Editor: Gerd Förch

CICD Series Vol.4: Results from Expert Seminar - Topics of Integrated Water Ressources Management

2010

CICD Series

Editor

Prof. Dr.-Ing. Gerd Förch,
Universität Siegen,
Centre for International Capacity Development,
Paul-Bonatz-Str. 9-11
57076 Siegen

E-Mail: info@cicd.uni-siegen.de

Printing Printing Office, Universität Siegen, Germany

This document has been produced with the financial assistance of the European Union. The contents of this document are the sole responsibility of the University of Siegen and can under no circumstances be regarded as reflecting the position of the European Union.

ISSN: 1868-8578

List of Authors

Prof. Dr. Hussain Al-Towaie - University of Aden, Yemen
altowaie@yemen.net.ye

Jigal Beez - German Development Service

Nasim Losai - Program Officer PAMOJA Trust

Andrew Jacob Ngereza - Mikocheni Agricultural Institute, P.O. Box 6226, Dar es Salaam, Tanzania, jngereza@yahoo.com

Simon Mang'erere Onywere - Kenyatta University, Department of Environmental Planning and Management, P.O. Box 43844 Nairobi
onyweres@yahoo.com

Franziska Steinbruch - franziskas@carrfoundation.org

Ayenew Tessera - M.A. in Political Science and International Relations, Lecturer, St. Mary's University College, Country Coordinator, Ethiopian Nile Basin Discourse Forum

Contents

1 Water Desalination Technology and its Impact in the Mena Region, Hussain Al-Towaie 1
- 1.1 Abstract . . . 2
- 1.2 Introduction . . . 2
- 1.3 Water Status . . . 3
- 1.4 Desalination Process and Technology . . . 5
  - 1.4.1 Multi-stage flash distillation "MSF" . . . 5
  - 1.4.2 Multiple-effect distillation "MED" . . . 6
  - 1.4.3 Reverse Osmosis "RO" . . . 7
- 1.5 Environmental Impact . . . 8
  - 1.5.1 Waste Water Discharge . . . 8
  - 1.5.2 Air Pollution . . . 10
- 1.6 Conclusion . . . 11

2 Dialogue with Furrow Fighters: PAMOJA Trust's Experiences in the Tanzanian Water Sector, Nasim Losai, Jigal Beez 13
- 2.1 Introduction . . . 14
- 2.2 The Role of NGOs in the Tanzanian Water Sector . . . 14
  - 2.2.1 NGOs as Representatives of the Civil Society . . . 16
  - 2.2.2 NGOs as Facilitators . . . 16
  - 2.2.3 NGOs as Trainers . . . 17
  - 2.2.4 NGOs as Advocators . . . 18
  - 2.2.5 NGOs as Watchdogs . . . 18
- 2.3 PAMOJA: A Tanzanian NGO in the Water Sector . . . 19
  - 2.3.1 PAMOJA's Background . . . 19
  - 2.3.2 PAMOJA's Water Activities . . . 20
  - 2.3.3 Community Level . . . 22
  - 2.3.4 Basin and Catchment Level . . . 24
  - 2.3.5 International Level . . . 26
- 2.4 Challenges for an NGO in the Tanzanian Water Sector . . . 27

2.5 Conclusion . . . 29
2.6 References . . . 29

3 Water, Environment and Food Security, Andrew Jacob Ngereza 33
3.1 Abstract . . . 34
3.2 Introduction . . . 34
3.3 Land Cover . . . 36
3.4 Land Use . . . 36
3.5 Water Basins . . . 37
3.6 Water Sector . . . 38
3.7 Major Environmental Problems in Tanzania . . . 40
3.7.1 Land Degradation . . . 40
3.7.2 Pollution Management and Urbanisation . . . 41
3.7.3 Agricultural and Rangeland Resources Management . . . 42
3.7.4 Management of Forest Resources . . . 43
3.7.5 Management of Wildlife Resources . . . 43
3.7.6 Management of Mineral Resources . . . 43
3.8 Recommendations . . . 44
3.9 References . . . 45

4 Anthropogenic Impacts on Water Resources in the Lake Naivasha Basin, Kenya, Simon Mang'erere Onywere 47
4.1 Abstract . . . 48
4.2 Introduction . . . 48
4.3 The Study Area and its Setting . . . 49
4.4 Hydrology/Hydrogeology . . . 52
4.5 Methodology . . . 54
4.6 Results and Discussion . . . 55
4.7 Conclusion . . . 63
4.8 Acknowledgements . . . 64
4.9 References . . . 64

5 Hydrological Research for Adaptive Management of Gorongosa National Park in Mozambique - Principles and Priorities, Franziska Steinbruch 67
5.1 Abstract . . . 68
5.2 Gorongosa National Park . . . 68
5.3 Historical Background . . . 69
5.4 Hydrological Resources Management . . . 72

5.5 Hydrological Research and Monitoring Priorities 73
5.5.1 Lake Urema and Floodplain Management 73
5.5.2 Urema Catchment Developments 74
5.5.3 Pungue River Basin Development 74
5.5.4 Zambeze River Basin Development 74
5.5.5 Climate Change 75
5.6 Conclusion 75
5.7 Acknowledgement 76
5.8 References 76

6 Water Governance: Policy and Practice in Ethiopia, Kenya, Ayenew Tessera 77
6.1 Abstract 78
6.2 Introduction 78
6.2.1 Physical Location of the Country 78
6.2.2 Topography 79
6.2.3 Climate 79
6.2.4 Government Structure 80
6.2.5 Population 80
6.2.6 Economy 80
6.2.7 Water Resources 81
6.3 Water Governance 84
6.3.1 Concept Definition 84
6.3.2 The Need for Water Governance 85
6.3.3 Policy and Legal Framework for Water Governance in Ethiopia . 87
6.4 Institutional Framework 97
6.4.1 Federal Institutions 97
6.4.2 Regional Institutions 99
6.4.3 Local Level Institutions 100
6.4.4 Private Institutions 100
6.5 Practical Application of Policy Framework 101
6.6 Conclusion 104
6.7 Recommendations 104
6.8 References 105

List of Figures

1.1 Per capita available renewable water in MENA /World Bank 2007/. Data includes non-conventional sources. 3

4.1 Location of the study area and SRTM DEM data of the Lake Naivasha area (Source: USGS Geodata Warehouse Africa). 52
4.2 Image and land cover map extracted from Landsat TM image of January 1986 55
4.3 Image and land cover map extracted from Landsat ETM image of March 2000 56
4.4 Image and land cover map extracted from SPOT image of May 2007 . . . 56
4.5 34 land cover units extracted from the satellite imagery of the years 1986, 2000 and 2007 57
4.6 58
4.7 Nine broad land cover classes grouped from the 34 cover classes 58
4.8 Impacts of the changing land use patterns: (a) horticultural activities; (b) intense arable farming in the Ndabibi area; (c) emergence of flamingoes in the small lake (Lake Ololdian) - note the receding water levels; (d) fringe of water hyacinth in Lake Naivasha combined with a higher turbidity of the water 60
4.9 Summary of in-situ-measured properties of water samples from various water sources in the Lake Naivasha Basin 62

5.1 Map of Urema Catchment and administrative boundaries of Gorongosa National Park; bold grey line-catchment boundary, hatched line- Gorongosa National Park, dark grey line- districts 70
5.2 Map of hydrology and morphology; black outline- GNP limits (hillshade derived from NASA-SRTM90) 70

6.1 Major river basins, basin areas and annual discharges 82

1 Water Desalination Technology and its Impact in the Mena Region, Hussain Al-Towaie

Prof. Dr. Hussain Al-Towaie[1]

[1]University of Aden, Yemen
altowaie@yemen.net.ye

1.1 Abstract

Water desalination has become one of the sources of water supply in many countries, especially in the Middle East and North Africa (MENA) where the renewable resources are limited. Water desalination can provide unlimited and constant supply of high-quality drinking water and reduces pressure on freshwater ecosystems and groundwater resources. However, as the capacity installed worldwide increases at a rapid pace, increasing concerns are also expressed over potential negative impacts of the desalination activity on the environment. The main concerns are the emission of air pollutants due to a fossil energy use and the waste water discharge to the sea: high salinity water, often containing residual anti-scalants. The selection of the appropriate desalination technology, the use of renewable energies and the proper way to deal with high salinity waste water discharge are very important to mitigate negative impacts of the desalination activity.

1.2 Introduction

The provision of potable water by sea water desalination is generally considered a benefit despite high construction and operating costs of plants. This is especially true when conventional sources of freshwater are absent or cannot be exploited without severe environmental damage. Desalination is an essential technology in water-scarce regions, where it sustains the human well-being as well as the socio-economic development. It may prevent an overexploitation of conventional water resources, but if not well-designed and -managed, it may have impacts on the marine environment, which is the recipient of brine and chemical discharges.
Whoever is familiar with the situation in arid countries knows that desalination plants are often large industrial facilities which emit substantial amounts of combustion gases. It is also known that potable water production means emitting a concentrate into the sea. However, a generally less noted fact is that this concentrate contains not only the contents of the sea water taken in, but also additives (or their conversion products) necessary for the desalting process and corrosion by-products.

The desalination of brackish water and sea water has become one of the viable

solutions for the water shortage in the Middle East and North Africa (MENA) region. Desalination processes are energy-intensive. Some of the countries of the region are blessed with conventional sources of energy, oil and gas, while others are not. In the oil-rich countries the water problem is (supposed to be!) solved by large desalination plants powered with conventional energy.

1.3 Water Status

The whole MENA region is running into severe shortages of water and energy when present demographic developments continue even in a moderate way and when poverty is to be overcome. There are no other appropriate water resources that could be exploited, except for sea water by desalination.

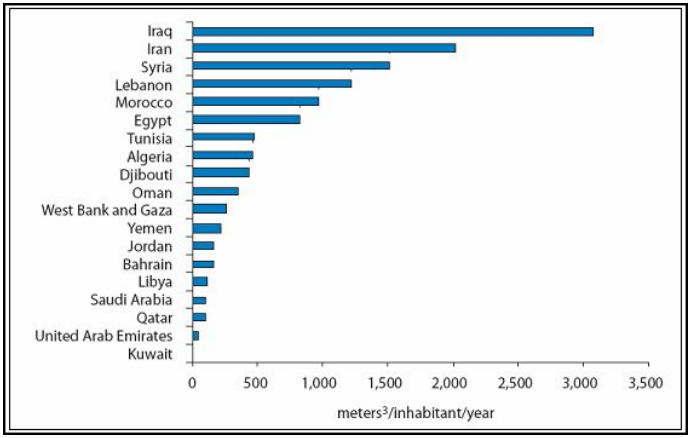

Figure 1.1: Per capita available renewable water in MENA /World Bank 2007/. Data includes non-conventional sources.

Table 1: Present GCC states' water use in (mill. m^3 /year)

States	Domestic	Agriculture	Industry	Total
U.A.E.	600	1,539	73	2,212
Bahrain	107	161	19	287
Saudi Arabia	2,387	18,575	193	21,155
Oman	85	1,150	6	1,241
Qatar	85	337	17	439
Kuwait	297	323	13	633
TOTAL	3,561	22,085	321	25,967

Most of this quantity stems from ground water, less than 5% from desalinated sea water and about 2% from the recycled sewage water.

Table 2: Estimated GCC states' future water demands (billion m^3 /year)

Sector	2005	2010	2015	2020	2025
Domestic	4.950	5.720	6.550	7.420	8.300
Agriculture	27.000	29.750	32.790	36.350	39.780
Industry	0.570	0.720	0.900	1.090	1.310
Total	32.520	36.190	40.240	44.860	49.380

Table 3: Distribution and production of GCC desalination plants /2004/

States	Present Plants	Under Construction	Total Production (Mill. m^3 /year)
U.A.E.	10	2	420
Bahrain	4	1	75
Saudi Arabia	23	4	1130
Oman	1	2	32
Qatar	2	1	95
Kuwait	4	1	240
TOTAL	44	11	1992

1.4 Desalination Process and Technology

The combined capacity of all sea water desalination plants approaches 24.5 million m^3 per day, that is to say about 9 billion m^3 per year. About 75% of the worldwide production is done in the MENA-Region (Arabian Gulf, Mediterranean and Red Sea). The most common commercially predominating desalination processes in MENA and worldwide are multi-stage flash distillation (MSF), multiple-effect distillation (MED) and reverse osmosis (RO). In the Gulf region, 90% are thermal processes (MSF, MED) while in the Mediterranean region 95% are RO plants.
A general description of these processes and the development of the technologies are presented below.

1.4.1 Multi-stage flash distillation "MSF"

Multi-stage flash distillation "MSF" is a desalination process that distills sea water by flashing a portion of the water into steam in multiple stages. First, the sea water is heated in a container known as brine heater. This is usually achieved by condensing steam on a bank of tubes carrying sea water through the brine heater. The heated water is passed to another container known as a "stage", where the surrounding pressure is lower than that in the brine heater. It is the sudden introduction of this water into a lower pressure "stage" that causes it to boil so rapidly and to flash into steam. As a rule, only a small percentage of this water is converted into steam. Consequently, it is normally the case that the remaining water will be sent through a series of additional stages, each possessing a lower ambient pressure than the previous "stage". As steam is generated, it condenses on tubes of heat exchangers that run through each stage. Multi-stage flash distillation plants produce over 85% of all desalinated water in the world. MSF distillation plants, especially large ones, are often paired with power plants in a cogeneration configuration. Waste heat from the power plant is used to heat the sea water, providing cooling for the power plant at the same time. This reduces the energy required from one-half to two-thirds, which drastically alters the economics of the plant since energy is by far the largest operating cost unit of MSF plants.

Developments in the MSF technology are as follows:

- increase in the unit size from 5 to 16 MGD;
- increase in TBT from 90 to 112°C;
- improvement of construction materials and structural aspects;
- capital cost is US$ 5 to 6 per installed gallon/day and desalinated water cost is US$ 0.8 to 1.5 per m^3.

1.4.2 Multiple-effect distillation "MED"

Multiple-effect distillation "MED", as defined in chemical engineering, is an apparatus for efficiently using the heat from steam to evaporate water. In a MED, water is boiled in a sequence of vessels, each held at a lower pressure than the preceding one. Since the boiling point of water decreases as pressure decreases, the vapor boiled off in one vessel can be used to heat the next, and only the first vessel (at the highest pressure) requires an external source of heat. While in theory, evaporators may be built with an arbitrarily large number of stages, evaporators with more than four stages are rarely practical. MED uses the principle of reducing the ambient pressure in the various effects. This permits the feed water to undergo multiple boiling without supplying additional heat after the first effect.

The incoming feed water is pumped into the plant through a number of preheaters located in each effect (evaporators) in order to raise its temperature. After passing through the last of these, the feed enters the "top" effect where the heating steam from a boiler or another source raises its temperature to the saturation temperature for the effect pressure. The second and the subsequent effects use steam produced by the previous effects. MED is the more thermodynamically efficient process compared to MSF.

Developments in the MED technology are:

- increase in the unit size from 1 to 5 MGD;
- reduction of scaling problems by proper design of condenser tube bundle and distribution of evaporating feed;

- now maintenance of TBT at 70°C to reduce scaling;
- capital cost is US$ 3.5 to 4.5 per installed gallon/day and desalinated water cost is US$ 0.7 to 1.0 per m^3.

1.4.3 Reverse Osmosis "RO"

Reverse osmosis "RO" is the process of pushing a solution through a filter that traps the solute on one side and allows the pure solvent to be obtained from the other side. More formally, it is the process of forcing solvent from a region of high solute concentration through a membrane to a region of low solute concentration by applying a pressure in excess of the osmotic pressure. This is the reverse of the normal osmosis process, which is the natural movement of a solvent from an area of low solute concentration through a membrane to an area of high solute concentration when no external pressure is applied. The membrane in this connection is semi-permeable, which means that it allows the passage of solvent but not of solute. The membranes used for reverse osmosis have no pores. The separation rather takes place in a dense polymer layer of only microscopic thickness. In most cases the membrane is designed to allow only water to pass through. The water goes into solution in the polymer of which the membrane is manufactured and crosses it by diffusion. This process demands that a high pressure is exerted on the high concentration side of the membrane, usually 2 - 14 bar (30 - 200 pounds per square inch) for fresh and brackish water, and 40 - 70 bar [(600 - 1000 psig)] for sea water. This process is best known for its use in desalination (removing the salt from sea water to get fresh water) and has been used in this way since the early 1970s. A large capacity SWRO plant of 15 MGD was built in Saudi Arabia in 1994.

Developments in the RO technology are:

- long life membranes with high recovery and resistance to fouling;
- better membrane module designs;
- devices for energy recovery "pressure exchangers";
- reduction of membrane costs compared to 10 years back;

- capital cost of SWRO plant is US$ 3.2 per installed gallon/day, US$ 1.93 for brackish water, and desalinated water cost is US$ 0.45 to 0.8 per m^3 for SWRO.

1.5 Environmental Impact

As the capacity installed worldwide increases at a rapid pace, increasing concerns are also expressed over potential negative impacts of the desalination activity on the environment. The main concerns are waste water discharge to the sea and the emission of air pollutants due to a fossil energy use.

1.5.1 Waste Water Discharge

The sea as a source of drinking water seems to be unlimited but pollution by land-based activity often impairs the quality of coastal water bodies that serve as feed water for desalination plants. 'Hot spots' of marine pollution are typically found near centres of intense human activity such as cities, harbours and industrial areas, which are also the areas where desalinated water is mostly needed for socio-economic development.
Sea water desalination plants also contribute to the waste water discharges that affect the coastal water quality. This is mostly due to the highly saline brine that is emitted into the sea, which may increase in temperature, contain residual chemicals from the pre-treatment process as well as heavy metals from corrosion or intermittently used cleaning agents. The effluent from desalination plants is a multi-component waste, with multiple effects on water, sediment and marine organisms. It therefore affects the quality of the resource it depends on.

The three highest concentrations of desalination plants worldwide are in the MENA region. The first highest concentration of desalination plants is found in the Arabian Gulf with an installed capacity of 11 million m^3 per day (45% of the worldwide daily production). The second highest agglomeration is located in the Mediterranean with an installed capacity of 4.2 million m^3 per day (17% of the worldwide daily production). The third highest concentration of desalination plants is situated in the Red Sea with an installed capacity of 3.4 million m^3 per day (14% of the worldwide daily production).

High salinity, increased temperature, residual chlorine, antifoaming additives, and, potentially, coagulants and cleaning solutions are characteristics of the rejected stream. Copper may be a concern if copper-nickel alloys are used as heat exchanger.

The impacts of a desalination plant on the marine environment depend on both, the physico-chemical properties of the reject streams and the hydrographical and biological features of the receiving environment. Enclosed and shallow sites with abundant marine life can generally be assumed to be more sensitive to desalination plant discharge than open sea locations, which are rather able to dilute and disperse the discharges. The response of the impacted marine ecosystem depends on its sensitivity and the magnitude of the impact, which in turn depends on factors such as distance, transport direction and dilution. Small enclosed or semi-enclosed seas may be understood as entire ecosystems although sub-ecosystems may be defined and examined separately. For example, one half of the world's sea water desalination capacity is located in the Arabian Gulf and overall impacts on this enclosed sea may be considered in addition to local effects on certain biotopes. In contrast, the accumulation of desalination plants on the Canary Islands will not produce measurable effects on the Atlantic Ocean as a whole, but distinct coastal ecosystems may be affected by the discharge.

For a sustainable use of desalination technology, it is necessary to investigate the impacts of each project by means of a project- and location-specific environmental impact assessment study. In general, the following approaches can be considered in order to mitigate environmental effects:

- high salinity: reject stream can be pre-diluted with other waste streams such as power plant cooling water;
- high temperature: heat dissipation to atmosphere before entering the water body (e.g. cooling tower or elongated outfall channels);
- installing a diffuser system or locating the discharge in a favorable site which dissipates the heat and salinity load quickly;
- impacts from chemicals:
  - treatment before discharge,

- substitution of hazardous substances, and
- implementing alternative treatment options such as the non-chemical pre-treatment option (e.g. UF and MF).

1.5.2 Air Pollution

Most of the large settlements in the MENA region are situated near the sea shore at locations with good solar radiation. The concentrating solar power (CSP) technology has been proven to work reliably since more than 15 years of commercial operation in California. At present, the cost of solar energy from CSP corresponds to an oil price of around 60$/barrel. A cost reduction of factor 2 to 3 is feasible by economy of scale and by learning effects. Studies of cost reduction achievements for the German Ministry of Environment suggest that the solar collector capacity as required for pro-ducing 1 billion m^3 of desalinated water per year is sufficient to bring costs down so that power can be generated for 5ct/kWh and water be desalinated for 0.9 $\$/m^3$, under the condition of an annual direct normal irradiation of 2500 kWh/m^2 and a return of investment of 6%. The more CSP technology will be applied, the more costs will go down and the faster it will expand.
The studies show that solar energy has a great potential in sun-belt regions, much larger than would be needed to accommodate the desalination and power generation needs for the foreseeable future.

For illustration, consider the case of Sana'a. The City of Sana'a is the capital of the Republic of Yemen and is one of the oldest cities and a World Heritage City as well. The water supply of the Yemeni Capital Sana'a is in a poor state right now and is approaching a critical point since more than 80% comes from extracted fossil water reserves in the geological Sana'a Basin. The rate of extraction exceeds the recharge rate by more than the factor 5. According to a number of investigations, the water table is now at 700 metres below the surface and is sinking by 7 metres per year.

The proposed Solar Desalination Water for Sana'a from the Red Sea Project aims at desalinating water using concentrating solar power (CSP) from the Red Sea close to the coastal city of Hudaidah. The quantity of the desalinated water would then be transported for a distance of about 250 km with an elevation of 2,700 m.

For desalinating and pumping 1 billion m^3/year for Sana'a, a collector area of about 20 km^2 is needed. Therefore, desalination of sea water with solar energy is the preferred strategy with regard to water for Sana'a as well as for the whole MENA region.

1.6 Conclusion

Desalination has become one of the viable solutions for the water shortage in the Middle East and North Africa (MENA) region, but if not well designed and managed, it may have negative environmental impacts. The main concerns are the emission of air pollutants due to a fossil energy use and the waste water discharge into the sea.
A report from the WWF Global Freshwater Programme condemned sea water desalination as "an expensive, energy-intensive and greenhouse gas emitting way to get water". Using solar energy instead of a fossil fuel is a promising alternative. The concentrating solar power (CSP) technology has been proven to work reliably. At present, the cost of solar energy from CSP corresponds to an oil price of around 60$/barrel. Cost reductions of factor 2 to 3 are feasible by economy of scale and learning effects.

The dangers of waste water discharge on the marine environment have not been studied thoroughly until very recently. General guidelines to mitigate environmental effects of the high salinity and temperature of waste water discharge are as follows: reject stream can be pre-diluted with other waste streams, heat dissipation to atmosphere before entering the water body, installing a diffuser system or locating the discharge in a favorable site which dissipates the heat and salinity load quickly. Mitigation of impacts from chemicals can be achieved by treatment before discharge, substitution of hazardous substances and implementing alternative treatment options.

2 Dialogue with Furrow Fighters: PAMOJA Trust's Experiences in the Tanzanian Water Sector, Nasim Losai, Jigal Beez

Nasim Losai[1] , *Jigal Beez*[2]

[1]Program Officer PAMOJA Trust
[2]German Development Service

2.1 Introduction

In Tanzania, some irrigation farmers guard their furrow intakes with machetes and clubs. Some water users swear that they will never pay a shilling for the liquid as it is a gift of god and since none of their ancestors ever did so. The cow splashing in the spring does not care anyway and the water officer is praying for a transfer. There are many issues at stake in the Tanzanian water sector.

This presentation analyses the role of a non-government organisation in Integrated Water Resources Management in Tanzania by means of the example of PAMOJA Trust, an NGO which is based in Moshi, Kilimanjaro Region, but which is active in other parts of Tanzania and Kenya as well. PAMOJA Trust has the vision of being an effective facilitator of good governance at the local level through the promotion of the Joint Action Concept, which propagates the collaboration between local governments, the civil society and the private sector. As PAMOJA Trust recognises the need for instituting good water governance, it aims to develop strategies and solutions for resolving conflicts that arise from contested claims over water. Therefore, PAMOJA Trust supports initiatives that link the Tanzanian water sector reforms and the concept of Integrated River Basin Management (IRBM) for the benefit of the community and for a sustainable management and use of water resources. This paper will examine how PAMOJA Trust implements its community-based and participatory approach to water management and how it is adopting the IRBM approach in collaboration with the Pangani Basin Water Office. Thus, this paper highlights the strengths and limitations of NGO activities in IWRM in Tanzania.

2.2 The Role of NGOs in the Tanzanian Water Sector

The concept of NGOs is not very old in Tanzania (Ndumaro 2007: 6ff). Though civil society organisations concerned with social and development issues developed before independence, nearly all these organisations were integrated into the party and government structure of Tanzania's single party system after independence. According to the perception of the socialist Tanzanian state from the late 1960s until the mid 1980s there was no need for civil society organisations as the single ruling party and the government were supposed to cater for all the needs

of the Tanzanian society. Immediately after independence the state was seen as the dominant actor to bring about development, almost at the complete exclusion of other actors. Through broad nationalisation, most of the private sector was brought under state control. The space in civil society was severely curtailed by means of the authority of the single party, the abolishment of local authorities and the limitations on independent associations and cooperative societies. The government dominated all spheres of life through internal control and support from external donor agencies.

Things changed drastically when *mageuzi*, the Swahili version of perestroika, entered Tanzania. Liberalisation with market reforms led to a multi-party system and the withdrawal of the state from social service delivery. Hence, there was a gap which was filled by emerging civil society organisations. Increasing social differentiation also led to the emergence of CSOs concerned with poverty eradication. Moreover, from the 1980s onwards, environmental and gender issues started to appear on the development agenda. Subsequently, organisations catering for these issues evolved. Another incentive for the foundation of many NGOs was the tendency of donor agencies to focus their cooperation on collaboration with NGOs as they had gained bad experience with government institutions (a trend which has reversed in the meantime). In order to give the highly developing NGO sector a legal framework, the Tanzanian government formulated the National NGO Policy (2001) and the NGO Act (2002). According to the NGO Policy (paragraph 5.1) a NGO is

"a voluntary grouping of individuals or organizations which is autonomous, non-partisan and not-for-profit sharing: organized locally at the grassroots level, nationally or internationally for the purpose of enhancing the legitimate economic, social and/or cultural development or lobbying or advocating on issues of public interest of a group or individuals or organizations."

Around the same time the Tanzanian government was creating a legal framework for NGOs, it also introduced a new National Water Policy (NAWAPO) in 2002 (GoT 2002), which was followed by changes in the legislation (Water Resources Bill, Water Supply and Sanitation Bill) and the National Water Sector Development Strategy. This new policy meant a change from a government-driven approach to a demand-driven approach. Communities are now supposed to be

integrated into the planning and management of water issues as well as into cost recovery. Furthermore, Integrated Water Resources Management principles were included in the policy together with environmental issues. Hence, ample opportunities for NGOs emerged in the water sector.

2.2.1 NGOs as Representatives of the Civil Society

The new national water policy puts emphasis on the active participation of communities, local governments, the civil society and the private sector whereas the role of the central government diminishes. Here, NGOs are representatives of the civil society and explicitly recognised as one of the key actors in the water sector (NAWAPO 2002, article 37). This is repeated in the Water Sector Development Programme which identifies NGOs and CBOs as key actors in the water sector. The role of NGOs as representatives of the civil society was already recognised during the formulation of the policy, when NGOs took part in the process of reviewing the drafts (NAWAPO 2002, article 6).

The national water policy also asks the civil society to engage in catchment management[3]. At the catchment level, representatives of the civil society are supposed to be part of the catchment and sub-catchment committees. This is also a task for NGOs active in the water sector.

2.2.2 NGOs as Facilitators

Another role of NGOs is the one of a facilitator. NGOs can facilitate processes of the establishment of water management bodies as PAMOJA's example will show below. Furthermore, NGOs can facilitate the process of community participation, e.g. in planning and constructing rural water supply or irrigation schemes, which is envisaged by the NAWAPO to supplement activities of government authorities. Moreover, the NAWAPO includes the possibility that NGOs support the water sector technically and financially (NAWAPO 2002, article 37), though this task seems to be more directed towards NGOs which receive major international donor support. According the National Water Sector Development Strat-

[3]The Tanzanian institutional set-up of water resources management consists of five levels, namely the national level, the basin level, the catchment level, the district level and the community or water user associations level.

egy, NGOs and CBOs will be encouraged in financing, developing and managing the water supply and sewerage service in low-income urban areas (NWSDS 2005, article 52). In addition, the Situational Analysis of the Ministry of Water views NGOs as funding agencies which have to be incorporated into governmental planning process (MoW Situational Analysis 2006, article 15).

Furthermore, this situational analysis states that the roles and responsibilities of the decision-making authority as well as the control of resources for the delivery of basic services are in the first instance supposed to be transferred to the district councils, and in the second instance from the district councils to lower-level government administrations or to other suitable institutional agents, including community-based organisation, NGOs and the private sector (MoW Situational Analysis 2006, article 5). Here, as well as in the Water Supply and Sanitation Bill, it is envisaged that NGOs could actually run water schemes.

Moreover, NGOs can be facilitators by bringing together different stakeholders for dialogue processes and thereby developing reasonable solutions to overcome problems at the community level as well as at the national level.

2.2.3 NGOs as Trainers

The principle of decentralisation by devolution means to transfer the management to the lowest appropriate level possible. Within the water resources management, water user associations (WUA) or water user groups are considered to be the lowest appropriate level of management. However, in many areas in Tanzania, these organisations do not exist or have only a weak capacity, which means that there is a huge demand for training and capacity building of water user associations. This cannot be done by the government staff alone. Thus, NGOs can have the role of trainers as they assist in the establishment of water user associations and strengthen the capacity of existing WUAs. The Water Sector Development Programme of the Tanzanian government states that district water and sanitation teams are supposed to employ local NGOs and firms as facilitation service providers. This can also be found in the Rural Water Supply and Sanitation Programme which explains that specialised NGOs, consulting firms or extension workers from the district itself build the capacity of the user groups. In this context, the central government is enabling agency for NGOs and the private

sector (see WSDP).

2.2.4 NGOs as Advocators

The new national water policy gives local communities many opportunities to participate in water issues. However, in most local communities little knowledge exists about the rights and possibilities provided by the new legislation. The authoritarian state of the past and the attitude of government officials caused the local perception that all policy issues are per se a threat to local well-being and just another try to interfere with the lives of the common people for the sake of further exploitation. On the government side there are also only limited efforts and means to make people aware of new policies. Therefore, NGOs have to fill the gap of informing the people about their rights and obligations. NGOs as neutral non-partisans are in a position to do so without being received with bad perceptions. Thus, NGOs are popularising the national water policy so that local communities can take development processes into their own hands and claim their rights towards government representatives.

2.2.5 NGOs as Watchdogs

The general role of NGOs as watchdogs of the governmental policy has to be fulfilled in the water sector as well. NGOs are supposed to monitor the implementation of the government policy and to point to shortcomings of the implementation process or the policy itself[4]. The national water policy explicitly identifies NGOs as part of participatory monitoring and evaluation teams at the district and community level (NAWAPO 2002, article 38). This should be done at the local government and national level as well[5]. Part of the monitoring tasks is to conduct budget tracking exercises to ensure the right use of funds. Training the community on budget tracking, also within the water sector, is a task for NGOs in order to fulfil their monitoring function.

Moreover, environmental issues need special monitoring and lobbying of NGOs in the water sector. The environment is an essential part of IWRM though it is

[4] Unfortunately, it is not known if these common monitoring missions are actually taking place.

[5] However, there are no examples for the fact that this plan has already been realised anywhere in Tanzania.

often forgotten, since usually the environment has no other representative during stakeholder meetings apart from NGOs. In this connection, NGOs have to fulfil a special task.

2.3 PAMOJA: A Tanzanian NGO in the Water Sector

After having explored the roles of NGOs in the water sector as they were given by the national water policy, the Tanzanian NGO Pamoja and its activities in the water sector will be analysed to show how Tanzanian NGOs can become active in this sector.

2.3.1 PAMOJA's Background

Pamoja Trust is a registered non-governmental organisation based in Moshi, the capital of the Kilimanjaro Region in northern Tanzania. Its aim is to facilitate the collaboration between local governments, the civil society and the private sector. A board of trustees monitors the performance of the organisation and provides support and guidance. Currently, Pamoja's staff consists of a director, three programme officers and an external advisor.

Pamoja evolved from a planning and joint action project which was facilitated by the SNV Netherlands Development Organisation in the Same District, Kilimanjaro Region, in the mid 1990s. In cooperation with local district authorities this project was started to let the civil society and private sector participate in decision-making at the district level.
The tools of district advisory committees and district education committees were developed. As these tools proved to be successful, the programme was expanded to the regional level and given the name Pamoja, which is Swahili and means "togetherness", referring to the joint action concept as well as to Pamoja's team spirit of working together. The development of Pamoja into an NGO in 2002 was inspired by the desire to have a professional capacity building NGO with the mandate to promote good governance through practice of the joint action concept at the district level in the Kilimanjaro Region and even beyond. These activities were supplemented by the establishment of NGO networks to strengthen local civil society organisations. Currently, Pamoja has employed a director, an admin-

istrator and two programme officers for education and natural resources management. Furthermore, the German Development Service (DED) has seconded an advisor to support Pamoja's water activities. Within the German Development Cooperation's Water for Life Programme (WALPRO) the collaboration between PAMOJA and DED aims at supporting the component goal that "[s]elected sector institutions and Local Government Authorities are strengthened to facilitate the implementation of the Water Sector Development Programme."

PAMOJA's vision is to be an effective facilitator of good governance at the local level through promoting the joint action concept, which propagates the collaboration between local governments, the civil society and the private sector. The core of the joint action model consists in the support of stakeholder platforms in good governance, in governance of water resources and in cross-border dialogue. These platforms are a result of the reform processes that introduced the specific roles and functions of local governments, the private sector and civil society organisations in priority setting, planning, implementing and monitoring for tentative solutions.

This outcome has been realised in a gradual process of changing the mindsets from government to governance, where all parties participate in round table dialoguing on relevant issues of attention at that particular moment and reach consensus. Presently, other districts in the region and the country have initiated similar strategies of stakeholder platforms and dialoguing ideas relevant to their own situations. On the basis of exchange visits, more and more districts are adopting them as an innovation and gap-filling method in the development process, which is thus done on a partnership basis.

2.3.2 PAMOJA's Water Activities

In 2002, when Pamoja was registered as an NGO, it expanded its activities beyond governance and education in the water sector. The intended outcome of water resources governance consists in being part of process management and contributing to broadening partnership and up-scaling lessons for learning.
Though Pamoja also takes ongoing water activities in southwestern Tanzania, most of its programmes focus on the Pangani Basin, which covers an area of about 56,300 km^2, with 5% located in Kenya and 95% spanning the Arusha,

Manyara, Kilimanjaro and Tanga regions of Tanzania. The river system drains Mount Kilimanjaro and Mount Meru as well as the Usambara and Pare Mountain ranges, which are famous for their endemic biodiversity.

The Pangani River passes through the arid Maasai Steppe and feeds the cities of Arusha and Moshi before it reaches the Indian Ocean where it supplies freshwater to the coastal town of Pangani and the mangrove forest at the delta. Most of the water in the Pangani Basin is used for irrigation or hydropower. Up to 55,000 ha of land is under irrigation for crops and there are three hydropower facilities that supply up to 20% of Tanzania's electricity needs (IUCN 2003, PBWO 2007). Global climate change has reduced the ice-cap on Kilimanjaro and thus one of the principal sources for the Pangani River, while deforestation has compromised the region's ability to retain water. These reductions in supply, coupled with increasing water demands for irrigation and hydropower generation, have led to considerable conflicts over the allocation and use of water in the Pangani Basin. Conflicts are varied and include disagreement with the commercialisation of water, water allocation between upstream and downstream users, disputes over allocation between agriculture and hydropower, and disputes between agriculturalists and pastoralists.

In the water sector, Pamoja recognises the need for instituting good water governance and aims to develop strategies and solutions for resolving conflicts that arise from contested claims over water resources within river basin settings, e.g. upstream-downstream conflicts or agriculturalist and pastoralist conflicts. Pamoja supports initiatives that are linked with the water sector reforms (water supply and water resources management) and the concept of Integrated River Basin Management (IRBM) for the benefit of the community and for a sustainable management and use of water resources. As the water sector reforms reduce the central government influence and provide an environment for non-state actors to play a role, Pamoja has joint hands in ensuring the effective translation of current reforms into practice in a manner that supports the local communities and at the same time contributes to the sustainable use and management of water resources.

Pamoja works on:

- facilitating the effective implementation of NAWAPO

- applying and relating NAWAPO in the local context
- adopting the IRBM approach in collaboration with the Pangani Basin Water Office
- community-based and participatory approach to water management
- environmentally sustainable management and use of water resources.

As a result, Pamoja supports initiatives at the international level (cross-border dialogue), at the basin and catchment level (establishment of sub-catchment forums) as well as at the community level (capacity building of WUAs).

2.3.3 Community Level

One of the first Pamoja activities in the water sector started at the community level. In collaboration with the World Conservation Union (IUCN) and the Pangani Basin Water Office (PBWO) a situation analysis was conducted with regard to the nature and history of water conflicts within the Pangani Basin. As a result a site intervention programme was started to learn about and share experiences in water conflict resolution.
The approach was to create institutions for a water dialogue at the local level to enable good water governance. In the partnership between the PBWO, the IUCN and Pamoja, the PBWO has a regulatory mandate for water management. The IUCN has the technical capacity and access to resources and international links, and Pamoja has experience in partnership approaches and the establishment of multi-stakeholder dialogue platforms.

Using its experiences in the governance sector, PAMOJA has been supporting the establishment of water user groups in the piloted conflict management sites of Ruvu, Hingilili (both in Same District), Soko (Moshi Rural District) and Rundugai (Hai District). The water user groups identified and prioritised their problems, and made action plans through the facilitation of PAMOJA and the PBWO. This process was supported by the IUCN and some groups have formulated by-laws and group constitutions. This has resulted in agreements on land use management in Ruvu, and on water allocation systems in Hingilili, Soko and Rundugai. The water allocation system in Hingilili has led to the establishment of

a sub-catchment water resources management umbrella organisation. Therefore, PAMOJA's activities in the water sector focus on the capacity building of water user entities in order to enable them to perform their role as envisaged by the NAWAPO.

Pamoja also cooperates with water user associations in the Mbeya Region, where it is currently training 23 irrigation associations on water management and the NAWAPO. In the Mbeya Region, a situational analysis of a rural water supply scheme has also been conducted as a baseline for the establishment of a water user association.

The trainings provided by Pamoja to these water user groups include:

- training in finance, record keeping and administration
- establishment of maintenance plans
- development of constitutions
- support in the process of registration
- development of working manuals
- good leadership
- Integrated Water Resources Management
- gender mainstreaming
- conflict resolution
- HIV awareness raising
- support of monitoring and evaluation programmes.

The capacity building activities are supplemented by improving the structures for water distribution and facilitating environment protection activities.
The capacity building of water user entities includes the popularisation of the national water policy, which is aimed at decentralising the governance of water.

Even though the national water policy is hardly known by water users, it is appreciated once explained.

PAMOJA also used the opportunity of the annual MAJI WEEK, a national event dedicated to water activities, to conduct NAWAPO awareness raising programmes in schools which are complemented by art and drama competitions. Pamoja also supports partnerships between schools and water user associations in spring as well as riverbank protection activities by facilitating the establishment of tree nurseries for these schools. Half of the number of seedlings raised by the students is planted by WUA members for conservation purposes, whereas the other half is used by the schools and students for their own activities.

2.3.4 Basin and Catchment Level

The institutional framework and the New Water Act provide for a National Water Board and Basin Water Boards, both of which are made up of stakeholder representatives of the water-related sector institutions, water users, the private sector, NGOs, and women groups. Implementation will therefore be done with the active participation of all stakeholders (GoT WSDP 2006). Pamoja's role as NGO was acknowledged by the fact that one of its staff members was a member of the board of the Pangani Basin Water Office until his untimely death in an accident. Another way in which Pamoja participates in basin activities is by being part of the process of the establishment of the Kikuletwa sub-catchment forum.

In early 2003, the PBWO in northern Tanzania, the IUCN (from its East African Regional Office in Nairobi) and PAMOJA entered into a partnership, which was facilitated by SNV. The purpose of the partnership was to bring a change in the governance of water resources in the Pangani River Basin, using the concept of Integrated Water Resources Management. Through a number of pilot activities, experience was gained on the present challenges of water management.
With the increasing demand for water, mainly fuelled by a high population growth and accelerating economic activities in the river basin, yet faced with declining water yields due to environmental pressures and effects of climate change, the key immediate governance challenge in the basin is an equitable, just and reliable water allocation regime.
Based on the experiences gained in the activities on the community level, the

IUCN-PBWO-PAMOJA partnership has scaled up its activities in cooperation with SNV.

The concept of a catchment forum was introduced into the National Water Policy (2002) and in the Draft National Water Sector Development Strategy (2005). However, no such forum has been established in Tanzania yet. Using the Kikuletwa sub-catchment as a case study area, the following design process is going on:

First step: Carrying out an in-depth inventory, including all the aspects of relevance for the establishment of a forum for the Kikuletwa sub-catchment area, which extends from Mt. Meru towards the Nyumba ya Mungu reservoir. This multi-dimensional inventory has been conducted by Pamoja Trust.
A review meeting is envisaged in order to distil key issues to be taken into consideration when designing the forum has been delayed due personal fluctuation on the side of the partners. A reference group is supposed to subsequently prepare a proposal for the establishment of the forum, which will then form the basis for a consultation round with all stakeholders.

Second step: On the basis of extensive consultations, consensus on the establishment of the forum has to be achieved. Project activities will be supporting the forum in the formulation of its mandate and activities, and extensive training will be provided to equip forum members for their tasks.

Third step: In the first year of operation of the forum, project support is envisaged to consist of performance monitoring, support to adjustment in mandates and tasks, and the drawing of lessons for both national application and international learning.

The first step of the catchment forum design process was the inventarisation of various aspects of relevance for the establishment of a catchment forum. For this case, PAMOJA Trust was assigned to the organisational landscape (both formal and informal) of relevance to water management in the Kikuletwa catchment (Pamoja 2006). The objective of this assignment was to identify the various stakeholders present in the sub-catchment and to classify their interest and role in water use (the picture on the ground) in order to create insights as a basis for governance interventions. This information will help to develop the design of a dialogue forum through which these stakeholders in the sub-catchment will be

represented. This process was completed by PAMOJA in 2006 and presented to the partners. Currently, the facilitators (SNV) are looking forward to have a design team at their place.

2.3.5 International Level

On the international level, Pamoja facilitates the cross-border dialogue process, which is implemented in the Chala-Jipe and Umba Rivers in the Pangani Basin. The cross-border dialogue aims at:

- sharing knowledge about the current situation of the ecosystem resources, existing procedures (formal and customary) for water allocation and management, basic concepts, principles and elements of Integrated Water Resources Management;
- raising awareness on the requirements of Integrated Water Resources Management with respect to multidisciplinary inputs at different levels of working to conduct an integrated process as well as multi-stakeholder dialogues among user groups in planning, management and decision-making;
- raising awareness on policies and responsibilities of different stakeholders to ensure collaboration in policy implementation (horizontally and vertically).

The dialogue process started way back in 1994 when the need for the transboundary water management between the Pangani Basin Water Office of Tanzania and the Coast Development Authority of Kenya arose. However, it was not really successful. PAMOJA's facilitation of the process started in 2003 through InWEnt support and continued up to 2006. Several workshops were held since 2004 for the development of the Joint Cross-Border Integrated Water Resources Management Programme in the Lake Chala-Jipe and the Umba River Ecosystem for Tanzania and Kenya. This framework for sustainable development was launched by the Regional Commissioner of Kilimanjaro on behalf of the Tanzanian Minister of Water in 2006.

The cross-border dialogue stakeholders included the University of Dar es Salaam, the Coast Development Authority, the Pangani Basin Water Office, the University

of Nairobi, the districts of Kwale and Taita-Taveta in Kenya as well as Rombo, Mwanga and Lushoto in Tanzania, while PAMOJA and InWEnt were facilitators of the process.

2.4 Challenges for an NGO in the Tanzanian Water Sector

The work of an NGO in the Tanzanian water sector implies various challenges. The biggest is without a doubt the financial aspect. According to a study of the University of Dar es Salaam, NGOs that are active in civic advocacy depend to 84% on foreign funds, which is the highest foreign dependency of all sectors (Rutasitara and Ngowi 2007: 104). This holds also true for Pamoja which is working on governance of water and other governance issues. Pamoja is mainly depending on foreign donors to conduct its work. In fact, as an NGO, Pamoja was born out of the activities of SNV and has no member base which could contribute to its activities. Therefore, Pamoja is heavily affected by changes in donor policies. Initially, Pamoja profited from core funding through Dutch organisations. Then, it was en vogue to directly support civil society organisations. However, the donor mood turned towards government budget and basket support recently, and Pamoja had to cope with the loss of comfortable core funding. It is now purely based on assignments and consultancies, which affects strategic thinking and experimenting with own ideas, as Pamoja is struggling to make money to keep the organisation alive. Donor dependency does not only mean financial dependency but also strategic dependency.

As an organisation dependent on external financial resources, Pamoja has to cope with donor strategies and design its strategies according to donor requirements and not necessarily with regard to the requirements of the local communities. However, many donor agencies also depend on organisations like Pamoja to justify their own activities. In this context, there is a danger of being exploited by the donors and being forced to play according to their rules instead of doing what the organisation feels is proper.

Many activities cannot be followed up properly due to poor funding; especially working with local communities in remote areas requires a lot of travelling, which causes costs too high for many donor agencies. In some areas, local com-

munities are used to being paid allowances for attending workshops, which renders working with low budgets difficult.

Moreover, many donors have tight schedules that do not go together with slow realties in rural Tanzania. Beside finance and donor dependency another major challenge is the cooperation with government institutions. It is for example necessary to cooperate with government institutions, if someone is working with the community. The collaboration with government officials is also part of Pamoja's joint action strategy. Hence, the local government is a partner of Pamoja. Additionally, government offices invite tenders, for which Pamoja is applying. And last but not least: As Pamoja started as a district project, there are many personal connections between the Pamoja staff which used to work for the government. The fact that the government is important for Pamoja as a partner and funding institution jeopardises the watchdog function of Pamoja. However, Pamoja's approach is not that of a barking watchdog. Pamoja intends to collaborate with government institutions in order to facilitate good governance. By offending government institutions a fruitful dialogue would be made impossible, but in a dialogue constructive and fair criticism can lead to improvements.

As a part of its advocacy work Pamoja is engaged in budget tracking issues. Here, we can see a success of the dialogue approach as initial budget tracking was perceived as interference with government issues, whereas nowadays many government officials support these exercises since they see a benefit for their own work. It is commonly agreed that the culture of transparency and accountability still needs stronger support, not only at the government level. Finally, the capacity of NGOs and CBOs is a challenge. Beside the already mentioned financial constraints NGOs are facing logistical problems like insufficient transport and office facilities as well as knowledge management. There is also a lack of expertise to fulfil all the tasks NGOs encounter. This means that if qualified staff is leaving an NGO, it is difficult to find adequate successors. The old saying that when an old man dies in Africa, it is as if a library burns, can also applied to experienced staff leaving an NGO.

2.5 Conclusion

According to the Tanzanian legislation, an NGO is supposed to enhance the legitimate economic, social and/or cultural development, lobby or advocate on issues of the public interest of a group, individuals or organisations. By working on good water governance and empowering Tanzanian water users, Pamoja is fulfilling the desired role of an NGO as it is enhancing the legitimate economic, social and environmental development as well as lobbying for a sustainable and equitable water use. At the beginning of this paper, five roles of an NGO in the water sector were highlighted. As NGO, Pamoja is representing the civil society in various collaboration projects with government institutions. However, there is neither an established form of getting the mandate from the civil society to be their representative nor an established opportunity to give feedback to the civil society. Pamoja is giving feedback during the community meetings it is conducting, but there is no civil society forum to which Pamoja as self-appointed civil society representative could be accounted to.

Pamoja is much stronger in its roles of a facilitator and trainer. In many activities Pamoja facilitates the community participation in development processes and multi-stakeholder dialogues. By means of its capacity building activities Pamoja proves to be an effective trainer. Moreover, by making the water users aware of their rights and obligation through popularising the national water policy, Pamoja is fulfilling its task in advocating water issues well. Due to the Tanzanian consensus culture and the special relation to the government as a dialogue and business partner, the watchdog role is not that fierce as could have been expected.

Nevertheless, the paper has shown that there is a need for NGOs to be active in the water sector and that they can do so by delivering quality work. At present, some farmers are not equipped with machetes anymore but carry their rubberstamps to sign memoranda of understanding with former enemies, now accepted as fellow stakeholders.

2.6 References

Government of Tanzania, Ministry of Water 2002: National Water Policy.

Government of Tanzania, Ministry of Water 2005: National Water Sector Development Strategy 2005 - 2015. Final Draft.

Government of Tanzania, Ministry of Water 2006: Situational Analysis of the Water Sector in Tanzania. Final Report of the Joint Working Group on Water, 6th September 2006.

Government of Tanzania, Ministry of Water 2006: Water Sector Development Programme 2006-2025.

IUCN Eastern Africa Programme 2003: The Pangani River Basin: A situational Analysis. Nairobi: Scan House Press.

Lerise, Fred Simon, 2005: Facilitating Cross-Border Dialogue. The Case of Umba River Ecosystem in Kenya and Tanzania In: FWU, Vol. 3, Topics of Integrated Watershed Management - Proceedings, 69-88.

Ndumbaro, Laurean; and Andreq Kiondo, 2007: Defining the non-profit sector: the Tanzanian experience. In: Ndumbaro, Laurean and Saida Yahya-Othman: The third Sector in Tanzania: Capabilities and Challenges of Civil Society Organisation. Dar es Salaam Aga Khan Development Network, 6-17.

Pangani Basin Water Office 2007: Pangani River System: Sate of the Basin Report 2007. n.l.

Pangani Basin Water Office et al. 2006: Joint Cross Border Integrated Water Resources Management Program in the Lake Chala-Jipe and Umba River Ecosystem Tanzania -Kenya. A Framework for Sustainable Development.

PAMOJA Trust 2006: Organisational Landscape Kikuletwa Subcatchment, Pangani Basin. Draft for Discussion. May 2006.

Rutasitara, Longinus; and Bonaventure Ngowi 2007: Revenue Structure: a survey of non-profit organizations in Dar es Salaam and Zanzibar. In: Ndumbaro, Laurean and Saida Yahya-Othman: The third Sector in Tanzania: Capabilities and Challenges of Civil Society Organisation. Dar es Salaam Aga Khan Development Network, 80-134.

Nasim Losai holds a Master's Degree in Rural Development from Sokoine University Morogoro (Tanzania) and is working as a Program Officer for Natural Resources Management for the NGO PAMOJA Trust in Moshi, Northern Tanzania.

Jigal Beez holds a Ph.D. in Social Anthropology from the University of Bayreuth (Germany) and is currently employed by the German Development Service Tanzania and seconded to PAMOJA Trust as an advisor for the governance of water.

3 Water, Environment and Food Security, Andrew Jacob Ngereza

Andrew Jacob Ngereza[1]

[1]Mikocheni Agricultural Institute,P.O. Box 6226,
Dar es Salaam, Tanzania.
jngereza@yahoo.com

3.1 Abstract

Access to safe water is essential for addressing poverty and health problems especially in rural areas, where more than 80% of Tanzania's population lives and has limited access to clean water for domestic use as well as for crop production and adequate sanitation. Economic benefits could be achieved through health improvements and by saving time from the drudgery of carrying water over long distances. According to current information incidences of water-borne, water-related and water-washed diseases indicate that these are mostly prevalent where people use contaminated water or have little water for daily use. Since such diseases account for over half of the diseases affecting the population, the government aims for sustainable rural water supply. The management of water also involves the participation of all stakeholders in order to achieve a sustainable access, an efficient and equitable use as well as the adequate protection and conservation of water. One third of Tanzania receives less than 800 mm of rainfall and is thus arid or semi-arid. Only one-third of the rest of the country has a precipitation above 1,000 mm. However, about 7% of Tanzania's land surface is covered by lakes which border the country apart from other inland lakes. Ground water is also another source for both urban and rural water use. The largest use of water is domestic water supply.

3.2 Introduction

Poor people, most of who live in rural areas, have limited access to clean water for domestic use as well as for crop production and adequate sanitation. Economic benefits are achievable indirectly through health improvements and by saving time from the drudgery of carrying water over long distances. Existing data on the incidences of water-borne, water-related and water-washed diseases indicate that these are mostly prevalent where people use contaminated water or have little water for daily use. Since such diseases account for over the half of the sickness affecting the population, the government aims at facilitating particularly a sustainable rural water supply as more than 80% of Tanzania's population lives in rural areas. The management of water also involves the participation of all stakeholders in order to achieve a sustainable access, an efficient and equitable

use as well as the adequate protection and conservation of water. One-third of Tanzania receives less than 800 mm of rainfall and is thus arid or semi-arid. Only one-third of the rest of the country has a precipitation above 1,000 mm. Moreover, the long dry season, normally extending from June to October, has an effect on low river flows and the drying of water reservoirs. However, about 7% of Tanzania's land surface is covered by lakes which border the country apart from other inland lakes. These include Lake Victoria (the second largest fresh water lake in the world), Lake Tanganyika (the second deepest lake in the world), and Lake Nyasa. Inland lakes include the Lakes Rukwa, Eyasi and Manyara. There are also big rivers flowing into the lakes. Furthermore, ground water is another source for both urban and rural water use. The largest use of water is the domestic water supply. Due to an increase in economic activities and the delivery of social activities that utilise water in one way or another, the supply of water has become a burden which the government cannot meet without the participation of the private sector. It is the government's policy to involve the beneficiaries in all water projects both in urban and rural water supply. The water sector contribution to the GDP has remained at 0.2% for some years, a proportion which is insignificant, considering the importance of the sector to the economy. Hence, the government is encouraging private investments in the water sector. Measured by its share of contribution to the GDP, water features among the smallest sectors in Tanzania. For some years the water sector contribution to the GDP remained at 0.2%, which is very insignificant compared to what other sectors contribute, for example agriculture, which in 1999 accounted for 48.9% of the national GDP. However, water as a resource and as an area of activity plays a more important role in the social and economic development in Tanzania when one takes into consideration the linkage effects of this sector. For example, even agriculture, which is the greatest sector in all important aspects, cannot run without water. Fortunately, water in Tanzania is among the sectors with a greater growth potential. In 1999, the contribution of water to the GDP recorded a handsome increase of 3.0%. Underground water is also another important source of water for both urban and rural settlement areas.

3.3 Land Cover

The estimate of overall land use is derived from a recent remote sensing mapping exercise using the Land Satellite images covering parts of the country. However, there are efforts to produce a digital land use/cover map of the country at IRA. According to the National Reconnaissance Level Land Use and Natural Resources Mapping Project (1997), land use/cover (areas in '000 ha) in Tanzania is estimated as summarised in Table 1.

Table 1: Distribution of major land cover/use types

Land use/cover types	Area ('000 ha)	Proportion (%)
Forest	2,723	2.90
Woodland	37,436	39.6
Bushland	17,316	18.3
Cultivated land	19,360	20.5
Open land	139	0.2
Water features	7,352	7.8
Urban areas	65	0.1

Source: National Reconnaissance Level Land Use and Natural Resources Mapping Project (1997).

3.4 Land Use

The land under total cultivation amounts to 42%, 29% is under protection (national parks, conservation areas as well as game and forest reserves) and other areas are infested by tsetse flies (26% of rangeland), which restricts livestock production and the use of animal traction.
Table 2 offers a summary of cropland in Tanzania (in '000 ha).

Table2: Land use systems in Tanzania and approximate areas

Land use / Total land	Estimated Area ('000 ha) / 95.000	Percentage / 100
Total agricultural land	51,000	54.2
Actual land cultivated	10,000	10.6
Perennial cropland	1,600	1.7
Potential irrigated land	1,000	1.1
Actual irrigated land	150	0.2
Commercial farmers	560	0.6
Smallholder farmers	4,470	4.7

Source: URT (2000).

3.5 Water Basins

There is a great variation of water availability between different parts of the country. The variation is explained by differences in topography, rainfall patterns and climate. About one-third of Tanzania receives less than 800 mm of rainfall per annum and this area is considered arid or semi-arid. Moreover, Tanzania experiences a long dry season, normally extending from June to October, which results in low river flows and the drying of water reserves. Surface water resources in Tanzania consist of lakes, rivers, springs, man-made reservoirs and natural ponds. Considerable water resources exist in the country's lakes, namely Tanganyika, Nyasa, Rukwa, Eyasi and Natron. About 50% of the surface runoff water is derived from the main rivers flowing directly to the Indian Ocean, including Pangani, Wami, Mkondoa, Ruvu, Rufiji, Ruaha, Kilombero, Mbarangandu, Matandu, Mbwemkulu, Lukuledi and Ruvuma. The remaining 50% are divided into the following classes: surface water drainage into the main internal drainage basins, which have no outlet to the sea (Lake Rukwa, Bubu depression complex, Lake Eyasi and Lake Manyara), others flowing into Lake Victoria (Meri, Maru and Kagera Rivers), River Malagarasi draining into Lake Tanganyika, and the Rivers Songwe and Ruhuhu draining southwards into Lake Nyasa and the Zambezi River system. Tanzania encompasses 5,439,000 ha of lakes and swamps, which represent 5.8% of the total land surface, but this number excludes season-

ally inundated flood plains.

Tanzania is divided into five major drainage systems and these are (1) the Indian Ocean drainage system, (2) the internal drainage of the Lakes Eyasi, Natron and the Bubu depression complex, (3) the internal drainage of Lake Rukwa, (4) the Atlantic Ocean drainage system, and (5) the Mediterranean Sea drainage system. Ground water is a major source of water for many areas in Tanzania and actually the most viable alternative supplement in the central and northern parts of the country as well as in the drier regions of Dodoma, Singida, Shinyanga, Tabora, Mwanza, Mara, Arusha, Coast and Southern Kilimanjaro.

3.6 Water Sector

The water sector development in Tanzania is governed by the water sector policy. The current water sector was issued in 1991. However, the government has recently embarked on a policy reform programme that covers the entire social, economic and political body, including the water sector. Therefore, the water sector policy is supplemented by the water sector reform programme, which is still going on. It works on improving the policy as well as the sector management and operational setup. Overall, the water policy in combination with the ongoing sector reform stipulates the following aspects: water considered as a basic need; the government's aim to achieve equitable access to and an adequate sustainable supply of clean and safe water both in rural and urban areas; the policy's goal to ensure universal access to a clean and safe water supply within a distance of 400 metres from people's homes; water development and supply as a liberalised area of work. All potential actors, for example communities, the private sector and NGOs, local and foreign, are allowed and encouraged to engage in water projects (especially by means of investing) to supplement governmental efforts in the development and delivery of water supply services. The government will make efforts to promote the active participation of the private sector and beneficiaries in service delivery in order to improve efficiency, effectiveness and to enhance the sustainability of the services.

While the water sector is a liberalised area of work for all types of institutions interested, the government, through the ministry responsible for water, also has

the following main responsibilities and functions: to develop, review and further improve the water and sanitation policy; to facilitate, coordinate, monitor and regulate the provision of water and sanitation services to the public with a gender perspective; to develop competent sector professionals of high integrity. The regulatory and institutional framework for water resources management is provided by the Water Utilisation (Control and Regulation) Act. No. 42 of 1974, referred to as the Principal Act, and its Amendment Act No.10 of 1981 as well as by the Written Laws (Miscellaneous) Act. No. 17 of 1989 and the General (Regulations) Amendment. The amended act declares that all water in the country is vested in the United Republic of Tanzania, sets conditions on the use of water and authorises the Principal Water Officer to be responsible for setting the policy and allocation of water rights at the national level. As for the designated water drainage basins with established Basin Water Offices, they lie under the responsibilities of the Basin Water Officer. Currently, much of the water in Tanzania is used for domestic purposes. The population (about 80%) lives in the rural areas and only the remaining 20% live in urban centres. Consequently, much of the water is used in the rural areas. Yet, despite the greater resource potential, many of the sources remain undeveloped and a good proportion of the population uses water from undeveloped and crudely developed sources: lakes, rivers and ponds, shallow and open wells. Until the year 1999, only 45% of the rural population and 68% of the urban population had access to clean and safe water supply. While these figures are only national averages, the situation varies a great deal among different geographical locations. With regard to sewerage services, many urban areas continue to be affected by poor sanitary services. Only about 7% of the urban dwellers are connected to the existing water-piped sewerage system, which so far is established only in a few towns where it generally was constructed a long time ago - owing to the country's development policy which for a long time has put major emphasis on the development of social service sectors, including also the water sector; owing also to the water policy that has been encouraging other stakeholders than the government to engage in water sector development activities. Today, Tanzania has a long list of institutions, both public and private, working in the development and delivery of water and sanitation services. There are factors which denote the use of the existing greater potential and opportunities for investment in the water sector now and for several years to

come. These include the following: the greater unexploited water resource potential; the growing demand for water sector services that is still unmet; and the increasing demand since both the population and the quest for socio-economic developments in Tanzania are also growing.

3.7 Major Environmental Problems in Tanzania

3.7.1 Land Degradation

Land degradation, including loss of soil and desertification, is an increasing problem in Tanzania. It is estimated that 30% of the territory is affected by the loss of soil, especially in Shinyanga, Dodoma, Morogoro and Arusha. Major factors of land degradation are natural constraints, improper cultivation, the rapid population growth, logging for fuel woods and land tenure issues. Human impacts on deforestation, soil erosion, overgrazing, the degradation of water resources and the loss of biodiversity have all resulted in land degradation. Poor agricultural practices such as shifting cultivation, the lack of crop rotation practices and of agricultural technology and land husbandry techniques exacerbate the problem. Liviga (1999) contends that the effects of overstocking, which are localised, give rise to serious degradation in places such as Shinyanga and Mbulu, where livestock units have exceeded the carrying capacity. Land degradation is seen as a good indicator for the success of decentralised institutions at the local level to enforce laws and instruments which are meant to ensure a sound environmental management.

The government has driven forth several initiatives for soil conservation through the Natural Resources Board, the Range Development Commission and the National Land Use Planning Commission. Programmes to combat land degradation on district and regional bases are presented in the following:

- Environmental Conservation in Babati District
- Kigoma and Rukwa Integrated Development Programme
- Hifadhi Ardhi Dodoma (HADO) and Shinyanga (HASHI) Soil and Water Conservation Project

- Hifadhi ya Mazingira (HIMA) Soil and Water Conservation Programme in Iringa Region
- Soil Erosion Control and Agroforestry Programe (SECAP) in Lushoto
- Soil Conservation and Agroforestry Programme (SCAPA) in Arumeru District

3.7.2 Pollution Management and Urbanisation

Pollution is a major problem in urban areas of Tanzania. Improper treatment and disposal of solid and liquid wastes are the major contributors to urban area pollution. The combined results of these problems are that both air and water have been contaminated and have consequently become detrimental to human health. In Dar es Salaam, for example, less than 5% of the population is connected to a sewage system. Where a sewage system exists, raw sewage is discharged directly into the Indian Ocean without prior treatment. Thus, an appropriate water supply and sewage treatment is needed for the urban areas.

Air Pollution

It can be said that air pollution has not occurred yet, though data and monitoring results are insufficient to evaluate the extent of air pollution. 80% of the factories are concentrated in Dar es Salaam, where air pollution by industry possibly occurs. Air pollution by mobile sources such as vehicles is currently slight, but it will become a problem as the vehicle fleet increases in future.

Water Pollution

At present, pollution in major rivers turns out to be as follows:

- Pangani Basin: more than 6 industries in Arusha, Moshi and Tanga pollute the river;
- Sigi River: BOD is more than 135 mg/L;
- Ngerengere River: more than 5 industries discharge effluent into the river;

- Msimbazi River (in Dar es Salaam): BOD is more than 50 mg/L;
- Rufiji Basin: industries discharge effluent into the river.

The Iringa municipality discharges 1,470 m^3/day of domestic waste water into the Ruaha River. Moreover, Iringa and Mbeya consume about 38,000 and 49,000 tons of fertilisers per annum, respectively.
Most of the industries in Morogoro and Dar es Salaam do not have waste water treatment facilities. Notably, Lake Victoria and the Sigi River are covered by water hyacinth.

Solid Waste Management

84% of solid waste generated in urban areas is not collected. 60% of this portion is domestic waste that is buried or burned. Waste is generated also in informal settlement areas. In Dar es Salaam, collected solid waste is transported and dumped in the Vingunguti solid waste disposal site, which causes the contamination of soil and ground water due to leachate from the dumped waste.

3.7.3 Agricultural and Rangeland Resources Management

Agriculture and rangeland resources are the backbone of Tanzania's economy. It is estimated that about 55% of the land could be used for agriculture and over 51% for pastoral lands. However, only about 6% of the agricultural land is cultivated through the practice of shifting cultivation, which causes deforestation and land degradation. The Lake Manyara Basin, the Geita Gold Mines, the Usangu Wetlands and the Ngorongoro Conservation Areas have been particularly affected by inadequate control and land management.

The main cause for these problems consists in the lack of proper instruments for the enforcement of the existing legislation, policy and by-laws by local authorities. Again, where the mandates of central and local institutions on environmental management are weak, conflicting and confusing, the enforcement of laws and implementation plans becomes difficult, if not impossible.

3.7.4 Management of Forest Resources

Forest resources provide both direct products and by-products. The forest reserves are also linked with agriculture, beekeeping, energy, water uses and biodiversity. It is estimated that fuel wood and agricultural residues account for 92% of the total energy consumption in the country. As a result, the mismanagement of fuel resources significantly contributes to deforestation and environmental degradation. Hence, the central and local governmental institutions' inability to solve the problem has to be highlighted.

3.7.5 Management of Wildlife Resources

Tanzania is one of the few countries with vast numbers of wildlife resources. For example, Tanzania's "protected areas" cover about 25% of the total land (Nshala, 1999). The protected land is comprised of national parks, game reserves, game-controlled areas and the Ngorongoro Conservation Area. Unfortunately, communities living around these protected areas do not benefit from the wildlife industry. They live under uncertain conditions, affected by persistent attacks and the destruction of their crops by wild animals. This has resulted in an antagonistic relationship between the wildlife authorities and the local populace. Local communities resort to activities like poaching to gain benefits from the wildlife and other natural resources. This is a direct result of the central government policy of excluding local communities from wildlife management.

3.7.6 Management of Mineral Resources

With respect to mineral resources, a Joint Appraisal Mission Report (1999) noted conflicting authorities on matters regarding mineral prospecting and mining. Additionally, local authorities have a minimal role in the mineral resource management process, despite the fact that mineral depletion is occurring in the local communities' area. Any attempts made by local authorities to make by-laws, for example imposing mineral levy, have been met with an "outcry of double taxation" by mineral concessionaires against both the central government and the local authorities.

The Tanzanian economy depends upon mineral resources as a major source of

its revenues. However, mineral exploitation is often done without regarding environmental and social impacts. Thus, the Mining Act of 1998 addressed this problem and required mining companies to conduct environmental impact assessments. Mining activities are the major causes of environmental degradation by deforestation as well as of habitat destruction, loss of biodiversity and general damage to the land.

3.8 Recommendations

- Setting regulations as far as water use is concerned, for example the Regional Water Offices (RWO) taking care of water users in the basin;
- improvement of soil water conservation strategies through utilisation of crop residues;
- applications of traditional water harvesting techniques such as Majaluba systems in rice production and Vinyungu irrigation systems;
- sustainable use of water resources from different sources;
- construction of dams for irrigation and livestock;
- cultivation of drought-resistant crops such as sorghum and cassava in semi-arid and arid areas;
- instituting and strengthening the implementation of a "polluter pays" principle in order to minimise (particularly industrial) pollution;
- establishing regulations and guidelines for the disposal of hazardous wastes (including expired chemicals) and ensuring their implementation;
- offering incentives for pollution control in order to foster reduction and recycling of waste at all levels;
- educating farmers on better farming practices, including environmental and health risks associated with poor farming methods as well as agro-chemical use and abuse;
- establishing the capacity to monitor and deter principal polluting activities.

3.9 References

Country Profile on Environment -Tanzania (1997). JICA.

Division of Environmental (1997). Country profile: Implementation of the Agenda 21 - Review of the progress made since the United Nations conference on Environment and Development (1992), April 1997.

Mato, R.R.A.M.; & Kassenga, G.R. (1997). A study on the problems of management of medical solid wastes in Dar es Salaam and their remedial measures, resources. Conservation and Recycling, Vol. 21, pp. 1-16.

Murray-Rust, D.H. (1973). Soil erosion and reservoir sedimentation in grazing areas west of Arusha, Northern Tanzania. Research Monograph No.1. BRALUP, University of Dar es Salaam.

Mwandosya, M. J.; & Meena, H.E. (1998). Dar es Salaam Water Demand and End-use perspective. CEEST, Dar es Salaam.

National Environmental Management Council (1997). National Environment Implementation Assessment Procedures and Guidelines. Final Draft. Dar es Salaam, Tanzania.

NEMC (April 1995). Tanzania National Conservation Strategy for Sustainable Development (NCSSD). Revised Proposal.

Ngana, J. O. (1983). Rainfall and Agriculture, Drought and Famine in Dodoma District, Tanzania. IRA Publication.

United Republic of Tanzania (1995). Ministry of Water, Energy and Minerals, Water and Sanitation Sector Review, Final Report, pp. 45-46.

United Republic of Tanzania (1997). Agricultural and Livestock Policy. Ministry of Agricultural and Cooperative Development.

United Republic of Tanzania (2000). Soil Fertility Initiative. Ministry of Agriculture and Cooperative Development. Report No. 00/081 CP-URT.

World Development Indicators (1999). The World Bank.

4 Anthropogenic Impacts on Water Resources in the Lake Naivasha Basin, Kenya, Simon Mang'erere Onywere

Simon Mang'erere Onywere[1]

[1] Kenyatta University
Department of Environmental Planning and Management
P.O. Box 43844 Nairobi
onyweres@yahoo.com

4.1 Abstract

This study investigated the anthropogenic activities in the Lake Naivasha Basin and how they influence the quality of water resources. The quality of the water within the lake can be derived from the persistent presence of water hyacinth (Eichhornia crassipes), which reflects a high nutrient content in the lake's water. Water hyacinth is an invasive aquatic macrophyte associated with major negative economic and ecological impacts in the Lake Naivasha area. The intensity of land use within the basin was mapped from the land cover change, which in turn was interpreted from multispectral Landsat satellite imagery of 1986 (TM 30 m resolution) and 2000 (ETM 28.5 m resolution) as well as from SPOT imagery of 2007 at 10 m resolution. Thus, the surface area of the main lake has decreased by 12.89% from $134.937km^2$ in 1986 to $117.545km^2$ in 2007. Papyrus, water hyacinth and wetland/grassland areas along the lake have decreased by 37.17% from $54.624km^2$ to $34.318km^2$. The horticultural and irrigated farm area has increased by 103.25% from $45.097km^2$ to $91.66km^2$ in the same period, placing great pressure on both the quality and quantity of the water resources. The pieces of information obtained from the Lake Naivasha Fisheries Department showed a reduction of the total fish production from 513 to 110 tons in the period under consideration (a 22% decrease). The Naivasha Municipal Council records indicated a 30% decline in the water amount supplied to the town of Naivasha from $10.000m^3$ to $7.000m^3$ in the same period. These cutbacks were attributed to many factors, including the presence of water hyacinth and the decline in water quantity.

4.2 Introduction

Lake Naivasha occupies an important position in Kenya's economy because of the multi-million cut floor industry flourishing in the riparian areas of the lake. Additionally, it is an important area for the production of fish, livestock and geothermal power as well as the main water source for domestic use and irrigation activities around the lake. It is also an important tourist attraction as well as a site for boating and water sports. Because of its biodiversity it was identified and classified a Ramsar site in 1995 as a wetland of international importance

(www.wetlands.org/RDB/Ramsar_Dir/Kenya/ke002D02.htm) and is therefore a protected site. The lake is a fresh water lake in an otherwise marked series of alkaline lakes in the Rift Valley floor. The lake's freshness can be attributed to incoming water from the Rivers Malewa and Gilgil, to the loss of solutes through seepage into the surrounding pumiceous formations, and to some extent to geochemical and biochemical sedimentation. Melack and Gaudet (1981), in their study on major ion chemistry in the tropical African basin area, estimated the amount of water loss by seepage from Lake Naivasha to amount to 5% (1973), 11% (1974) and 20% (1975) of the total water loss.
Despite its importance, the lake faces enormous challenges from anthropogenic activities. In particular, the urban, peri-urban and rural populations have placed pressure on the lake's resources (water, fish, wildlife and forest). The diverse farming activities within the lake's basin affect the quantity and quality of water. This is reflected in high levels of siltation and pollution of the surface water as can be seen from the presence of high levels of nitrates, phosphates, BOD and the turbidity of the water. Thus, these aspects induce a lack of adequate clean water supply to the riparian communities.

The principal surface influx to Lake Naivasha stems from the north, down the Bahati and Kinangop escarpments through the Gilgil and Malewa Rivers, respectively, and covers an area of $3320 km^2$. The Malewa River contributes about 90% of the discharge into the lake and most of the rest is contributed by the Gilgil River (Aloo, 1996). Within the catchment there are alarming trends of land cover destruction resulting in negative impacts on the lake and in the proliferation of water hyacinth infestation. This project aimed at the assessment of land cover changes caused by agriculture, horticulture and urban settlement activities that contribute to the impairment of the water quality. An adequate understanding of the anthropogenic dynamics should guide integrated planning and natural resources management in the Lake Naivasha Basin.

4.3 The Study Area and its Setting

The Lake Naivasha area is dominated by quaternary volcanic ash and pyroclastic deposits in the plain areas and by some volcanic tuff and lava flow in the higher escarpments. The larger part of the basin around the lake is, however,

underlaid by lacustrine sediment deposits, most of which are conspicuously exposed at the Ol Njorowa Gorge (Clarke et al., 1990). There are volcanic centres within the basin which are associated with a belt of Holocene volcanism that includes the Longonot, Eburru and Lake Elmenteita volcanoes dated by Clarke et al. (1990) at 0.4 and 0.45 Ma. There were four major periods of volcanicity and faulting (Baker, 1986). The most recent eruptions in the area are reported to be 2000 years old (Thompson & Dodson, 1963). The Longonot volcano constitutes the Longonot volcanic group which incorporates seven formations (Clarke et al., 1990; Thompson & Dodson, 1963). The Olkaria volcanic complex is dominated by alkali rhyolite (comendite) lava and pyroclastic rocks. The Lake Elmenteita lava flows mainly consist of basalts and ash tuff, whereas the Eburru complex is dominated by trachytes. Widespread trachytic pyroclastics and tuff are located in the Kinangop escarpment. The youngest of the lavas (Ol Obonge at Eburru, and Ol'lolbutot at Olkaria) are small and located along fissures. They are a result of the last volcanic eruption in the area approximately 200 years ago. The lithosphere is thinned out and features an occasionally high temperature (Wendlandt & Morgan, 1982)

The geology of the area is generally composed of volcanic rocks and lacustrine deposits. In the basin there are complex geological structures, which have been subjected to several tectonic processes. The volcanic rocks consist of basalt, trachytes, ashes, tuffs as well as of agglomerates and acid lava. The lake bed mainly consists of volcanic material and deposited pyroclastics and ashes forming lacustrine sediments (Baker, 1986). The southern part lying within the catchment of the lake falls within the Greater Olkaria volcanic complexes which are made up of pyroclastics. Craters, fumaroles, hot springs and steam vents are found in several places in the Olkaria complex and the Eburru complex area.
The substrate in the Lake Naivasha area is composed of porous, permeable surfaces of volcanic ashes, pumiceous pyroclastics and faulted lava and tuff. This has influenced the soil formations that are mainly of pumecious ash origin. At the rift floor further influence comes mainly from volcanic eruptions of Longonot, Eburru, Kijabe and Olkaria. The earlier tectonic geology is reflected in the step-faults of Satima and Kinangop generating the Kingop plateau. Grid faulting has generated the Gilgil plateau. The Mau fault on the western escarpment is associated with flextures which have generated the Mau hills. These major

fault escarpments influence the topography (Onywere, 2005) of the rift floor and in general reflect the tectonic structure of the East African Rift Valley system which, in Kenya, is dominated by:

- an up-arched dome whose peak is at the Bahati fracture zone;
- alkaline volcanism, 2-3 km thick and composed of pumiceous pyroclastics, ashes, trachytes, ignimbrites, phonolites and phonolitic trachytes (Ebinger et al., 1987);
- faults arranged in echelon patterns influencing the drainage flow pattern; and
- intense rifting at the rift axis shown by a series of anatomising and bifurcating faults.

The major faults are by and large traceable from satellite images and reveal the structure of the terrain and the lines of surface runoff. The landform features of the Mau-Kinangop escarpments, the Gilgil plateau, the Kinangop plateau and the interior drainage basins of the Lakes Elmenteita, Naivasha and Ol Bolossat are seen in the Shuttle Radar Topographic Mission (SRTM) data of the basin (figure 4.1). The landforms influence the movement and accumulation of surface and sub-surface waters and subsequently the ground water flow. They also influence the rainfall patterns in the area.
Meteorological observations from six stations (Kwetu Farm, Gilgil - 0°21'S, 36°18'E, 1020.9 mm; Gilgil Railway Station - 0°30'S, 36°20'E, 635.5 mm; Kinangop Forest Station - 0°35'S, 36°38'E, 1154.6 mm; Naivasha KCC - 0°40'S, 36°23'E, 631.2 mm; Naivasha District Officer's Station - 0°43'S, 36°26'E, 670.9 mm; Kerita Forest Station - 0°59'S, 36°38'E, 1382.1 mm) averaged over a 30-year-period range from 630 mm at the Lake Naivasha shore area to 1380 mm at the Aberdare ranges (KMD, 2001). The rainfall pattern exerts important influences on the discharge from the catchment, the vegetal cover and the pattern of agriculture. Due to a hot, dry and windy climate in the Naivasha section of the Rift Valley, the annual evaporation loss (2060 mm) exceeds by far the annual mean precipitation of 852 mm. There is also a low rainfall reliability making rain-fed agriculture a challenging task. Ase et al. (1986) estimate that a low relative humidity and an average daily maximum temperature of 25°C tend to cause

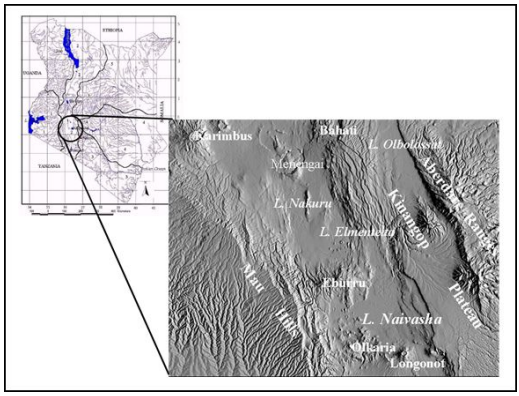

Figure 4.1: Location of the study area and SRTM DEM data of the Lake Naivasha area (Source: USGS Geodata Warehouse Africa).

an annual potential evaporation of 1500-1900 mm/year which is far in excess of rainfall. As reported by Gaudet and Melack (1981), the water loss by means of evaporation is high. Therefore, the area within the rift floor has a semi-arid climate and falls into the agroclimatic Zones III and IV in the Rift Valley floor. The most suitable farming system could be considered rangeland agriculture, but irrigation agriculture using ground water and water from Lake Naivasha and the Malewa River is largely practised.

4.4 Hydrology/Hydrogeology

The hydrogeology of the Lake Naivasha Basin is greatly influenced by the geology, topography and climatic factors. The topography and volcanicity in the area create three different hydrogeological regimes. Structural features such as faults often optimise storage, transmissivity and recharge, with the significant of these occurring in places that are adjacent to or within the surface drainage system. In the valleys, a shallow ground water table, low precipitation and low values of recharge are often envisaged. The density of fracturing of the drainage basin and its proximity to the Aberdare and Kinangop Catchments is important

in influencing the river and ground water recharge. Near surface aquifers are patched in surface lavas and tuff and pyroclatsic sediment at a depth between 50 and 150m. These are located along the plateau and within the riparian areas of Lake Naivasha. Many of the linear fractures run perpendicular to the drainage lines and intercept these. Moreover, they are used for the diagnostics of permeable fractures and recharge zones into deeper aquifers. In the Ndabibi area for example, the fractures intercept all the drainage flowing in from the Mau hills and the Eburru volcanic complex, never allowing the surface discharge to reach the lake. The fractures can be considered the most important factor influencing the depth of the aquifers, which in the Ndabibi area are at a depth of 100-300m, forming the middle aquifers that probably also provide the ground water recharge into Lake Naivasha.

Where the ground water comes into contact with the eruptive fissure zones - these are associated with cinder and caldera volcanism - as well as with related major fault zones and fractures, they manifest themselves as geothermal resources now under exploitation at the Olkaria geothermal station. Here, the depth of the geothermal aquifers from the records at the Olkaria geothermal station ranges between 900 and 2500 m. These are the deep geothermal aquifers. Along the Eburru and the Olkaria volcanic complexes scattered warm springs can be seen, rising from underneath lavas and the N-S trending fissures. Some of the fumaroles from the geothermal activity in Olkaria and Eburru are condensed for domestic consumption.
Aquifers are normally found in the fractured volcanic rocks and at times along weathered contacts between different lithological units. They are often confined or semi-confined with a low storage coefficient. The main aquifers are the lacustrine volcanic and sedimentary rocks. The permeability is generally low in the rift but there exist local variations as a result of some formations. Clark et al. (1990) estimated by inventories of boreholes that the lake sediments have a permeability of 12-148 m/d. However, aquifers with a relatively high permeability are found in sediments covering parts of the rift floor and are often unconfined with a high specific yield. Data from existing boreholes and wells reveal complex hydrogeological conditions and the depth to water table varies throughout the basin but generally ranges from 1.3 m at the lake shore area to about 240 m. The estimated hydraulic conductivity averages 10 m/day and the well yield constitutes 3 l/s/m

on average.

4.5 Methodology

Spatial image analysis techniques were used to map the land cover patterns from the three images: Landsat TM of 28/1/1986, Landsat ETM of March 2000 and SPOT of May 2007 centred at Lake Naivasha. The images were used to delineate the land cover classes. Image preparation, projection, registration and enhancements were done using the ERDAS Imagine image processing software. The statistical treatment of the satellite images of the study area used bands 1+2 (green) average, 3 (red) and 4 (infrared) which showed good contrast in the terrain features. The topography revealed the structure of the terrain and the lines of surface runoff. The vegetation cover mainly occurred on volcanoes or at the escarpments and along the riparian zones. The GEOVIS software was used to cartographically extract the terrain elements that constituted the land cover units. ArcView/ArcGIS and the visualisation capability of the ArcView 3D Analyst were used to further analyse the interpreted data and to compute the areas of each land cover unit as well as to develop the layouts for presentation. The tool was also used to select an appropriate symbolisation and to change the appearance of the map. Large-scale printouts of FCC were generated for the land use/land cover mapping in the field. The digital data were compiled, stored and analysed using ArcGIS.

Samples of water from selected boreholes and parts of the lake were taken to establish the water quality. The depth to the rest level of the water in the boreholes was measured to determine the depth to the aquifers. Field observation was performed to record the extent of the impacts caused by anthropogenic activities. Borehole water level measurements were conducted during sampling in the months of May and October 2006. Sampling parameters included in-situ measurements of water characteristics for the water quality analysis. The chemical analysis of the surface and ground water comprised temperature, pH, conductivity, total dissolved solids (TDS), alkalinity, total hardness, chloride, sulphate, nitrate, ammonia, phosphate, total suspended solids (TSS) and major cations.

4.6 Results and Discussion

The high degree of reflectance contrast of the study area parameters enabled the extraction of the 34 terrain parameters (land cover units) shown in figures 4.2, 4.3 and 4.4 as well as in figure 4.5. The topographic variations and the vegetal cover dictated the nature of the parameters. There was strong variance among water, riparian vegetation, deciduous bush, bare ground, horticultural cultivation, irrigated units, papyrus and water hyacinth, which facilitated their delineation. The river drainage lines dissecting through the escarpments could also be easily delineated. The image data were visually interpreted based on tonal values, texture and structure. The areas perceived to have similar characteristics were grouped into one class and digitised. The area coverage of the 34 specific land cover classes was computed. The data were then grouped into 9 large classes (table 2) to give a broader picture of the changes taking place in the basin. The image and the resulting digitised maps are shown in figures 4.2, 4.3 and 4.4.

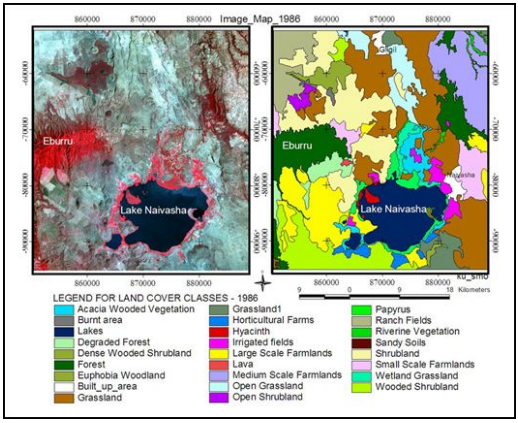

Figure 4.2: Image and land cover map extracted from Landsat TM image of January 1986

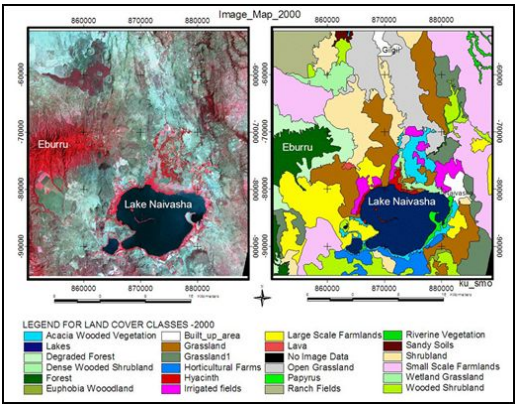

Figure 4.3: Image and land cover map extracted from Landsat ETM image of March 2000

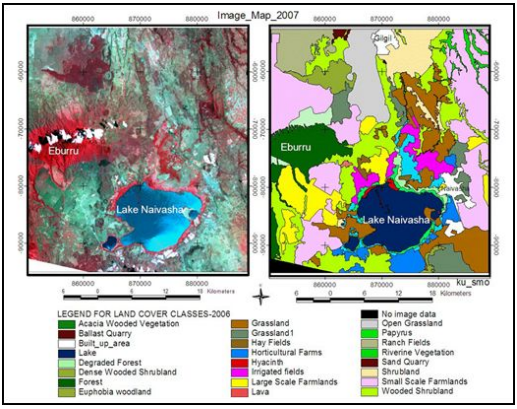

Figure 4.4: Image and land cover map extracted from SPOT image of May 2007

Interpretations from the time series image data of 1986, 2000 and 2007 show that the wider lake Naivasha Catchment comprises small- and large-scale subsistence, cash crops and rain-fed agriculture mainly located in the Kinangop plateau and

SUB-CLASSES	1986 (km^2)	2000 (km^2)	2006 (km^2)	1986-2000 % increase	2000-2006 % increase	1986-2007 % increase
Acacia Wooded Vegetation	37.125	46.176	35.607	24.28	-22.89	-4.09
Euphobia Woodland	4.124	2.701	4.913	-34.51	81.9	19.13
Wooded Shrubland	111.668	79.622	226.911	-28.7	184.99	103.2
Degraded Forest	33.03	65.884	20.197	99.47	-69.34	-38.85
Dense Wooded Shrubland	27.601	28.869	32.944	4.59	14.12	19.26
Eburru Forest	83.534	66.007	88.696	-20.98	34.37	6.18
Mau East Forest	8.624	9.65	9.367	11.89	-2.93	8.62
Kinangop Forest	49.539	-	-	Present	Obliterated	Obliterated
Riverine Vegetation	10.701	10.856	19.051	1.45	75.49	78.03
DENSE VEGETATION	365.946	309.765	437.686	-15.35	41.30	19.60
Grassland	311.868	192.08	172.58	-38.41	-10.15	-44.66
Grassland1	43.317	101.204	70.573	133.64	-30.27	62.92
Hay Fields	-	-	7.666	-	-	-
Open Grassland	59.806	145.383	84.826	143.09	-41.65	41.84
Open Shrubland	10.952	-	-	-	-	-
Shrubland	201.333	141.678	72.714	-29.63	-48.68	-63.88
Ranch Fields	68.91	57.118	57.361	-17.11	0.43	-16.76
GRASSLAND	696.186	637.463	465.72	-8.43	-26.94	-33.10
Hyacinth	6.555	8.972	4.371	36.87	-51.28	-33.32
Papyrus	31.948	8.176	17.712	74.41	116.63	-44.56

Figure 4.5: 34 land cover units extracted from the satellite imagery of the years 1986, 2000 and 2007

the Ndabibi area. The riparian area around the lake is mainly under horticulture farming. The following conclusions can be drawn from the comparison of the image data from 1986 and 2007:

- Most of the rift floor is marked by thick grassland, scattered grass and scattered bushes, which have reduced by 33% from $696km^2$ to $466km^2$ due to increased agricultural activity.
- The area of Lake Naivasha under open water has decreased from $135km^2$ to $118km^2$ - a decrease of 13%.
- The horticultural and irrigation activities around the lake have increased from $45km^2$ to $92km^2$ (103%).
- Lake Naivasha is fringed by a belt of water hyacinth, papyrus and some wetland vegetation of mainly yellow fiver acacia, which overall has decreased by 37% from $55km^2$ to $34km^2$.

Wetland Grassland	16.121	12.186	12.235	-	-	-
WETLANDS	54.624	29.334	34.318	-46.30	17.0	-37.17
Crater Lake	0.165	0.165	0.099	0	-40	-40
Lake Elmenteita	0.0223	0.106	-	-	-	Receded
Lake Naivasha	134.937	131.172	117.545	-2.79	-10.39	-12.89
Lake Ololdian	5.543	5.429	4.29	-2.06	-20.98	-22.61
SURFACE WATER	140.6673	136.872	121.934	-2.60	-10.91	-13.32
Horticultural Farms	17.701	38.923	45.49	119.89	16.87	156.99
Irrigated fields	27.396	39.289	46.17	43,41	17.51	68.53
IRRIGATION	45.097	78.212	91.66	73.43	17.19	103.25
Large Scale Farmlands	145.489	140.724	105.31	-3.28	-25.17	-27.62
Medium Scale Farmlands	114.14	-	-	-	-	-
LARGE FARMLANDS	259.629	140.724	105.31	-45.80	-25.17	-59.44
Small Scale Farmlands	58.851	277.772	329.211	371.99	18.52	459.4
FARMLANDS	318.48	418.496	434.521	31.40	3.83	38.44
Gilgil Township	7.549	10.657	14.249	41.17	33.71	88.75
Naivasha Township	12.645	14.876	24.297	17.64	63.33	92.15
URBAN	20.194	25.533	38.546	26.44	50.96	90.87
Lava	1.598	1.725	1.482	7.95	-14.09	-7.26
Sandy Soils	0.139	4.566	4.169	3184.89	-14.04	2723.74
Ballast Quarry	-	-	0.266	-	-	New
ROCK	1.737	6.291	5.917	262.18	-5.95	240.64
Burnt Area & No Image Data	4.664	2.468	13.936	Event	-	-
TOTAL AREA	1650.255	1644.328	1644.328	TOTAL	TOTAL	TOTAL

Figure 4.6:

SUB-CLASSES	1986 (km²)	2000 (km²)	2006 (km²)	1986-2000 % increase	2000-2006 % increase	1986-2007 % increase
DENSE VEGETATION	365.946	309.765	437.686	-15.35	41.30	19.60
GRASSLAND	696.186	637.463	465.72	-8.43	-26.94	-33.10
WETLANDS	54.624	29.334	34.318	-46.30	17.0	-37.17
SURFACE WATER	140.6673	136.872	121.934	-2.60	-10.91	-13.32
IRRIGATION	45.097	78.212	91.66	73.43	17.19	103.25
LARGE FARMLANDS	259.629	140.724	105.31	-45.80	-25.17	-59.44
Small-Scale Farmlands	58.851	277.772	329.211	371.99	18.52	459.4
FARMLANDS	318.48	418.496	434.521	31.40	3.83	38.44
URBAN	20.194	25.533	38.546	26.44	50.96	90.87
ROCK	1.737	6.291	5.917	262.18	-5.95	240.64

Figure 4.7: Nine broad land cover classes grouped from the 34 cover classes

- Farming activities have seen a change from large-scale to small-scale activities. Overall, more land has been used for agriculture with an increase of 38% from 318km^2 to 435km^2 and small-scale farming has increased from 59km^2 to 329km^2 - an increase of 459%.
- The growth of urban settlements amounts to 90% (from 20km^2 to 39km^2).
- The 49km^2 of forest cover present at the Kinangop plateau in 1986 were completely obliterated by 2000.

The land cover interpretation indicates that since 1986 the nature of agriculture around the lake and its catchment area has changed drastically from ranching-based agriculture to horticultural cultivation (figure 4.8a) and small-scale subsistence agriculture. The commercial activities surrounding the floriculture industry provide employment opportunities and have therefore led to an influx of people into Naivasha township and its surroundings. Naivasha is one of the most populated divisions in the country with a population of 175.457 and a density of 98 in 2002 (District Statistics Office, Nakuru, 2001). This is a tremendous rise from a population of 20.000 about 20 years ago. By 2006 the population had grown to 300.000 with the majority being employed in the flower farms. Thus, despite the riparian area of the lake supporting high numbers of human inhabitants, its vitality has raised concern. Former livestock rearing and ranching areas have given way to large irrigated horticulture around the lake and arable farming in the ares of Ndabibi (figure 4.8b) and Kinangop. Traditionally, the lake was used for watering livestock (Becht & Harper, 2002). All the activities take place in the catchment areas of the lake and exert impacts on the natural rhythm of the lake in terms of water level fluctuations as reflected in the decreased surface area of the lake. The lake's ecology is also changing as reflected in new faunal characteristics such as the presence of flamingoes in Lake Ololdian - the small lake in the Lake Naivasha system (figure 4.8c).

The ecology of the lake is also seen in the persistent presence of water hyacinth (figure 4.8d) in spite of some control measures. The presence of water hyacinth and the sediment loading has increased the necessity of water treatment for domestic supply. This has coerced the Naivasha Municipal Council into reducing its water supply capacity by 30% from 10.000m^3 to 7.000m^3 at present. Generally, the water has a high turbidity so that full conventional treatment is essential

before domestic use. However, livestock can make use of the water directly without treatment. The town has been growing at a very high rate while the provision of basic facilities has not been expanded at the same rate to serve the population. Consequently, the municipality is unable to cope with the present challenges. It follows that the town of Naivasha is already a water deficit area. The water supply systems can only meet 50% of the water requirements. Other demographic pressures are mainly peremptory exploitation of the forest cover and other vegetation for agriculture, grazing, sources of construction materials, food and fuel wood.

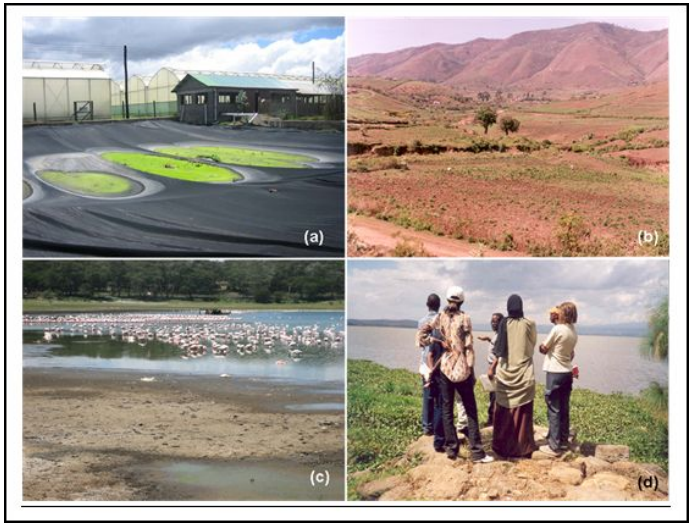

Figure 4.8: Impacts of the changing land use patterns: (a) horticultural activities; (b) intense arable farming in the Ndabibi area; (c) emergence of flamingoes in the small lake (Lake Ololdian) - note the receding water levels; (d) fringe of water hyacinth in Lake Naivasha combined with a higher turbidity of the water

Water level changes and pollution in Lake Naivasha have been of wider interest over many years, initially because of scientific curiosity about the causes of extreme fluctuations, but lately for the lake's economic value to irrigation as well

as to the supply of water to its environs. The receding lake is occasioned by a higher sediment load and lower water levels caused by abstraction for irrigation activities. The high evapotranspiration and over-abstraction of the lake waters are reflected by the changing chemistry of the water in the lake, which now has a mean conductivity of 368μ S.cm-1 compared to that of the borehole waters of 715.7μ S.cm-1 and that of the river waters at 107.1μ S.cm-1 from the in-situ-measurements (table 3) made in May 2006. From the pH measurements (8.36), it can be derived that the lake water tends to become alkaline, which, inter alia, is leading to the growth of blue-green algae and tiny crustaceans, a suitable food for flamingoes. In comparison to the main lake, Lake Ololdian now shows deferring water quality variation parameters. As seen from the water characteristics (table 3), the ground water chemistry of boreholes indicates that the Lake Naivasha catchment area has different water characteristics compared to the lake's waters. The quality reflects the complex volcanic geology of the watershed.

In certain periods of the year a flock of flamingoes are now attracted to Lake Ololdian, which in the previous years has never been recorded. Because of the low depth of the lake (mean depth of 9 m), relatively small drops result in large changes in the surface area and volume. This is affecting the breeding patterns of fish and the faunal biodiversity in general. The effect of the shrinkage of the lake margins on the fish breeding sites was reported by Abiya (1996) who showed a decreasing fish production from 513 tons per year in the 1980s to 110 tons per year in the 1990s (a 22% decrease). Additionally, the increasing agricultural activities and urban settlements around the lake are affecting the discharge and surface runoff into the lake. The activities also cause pollution inputs, which may significantly affect the vitality of the lake in terms of its biodiversity. The consumptive use of water from Lake Naivasha for irrigation (pasture, crops, horticulture), for urban and industrial (domestic, industrial, commercial) as well as for rural means (livestock, domestic etc.) is thus the major cause of pressure on the fresh water resource.

The presence of many large-scale horticultural interests relying heavily on irrigation gives rise to concerns over the impact of irrigation on the lake's levels and its water quality. Even the introduction of more efficient drip irrigation technologies in the greenhouse environment has not reduced the concerns on the challenges facing the lake through water abstraction and eventual discharge from the farms.

Name	Type	Latitude	Longitude	Alt. (m)	pH	T°C	EC (μScm^{-1})	TDS
Suswa Water Supply	BH	0°49'97.3	36°20'96.6	1907	7.34	26	850	0.480
Kijabe Ltd Kabibi	BH	0°45'50.3	36°12'03.3	2045	7.48	34	360	0.180
Naivasha Water Supply	BH	0°41'75.8	36°25'30.3	1904	7.48	22.7	400	0.200
Kigio Lodge	BH	0°35'59.1	36°24'14.6	1904	7.93	22.1	100	0.50
Nyamamithi Acres	BH	0°46'59.7	36°27'09.1	1913	7.15	20.9	580	0.290
Rubiri H20 Project	BH	0°48'06.1	36°26'30.8	1914	8.07	26.1	1240	0.610
Kedong Bird Farm	BH	0°49'36.2	36°26'32.6	1945	7.18	26.6	990	0.490
Pipeline Pump station	BH	0°37'18.2	36°21'55.1	1877	7.15	26.8	480	0.240
Great Rift Valley	BH	0°40'01.4	36°19'10.4	2038	8.38	26.4	900	0.440
Oserian Farm BH1	BH	0°49'40.6	36°16'55.2	1824	7.82	23.4	780	0.380
Oserian Farm BH2	BH	0°49'50.1	36°16'30.4	1854	7.4	23.3	790	0.400
Oserian Farm BH3	BH	0°49'28.9	36°15'09.9	1845	7.04	26.9	1040	0.520
Moindabi BH2	BH	0°47'54.7	36°12'45.6	1919	7.45	29.8	370	0.180
Crater Lake BH	BH	0°46'18.3	36°15'20	1857	7.32	26.8	1140	0.570
MEAN FOR BHOLE	BH	-	-	-	7.51	25.84	715.71	0.391
L. Naivasha Pt1 Malewa	LAKE	0°43'45.7	36°21'00.6	1836	8.2	23.1	240	0.120
L. Naivasha Pt2 Centre	LAKE	0°44'58.6	36°20'48.8	1836	8.9	23.6	330	0.160
L. Naivasha Pt3 Sewage	LAKE	0°44'08.3	36°24'17.3	1847	8.7	20.4	410	0.200
L. Naivasha Pt4 shore	LAKE	0°48'15.4	36°25'05.0	1844	8.9	23.4	390	0.200
Home Grown Tunnel	LAKE	0°43'82.5	36°24'80.9	1894	7.08	17.6	470	0.230
MEAN FOR LAKE	LAKE	-	-	-	8.36	21.62	368	0.182
Malewa River PT1	RIVER	0°40'06.5	36°23'14.8	1850	7.88	21.2	100	0.50
R. Turusha PT1	RIVER	0°28'45.7	36°25'14.3	1979	8.73	21.6	80	0.40
R. Malewa at Bridge	RIVER	0°29'48.2	36°25'51.0	1967	8.5	22.4	90	0.40
R. Gilgil PT1	RIVER	0°30'06.5	36°21'51.6	2003	7.85	20.6	160	0.80
River Gilgil	RIVER	0°37'33.1	36°21'27.8	1880	7.74	20	80	0.40
R. Turasha Upstream	RIVER	0°36'55.0	36°33'25.3	2376	7.74	19.7	160	0.80
R. Kitiri	RIVER	0°33'19.5	36°33'37.3	2339	8.0	18.2	80	0.40
MEAN FOR RIVERS	RIVER	-	-	-	8.06	20.52	107.1	0.528

Figure 4.9: Summary of in-situ-measured properties of water samples from various water sources in the Lake Naivasha Basin

In addition, agricultural activities have led to the opening up of fault gushes and gullies, interfering with a higher surface runoff that increases the discharge into the lake. The depletion of the forests on the Kinangop and Mau escarpments as well as within the Eburru volcanic complex has led to severe erosion damages seen in the images of deep gullies some hundreds of metres long. Agriculture has also a heavy effect on erosion in the area as can be seen from the turbidity of the water (figure 4.8d). The measuring of abstraction rates from Lake Naivasha itself has not been conclusively established. This would require each of the riparian farmers to abstract water from the lake to determine the quantities. This

has not been adequately addressed even with the existing legislation requiring that all farmers abstracting water from public utilities have to declare their rates of abstraction. Any efforts towards ascertaining the implementation of the legal claims are always met with resistance by the farmers.

4.7 Conclusion

The depletion of the forests on the Kinangop, Mau and Eburru escarpments has led to severe land cover changes and erosion damages. The main lake shows irregular changes of volume, which also affects the chemistry, salinity, productivity, bio-chemical oxygen demand and nutrients in the lake, leading to a high vulnerability of the biodiversity. The quality and health of the lake shows a seasonal shift between diatom and cyanobacterial dominance (Hubble & Harper, 2002), which are indicators of an increased nutrient loading in the lake. The major nutrient input is assumed to stem from the Malewa River (Harper et al., 1990) although waste discharge by means of the high population and increased intensive agricultural activities that use pesticides and fertilisers raise additional concerns. The health of the lake is compromised as can be seen from the hydrophytic species succession of *Salvinia molesta* (water fern), *Eichhornia crassipes* (water hyacinth), papyrus and *Acacia dreponalopium*(yellow fiver acacia). The use of satellite data to assess the rate of change of anthropogenic activities has lead to an improved mapping and quantification of the land cover units. The implication of land use trends and practices mapped from Landsat and SPOT data becomes apparent when SRTM DEM data and field observation data are integrated. The image and the DEM model stress the importance of morphotectonic control on the land cover changes in the basin. The data are therefore valuable in addressing the important question of environmental degradation in the Lake Naivasha Basin.

The quantity and quality of water getting into the lake is further compromised by the lack of sewerage treatment in Naivasha township and by runoff from the horticultural farms. The porosity and permeability of the geological formations also point to probable ground water contamination. The rising population and vulnerability of the productive wetland areas of the lake's riparian environment indicate that there are substantial challenges for sustainable development of the

lake's resources. The long-term viability of small-scale farming to support the community has lead to new challenges in the form of intensification of agriculture and thus to an increased farm input. Through the intervention efforts of the Lake Naivasha Riparian Association (LNRA) a buffer zone below the 1906 m contour has been identified as an off-limits area to all construction or cultivation activities (LNRA, 1996). However, the challenge consists in the implementation of this intervention strategy.

4.8 Acknowledgements

The fieldwork for this study was conducted in 2006 and supported by the MAWARI Project on Sustainable Management of Groundwater Resources in the East African Rift, which is supported by the CIFEG (International Centre for Training and Exchanges in the Geosciences) funds. The SPOT image of 2007 was acquired using the same funds. Acknowledgment is given to the initial support from the USHEPiA (Universities Sciences, Humanities and Engineering Partnerships in Africa) of the University of Cape Town (UCT), which in 2002 supported the purchase of Landsat satellite images for 2002 and 1986. The DAAD, by the bias the University of Siegen, and the Kenyatta University are thanked for supporting the DAAD International Seminar/Workshop "Topics of Integrated Water Resources Management" in Bagamoyo, Tanzania.

4.9 References

Ase, L. E., K. Sernbo, and S. Per, 1986, Studies of Lake Naivasha, Kenya, and its drainage area, Stockholms Universitet Naturgeografiska institutionen 106, 91 Stockholm.

Baker, B. H., 1986, Tectonics and volcanism of the southern Rift Valley and its influence on rift sedimentation, Geol. Soc. special publication No. 25, pp. 45 57.

Becht, R. and D. M. Harper, 2002. Towards an understanding of human impact upon the hydrology of Lake Naivasha, Kenya. Hydrobiologia 488 (1/3), November 2002, National Institute of Informatics, Kluwer Academic Publishers.

Clarke, M. C. G., D. G. Woodhall, D. Allen and W. G. Darling, 1990. Geological, volcanological and hydrological controls on the occurrence of geothermal activity in the area surrounding Lake Naivasha, Kenya, Ministry of Energy, Nairobi, Kenya, p.138.

Ebinger, C. J., T. D. Bechtel, D. W. Forsyth, and C. O. Bowin. 1987. "Effective Elastic thickness beneath the East African and Afar plateaus and the dynamics of the uplifts", Journal of Geophysical Research 94(B3): 2883-2901.

Gaudet, J. and J. M. Melack, 1981. Major ion chemistry in a tropical African lake basin, Freshwater Biology, 11: 309-333.

Harper, D.M., R. R. Boar, M. Everard, and P. Hickley, 2002. Lake Naivasha, Kenya. Hydrobiologia 488 (Developments in Hydrobiology 168) Kluwer, Netherlands.

Hubble, D. S. and D. M. Harper, 2002. Phytoplankton community structure and succession in the water column of Lake Naivasha, Kenya: a shallow tropical lake. Hydrobiologia 488 (1/3), November 2002, National Institute of Informatics, Kluwer Academic Publishers.

Kenya Meteorological Department (KMD), 2001, Climatological Statistics for Kenya. KMD, Nairobi

Kitaka, N., D. M. Harper, and K. M. Mavuti, 2002. Chemical characteristics, with particular reference to phosphorus, of the rivers draining into Lake Naivasha, Kenya. Hydrobiology 488.

LNRA, 1996. Lake Naivasha Management Plan. Lake Naivasha Riparian Association, P.O. Box 1011 Naivasha, Kenya. 20 pp. Lake Naivasha Riparian Association, P.O. Box 1011 Naivasha, Kenya.77 pp.

Onywere, S. M., 2005. Morphological Structure and the Anthropogenic Dynamics in the Lake Naivasha Drainage Basin and its Implications to Water Flows. fwu.fb10.uni-siegen.de/bkd/deutsch/Publikation/ Texte_FWU/volumen03/ FWU - Water Resources Publications Vol. 4 (2005) and University of Siegen, series WIS

Onywere, S. M., 1997. Structural analysis of the drainage basin of Kenyan Rift

Valley Lakes within the Aberdare Detachment using satellite data, GIS and field observations, unpublished PhD thesis, Department of Geology, University of Nairobi, Nairobi, Kenya. p. 200.

Thompson, A.O. and R. G., Dodson, 1963. Geology of Naivasha area, Report No. 55, Geological Survey of Kenya, Nairobi, Kenya, 80 pp.

Wendlandt, R. F. and P. Morgan, 1982. Lithosphere thinning associated with rifting in East Africa, Nature, London, Vol. 298, pp. 734 736.

www.wetlands.org/RDB/Ramsar_Dir/Kenya/ke002D02.htm

5 Hydrological Research for Adaptive Management of Gorongosa National Park in Mozambique - Principles and Priorities, Franziska Steinbruch

Franziska Steinbruch[1]

[1] franziskas@carrfoundation.org

5.1 Abstract

The Gorongosa National Park is located at the southern end of the Great East African Rift System in Central Mozambique. Seasonal flooding in the Pungue River Basin and water logging of the Urema Rift create distinct ecosystems. These supported some of the densest wildlife populations in all of Africa, which were almost wiped out during the Mozambican Civil War that ended in 1992. In 2004, the Carr Foundation made a 30-year commitment to rehabilitate the park alongside the Mozambican government.
The core principle of biological conservation and sustainable development for the Gorongosa National Park is Adaptive Management. It is a systematic and iterative approach conceding that knowledge of the Gorongosa ecosystem is incomplete. For the process mission, goals and measurable objectives of target states agreed upon are defined for each area of concern. Management decisions are made based on best current knowledge. Achieved outcomes are monitored and assessed against target states. The adaptive management process for water resources thus requires hydrological research to generate information about target states as well as to conduct monitoring for sound decision-making.

A long-term hydrological research and monitoring plan is developed, which shall guide research proposals and the prioritisation of projects. The following main fields of concern were identified: maintenance of Lake Urema and floodplain wetlands on the Rift Valley floor; mitigation against the effects of deforestation; ensuring the sustainable development of water resources in the Urema Sub-basin as well as in the Pungue Basin; mitigation against the effects of the Zambezi River Basin development on surface and ground water resources of the Rift Valley; and mitigation against hydrological changes associated with climate change.

Keywords: *Adaptive Management, East African Rift, Lake Urema, Pungue River Basin, Wetland*

5.2 Gorongosa National Park

The Gorongosa National Park (GNP) is situated in the Sofala Province and surrounded by the districts Dondo, Muanza, Cheringoma, Gorongosa and Nhamatanda.

It is located 30 km north of the special economic development corridor which links the port city of Beira with Zimbabwe. Furthermore, the GNP lies in the Urema Rift at the southern end of the Great East African Rift System in Central Mozambique. The park has a size of 3.688 km^2 and occupies the downstream area of the largest sub-catchment of the Pungue River, called Urema River Basin. The Pungue River drains from Zimbabwe through Mozambique into the Indian Ocean. The Urema Catchment has a size of 9.300 km^2 (Figure 5.1). The area of the Lake Urema Rift Valley floodplain within the GNP has a size of 510 km^2, from which the GNP draws its rich biodiversity and huge wildlife-carrying capacity. Lake Urema is the largest open water body in this floodplain located at an altitude of 14 masl. Its size ranges from 10 to 210 km^2 in the dry and wet season, respectively. The Urema Rift provides a natural hydraulic link between the Zambeze and Pungue River Basins. The most important water recharge area for the Lake Urema floodplain is Gorongosa Mountain, a 1683 m inselberg located outside the boundaries of the GNP (Figure 5.2).

The GNP is under the jurisdiction of the Ministry of Tourism of Mozambique and works closely with province, district and community administrations with regard to socio-economic and environment-conservation aspects. Catchment management lies within the responsibility of the Regional Water Authority of Mozambique (ARA Centro). The GNP is conducting hydrological monitoring and the rehabilitation of the station network together with ARA Centro.

5.3 Historical Background

In 2004, the Carr Foundation made a 30-year commitment to rehabilitate the park alongside the Mozambican government. The objectives are to restore the biodiversity of the GNP through the application of adaptive management and to develop ecotourism opportunities by involving local communities. Several historical facts, some of them irreversible, have to be considered when taking management decisions forward.
The GNP started as a hunting reserve in 1921 and was declared a national park in 1960. First proposals for the borderline considered the ecological and hydrological sustainability of the system. In subsequent years the size of the park was diminished twice due to pressure from surrounding communities, which resulted

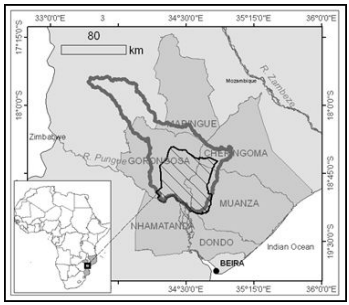

Figure 5.1: Map of Urema Catchment and administrative boundaries of Gorongosa National Park; bold grey line-catchment boundary, hatched line- Gorongosa National Park, dark grey line- districts

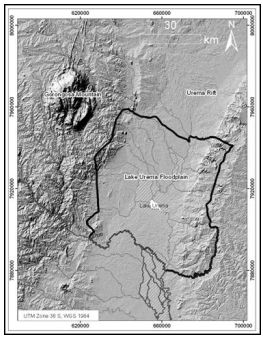

Figure 5.2: Map of hydrology and morphology; black outline- GNP limits (hillshade derived from NASA-SRTM90)

in the exclusion of wetlands and water recharge areas. Since 1967, the boundaries have remained unchanged.

Seasonal flooding in the Pungue River Basin and water logging of the Urema Rift create distinct ecosystems. These supported some of the densest wildlife populations in all of Africa. However, it is known from historical documents

that the GNP was overstocked with wildlife in the late 1960s, which resulted in the malnutrition of animals most of the year (e.g. buffaloes), the extinction of some so-called rare antelope species such as roan as well as in an overall damage of the biodiversity of the ecosystem (Tinley, 1977). In the late 1980s, towards the end of the civil war (which ended in 1992), most wildlife species were drastically reduced or wiped out entirely. As an example, Tinley (1977) estimated 3483 hippopotamus in the Lake Urema floodplain system, whereas the animal census in 2004 came to an estimate of 80. Bearing in mind that each species fulfils a specific function within the ecosystem, the hippopotamus were considered the 'ecological engineers' of the Urema floodplain. Since hippopotamus use drainage lines to move around, they would keep channels free of vegetation, deepen drainage channels and even connect pans with drainage channels. Accordingly, the decrease in animal numbers must have caused changes in the hydrology of the floodplain, which at present are far from being understood.

Changes have also taken place in the areas outside the GNP. The last flood event, which bridged the Zambeze-Pungue divide, occurred in 1958 just before the closure of the Kariba dam in the Zambeze River. With the closure of the Cahora Bassa dam in 1974 sediment deposition has decreased drastically and the Zambeze delta is drained by only one deeply eroded channel. Consequences are still speculative although elders attribute this to a drying of the Urema floodplain. Gorongosa Mountain - a high rainfall area with perennial streams feeding the floodplain - was covered with different types of dense forests from its base at 600 masl to its top in the 1970s. The forest was invaded by local people during the war, who used the mountain for various purposes ranging from shifting agriculture to hidden military camps. Consequently, the forest has disappeared entirely up to an altitude of 1100 m (Carr Foundation & WHRC, 2006). This may have an influence on the availability of water resources, that is to say on short onset floods instead of steady release as well as on water quality impacting the park's biodiversity.

Currently observed changes consist in a rapid wildlife recovery in the park, an increased social pressure on the park by people living in and around the it as well as in a drastic change in land use around the park such as deforestation, opening of roads and appearance of new settlements. Observed changes inside the park

and related to hydrological aspects are the encroachment of even-stand, woody vegetation into the floodplain and the erosion of termite hills in the floodplain, both suggesting drier conditions.

5.4 Hydrological Resources Management

The GNP created the Department of Scientific Services (DSS) in 2006. The responsibilities of the DSS consist in providing advice and facts to the park's management for decision-making, conducting environmental impact assessments for park infrastructure developments, monitoring environmental processes and managing the conservation planning process (CAP). The CAP includes the park's zoning process, the definition of the buffer zone and the elaboration of the conservation management strategy.
The core principle of the conservation management for the GNP is based on Adaptive Management (Beilfuss, 2006). Adaptive Management is an iterative process which acknowledges incompleteness of knowledge and comprehensive understanding of ecological processes causing observable changes in the ecosystem. Adaptive Management starts with the definition of a goal and a mission. Target conditions for a set of associated measurable objects are defined. Processes are monitored and evaluated against the target conditions and eventual interventions are taken, which are based on the current status of understanding and best practises derived from experiences in similar situations. The result of the intervention is monitored and assessed against the target conditions, which may require the redefinition of target conditions and measurable objects (Beilfuss, 2006). One very important aspect of this cycle is the documentation of the process by keeping a tracking report of steps resulting in certain decisions and corresponding impacts. Another important component of Adaptive Management is research, which is required to improve baseline knowledge and to provide information to set targets and current conditions. Research consists of two components: 1) monitoring, that is to say changing detection; and 2) comparative studies, i.e. studying the past to understand current conditions and to predict future ones.

The DSS has just finalised the hydrological research and monitoring strategy, which shall focus on activities and guide hydrological research projects for the

Adaptive Management of water resources during the next years (Beilfuss *et al.*, 2007).

5.5 Hydrological Research and Monitoring Priorities

Seven areas of research priority were identified during several consultation processes:

1. Lake Urema and floodplain management
2. land use changes in the upstream area of the Urema River
3. impact of water abstractions from the Urema catchment
4. impact of land use changes on water quality
5. impact of the Pungue River basin development
6. impact of the Zambeze River development
7. climate change

(Beilfuss *et al.*, 2007).

5.5.1 Lake Urema and Floodplain Management

Little knowledge exists about the ground water budget although it is assumed to be an important component that maintains the floodplain wet and Lake Urema water-filled around the year. Neotectonic activity in the tectonically active Urema Rift can have a major impact on the floodplain regime such as to destroy or increase Lake Urema. Therefore the main questions deal with the derivation of a detailed water and sediment budget of the Lake Urema floodplain as well as with the understanding of underlying geological processes.

5.5.2 Urema Catchment Developments

Ongoing and accelerated land use changes are observed in the Urema Catchment, which affect the hydrological cycle and the water quality. Several small- to medium-scale dams are projected for commercial agriculture in the Urema Catchment. In some areas, artisanal gold mining is practised causing erosion and water pollution. Research is supposed to provide baseline information and define indicators to identify environmental flows and to start monitoring impacts and changes.

5.5.3 Pungue River Basin Development

The government of Mozambique has driven forth an ambitious strategy for the development of the hydrological potential of the Pungue River Basin (DNA, 2007). This document suggests the construction of six large dams and 38 small to medium dams in the Pungue River Basin. The nearest dam would be at the southern edge of the GNP and the next dam would be 30 km upstream of this site. It is a huge concern for the GNP because the water resources of the GNP's sanctuary and the Lake Urema floodplain depend entirely on the interaction of the floodplain water levels with the Pungue River flood levels. Research has to model environmental flow requirements and develop a set of hydrological change scenarios.

5.5.4 Zambeze River Basin Development

The government is planning at least one other large dam 60 km downstream of Cahora Bassa, which will engrave the hydrological pressure on the downstream areas of the Zambeze River and its delta. Developments in the Zambeze River Basin lie within the responsibility of another Water Authority (ARA Zambeze) and thus cannot be dealt or interfered by ARA Centro responsible for the rivers in Central Mozambique. It is a subject of high concern to prove and understand the implications of less sediment loads as well as the resulting erosion of the Zambeze Valley to the availability of water resources in the Urema floodplain. It is assumed that the increase of the hydraulic gradients of the Pungue-Zambeze divide towards the Zambeze drainage channel causes head erosion into the Urema

floodplain and therefore an increased surface and ground water flow towards the Zambeze drainage ("water piracy"), thus draining out of the floodplain. This consequently results in the drying of the Urema floodplain even though normal rainfall-runoff occurs throughout the Urema Catchment.

5.5.5 Climate Change

Except for regional predictions nothing is specifically known about climate change in Mozambique. The study and monitoring of implications of changes in El Niño patterns and magnitudes are of relevance to the GNP. The GNP may serve as a ground control site for regional and global climate models. The investigation of the sediments of Lake Urema can provide information to understand the lake's history, past climate conditions and thus explain current hydrological conditions.

Monitoring priorities include the rehabilitation and installation of hydrometric equipment and the establishment of a water quality network. This work was initiated in close collaboration with ARA Centro.

5.6 Conclusion

Challenges for the Adaptive Management of hydrological resources of the GNP arise from the lack of comprehensive information and data (speculations instead of facts, subjective instead of objective statements) at the starting point of the management process. Research activities have to find solutions for lacking infrastructure (access) and safety issues (wild animals). The low level of local research capacity and people willing to enter a research career has to be targeted as an additional subject within each research project. Finally, scientific fact-finding is often perceived as a theoretical exercise while managers go on and take practical actions under time-pressure without being properly informed.

A chance consists in the long-term approach of the GNP's restoration project, which provides space for ongoing learning, adaptation and correction. The committed base funding programme provides a good fundament to leverage research funding. Within the next years research infrastructure will be available, which will attract researchers and facilitate studies. Finally, it provides the unique op-

portunity to learn with and shape the adaptive management approach through its implementation phases.

5.7 Acknowledgement

The author thanks the German Alumni Water Network for the invitation to the Expert workshop and the German Exchange Service for funding the event. The support provided by Waternet and Carr Foundation-Gorongosa National Park is acknowledged.

5.8 References

Beilfuss, R. (2006). Implementing the adaptive management system for Gorongosa NP. Report to the Carr Foundation-Gorongosa National Park, Mozambique. (Unpublished).

Beilfuss, R., Steinbruch, F., & Owen, R. (2007). Long-term plan for hydrological research: Adapative management of water resources at Gorongosa National Park. Report to the Carr Foundation-Gorongosa National Park, Mozambique. (Unpublished).

Carr Foundation, Woods Hole Research Centre (2006). Forest change analysis on Gorongosa Mountain in the period of 1972-2005. Report to the Carr Foundation-Gorongosa National Park, Mozambique. (Unpublished).

DNA (2007) http://www.pungweriver.net/

6 Water Governance: Policy and Practice in Ethiopia, Kenya, Ayenew Tessera

Ayenew Tessera[1]

[1]M.A. in Political Science and International Relations,
Lecturer, St. Mary's University College,
and Country Coordinator, Ethiopian Nile Basin Discourse Forum.

6.1 Abstract

Ethiopia has long been remembered as the "Water Tower" and the "Bread Basket" of Northeast Africa since twelve major river basins and several lakes originate from its territory. Paradoxically, the country has nevertheless been suffering from recurrent droughts, food insecurity and famine, and is experiencing apparent water stress. The latter is grounded in poor water governance. Although a general policy and legal frameworks exist at the federal level for water governance, there are no detailed regulations both at the federal and state/local levels. Hence, practice is extremely far from the intentions put down in the policy documents. Interstate, inter-governmental and inter-sectoral coordination as well as stakeholders' participation do not exist in the governance of the water sector in Ethiopia. In other words, there are no formal linkages and coordination mechanisms between regional states sharing the same river and the federal ministries and agencies, and even between the ministry and regional bureaus. It is recommended that for an optimal utilisation and effective governance of the country's water resources, it is essential and highly beneficial to choose an integrated rather than a fragmented approach to water resources development and governance. Effective governance and integrated water resources management promote the coordinated development of water, land and related resources to maximise the economic and social welfare in an equitable and sustainable manner.

Paper presented at the International Seminar "Topics of Integrated Water Resources Management" held from November 4-11, 2007 in Bagamoyo, Tanzania

6.2 Introduction

6.2.1 Physical Location of the Country

Ethiopia, one of the oldest nations in the world, is situated between approximately 3°- 15°'N latitude and 33°- 48°'E longitude. The country covers a land area of about 1.12 million km^2, occupying a significant portion of the Horn of Africa. Ethiopia is the 27th largest country of the world (after Colombia), comparable in size to Bolivia, and is about two-thirds as large as the US state of

Alaska. It shares boundaries to the east and southeast with Djibouti and Somalia, to the north with Eritrea, to the south with Kenya and to the west with the Sudan.

6.2.2 Topography

Ethiopia is the most elevated part of Northeast Africa whose altitude ranges from the highest peak at Ras Dashen (4.620 masl) in the northwest down to the Danakil depression (120 masl), one of the lowest dry land points on earth, in the northeast part of the country. The highlands (areas $>$ 1.500 masl) constitute around 45% of the total area of the country while the lowlands (areas $<$ 1.500 masl) constitute the remaining percentage of the country's surface. There is an essential difference between the highlands and the lowlands in terms of climate, population distribution, economic activities and lifestyle.

6.2.3 Climate

The elevation and geographic location of the country are factors responsible for the formation of climatic zones in Ethiopia. The traditional climate classifications of the country based on altitude and temperature show the presence of five climatic zones, namely Wurch (cold climate at $>$ 3.000 masl), Dega (temperate-like climate at 2.500-3.000 masl), Woina Dega (warm climate at 1.500-2.500 masl), Kola (hot and arid climate, at $<$ 1.500 masl) and Berha (hot and hyper-arid climate).
Classification with respect to rainfall regimes shows the presence of monomial, bimodal and diffused patterns of rainfall climates. Consideration of the moisture index shows that large portions of the country fall under semi-arid and arid climates. The mean annual rainfall ranges from about 2.000 mm in some pocket areas in the southwest to about less than 250 mm in the Afar lowlands in the northeast and Ogaden in the southeast. Rainfall decreases northwards and eastwards from the high rainfall pocket areas in the southwest.

Temperatures are also very much modified by the varied altitude of the country. The mean annual temperature varies from about 100°C in the highlands over northwest, central and southeast to about 35°C in the northeastern edges.

6.2.4 Government Structure

Ethiopia now has a federal state structure consisting of a federal government and nine ethnically based regional governments which are further divided into 68 zones, 550 districts (woredas) and six special woredas, and several neighbourhoods (kebels). In addition to nine regional states, Ethiopia has two chartered cities (Addis Ababa and Dire Dawa) which serve as administrative entities. The nine regional states and two chartered cities are (in alphabetical order): Addis Ababa, Afar, Amhara, Benishangul-Gumuz, Dire Dewa, Gambella, Harari, Oromiya, Somali, Southern Nations Nationalities and People's Region, and Tigray.

6.2.5 Population

The population of Ethiopia is now (according to 2007 census) estimated to be 81.2 million, making it the second populous country in Africa after Nigeria. Ethiopia's population has grown rapidly in the last several decades, from 33.5 million in 1983 over 53.5 million in 1994 to 81.2 million in 2007. The population is projected to increase to 122 million by the year 2025, based on the growth rate of 2.92%. The population is highly diverse and composed of more than 80 different ethnic groups descended from the four language families of the Semitic, Nilo-Saharan, Cushitic, and Omotic. The population density for 1994 was about 47 persons per km^2 with a male and female composition of 50.3% and 49.7%, respectively. About 85% of the population lives in rural areas while the remaining 15% are urban dwellers.

6.2.6 Economy

Ethiopia is one of the least developed countries in the world. It is consistently positioned close to the bottom of the annual UNDP Human Development Index (5/9/2007). The average annual income in Ethiopia is not far from US$ 100 per person. About 5-6 million people simply do not have the money to buy food, even in periods of surplus (IFPRI, 2007). Food security remains the greatest concern in Ethiopia with UN estimates suggesting that 42 million people receive amounts of food below the minimum nutritional requirement. Ethiopia's economy is sus-

tained primarily through subsistence farming, which engages more than 80% of the total population, which moreover accounts for almost 41% the Gross Domestic Product (GDP) and for 80% of exports. Insult is added to injury when frequent droughts and poor agricultural systems have undermined this sector's productivity. On top of this, Ethiopia is one of the highly indebted poor countries with heavy debt burdens.

Although the economic reforms (decentralisation, market-orientation, and privatisation) established after the political change in 1991 have brought some improvements in the Ethiopian economy, Ethiopia still remains one of the poorest nations in the world. The major export items of the country include coffee, hides, oilseeds, beeswax, sugarcane and other small agricultural cash-crops. Ethiopia's livestock population is estimated to be the largest in Africa and in 1987 accounted for about 15% of the GDP. Thus, exports are almost entirely agricultural commodities, whereas coffee is the largest foreign exchange earner.

6.2.7 Water Resources

Major River Basins

Ethiopia has long been remembered as the "Water Tower" and the "Bread Basket" of Northeast Africa since twelve major river basins and several lakes originate from its territory (see table 1). Out of 12 major drainage basins about five are transboundary, flowing into the territories of Sudan, Kenya and Somalia. The Wabi Shebelle and Genale-Dawa drain to the desert areas of Somalia and flow into the Indian Ocean whereas Abay (Blue Nile), Tekeze-Angereb (Atbara) and Baro-Akobo (Sobat) drain to the Sudan and thence to Egypt and finally join the Mediterranean Sea through the main Nile. The total annual surface runoff from these basins is estimated to be about 122 billion m^3 while the ground water is estimated to amount to 2.6 billion m^3. Ethiopia has a gross hydroelectric potential of about 139.250 Gigawatt hours (GWh) per year and a potential irrigable land area of about 3.7 million ha.

Source: Ministry of Water Resources, Water and Development Bulletin, Volume 3, No.9

No.	Basin	Basin area (km²)	Basin area (%)	Annual discharge	
				Billion m³	%
1	Abbay	199.812	17.56	54.4	43.05
2	Awash	112.700	9.9	4.9	3.76
3	Baro-Akoba	74.102	6.51	23.23	19.31
4	Genele-Dawa	171.050	15.03	6.1	4.81
5	Tekeze	90.000	7.9	8.2	6.24
6	Wabi-shebele	200.214	17.59	3.16	2.59
7	Omo-Ghibe	78.200	6.87	16.6	14.7
8	Mereb	5.900	0.52	0.72	0.21
9	Rift Valley Lakes	52.740	4.63	5.64	4.62
10	Danakil	74.0002	6.5	0.86	0.7
11	Ogaden	77.100	6.77	0.0	0.0
12	Aisha	2.200	0.19	0.0	0.0
	Total	1.138.020	100	123.81	100

Figure 6.1: Major river basins, basin areas and annual discharges

Lakes

Lakes are one of humanity's most important resources, especially in the tropics, where they are often viewed as highly productive biological systems. They provide water for consumption, fishing, irrigation, power generation, transportation, recreation, disposal of wastes and a variety of other domestic, agricultural and industrial purposes. As mentioned before, Ethiopia has several lakes, the major ones of which include the Lakes Tana, Ziway, Langano, Abiyata, Abaya, Chamo, Awassa, Shalla and Chaw Bahir.

Lake Tana (3.600 km^2, elevation 1.788 m), the largest lake in the northwestern part of Ethiopia, is the source from where the famed Blue Nile is supposed to start its long journey to Khartoum. Lake Tana is very important to Ethiopia as a permanent source of both water and hydroelectricity. Four perennial rivers and numerous seasonal streams feed the lake. The 37 islands that are scattered over the surface of the lake shelter fascinating churches and monasteries, some of which have histories dating back to the 13th century. The Lake Tana Basin significantly contributes to the livelihoods of tens of millions of people in the lower Nile River Basin. It has a huge fish potential and isa source of tourist attraction. The lake is also a natural reservoir for the power station at Tis-Abbay.

The rest of the lakes are found in the Ethiopian Rift Valley which runs the whole length of the country from neighbouring Eritrea in the northeast to Lake Turkana in the southwest, bordering Kenya. The Ethiopian Rift Valley Lakes Basin (RVLB) is one of the 12 Ethiopian river basin ecosystems which share a common geological structure, history and similar biological asset. They are a chain of permanent lakes lying entirely in the southern part of the Ethiopian Rift Valley. The Rift Valley Lakes are very important in terms of biological resources. Their ecosystems support both aquatic and terrestrial biodiversity such as migratory birds, wildlife, fishery resources and aquatic and terrestrial vegetation. These ecosystems serve as wintering grounds and maintenance stations for a large number of terrestrial and aquatic birds (Zinabu, 1994).

Problem Statement

Although Ethiopia's water resource is large, very little of it has been developed for agriculture, hydropower, industry, water supply and other purposes. Out of the 3.7 million potential irrigable lands, to date, only about 160.00 ha (about 4%) have been developed. Out of the hydroelectric potential of about 139.250 Gigawatt hours (GWh) per year, only 1.6% is utilised so far. The national coverage of potable water supply amounted to 47% by 2005 while the coverage of sanitation services was only 30.63% (CSA, 2005). There is also a wide divergence in the water supply coverage between urban (78%) and rural (41.16%) areas as the sanitation ratio for urban areas is 80.18% while for rural regions it is 21.34% (ibid.).
In spite of the fact that fresh water bodies are very limited and sensitive resources that need proper care and management, they are probably the most abused resources in Ethiopia. The inefficient and uneconomic use of water may aggravate water stress in the country.

Besides, there is spatial and temporal variation of water resources in Ethiopia which has resulted in an uneven distribution and cyclic flood-drought disasters. Out of 122 billion m^3 of annual surface runoff, between 80 - 90% is contributed by four river basins located in the west and southwest of Ethiopia. The remaining eastern and central river basins yield only 10-20% of the runoff (MoWR, 1999). The range between the highest monthly mean discharges is several times greater

than the lowest monthly mean discharges in almost all of Ethiopia's large rivers. A large proportion of Ethiopia's smaller rivers and streams dry out completely during long dry spells in many areas. Against this background, the frequency of droughts has increased over the past three decades, resulting in significant social, economic and environmental imbalances. There are also growing constraints to water supplies in Ethiopian dry lands. Other issues compounding the water supply problems include watershed degradation and poorly managed surface and ground water resources. Although this imbalance is one of the issues that the Ethiopian Water Resources Management Policy attempts to address in its formulation, there is clearly an urgent need for the practical implementation of this policy to steer the management and distribution of Ethiopia's water resources. This paper examines the legal and institutional frameworks available for water resources management as well as their current status in terms of application and constraints. Based on the identified policy gaps, the paper suggests recommendations.

6.3 Water Governance

6.3.1 Concept Definition

Water governance refers to the range of political, social, economic and administrative systems that are in place to develop and manage water resources, as well as to the delivery of water services at different levels of society (GWP, 2002). It comprises the mechanisms, processes and institutions through which citizens and groups articulate their interests, exercise their legal rights, meet their obligations and mediate their differences (UNDP, 2001). Thus, water governance generally refers to the wide range of social, economic, political, institutional, administrative systems and decision-making processes. Such systems exist to regulate the development and management of water resources and the provision of adequate, safe and reliable water supply services. Governance stipulates who makes what kinds of decisions, when and according to what criteria, norms and operational values. Such decisions range from those that are made at lower government institutions to those that are made at higher levels. Truly, the inadequacies and incompetence of institutional arrangements and legal frameworks do seriously affect water governance. In order to achieve more effective water governance, it

is necessary to create an enabling environment which facilitates efficient private and public sector initiatives and stakeholder involvement in articulating needs (GWP, 2003).

Good governance has certain necessary conditions, which encompass inclusiveness, accountability, participation, transparency, predictability and responsiveness. The governing system lacking these conditions is referred to as *poor governance*. Poor governance leads to increased political and social risks, institutional failure and rigidity as well as to a deterioration in the capacity to cope with shared problems.

6.3.2 The Need for Water Governance

Why do we govern water? What is the importance of governing water wisely? Water is a finite asset and the foundation of all living creatures on earth. It is subject to depletion and competition among the users is common. Therefore, effective water governance is necessary to solve the problem of water crises. Effective water governance determines the roles and responsibilities of the different interest groups and actors (governmental and non-governmental) in water resources management and development. Resolving the challenges in this area is essential, if we are to achieve sustainable water resources development and management. If we are to secure access to water for all, maintain vital ecosystems and produce economic development out of water management, effective water governance is obligatory. Effective governance can overcome fragmentation and conflicts of interests over water resources. In the past few years the concept of Integrated Water Resources Management (IWRM) has come to the fore as the means to ensure an equitable, economically sound and environmentally sustainable management of water resources and provision of water services. Improving co-ordination and consultation, building partnerships and avoiding single-purpose strategies are essential to IWRM. IWRM requires a framework where the different and often competing water interests find a common ground and where multi-sectoral stakes are regulated and balanced.

The importance of water governance for sustainable development has recently attracted international significance within the water community. At the second World Water Forum in The Hague (2000), the GWP Framework for Action stated

that the water crisis is often a crisis of governance and singled out the effectiveness of water governance as a priority for action. Since the second World Water Forum, water governance has become increasingly prominent in the international debate on water. At the World Summit on Sustainable Development in Johannesburg (2002), governance was highlighted and Article 4 of the introduction to the Plan of Implementation states explicitly that '[g]ood governance within each country and at the international level is essential for sustainable development.' While international recognition is important for raising political awareness, governance is mainly an issue to be addressed at the country and local levels (GWP, 2003).

The broad objectives of water management cover the utilisation and development of water resources in an efficient, environmentally sound, equitable and reasonable manner in order to satisfy the society's demand for water, water-related goods and services, as well as to safeguard the ecological functions of water resources.
The Economic Commission for Africa recognises water and its prudent management as a key to reversing the downward spiral in human welfare resulting from a combination of rapid population growth, stagnating per capita food production and accelerating environmental degradation across the African continent (ECA, 2001).

In Ethiopia, water activities are often split among a number of ministries and departments at the national level. The fragmentation of responsibilities among sectoral ministries and administrative agencies hinders coordination and impedes attempts to integrate water management activities. Therefore, good governance is needed to create an enabling environment which can respond to economic situations and avoid duplications of responsibility.
The sustainable development of water resources and effective governance are inseparably linked with each other. The weaker the stance of water governance, the deeper is the crisis in water resources management and development. The issue of governance is taking its momentum in the context of Ethiopia's social, economic and political systems. Issues of institutional linkages, coordination, collaboration and effective participation and involvement of stakeholders have continued to be the concern of government and those institutions that are partner-

ing in the areas of social and economic development (UNESCO, 2004). This is highlighted in the discussion under the sub-titles following this paragraph.

6.3.3 Policy and Legal Framework for Water Governance in Ethiopia

FDRE Constitution (1995)

The constitution of the Federal Democratic Republic Ethiopia (FDRE) has eleven chapters and 106 articles. The constitutional articles which are relevant to this study are presented in the following. Article 40 (3) ensures state ownership of rural and urban land as well as of all natural resources. Here, land is made a common property of the Nations, Nationalities and Peoples of Ethiopia and shall not be subject to sale or to other means of exchange.
Article 43 (1) deals with the Right to Development. It states that "[t]he Peoples of Ethiopia as a whole, and each Nation, Nationality and People in Ethiopia in particular have the right to improved living standards and to sustainable development." Sub-article 2 of this article is devoted to the right to participation and relates that "Ethiopian Nationals have the right to participate in national development and, in particular, to be consulted with respect to policies and projects affecting their community."

Article 51(2) is concerned with the powers and functions of the federal government. It is stated that the federal government shall formulate and implement the country's policies, strategies and plans in respect of overall economic, social and development matters. Sub-article 5 specifically says that the "federal government shall enact laws for the utilisation and conservation of land and other natural resources, historical sites and objects." Sub-article 9 of the same article further grants to the federal government the responsibility for the development, administration and regulation of airways, railways, waterways and sea transport and major roads linking two or more states, as well as for postal and telecommunication services. This is substantiated by sub-article 11 which states that the federal government shall determine and administer the utilisation of the waters or rivers and lakes linking two or more states or crossing the boundaries of the national territorial jurisdiction.

Article 52 (1 & 2) deals with the powers and functions of states. Accordingly,

sub-article 1 defines that all powers not given expressly to the federal government alone, or concurrently to the federal government and the states, are reserved to the states. Sub-article 2 constitutes the following: "Consistent with sub-Article 1 of this Article, States shall have the following powers and functions: ..sub-article 2(d) to administer land and other natural resources in accordance with Federal laws."

National Water Resources Management Policy (1999)

The Ethiopian Water Resources Management policy is based on the constitution of the FDRE government macroeconomic and social policies and development strategies. The document considered the following aspects as water resources problems in Ethiopia:

- Uneven spatial and temporal occurrence and distribution with between 80-90% of Ethiopia's water resources located in the four river basins, namely Abbay/Blue Nile, Tekeze/Atbara, Baro-Akobo/Sobat and Omo Gibe in the west and southwestern part of Ethiopia where the population share is no more than 30-40%. The water resources fraction available in the east and central river basins is only 10-20% whereas the population in these basins makes up over 60% of the total population. The temporal distribution poses no less a problem. The required amount is not available at the right time;

- low level of water utilisation for socio-economic development exists (in the areas of water supply, irrigation, and hydropower generation) due to the absence of a well-defined coherent policy and the lack of the required huge investment; and

- prevalence of intensive centralism of management that does not focus on rural development.

Hence, in an attempt to solve these and other related problems, the policy was formulated and outlines some fundamental policy principles supposed to guide the equitable, sustainable and efficient development, utilisation, conservation and protection of water resources in Ethiopia based on the Dublin-Rio statements of 1992. These are summarised as follows:

- Water is a natural endowment commonly owned by all the peoples of Ethiopia.
- Ethiopian citizens shall have access to sufficient water of acceptable quality to satisfy basic human needs. The policy gives top priority to drinking water supply over other uses.
- Water is both an economic and social good.
- Water resources development should be based on rural centred, decentralised management and participatory approaches. This focuses on promoting decentralised management, fostering the participation of user communities and supporting community self-initiatives in water resources management.
- Management of water resources shall ensure social equity, system reliability and sustainability norms.
- Integrated Water Resources Management is emphasised in the policy document and thus the policy recognises the hydrologic boundary or basin as the fundamental planning unit and water resources management domain.

The policy recognises water as a scarce and vital socio-economic resource, and attempts to enhance the integrated and comprehensive management of water resources that avoids fragmented approaches and promotes the involvement and meaningful participation of the private sector in the management of water resources. Moreover, the policy gives attention to build and strengthen the necessary capacity in terms of institutions, legislation, facilities, human resources, finance, information systems and research studies for a better and more efficient management of water resources.

The water resources management policy document is indeed comprehensive, covering nearly every issue and every sub-sector under the water resources sector (water supply and sanitation, irrigation, hydropower, general water resources, inland water transport, aquatic resources, water for tourism and recreation, water allocation and apportionment, watershed management, water resources protection and conservation, environment, technology and engineering, monitoring, ground water resources, stakeholder issues, gender issues, etc.).

Ethiopian Water Resources Management Proclamation (2000)

The proclamation was enacted to implement the fundamental principles, objectives, goals and the stipulated sectoral and crosscutting policy issues articulated in the water policy of Ethiopia towards ensuring the protection and the utilisation of the water resources for the highest socio-economic benefits of the people of Ethiopia. The proclamation has nine parts and 33 articles as well as several sub-articles. The social, legal, environmental, institutional and many related legislative provisions are treated here as appropriate and required. The proclamation declares that "[a]ll water resources of the country are the common property of the Ethiopian people and the state" (FDRE Proc. 197/2000 Article 5). This is an endorsement of article 40 (3) of the constitution of the Federal Democratic Republic Ethiopia.
The proclamation has the following fundamental principles:

- The integrated basin master plan studies and the water resources legislative framework shall serve as points of reference and ensure that any water resource is put to the highest social and economic benefit of the people of Ethiopia.

- The socio-economic development programmes, investment plans and programmes and water resources development activities of any person shall be based on the country's water resources policy, the relevant basin master plan studies and water resources laws.

- The supervising body shall ensure and administer that the management of any water resource is put to the highest socio-economic benefit of the Ethiopian people in accordance with the provisions of the Ethiopian water resources policy, the basin master plan studies and water resources laws.

- The management of the water resources of Ethiopia shall be in accordance with a permit system (FDRE Proc. 197/2000 Article 6).

Regarding water use priority, the proclamation states that "[d]omestic water use shall have priority over and above any other water uses" (FDRE, 197/2000 Article 7, sub-article 1).
According to the Ethiopian Water Resources Management Policy, every citizen

has the fundamental right to access safe water for his/her basic needs. The fundamental principle issued by the government in relation to this issue determines that "[a]s far as conditions permit, every Ethiopian citizen shall have access to sufficient water of acceptable quality to satisfy basic human needs"(Ethiopian Water Resources Management Policy, Chapter 3).

The supervisory body (Ministry of Water Resources - MoWR) shall, among other things, be responsible for determining the allocation and manner of use of water resources among various uses and users; establishing quality standards for surveys, design and specification of water works as well as standards for the construction of water works necessary for the development of water resources; and giving order and issue directives of all kinds for rectification or suspension of water works that stand against the national water policy and relevant basin master plan studies and water laws. The supervisory body also gives order and issues directives for water use restrictions in a situation of water shortage emergency (Pro. 197/2000 Article 8). According to the proclamation, the right to allocate and apportion water to all regional states regardless of the origin and location is best bestowed by the legal jurisdiction of the Ministry of Water Resources in its capacity as supervisory body. Thus, regional states are only executors of the national policy. The legal provisions in the proclamation, with regard to ownership of the resources and its allocation and apportionment, clearly show that the development, management, utilisation and protection of all water resources in the country lies effectively in the hands of the federal government. The fact that the Federal Ministry of Water Resources is the government agency responsible for drafting the water law and submitting it to the Federal Council of Ministers, and to further deposit it to the Council of Peoples Representative (the Federal Parliament) for its ratification testifies that there is no other law or water legislation to be used and issued at regional and local levels. In effect, there is one national water policy and one water proclamation to be effective at all levels. Regional states and local administrative bodies, without requiring any new law for water, are strictly obliged statutorily to implement the water policy and the water proclamation in accordance with set directives and guidelines by the Federal Ministry of Water Resources.

There is no explicit mention of the participation of the private sector, coordi-

nation among relevant offices and public participation, except the possibility of forming water user associations to utilise water for beneficial purposes (proc. No.197/2000 Article 27).

Ethiopian Water Resources Management Strategy (2001)

The Ethiopian Water Sector Strategy has been issued to translate the Ethiopian Water Resources Management Policy into action. The strategy provides the framework, which contains ways and means of attaining the intended objectives put forward in the water resources management policy. The goals and guiding principles of the strategy remain the same with that of the Water Policy.
The water strategy sets the framework for making a meaningful contribution towards achieving a broader national development objective of poverty alleviation and sustainable development. Hence it provides a road map to contribute towards

- improving the living standard and general socio-economic well-being of the Ethiopian people;
- realising food self-sufficiency and food security in the country;
- extending water supply and sanitation coverage to large segments of the society;
- generating more hydropower;
- enhancing the contribution of water resources in attaining national development priorities; and
- promoting the principles of Integrated Water Resources Management.

The strategy is divided into four sub-sectors. These are (1) the general water resources strategy, (2) the water supply and sanitation strategy, (3) the irrigation development strategy, and (4) the hydropower development strategy.
The general water resources strategy covers areas such as water resources development, water resources management, enabling environmental and transboundary water development, stakeholders' involvement, gender mainstreaming, disaster and public safety, environmental and health standards as well as technology

and engineering, while the main elements of irrigation, hydropower and water supply as well as sanitation strategies consist of technical and engineering, financial and economic, institutional, capacity building, social and environmental aspects.

The water strategy attempts to create an enabling working environment by means of the following mechanisms: (1) establishing water resources management institutions for sustainable development and management of the water sector, like (a) River Basin institutions; (b) autonomous or semi-autonomous utility agencies (water boards) in big cities; (c) water users associations; (d) irrigation agencies, if appropriate; (e) water committees at woreda, kebele, community and water scheme levels; (2) developing and implementing capacity building programmes (trainings) at all levels (federal, regional, zonal, woreda, private sector and local communities); (3) formulating appropriate and essential water legislation required to expedite water resources development and management; (4) providing a legal basis for the participation of all stakeholders, including water user associations, the community, particularly women so that they may play the central role in water resources management activities; (5) treating water resources as a unitary resource requiring coherent planning for its effective use and management in order to reflect its economic value; the privatisation of utility services and increased user involvement will be promoted; (6) stakeholders at each level in the water resources sector will be consulted and their participation in the decision-making process will be secured; (7) promoting building and strengthening of partnerships between community-government-private and sector-external support agencies by creating platforms for discussions and consultations among the stakeholders; (8) developing guidelines, principles and norms for streamlining the interventions of external support agencies and NGOs; and (9) securing effective collaboration amongst all the formal and informal stakeholders in the water supply and sanitation sub-sector.

Water Sector Development Programme (WSDP-2002)

The government of Ethiopia has developed a 15-year Water Sector Development Programme-WSDP (2002-2016). The programme was issued in 2002 by the MoWR. And clearly states that the WSDP in general and the specific sub-sectoral

programmes and projects proposed therein should

- be consistent with the national water management policy and the national water strategy;
- be in line with the national economic development strategy, and relevant to the socio-economic development of Ethiopia;
- promote the sustainable development and management of water resources;
- consider the "basin" as a planning unit for the development and management of water resources;
- incorporate linkages with the ongoing and planned projects;
- support the Millennium Development Goals related to water and the objectives that have a bearing on the achievement of the overarching MDGs such as poverty alleviation and food security.

Having fully realised that the inadequate supply of the population with clean water is hampering improvements in various dimensions of social and economic developments, Ethiopia is genuinely considering an adequate clean water supply to improve the abject poverty condition of its people. It is believed that the provision of adequate clean water also improves health conditions and releases labour force for productive engagement in various social and economic activities, especially with regard to the female population that spends a lot of time on carrying water for domestic uses.

The planning horizon of the WSDP is 15 years, divided into three 5-year periods of the short-term (2002-2006), medium-term (2007-2011) and long-term (2012-2016) set to suit the existing practice of 5-year development plans of regional and federal institutions of Ethiopia.
In terms of sectoral priorities, the WSDP focuses, among other uses, particularly on actions to make clean water available for drinking and sanitation; make water available for livestock in nomadic and other special areas; extend irrigation for agricultural production to the feasible maximum; expand generation capacity to meet hydroelectric power needs; provide water for industrial development; and provide water for fisheries, tourism and transportation.

Within the above-mentioned perspective, highest priority is given to those programmes and projects that have either been started, appraised or considered for founding, identified in master plan studies, considered for capacity building or designated in the Nile Basin Initiative (NBI) and the Eastern Nile Subsidiary Action Programme (ENSAP).

Targets to be achieved under the WSDP

1. Water Supply and Sewerage Development Programme (WSSDP). This programme consists of urban water supply, rural water supply, livestock water supply and urban sewerage projects.

2. Irrigation Development Programme (IDP), consisting of projects for the development of irrigation schemes in the short-, medium- and long-term processes. Wherever possible, priority shall also be given to the completion of ongoing and suspended large-scale irrigation projects. Increasing emphasis will be given to the development of large- and medium-scale irrigation schemes in the medium- to long-term.

3. Hydropower Development Programme (HDP). This programme has been designed to meet the local electricity demand in the national grid or "interconnected system", to export demands and to specify small-scale hydropower development targets for rural areas.

4. Water Resources Development Programme (WRDP). This scheme is chiefly concerned with laying the solid foundations for successful programme implementation in the other sub-sectors, especially irrigation and hydropower, by means of collection and analysis of various kinds of data and information that are needed. This can be done by means of establishing hydrology and meteorology stations and transforming the current data transmission and analysis practices into modern and efficient computerised applications.

5. Institution- and Capacity- Building Programme (ICBP). The national water policy calls for the establishment of an appropriate institutional framework from the national to the lowest administrative levels in accordance with the evolving forms of decentralised management. The ICBP consists of two main components: developing human resources and strengthening water

resources institutions through structural reforms and the provision of equipment. The ICBP goal consists in building the necessary manpower, material and institutional capacities that will enable the successful implementation of all the WSDP sub-sectoral projects. An essential part of its mission is to improve the quality of decision-making, technical ability, efficiency and managerial performance of planning and operations of the WSDP.

Implementation strategy

The WSDP implementation strategy incorporates the goals that are provided by the national water strategy which includes strengthening the existing institutional structure; ensuring strong coordination among all programme components; prioritising programme implementations to meet funding constraints; assigning priority to complete the ongoing programmes/projects; and promoting decentralised management. The implementation of WSDP activities and projects will involve a large number of partners, each with different roles and functions. These include (a) government institutions, (b) the private sector, (c) local communities and individuals, (d) NGOs, and (e) external support agencies.

Ethiopia's Water Resources Management Regulation has been issued by the Council of Ministers under the proclamation No. 115/2005. The contents of the regulation are those covered in the proclamation, but describe in more detail the procedures as to how the various legal materials contained in the proclamation are to be realised on the ground. The regulation has ten parts and 39 articles. Part two is about water resources utilisation (application for permit, Article 3; duties of supervising body, Article 4; discharge of water after use, Article 5; termination, suspension, transfer or variation of a water use permit, Article 6). Part three is about water works permit (application and the manner of dealing with these, Article 7; duration and extension of permit, Article 8; duties of permit holder and supervising body on completing works, Article 9; etc.). Part four deals with water quality control while part five is about certification of professional competence and classification to undertake water works construction. Similarly, part six deals with certificate of competence for a consultancy service whereas part seven is about water users' cooperative societies. Part eight determines fees and charges for water works permits and water uses, part nine deals with the issues of dispute settlement procedures and the final part is about miscellaneous provisions.

6.4 Institutional Framework

Ethiopia is a federal state composed of nine the national regional states of Tigray, Afar, Amhara, Oromia, Somalia, Benshangul/Gumuz, Southern Nations, Nationalities and Peoples, Gambela and the State of the Harari. Addis Ababa and Dridawa are chartered cities. A policy of decentralisation of authority to regional administration has been pursued since 1991. The development strategy taken by the government is the Agricultural Development Lead Industrialisation (ADLI), which is intended to be rural- based and people-focused.

6.4.1 Federal Institutions

In its history of water institutions, Ethiopia had the first modern type of water sector institution in 1956 called "Water Resources Department", which was accountable to the Ministry of Public Works at that time. Since then, the water sector in Ethiopia has passed through considerable institutional changes and developments. In the pre-1991 period, water sector institutions such as the Water Resources Commission, the Water Resources Development Authority, the Water Supply and Sewerage Authority and the Ethiopian Valleys Development Studies Authority were organised as centrally placed national organisations with the legal competence of operating and functioning all over the country in accordance with the tasks and roles stipulated by law to each one of them.

Nevertheless, with the political and economic changes in the country since 1991, the organisations have either been restructured to suit the new political and economic orientation or they have altogether been dissolved or disbanded. The hitherto operating Ministry of Water Resources (MoWR) was established in 1995 under the justification that the continued existence without making changes in the institutional setup of the previous organisations has been considered irrelevant and called for major institutional changes. However, although frequent restructuring of water institutions with the objective of bringing about efficiency, effectiveness, linkages, coordination and collaboration is a common phenomenon in Ethiopia, there is still a lack of effective coordination among stakeholders in general. Coordination among key stakeholders such as federal and regional public water institutions, NGOs, multilateral and bilateral agencies and the private

sector itself is still an issue that needs improvement.

Pursuant to the declaration of the Millennium Development Goals by the United Nations in 2000, the government of the Federal Democratic Republic of Ethiopia has continued to further devolve decision-making processes about planning and implementation of social and economic activities down to the local levels. The decentralisation and regionalisation policy is supposed to be an enabling environment for the establishment of water institutions at different levels. There are various institutions that exist at the federal level, which are directly or indirectly involved in the development and management of water resources. These include:

- Ministry of Water Resources (MoWR), responsible for administering major rivers, river basins and lakes; involved in conversion and water works (dams, irrigation canals, drilling of wells), developing drinking water supplies and formulating a water policy;
- Ethiopian Electric Power Corporation (EEPCO), responsible for building macro-dams (hydroelectric plants) and irrigated farms (adjacent to dams);
- Ministry of Agriculture and Rural Development, responsible for small-scale irrigation, development of small dams, pans and ponds for domestic stock as well as for determining land-use planning;
- Ministry of Health, responsible for draining and spraying marshy and unhealthy areas;
- Environmental Protection Authority, responsible for conducting Environmental Impact Assessment (EIA) studies and formulating environmental policy issues;
- Ministry of Infrastructure, responsible for constructing roads and other facilities;
- National Meteorological Service Agency, responsible for collecting, protecting and disseminating meteorological information;
- Ministry of Mines and Energy, responsible for extracting mines and installing energy plants;

- Ministry of Industry, responsible for the establishment of environmentally friendly industries and the observation of polluting sectors such as tanneries and textiles;
- Geological Survey of Ethiopia, responsible for preparing hydrogeological maps for ground water assessment;
- Water Resources Development Fund Office, responsible for giving loans to urban water supply services and irrigation schemes on cost recovery basis;
- Ethiopian Social Rehabilitation and Development Fund, engaged in water supply and small-scale irrigation development activities;
- Addis Ababa Water Supply and Sewerage Authority, providing water supply services for dwellers of the federal city and the federal political, social and economic entities functioning within the city proper.

In addition to those that are listed above, there are organisations at the federal level which are answerable to the MoWR as they are established by law as public enterprises. Although they are autonomous entities, they still report to the Ministry of Water Resources as its subsidiary on issues related to water resources planning, development and management. The organisations include the Water Works Design and Supervision Enterprise (WWDSE), the Ethiopian Water Works Construction Enterprise (EWWCE), the Water Well Drilling Enterprise (WWDDE), and the Awash Basin Water Resources Management Authority (the only basin institution which is currently operating for the Awash River Basin).

6.4.2 Regional Institutions

The regional governments have legislative, executive and judicial power over their administrative areas, except in matters of defence, foreign relations and citizenship, which fall under the jurisdictions of the federal government. All the regional states have established Bureaux for Water, Mines and Energy. The restructuring process of the regional water institutions has continued with the further decentralisation process of planning and implementation to the lowest administrative units called “woredas” (local). This means that the planning and implementation of water resources development and management, which are within

the legal competence of the regional states, are further devolving down to the local administrative units. Regional bureaux and those that were at the zonal level are giving away some of their duties and responsibilities to the *woredas* which are supposed to engage in developing small-scale irrigation schemes. In addition, water supply schemes have been constructed, maintained and operated using the competence of *woredas* with the help of specialised enterprises/organisations.

6.4.3 Local Level Institutions

The *woreda* decentralisation process has enabled the creation of woreda water desks. These desks are responsible for planning, budgeting, implementing, monitoring and following up water projects and programmes in their respective localities. So far, it is not clear how many of the *woredas* existing in each of the regional states have been able to organise *woreda* water desks. These local water desks are reporting to a woreda level government administrative body - the Desk for Rural Development - and not directly to the Regional Water Bureaux. The Rural Development governmental body that exists at the *woreda* (local) level is reporting to the Woreda Administrative Council, the locally based highest authority, and further to the highest level.

6.4.4 Private Institutions

There are only a few private institutions that are involved in the development and management of water resources. Some have started engaging in consultancy services in the areas of water and related projects. There are also very few small water well drilling companies specialised in water works. They usually lack machinery, equipment, adequately trained staff and management skills. But in the case of some few consulting engineers, their presence in the business is an indication of their value-adding contributions to the effectiveness of meeting the MDGs and government plans in general.

There are no private water companies that are engaged in providing water supply services. The informal sector is usually involved to a limited extent in the maintenance of small water supply schemes in the rural areas and in urban centres, in the majority of cases around households that are willing to offer such jobs. There

are no specialised private water companies that could supply water for irrigation development either.

6.5 Practical Application of Policy Framework

The government of Ethiopia has formulated and issued the water policy in 1999, the water proclamation in 2000, the water strategy in 2001, the water programme in 2002 and the water regulation in 2005. All other subsequent legal documents are based on the water policy. It provided reasonable coverage for all the stakeholders and gave due attention to the principles of Integrated Water Resources Management. But the coverage has existed only on paper and has been seen only marginally on the ground due to the absence of a conducive enabling environment. Effective governance can only be realised through the existence and proper interplay of relevant public, private NGOs, international development partnering agencies and community-based organisations.

The water policy, though comprehensive and sound in its coverage, has several policy gaps. The policy generally lacks the following aspects:

- arrangements for implementation, monitoring, follow-up and feedback;
- reasonable coverage of rainwater management;
- provision for rights of access to water and transfer of water rights;
- reasonable coverage of the pastoralist issues;
- provision against high turn-over of the skilled, trained and experienced manpower out of the water sector;
- active participation of all stakeholders in the policy implementation;
- regulatory instruments, especially at regional, zonal, woreda and grassroots level;
- provision for legal basis for the participation of all stakeholders including water user associations, communities (in particular women), NGOs and private sector;

- strong institutional linkage between MoWR and the regional water bureaux;
- necessary guidance, coordination and collaboration among stakeholders at all levels regarding activities of water policy.

Thus, there is a need for the operationalisation of the policy by means of creating linkage mechanisms for policy implementation among the stakeholders - national, regional, zonal, woreda, communities, NGOs and private sector - and creating a system for policy implementation, review and exchange of information on policy issues as well as for stakeholder participation and consultation with regions, private institutions, NGOs and development partners.
Since the water policy lacks implementation capacities, manpower capacity building is imperative for the policy to be successful. There is a strong need for capacity assessment, determination of training needs and development of training programmes at all levels.

The water resources development and management faces the challenges of droughts, floods and famines. The extreme variability of rainfall creates environmental and economic impacts too much or little rain leading to floods or droughts. This calls for measures to be taken in order to store the surplus water that comes in the form of floods and to use it during droughts for different purposes.
There are several dams that have been constructed to store surplus water in order to use it during the time of less water availability. Some of these dams are the Koka Dam, the Fincha Dam, the Melka-Wacana Dam, the Alwero Dam, the Gilgel-Gibie Dam and the Tekeze Dam (Theshome, 2007). The water stored by the Koka and Fincha Dam, apart from generating hydroenergy, is properly utilised for downstream irrigation. On the contrary, regulated water from the Melka-Wacana, Gilgel-Gibie and Alwero Dams has not been used for downstream irrigation development, but has been wasted and is still being wasted from the time when the dams were completed up to date (ibid.).

The Alwero Irrigation Project, the Omo Ratte Joint Venture Agricultural Development, the Tana-Beles Project, the Awash Irrigation Projects, the Meki-Zuway Pump Irrigation Project, the Alaba-Kolito Irrigation Project, the Gode Irrigation and the Borkena Irrigation Projects that were constructed in the late 1980s have been terminated due to the change of government in 1991. There were no activ-

ities on these projects for almost the last 15 years (ibid.). Investments between 300-400 million birr have been made with no benefits being derived from the investments. The WSDP has given priority to re-activate these projects in phase I (2002-2006) and phase II (2007-2011). But so far, very little progress has been done.
It is very imperative for all stakeholders concerned to participate in water development projects from inception to completion as well as in maintenance. The development partners of public and private institutions, donors, NGOs, civil societies and communities need to double their concerted efforts and to coordinate their work in order to achieve effective results in irrigation development to produce food crops for sustainable food security as well as for the reduction of poverty and for food aid.

There are various stakeholders at different echelons of the water administration. However, there are no formal linkages and coordination mechanisms between the federal ministries and agencies and even between the ministry and regional bureaux. Various organisations generate and utilise a wide range of data at all levels. For proper collection, dissemination and accessibility, it lacks integration and coordinated effort. Moreover, data and information are not transparent and accessible to the stakeholders as required (UNESCO, 2004).
Although communities play an important role in water resources development and management, community participation continues to be a challenging issue in the sector due to a lack of awareness (UNESCO, 2004). In sub-Saharan countries, there is a decreasing rate in the execution of new water supply and irrigation projects. This is further compounded by the failure of existing schemes on account of the lack of proper operation and maintenance. As a consequence, communities are without appropriate service facilities, particularly for drinking water and sanitation. Community involvement and public participation could be seen as a way to assist the retrieval from this situation in Africa. Community participation should be orientated towards facilitating sense of ownership and responsibility in the communities. Involvement of the community in water supply projects and the training of grassroots-level technicians have proven successful in many African countries and have helped to reduce investment costs by about 40 to 50% (UNESCO, 2004).

Although the water policy and the water strategy have responsibly covered the intent of participation of the private sector in the development and management of the water resources, the actual participation of the private sector on the ground is highly limited due to a restricted enabling environment. There is no institutional setup for the private and public sector to collaborate, discuss shortcomings and devise new ways for cooperation.

6.6 Conclusion

Ethiopia has a water resource potential of about 122 bcm and an irrigable land of about 3.7 million ha. Currently, 2% of the water potential and 4% of the irrigable land potential is utilised. Low levels of institutional and skilled manpower capacity, shortage of financial resources, a low level of infrastructural development as well as a low level of involvement of stakeholders in development processes are the major development constraints.
The government has formulated and issued the water policy in 1999, the water strategy in 2001 and has drawn up a water sector development programme (2002-2016) in 2002. By 2016, the WSDP has envisaged to raise the water sector coverage from 31% to 76%, irrigation development from 200.000 ha to 472.000 ha and hydropower development from 1.314 GWh to 4.040 GWh.

Furthermore, the government has established necessary institutions from federal to local levels for water resources development and management. Practically, however, the water policy has been executed only on paper and changed the situation only very little on the ground. The water policy, though comprehensive and sound in its coverage, has several policy gaps. The water resources development and management faces several challenges in Ethiopia. This calls for measures to be taken in order to practise effective water governance in the country.

6.7 Recommendations

The water policy is sound on paper but has not yet been materialised on the ground. A more conducive environment must be created to encourage all stakeholders to actively participate in the water sector development. Generally, the following recommendations are made to rectify the policy gaps:

- Workable mechanisms should be developed at all levels to narrow the water policy gaps.
- Policy implementation arrangements, monitoring, follow-up and feedback mechanisms on policy implementation have to be devised.
- The water policy needs to be adequately communicated to the public.
- The legal basis for the participation of all stakeholders should be put forward.
- The enforcement capacities (institutional, legal, financial) should be strengthened to ensure that enacted legislation is put into practice.
- Strong coordination and linkage mechanism should be created for policy implementation among stakeholders.
- For proper collection, dissemination and accessibility of information, there should be a central database (MIS).
- Manpower capacity building is imperative for the policy to succeed.
- Attention should also be given to rainwater harvesting schemes (to store the surplus water that comes in the form of floods and to use it during droughts for human and livestock water consumption, irrigation, etc.).
- Community participation should be orientated towards fostering a sense of ownership and responsibility.
- Internal dynamism has to be brought to the task of rural poverty alleviation.
- River Basin authorities should be established.

6.8 References

CSA/Central Statistical Agency of Ethiopia. Statistical Abstract 2005.

FDRE (1995). Constitution of the Federal Democratic Republic of Ethiopia, Addis Ababa.

IFPRI (10/9/2007). “Atlas of the Ethiopian Rural Econom”, cited from http://www.ifpri.org/country/ethiopia.asp-.

MoWR (1998). Water and Development Bulletin, Volume 3, No. 9, 1998, Addis Ababa, Ethiopia.

MoWR (1999). The National Water Policy of Ethiopia.

(2000). Ethiopia’s Water Resources Management Proclamation No. 197/2000.

(2001). Ethiopia’s Water Resources Management Strategy.

(2002). Water Sector Development Program of Ethiopia.

(2005). Water Resources Management Regulation of Ethiopia.

Teshome, W. (2007). Opportunities and challenges for private sector participation in the water resources development and management in Ethiopia.

UNESCO (2004). National Water Development Report for Ethiopia (Final). Addis Ababa, December 2004.

UNDP (5/9/2007). “Water and Environment”, cited from http://www.et.undp.org/energy/energy/-htm.

UN Water/Africa (2001). The Africa Water Vision for 2025: Equitable and sustainable use of water for socioeconomic development.

Zinabu, G. (1994). “Human Interactions and Water Quality in the Horn of Africa in Emerging Water Management Issues”, February 1998 Symposium Proceedings.

Complete List of Volumes

Vol. 1

LARS 2007 Proceedings

Vol. 2

Alumni Summer School - Well Drilling and Rural Water Supply

Vol. 3

Summary of Master Theses from Arba Minch University

Vol. 4

Results from Expert Seminar - Topics of Integrated Water Ressources Management

Vol. 5

Adane Abebe - Hydrological Drought Analysis - Occurence, Severity, Risks: The Case of Wabi Shebele River Basin, Ethiopia

Vol. 6

Bogale Gebremariam - Basin Scale Sedimentary and Water Quality Responses to External Forcing in Lake Abaya, Southern Ethiopian Rift Valley

Vol. 7

Stefan Thiemann et al. Integrated Watershed Management - Financial Aspects of Watershed Management