. If properly practiced, JFM can act as a conflict management tool (Catchment Forest Project Overview, 2007), for example offenders that violate the forest boundaries are sent to the village environmental committee for education rather than to jail.

2.1.4 Conservation threats and status

Forest reserves have been subjected to degradation due to agricultural expansion, illegal tree cutting (for timber, firewood and building poles) and forest fires caused by farmers who use fire as a tool for land preparation for agriculture. The situation is worsened by the inability of the government to manage all its forest resources as a result of inadequate human and financial resources and the lack of involvement of the local community to manage and sustainably develop forest resources (Catchment Forest Project Overview 2007). Resource use surrounding the Ulugurus has caused the loss, fragmentation and degradation of large forest areas. The principle cause of forest loss and fragmentation is the expansion of agricultural land, which has been most intense below 1800 m. Pit sawing, mining and fire are degrading the few remaining patches of lowland forest. Most of the forest loss has been outside of the forest reserves; recently however, there has been forest clearance within local authority reserves such as Mangala (Burgess et al. 2007b). Biodiversity values are disturbed and reduced by human activities. Rare and endemic species are replaced by species found over a much greater portion of Africa. Forest utilization therefore poses a threat to the conservation of biodiversity in the Easte.

Photo 2.1 Deforestation in Mgeta highlands in the Uluguru Mountains.

The main problems in the Uluguru Mountains forest reserves have arisen from human disturbance such as cutting timber, taking tall thin trees for poles and encroachment for agricultural purposes. Photo 2.1 illustrates the results of deforestation. Figure 2.2 shows the changes in forest cover in the Uluguru Mountains between 1955 and 2000. Other impacts relate to firewood collection and paths for traveling between villages and collecting things such as medicinal plants and herbs (Schösler and Riddington 2006). Fires that spread from farmlands and into the forest and the presence of invasive species (Rubus in the south and Maesopsis in the north) threaten the habitat (EAMCEF 2007).

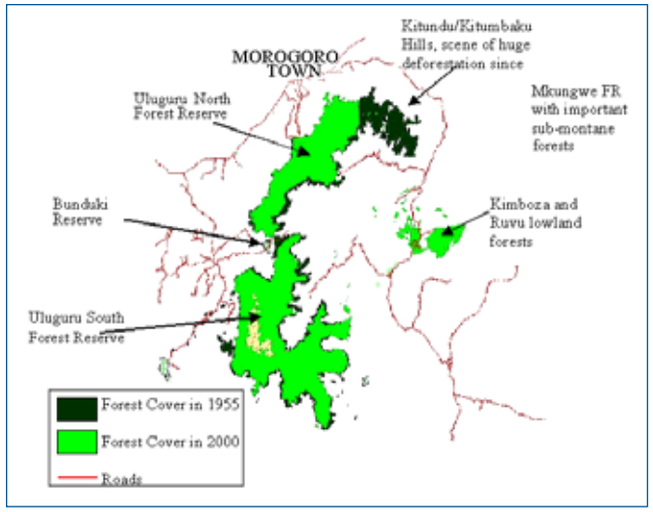

Figure 2.2. Forest cover in the Uluguru Mountains in 1955 and in 2000 (African Conservation 2008).

People living in communities in the mountains are also responding to a rising demand for natural resources elsewhere. With increasing urban populations and economic growth in the basin, the demand for fresh water, fertile agricultural land and fruit and vegetable products has increased. The Ulugurus—with favourable climatic conditions and relatively fertile land—currently provide agricultural products for almost the entire basin and are considered to be the breadbasket of the area. Villages with good access to markets are starting to develop agricultural irrigation and are increasing extraction of water from the Ruvu tributaries. The dramatic decline in river flow in the Ruvu has been attributed to this, although the extent remains uncertain (Schösler and Riddington 2006). Furthermore, siltation as shown in Photo 2.2 can be a direct result of poor agricultural practices upstream.

Photo 2.2 Siltation resulting from poor agricultural practices upstream at Mgeta River.

2.2 Water and wetlands resources

In the Kidunda area, the two major rivers are the Ruvu and Mgeta, and there is a third smaller river, the Mkulazi. These are fed by smaller streams from the surrounding upland mountain catchment areas (Norconsult 2008). The Ruvu is dynamic and has four features: hilly upstream reaches, upstream foothills, middle reaches and lower reaches.

Hilly upstream reaches (220-270 km): The Ruvu originates in the Uluguru mountains, where small streams combine to form three main tributaries. The Mgeta and Ruvu drain the south side and the Ngerengere drains the north. Characterized by high mountains, steeply sloping banks, a narrow channel, rocky substrate and frequent rapids, the steep gradient makes the current flows fast, less turbid and better oxygenated. The banks are lined with overgrowth of trees and grasses. The top end of the Ngerengere has been dammed for water supply to Morogoro, resulting in the Mindu dam. The EIA of this dam and its observed impacts were not available (DAWASA 2008).

Upstream foothills (200-220 km upriver): As the Ruvu descends to the foothills, the gradient is reduced, the pools are larger, there are marshy areas such as the Gonabis wetlands, rapids are less frequent, the substrate becomes sandier and the current slower (DAWASA 2008).

Middle reaches (90 – 200 km upriver): The low gradient slows the flow and the channel is wider, relatively steep-sided. It is fringed with aquatic vegetation such as Vossia and Phragmites grass and reed beds, water lilies, with Ficus verruculosa, Syzigium and Albizia tree species Elephant Grass (Penisetum spp), and various herbaceous annuals. Submerged vegetation is common. The river is characterized by large meanders and small islands. The substrate is finer and ranges from rock to silt with reed cover and in-stream sand bars. During the rains, the main river channel floods its banks and four extensive floodplains are formed: between the estuary and the village of Ruvu, around the Dar es Salaam – Morogoro road Bridge, one below Kidunda village and the fourth is the 250 km^2 Gonabis, between the confluence of Mgeta and Ruvu. It is here that the floodplains are generally silt laden, and used for rice and maize farming with oxbow lakes/pools used for fishing, livestock and household use (DAWASA 2008).

Lower reaches/estuary (from the sea to 90 km upriver): The estuary is strongly influenced by the marine environment up to 23 km inland. The salinity fluctuates through the tidal cycle and seasons. The highest salinity is during the spring high tide, during the low rain season substrate varies from sand to mud and categorised by 2,123 ha of mangroves, mainly Rhizophora mucronata, Sonneratia alba, Ceriops tagal and Heritiera littoralis. The latter is a riverine mangrove. About 100 ha of mangrove have been cleared on the southern bank for construction of solar salt works. In the dry season, the whole river is reduced to deep water channels , ponds and oxbow lakes resulting in a concentration of crocodiles and hippos in the lower and middle reaches (DAWASA 2008).

2.2.1 Coastal Rivers

Fig 1.1 shows that apart from the main Ruvu river system there are other small rivers draining the basin into the Indian Ocean. These rivers are Mkusa, Mpiji, Msimbazi on the southern part of the Ruvu river and Msimbazi, Kizinga, Mzinga, Mbezi and Luhute in the extreme south of the basin.

Dar es Salaam City has 4 of the major coastal rivers - Mpiji, Msimbazi, Mzinga and Kizinga (JICA, 2005) whose areas are shown below in Table 2.1. Three of the coastal rivers (Mzinga, Kizinga and Msimbazi) are perennial and Mpiji River is seasonal.

Table 2.1 Catchment areas for Dar es Salaam main rivers (JICA 2005)

River name	Length (km)	Catchment Area (km2)
Mpiji	12.74	52.06
Msimbazi	35.82	289.21
Kizinga	17.45	432.02
Mzinga	10.40	40.72

Msimbazi River

The Msimbazi River has a total length of about 35 km within a catchment area of about 289 square kilometres. The river flows from Pugu forest Reserves with tributaries of Sinza, Ubungo and Luhanga tributaries and flows to the eastern side towards Indian Ocean. It is an important water resource for residents of Dar es Salaam and its neighbourhoods for drinking, bathing, support for agriculture, industry, and as an environmental buffer. However industrial effluents and illegal sewage systems are threatening the Msimbazi ecosystem services. The river is highly polluted with heavy metals from industries and detrimental to its functional benefits and even irrigation of vegetable gardens which is commonly practiced.

Kizinga and Mzinga rivers

The Kizinga and Mzinga river systems originate from the Pugu/Kisarawe hills and consist of sandy sediments favouring infiltration which recharges the ground water sustaining flow during the dry season. The rivers flow in the north-east direction to the Indian Ocean. Kizinga has a total length of 17.5 km and a catchment area of 432 square kilometres, Mzinga has a total length of 10.4 km and a catchment of 41 square kilometres. The water in the Mzinga and Kizinga rivers meets domestic standards for drinking water. Mzinga is not perennial while Kizinga flows throughout the year and support domestic water supply in the Mbagala area (Mjemah 2007).

Mpiji River

The Mpiji River forms the northern border between Dar es Salaam and Coast Regions. It is a seasonal river stretching to about 12.7 km long with a catchment of 52 square kilometres. Despite the growing city towards Bagamoyo, the river is still less polluted compared to the other rivers draining the city centre.

Other smaller rivers

There are also small and seasonal rivers and streams including Tegeta, Mbezi, Mlalakuwa, Kijitonyama, Sinza and Tabata. These are essentially temporal rivers largely serving as a drainage network for Dar es Salaam city.

2.2.2 Water supply and demand

The Ruvu River is the source of surface water supply for domestic and industrial uses for about 3 million residents of Dar es Salaam City, Kibaha and Bagamoyo towns and also to the people residing along the pipeline. It is estimated that by the year 2020 the population of Dar es Salaam will reach about 6 million. This population together with increases in water demand for industrial production, domestic and irrigation will result in serious water shortages (MoWLD 2005).

Current abstraction rate from the river is estimated at 270,000 m^3/day. However, there is a loss of about 53% along pipelines due to leakage, irrigation and other unplanned uses. (MoWLD, 2005) Currently estimated water demand for the City of Dar es Salaam is about 410,000 m^3/day, while the actual water supply is about 126,900 m3/day from surface sources and 50,000 m^3/day from ground water sources (MoWLD 2005). It must also be noted that Kizinga River is another source for Temeke Municipality in Dar es Salaam.

2.2.3 Conservation threats and status

Villages with good access to markets are starting to develop irrigation agriculture and are increasing extraction of water from the Ruvu tributaries. The dramatic decline in river flow in the Ruvu has also been attributed to this, although the extent remains uncertain (Schösler and Riddington 2006). There has also been a high influx of pastoralists in the area which is though to contribute towards land degradation especially wetlands creating impacts to water resources in the area.

2.3 Ground water resources

About 75% of Tanzania is underlain by crystalline basement complex rocks of variable composition and ages, but predominantly Precambrian, which form the basement aquifers (Mato, 2002). Other aquifer types include karroo, coastal sedimentary formation of limestone and sandstone and the alluvial sedimentary sequence, which mostly include clay, silt, sand and gravel, and volcanic materials. Recharge is mostly by direct rainwater infiltration (Mato, 2002).

The potential for ground water development was assessed through a study by the Japanese International Co-operation Agency (JICA) in 1993 for different areas in the basin and was found to be available in the following geologic units (MoWLD 2005):

- Precambrian metamorphic limestone in the north east foot of the Uluguru mountains
- Karoo formation and quaternary deposits along the Mgeta river and south east of Uluguru mountains
- Jurassic limestone in the Ngerengere area
- Alluvium in the flood-plain; present river channel and relict of stream channel
- Neogene and Quaternary deposits

An isotope study by the Ministry of Water and Livestock Development (MoWLD 2005) found that the origin of ground water in the Ruvu sub-basin is by direct rain infiltration; through rapid and active recharge areas to the West and East. Some slight mixing with old, marine water has been observed in a few areas. The study has also indicated that ground water provides base flow in rivers especially during the dry season. Ground water is of acceptable quality for domestic use except where salinity is high, which is more frequently observed where there is mixing with marine water.

2.3.1 Ground water in Dar es Salaam

The master plan for Dar es Salaam urban planning was last prepared in 1979, and consequently the city has expanded in an unplanned manner in recent years. Mato (2002) reported there were more than 40 unplanned and unserviced areas in Dar es Salaam where more than 70% of the population lives. However through the Community Infrastructure Upgrading Programme

under the World Bank, the project has rehabilitated 13% of the previously unplanned areas so that the remaining area is only 57%.

Ground water is one of the most important alternative sources of water for Dar es Salaam City and its peri-Urban areas. Over 50% of Dar-es-Salaam residents rely on ground water because of the unreliable supply of water from Ruvu River, which is the existing main source of water supply. This is due to vulnerability of the unregulated Ruvu River to adverse impacts of droughts and floods (WRBWO 2008).

The use of ground water in Dar Es Salaam Region started in the early fifties involving boreholes of medium depths of more or less than 100 metres with relatively good quality and high yield. Most of these wells were abandoned due to, old age (rusting and collapsing of pipes) and deterioration of water quality (salt water intrusion) (WRBWO, 2008). There were a number of shallow wells and a few deep wells to supply rural areas of Dar es Salaam Region drilled by the then Dar es Salaam Water Engineer's office. During 1997, an extreme drought occurred which resulted in the water level in Ruvu River drastically dropping.

According to the Dams and Drilling Construction Agency (DDCA), which is a publicly owned company that reports to the Ministry of Water, they have drilled 2062 boreholes in Dar es Salaam since 2007. There are approximately 3,500 boreholes in total which includes those drilled by private companies.

2.3.2 Ground water pollution

Urban centers have become major sources of diffuse pollution of ground water due to a variety of human activities. Potential sources of ground water pollution include domestic and industrial wastewater, leaching of toxic substances from solid waste dumpsites and mining tailings, storm water and poor agriculture practices (Mato 2002). Other sources of ground water pollution are from both urban and rural agriculture. Major concerns in Dar es Salaam include municipal sewage, solid wastes and industrial effluent disposal practices. Point sources include on site sanitation facilities, such as septic tanks and pit latrines, infiltration from waste stabilization ponds, solid waste dumpsites, underground fuel storage tanks, industries and other commercial establishments (Mato 2002).

Ground water is used in Dar es Salaam to augment public and private supplies. However, waste disposal is inadequately disposed of, and consequently the quality of the ground water resource and its future dependence for potable water supplies (Mato 2002). The sewerage system in Dar es Salaam City was first constructed in the 1950s and serves only 12% of the residents. The remaining population uses pit latrines (79%) and domestic tanks (9%). Effluent from the septic tank system and pit latrines percolates into the soil representing a potential source for ground water contamination. A study by Gondwe et al. (1997) looked at the impact of septic tank-soak pit systems widely used on the shallow unconfined aquifer at Sinza ward in the city of Dar es Salaam. The ground water was observed to have the same quality as the septic-tank effluent, thus indicating that the ground water was heavily contaminated by the septic effluent. This suggests that the septic tank-soak pit systems failed to sufficiently treat the domestic wastewater effluent. In addition, the emptying of pit latrines is often done by hand and new pits are dug next to the old one. With such diffuse sources of contamination it is not surprising, that more than 40% of the ground water samples analyzed in Dar es Salaam do not comply with the Tanzania standards (Mato 2002).

Research by Mato (2002) concluded that indiscriminate disposal of wastes is the major source of ground water pollution problems in Dar es Salaam. More than 35%, 40% and 20% of samples taken from boreholes failed to comply with the national standards for drinking water in nitrate, faecal coliform and chloride contents respectively. Alkanes and polycyclic aromatic hydrocarbons (PAHs) were identified in some borehole samples. Mapping of ground water vulnerability revealed that 50% of the city is located in a high vulnerability zone, which means that the ground water can potentially be polluted by anthropogenic sources. Important areas like the well fields of Mbagala and industrial areas of Changombe are in the high vulnerability zone (Mato 2002).

The geological deposits in the area of Dar es Salaam consist of basically three geological layers: alluvial, coastal plain and limestone deposits. The alluvial and coastal plain deposits are of Pleistocene to Recent age and are found mainly moving from the coast towards the mainland. The coastal plain deposit is comprised mainly of white-buff sands and gravels with clay layers in it. Mixed alluvial deposits occur on recent flood-plains along Msimbazi, Kizinga and Mzinga Rivers. These consist of sand, clay and sometimes gravels and pebbles (Mjemah 2007).

In areas with a high water table the sewage is directly disposed into the ground water within the pit latrine or soak away pit of the septic tank. This mainly impacts shallow aquifers, but pollution could easily reach deep aquifers should there be fissures in the geological formation. The pollution loads are expected to be 60 tonnes/day of BOD_5 and 20 tonnes/day of total nitrogen by 2015 (Mato 2002). Such loading rates can have a devastating impact on ground water quality.

One of the major threats of pollution is from chemical industries, which may be discharging wastewater containing high levels of harmful substances. There are specific laws in place to control discharges, but enforcement is inadequate (Mato 2002). Pollution containing petroleum hydrocarbons originates from petroleum products businesses, inappropriate disposal of used lube oils and poor loading and loading procedures at depots (Mato 2002). Furthermore, waste oils from vehicle maintenance are discharged on site. Although discharge levels are low for each polluter, the combined effect can be considerable.

Although sanitary landfills are advocated in Tanzania, the practice remains for crude dumping of solid waste into the ground. Most domestic solid waste comes from the kitchen which putrefies in the soil and contributes to organic pollution of ground water. Heavy metals and more persistent pollutants such as pesticides can have a long term impact if the leachate reaches an aquifer.

2.3.3 Ground water Monitoring

Commercial drilling has been undertaken by people with inadequate expertise and experience in the field of ground water exploration. This has resulted in the random drilling of wells that are not monitored. As a result, ground water over pumping and contamination is occurring due to salt water intrusion and pollution from sanitation strictures such as pit latrines and septic tanks.

A comprehensive ground water monitoring and management programme for both shallow and deep aquifers is inevitable and part of the WRBWO mandate (WRBWO, 2008). WRBWO have carried out a borehole inventory test programme which covered five Wards in Kinondoni, followed by detailed inventory of the boreholes to cover the three Municipalities, Ilala, Kinondoni and Temeke. A second inventory programme involved two Hydrogeology experts from the WRBWO in collaboration with the Dar es Salaam Water Authority (DAWASA), Ministry of

Water and Irrigation (MoWI), Ward Executives, Municipal Directors and Drilling Companies residing in Dar es Salaam. The geographical location of the boreholes was recorded, water quality for some boreholes checked, water right status assessed and awareness creation in relation to water utilization act and regulations conducted. The exercise covered 16 wards in Kinondoni and Ilala whereby 418 boreholes were located (WRBWO 2008).

Some of the challenges in carrying out such an inventory were a low level of cooperation by owners, lack of borehole completion reports from owners (they claim not to be provided by drillers), continued uncoordinated drilling and lack of knowledge amongst water users on water laws and regulation.

The WRBWO are proposing to carry out the inventory of all boreholes drilled in the Region of Dar es Salaam and develop a comprehensive ground water management programme for both shallow and deep aquifers. This will require coordination with other agencies such as CA.

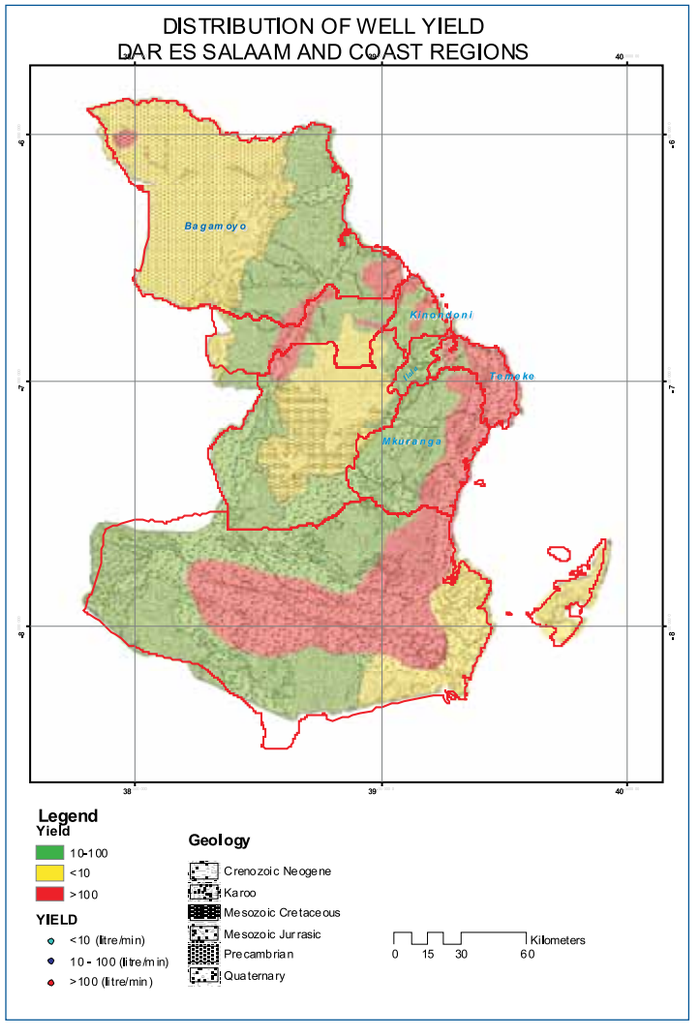

Figure 2.3 Map of distribution of the well yield in the Dar es Salaam and Coastal Regions (JICA, 1994)

The ground water management programme includes, establishing a monitoring network on the newly found deep aquifers in Kimbiji and Mpera. In addition, the programme will locate and install ground water monitoring wells in the identified ground water potential areas and areas prone to pollution for both ground water and surface water. This includes recharge areas, Industrial waste disposal sites, Municipal dumping sites, areas close to sewerage systems, oil storage facilities, unauthorised garages, and farming and livestock keeping areas. The WRBWO will also mark the hydrogeological boundaries of the Dar es Salaam Region, carry out regular sampling, and report on water level, quality, ground water abstractions and updating water right status (WRBWO 2008).

Figure 2.3 shows the area for concentration and the geological formations potential for ground water production in the Dar es Salaam and Coastal Regions.

2.3.4 Kimbiji and Mpiji Aquifers

To combat water shortage to the City, the Ministry of Water and Irrigation launched a task force, which was financed by World Bank through DAWASA. The task involved drilling boreholes for ground water exploitation to augment the water from the major source, Ruvu River (WRBWO 2008). Phase 1 of a study on regional ground water potential, aided by drilling and geophysical exploration data provided by Tanzania Petroleum Development Corporation (TPDC), revealed that two unconsolidated aquifer provinces referred to as Kimbiji Aquifer Province and Bagamoyo Aquifer Province are found within the Dar es Salaam region, south and north of the city, respectively. Machuisi Province was later renamed as Bagamoyo Aquifer Province (DAWASA 2007). DDCA are also involved with this process, as they carried out a ground water survey for all boreholes, and will be consulted in the drilling process.

The Bagamoyo Aquifer Province was considered to be an interesting candidate for providing additional or full-scale supply of water to Dar es Salaam. Its location favours the replenishment of water from Lower Ruvu Intake and in particular the trunk main along the cost north of the city. Recent results of the exploratory drilling at Mpiji reveal that a reasonably productive aquifer exists there, but water quality characteristics have turned out to be disappointing. The water contains excessive amounts of chloride, sodium and carbonate hardness and would need to be blended with Ruvu River water before being supplied to households (DAWASA 2007).

On the other hand, the Kimbiji site (Photo 2.3) appears to have water of exceptionally good quality, flowing under artesian pressure. No water treatment, apart from disinfection, would be required if this well would be connected to Dar es Salaam's water supply system.

Photo 2.3 Kimbiji well field

The Kimbiji Aquifer Province is considered a prime candidate for providing additional or full-scale supply of water to Dar es Salaam. Its location favours the existing pipeline and distribution facilities within the city and, in particular, the area where urbanization is growing and water sources are required (DAWASA 2008).

The geology of the Kimbiji area is coastal, comprised of young sedimentary deposits of ternary and Tertiary period. The depth of sediments varies from 200 m in Bagamoyo to 900–1400 meters in Kimbiji. The sediment consists of pure sands with a wide range of sizes; including clay bound sand, limestone, marl and sandstone, which have good transmissivity (MoWI 2008). Aquifer recharge is local and regional; local recharge is contributed by rainfall infiltration through superficial white buff sands and perennial rivers in the study area, while regional recharge is currently not defined and needs further assessment (MoWI 2008).

The water in this renewable aquifer, estimated to contain some 1,000 km^3 of freshwater, originates far inland. Samples have been taken to carry out an isotope analysis to determine the exact sources of the aquifer. Dar es Salaam's additional water demand is estimated to be 0.2 km^3 per annum to satisfy total demand in the year 2030. With adequate management and protection this large reservoir may serve as a reliable source of clean drinking water for the city and surroundings (DAWASA 2008).

However, the aquifer field is currently limited to one 610 m exploratory deep well at Kimbiji, one 200 m deep observation well nearby and a similar well configuration at Mpera (south of Kimbiji)—all drilled and logged for water exploration. A wider and deeper knowledge of the entire aquifer is required in order to assess the scale of the resource and to plan for its sustainable development and future use as a national asset (DAWASA 2008).

Consequently, the Ministry of Water and Irrigation, along with DAWASA, are procuring a Phase 2 study of the Kimbiji aquifer to fully understand the hydro geological dynamics of the whole catchment, which might have a relationship with the Kimbiji aquifer. The study will also provide a description of the hydrogeology, a modeling of the aquifer, the safe potential yield, a cost-benefit analysis of drilling boreholes in Kimbiji, a development and monitoring plan and capacity building. The preliminary findings about the catchment, which covers the Dar es Salaam, Coast and Morogoro regions, showed that the Rufiji basin may possibly be connected to the Kimbiji aquifer (MoWI 2008).

Norconsult carried out a 'Review of Ground Water Resources' in May 2007 in the Kimbiji area with DAWASA that analysed the way in which they fit into the overall preferred water-supply strategy (DAWASA/Norconsult 'Water Source Development Master Plan' of June 2007). The favourable drilling results (and short-duration pumping test of a trial production borehole at Kimbiji) led Norconsult to recommend production boreholes of 600 m depth, which (with advanced design specification and careful construction) are predicted to have very high individual yields (over 15 Ml/day) (GW-Mate 2007). GW-Mate (2007) agrees with the high ground water yield potential of this area and suggested drilling shallower (250-300 m) production boreholes instead of deep boreholes because they would be less risky in terms of losing boreholes during construction and/or operation.

Priorities

The immediate priorities are to commission and supervise the survey of existing use of ground water by the dispersed rural population and make arrangements to compensate people for any potential water-table fall, identify the significance of any (small and isolated) ground water-fed wetlands (papyrus swamps) and ground water-dependent terrestrial vegetation that might be affected and protect the designated DAWASA well field area from invasion and/or clandestine well drilling. This would include demarcation of the estimated well field area and its local sources of recharge (GW-Mate 2007).

Another priority is to establish the current scale, trends and drivers for ground water use (both by private initiatives and public institutions) that includes levels of investment and cost, hydrogeological status (well depths and recovery water-levels), operational problems and risks such as yield reliability and quality concerns in order to form the basis of policy development in relation to minimum necessary controls, construction permits and standards (GW-Mate 2007).

Other issues include regular updates and training of professional and technical staff, especially in GIS data handling, aquifer modeling, ground water chemistry, remote sensing etc. In addition, the region faces a challenge of overcoming the lack of political and public awareness of the importance and special needs of ground water protection and management (GW-Mate 2007).

2.3.5 Water Quality of Kimbiji Aquifer

Water from the exploratory deep borehole is of exceptionally good quality. Preliminary water quality analyses by NIVA Oslo indicate all measured parameters to be comfortably within stringent EU standards, with no exceptions. The water quality improves with depth. No water treatment, apart from disinfection, will be required if this well is connected to Dar es Salaam's water supply system. Some 73 elements have been analysed so far; none of which have been found to exceed EU standards for drinking water (Kihila 2005).

Photo 2.4 Growing settlement near the Kimbiji Well field

2.3.6 Conservation threats and status

Urban centers have a number of pollution sources that are difficult to control. These not only have an impact on drinking water supplies but also on ecosystems that are dependent on ground water. For well fields to be protected, measures need to be taken to prevent encroachment; this means that demarcation must be carried out, but it has not been done yet due to WRBWO's lack of capacity. Currently, nothing is being done officially to stop people building in the area (see Photo 2.4), although people are being told that they cannot settle in the catchment zone.

2.4 Water Quality

2.4.1 Surface water quality

WRBWO has made an inventory of the water quality in selected sites in the basin. A total of 50 samples were collected from 33 sites. Water samples from rivers, boreholes and dam were analysed for physical-chemical and bacteriological parameters. The effluent samples from industries and wastewater treatment plants were analysed for pH, electrical conductivity (EC) and dissolved oxygen (DO). Nutrient pollution was determined by analysing phosphate and nitrates, and biological oxygen demand (BOD) and chemical oxygen demand (COD) were analysed for organic pollution.

All samples from rivers show that they are contaminated with faecal coliform, measured in colony forming units (CFUs per mililitre). The range is 350–50,000CFU/100 ml. Some of the rivers contain a high content of phosphate with a range of 0.03–15 mg/l, which indicates nutrient pollution although nitrate content was found to be less than the Tanzanian standard of 10 mg/l. Samples that were analysed for organic pollution showed low dissolved oxygen content, and BOD and COD values were very high.

Table 2.2 shows the results for two selected points on Mzinga River sampled on 23rd May, 2006 for nitrate and phosphate. One was upstream at Ruhungo, and the second was at a bridge downstream. The results show that pollution loading increases downstream.

Table 2.2. Nitrate and phosphate concentrations in the Mzinga River (WRBWO 2006)

	Mzinga at Ruhungo (upstream)	Mzinga at a bridge (downstream)
Discharge	0.7 m^3/s = 60,480m^3/day	0.64 m^3/S = 55296 m^3/day
Phosphate	0.3mg/l	0.8mg/l
Phosphate pollution loading[1]	60480 m^3/day x 0.3 mg/1000 m^3 = 18.0 mg of Phosphate/day	55296 x 0.8/1000 = 44.0 mg of Phosphate/day
Nitrate	Nitrogen = 1.6 mg/l	Nitrate-Nitrogen = 2.4 mg/l
Nitrate pollution loading	60480 m^3/day x 1.6mg/1000m^3 = 96.8 mg of Nitrate-Nitrogen/day	55296 x 2.4/1000 = 134.0 mg of Nitrate-Nitrogen/day

[1] Pollution loading = discharge (m3/day) x concentration of phosphate (mg/m3)

Industrial effluents were also analyzed and found to have high BOD and COD values. BOD ranged from 150–300 mg/l and COD was 150–5000 mg/l. This is also the case with the samples from wastewater treatment plants; BOD ranges were 80–200 mg/l and COD 200–600 mg/l. It was found that most of the industries visited do not have wastewater treatment plants, thus it is not surprising that the discharged effluent is not of acceptable quality.

These are our recommendations:

- In order to know the impact there should be an effort to plot the selected sites on maps; this will help in deciding where to locate permanent monitoring stations.
- A complete inventory of the many industries in Dar es Salaam needs to be conducted.
- Land use information should be taken into consideration when managing water resources.
- Human activities are the major cause of pollution to water bodies, thus a campaign to create awareness is required for all stakeholders that depend on water sources in the basin.
- The WRBWO should have a clear picture of the management of wastewater treatment plants in the entire basin. For example, the former Tanzania Leather and Associated Industries (TLAI) ponds in Morogoro are in use but it is not clear who is the responsible authority for managing the ponds.

Table 2.3, on the following page provides a summary of water quality at various sites in the Ruvu sub-basin. In a study conducted by DAWASA, it was observed that in the Ruvu River system, concentrations of all characteristic parameters are generally higher in the Ngerengere River. The higher conductivity suggests corrosive water and a high content of TDS and salts. The content of chloride in the Ngerengere exceeds the World Health Organization (WHO) drinking water quality standards during the highest peaks. Analyses indicated a Na-Ca-Mg-Cl water type in the Ngerengere, Mg-Cl water type in the Lower Ruvu and Ca-Mg-Cl-SO4 in the upper Ruvu River. Analysis of heavy metals and pesticides did not reveal detectable concentrations of any of the tested elements. The water quality meets the drinking water guidelines for heavy metals and pesticides. However, in dry periods, the guidelines are exceeded in the Ngerengere River, mainly due to high chloride contents and conductivity, but these are not hazardous to health (DAWASA 2008).

2.4.2 Ground water quality

An isotope study was carried out in 2005 by the Ministry of Water and Livestock Development (MoWLD, 2005). The aim was to assess the ground water resource potential of the Ruvu sub-basin as well as to determine the ground water quality and recommend on its suitability for domestic uses to the city of Dar es Salaam. Results from sampling indicated that most of the river water samples exceed the standards quality for drinking water with respect to turbidity, colour, permanganate value and iron. Most of the ground water of shallow and deep wells had variable quality. Some samples were acidic waters while others were alkaline, very hard and saline water.

Table 2.3. Visited sites and water quality results in the Ruvu sub-basin (WRBWO 2006)

SAMPLING DATE	LAB No.	LOCATION	TURBIDITY NTU	COLOUR (mgPt/l)	pH	EC (is/cm)	TDS(mg/l)	Calcium (mg/l)	PHENOL-ALK mg/l	TOTAL-ALK(mg/l)	T-Hardness(mg/l)	Magnesium (mg/l)	Chloride (mg/l)	Fluoride (mg/l)	Iron (mg/l)	Manganese (mg/l)	Nitrate-N (mg/l)	Nitrite-N (mg/l)	Phosphate (mg/l)	Sulphate (mg/l)	Faecal colliform (CFU/100ml)
24/5/06	93/06	Mzinga/ Bridge	6	36.0	7.1	140	68.9	4.8	NIL	12.0	30.0	4.0	21.3	NIL	0.25	0.6	5.9	0.009	23	2.0	480
25/5/06	98/06	Kikundi M/Mpya	12	65.0	7.7	1077	497.0	32.0	NIL	80.0	110.0	7.3	56.7	0.18	1.25	0.2	2.2	0.052	0.4	24.0	5600
26/5/06	99/06	Bwawani Ngerengere	49	297.0	7.8	758	379.0	23.2	NIL	44.0	108.0	23.2	12.8	0.52	0.85	1.5	1.2	0.010	0.39	23.0	880
26/5/06	100/06	Kidunda	28	167.0	7.7	252	127.0	12.8	NIL	36.0	40.0	12.8	7.1	0.25	1.44	2.5	3.6	0.034	0.4	21.0	450
27/5/06	101/06	Kinole Intake	9	59.0	7.8	90	45.6	2.4	NIL	36.0	14.0	2.9	4.3	0.08	0.91	0.3	3.1	0.003	0.2	2.0	3400
27/5/06	102/06	Kibungo/ Bridge	10	30.0	7.6	114	56.6	8.8	NIL	22.0	28.0	8.8	7.1	0.22	1.01	0.4	1.5	0.004	0.3	0.0	4500
3/6/06	103/06	Kizinga Intake	36	700	7.1	1288	648.0	36.2	52.0	1480.0	124.0	8.75	100.7	0.16	0.19	0.4	2.9	0.007	1.6	33.0	3400
3/6/06	104/06	Mzinga Maji Matitu	26	145.0	6.2	864	446.0	20.8	4.0	133.0	94.0	10.2	164.5	NIL	0.25	NIL	0.9	0.003	0.2	23.0	
3/6/06	105/06	Mzinga/ ConPuence	17	226.0	6.5	1034	521.0	7.2	NIL	60.0	54.0	8.75	32.61	0.28	0.14	0.2	1.1	0.002	0.2	29.0	400
3/6/06	106/06	Mzinga/ Kizingo	27	216	7.1	1242	622.0	20.0	104.0	104.0	10.7	12.8	0.34	0.69	NIL	1.5	0.01	0.850	35.0	30.0	51600
17/6/06	108/06	Ruvu at Bridge	211	5300	6.3	255	128.0	12.8	NIL	108.0	36.0	0.5	11.34	0.3	0.8	12	0.0	0.210	5.0	54.0	400
18/6/06	107/06	Wami/ Mandera	33	260	5.4	276	136.0	8.8	NIL	80.0	56.0	0.26	7.09	0.08	0.22	0.5	0.8	0.012	0.1	0.8	

A detailed analysis of chemical data of the surface and ground water for the Western part of the Ruvu sub-basin (see Figure 2.5 for sampling locations) found that the Mgeta River and Mfizigo rivers have fresh waters (Mg Ca HCO_3 type), and Ngerengere river is slightly brackish (Mg Ca Na Cl HCO_3 type). Other surface waters nearby such as Ubena magereza, Msolwa and Chalinze are also slightly brackish (Na Mg Cl HCO_3 type). Samples from Kola hill boreholes are brackish (EC 836 to 2220 US/cm, Na Ca Mg HCO_3 SO_4 type), which could be due to water rock interaction. Ground water samples taken near Ngerengere River were brackish to saline.

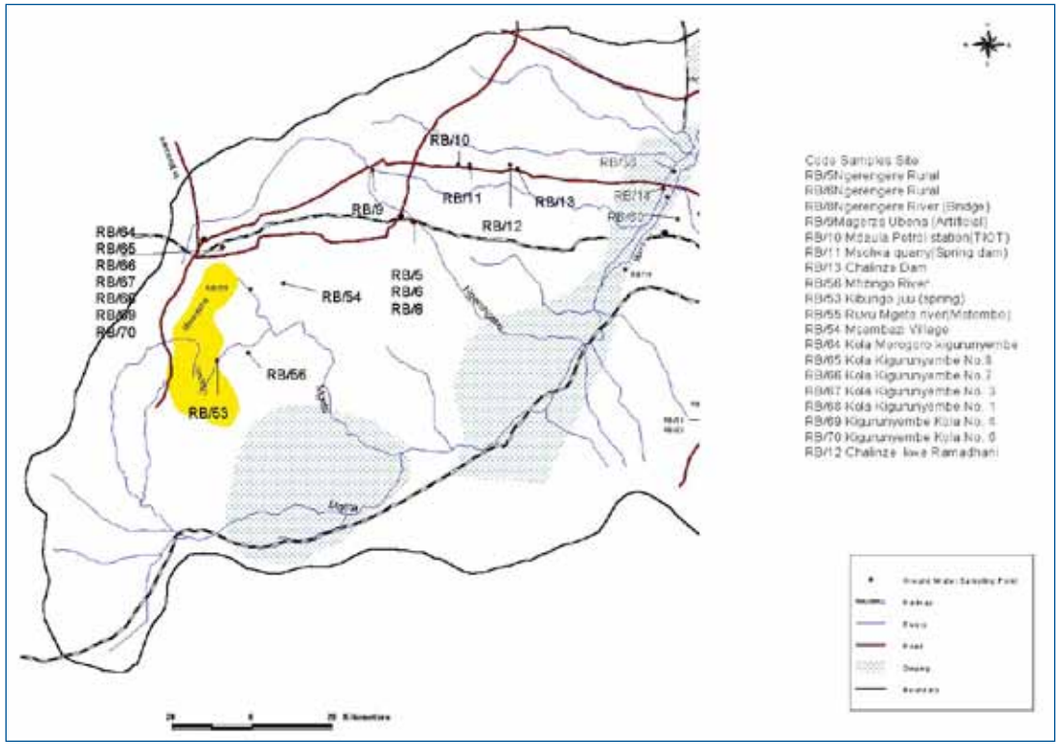

Figure 2.4 Sampling points in western area of the Ruvu sub-basin (MoWLD 2005).

In the eastern area of the Ruvu sub-basin (see Figures 2.4 and 2.5 for sampling locations) surface water from the Ruvu was fresh (Ca Mg HCO_3 type). In the Dimara farm Oxbow lake the water was saline (Mg Ca Na Cl type water). Finally, ground water in the Dar es Salaam area is generally fresh, however some brackish and a few saline water samples were observed.

2.5 Environmental Flows

The National Water Policy of Tanzania, as revised in 2002, recognizes the flow needs of the environment as a second priority in allocation of water resources, following water requirements for basic human needs and domestic activities (URT 2002).

River and stream flows in the proposed Kidunda dam area (which will be used to store and supply water to Dar es Salaam) follow the nature of rainfall with sharp increases in the rainy season. Historic peak flows in the Ruvu at Kidunda have been recorded to be as high as 400m^3/s, with mean flow at about 50 m^3/s. Low flows have occurred relatively frequently

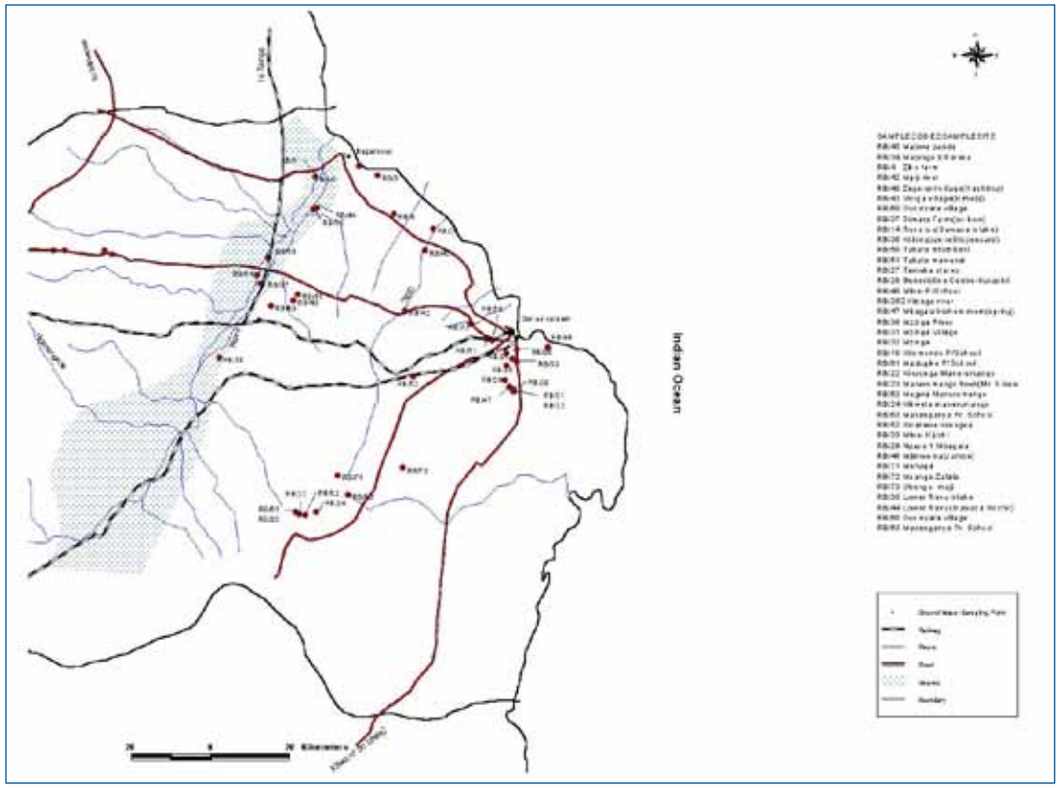

Figure 2.5 Sampling points in the eastern area of the Ruvu sub-basin (MoWLD 2005).

with the probability of not meeting the stipulated demand once every four years. Securing adequate amounts of water to existing infrastructure is a key driver to the proposed Kidunda Dam (Norconsult 2008).

The Kidunda Dam will result in changes in downstream flow and seasonal inundation. This in turn will have an impact on the ecology, disrupt wildlife corridors, affect reproductive behaviour of aquatic organisms and the nutrient supply to estuarine species, as well as negatively impact other wetland habitats. On the other hand, wildlife will find secure water and grazing, but may compete with livestock. The dam will also increase access to water downstream for irrigation and recharge to ground water (Norconsult 2008).

To reduce the severity of negative impacts as a result of an altered flow regime, Norconsult (2008) recommended that the flow release strategy mimics historical flow patterns and allows mixing of the upper and lower water layers. Otherwise changes in flow patterns and de-oxygenated water could result in a significant reduction in the downstream fishery.

Maintenance of the environmental flow requirements would be controlled by outlet towers. Water can be released through the outlets at the beginning of the rainy season in order to avoid a delay in stream flow as the dam fills. If the outlets are open at peak flow, this allows a 33% reduction in the buildup of headwaters during flood peaks. To reduce saltwater intrusion, a minimum environmental flow of 200 ml/day is required (Norconsult 2008).

2.6 Protected areas, Biodiversity and Conservation

Within the Eastern Arc Mountains, at least 96 vertebrate species are endemic, which include 10 mammal, 19 bird, 29 reptile and 38 amphibian species. At least 800 vascular plant species are endemic and almost 10% of these are trees. Seventy-one of the endemic or near-endemic vertebrates are threatened by extinction (8 critical, 27 endangered, 36 vulnerable), with an additional seven wide-ranging threatened species. Hundreds of plant species are also threatened (Burgess et al. 2007a).

2.6.1 Uluguru Mountains

As previously mentioned in section 2.2.1, the Uluguru range contains seven forest reserves supporting Eastern Arc habitats within Morogoro Rural District (Uluguru North, Uluguru South, Kasanga, Mkangala, Mlaliwila, Ngambaula and Tongeni River) (EAMCEF 2007). In terms of endemic species (Table 2.4) the Uluguru Mountains possess at least 14 strictly endemic vertebrate species with at least 3 additional species that have not yet been described. A further 16 Eastern Arc endemic species have also been identified in this mountain. There are also at least 26 Eastern Arc endemic trees. The forests of the main ridge are quite well known biologically, although each new survey continues to uncover additional species. The outlying areas are poorly known, with some having had almost no biological investigation (EAMCEF 2007).

Table 2.4. Summary of the species richness and endemism of the Uluguru Mountains (Burgess et al. 2007b

Taxon	Species richness	Endemics	Near endemics	No. species not recorded in the last 10 years
Mammals	76	3*	10	30
Birds	140	2	10	2
Reptiles	45	5*	16	12
Amphibians	39	6	18	3
Total	**300**	**15**	**54**	**47**

At least 47 species have not been recorded from the Ulugurus over the last decade. The majority of these species are mammals, which probably reflects a low survey intensity. However, it is possible that some animals previously recorded in the Ulugurus are no longer present due to habitat loss. Of greatest concern are those species endemic to the Ulugurus that have not been recorded during the last 10 years, as it is possible that they are now extinct. These are the four endemics that have not been recorded for ten years are: the sub-species of golden mole *Chrysochloris stuhlmanni tropicalis,* the snakes *Typhlops uluguruensis* and *Prosymna ornatissima* and the amphibian *Hyperolius tornieri*, although the validity of that species has been questioned. Of greatest concern are the low- and mid-altitude endemics *Prosymna ornatissima* and *Typhlops uluguruensis* because habitat loss has been most severe in the mid- and low-altitude sites.

Resource use surrounding the Ulugurus has caused the loss, fragmentation and degradation of large forest areas. The principle cause of forest loss and fragmentation is the expansion of agricultural land. This has been most intense below 1800 m. Pit sawing, mining and fire are degrading the few remaining patches of lowland forest. Most of the forest loss has been outside of the forest reserves however recently there has been forest clearance within local authority reserves such as Mangala (Burgess et al. 2007b).

Studies in the 1970s (Pócs 1976) illustrated how the mossy forests of the higher altitude portions of the Ulugurus were able to capture water from clouds and hold that it, releasing it slowly. This ability of forests, especially ones covered with epiphytic plants to gather water from clouds and then pass this water gradually to watercourses was recognized over 100 years ago in Tanzania. The cloud base in the Ulugurus is generally just above the straight line of the reserve, marking the border between forest and farmland. Once one moves above the boundary upwards through deforestation (as in the Kitundu Hills in the Ulugurus) the cloud base moves upwards. The forest can capture the water from the clouds, but if the clouds are gone then this is no longer possible. Deforestation will change the cloud patterns and is a probable explanation for many of the local stories about the short rains becoming less frequent and the area being hotter and drier than in the past. This general situation is believed to hold true for all the other areas of the Eastern Arc as well (Burgess et al. 2007a)

2.6.2 Ruvu South Forest Reserve

Ruvu South is one of the most important coastal forests in Tanzania (see section 2.2.2). The reserve is a 35,000 ha mosaic of forest, woodland, thicket, swamp and grassland in Kibaha and Kisarawe Districts, Coast Region. Approximately 9,800 ha of the reserve can be considered forest, much of this riparian forest. The forest is under constant pressure from the illegal production of charcoal to supply markets in Dar es Salaam, which lies 45 km to the north-east of the reserve. Currently the Ruvu Fuel-wood Pilot Project, a project of the Forestry and Beekeeping Division is responsible for the management of the reserve. Since 2000, the Tanzania Forest Conservation Group has been promoting Joint Forest Management at Ruvu South. The reserve is 45 km west of Dar es Salaam and the Tanzanian Central Line Railway cuts through the reserve as does the Kazimzumbwi–Mzenga road.

There are four Eastern Arc/Coastal Forest endemic vertebrate species in the reserve and two species endemic to the Coastal Forests. There are also 33 plant species within the reserve that are endemic to the Swahilian Regional Centre of Endemism. A population of elephants frequents the reserve, probably migrating between the reserve and the northern Selous and the area is part of the 'Kisarawe District Coastal Forest' Important Bird Area (Baker and Baker 2002).

2.6.3 Selous Game Reserve

The Selous Game Reserve, located in southern Tanzania, is one of the largest fauna reserves of the world. It was designated a UNESCO World Heritage Site in 1982 due to the diversity of its wildlife and undisturbed nature. It is the world's largest game reserve and second only to the Serengeti for its concentration of wildlife. It is also the sanctuary of the largest elephant herd in the world; about 32,000 elephants live in the reserve—70 per cent of those in Tanzania. Some of the animals typical of the savannah (for example elephants, hippos, African wild dogs and crocodiles) can be found in this park in a larger numbers than in any other African park (Baker and Baker 2002).

2.6.4 Pande Game Reserve

Pande Game Reserve is an area of East African Coastal Forest in Dar es Salaam Region. The Game Reserve was gazetted in 1990 and 1226 ha between 80–126 m above sea level, encompassing forest, thicket, grassland and woodland. Pande Game Reserve is part of the Eastern Arc/Coastal Forest Biodiversity Hotspot, one of the highest priority areas for biodiversity conservation in the world. Pande has also been classified as an important bird area. (Baker and Baker 2002).

Pande has populations of 12 vertebrates endemic to the East African Coastal Forests including one endangered primate. The reserve is managed by the Wildlife Division. Over the last 50 years most of the mature forest in Pande has been lost due to timber harvesting and charcoal production. Pande has one endangered, one vulnerable and five near-threatened animal species based on the IUCN Red List. Plants of conservation concern include the three taxa that are thought to be strictly endemic to Pande: *Tricalysia bridsoniana* var. *pandensis*, *Sapium* sp. nov. and *Leptactina* sp. The reserve has a high diversity of bats and Pande is part of the Pande and Dondwe Coastal Forest Important Bird Area (Baker and Baker 2002).

2.6.5 Ngaramia Forests

Ngaramia Riverine Forest extends for 3 km along the Ngaramia River in Temeke district, 30 km south of Dar es Salaam. It is an example of East African coastal forest although only small areas of closed canopy forest remain. The forest has been heavily exploited for charcoal and parts of the forest have been cleared for agriculture, however, the forest continues to play a crucial contribution in protecting the water source and provides habitat for many species of fauna and flora typical of East African coastal forests. Ngaramia is an example of an East African Coastal Riverine Forest. The forest has a number of species with ranges restricted to the Coastal and Eastern Arc forests including the bush babies *Galago zanzibaricus* and *Otolemur garnettii*.

2.6.6 Conservation threats and status

A number of recent studies have indicated that as forest area declines the risk of extinction for the species remaining in those forests increases. Even more concerning is that there is a time-delay—sometimes decades in duration—between the deforestation and the extinction of a species.

Hence, even if the population of, for example, the Uluguru Bush Shrike looks moderately safe at the present time, the effects of the current deforestation may continue to reduce the population for many years and can lead to extinction even if deforestation is halted. Such predictions, based on analysis of the best available data, indicate that the loss of forest from the Eastern Arc Mountains in general, and the Ulugurus in particular, can have consequences well into the future. Moreover, if there is a lag time to extinction, there may well be a lag time in climatic changes around these mountains, potentially affecting the residents of Dar es Salaam (whose water comes from the Ulugurus) and Tanzania in general.

Around 75% of the original forest cover of the Eastern Arc has been lost, mainly to subsistence agriculture and the loss is continuing. In most places the forest is now confined to the Catchment and Local Authority Forest Reserves. A few villages also have forest reserves or unreserved forest patches but these are typically small and many are still being cleared for farmland.

Where the forests are disturbed by human activities there is a reduction in the biodiversity values. Rare and endemic species are replaced by species found over a much greater portion of Africa. Forest utilisation therefore poses a threat to the conservation of biodiversity in the Eastern Arc; however, the levels of utilisation, which can be tolerated by the endemic species, are not known (Baker and Baker 2002).

2.7 Fisheries

There is limited literature on fishing in the Ruvu River; Table 2.5 summarizes the available information. Bernacsek (1980) has identified the varieties of fish in the river as indicated in the Table below. The aquatic fauna includes a number of freshwater prawns species (*Macrobranchium* spp.) crabs, snails, frogs, insects and about 82 species of fish (see Table below). Otters (*Aonyx capensis*) and large numbers of hippos and crocodiles are also present. Norconsult (2007) notes that *Labeobarbus, Labeo* and *Synodontis* were present.

Table 2.5 Types of fish found in Ruvu sub-basin (Bernacsek 1980)

Scientific name	Swahili name
Clarias mossambicus	Kambale
Amphilius grandis	
Eutropis grandis	Pate , Mbata
Pareutropius longifilis	
Bagrus orientalis	Katoga, Kitoga
Labeo coubie	
Labeo cylindricus	Ningu, Nyampotu, Mbununu
Petersius conserialis	Kasa
Barbus radiatus	
Barbus quadripunctatus	
Barbus zanzibaricus	
Barbus kerstenii	
Distichodus petersii	
Distichodus apleurogramm	
Citharinus latus	
Alestes stuhlmann	Kasa, ngacha
Hydrocynus vittatus	
Chanos chanos	
Salmo trutta	
Pellona ditchella	Chaa, simu koko

2.7.1 Conservation threats and status

Conservation threats in the river include pollution upstream particularly from Morogoro Municipalities. Other threats include fishing using poisons in the river and overfishing, which depletes juveniles before they have the opportunity to reproduce. Siltation from the Uluguru Mountains could also be a hazard as this can destroy breeding habitats. Increasing livestock population will also add to the potential threat to the fishing stock by exacerbating soil erosion and heavy siltation.

2.8 Soils

The lithogy of the Ruvu sub-basin ranges from gneiss around the highlands of Uluguru Mountains to late Precambrian and Cambrian crystalline rocks. In the lowlands of the Ruvu sub-basin the lithology ranges from Paleozoic to Quaternary sediments and tertiary sediments towards the Indian Ocean (Hathout 1972).

The soils in the sub-basin range from sandy clay with excessive drainage to sandy loam with excessive drainage in the highlands of the Uluguru. In the middle of the sub-basin the soils range from sandy loam to sandy clay loam, both with imperfect drainage. As the sub-basin drains towards the coastal area, soils range from loamy sand with good drainage to sandy with moderate drainage (Hathout 1972).

2.9 Impacts of climate change and land use

Observed climatic changes indicate that Africa warmed 0.7°C over the 20th century, with a decadal temperature increase of 0.05°C (Hulme et al. 2001; IPCC 2001). For East Africa this warming has been associated with an increase in precipitation in some areas. Projected Climate Change for Africa (Hulme et al. 2001; IPCC 2001) indicates that there will be a regional warming ranging from 0.2°C per decade (low scenario) to more than 0.5°C per decade (high scenario), which will lead to a 5–20% increase in precipitation from December–February (wet months) and 5–10% decrease in precipitation from June–August (dry months).

According to the Initial National Communications, the mean temperatures for Tanzania will increase throughout the country, particularly during the cool months, by 3.5°C, while annual temperatures will increase between 2.1°C in the North Eastern parts and 4°C in the central and western regions of the country (URT 2003). These changes in temperature will affect the coping strategies of the local communities. Predictions also indicate that areas with two rainy seasons a year will experience increased rainfall of 5–45% and those with one rainy season will experience decreased rainfall of 5–15%.

The Initial National Communication (URT 2003) shows that the rainfall patterns and soil moisture will vary due to changes in mean temperature, thus affecting the runoff into rivers. For instance, there will be an increase in temperature between 1.8°–3.6°C in the catchment areas of the Pangani River in the north and northeast of the country, as well as a decrease in rainfall, which will lead to a 6-9% reduction of the annual flow of the river. Ruaha River, which feeds into Mtera and Kidatu hydropower stations, is expected to experience an increase in flow by 5-11% due to low temperature fluctuation between 3.3° and 4.6°C and hence an increase in rainfall. Floods along the Rufiji and Pangani Rivers would cause damage to major hydropower stations and human settlements in these river basins.

Future climate change scenarios suggest higher mean rainfall for the Ruvu sub-basin catchment, which supplies Dar es Salaam; there are uncertainties about the temporal variability of rainfall within this changed climate, with the possibility of more frequent flooding and drought events (Miller-SAB 2008**).** In particular, for the Ruvu sub-basin, an increase of rainfall between 0 to 10% is forecasted. Increases in temperature and precipitation will lead into changes in evaporation and runoff. For the existing high rainfall and low evaporation regime of the Uluguru Mountains, the result is most likely to be an increase in runoff, which will maintain the flow in the rivers for the next 50 years (Norconsult, WRA and NIVA 2007).

However, climate change also needs to be viewed in the context of land use change, which has a critical impact on hydrological regimes. In the Uluguru Mountains, Yanda et al. observed (2007) that vegetation cover has changed considerably between 1995 and 2000 (Table 2.6). The disappearance of vegetal cover has lead to increased surface runoff and flash floods and reduced infiltration, ultimately resulting in reduced base flows in rivers, which contradicts the above prediction. In addition, although it is difficult to prove, anecdotal evidence indicates that cloud-bases have moved higher up the hills and hence the catchment values of the eastern Arc Mountains have probably declined. All of the Eastern Arc blocks report these phenomena, but there are no hard data to either prove or disprove their effects on the catchment values of the forests (Burgess et al. 2007a). Therefore, for the future water resources management, WRBWO needs to undertake some further research to establish different scenarios anticipated in the Ruvu and Wami sub-basins.

Table 2.6. Land use/cover for the Ruvu sub-basin (1995 – 2000) (Yanda et al. 2007)

Land use/Land cover	1995		2000	
	Area	%	Area	%
Natural Forest	93454	8	70101	6
Woodland	451788	40	231124	20
Bush land	259145	23	129052	11
Grassland	253179	22	331938	29
Permanent Swamp	1307	0		
Cultivated Land	79793	7	366486	32
Urban	1365	0	11571	1
Water	241	0		
Total	1140272	100	1140272	100

2.10 Summary of key points

2.10.1 Ruvu sub-basin resources

Key forest resources for Ruvu River include the Uluguru Forest, which is where the headwaters of the river is situated and the Ruvu South Forest Reserve, which provides increased flows to the river. Major tributaries are Ruvu, Mgeta and Ngerengere tributaries. Protected areas in the basin include the forest resources and the Selous Game Reserve. There is a variety of biodiversity, mostly in protected forests and Selous Game Reserve, and a number of threatened species in the Uluguru Ruvu South Forests as well as in the Selous Game Reserve.

Fisheries in Ruvu River are an important socio-economic activity mostly in the lowlands and towards the estuary; however, fish production in the river is not very high but supports livelihoods mostly in the lowlands and coastal areas.

There are ground-water resources in rural Morogoro, Kiserawe and Temeke and the Kimbiji aquifer has great potential for enhancing Dar es Salaam's water supply.

2.10.2 Threats to the Ruvu sub-basin resources

Among the main threats to the Ruvu sub-basin are resources degradation in the Uluguru Mountains, Ruvu South Forests and Selous Game Reserve. Other threats include resource use conflicts, poor farming practices on the slopes of the Uluguru Mountains, industrial pollution in Morogoro Municipality and downstream impacts on domestic and fisheries mostly in Ngerengere River. Ground-water pollution in Dar es Salaam city is increasing due to a combination of leakage from latrines and illegal drilling.

The main causes of the above threats are weak governance of natural resources, uncontrolled agricultural expansion, and illegal tree cutting for timber, firewood and building poles. Other causes are uncontrolled bush fires, immigration of pastoralists, industrial pollution and the illegal drilling of shallow wells.

Recommended intervention measures are enhancement of participatory forest management, enforcement of natural resources management bylaws, enforcement of pollution control measures, land use planning and enforcement of laws against drilling shallow wells in Dar es Salaam.

3 Socio-economy in the Ruvu sub-basin including coastal rivers

This section will include a description of all stakeholders, including their roles and responsibilities, interests and impacts on the river basin. Table 3.1 provides an overview of some of the elements such as land area, population, population density and land use in the Wami-Ruvu basin.

Table 3.1 Socio- Economic profile of the Wami /Ruvu Basin (National Bureau of Standards/ Regional Commissioner's Office 2003)

Total Area: km²	**72,930**
Percent of Tanzania	7.7%
Population (2002)	5.4 million
Density/km²	74
Percent of Population of Tanzania	16.1%
Total Number of (partial) Districts	19

Land Use	**Tanzania**	**Dodoma**
Small Holder Cultivation	5%	
Large Scale Agriculture	1%	
Grazing Land	39%	
Forest/Woodlands	50%	27%
Other Lands	5%	
TOTAL	100%	

The population of the Wami and Ruvu basins combined is approximately 5.4 million, which includes Dar es Salaam (3 million) and the smaller cities of Morogoro, Kibaha and Dodoma. About 80% of the basin population lives in urban areas and 20% in rural areas, thus the population is very urbanized compared to the rest of the country, which is 20% urban and 80% rural. Outside of urban areas, population densities are around 30-35 people per km². Regional population growth rates are 1.6–4.6 percent/annum (WRBWO 2008).

The average size of a household is 5 people with a patriarchal structure. Literacy rates in the area are about 65%, but this is higher for urban males and much lower for rural females. Life expectancy is 45-48 years. The eastern parts of the basin are predominately Muslim while western parts of the basin are 50% Muslim and 50% Christian/other. Throughout the basin, the official language is Kiswahili (WRBWO 2008).

Outside of the major urban areas, approximately 75% of total household income in the basin is earned from agriculture—sugar cane, sisal and cotton are produced as cash crops. Surplus food crops such as maize, rice, sweet potatoes and beans are typically sold in local markets. Other rural livelihood activities include tending livestock, hunting, bee-keeping and, to a lesser extent, fishing. Most other people in rural areas are self-employed in the informal sector. People living in urban and trading centers tend to be self-employed as merchants, traders, shop owners, or formally employed in public and private institutions. Unemployment rates are as high as 25-40 percent in both urban and rural areas (WRBWO 2008). The average annual cash household income in the basin is unknown but in predominately rural areas it is probably only about TZS 75,000 (or USD 56 [current exchange rate]) per year. Region-wide GDP/capita estimates are USD 160–USD 214/year (WRBWO 2008).

Roads between major urban centres are generally good quality asphalt highways. The east-west Dar es Salaam–Morogoro highway bisects the basin and links other major urban centres in the basin to Dar es Salaam. Roads in rural areas are typically gravel or dirt, which are often impassable during the rainy season (WRBWO 2008).

Electricity is also generally available in urban areas and cell phones are widespread. Social infrastructure (such as schools and hospitals) is also well-developed, although often poorly maintained in more urbanized areas of the basin. Potable water supply coverage ranges from 50–80% in rural areas to 90-100% in urban areas, but a reported 18–59% of these facilities are currently not working (WRBWO 2008).

A specific socio-economic profile of the basin is not available, but Table 3.2 shows some key data from selected districts in the basin (WRBWO 2008). Districts in the sub-basin include Dodoma Urban and Rural, Mpwapwa, Kongwa, Kilosa, Mvomero and Bagamoyo.

Table 3.2 Statistics for Selected Districts (WRBWO 2008)

Statistics for Selected Districts:	**Kilosa**	**Morogoro Rural**	**Morogoro Urban**	**Mpwapwa**	**Dodoma Rural**	**Dodoma Urban**
General						
Population Percent Growth Rate (est.)	2.3	2.2	4.6	2.4	1.6	3.4
Population Density/km²	33	31	849	34	31	126
Percent Urbanization (1988)	17	5	100	16.7	2	48.3
Household Size (1988)	5.1	4.9	4.2			
GDP/capita/year USD (2000, Region)	214	214	214	160	160	160
Ratio Dependents/Economically Active, 1988	0.97	1.03	0.72	1.06	102.4	0.898
Principal Occupations % (1988):						
Legs./Admin./Managers	0.2	0.2	0.9			
Profes./Technic./Teachers	1.8	1.4	6.9			
Clerks. Service & Shop Sales	1.8	0.6	9.4			
Cultivators/Mixed Farming/Ag. Workers	67.7	71.3	20.1			

Statistics for Selected Districts:	Kilosa	Morogoro Rural	Morogoro Urban	Mpwapwa	Dodoma Rural	Dodoma Urban
Craftsmen/Machine Operators	0.8	0.4	8.4			
Small Scale Traders/labourers/ Other	2.2	1.2	12.2			
Unemployed, N/S	25.5	24.9	42.1			
TOTAL	100	100	100			
Agriculture						
% Arable Land Under Cultivation (2000/01)	10	12	-	47	12	47
% Food Crops/Cultivated	35	47	100	78	78	82
% Cash Crops/Cultivated	65	53	0	22	22	18
TOTAL %	100	100	100	100	100	100
Principal Food Crops: (%area)						
Maize	62.1	57.4	59.7	43.3	29.0	14.0
Paddy	13.9	24.9	35.5	0.3	1.3	0
Sorghum	7.0	8.2	4.7	46.5	12.7	44.8
Cassava/Millet	3.1	1.0	0.1	6.0	50.9	32.3
Bananas	2.3	2.9	0	0	0	0
Beans/Sweet Potatoes/Nuts	11.6	5.6	0	3.9	6.1	8.9
TOTAL	100	100	100	100	100	100

Statistics for Selected Districts:	Kilosa	Morogoro Rural	Morogoro Urban	Mpwapwa	Dodoma Rural	Dodoma Urban
Principal Cash Crops: (% area est.)						
Sugar Cane	15	5	0	0	0	0
Sisal	85	95	0	0	0	0
Groundnuts				98	67	85.5
Cotton/Coffee/Sunflower/*Sim-sim*/Other	n/a	n/a	0	2	33	14.5
TOTAL	100	100	0	100	100	100
No. of Existing Irrigation Schemes	31	10	0			
Area Under Irrigation (ha.)	14,521	12,536	0	1629	1546	0
% of Potential (Av. Region)	12	12	0	73	29	0

Statistics for Selected Districts:	Kilosa	Morogoro Rural	Morogoro Urban	Mpwapwa	Dodoma Rural	Dodoma Urban
Infrastructure:						
All-Weather Roads %	68	36	100			
Railway	yes	yes	yes	yes	yes	yes
Commercial Airport	no	no	no	no	no	yes
Electricity %	1	1.2	40			
Education						
Adult Literacy % (Av. All Region, 1988)	63	63	63			
Life Expectancy (All Region, 1988)	45–48	45–48	45–48			
Water Supplies: (2000)						
% Coverage Rural	n/a	49	-	79	78	
% Coverage Urban	100	90	n/a			
% Water Supply Facilities Not Working:						
Electrical %	0	40	0			
Diesel %	0	49	none			
Gravity %	0	11	0			
Hand Pumps %	59	18	43			

Basic data sources: (National Bureau of Standards/Regional Commissioner's Office 2003)

3.1 Industrial interests

3.1.1 Introduction

Industries in the Basin play an important role with regard to the status of the socio-economy of the sub-basin. Most of the industries are concentrated around the Coastal Rivers in Dar es Salaam. In this area, most rivers (e.g. Mpiji, Msimbazi) are so polluted by industrial effluents that the water is not acceptable for consumption, agricultural use, or even other industrial processes (WRBWO 2006). As a result, residents are drilling boreholes to obtain water.

3.1.2 Existing industries

Table 3.3 shows a list of some of the industries in the Ruvu sub-basin (mainly in Dar es Salaam and Morogoro) that were visited during the water quality monitoring programme carried out by WRBWO in 2006.

Table 3.3 Selected industries within the basin, their location, type and discharging bodies (WRBWO 2007)

Name of Industry	Location	Production	Discharging Bodies
Canvass Mill	Morogoro	Textiles	Ngerengere River
21st Century	Morogoro	Textiles	Ngerengere River
Highland Sisal Estate	Morogoro	Sisal	Ngerengere River
Tungi Sisal Estate	Morogoro	Sisal	Ngerengere
Tanzania Plastic Manufacturer (1998)	Morogoro	*Magunia*	Ngerengere
Royal Diary	Dar es Salaam (DSM)	Milk, juice and cream	Ground water
Dar Breweries	DSM	*Chibuku*	Ground water
Tanzania Brewery Limited	DSM	Beer	Msimbazi River
TanpakTz, Sabuni Detergent BIDCO,Cocacola (Kwanza), Mikocheni WSP	DSM	Domestic sewage& Mwenge and Mikocheni industries effluents	Mlalakuwa River
Tradeco, Nida Textile, Associate Breweries (Serengeti)	DSM	Beer, Textiles	Kibangu River
Karibu Textile Mill	DSM	Textiles	Kizinga River
Urafiki Textile	DSM	Textiles	Ground water
East Hide Group	Morogoro	*Ngozi*	Ngerengere River
Tanzania Cigarette	DSM	Cigarettes	Ground water
Tanzania Leather Associate Industries	Morogoro	Industrial effluent and domestic sewage (TLAI WSP)	Ngerengere River
Mansor Daya Chem	DSM	Pharmaceutical	Ground water
Mkwano	DSM	Soap	Ground water
Mabibo Wastewater Sewage Pond	DSM	Domestic sewage	Ground water
Vingunguti WSP	DSM	Domestic sewage	Ground water
Alliance One Tobacco Processor	Morogoro	Tobacco	Ground water

Industries interviewed for this report included the Tanzania Breweries Limited (TBL) and Karibu Textile Mill in Dar es Salaam, 21st Century textiles and East Hides group in Morogoro.

Tanzania Breweries Limited

TBL is part of the multinational company, SAB/Miller and they use 2000 m^3/day of water. Fifty to sixty per cent of the water supplied to TBL comes from Dar es Salaam Water Supply Company (DAWASCO). TBL financed DAWASCO with TZS 380 million to provide a connection from a further point that has more pressure. Unfortunately, the water supply has not improved. The remaining 50% comes from boreholes. TBL have financed a private local company, Winners Traders, to survey and drill five boreholes. Winners have an agreement to operate the boreholes to supply TBL with water, while TBL supply Winners with power. Four boreholes belong directly to TBL. The water from the boreholes drilled by Winners needs to be treated through reverse osmosis to desalinate the water; in fact, TBL dumps 30–40% of water from these boreholes. Some boreholes drilled by TBL have been abandoned due to increased salinity. Consequently, TBL prefers surface water because of the higher salinity from boreholes.

TBL have state of the art treatment, and they treat all effluent from the Dar es Salaam plant. They are planning to carry out wastewater recovery in the next four months by recycling water for steam generation, cleaning and cooling towers. TBL also has plants in Mwanza, Arusha, Moshi and Mbeya, and are constructing effluent plants for treatment for all of their facilities.

Karibu Textile Mill (KTM)

Karibu Textile Mill (KTM) produces textile products and is located in Dar es Salaam. KTM abstract their water from the Ruvu River directly downstream of the DAWASCO intake. The water that they use to wash the cloth is not treated. However, they do treat the water that is used in the dying process. The water treatment involves a settling tank and chemical treatment.

One of the main issues with the plant was the high level of contaminated effluent being discharged that immediately impacts the surrounding neighbourhood and the downstream environment. The effluent contains dyes, caustic soda, urea, and resist salt (which prevents dyes from running). There are two stages to the process; the first is bleaching that uses caustic soda, which is dangerous, and the second is printing, which uses dyes. An underground PVC pipe was constructed in 2004 that discharges effluent 1 km from the plant to the Kizinga River. However, due to blockage of this pipe, overflow from the holding chambers has been discharged directly into the surrounding neighbourhoods. There were complaints to the National Environment Management Council (NEMC) that the water effluent from KTM plant was not treated and was being discharged through the residential area. The media reported the problems in the area and said that the water was discoloured and smelt foul.

Consequently, the WRBWO came and took samples and NEMC investigated. The WRBWO found that the pH was too high—11.8, and the allowable range is between 6.5 and 7.5). Consequently, the plant was closed down until it met certain conditions laid out by NEMC and the WRBWO. One of the immediate actions in March 2008 (that was a condition for the plant to reopen) was to construct larger chambers to contain effluent.

NEMC and the WRBWO have advised KTM to build a dosing tank to contain and treat their effluent that will hold 300,000 litres divided into two equal partitions. A precise level of acid will be added to neutralize the effluent. The effluent was previously treated manually by adding acid to the effluent but not necessarily in measured doses; consequently the proportions

were not always correct, which was ineffective. The dosing tank is still under construction and the aim was for it to be completed by August 2008. Meanwhile, effluent has been discharged directly with a pH of between 9 and10. KTM have a laboratory on site that is currently testing the effluent for pH.

KTM carry out in-house monitoring and they are now obliged to give monitoring reports to the government. Currently the government (WRBWO and NEMC) will be frequently following up and monitoring to check on the compliance with the conditions for the factory to reopen.

21st Century Textiles

21st Century Textiles Ltd is part of Mohammed Enterprises Tanzania Ltd. The plant in Morogoro produces textile products including yarn, grey fabric and finished fabric. Effluents are produced during wet processing, and the grey fabric needs to be treated by water and chemicals. Water for the plant comes from Morogoro Urban Water Supply Authority (MORUWASA) and requires softening before use. The supply is generally adequate, but there were shortages between 1996 and 1997.

The plant was built in 1984 and included a treatment facility. Treatment includes aeration, dosing with chemicals before aeration for neutralization, and filtration. The aim of the treatment is to neutralize caustic soda and to bring pH levels to less than 8.2. The pH can be as high as 10 in the untreated effluent but it measures around 8 when released. In May 2008, the company introduced a new treatment process from India that removes the dye. After treatment the effluent is pumped to the Tanzania Leather Associate Industries (TLAI) ponds waste stabilization ponds. This is actually out of necessity rather than a requirement, due to buildings in the release pathway to the river.

There are cases when treatment has failed at the plant because electric cables were stolen. However, they have the capacity to contain a few hundred cubic metres of effluent, which is the result of two to three days of production. After this point, the plant has to be shut down. There have been complaints from neighbours when there was a breakdown.

East Hides group

East Hides, an international company that specializes in tanning and distributing hides and skins, acquire their water supply from two sources: boreholes and MORUWASA. The company owns three boreholes and the WRBWO are processing the water permits. The water from the boreholes alone is not sufficient for the company.

The process of tanning hides, known as ‘chrome tanning’ employs a number of chemicals including salt, lyme and chromium sulphate and water are used for washing the hides. There is also a treatment plant, which includes aeration. The WRBWO has only tested the effluent once and this was after an awareness-raising workshop. East Hides carries out in-house monitoring but the information is not readily available. Effluent is tested before it is released, and the company uses the TLAI ponds for treatment.

3.1.3 Pollution aspects

Pollution by industrial activities in the sub-basin is a significant management challenge for the WRBWO. No organizations have been prosecuted for exceeding the established guidelines. If results are above acceptable standards then the WRBWO writes to the offending organization to explain their breach. They are then given some time to fix the problem before follow-up checks are carried out. For example, KTM in Dar es Salaam is chronically polluting; this year they were closed down by WRBWO in collaboration with NEMC through the EMA (Environmental Management Act) and were given a number of conditions before they could re-open (see above). In another example, a workshop was convened to discuss the future of the TLAI ponds in Morogoro. This was precipitated by cases of pollution in the Ngerengere River. The workshop, headed by the Director of Water Resources, brought together NEMC, WRBWO, the Morogoro municipality and industries using TLAI ponds. They intended to create awareness about the impacts on the river by the industries and they developed a strategy to tackle pollution problems, which included follow-up monitoring and improvement of the industries’ treatment facilities.

Polluted water means that more energy and financial resources need to de directed towards water treatment. It can also impact the productivity of farms. For example, Kimango Farm, which is just downstream of Morogoro town along the Ngerengere River, has reported a number of incidents where polluted water from upstream has killed the fish downstream. The farm’s productivity was affected because they had to stop irrigating otherwise there would have been significant crop losses. Instead they have turned to drip irrigation to avoid direct contact of the contaminated water with plants. The cost of drip irrigation is higher because of the need to invest in the system, as the cost of water is not an issue. The farm has reported the situation to WRBWO. In response, the basin office convened a meeting with several stakeholders including DAWASA and some industries regarding pollution of the river. The industries were instructed to treat their effluent. As noted above, the situation is even worse for rivers receiving effluents from Dar es Salaam industries.

There are other sources of pollution, such as the discharge from a treatment pond at Mzumbe University, and non-point sources from agricultural activities, which include pesticides, fertilizers and sediment from erosion. Fishing using pesticides is often cited as the cause of pollution and fish deaths but more data and monitoring are needed to prove that this is the case.

3.2 Major infrastructure impacting on the river sub-basin

Mindu Dam is one of the major water infrastructures in the Ruvu River system. The reservoir is located 7 km south of Morogoro along the Iringa road. The reservoir was constructed in 1983 and operations commenced in 1985. The reservoir, located at latitude 60° 51’S to 60° 52’S and longitude 37° 30’E to 37°40’EI, lies in the southeast of Ngerengere River valley, at a gap between the Uluguru and the Mindu Mountains. The reservoir is about 500 m above sea level (masl); with a measured length of about 1.5 km while the surface area is about 508.4 ha. The deepest point, measured during the rainy season, was 12 metres. The dam structure is about 1.56 km long with a 100 m wide ungated type spillway that discharges at a rate of 710 m^3/s. The full level of the reservoir is 507 m, the lowest drawdown level is 501.1 m and the highest water level before water spills out is 507.6 masl (Kihila 2005).

The major rivers that feed the reservoir include the Mlali, Mgera, Lukulunge, Mzinga and the Ngerengere, is the only river flowing in and out both ends of the reservoir. The starting operation capacity of the dam was 20.7 million m^3 and the estimated current capacity of the reservoir is about 13 million m^3 (11.28 million m^3 is the active volume and 2.02 million m^3 is the dead volume or storage normally not accessed for use). The reservoir reaches its lowest level—50% of capacity—during the dry season due to the dry spell’s demand levels (Kihila 2005).

There have been several problems since the Mindu Dam came into operation. First, there is pollution of the reservoir from agriculture, mining and human settlement in the catchment area. The dam is demarcated 500 m from the banks in a 26 km area. This means that people need to move that are still in the area. Those that occupy land in the demarcation zone have been compensated several times due to the construction of a Tanzanu pipeline, highway construction, electricity pylons and the Mindu Dam itself. As there is little enforcement, people keep moving back into the area or sell their land to someone else. Another major problem is the decline of reservoir storage capacity with time. The lifespan of the reservoir is 50 years, but 30% has been lost due to siltation. Ndibalema (1996) reported that 'the storage volume reduced from the expected 20 million m^3 to 11milion m^3 in 1996. Also the Ministry of Water and Irrigation through the Central Water Board (CWB) has pointed out that one of the threats facing Mindu Dam is sedimentation (CWB 2001). There is no adequate scientific data on the level or rates of siltation so the dam's sustainability in terms of its capacity is uncertain.

Another problem associated with the construction of the dam is the change in flow regime of the Ngerengere River downstream of the dam. Interviews carried out with the Village Executive Officer (Ngerengere Village) indicated that water supply projects at their village have been affected since the commissioning of the dam. The river changed from perennial to seasonal and salinity levels increased.

Photo 3.1 Mindu Dam

Other major infrastructure projects in the Ruvu sub-basin are the lower and upper Ruvu intakes for the water supply to Dar es Salaam and the Bagamoyo, Mlandizi and Kibaha villages along the pipeline.

The government of Tanzania intends to construct a dam that will control the Ruvu River at Kidunda and will be a significant source of water supply for Dar es Salaam. An Environmental Impact Assessment (EIA) was carried out by Norconsult on the proposed Kidunda dam. This EIA was based on the original dam specification that would hold a volume of 60 Mm^3. An additional EIA is being undertaken for a storage capacity of 150 Mm^3, and the spillway would be raised from 90 m to 92 m. Consequently, the dam area would increase from 27 km^2 to 43 km^2. The original dam of 27 km^2 would be operated only over a few months of the year (October to December) at approximately 0.8-1.25 Mm^3/day, to augment the flows of the Ruvu River to cater for the dry season water needs for the next 30 years for the 2.8 million people in Dar es Salaam, Bagamoyo, Kibaha and surrounds. The dam would have a reasonable downstream environmental flow and limited reserves for downstream water rights (Norconsult 2008).

The justification for building the dam is that is that the Ruvu River is vulnerable to climate variability such as droughts. This would be reduced by increased water storage upstream, and ensure water security for Dar es Salaam (Norconsult 2008). The impact of no-action will mean increased water scarcity, and significant long-term consequences including environmental health disasters, a build up of sewerage and industrial waste, and economic losses (Norconsult, 2008).

The dam location is about 2 km upstream from Kidunda Village, on the border of Morogoro and Kibaha Districts. The 27 km^2 reservoir boundary is on the Selous Game Reserve in the south and Mkulazi Forest Reserve in the north (Norconsult 2008). The larger reservoir will impact the Selous Game Reserve and the communities that benefit from the resources in the area.

The government is going to compensate those who are going to be displaced. Manyunywe is the only sub-village in the Kidunda Ward that will be completely affected. Five households out of 46 will be moved to Kidunda sub-village. However, the village would have preferred that they were all moved together. They will be compensated for their houses and crops. Other villages in the Selembala Ward that will need to be relocated are Kiburumo, Bwira Chini, Bwira Juu, Kibiro and Kiganila.

The villagers will benefit from the dam construction through employment, improved roads and communication in the short term and in the long term there will be fishing and tourism. The village has requested that the government establish a dispensary, as the presence of the dam will increase the population. The village also wants to practice irrigation, which the government is currently considering. Irrigation is not practiced yet because the water level in the river requires mechanized pumping.

3.3 Agricultural and irrigation interests

Traditional irrigation is practiced in the Uluguru highlands particularly in the Mgeta area where rainfall is not adequate as it is on the eastern windward side of the Ulugurus (i.e. Matombo area). In the lowlands of the basin a number of irrigation schemes used to operate such as the Chauru scheme, which was formerly a National Food Corporation (NAFCO) farm. Other schemes include the Makurunge scheme and the Bagamoyo Irrigation Development Programme, both of which were run by communities in the area. Additional schemes in the basin are indicated in Table 3.4 below, although most of them are not currently operational.

Apart from the previous schemes, the Zonal Irrigation Office is planning to undertake feasibility studies in Kongwa and Tulo villages. The structure of the Zonal Irrigation Office is provided in section 4.8.1.

The crops grown in irrigation schemes are usually onions and paddy rice. A few areas, such as Mlali, have problems with salinity of soil and water. There are generally few areas with water quality problems. Irrigation schemes use mostly surface water, although there are a few private sectors that use ground water.

With traditional groups, the Zonal Irrigation Office provides training to improve the schemes, which is the target of the directorate. There are few engineers at the district level, but the policy states that every district should have an irrigation engineer. Funding for the irrigation schemes is from the government and from donors via the government.

The Irrigation National Master Plan was initiated in 2002 and will be completed in 2017. The aim is to improve irrigation schemes, and develop further areas for irrigation. The current acreage is 246,000 hectares irrigated area for whole country, projected to 570,000 hectares in 2017. Under the Agriculture Sector Development Programme (ASDP), irrigation has two funding streams:

- District Irrigation Development Fund—75%
- National irrigation Development Fund—25%

To obtain funds, the district writes an application for irrigation funds that is submitted to the zonal office for review and then to the Ministry of Water and Irrigation. The criteria to obtain funds stipulate that the internal rate of return of a proposed project must be greater than 12%. This means that there needs some sort of economic analysis before application.

Table 3.4. Irrigation Schemes in the Ruvu sub-basin (Zonal Irrigation Office Morogoro, Personal Communication, 2008)

Region	District	Name Of Scheme	Irrigated Area (Ha)	Potential Area (Ha)
Coast	**Bagamoyo**	Ruvu (Chauru)	720	1500
		Bagamoyo (B.I.D.P.)	60	2000
		Kidogozero		500
		Makurunge		250
		Mkoko		500
		Kigongoni		2000
		Kiwangwa		200
		Chalinze		50
		Msoga	150	
		Matsushita Electric.		
		Siafco	0	200
		Genenter		
	Kibaha	Kwamfipa	10	50
		Mkuza	300	3500
		Mwanabwito	5	300
		Mwendapole	5	10
		Ruvu Basin	0	8000
		Ruvu Jkt	0	60
		Viziwaziwa	5	300

Norconsult et al. (2007) reported that major current water rights in the Ruvu sub-basin have a maximum of 121 Ml/d. The majority of the water rights are located either in Ngerengere tributary (total of 51 Ml/day) or the Lower Ruvu region with total 70 Ml/day. A larger water right of 56 Ml/day is at the extinct Chauru irrigation scheme 5 km upstream of Morogoro Road Bridge.

3.4 Pastoralist interests

Pastoralism is wide spread in the Ruvu sub-basin ranging from the lowlands of the basin in the Mvuha area, to Ngerengere down to Chalinze, Kiserawe and Bagamoyo Districts. Over the years a large migration has taken place into the Ruvu sub-basin due to the availability of good pasture and water for the livestock.

In Sanga Sanga sub-village around Mvuha area are the following livestock villages: Sanga Sanga, Kongwa, Tulo, Magagone, Dutuni, Bwakila, Kisaki, Tununguo and Nayambogo. The people indigenous to the area are the Wakutu and Waluguru while the pastoralists are Maasai and Mang'ati. The population of livestock is increasing and land is decreasing so they have to decrease the head of livestock. This policy is slowly being accepted.

The pastoralists in the Mvuha lowlands get water for themselves and their livestock from the Mvuha River, where there is sufficient water but the river is 2 km from the village (Sanga Sanga). Women are the ones that fetch the water. There are more than 10,000 livestock in the village.

There have previously been conflicts over village boundaries. Land officers for the district have placed beacons to demarcate the land. During the dry season, the Maasai migrate to the Ruvu River and further down to the lowlands including Kongwa, Kilengeze and Magogoni. Sometimes cattle enter people's farms while trying to access water and that can cause conflicts. Generally, the issue is discussed between the communities and it is resolved, although in some areas conflicts have been reported to escalate into violence.

Other pastoralist immigrants migrate to Sanga Sanga during the dry season from Morogoro. The inhabitants of Sanga Sanga find it is difficult to prevent them coming as the area is very large and there is no monitoring or patrolling. The major concern is pollution. The pastoralists are ready to contribute to the cost of building a cattle trough, but there are no plans to date. However, this is a long-term solution to which they are willing to contribute.

Conflicts have been reported throughout the Kiserawe and Bagamoyo Districts between farmers and pastoralists over water and grazing lands. For example, in Kiserawe animals were using water from stagnant ponds, but people also used this water. Livestock also contributed to the destruction of river-banks, and sometimes were found to be grazing on farmers' lands. In the Kidunda area pastoralists have been migrating into the area recently (since May 2007) due to the presence of good pasture and plenty of water. It has also been speculated that their migration could be linked to movement of pastoralists from the Ihefu in the Usangu plains. Cattle compact the soil and cause erosion. This gives rise to conflicts when the pastoralists are asked to move. There is currently no provision for watering points so livestock are watered directly at the rivers.

These conflicts are generally resolved by discussion and negotiation, although some are solved in legal courts. Provision of livestock infrastructure and land use planning would contribute to resolving this long-standing conflict. However, planning for the water use of migrating groups is a challenge as they are not stationary and their abstractions tend to be seasonal.

Photo 3.2 Livestock grazing in Matombo area.

3.5 Rural Water Supplies

The main problems in the rural water sector are pollution, inadequate water supplies, and weak management capacities in finance and organization. The status of rural water supply schemes in the Ruvu sub-basin depends on the altitude and geographical location of the area in respect to the river. Broadly, water sources in the highlands of Uluguru have a reliable supply and relatively clean water compared to villages in the lowlands with less frequent rains and high evaporation.

The highlands of the eastern side of Uluguru at Matombo and Kinole have better water supplies in terms of quantity and quality. However water supplies based on upstream and downstream linkages have problems of water quality. Nonetheless, village governments enforce bylaws to maintain the water quality. The western part of Uluguru, notably in the Mgeta area, experience water shortages due to the fact that the area falls in a rain shadow where there is limited rainfall. There are hand-dug wells to offset the shortage.

In Mvuha and Ngerengere, in the lowlands of Ruvu, the main problem is water pollution from upstream users that include industries, people and animals. The options available are either boiling the polluted water from upstream or seeking alternative ground water sources if they are available. This situation is found in Kiserawe, Kibaha and Bagamoyo Districts, which also benefit from piped water from the Ruvu River. Kiserawe is more vulnerable as they rely on a limited number of springs and ground water. In Temeke District the main source is ground water through shallow and deep wells managed by private operators and DAWASCO. Water conflicts are experienced in the lowlands due to increasing livestock in the area.

In all settings, it was observed that water committees have been established although they are weak, particularly in the management of funds that has been generated from fees for water services. The functions of these committees are further elaborated in section 4.6.2. However, their main function is to manage the water source and collect fees for the supply of water. In some cases water is free, but in others, where there is a more developed water supply scheme or irrigation network, then users are expected to pay for the service. For example, in the Kisarawe District, the district office supplies water in town, and in rural areas water services are bought from the district via a water committee. Every village has an account, and is expected to report problems to the district. Small towns now have water boards that manage water supply, and with time these are supposed to be autonomous. The idea is for the government to invest in infrastructure, and then the authority will manage the infrastructure.

3.6 Urban Water Supply

3.6.1 Morogoro Urban Water Supply Authority

The main source of water for MORUWASA is the Mindu Dam (75%) and a small amount is obtained from ground water. MORUWASA supplies 94% of Morogoro and has 18,891 customers, although nearly 3000 do not pay water service fees. Unaccounted water, which includes leakages, theft and water that is not paid for, consumes 27.4% of the supply. The shortfall (i.e. not receive from the MORUWASA) comes from sources such as the river and shallow wells. Some general information on the water supply situation for MORUWASA is provided in Table 3.5.

Table 3.5 Water supply situation as of July 1st, 2007

Municipal population	286,500 (2002 census)
Demand	30,000 m^3/d
Production	25,000 m^3/d
Coverage	94% as Jan 2008
Unaccounted for water (UFW)	27.4%
Length of distribution network	384.5 km
Total number of customers	18,891
Number of active customers	16,003
Total number of metered customers	14,599
Average monthly revenue collection	230 million TZS
Operating ratio (OR)	0.98 – this is cost effective as long as it is less than 1
Total number of staff	154
Female staff as a % of total no of staff in MORUWASA	20%
Staff turn over	0
% of core staff to total number of staff	49%

MORUWASA relies on domestic customers for revenue whereas it used to depend on industries that are no longer present in Morogoro. The municipality has 54,000 households, and there are 830 poor households that cannot afford to pay for water supply services. Of these, 483 households have their water service paid for by MORUWASA and receive 5m^3/month per household. A summary of the customer profile in Morogoro is provided in Table 3.6.

Table 3.6 Customer profile

Category	Number of customers	% of total	Contribution towards revenue in %
Domestic	17,847	94.47	69
Institution	433	2.30	17.4
Commercial	528	2.79	7.8
Industries & garages	83	0.44	6.80
Others			
	18,891	100	100?

Water supplied from MORUWASA is meant to be metered. Some people pay a fixed minimum charge or a flat rate. The flat rate is flexible and can be applied when a meter is not working (Table 3.7). MORUWASA checks the meter rates over six-month periods and charges the average volume of consumption in that time period. The minimum charge is a fixed rate regardless of consumption; this is calculated from average consumption in the city. The rates for metered water supply and sewerage disposal are provided in Table 3.8.

Table 3.7 Current tariff structure—service charge per month

Category	Service charge
Domestic	1500 TZS/month
Others	2000 TZS/month

Table 3.8 Current tariff structure – water sales and sewerage disposal

Category	Current tariff (water sales)	Current tariff (sewerage disposal)
Domestic	465 TZS/m^3	120 TZS/m^3
Institution	515 TZS/m^3	130 TZS/m^3
Commercial	610 TZS/m^3	135 TZS/m^3
Industries & garages	780 TZS/m^3	150 TZS/m^3

Because the sewerage system was only put in place in 2004, there is low coverage. Only 747 (3.07%) of the village's properties are connected but there is capacity for 10,000 properties. The sewerage system will be expanded under the WSDP.

Construction of the reservoir began in 1983 and it became operational in 1985 with a 50-year lifespan. However, 30% of capacity is roughly estimated to have been lost due to siltation. Around the Mindu Dam, people are mining gold and could potentially be using mercury although none has been detected to date. Mining also results in a high level of erosion and this has washed into the reservoir, also reducing its capacity. Cultivation upstream is causing further siltation to the dam and bush fires reduce vegetation and increases erosion. There is also a high level of pollution from agricultural chemicals and fertilizers, mining contamination and human waste from latrines from when people were living around Mindu Dam. Other upstream impacts are Mzumbe University, Tanzania Military and surrounding villages. A study is going to be conducted on the Mindu Dam to determine its future.

The leading priorities for MORUWASA are ensuring catchment protection upstream and co-ordinating with stakeholders to safeguard water sources. Co-ordination should start with WRBWO, but they also need the authority and enforcement of the law needs to follow. Mindu Dam is reported to dry in certain drought years and therefore MORUWASA must look for other options for supplying water in Morogoro.

3.6.2 Dar es Salaam City Water Supply

Dar es Salaam Water Supply Authority (DAWASA) is operated by Dar es Salaam Water Supply Company (DAWASCO), which took over management of the Dar es Salaam water and sewerage operations from CITY WATER Ltd in June 2005. A private company was originally brought in to manage the water distribution of the city under the direction of DAWASA but they failed to operate adequately and the government terminated the contract. Consequently, the government formed a public institution (DAWASCO) to oversee the facilities as a stop-gap measure. DAWASCO has been in place for three years already, but the plan is to have one institution rather than both DAWASA, which owns the infrastructure, and DAWASCO, which is the operator.

DAWASCO extracts water from the Ruvu and Kizinga Rivers, as well as 31 boreholes (of which only 22 are operational). The current water demand for the Dar es Salaam area is estimated to be around 415,000 m^3/day while the actual available supply is about 270,000m^3/day for surface sources with about 50,000 m^3/day coming from ground water sources. The installed capacity of the existing network is 279,000 m^3/day.

The ground water sources are generally of good quality; however a few boreholes have high salinity with EC (electrical conductivity) exceeding 2000 mS/cm. A study was carried out by the Ministry of Water and Livestock (2005) to look at the possibility of the use of ground water in conjunction with surface water. Isotope measurement techniques and conventional methods are being used to assess the ground water resources potential in the study area.

Table 3.9 summarizes the sources of water used by DAWASCO. There are three water treatment plants at Upper Ruvu, Lower Ruvu and Mtoni with a total installed capacity of 605,000 m^3/day. The plants were constructed more than 25 years ago, and their performance is low resulting in unsatisfactory quality and uneven water supply to residents (Mato 2002). DAWASCO has found that the willingness to pay for water is minimal because the supply is erratic, but with a more constant supply payments may be more forthcoming. There is insufficient flow in the river during droughts, and there are high demands that are not met in parts of the city that are not connected to the public water supply system, e.g. the southern part of the city (MoWI 2008). The sharp reduction in the base flow of the Ruvu River and the reliability of its water-supply intakes, which is of uncertain origin but probably due to a combination of climate variability, catchment deforestation/land-use changes and unlicensed upstream abstraction, is a threat to water supply in Dar es Salaam (GW-Mate 2007).

Table 3.9 Surface water sources for Dar es Salaam City, 1994 (JICA 1994)

Name of the plant	Source	Year of construction	Design capacity, m^3/day	Operating capacity, m^3/day
Upper Ruvu	River Ruvu	1959	210,000	82,000
Lower Ruvu	River Ruvu	1975	386,000	182,000
Mtoni	River Kizinga	1949	9000	6000
TOTAL			605,000	270,000

The rapidly expanding population of Greater Dar-es-Salaam (current population about is 3 million and is estimated to more than double by 2030) have intermittently experienced serious water-supply shortages since 1996 (GW-Mate 2007). The projected trends for water demand are shown in Table 3.10. The estimated average water supply demand in 2020 will be about above 1 million m^3/day. The water balance assessment from previous studies shows that the city is in need of an additional 720,000 m^3/day to satisfy total demand by the year 2032. The current population for the DAWASA area of operation is 3.6 m with a growth rate of 4% (2002 census report) expected to reach 6,707,676 by 2032. Thus, there is a need to assess all possible sources of water before making decisions about the future supply system (MoWI 2008).

Unaccounted for water is approximately 50%. In a project funded by the World Band and the African Development Bank, the Dar es Salaam Water Supply and Sanitation Project is improving water supply by finding illegal connections and rehabilitating old and dilapidated piping systems. The aim is to supply 70% of residents by the time the study ends in 2009.

Table 3.10 Trend of water supply demand for Dar es Salaam service area from 1990 to 2020 (MoWLD 2005)

Year	1990	1995	2000	2005	2010	2015	2020
Mean daily demand							
Areas in the distribution net work of DSM (m^3/day)	223,393	302,107	331,936	431,828	535,170	665,903	829,533
Areas along transmission mains (m^3/day)	81,665	77,048	77,631	88,829	102,341	119,003	139,640
Maximum daily demand							
Areas in the distribution network of DSM (m^3/day	279,867	377,634	414,919	539,785	668,963	832,378	1,036,917
Areas along transmission mains (m^3/day)	102,069	96,310	97,039	111,037	127,926	148,753	174,550
Total (m^3/day)	381,935	473,944	511,959	650,822	796,889	981,132	1,211,467
Total (m^3/sec)	4.42	5.49	5.93	7.53	9.22	11.36	14.02

About 55-65% of the water demand is domestic, 10-20% is commercial, 10-15% is institutional and 20-30% is industrial. It is estimated that 22% of households have piped water directly to their residences. The domestic tariff for water in Dar es Salaam is TZS 488 for the first 5 cubic meters and TZS 654 thereafter. For non domestic consumption the tariff is TZS 725 per cubic meter for any amount of consumption. People obtain water through private connections, water points and water vendors. Information on the number of connections and revenue from water supply is provided in Table 3.11. DAWASCO does not deal directly with the water vendors. The poorest of the poor don't pay for the first 5 cubic metres of water each month. But they need to contact DAWASCO. Some people write letters, then an officer from DAWASCO goes to evaluate the situation, looking at the quality of the house, how the person obtains food, and their means of paying bills. They also talk to water vendors in the neighbourhood to find out if they are receiving water for free from the vendors because they are too poor to pay.

There are water committees where there are water kiosks with standpipes. Money is collected by the committee and used to maintain a standpipe. Prior to a community being handed the kiosk, DAWASCO or NGOs provide training on forming water committees, reading water meters and other activities. The water committee is decided through the local government structure.

Table 3.11. Water supply in Dar es Salaam (2007/08) (DAWASCO 2008)

Water Production	91,761,000 m^3
Water Sales	43,229,000 m^3
Unaccounted for water (UFW)/Non revenue water	49%
Total number of connections	140,809
Number of active connections	63,537
Number of inactive connections	77,272
Total number of metered customers	34,128
Total revenue collection	19,378 million TZS
Arrears	24,158 million TZS
Recurrent expenditure	18,619 million TZS
Expenditure/Net Collection Ratio	0.85

The sewerage network length in Dar es Salaam is 142 km and has 14,000 customers, which is only 7% of the population.

Future water supply

The World Bank financed strategic options studies with DAWASA for the development of future water supply sources, which reviewed 26 surface and ground water options. The two most promising options were the Kidunda Dam and Kimbiji well field. The Kidunda Dam would regulate flows in the Ruvu River and thus ensure optimal supply to the Lower and Upper Ruvu intakes. The dam would supply 300 Ml/day from the existing intakes (at an indicative capital cost of US$ 0.18/m3 or alternatively it could supply shallow ground water in the lower Ruvu Valley at times when dry weather river flows were insufficient (with an additional capital cost of US$ 0.03/m(GW-Mate 2007).

The second option World Bank presented is the exploitation of ground water in the coastal aquifers. Initial assessment of regional ground water potentials was greatly aided by drilling and geophysical exploration data provided by Tanzania Petroleum Development Corporation

(TPDC), which found potential in the Kimbiji aquifer, south of Dar es Salaam (MoWI 2008). The total supply sought in the long-term (25-year) plan is about 260 Ml/day, which would best be developed on a staged basis with an estimated capital cost of as low as US$ 0.05/m3 (GW-Mate 2007). Further discussion on ground water in the city is provided in section 2.4 and details on the Kidunda Dam are in section 3.2.

3.7 Past, current and future interventions by organizations

The WRBWO, since its inception in 2002, has been building capacity to address its functions effectively and efficiently. In so doing, the office has been working with different partners to address issues such as ground water resources, capacity building for basin staff, surface water resources monitoring and water quality monitoring.

3.7.1 Governmental Organizations

The office has worked with different governmental organizations in the basin to fulfill water management. Through the Dar es Salaam Water Supply and Sanitation Project (DWSSP), the office worked with DAWASA to carry out a study on the Future Water Sources for Dar es Salaam where two options were proposed. Ground water development and the Kidunda Dam are the options that are being investigated further to provide a solution to the water scarcity problem in Dar es Salaam. Another area of cooperation under the same project has been building capacity of the Office through staff training, provision of office equipment and rehabilitation of 36 hydro-meteorological stations that could assist in data collection.

DAWASCO is also working with the WRBWO to demarcate the Kizinga catchment's intake areas to prevent encroachment and destruction of the water source. The demarcation has only been partially successful as some beacons have been vandalized and people still need to be relocated from the area.

3.7.2 Non-governmental/International Organizations

JICA has worked with WRBWO in different areas with regard to provision of water supply services in the Basin. JICA's area of interest has been ground water (JICA 2005) and currently capacity building with the local government authorities and basin offices. The World Bank and other donors are providing funding to implement the government's Water Sector Development Plan, which includes building water supply systems and creating capacity within villages and districts to manage the systems and protect the water sources.

NGOs that have been working in collaboration with WRBWO in the basin include Inwent who facilitated IWRM workshops in Morogoro, SNV who aided in preparing the terms of reference for this situation analysis and have agreed to work with the WRBWO to form water user associations and IUCN who are facilitating the development of the situation analysis for the Ruvu and Wami basins.

A number of organizations such as CARE International, TFCG, the Wildlife Conservation Society of Tanzania (WCST), the Uluguru Mountain Agriculture Development project (UMADEP) have worked in the basin with villages on environmental conservation through creating environment committees to manage natural resource, building capacity of these committees and planting trees to improve soil conditions.

Other NGOs such as CARE and World Vision have supported water supply schemes. For example, CARE carried out capacity building of conservation of the water and implementation of by-laws in Langali village in the Mgeta area in the Uluguru Mountains. The village developed by-laws that were approved by the village councilors and the ward, as well as endorsed by the district council. In Kinole, Mviwata (a network of farmers in Tanzania) and the French Development Agency supported a number of projects including constructing of market infrastructure, a training centre, road improvements and developing a water supply scheme. The gravity scheme was created for untreated domestic water supply.

DAWASCO, which is downstream of the Ruvu River, is threatened by upstream users both in water quantity and quality. DAWASCO is collaborating with CARE and Coca-Cola in a project in the Uluguru Mountains known as Payment for Ecosystem Services (PES). The goal of the project is to improve water quantity and quality running down to the upper and lower Ruvu intakes that are run by DAWASCO. Currently there are no major irrigation schemes in the basin but plans are underway to initiate some as indicated in the irrigation section (Section 3.3).

3.8 Conflicts in the basin

Conflicts in the basin vary depending on location. In the highlands, immediate downstream users complain of water being polluted from bathing and washing upstream. This situation was noted in lowlands in Mvuha and Sanga Sanga villages. Most water supplies on the slopes of the Uluguru Mountains are from river water and no treatment is needed.

Another conflict is that some industries in the Morogoro Municipality upstream along the Ngerengere River release effluents that do not comply with pollution standards and taint the river for domestic, irrigation and livestock users downstream. For example, Ngerengere communities, including Kimango Farm, suffer from effluent pollution by industries in Morogoro Municipality. It was noted that pollution levels upstream have affected the fishing industry in the Ngerengere River and a serious concern was voiced at Ngerengere town about the consistent pollution in the river. Also MORUWASA is at odds with upstream settlements that pollute Mindu Dam through land use activities and effluents from poor oxidation ponds.

Some industries in Dar es Salaam are discharging effluents that do not meet water quality standards resulting in contamination of the river and ground water sources. KTM (see Section 3.1) is working on improving its performance in effluent management to meet the NEMC environmental management criteria. Petroleum companies are polluting the ground water through storage of oil and consequent leakages to the ground water table. Poor sewerage treatment is affecting shallow ground water development in Temeke District, particularly in Mtoni and Mbagala.

Photo 3.3. 21st Century Textile effluent treatment pond

Photo 3.4. Community using polluted Ngerengere River for domestic use at Ngerengere

There are also conflicts between pastoralists and farmers that are also discussed in section 3.4. This type of conflict is widespread in the Lower Ruvu system in Ngerengere, Kiserawe District and Bagamoyo. The recent influx of pastoralists to Morogoro and Coast Regions is a concern to communities engaged in agriculture as well as domestic water supply. In most cases these pastoralists are in large numbers without having any infrastructure for their livestock, which therefore drink directly from rivers, degrade river-banks and eat farmers' crops. Clashes often occur and are often solved by the communities or in legal courts, but the problem persists. The future development of Kidunda Dam will also draw more people who wish to access water availability in the area.

Photo 3.5 Livestock migrating into Kidunda area

Photo 3.6 Kizinga River and settlement in the neighborhood

Photo 3.7 Effluent at KTM Factory

Conflict also arises over payment for illegal water abstractions made by people who do not want to pay for water as they feel that have been using the water source for years (or even generations) and they do not see why they should hand over its ownership to WRBWO. In such cases education and communication about the need to share and protect water resources in the basin are necessary. There must be investment in protecting water sources and monitoring of abstractions.

3.9 Summary of key points

There has been poor industrial compliance to national standards in the Morogoro Municipality regarding effluent discharge. Pollution of the Mindu Dam has been problematic as there are various institutions involved and its coordination has been complicated. Concerted efforts, including those by NEMC, have been made to intervene and address pollution in Morogoro Municipality.

Uncontrolled shallow well drilling in Dar es Salaam continues to challenge WRBWO, as withdrawn water is neither clean nor safe, which resulting in water-borne diseases due to pit latrines situated near the wells. The future water sources in Kidunda Dam and Kimbiji should be addressed as soon as possible as water from Ruvu River is failing to meet water needs in Dar es Salaam, particularly during the dry season. DAWASCO can only meet 60% of the needs of the city residents.

4 Water Resource Management in the Ruvu sub-basin and coastal rivers

Water sources are generally considered to be community property but struggles over different uses of water often arise: domestic, agricultural, industrial and water for the environment. The participation of the private sector in the water sector is very limited although many NGOs and Community Based Organizations (CBOs) that are inactive could facilitate community capacity building within the basin. For example Dodoma has about 45 such organizations (WRBWO 2008).

4.1 Policy frameworks

The current policy framework for the sector is set out in the National Water Policy (NAWAPO 2002), which is oriented towards reaching the Millennium Development Goals (MDGs) for water and sanitation in Tanzania and incorporates the overall development goals set out by the Vision 2025 and the National Poverty Reduction Strategy (NPRS).

For water resources management NAWAPO (2002) emphasises:

(i) *Comprehensiveness*—a holistic basin approach for integrating, multi-sector and multi-objective planning, management that minimises the effects of externalities, and ensures sustainability and protection of the resource

(ii) *Sustainability—water* resources will be utilised within sustainable limits (safe yields of surface and ground water and assimilative capacities for discharge of pollutants)

(iii) *Subsidiary—river* basins would be the units of operational WRM, Basin Water Boards comprising basin stakeholders with decisions on water

(iv) *Separation*—water resources management and regulatory functions separated from service delivery functions

(v) *Economic, participatory and regulatory instruments* for managing water resources.

Following the adoption of the National Water Policy (NAWAPO) of 2002 Tanzania introduced a decentralized and participatory approach of water governance. The government adopted the National Water Sector Development Strategy (NWSDS) to implement NAWAPO. Emphasis is on IWRM, which is also reflected in the Water Sector Development Programme (WSDP) 2006-2025 that was launched in March 2007 during World Water Week. The WSDP provides a strategic background for the implementation of plans and interventions for the achievement of national targets and calls for development partners to actively engage and support the water policy/strategy.

The National Water Sector Development Strategy has been prepared with a time horizon up to 2015 in order to guide policy implementation. It sets a number of specific targets for both integrated water resources management and improvement of water supply and sanitation services.

4.2 Legal Frameworks

The Water Utilization (Control and Regulation) Act No. 42 of 1974, with its subsequent amendments, previously governed water resources management in Tanzania. In 1989, by authority of this Act, the Minister for Water gazetted nine water basins for the purposes of water resources administration and management.

Under this legislation, the Government established Basin Water Offices in the Pangani River Basin (1991), Rufiji River Basin (1993), Lake Victoria Basin (2000), Wami/Ruvu Basin (2001), Lake Nyasa Basin (2001), Lake Rukwa Basin (2001), Internal Drainage Basin to Lake Eyasi, Manyara and Bubu depression (2004), Lake Tanganyika Basin (2004), Ruvuma and Southern Coast Basin (2004). These water offices have appointed boards and are headed by a Basin Water Officer. The institutions are mandated with management of the water resources and implementation of the water law at the basin level.

The Water Resources Management Act, No. 11 of was passed in May 2009 and is operational as of July 2009. The Act provides for the institutional and legal framework for sustainable management and development of water resources and outlines principles of for water resources management. It also provides for the prevention and control of water pollution and for participation of stakeholders and the general public in implementing the national water policy.

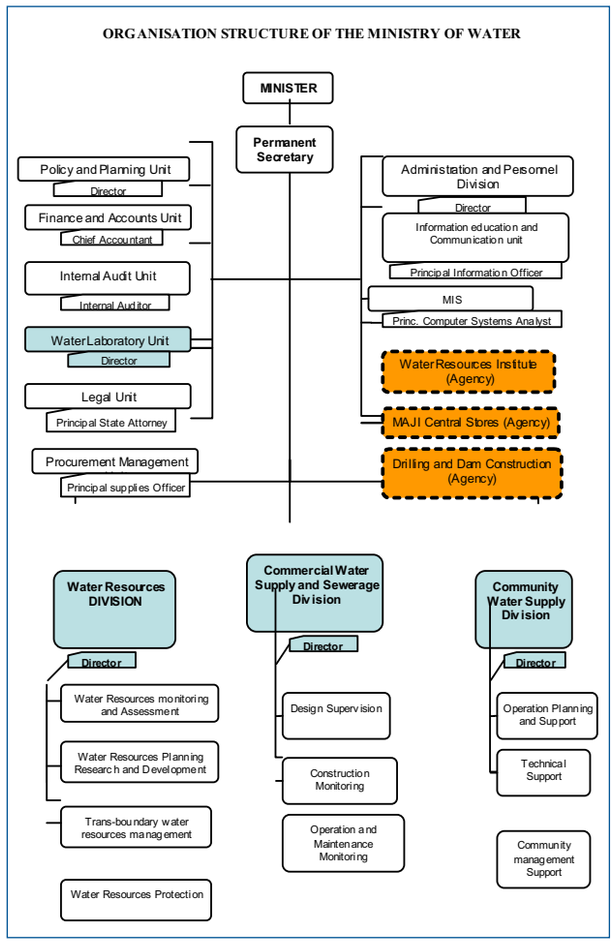

Figure 4.1 Organizational structure of the Ministry of Water, Tanzania

Implementation of the WSDP is contingent on the water law, as it is difficult (but not impossible) to implement policy without legal guidelines. To ensure that polices do not conflict there is funding available for policy harmonization for all water related sectors under the WSDP.

4.3 Organizational structure

There is a permanent secretary under the Minister of Water and Irrigation (previously the Ministry of Water and Livestock Development). There are 3 technical directorates in the Ministry, which consist of Water Resources, Community Water Supply and Sanitation (previously Rural Water Supply and Sanitation), and Commercial water supply (previously urban water supply). Then there are support departments of policy and planning, and administration. Figure 4.1 shows the organizational structure of the Ministry of Water.

According to the NAWAPO (2002) water resources management in Tanzania should be organized around participatory and representative forums, starting at the national level and spreading to the basin and sub-basin level (see Table 4.1). The policy identifies five levels of basin management—national, basin, catchment, district and community or water association level. The institutional framework for water resources aims to integrate sectors at different levels, and this is formalized in the new water law. Irrigation, tourism, agriculture and other such sectors interact at the national level through the national water board. At the basin level there are integrated boards (such as the Wami/Ruvu Basin Water Board) with different water users and sectors. Each basin office is required to implement the decisions made by the board and carry out operations. At the catchment level, the aim is to have a catchment council that will provide integrated planning and district councils will participate fully in basin boards and catchment councils. Districts are also responsible for planning and developing water resources. The community level and Water Users Associations (WUAs) are responsible for local-level management of allocated water resources (IUCN Eastern Africa Programme 2003).

Establishment of WUAs is critical as they provide the institutional mechanisms for addressing water needs and conflict resolution at the local and sub-catchment levels, which is a challenge because WUAs are still in their infancy and only beginning to evolve. However, those already established in Pangani basin and Great Ruaha catchment have proved to be successful and effective mechanisms for water resources management.

Table 4.1 Functional Responsibilities for Water Resources Management

Organization	Functions and Responsibilities
Minister responsible for Water	Presents national policy and strategy to the Government. Ensures policies and strategies are implemented. Appoints Chairman and members of Basin Water Boards. Determines appeals from all levels in framework.
Ministry responsible for Water	Sectoral co-ordination, monitoring and evaluation. Reviews policy development, including legislation and financing. Formulates technical standards and WRM guidelines. Co-ordinates trans-boundary water issues. Ensures dam safety. Oversees water quality monitoring. Development of water resources of national interest. Co-ordinates data collection and assessment of water resources. Supervises monitors and evaluates Basin Water Boards. Supervises the Water Resources Institute Agency. Supervises the Drilling and Dam Construction Agency.
National Water Board	Advises the Minister on: - integration of inter-sectoral planning - co-ordination of basin planning and management - inter-sectoral/inter-basin conflicts - investment priorities and financing patterns - interbasin water transfer - transboundary water resources management.

Organization	Functions and Responsibilities
Basin Water Boards	Collect data, process and analyse for WRM monitoring and resource assessment. Co-ordinate technical aspects of trans-boundary issues in the basin. Co-ordinate and approve basin WRM planning/budgets. Approve issue and revoke water use and discharge permits. Enforce water use permits and pollution control measures. Co-operate between sectors at the local level. Resolve conflicts and co-ordinate stakeholders. Integrate district plans.
Catchment/Sub-catchment Water Committees	Coordination of catchment/sub-catchment integrated water resources management and planning. Resolution of water resources conflicts in the catchment/sub-catchment, and other delegated. responsibilities from Basin Water Board.
Water User Associations	Manage allocation of water resources at local level. Manage equitable allocation of resources during drought. Mediate in local disputes.
Regional Secretariat	Provide representation on Basin Water Boards.
District Councils	Provide representation on Basin Water Boards. Provide representation on Catchment Committees. Formulate and enforce by-laws. Promote efficient water utilization. Prepare district plans.

Below the Director of Water Resources are four Assistant Directors: Water Resources Assessment And Monitoring, Water Resources Planning And Research, Water Resources Protection And Environment and Transboundary Water Resources. The Water Resources department also manages/co-ordinates the nine river basin offices, which consists of four lake basins and five river basins that are listed above. .

4.3.1 Wami/Ruvu Basin Water Board

The Wami /Ruvu Basin Water Office, established in 2001, reports to the Wami /Ruvu Basin Water Board, which consists of seven to ten members appointed by the Minister of Water. The present board members are drawn from institutions that represent the Government, public, private enterprise and NGOs. The Wami/ Ruvu Basin Board are advised by the Basin Water Office on management issues such as the allocation of water at the basin level and collection of water user fees. They currently have ten members who represent the following stakeholders:

- Ministry of Agriculture
- Ministry of Water
- Wami/Ruvu Basin Water Office–Secretary
- Utilities–DAWASCO
- Large users–Mtibwa Sugar
- NGO from Dodoma–Mamado (dealing with water and development)
- Lawyer – representing women (Chair person)
- Ministry of Industry and Trade
- Kimango Farm
- Vice President Office–Environment

Board members are chosen through a process that starts by the WRBWO writing to different institutions to request for the CVs for possible candidates for the Board. The CVs are processed and a shortlist is submitted to the Ministry of Water and Irrigation, who chooses Board members from this list or from elsewhere. Under the new legislation, the number of board members will increase and include WUAs and more NGOs.

The board meets at least twice a year and last year they met three times. A sub-committee of the board meets more frequently to discuss water rights. Each February they meet to approve the annual work-plan and budget, and in June the WRBWO submits their progress report for review. In all sittings application of water rights submitted to the board are reviewed.

4.3.2 Wami /Ruvu Basin Water Office

WRBWO is the executive office of the Board and is headed by the Basin Water Officer. For daily technical work the Basin Officer reports to the Director of Water Resources. WRBWO has its headquarters in Morogoro and two sub-offices in DSM and Dodoma. The vision, missions and commitments of the Office were previously presented in section 1.3.2. Specific responsibilities of the Office include:

- to issue water use permits
- to monitor and regulate water use according to natural availability
- to control and take legal measures against water resource polluters
- to resolve water use conflicts
- to collect different water user fees and use them for office operation
- to sensitize stakeholders on the sustainable use of water resources
- to facilitate the formation of Water User Entities
- to facilitate the formation of catchment/sub-catchment committees
- to conduct operation and maintenance of water resource monitoring stations
- to assess and monitor the quantity and quality of water in the basin
- to coordinate the Integrated Water Resources Management plans
- to participate in water resources protection programs.

In the draft legislation, more responsibilities are being added to the Boards. As the basins move towards autonomy, the board will serve as an executive body and employ staff directly. This means that engineers and other staff will be paid by the Board.

Wami and Ruvu basins under one office because the Tanzanian government amended the water utilization act in 1991 and they realized that many small rivers drained into large drainage basins. They saw that if they provided a basin office to all rivers then there would be too many basins. Thus, basin offices were required to cover areas that contained several river basins draining into the ocean. Consequently, the Wami and Ruvu were combined to be administered by one board.

Using hydrological boundaries, the basin has been divided into seven sub-catchments that might be revised using more in-depth data on hydrology form the field. Each sub-catchment will have several WUAs which will form sub-catchment committees and define the boundaries of the sub-catchment.

In the past there were regional water engineers, but when the river basin structure was established in 2004, the regional focus was dissolved. There are still representatives in the regions, so the WRBWO has two sub-offices—one is Dar es Salaam and the other in Dodoma.

Table 4.2 Major abstractions in the Ruvu sub-basin

Water Right No.	Name	Place	Amount of Water in litres	Source Name	Source Type	District
2261	Mrs B.H. Mann	Bagamoyo	908 l/day	Well	Ground water	Bagamoyo
1417	Henry G. Dodd	Morogoro	7075 l/day	Kikundi River	Surface	Morogoro
622	Tanganyika Packers Ltd.	Kisarawe	5,675 l/day	Pool	Surface	Kisarawe
4585	TPDF Vikenge	Morogoro	222.2	Ngerengere River	Surface	Morogoro
170	Tanganyika Packers Ltd.	Kisarawe	6810 l/day	Well	Surface	Kisarawe
4714	MD. MOROUWASA	Morogoro	300.9	Ngerengere River	Surface	Morogoro Urban
4374	Mr. Asmani Ismail	Morogoro	5448 l/day	Ngerengere River	Surface	Morogoro
2486	Kiroka Plantation	Morogoro	44,540 l/day	Kiroka River	Surface	Morogoro
RU 0002	Mgolole Sisters	Morogoro	1,500 l/day	Borehole	Ground water	Morogoro
MG. 88	M.D. MOROUWASA	Morogoro	60.8	Morogoro River	Surface	Morogoro Urban
22&2427	Director of P.W.	Bagamoyo	1050.9	Ruvu River	Surface	Bagamoyo
MG.82	Catholic Integr Comm.	Morogoro	8000 l/day	Borehole	Ground water	Morogoro Rural
MG.83	Catholic Integr Comm.	Morogoro	8000 l/day	Borehole	Ground water	Morogoro Rural
619	Tanganyika Packers Ltd	Kisarawe	5,675 l/day	Pool	Surface	Kisarawe
619	Tanganyika Packers Ltd	Kisarawe	5,675 l/day	Pool	Surface	Kisarawe
4920	Ismail Jumbe Diwani	Morogoro	5,000 l/day	Wami River	Surface	Morogoro
1489	National Lutheran Council	Morogoro	2270 l/day	Stream	Surface	Morogoro
621	Tanganyika Packers Ltd	Kisarawe	5675 l/day	Pool	Surface	Kisarawe
4347	DED-Kisarawe	Kisarawe	215.4	Storm	Surface	Kisarawe

4.4 Water rights

One of the core functions of the WRBWO is water allocation. Under the current law every abstraction must have a water use permit. It is supposed to take 40 days to get a water right processed, but it often takes longer as the board needs to collect information from different stakeholders. The process starts by the water user filling in an application form that asks for specifics about the reason for and amount of water requested to be abstracted. All applications are assigned a water right number and the request is submitted to the Ministry for publication to be registered into the official gazette. This is posted on relevant district notice boards for several days, so any objections can be raised at this time. If there are no problems, then after 40 days, the application can be submitted to the Board. However, the Board does not meet frequently, allowing for wider consultation with the district agriculture and livestock officers to see if the requested abstraction impact on others' water rights. If everything is in order, then the board will approve the rights and the applicant will receive the document within a week. For some schemes, it is necessary to carry out an EIA and obtain an environmental certificate from NEMC. Table 4.2 shows some of the major abstractors in the sub-basin.

It is possible to obtain a provisional water right if works are not yet completed; applicants have a year to complete the infrastructure and will receive the water right once completed. In the new legislation, there will be a time-frame for each water right.

There are a number of problems that were identified with applying for water rights, such as water users being unaware of the requirement to file an application for an abstraction. The application forms are not readily available outside of major urban centres. District offices are encouraged to aid users in applying for water rights but regardless of their help the forms often have incomplete information. The WRBWO intends to address these problems with capacity building activities including training, workshops and awareness campaigns through media and television. For example there has been training in the Kizinga River Catchment where the communities were informed of the laws stressing what activities are against the law. The Board has presented education on water laws and rights through the media and during field trips and site visits.

Each year, the WRBWO formulates an annual work-plan that includes institutional capacity building within and outside the basin or country. They also offer capacity building for communities, although it is relatively *ad hoc* because there are no formal structures for such measures. Once WUAs are in place, it will be easier to conduct structured capacity building activities.

4.4.1 Payment for water rights

Clients of the WRBWO can pay fees for their water rights directly to the office or through a bank account, whereupon they will receive a receipt. Annually, in the month May or June, the WRBWO prepares bills for distribution that are then distributed by July. Water rights are billed whether or not a client is drawing water form their allocated abstraction point.

Many people do not respond to payment requests. Previously people used water as a free commodity, so many are not willing to pay for their water rights. In fact, only 30% of customers pay for their water rights. The WRBWO relies on income from larger users because small users do not pay very often because they see water as a gift from God. The rates are currently very low, as they were last reviewed in 2002. The cost of collecting money is often higher than the amount collected, especially from small users who may only be paying the minimum amount of 35,000 TZS.

The amount to be obtained from small-scale users (i.e. single borehole) is 500–600,000 TZS. There are seven large users which should pay a total of 300 million TZS. If large users are not paying then the Office has a funding problem. For example, DAWASCO is not fully paying for their allocation; instead they pay by extraction and claim that they are not using some of their allocated water sources.

The Basin Water Office is trying to develop a better mechanism for fee collection whereby different agencies could collect fees such as district agencies and WUAs. The WRBWO is attempting to raise its profile through awareness campaigns.

The law does not provide adequate power to ensure people pay for their water rights, and the WRBWO has never prosecuted anyone. If the Basin Office cannot take action, then people are not likely to pay in the future. The WRBWO needs to be able to exert the law to prosecute, but also wants to exercise social means through dialogue and raising awareness.

4.5 Financial issues of Current institutional set up

4.5.1 Funding sources

The main source of funding for the basin, the central government, has been declining over the past ten years, whereby only 3–5% of the Ministry's budget allocation was for water resources management activities. Currently the Water Sector Development Programme, through the MoWI, is the main source of funding for the WRBWO at about 2.5% of 6 billion TZS.

The strategy for meeting the water resource management recurrent costs will be to:

- set water user fees to ensure that they reflect real value of water by using economic parameters such as inflation rate, market values and opportunity costs of water
- set abstraction and discharge charges based on the costs of providing effective water resources management as determined by approved annual operating budgets, taking into account any subsidies from Government
- increase water user fee collection capacity at basin and catchment levels
- allocate revenue from water charges to the organizations responsible for water resources management at different levels in a transparent manner (WSDP 2004).

4.5.2 Income generation

The income generation for the WRBWO has been through the user water charges which contribute only 30–40% of the Basin Office operational costs. However, both the level of recovery of the water charges and the lack of transparency in the retention of funds at the operational level has resulted in inadequate contributions to the recurrent cost of water resource management, both at the MoWLD headquarters and in the field (MoWI 2006).

In the short-term, the Basin Office expects that revenues will increase when all water users are registered, water use is more carefully monitored, tariffs more accurately reflect use-values, and collection rates improve.

In the longer term, willingness–to-pay economic water user fees should also improve as institutions at the basin level (WUAs, Catchment and basin level forums) increase in number and gradually become better informed about the need for astute water allocation and management in the basin (WRBWO 2008).

The Ministry of Water and Irrigation will further carry out studies to look for financing options of the Basin Water Resources Management. This will be key to the Basin's financial autonomy as that is one of the pillars of the sustainability. For example, a recent study by CARE Tanzania in payment for watershed services in Ruvu River suggests that buyers and sellers of watershed services may be identified and arrangements made in order to manage the upstream watersheds (WWF et al. 2007). In addition, the criteria for charging water user fees will be subject to regular review and approved by the Minister responsible for Water (URT 2002).

4.6 District and village level management

4.6.1 District Level

The District organization structure shown in Figure 4.2 indicates the main components of local government. The sector departments that deal directly with water resources development and environmental management are the District Water Engineer and the District Natural Resources. However, according to IWRM, water management is integrated with all sectors. It should be noted that considerable power and responsibilities have been devolved to the district level, but there is insufficient capacity to implement all government programmes.

NAWAPO prescribes that District Councils shall participate fully in Basin Boards and Catchment Committees. The Districts are responsible for planning and development of water resources in accordance with basin plans, protection and conservation of natural resources in the villages and wards, establishment of by-laws on the management of water resources and conflict resolution in accordance with established laws and regulations. In addition the District Councils will make assessment of water demands of their respective districts, and participate fully in the preparation of Basin plans.

Communication between the district and WRBWO has been *ad hoc* and often at a personal level. Recently, staff members from some of the district and municipality offices have received awareness and facilitation training from the basin office. They aim to bring water management knowledge to the districts and form District Facilitation Teams (DFT) with representatives that include employees from all departments and sectors. They use a technique called 'opportunities and obstacles in development' to generate water resources projects. The team goes to villages to promote integrated planning. The WRBWO has completed this training in 9 out of 17 districts.

The districts and municipalities sometimes receive information on water right applications and are asked to provide their recommendations. They might visit a site to determine whether water can be extracted from the proposed area. Some municipalities and districts, such as Temeke, have a checklist for examining various items such as the location of latrines in order to avoid potential conflict with neighbours. A municipality relates its recommendations with the applicant and the WRBWO.

Water rights awareness is higher at the district level than at the community level. For example, the Chauru Irrigation Scheme in Bagamoyo District is owned by the district, and the scheme has processed their own water right. The role of the district water engineer is to discover problems within the district and draw up plans for solving them. Community development officers work with the engineer in villages.

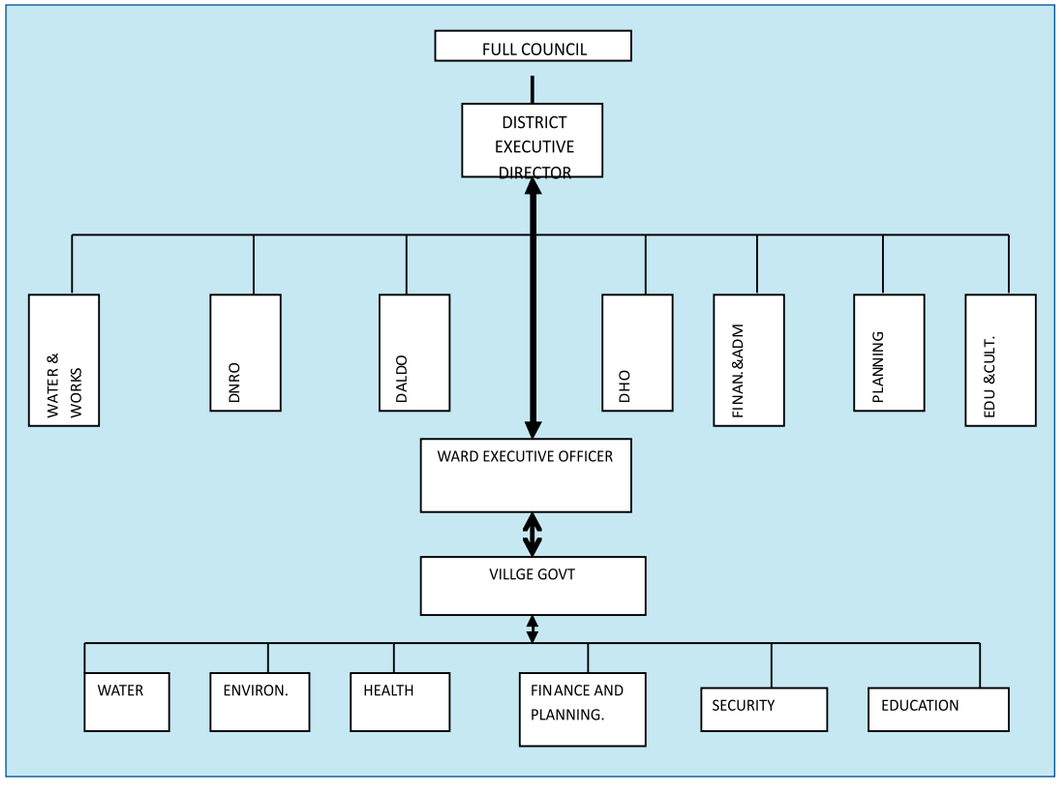

Figure 4.2 Generic Organization structure of the District Council

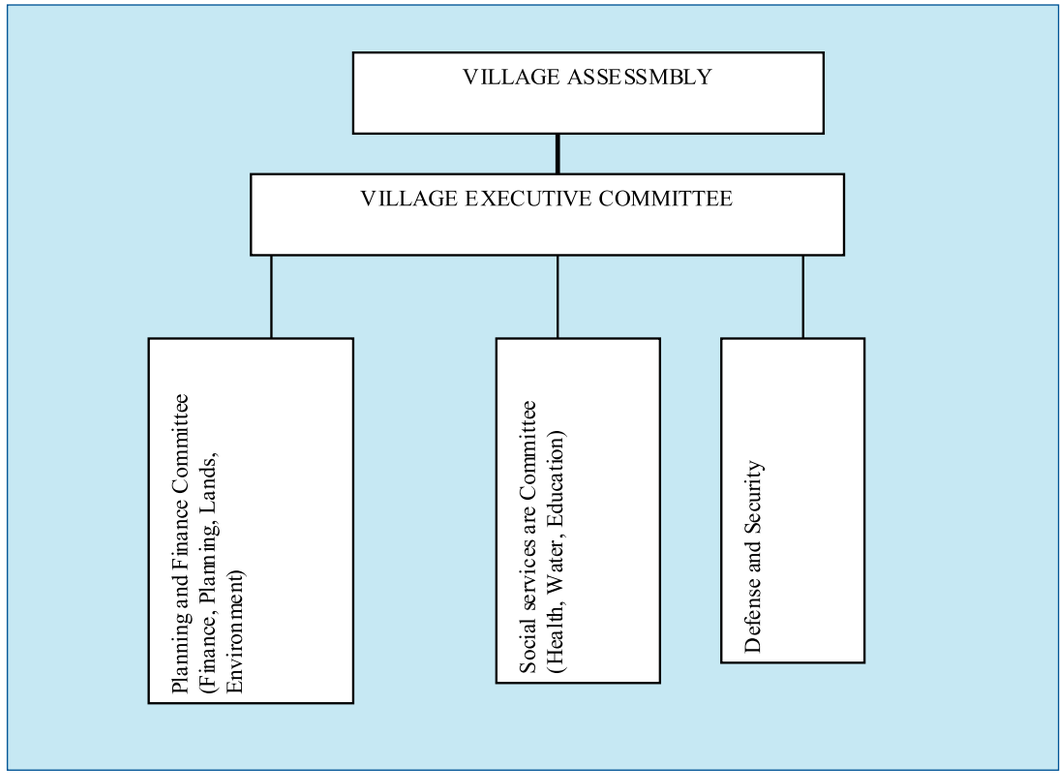

Figure 4.3 Generic Village Government structure

4.6.2 Village level

In general, communities play a major role in the water sector because they are the primary users, guardians and managers of water sources. Participation of both men and women in decision-making, planning, management and implementation of water resources management and development must be enhanced. As future managers of water resources, youth need to be involved and educated for better management and future sustainability.

Section 3.5 mentioned that water committees are often formed at the local level to manage water supply. The members of the water committee are selected by the village assembly and report to the village executive committee (see Figure 4.3). The water committee is responsible to manage the water sources and collect fees to maintain the supply network (pipes, pumps and taps), ensure sustainability and prevent of pollution. There are sometimes water committees for the entire ward and in sub-villages and in some cases, such as in urban areas, there is a water committee for each water source (i.e. borehole, tap). Water committees tend to be present where access to water is limited and supplies are scarce.

Water committees sometimes clash with village government over the division of finances. In most cases the financial and technical support has come from the government or from various donors such as NGOs. In some communities, there are farmers' associations that manage water for irrigation. These tend to be stronger in areas with irrigation infrastructure. They are not always within the village government structure.

4.6.3 Water User Associations

WUAs are in the Water Policy, which was approved in 2002. WUAs or Water User Groups (WUGs) are the lowest level of management within the Tanzanian water management structure. WUAs aim to assist the Basin Water Office in managing water sources in the basin. Such associations are responsible for local level management of allocated water resources, mediation of disputes among users and between groups within their areas of jurisdiction, collection of data and information, participation in the preparation of water utilization plans, conservation and protecting water sources and catchment areas, efficient and effective water use and ensuring return flows, enforcement of the law and implementation of conditions of water rights, and control of pollution. In the future, WUAs will form sub-catchment committees and provide representatives on Basin Boards and Catchment Committees.

WUAs consist of multiple water users from a common source such as irrigation, domestic water supply and livestock owners committees for a single spring organization. The WRBWO encourages the formation of WUAs as umbrella organizations for all water users in an area using one drainage system.

A WUA can apply for water rights for activities such as irrigation or livestock watering, which is intended to make administration easier, because then the Basin Office deals with a WUA alone and not multiple individuals. WUAs are also supposed to collect fees from water users that will ultimately be used to pay for their water right (IUCN Eastern Africa Programme

2003). The process of obtaining water use permits is outlined in section 4.4. In order to have a strong WUA, the WRBWO suggests that each association or group employ a member to allocate schedules and day-to-day activities. This position would be funded from water user fees, operation and maintenance fees.

There are approximately 34 WUGs in the Wami and Ruvu basins; these consist of water user committees that are responsible for domestic water supply, irrigator associations responsible for canals, livestock keepers and fisheries. Currently, there are no formal water user associations that would bring these disparate groups using the same water source under one umbrella association. The WRBWO is planning to use district facilitation teams to travel to different areas to enhance the formation of WUAs in various communities. Establishment of WUAs is critical because they provide the institutional mechanisms to address water needs and conflict resolution at the local and sub-catchment levels.

4.7 Gender aspects in Water Resource Management

Active and effective participation of women and men in rural water supply programs is mandated in the NAWAPO. In rural areas, women bear the burden of searching for water and are informally guardians of the environment. However, this pivotal role has seldom been reflected in institutional arrangements for the development and management of rural water supply and sanitation services. Rural water supply programs are required to improve of women's participation by the following:

(i) fair representation of women in village water user entities will be encouraged
(ii) rural water supply programs shall be based on what both men and women in rural communities know, want, and are able to manage, maintain and pay for.
(iii) raise awareness, train and empower women to actively participate at all levels in water programs, including decision making, planning, supervision and management.

Gender has been mainstreamed according to the water policy, which requires equal male and female representation. For many water supply schemes there are more women than men on the committees. Women are often elected as the chair and are commonly nominated as treasurers. However, the power of the women on the committees varies. For example in Kinole in the Ulugurus very few women attend the meetings because they are uneducated and lack awareness and they do not see the value of attending the meetings if their voices will not be heard.

4.8 Other Policies and Institutions

Water is a basic natural resource and a fundamental input to various socio-economic development activities, such as industrial production, irrigated agriculture, livestock development, mineral processing and hydropower production. Since water resources management and water supply and sanitation are multidisciplinary and multi-sectoral activities, the individual health, environmental, local government reform, rural development, land, settlement and forestry policies provide strategic linkages to the NAWAPO, and supplement the aims and objectives of NAWAPO as envisaged under this programme. Below are water related policies relevant to water resources management (URT 2002).

Health Policy*:* The vision of the Ministry of Health and Social Welfare is to provide health services of high quality that are effective and accessible to all, and delivered by an effective and sustainable national health care system. Health sector policy emphasizes the need for adequate supply of water and basic sanitation in order to minimize water borne diseases and recognize that the health of individuals, families and the community at large is dependent on the availability of a safe water supply, basic sanitation and improved hygiene.

Environmental Policy: Environmental policy objectives for the water sector are geared to ensuring that planning and implementation of initiatives related to water resources are carried out in an integrated manner, and in a way that protects water catchment areas and their vegetation. Environmental policy promotes EIAs and sustainable water management by closely collaborating with NEMC, the Division of the Environment of the Vice President's Office and other agencies. Implementation of the environmental policy gives NEMC the authority to set standards and issue permits for the discharge of effluents into the environment, including into water bodies. The roles and responsibilities of the Basin Water Offices and the NEMC in controlling pollution will need to be reviewed and harmonised under this programme.

Forestry Policy: This policy recognizes that water sources are one of the key pre-requisites for local and international development. The policy stresses that population pressure and inefficient forestry management and protection have contributed to the deterioration of catchment forest areas, causing water shortages. The Forestry Policy in conjunction with the Land and Settlement Policy, (discussed below) needs to address measures for protecting important catchment areas, recharge areas, springs and other key water sources and zoning flood prone areas.

Local Government Policy: The overall objective of the local government policy is to improve service delivery by making local authorities more democratic and autonomous within the framework established by the central government. The policy identifies the provision and facilitation of water and sanitation services as an important responsibility of local government. The policy is intended to create viable entities, develop required local government and central government relations, establish the necessary legal framework and develop the necessary capacities for effective performance by local government organizations. The policy not only confirms the legitimacy of local authorities, but also helps them generate more revenue, reduce costs and operate water facilities more efficiently.

The policy also envisages that the future magnitude of grants to local government will depend on the performance of the authorities, the state of the economy and the financial consequences of reducing the implementation role of ministries through decentralisation and privatisation. Implementation of local government policy will provide an environment that is conducive and complementary environment for the WSDP to operate, although a prime challenge remains for the decision-making leadership and funding.

Rural Development Policy and Strategy (RDPS)**:** The RDPS acts as a platform on which sector ministries' policies are coordinated, harmonised, and integrated, to give the rural development process a holistic view. In the case of the water sector, the RDPS states that:

- the central and local governments will pursue and/or promote an integrated approach to rural water supply and sanitation, productive activities and human consumption
- the central and local governments and other stakeholders will mobilize funds and attract private resources to ensure increased supply of safe water within household proximity

- the central government will create an environment conducive to private sector participation in developing rainwater-harvesting technology that is appropriate for rural areas.

The new implementation arrangements and requirements are in compliance with the overall principles of public sector reform and the Local Government Reform Programme.

Land and Settlement Policy: The National Human Settlement Policy and the National Land Policy are two distinct policies but they both recognize the existence of unplanned settlements in most urban areas. Unplanned settlements in rural areas can lead to significant degradation, soil erosion, pollution of streams, etc.—all impacting downstream and in-stream water users. In turn, these settlements will bring about unplanned water demands that can impact other users who have water user rights through permits. The former calls for the upgrading of those settlements through the provision of basic infrastructure services, such as roads, water supply and sanitation.

Energy Policy*:* Hydropower is emphasized as a viable and less expensive source of energy. More than 60% of electrical power is generated through hydropower plants, and more is available for development. Although hydropower is not a consumptive water user, it requires large storage reservoirs situated in areas with high evaporation losses, safe management of dams and reservoirs, resolution of conflicts with downstream and upstream water users, management of floods and minimisation of negative impacts to the environment.

Agricultural Policy: This policy advocates the use of irrigation to improve food security, increase agricultural productivity and income whilst producing higher value crops. Achieving anticipated agricultural and livestock targets will require a considerable contribution of water as a basic resource for agriculture development. With water resources being available in large lakes, reservoirs and rivers, there is good potential for agricultural development through irrigation, which will draw on these resources and, thus, require effective resource management practices in the future.

4.8.1 The Zonal Irrigation Office

Procedurally, the Zonal Irrigation Office designs irrigation schemes, and is also involved in water management issues, such as irrigation scheduling and promoting proper agronomical practices. The Office facilitates the formation of water user groups, which are sometimes formally registered with the WRBWO. The Office also carries out training on the proper operation and maintenance of schemes. Feasibility studies are carried out to establish new irrigation schemes. The Zonal Irrigation Office has also established guidelines on formulation, design and construction, and operation and maintenance of irrigation schemes.

The Office covers Dar es Salaam, the Coastal and Morogoro Regions. At the district level, there are irrigation technicians who make links with the Zonal Irrigation Office. The types of irrigations schemes include:

- Large scale—Ruvu, Dakawa rice farms
- Traditional—not technically designed schemes, canals, abstraction (larger groups)
- Small holders—improved traditional schemes

4.8.2 The Dams and Drilling Construction Agency (DDCA)

The primary activities of the Dams and Drilling Construction Agency (DDCA) are drilling boreholes and constructing small and medium-size dams in any basin. The DDCA, a publicly owned company, reports to the Permanent Secretary from the Ministry of Water. It collects revenue for its services, although the government provides some subsidies (0.43% of revenue). The DDCA has drilled 2062 boreholes in Dar es Salaam since 2007, where there are 3,500 boreholes, including those drilled by private companies.

DDCA's clients include the central and local governments, NGOs such as Plan International and WaterAid, the private sector and DAWASA. They are involved with the development of the Kimbiji well field, as they carried out a ground water survey for all boreholes, and will be consulted in the drilling process. The DDCA also builds small dams for small-scale irrigation and livestock but generally not for hydropower. However, in other basins they have been involved in larger dams.

DDCA has six zonal offices throughout the country, including the Eastern, Northern, Western, Lake, Central and Southern highlands zones. If the zone offices were not present, then drilling would be more expensive due to the cost of transporting equipment to a site. However, capacity in the zonal offices is inadequate so there are plans to improve this situation.

Apart from reporting to the Permanent Secretary, DDCA interacts with the Water Laboratory Department, which tests water quality of samples provided from new boreholes, which they pass on to customers. In addition, DDCA employs environmental specialists who are involved in surveying new boreholes and they report about and provide advice on environmental impacts. They also carry out or hire consultants to conduct EIAs prior to the construction of dams. Prior to drilling or construction at a new site, a survey is carried out that also involves discussion with the local government.

Under the new water law, the DDCA is supposed to consult the WRBWO when constructing a new borehole or dam basin office in a new arrangement. Currently they have no formal consultation, although information is sometimes shared through informal channels. Furthermore, DDCA currently does not facilitate water rights. Thus customers are not informed about the need to apply for a water permit when building water infrastructure. In the future, WRBWO will provide permits for drilling.

4.9 Data collection and monitoring

In 2006/07 the WRBWO undertook hydro-meteorological network rehabilitation in the sub-basin where 1 meteorological and 15 hydrometric stations were rehabilitated. Table 4.3 displays details of the rehabilitated stations. During two years of operation, data has been collected by WRBWO. Table 4.4 shows the Discharge Measurements in the Ruvu sub-basin and Table 4.5 shows mean discharge measurements by various sources.

Table 4.3 Gauging stations in the Ruvu sub-basin (Norconsult WRA and NIVA 2007)

Station name	Location (UTM coordinates)	Catchment area (sq km)	Region	Distance from nearby town	Status of the station	Soil type	BM description	BM value (masl)	Control
Ruvu at Kibungo 1H5	37M 0368395 9223751	419.69	Morogoro	51 km from Morogoro	Non-operational	Silty clay, rocks on the Left Bank	Standard WD&ID beacon on RB	8.681	Bridge
Ruvu at Mikula 1H10	37M 0402121 9195610	5,870	Coast/Dar	87 km from Ngerengere Centre	Non-operational	Clay	Destroyed, to be re-established	7.255	Outcropping stones
Ruvu at Kidunda 1H3	37M 0416595 9197305	6,777.27	Coast/Dar	71 km from Ngerengere centre	Non-operational	Silty clay	Destroyed, to be re-established		Open channel
Ruvu at Morogoro Road Bridge 1H8A	37M 0466229 9260790	15,190.0	Coast/Dar	60 km from Dar es Salaam	Operational with new gauges	Clay	Bolt in concrete	6.523	Concrete intake structure
Mvuha at Ngagama 1HC2	37M 0371605 9204285	251.3	Morogoro	83 km from Morogoro	Non-operational	RB-silty clay LB- gravel rocks	Bolt in concrete on LB Destroyed, to be re-established	8.519	Open channel
Mvuha at Tulo P/S 1HC2A	37M 0380418 9199811	251.3	Morogoro	10 km from Mvuha centre	Non-existent	Silty clay with slates on LB	Bolt in concrete Destroyed, to be re-established	5.227	Stones across the river
Mgeta at Mgeta 1HB2	7°02' S; 37°34'E	101	Morogoro	40 km from Morogoro	Operational with old gauges	Clay	Concrete block on RB Destroyed, to be re-established	4.645	Open channel

Station name	Location (UTM coordinates)	Catchment area (sq km)	Region	Distance from nearby town	Status of the station	Soil type	BM description	BM value (masl)	Control
Mgeta at Duthumi	37M 0364989 9181000		Morogoro	24 km from Mvuha	Non-operational	Silty clay	Concrete block near the recorder house on LB	-	Open channel
Morogoro at Morogoro 1HA8A	37M 0353215 9243432	191	Morogoro	5km from Morogoro	Non operational	Clay	Concrete block Destroyed, to be re-established	2.134	Weir
Mzinga at Mzinga	06°54'15'S, 37°35'56'E		Morogoro	10km from Morogoro	Non operational	Sand	Destroyed, to be re-established		Open Channel
Ngerengere at Konga 1HA9A	6°54'S; 37°35'E	205	Morogoro	20 km from Morogoro	Non-operational	Sand	Concrete block on RB Destroyed, to be re-established	6.94	Bridge
Ngerengere at Mgude 1HA15	37M 0405484 9252449	2,370	Coast/Dar	3 km from Ngerengere centre	Non-operational	Clay	Destroyed, to be re-established		Open channel
Ngerengere at Utari Bridge 1HA1A (new site)	37M 0425296 9224573	2,840	Coast/Dar	44 km from Ngerengere	Shifted to a new location (u/s bridge)	Clay	Destroyed, to be re-established	5.974	Bridge
Kizinga at Buza 1J5	37M 0526563 9237444		Coast/Dar	20 km from Maji Ubungo	Non operational	Sandy	Bolt in concrete Destroyed, to be re-established	5.217	Flume
Mzinga at Majimatitu 1J6	37M 0527118 9231985	411	Coast/Dar	37 km from Maji Ubungo	Non-operational	Sandy	Destroyed, to be re-established	1.585	Flume

Table 4.4 Discharge Measurements in the Ruvu sub-basin (Norconsult WRA and NIVA 2007)

Date	SOURCE NAME	LOCATION	Q m^3/SEC
17/06/06	Ruvu River	Morogoro/Dar Road	108.720
26/05/06	Ngerengere River	Bwawani	4.050
23/05/06	Mzinga River	Bridge Road Crossing	0.637
23/05/06	Mzinga River	Ruhungo Village	0.669
25/05/06	Kikundi River	Confluence Moro River	0.015
27/05/06	Mbezi River	Mkuyuni W/S Intake	4.880
14/06/06	Morogoro River	Mambogo Bridge R/c intake	2.801
13/06/06	Morogoro River	Mambogo	2.336
14/07/06	Mkindo River	Lukenge Village D/S	7.554
4/05/06	Kinyasungwe River	Mgunga	No data (Dry)
6/05/06	Mkondoa River	Kilosa Bridge	7.259
14/06/06	Kikundi River	Morogoro	0.268
22/02/06	Ilonga River	Ilonga	0.062

Table 4.5 Mean flow measurements by various sources (Norconsult WRA and NIVA 2007)

Station number	River	Location	Mean annual flow (m^3/sec) by various sources		
			CIDA 1979	JICA 1994	WREP 1997
1 H2	Ruvu	Ruvu sisal estate	52.7	74.7	N/A
1 H3	Ruvu	Kidunda	49.5	57.8	N/A
1 H5	Ruvu	Kibungo	18.1	18.45	18.77
1 H8	Ruvu	Morogoro Road	68.8	61.1	61.79
1 H10	Ruvu	Mikula	51.0	50.2	45.94
1 H A1	Ngerengere	Utari Bridge	4.48	N/A	5.04
1 H A1A	Ngerengere	Utari Bridge	6.77	4.33	N/A
1 H A5	Ngerengere	Kiluwa	N/A	3.88	NA
1 H A8	Mgeta	Morogoro	N/A	NA	0.83
1 H A9A	Ngerengere	Konga	N/A	NA	0.98
1 H A15	Ngerengere	Mgera	N/A	4.73	NA
1 H B 1	Mgeta	Kisaki	N/A	6.33	5.79
1 H B 2	Mgeta	Mgeta	4.16	2.46	2.58
1 H C2	Mvuha	Mvuha	N/A	9.00	17.03
1 H C2 A	Mvuha	Tulo	N/A	NA	2.5

The Basin Office is establishing monitoring wells for the entire basin. There are 48 river gauging stations within the basin and only 29 are operational with automatic data loggers. Ten gauges have tendered documents to be rehabilitated, but the procurement process is lengthy. Within the existing network, the Basin Office conducts a monitoring programme that involves technicians gathering data every few months during both the wet and dry seasons. WSDP is planning to establish real-time data collection stations via remote transmission.

The WRBWO is collaborating with the Tanzanian Meteorological Agency for data sharing. WRBWO intends to establish a Water Quality Monitoring Programme in order to address key issues regarding water quality. Before the programme commences, they will conduct a baseline study on Wami and Ruvu River systems and the Coastal Rivers South of Dar es Salaam that drain to the Indian Ocean. A team that comprised of an Environmental Engineer, Hydrologist and Water Laboratory Technician made an inventory to the proposed monitoring areas.

A total of 44 sites in the Ruvu sub-basin were visited and samples were collected (23 for wastewater analysis and 21 for water quality). The Ruvu River sub-basin has 9 stream flow gauges as shown below in Table 4.3. Discharge measurements are displayed in Table 4.4 and mean flow measurements are in Table 4.5.

4.10 Summary of key points

The basin operates with IWRM guidelines, whereby management of water resources is conducted at the basin level and within the bounds of the NAWAPO of 2002. Most water users have been reluctant to pay water user fees. Currently, only the major users such as MORUWASA and DAWASCO pay for water. More effort is required to create awareness among users to fulfill their roles. Industries have been the main offenders on the discharging effluents. Efforts are still continuing with the support of NEMC to promote good water quality for humans and biodiversity.

The major source of funding has been the government whose allocations have decreased over time. Various strategies have been put forward, including conducting a study of how to achieve sustainable self-financing for the basin. The current water tariff will be reviewed regularly and adjusted accordingly. District Councils are better situated to manage water at local levels. Although women are active on many village water committees, they still need to be empowered to effectively participate in decision making. Village Water Use Committees still require capacity building to effectively manage resources and finances. Data collection—particularly monitoring of abstraction—is still weak due to inadequate financial resources within the basin.

5 Opportunities and Constraints in the Ruvu sub-basin including coastal rivers

5.1 Problems and issues within the sub-basin

Based on interviews conducted for the purposes of this Situation Analysis and a stakeholder workshop held in Morogoro 15–16 December 2008, this section of the report compiles information to assemble the perspectives of various stakeholders in the Ruvu sub-basin. The main problems and issues can be broadly be categorized into water resources, socio-economics and conflict, policy and law enforcement, and management and administration. On the basis of these issues, the concluding section lays out a number of priority areas for action.

5.1.1 Water resources

Encroachment of water sources

Protection of water intake areas is crucial to maintaining water sources. Although some intakes have been demarcated, people living within the demarcation zone are not always relocated. For example, DAWASCO demarcated the Kizinga intake area as a first step towards preventing encroachment. This was enforced through co-operating with local communities and the government. Residents understand the need to protect the intake zone, but felt it was unfair that they were required to move from the demarcation area and not necessarily be compensated. People that were moved previously had been compensated for their land; however, the government did not carry out demarcation at the time to protect the area, so people returned to the area. Encroachment activities along the river-banks include agriculture, local fisheries, and alcohol distillation (*gongo*). Farming, especially in the dry season on the flood-plain, results in a severely reduced flow at the DAWASCO intake. In addition, flow is reduced when fishers divert water to aquaculture ponds.

The continued protection of river-banks needs to be addressed. Pastoralists that need access the river to water for their livestock contribute to river-bank erosion. However, they are willing to use and even contribute to the construction of cattle troughs but often they do not exist or are insufficient in number. Farming too close to river-banks and water sources also results in erosion. Environmental committees exist in some communities and help to raise awareness about the protection of water sources, although their power and ability to influence is varied.

Deforestation has multiple impacts on water resources. First, it is believed to impact the level of rainfall in the region. It directly affects the level of water storage in catchment forests. Without adequate forest protection, water run-off increases and flows become more variable. Removal of forest cover for charcoal production and development of agricultural land hastens erosion, which also impacts the flows in rivers due to siltation. Other impacts include a loss of biodiversity and natural forest products to support local communities.

Increasing demand and impacts of water storage

Due to an increasing urban population and economic growth in the basin, the demand for irrigation for fertile agricultural land and fruit and vegetable products has increased, especially in the Ulugurus. Villages with infrastructure, such as roads that facilitate access to markets, are starting to develop irrigation agriculture and are increasing extraction of water from the Ruvu tributaries. The dramatic decline in river flow in the Ruvu has also been partly attributed to this (Schösler and Riddington 2006).

Water is scarce in the sub-Basin during the dry season due to the Mindu Dam, which is owned by MORUWASA. The construction of the dam did not fully consider downstream users and the need for environmental flows. The Kidunda Dam needs to ensure that sufficient water is released to the environment to maintain ecosystems downstream.

Another issue is that the Kindu Dam is likely to flood some of the villages in the area which will be relocated. The villagers are hoping to use the dam for irrigation although it has been designated for water supply to Dar es Salaam. This issue needs clarification by the government so that those directly impacted by the dam have adequate compensation and access to water resources for their livelihoods.

Pollution

Downstream communities in the basin are often affected by upstream pollution. For example, agriculture and mining pollution upstream of the Mindu Dam is a continued problem, as is pollution from washing, bathing, and industrial effluents. Downstream impacts include sedimentation from erosion as a result of deforestation and agricultural practices and contaminated water. This reduces access to safe drinking water and water for livestock and agriculture, and investment must be made in other water resources such as ground water. However, people often use contaminated water as there is no other alternative and, without boiling it, run the risk of water-borne diseases such as cholera. If the water is boiled for safe consumption this puts added pressure on forest as they are exploited for fuel.

The source of pollution is often difficult to determine. Possible polluters tend to blame each other; contamination can come from industry, agriculture, fishers that use poison to catch fish and domestic sewage. Even if monitoring is carried out it does not always allow the WRBWO to pinpoint the source of pollution.

Pollution of the shallow ground water in Dar es Salaam is critical. The sewerage system is inadequate for the city and other forms of waste disposal such as septic tanks and latrines are often inadequately managed, causing contamination of the shallow aquifer. Well fields for deeper aquifers are also often not adequately protected, meaning that encroachment from human activities can result in contamination of the ground water. This type of impact is often irreversible if the recharge rate is low. This is especially a concern for the Kimbiji aquifer because the area lacks ground water zoning around the potential wells. There also needs to be more research in the Kimbiji area to determine potential and sustainable aquifers.

5.1.2 Socio-economics and conflict

The WSDP addresses a priority for many communities, access to water supply for domestic use, but often construction of the water supply networks are delayed due to problems with contractors. For example, Ngerengere has raised the required 5% of the cost for a water

supply scheme and two boreholes have been drilled. However, the village is waiting for the contractor to fix the distribution network, a problem that has existed for two years.

Section 3.8 outlined various types of conflict in the basin, usually conflicts between upstream and downstream users regarding water quality. There are also increasing conflicts between pastoralists and farmers over access to land and water. Finally, there are conflicts over access to water in Dar es Salaam. Due to the lack of infrastructure to supply water, illegal shallow wells have been drilled haphazardly. These are at risk of contamination from latrines and septic tanks. In addition, water supply networks are vulnerable to illegal connections and disconnected water metres.

5.1.3 Policy and law enforcement

Water permits and protection of sources

The WRBWO reports low payment rates for water user fees. It is often difficult to get users to register for water rights, especially if a community has been historically extracting water from the river without previously paying. Water usage without water rights impacts the operation of the Basin Office. Substantial water users such as DAWASCO, however, are not receiving enough money from water fees to cover operations, so they sometimes need funds from the government. The willingness to pay is low because the supply is erratic, therefore a more constant supply may ensure that payments would be more consistent. The Water Resources Management Act, No. 11 of 2009 provides a legal framework for sustainable management and development of water resources, and importantly, enforcement support. The Act outlines principles for water resources management, provides for the prevention and control of water pollution and provides for participation of stakeholders and the general public in implementation of the National Water Policy.

Protection of water resources is often inadequate, not because of the lack of laws and regulation, but due to limited enforcement. This is compounded by a lack of awareness on the need to protect water sources within communities. Furthermore, there is inadequate monitoring of surface water abstractions, pollution and the location of boreholes. Illegal drilling of boreholes and the over-pumping of ground water are main concerns, especially along the coast where these activities have resulted in saline intrusion and subsidence.

Water quality

The law does not provide adequate power to ensure that people pay for their water rights and therefore the WRBWO reported that no organizations have been prosecuted for infringements. If results are above acceptable standards then the WRBWO writes to the offending organization to explain their breach. They are then given some time to amend the situation before follow-up checks are carried out. If the Basin Office cannot take action, then people will not pay in the future. The Office needs to be able to use the law to prosecute although they employ social means such as dialogue and awareness raising to prevent breaches.

The management of effluents is often inadequate. Treatment ponds such as the TLAI ponds in Morogoro are insufficient because of a lack of clear guidance and definition of responsibilities for the industries and municipality to manage the ponds. There is sometimes a problem of access to monitor industries due to a lack of knowledge of the role of the office in monitoring the industries for compliance. Compliance monitoring needs to be done at short notice to ensure regulations are being followed. Yet some companies want the Basin Office to make appointments to monitor the effluent. Also, there is a little awareness of the impacts of the discharges to downstream users. Dialogue between downstream and upstream is limited, except in cases where there is sustained conflict.

5.1.4 Management and administration

Weak stakeholder linkages

The WRBWO is not well known and its role is not clear to all stakeholders. Those who are aware of the basin want to see tangible outputs from the office beyond issuing permits and collecting water fees. This includes protecting water resources, providing technical support, disseminating data and building capacity.

Stakeholder involvement in the management of water resources in the sub-basin is weak and would benefit from a stakeholder forum to discuss common issues impacting their activities as well as promote the sharing of information between institutions. Such a dialogue could diffuse potential conflicts and mistrust among stakeholders. However, currently the linkages between the Water Basin Office and Local Government Authority are not strong throughout the basin. Local government (district, wards, and communities) provides a conduit to reach water users and are essential in the formation of catchment forums and water user associations.

Information gathering and coordination

Making decisions about the amount of water to be abstracted requires up-to-date information on the status of the resources. WRBWO currently has 48 river gauging stations within the basin and only 29 are operational with automatic data loggers. However, some of these have not been operational for a long time. Ten gauges have tendered documents to be rehabilitated but the procurement process is lengthy.

Collaboration between institutions is often weak. Communication among departments at district, regional and national level is often limited. Not only is communication between sectors inadequate but also between levels of bureaucracy; consequently, decisions that are made at the national level are not always useful to communities. The lack of harmonization among policies at the national level results in poor multi-sectoral coordination. For example, the demarcation zone around water bodies varies between ministries and creates confusion when trying to relocate people. This communication deficit also applies to broader issues such as the impacts of climate change on water resources. Further, there is little, if any, active collaboration with academic institutions. Students who approach them for information but DDCA does not necessarily respond to their research needs. The same issue needs to be addressed with the WRBWO.

Weak capacity

A challenge faced by many of the institutions in the Ruvu sub-basin is a lack of capacity. For example, the Regional Catchment Office, which protects the catchment forests, does not have enough staff or vehicles to patrol the catchment area. Plus people do not understand the need for forest conservation and simply take timber to supplement their incomes.

Villagers generally lack awareness about water permits and the role of the Basin Office in issuing the permits. Furthermore, the WRBWO is still building its capacity to monitor

compliance with water abstraction rates. Similarly the office does not have the capacity to monitor regularly effluent levels, thereby creating conflicts with downstream users.

5.2 Priority areas for Action

WRBWO is still a developing basin office with limited financial and human resources so it is critical that they choose priorities wisely in order for the limited investment to bear fruit for further development and for the office to ensure that there is a reliable sustainable water resource in the basin.

a) WRBWO has already developed a business plan derived from a SWOT analysis (strength, weakness, opportunity threat).that highlights the following areas of focus: basin level water resources management
b) preparation of integrated river basin management and development plans
c) development of priority WRM infrastructure and studies at the basin level

The WRBWO has suggested that future investment in the basin include:

- water user association formulation and capacity building essential to managing the water resources
- sufficient equipment for the collection of data so that the office can manage allocations of water resources
- secure water sources for most of the district towns in the basin to ensure water supply
- awareness raising on the existence and function of the office and the value of water
- a borehole inventory in Dar es Salaam
- autonomy of the basin that includes a reliable source of funding to run all activities
- investment to construct more storage facilities (reservoirs, ground water storage)
- human resource development

This situation analysis and workshop determined a number of priority areas, which are described in detail in the sections below.

5.2.1 Strengthened stakeholder capacity and participation

Identification of stakeholders

The WRBWO needs to understand its stakeholders—from industrial to irrigation to domestic users—perhaps through stakeholder mapping or analysis. This could be coupled with improving communication between the basin office and key stakeholders such as the districts.

The WRBWO must market itself to communicate its role to water users and they should define roles and responsibilities for their stakeholders and identify areas for delegation. For example, information on water permits applications can be provided at the district level rather than just at the basin office.

Strengthening capacity of stakeholders

There should be more communication and knowledge sharing between WRBWO and the districts, which in turn can be conveyed to communities. For example, an inventory of specific awareness creation on the district level could be created. District Facilitation Teams have been established that are intended to implement integrated water resource management. These teams have been trained in various aspects of water management as well as water permits, water law and financial management in order to provide support in the creation or strengthening of stakeholder forums and WUAs.

The basin office could distribute data and information on sources and monitoring of source capacity. For example, there is reduced flow at Sagara spring in Kongwa and the district cannot get to the bottom of the problem. Technical expertise from the Basin Water Office is needed to solve this complication because the technical capacity is not available at the district level.

Coordination and collaboration among stakeholders

IWRM calls for stakeholder participation in the management of water resources through catchment forums, as defined in the water policy, but they need to be put into practice, possibly with input from the district offices. Catchment stakeholder forums can assist in delegation of basin office roles, sharing of information and conflict resolution.

Through stakeholder platforms, districts can assist in the formation of WUAs. The survey showed that there are several water committees in the Ruvu sub-basin and such potential groups could be facilitated to form WUAs.

The same platform can contribute towards conflict resolution using District Councils that have mandates over natural resource use in their districts. In the same vein, the stakeholders will also facilitate marketing and awareness raising in the districts and elsewhere on the WRBO and its roles and responsibilities. It should be noted that delegating responsibilities to the districts to create WUA and catchment forums requires financial and human capacity investment. .

There also needs to be more inter-sectoral co-ordination in areas such as managing pollution within the basin. The Basin Office has a large number of potential partners, including District Councils, Zonal Irrigation offices, Irrigators, Water Supply Agents, NGOs and private investors that can be coordinated to implement these actions. Some of these partners are willing to work with the Basin office in areas such as awareness creation on water permits and processing the applications at the district level. Therefore the basin should delegate some of its responsibilities to lower levels.

Finally, industries should be sensitized on the impacts of their effluents to downstream users. The Basin can work with industries to find solutions and minimize impacts by convening regular meetings to discuss and plan the implementation of restorative measures.

5.2.2 Reliable information to support planning & management

Understanding of current and future water resources

The data collected by the WRBWO and partners provide information on the available water resources in the Basin. Thus it needs to be stored and processed for use in decision-making. There needs to be investment in the Basin Office's capacity for not only data collection, but also data management, including computer hardware and software and staff training for data entering and analysis.

Specifically, there is a need for a database describing water resources—particularly on ground water resources in semi-arid areas. There should also be an inventory of private ground water drillers in Dar es Salaam and where they are drilling. Information on the location of wells and guidelines for drilling can be a step forward in controlling *ad hoc* well development in the city.

Information on water users and uses

The WRBO must ensure adequate instrumentation for both surface and ground water resources in the basin. Abstraction rates and water quality must be measured regularly, for surface and ground water resources, particularly in the Dar es Salaam area. A specific concern is the need for regular monitoring of effluent discharges to rivers that affect ecosystem health and downstream users.

WRBWO needs to enhance co-operation and sharing of the collection and monitoring of ecosystems data on hydrology. For example, there are indicators of water flow and quality for monitoring that arisen from studies carried out by CARE. A systematic arrangement between the office and such initiatives would enrich the office database. In addition, some Districts Councils are undertaking various projects that will add value to water resources management in the basin. Another example is DDCA, which is a strategic partner since it deals with most clients requiring drilling services. They could provide WRBWO with information on the water infrastructure being developed such as boreholes and inform their clients on the need to obtain a water right. Regular sharing of this information is critical.

5.2.3 Resources efficiently planned and managed

Effective planning

IWRM planning is essential at all levels from the basin to sub-catchment to streams. They need to understand how multiple users will access, use and manage the resource. This could mean designing structures for different users, such as livestock keepers and farmers, promoting conservation farming and exchanging information on how to resolve conflicts. Obstacles to implementing such plans in place requires that opportunities first be defined and studied. . Simple but effective monitoring and evaluation plans that can detect changes—including quantity and quality and allow for adaptive management of water resources—could be implemented.

IWRM should also take into account other sectoral plans especially land use planning which also includes multiple stakeholders.

Improving water use efficiency

Improving water use efficiency can include a range of activities such as improving existing infrastructure by, for example, lining irrigation canals to reducing leakage. Other possibilities include creating awareness on efficient technologies and conservation strategies such as harvesting rainwater. Larger-scale solutions can also be explored, including the introduction of water storage facilities and modifications to existing resources to minimize water losses in irrigation and domestic use.

Conserving water quality

Protection of the forests is vital for water management and can only be achieved through adequate monitoring and patrolling. This means a greater level of capacity in the Catchment Forest Project, as well as building fire lines and having access to fire fighting services. Other priorities include village tree planting, income generating activities (such as beekeeping, aquaculture and livestock keeping) and awareness raising. Environmental conservation should also include monitoring environmental flows and pollution levels from effluents from industries. WRBO must participate and invest such initiatives with other lead partners such as CARE, Eastern Arc Mountains Conservation Endowment Fund and the Regional Catchment Project so that village environmental committees can play a more substantial role in forest protection.

In the case of ground water, improved protection of well fields can be achieved by demarcating and zoning the sub-catchment so that polluting activities are limited. There is also a need to protect future potential water sources from pollution, such as the Hombolo sub-catchment and the Bubu River. This will save the cost of relocating people in the future

5.2.4 Strengthened regulation and compliance

Harmonizing laws

There are cases of conflicting legislation, such as is the case of the distance allowed to build a structure from water source, so there is a need for harmonization and enforcement of all laws that improve catchment protection. At the same time, there needs to be awareness on what laws apply where and how.

Strengthening interagency cooperation and enforcement

Existing laws are not fully effective to control polluters and illegal abstraction. Stronger legislation is being drafted but support for implementation is crucial. The continual inadequate monitoring of polluters means that is difficult to enforce regulations and that the WRBWO in not widely acknowledges as a legitimate entity to manage water. Collaboration with other government agencies such as NEMC can improve monitoring and enforcement of regulations.

The WRBWO requires resources to monitor compliance on the quantity of approved abstractions and to comprehend the available water resources in the basin. This is essential for determining future allocations. WRBWO also needs to collaborate with other institutions to monitor effluent quality from industries in order to safeguard downstream users

5.2.5 Ensuring sustainable financing

WRBWO has reported that revenues collected from water permits provide 40% of the finances needed for operation, therefore 60% of funding comes from the government. The basin office should undertake research on the current water tariff and its rationale. Furthermore, it may wish to consult with SADC and neighboring countries on how financial sustainability can be achieved.

Another financial issue to consider is that some stakeholders have expressed an interest in water permits that indicate seasonal abstraction amounts rather than a constant value. This reflects the seasonality of flows in the river and ensures that there is sufficient water for the environment during rainy and dry seasons. Such variations in abstraction could be charged accordingly but would require more vigilant monitoring.

5.3 Opportunities to implement priority action areas

Comprehensive water resources management that maintains a healthy ecosystem with biodiversity in the basin is critical to all basin stakeholders, including those in Dar es Salaam and Morogoro Municipalities irrigation schemes and industries.

It is against this background that the government is committed, through its long-term programme (WSDP), to see that the above is achieved. Other strategies that have been undertaken by the WRBWO are the development of the Business Plan and a Situation Analysis that will provide focused areas for action and hence a marketable output.

Available supporting partners may include but is not limited to IUCN, JICA, and SNV. Future joint ventures should be explored with district councils, water supply agents, major irrigators, NGOs and future partners.

Annex 3 provides some possibilities and examples of how the priority areas of action could be potentially implemented.

6 Conclusions

6.1 Recommendations and way forward

The stakeholder workshop employed the outputs of the situation analysis and priority areas identified in order to synthesize the discussions into a Logical Framework, which is shown in Figure 6.1. The Goal of the sub-basin is that they sustainably manage water resources for the socio-economic and environmental needs, interests, and priorities of the sub-basin population.

Five main results areas were identified:

1. Strengthened stakeholder capacity & participation
2. Reliable information to support planning & management
3. Resources efficiently planned and managed
4. Strengthened regulation and compliance
5. Sustainable financing ensured

A logical frameworks for the two sub-basins combined was also developed so as to provide focus to the WRBWO. (Figure 6.2).

Using this logical framework the WRBWO can put together a plan of action. The aim is to efficiently use available resources to invest in successful projects that will achieve the Water Sector Development Programme.

6.2 Gaps in information

There is inadequate information about the impact of climate change on the basin resources. This is an area that is important for a better understanding of future scenarios on water resources. It is also noted that no studies of environmental flows have been undertaken in the basin. This is important to safeguard the biodiversity in the river ecosystem. The data on actual abstraction is missing although users have general water permits that are not necessarily observed. Similarly, regular water quality profiles are not available for many portions of river. There is no recent data on fishing in the river; only old information was available. Lack of cooperation from industries hinders data acquisition on effluents discharged, which limits effective planning.

Figure 6.1 Logical Framework for the Ruvu River Sub-Basin

Logical Framework for the Ruvu River Sub-Basin

Goal: Sub- Basin water resources sustainably managed for the socio-economic and environmental needs, interests, and priorities of the sub-basin population.

Result 1: Strengthened stakeholder capacity & participation

Sub-result 1.1: Stakeholders Identified

Activities: Conduct stakeholder mapping; Stakeholder data base and communications network

Sub-result 1.2: Stakeholders' Capacity Strengthened

Activities: Conduct capacity needs assessment; develop targeted capacity building program; Convene trainings for WUAs on NAWAPO and IWRM, organizational development, financial management; Create awareness about water rights & responsibilities

Sub-result 1.3: Stakeholders Coordination and Collaboration

Activities: Support the formation of WUAs; Support the formation of sub-catchment forums

Result 2: Reliable information to support planning & management

Sub-result 2.1: Current and Future Water Resources Understood

Activities: Water resources assessment; Environmental Flow Assessment; Network rehabilitated and maintained; climate risk and vulnerability studies; Water quality and pollution studies; Studies on the economic valuation of water under different uses

Sub-result 2.2: Water Use, Users and Demands Known

Activities: Water audit, including survey of water users, use and needs

Sub-result 2.3: Improved Technologies

Activities: Trials on appropriate technologies for improving efficiency in all sectors; GIS

Result 3: Resources efficiently planned and managed

Sub-result 3.1: Effective Planning

Activities: Basin level IWRM planning; IWRM planning at sub-catchment and lower levels; O&OD process; Implement plans, M&E plans

Sub-result 3.2: Water use efficiency Improved

Activities: Introduce storage and modifications to minimize water losses in domestic and irrigation use; Awareness creation on efficient technologies and conservation strategies; Rainwater harvesting

Sub-result 3.3: Water Quality Conserved

Activities: Protection of sensitive areas; Pollution control; Collaboration with environmental committees; implement EFA;awareness creation

Result 4: Strengthened regulation and compliance

Sub-result 4.1: Laws Harmonized

Activities: Identify conflicting legislations; Seek technical advice, stakeholder input; negotiations and awareness raising

Sub-result 4.2: Strengthened Interagency Cooperation and Enforcement

Activities: Awareness raising on water policy and legislation (translation into popular formats; meetings; focal visits, study tours, develop program for primary school education); Strengthen roles of district councils; Develop relevant by-laws; Develop incentives for compliance; Strengthen enforcement systems; Develop allocation guidelines; Monitoring

Result 5: Sustainable financing ensured

Sub-result 5.1: Resources Mobilized Internally

Activities: Review and revise pricing; explore for additional sources to expand revenue base; implement systems for payment compliance; Develop business plan for financial autonomy; Awareness creation on payment

Sub-result 5.2: Resources Mobilized Externally

Activities: Donor analysis and courtesy visits; Proposal development; Marketing of proposals

Figure 6.2. WSDP Framework for the Wami-Ruvu Basin

WSDP Framework for the Wami-Ruvu River Basin

Example Goal: Healthy Wami and Ruvu River Basins that supply water of adequate quality and quantity to the people and environment of the Basins

Result 1: Strengthened stakeholder capacity & participation

Sub-result 1.1: Stakeholders Identified

Activities: Conduct stakeholder analysis; Convene workshops that bring stakeholders together; stakeholder data base

Sub-result 1.2: Stakeholders' Capacity Strengthened

Activities: Conduct capacity needs assessment; develop targeted capacity building program for specific stakeholder groups; Convene trainings for WUAs on NAWAPO and IWRM, organizational development, financial management, monitoring; Create awareness about water rights & responsibilities; Ensure beneficiaries of capacity building participate in IWRM; Targeted conflict resolution activities

Sub-result 1.3: Coordination & Collaboration

Activities: Support the formation of WUAs; Support the formation of sub-catchment forums

Result 2: Reliable information to support planning & management

Sub-result 2.1: Current and Future Water Resources Understood

Activities: Water resources assessment; Network rehabilitated and maintained; Water & climate risk and vulnerability studies; Water quality and pollution studies; Studies on the economic valuation of water under different uses; Environmental Flow Assessment; information management and exchange strengthened; Monitoring

Sub-result 2.2: Water Use, Users and Demands Known

Activities: Water audit, including survey of water users, use and needs

Sub-result 2.3: Improved Technologies

Activities: Studies and trials on appropriate technologies for improving efficiency in all sectors; GIS systems

Result 3: Resources efficiently planned and managed

Sub-result 3.1: Effective Planning

Activities: Basin level IWRM planning; IWRM planning at sub-catchment and lower levels; O&OD surveys; Implement plans

Sub-result 3.2: Efficiency Improved

Activities: Large and small modifications to minimize water losses in domestic and irrigation use; Awareness creation on efficient technologies, rainwater harvesting, pollution and conservation strategies

Sub-result 3.3: Sources & Catchment Conserved

Activities: Protection of sensitive areas; soil and water conservation; Pollution control; Collaboration with environmental committees; implement EFA;awareness creation

Result 4: Strengthened regulation and compliance

Sub-result 4.1: Policy Documents Harmonized

Activities: Mapping regulations; identify policy conflicts; technical advice, stakeholder input; negotiations and awareness raising

Sub-result 4.2: Strengthened Interagency Cooperation and Enforcement

Activities: Stakeholder analysis; Awareness raising on water policy and legislation (translation into popular formats; meetings; focal visits, study tours, develop program for primary school education); Develop relevant by-laws; Strengthen links to district councils; Develop incentives for compliance; Strengthen enforcement systems; Develop allocation guidelines; Monitoring

Result 5: Sustainable financing ensured

Sub-result 5.1: Resources Mobilized Internally

Activities: Review and revise pricing; explore for additional sources to expand revenue base; implement systems for payment compliance; Develop business plan for financial autonomy; Awareness creation

Sub-result 5.2: Resources Mobilized Externally

Activities: Donor analysis and courtesy visits; Proposal development; Marketing of proposals

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Annex 1

List of institutions and interviewees in the Ruvu sub-basin

CARE International
Cypriano Kassase, Project manager—UMEMCP

Mvomero District Council
J.M.A. Kizuguto, District Agricultural and Livestock Development Officer

Regional Catchment Forest Office, Morogoro
Togolai Tindikali, Acting Regional Manager

Zonal Irrigation Office, Morogoro
Iman Nzobo, Acting Zonal Irrigation Engineer

Sokoine University of Agriculture (SUA)
Dr Ibrahim Chikira Mjemah, Head Department of Physical Sciences

Tanzania Breweries Limited (TBL)
Salvatory Rweyemamu, Plant Manager

DAWASCO, Mtoni
Enoch Mgonja, Maintenance Officer

Karibu Textile Mills
Jovit Blazi, Production Supervisor

Drilling and Dam Construction Agency (DDCA), Dar es Salaam
Mrs Naomi N. Lupimo, Technical Support Manager

Temeke Municipality
Stephen Kongwa, Acting Municipal Director
Damas Primy, Municipal Water Engineer
P.T. Kagimbo, Head Urban Development, Natural Resources and Environment

Kisarawe District Council
Amiri S. Gwakiraiji, District Executive Director
Omari Mazola, Proposed Head Land, Water, Works and Natural Resources

Bagamoyo District Council
J M Maarufu, Acting District Executive Director

World Vision, Ngerengere
Adam Mwakitalima, Assistant Accountant

Ngerengere Village Council
Rukia Ali Kihimba, Village Executive Officer

Kinole Village Council
Elizabeth Mwangobole, Ward Executive Officer
Said Nganganeanga, Ward Education Coordinator
Richard Mvera Adam, Ward Agricultural Officer

Mvuha Village Council
Shomari Mohamed Lufuli, Village Executive Officer
Hamis Issa, Village Security Officer

Pastoralists, Mvuha Village
Robert Mrefu Omabi Oremref, Secretary Sangasanga sub-village
Tobiko Nyasi (Mrisho Mainge)
Kaipai Sogoyeti

Morogoro Urban Water Supply and Sewerage Authority (MORUWASA)
J.K. Mtaita, Managing Director

Mzumbe University
Prof Faustin Kamuzora, Deputy Vice Chancellor
David Mwagosi, Health Officer

21st Century Textile Mills, Morogoro
Clement Munisi, Production Manager

East Hides, Morogoro
Nelson Chandia, Administrative Officer

Kimango Farm, Morogoro
Martin H Salu, Agricultural Officer

Kidunda Village
1. Abed Halfan Mnyanga, Village Chairman
2. Ramakdhani Hussein Mnemvu, Village Executive Officer
3. Saleh Yousef Janga, Chairman of Kidunda sub-village

DAWASCO
Alex J. Kaaya,
Chief Executive Officer

Sekab BioEnergy Ltd
Anders Bergfors,Managing Director

JICA
RUWASA-CAD
Mikiko Azuma, Community Water Supply Facility Planning/Operation and Maintenance

GTZ Tanzania
Ernst Doering, Head of Programme Support, Water Sector Development
Tony Richards, Consultant

Water Resources Division of MoWI
Lister P K Kongola—Assistant Director Water Resources Division

Annex 2

Questions for Stakeholders

1. Do you know about the Wami /Ruvu Basin Water Office (WRBWO)?
2. What are your linkages to the WRBWO?
3. What are your activities in the Wami/Ruvu Basin?
4. What activities are you undertaking that are related to water resource management?
5. Have you been involved with water user groups or associations/ environmental committees ? How?
6. How do pastoralist, irrigation, and/or agricultural activities impact on water resources ?
7. Do you know about water rights? Do people in your project/district pay for water rights?
8. How do you fund your activities?
9. Are there problems with water quality? What are you doing to mitigate this?
10. What strategies do you undertake to ensure gender equality?
11. Are there any conflicts over water or other natural resources? How are they resolved ?
12. Who are your partners? What is your relationship with the government?
13. What should be the priority areas of investment in your area in the future?
14. Do you share your information with WRBO ?
15. Whom do you think is the critical stakeholder in the basin ?

Annex 3

Implementation of priority action areas

Below are tables that were constructed during the stakeholder workshop which outline how the priority action areas could potentially be implemented.

Result 1: Strengthened stakeholder capacity and participation

Activity	Who is responsible?	Partners – who is involved?	Resources - human - material - financial
Stakeholders identified			
Conduct stakeholder mapping and forum	WRBWO	Districts, NGOS, government agencies, private sector	Staff time, travel, funds
Facilitate meeting on conflict resolution	WRBWO	Districts, NGOs, politicians, influential local leaders	Funds, staff, transport, technical support
Capacity of stakeholders strengthened			
Assess training needs	WRBWO	MoWI, Consultant, NGO	Funds, staff
Create awareness on policy and laws to stakeholders	WRBWO	LGA, MoWI, MoL, MNR, VPO-Environment, NEMC	Funds, staff
Create awareness on efficient use of basin resources	WRBWO	NGO, District, MoL, MNR, MoWI	Funds, staff
Facilitate study visit to stakeholders	WRBWO	LGA, MoWI, NGO	Funds, staff
Coordination and collaboration among stakeholders			
Establish stakeholders database	WRBWO	Consultant, NGO, MoWI, Industries, Communities, Districts, LGAs	Funds, staff
Establish water user associations	WRBWO	MoWI, NGOs, MoWI, Communities, Industries	Funds, staff
Design water projects	WRBWO	MoWI, Consultant	Funds, staff
Establish communication network	WRBWO		Funds, staff

Result 2: Reliable information to support planning and management

Activity	Responsible authority	Partners	Resources - human - material financial
Information on current and future water demand and use			
Conduct survey on water being used and needed in different sectors	WRBWO	Agriculture, livestock, industry, environment	Staff, transport, TZS
Assess environmental flows	WRBWO	Experts from universities, research institutions Districts and communities Private sector Industries Development partners	Staff, training materials, TZS
Assess system efficiency i.e. irrigation system looking for unaccounted water	Zonal irrigation Water authorities	Water users, WRBWO	Staff, transport, equipments (water meter, flow meter)
Information on current and future water resources			
Survey known sources/ mapping of water sources i.e. boreholes	WRBWO	- Water authorities - DDCA - Zonal irrigation - Districts - Research institutions i.e. University of Dar es Salaam, Institute of Resource Assessment	Staff, transport, equipment (GPS)
Study modeling t predict potential of future resources	WRBWO	Research institutions	Experts, staff, modeling software, TZS, equipments
Collaborate with research institutions and universities	- WRBWO - Institutions - MOWI	- NGOs - Communities, Community Based Organizations	Staff, transport, meeting materials
Establish functioning monitoring network Procure data storage and collection equipment	- WRBWO - Water Authority	- MOWI - Communities (know why there is gauging station) - Districts	TZS, staff, equipments and infrastructure

Activity	Responsible authority	Partners	Resources - human - material financial
Identify parameters that need to be measured (chemicals, geological information)	WRBWO	- Laboratories - MOWI	TZS, staff
Train on data collection	WRBWO	- Local communities - WRBWO	TZS, transport, training material
Establish functional database on water use, demand (sources, pollution) Analyse data to glean specific information	WRBWO	- Research institutions - Experts	Consultants, TZS, training material, equipments
Create mechanism to access data i.e. website, model subcatchment, chemical, geological surveys	WRBWO	MOWI	Consultant, Staff, TZS
Improved technologies			
Conduct workshop to learn about new technologies i.e. GIS, drip irrigation and train stakeholders how to use technologies	- WRBWO - MOWI	Universities and research institutions	Consultants, training materials, equipments, TZS
Model sites/demonstration sites	(Depends on sector irrigation – zonal irrigation office Industry – Ministry of Industry and Trade) - MOWI - WRBWO	- District communities - Research institutions	Consultants, equipments, TZS
Recruit of skilled staff	- WRBWO (write ToR) - MOWI (employer)	- WRBWO, MOWI	TZS – not too much
Learn from other places/ organization (e.g. study tours, site visits, use of different sources) Study economic valuation of water (sustainable financing)	WRBWO	Other basins and ministries - Research institutions - NGOs and CBOs - Different sector (agriculture, industry, domestic)	TZS, Transport

Result 3: Resources efficiently planned and managed

Activity	Responsible authority	Partners	Resources - human - material - financial
Sub-result: Effective land use and water resources planning			
Develop IWRM plans at basin and catchment levels - water resources assessment - conduct water demand survey - engage in participatory planning	WRBWO	LGS,, NGOs, Water utilities, Development partners (DPs)	Human Financial
Implement village level land planning and integrate it with IWRM plans	Local leaders and WRBWO	LGAs	Human Financial
Conservation of water resources (quality)			
Provide storage facilities (e.g. dams)	Central government	WRBWO, DPs, Water utilities, LGAs and NGOs	-financial -human -construction materials
Harvest rainwater	MoWI schools and interested parties	WRBWO, NGOs, women organizations	-financial -human -construction materials
Improve irrigation efficiency	Zonal irrigation unit	LGAs, WRBWO	Financial Human
Enforce compliance of water rights	WRBWO	Water users	Financial
Raise awareness	WRBWO	LGAs, NGOs, DPs Water utilities	Financial
Conservation of water resources (quality)			
Provide structures for livestock (cattle troughs)	Ministry of Livestock Development and Fisheries	LGAs, NGOs, DPs, WRBWO	Financial Human
Assess and survey pollution and establish mechanism for collaboration on pollution enforcement	WRBWO	NEMC, LGAs, NGOs	Financial Human
Enforce compliance	WRBWO	NEMC, LGAs	Financial Human
Raise awareness	WRBWO	LGAs, NGOs, DPs, Water utilities	Financial Human
Adaptation to change			
Research climate change and risk analysis	WRBWO	VP Office Tanzania Meteorology Association Research institutions	
Integrate climate risk into planning process			
Awareness raising			

Result 4: Strengthened regulation and compliance

Sub-results: Harmonize laws;
Enforcement of laws and regulations for surface and ground water;
Ensure fair and transparent allocation

Activities under Harmonize laws (A)	Activities under Enforcement of laws and regulations for surface and ground water (B)	Activities under Ensure fair and transparent allocation (C)
Identify different conflicting laws Organise stakeholders workshop to discuss and harmonize laws Awareness creation to stakeholders on harmonized laws	Sensitization of laws and regulations for surface and ground water District Councils to liaise with WRBWO to enforce laws WRBWO to learn best practices from others	Democratically formed allocation committees To prepare bylaws to be enforced by the committee To prepare allocation regulations

Result Activity	Who is responsible	Partners (who is involved)	Resources • Human • Materials • Finances
A : Harmonize laws	WRBWO	District Councils; stakeholders, relevant sectoral ministries	Human Financial
B: Enforce laws	WRBWO	District councils	Human Financial
C: Ensure fair allocation	WRBWO	District Councils, Village Councils Stakeholders	Human Financial

Ensure Sustainable Financing

Sub-result 5.1: Mobilization of external financial resources
Sub-result 5.2: Mobilization of internal financial resources

Activity	Responsible authority	Partners	Resources - human - material - financial
To identify financing institution	WRBWO	Ministry of Water and Irrigation, Local government authorities, NGOs	Human Material Financial
To prepare project proposals	WRBWO	Ministry of Water and Irrigation, Local government authorities, NGOs	Human Material Financial
To enact by-laws concerning collection of water fees and enforce them	WRBWO District council	NGOs and Water user associations	Human Material Financial
To increase customer base by sensitizing them to apply for water rights	WRBWO	Local government authorities, NGOs and users	Human Material Financial
To prepare finance mobilization strategy to be used by basin offices	WRBWO	Private sector	Human Material Financial
To create community awareness	WRBWO	Local government authorities, NGOs and users	Human Material Financial

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IUCN is the world's oldest and largest global environmental organization, with more than 1,000 government and NGO members and almost 11,000 volunteer experts in some 160 countries. IUCN's work is supported by over 1,000 staff in 60 offices and hundreds of partners in public, NGO and private sectors around the world.

IUCN Water and Nature Initiative

The IUCN Water and Nature Initiative is an action programme to demonstrate that ecosystem- based management and stakeholder participation will help to solve the water dilemma of today – bringing rivers back to life and maintaining the resource base for many.

Wami/Ruvu Basin Water Office

The Wami/Ruvu Basin Water Office (WRBWO) and Wami/Ruvu Basin Water Board (WRBWB) were established in July 2002, with the vision of to ensure that basin water resources are sustainably managed for the socio-economic and environmental needs, interests and priorities of the basin population.

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