Universität für Bodenkultur Wien
University of Natural Resources and Applied Life Sciences, Vienna

Department für Wasser-Atmosphäre-Umwelt
Institut für Siedlungswasserbau, Industriewasserwirtschaft und Gewässerschutz

SMALL TOWN WATER SUPPLY

Analysis and Improvement of Infrastructure, Organization and Management Structures.

Case Study in Sofala Province, Mozambique

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STRAHL, MARC-SEBASTIAN

Betreuer: Haberl, Raimund
Mitbetreuer: Jung, Helmut

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ABSTRACT

Small towns are important for national development and there is growing consensus that better service in small towns is necessary. This is also valid for water supply. However, small towns grow unplanned and there is a lack of professionals. Solutions tailor-made for each town are needed as characteristics differ strongly from town to town.

According to the situation described, the research question arises: How can small town water supply be organised successfully, according to national water supply policy and according to the situation in small towns?

To answer the research questions, three methods of research are utilised: literature research, expert interviews and a field study, done in three small towns in the province of Sofala, Mozambique.

The literature overview highlights the critical importance of small town water supply. In Mozambique this situation led to a fundamental change in the policy for small town water supply. The new framework is a big step towards autonomous water supply and complies with most requirements described in the literature. Shortcomings are the lack of monitoring, the lack of clear definition of responsibilities and no clear statement on how to involve the consumers.

Among numerous management models, the Delegated Management Model (DM) is the preferred one for small towns in developing countries. A form of DM is Private-Public-Partnership (PPP). The PPP approach was chosen as the future model to organise and manage small town water supply in Mozambique.

The field work and the expert interviews showed constraints with respect to organisation, technical equipment and staff knowledge. During the field work, a lot of data could not be collected. This is also due to a lack of basic knowledge of staff about how to operate a water supply entity and lack of sensitisation to how important data acquisition is.

The conclusion shows, that knowledge constraints in small towns are related to lack of education and experience. The possibilities to gain education are limited in Mozambique and the market for highly educated staff is thin. Possibilities to gain proper education have to be extended and small towns have to be made attractive for young urban professionals. This shows the dilemma in which small towns are caught. They need qualified personnel to develop themselves. But these in turn demand a certain standard of living and prefer to stay in urban centres.

For successful small town water supply, the different circumstances, development chances and possibilities of each town have to be considered. The water supply systems are old, run-down and too small to supply the population, as evidenced by the field study. Huge investments are necessary to establish small piped systems as the main source for drinking water. For proper water supply, stakeholder involvement is necessary just as autonomy of the service provider and demand responsiveness. Additionally assessments before investment have to be done. Capacity building in business planning and water supply issues is urgent, too. A sense of responsibility and awareness of how important data collection and evaluation as well as maintenance of the facilities are, have to be raised. A framework with clear responsibilities, incentives and penalties is necessary.

ABSTRACT AUF DEUTSCH

Kleinere Städte sind wichtig für die Entwicklung eines Landes und die Tatsache, dass öffentliche Dienstleistungen in diesen Städten verbessert werden müssen, erfährt immer mehr Zustimmung. Dies trifft natürlich auch auf die Wasserversorgung zu. Jedoch wachsen diese Städte unkontrolliert und es mangelt an Fachkräften. Passende Lösungen für jede einzelne Stadt sind notwendig, da diese sich stark voneinander unterscheiden.

Anhand der beschriebenen Situation ergibt sich die Fragestellung: Wie kann die Wasserversorgung in kleineren Städten anhand der nationalen Wasserversorgungspolitik und der Situation vor Ort erfolgreich organisiert werden.

Um diese Frage zu beantworten, wurden drei Forschungsmethoden angewandt: Literaturrecherche, Experteninterviews und eine Feldstudie in drei kleineren Städten in der Provinz Sofala, Mosambik.

Die Literaturübersicht zeigt, wie immens wichtig die Wasserversorgung in kleineren Städten ist. In Mosambik führte dies zu einer grundlegenden Änderung der Politik für kleinstädtische Wasserversorgung. Das neue Rahmenwerk ist ein großer Schritt in Richtung autonome Wasserversorgung und erfüllt die meisten Bedingungen, welche in der Literatur beschrieben wurden. Defizite sind der Mangel an Monitoring und klaren Bestimmungen von Verantwortlichkeiten sowie dass die Einbindung der Verbraucher nicht näher beschrieben wird.

Unter mehreren Management-Modellen, ist delegierte Verwaltung (Delegated Management) das bevorzugte Model für kleinere Städte. Eine Form davon ist privat-öffentliche Partnerschaft (Private-Public-Partnership, PPP). Der PPP-Ansatz wurde als zukünftiges Modell zur Organisation und Verwaltung der Wasserversorgung in Mosambiks Städten von der Regierung Mosambiks ausgewählt.

Die Erhebungen vor Ort und die Experteninterviews zeigen Mängel in Bezug auf Organisation, technische Gerätschaften und Wissensstand des Personals. Vor Ort konnten viele Informationen nicht erhoben werden. Ursachen waren das Fehlen von Grundwissen des Personals, wie ein Wasserversorgungsunternehmen geführt werden sollte und mangelnde Sensibilität gegenüber der Tatsache, wie wichtig Datenerhebung ist.

In den Schlussfolgerungen wird aufgezeigt, dass das Fehlen von Ausbildung und Erfahrung zu Wissenslücken führt. In Mosambik sind die Möglichkeiten zur Ausbildung gering und es mangelt an gut ausgebildetem Personal. Die Möglichkeit, eine ordentliche Ausbildung zu erhalten, muss ausgeweitet werden und kleinere Städte müssen für junges Fachpersonal attraktiver werden. Dies zeigt das Dilemma, in welchem kleinere Städte stecken. Sie benötigen Fachpersonal, um sich zu entwickeln. Dieses verlangt jedoch wiederum einen gewissen Lebensstandard und zieht es vor, in den großen Städten zu bleiben.

Um die Wasserversorgung von kleinen Städten erfolgreich zu gestalten, müssen die unterschiedlichen Umstände und Entwicklungsmöglichkeiten jeder Stadt miteinbezogen werden. Die Wasserversorgungsnetze sind alt, heruntergewirtschaftet und zu klein um die die ganze Bevölkerung zu versorgen. Dies wurde durch die Untersuchung vor Ort bestätigt. Damit kleinräumige Leitungssysteme (Small Piped System, SPS) zur Hauptquelle der Trinkwasserversorgung werden, sind massive Investitionen nötig. Für eine angemessene Versorgung müssen alle Akteure beteiligt werden. Die Autonomie des Betreibers ist genauso wichtig wie Nachfrageorientierung. Bevor investiert wird, müssen zusätzliche Erhebungen durchgeführt werden. Aufbau von Kapazitäten in den Bereichen Geschäftspläne und in Fragen der Wasserversorgung sind dabei ebenso wichtig. Zudem sollten Betreiber Verantwortung übernehmen und ein Bewusstsein dafür entwickeln, wie wichtig Datenerhebung und -auswertung sowie die Wartung der Anlagen sind. Rahmenbedingungen, die klare Verantwortlichkeiten festlegen und Anreize schaffen sowie Sanktionen erlauben, sollten ebenfalls eingeführt werden.

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LIST OF ABBREVIATIONS

AIAS	Administration of Infrastructure for Water Supply and Sanitation (Administração de Infra-Estruturas de Abastecimento de Água e Saneamento, Mozambique)
ANEPA	National Potable Water and Sanitation Agency (Agence nationale de l'eau potable et de l'assainissement, Mauritania)
APAS	Provincial Water Board
ARA	Regional Water Administration (Administração Regional de Águas, Mozambique)
BDS	Business Development Service
BOO	Built-Own-Operate
BOT	Built-Operate-Transfer
BPD	Building Partnership for Development in Water and Sanitation
CBO	Community Based Organization
CFM	National Railway Company of Mozambique (Camnihos de Ferro de Mocambique)
CPAS	Provincial Water and Sanitation Council (Conselhos Provinciais de Água e Saneamento, Mozambique)
CRA	Regulatory Board of Water Supply (Conselho de Regulação do Abastecimento de Água, Mozambique)
DAR	Rural Water Department (Departamento de Água Rural; Mozambique)
DAS	Department for Water Supply and Sanitation (Departamento de Água e Saneamento, Mozambique)
DAU	Urban Water Department (Departamento de Água Urbana; Mozambique)
DM	Delegated Management
DMF	Delegated Management Framework
DNA	National Directorate of Water (Direção Nacional de Águas)
DPOPH	Provincial Directorate of Public Works and Housing (Direcção Provincial de Obras Públicas e Habitação, Mozambique)
ENH	National Oil company (Empresa Nacional de Hidrocarbonetos, Mozambique)
FIPAG	Water Supply Investments and Assets Fund (Fundo de Investimento e Património do Abastecimento de Água, Mozambique)
GDP	Gross Domestic Product
GNP	Gross National Product
GoM	Government of Mozambique
GPOBA	Global Partnership on Output-Based Aid
IMS	Independent Micro Systems
IRC	International Water and Sanitation Centre
IWA	International Water Association
LA	Local Administration

LG	Local Government
MDG	Millennium Development Goals
MOPH	Ministry of Public Works (Ministério das Obras Públicas e Habitação, Mozambique)
MZN	Mozambican Metical (currency)
NGO	Non-Governmental Organization
NWP	National Water Policy
O&M	Operation and Maintenance
ONEA	National Office for Water and Sanitation (L'Office National de l'Eau et de l'Assainissement, Burkina Faso)
PAARSS	Program for Rural Water Supply and Sanitation in Sofala (Projecto de Abastecimento de Água Rural e de Saneamento em Sofala, Mozambique)
PEPAM	Program for Drinking Water and Sanitation (Programme d'eau potable et d'assainissement du Millénaire , Senegal)
PPP	Public-Private-Partnership
PRONASAR	National Rural Water and Sanitation Program, Mozambique
PUP	Public-Public-Partnership
SDPI	District Office of Planning and infrastructure (Serviços Distritais de Planeamento e Infra-Estruturas, Mozambique)
SODECI	Water Supply Association Ivory Coast (Société de Distribution d'Eau de la Côte d'Ivoire , Ivory Coast)
SPAS	Provincial Water and Sanitation Service (Serviços Provinciais de Água e Saneamento, Mozambique)
SPS	Small Piped System
TI	Transparency International
UN	United Nations
UNICEF	United Nations International Children’s Emergency Fund
UNSGAB	United Nations Secretary General Advisory Board on Water Supply and Sanitation
WBI	World Bank Institute
WC	Water Committee
WHO	World Health Organization
WOP	Water Operator Partnership
WSP	Water and Sanitation Program
WUA	Water User Association

PREFACE

Water is an essential good for human society. In July 2010, the UN General Assembly recognized the right to water as a human right (UN 2010a). In our society, water plays a central role, even if not perceived as such consciously by the majority of the Western nations' population. 'Water comes from the tap, as electricity from the socket'.

In the developed nations, supply is secured with most advanced technical aid and people have almost unlimited access to clean water. In Europe 98 % use an improved drinking water source (Figure 1). Albeit access to improved drinking water is still denied to 884 million people world-wide, of which 320 Million live in Africa. In Mozambique 12.1 Million (53 % of its total population) depend on unsecured sources. Of these, 29 % (2 Million) live in urban areas (WHO 2011).

Figure 1: Definition of improved and unimproved drinking-water sources (JMP 2011)

Structure and Content of this thesis

In the first chapter, the problem statement, objectives, topical limitations and the methodology are formulated. The second chapter describes the water supply situation in Mozambique with focus on the institutional framework and small town water supply. It further will describe small towns and their water supply and shows different management models for small town water supply and outlines the model favoured at the moment in developing countries. In chapters three and four the results of the field study and the expert interviews are presented. Chapter five is to answer the research question posed at the beginning of this thesis and ends with the conclusion.

1 INTRODUCTION

1.1 Problem Statement

In the 1980's rural water supply was dominant in Mozambique and small towns did not receive special attention. This changed slightly in the 1990's, when piped networks and standpipes came up and more complex models involved formal Water User Associations (WUA). Small towns were included in the water supply plans for developing countries. During the last years small towns got more and more recognised and the idea to define small towns as a new category were raised (SDC 2009). But why did this change of thinking occur?

Small towns are important to create economies for provision of goods and services as health care or schools but also for commercial and industrial enterprises (Pilgrim et al. 2007). They are central in reducing the stress on urban slums and in supporting rural areas by social and economic development (UNDESA 2010). But they lie in a grey area between rural areas and urban centres, where neither community management nor utility-based solutions are fully suitable. Given the fact that the population in these towns is equal to that in rural areas and urban centres, there is growing consensus that they deserve better services (Pilgrim et al. 2007). Negligence of small towns is intensified by uncertainty regarding which approaches could bring small town water supply on track or forward. Also if donors and the government decided to assist small towns, profound analysis and capacity are amiss. Consequently small towns are all treated the same. They get the same financing, technology and management capacity training (WaterAid/BPD 2010).

The reason for the change in thinking lies in urbanisation of developing countries which is happening fast, also in small towns and medium sized towns (Martine 2007). Therefore it is important to have a look at these towns and try to steer their development. 20 – 40 % of the urban population lives in towns and these are growing quickly. The population in Africa, Asia and Latin America is expected to double from 2000 to 2015 and double again from 2015 to 2030 (Triche et al. 2006). These three regions will shift from a 60 % rural 40 % urban distribution to 25 % rural 75 % urban, like in Europe or North America. This shift will take place mostly in favour of small towns. For every large town (50,000 – 200,000 Inh.) there are about 8 - 10 small towns (2,000 – 20,000 Inh.) and 2 - 3 medium sized towns (20.000 – 50.000 Inh.). However, the growth rates of single towns and their development are difficult to predict, which makes planning of services even more complicated (Pilgrim et al. 2007). Consequently, new approaches are necessary for small towns to provide basic services like water supply (Harvey 2010).

Mozambique shows this urbanization trend too. In 2009 38% of the Mozambican lived in urban areas, 31% in 2000. 2015, the urban population will be 42%. Today, of the 9 million people living in urban areas, 60% (or 5.3 million) live in towns smaller than 500,000 inhabitants (UN 2010b). In 2015, about 1.3 million people will live in 80 towns with a population ranging from 2.000 – 50.000 residents. This totals 30% of the total urban population in 2015 (Lazarte & Macário 2010).

Referring to (van Woersem et al. 2007) there are about 300 small towns with a small piped system[1] (SPS) for water supply. About 75 % of them are not functional or need urgent rehabilitation.

This shows the urgency of bringing small towns on track. Water supply is one possible measure to strengthen their position.

1.2 Objectives

According to the situation described above, a main research question arise:

- **How can small town water supply be organised successfully, according to national water supply policy and according to the situation in small towns?**

To find a proper answer, it is necessary to understand the national terms and conditions which give the direction of water supply in general and small town water supply in detail. Therefore it is important to understand the framework within the water supply of Mozambique is organised. This leads to the second research question:

- **How is the framework for small town water supply in Mozambique organised and which processes within this framework can guarantee successful small town water supply?**

Besides the framework, it is furthermore necessary to analyse actual approaches used for small town water supply management. Thus, a third research question is

- **Which management and organisation model is to be favoured for small town water supply in developing countries and especially in Mozambique?**

1.3 Research Limitations

1.3.1 Millennium Development Goals (MDG) in the Context of this Thesis

Fulfilling the MDG[2] is a global intention and much is set in motion to do so. Therefore a multitude of data is generated and made available[3]. Besides the targets concerned with the development of small towns water supply, no further explanation or discussion of the MDG is seen necessary, as the MDG are not part of this work. The history of the MDG can be found in Hulme 2009, analyses in Clemens, et al. 2004 or Easterly 2007.

The essential target concerning water supply is sub-target C - Half *the proportion of people without sustainable access to safe drinking water and basic sanitation* - of Target 7 “Ensure Environmental Sustainability”. The indicator used for measuring progress is the proportion of the population using improved drinking water sources. Other targets are directly affected by improving water supply, for example Target 1 ”Eradicate Extreme Poverty and Hunger” or Target 4 “Reduce Child Mortality”.

[1] Small Piped Systems are water supply sytems supplying maximum several thousand inhabitants.

[2] The Goals and their Indicators are avaiable on http://mdgs.un.org/unsd/mdg/Host.aspx?Content=Indicators/OfficialList.htm,

[3] All data can be found on http://mdgs.un.org/unsd/mdg/Data.aspx

1.3.2 Corruption in the Water Sector

Corruption is too important to be ignored but also too complex to be discussed in deeper detail. The water sector all over the world showed a risk of corruption and therefore in Mozambique, too (Transparency International 2008). Mozambique's rankings in the TI's Corruption Perception Index, and WBI's Control of Corruption Index are low. Reasons are the complexity of the water sector, low accountability of public accountability, limited capacities of institutions, major planned investments by government and donors as well as specific corruption areas. These findings of an IRC study in 2009 lead to DNA developing an anti-corruption strategy under guidance of the IRC. Focus lies on strengthening transparency, accountability and integrity in the sector (IRC 2011).

1.3.3 Sanitation in the Context of this Thesis

Clearly water supply and sanitation are interwoven. Further, it is commonly accepted that sanitation is essential to improve the standard of living and to protect environmental sources. Although it would go beyond the scope of this work to also cover sanitation, too.

1.4 Methodology

To answer the research questions formulated above three methods of research will be utilised.

- Literature Research
- Expert Interviews
- Field Study

1.4.1 Literature Research

The literature research is done to gather information to answer the main and both sub research questions. To do so focus lies on following topics:

- **The Mozambique Water Sector**. Here the focus lies on institutional framework and policy to describe roles and responsibilities in the water sector and to answer the second research question.
- **The Mozambique Small Town Water Supply**. Here focus lies on how the actual situation is described in the literature to gain an overview of the small town water supply in Mozambique.
- **Small Towns**. Here the focus lies on how small towns are seen in the literature. This part is to gain the theoretical background of small towns.
- **Water Supply Organisation Models** in developing countries. Here the focus lies on how the literature describes small town water supply management and organisation. This is done to find appropriate solutions which can be adopted for the main research question.

For this, available publications of the following organisations, associations and governments related with the water sector were used (in alphabetical order):

Building Partnerships for Development in Water and Sanitation (BPDWS)

Government of Mozambique (GoM)

International Water and Sanitation Centre (IRC)

International Water Association (IWC)

The World Bank

United Nations (UN) and associated organisations

WaterAid

Water and Sanitation Program (WSP)

Water Research Commission (WRC)

Water Supply and Sanitation Collaborative Council (WSSCC)

Water, Engineering and Development Centre (WEDC)

World Health Organization (WHO)

1.4.2 Field Study

To find an answer to the first research question it is necessary to collect fundamental data about the actual situation of small town water supply. To gain a broad and sophisticated picture of small town water supply in Mozambique, three towns with different economical and infrastructure situation were chosen:

- Marromeu, with 40.000 Inhabitants (2007) is fast-growing (8% per year). Reason is a huge sugar industry on site employing 3,000 in regular season and up to 8,000 while harvesting. Through this a lot of people have a regular income and economy in Marromeu is in relatively good condition.
- Inhaminga grows even faster (19% per year), but starting from a lower level (10,000 inhabitants in 2007). With the restored railway, Beira (over 500,000 Inhabitants) can be reached more quickly and cheaper by more people than before. This railway stop is important as Beira is a potential market for agriculture products. Also, Inhaminga lies on the road to Marromeu and numerous small bars line the street.
- Búzi instead is a quiet town at the Búzi river with a constant 10,000 inhabitants over the last ten years. It lies at the end of the road and no transit is passing through like in Inhaminga for example. However, oil was found close to Búzi which could give the town a boost.

All three towns act as local centres where the local administration is settled. Markets, schools, gas stations, pensions, police stations, churches and mosques exist in every town which makes each town a centre of attraction in the close region.

In order to collect data about the actual water supply situation in the small towns, a questionnaire was developed. The interview partners were the head of the responsible local institution and the operational staff.

The questionnaire sets its focus on assessment of

- **Organisational structure,**
- **Technical equipment and Data**
- **Operation and Maintenance**

- **Economical Data**

A check list of the IWA Performance Indicators was used to collect complimentary information such as

- **Context Information**
- **Water Volume Data**
- **Personnel Data**
- **Physical Data**
- **Operational Data**
- **Demography and Customer Data**
- **Quality of Service Data**
- **Financial Data**

The questionnaire can be found in Annex 7.2.

Contact to these persons was established with the help of Mr. Derntl, who has been active as a water and sanitation consultant in Mozambique for several years. He contacted Mr. Abel Florencia of DAS in Beira and informed him about the planned activities and the time schedule. Mr. Florencia in turn informed the responsible persons in the respective towns about the planned activities.

Whenever possible, other stakeholders in the towns were interviewed. For these interviews, the questionnaire for Water Supply Officers was used, too. But the questionnaire was not adhered to stringent and the interviews were allowed to follow the course of the conversation.

1.4.3 Expert Interviews

A questionnaire was developed to interview national and international experts on Mozambique's small town water supply. The questionnaire can be found in Annex 7.1. The focus of the questionnaire lies on the main research question and **it is expected to outline the actual situation of small town water supply in Mozambique**.

To this end the idea was to interview three different types of stakeholders:

- **Experts from governmental agencies** (DNA, AIAS, DAS) to get a closer view from the inside
- **International experts** working in Mozambique (WSP, UNICEF) to round up the international expert view gained through literature research
- **A Lecturer of the faculty for engineering of the Mondlane University in Maputo** to have a third (independent) opinion besides the two mentioned above

Furthermore, the intention to gather the latest information concerning the research questions, through conversation with all three types of interview partner.

The following Experts were interviewed

- **Dinis Juizo**, Universidade de Mondlane. Professor
- **Ella Lazarte**, WSP. Leader of small town piped systems

- **Abel Florencia**, DAS. Chief of Small Piped Systems and Water sources (Pequenos Systemas and Fontes Dispersas)
- **Eduardo Jossefa**, DNA rural. Head of Evaluation and Monitoring
- **Francisco Naene**, DNA rural, Evaluation and Monitoring
- **Ana Mabate**, DNA rural, Project Implementation

The following experts were planned to be interviewed, but it did not materialise:

- An expert from UNICEF Maputo. No appointment was possible during the two stays in Maputo
- Nelson Matsinhe, Universidade de Mondlane. No answer was received on e-mail request.
- Antonio Pedrito, AIAS. No answer was received on e-mail request
- Roberto Come, DNA. No answer was received on e-mail request

The interviews with WSP, DNA and DAS were made possible with the help of Mr. DI Thomas Derntl. The interview partner from Mondlane University was contacted on my own, following a suggestion of Mr. DI Helmut Jung.

1.4.4 Method used for Discussion

The approach to analyse the gathered data and information follows the causality principle. The assumption is that every effect (like a phenomenon or issue) has its cause. To find these causes is task of the discussion which follows at least three steps

- First, the data and information gathered is analysed regarding to phenomena or problems. This will be done for the literature part as well as for the field study.
- The second step is to analyse the phenomenon or problem with view to its causes. Having a look only at the phenomenon or problem is not sufficient. If only the phenomenon or problem is solved, it is likely the same phenomenon or problem will occur again sooner or later, maybe in a modified way.
- Often the causes first examined are possibly an effect of another cause themselves. If this is the case a third step is taken. Here, the causes are examined to locate their source in turn.
- This search for a cause can be carried out a third (or even a fourth) time if the true source for the first phenomenon or problem is still not located.

This method is used for discussion of phenomenon or issue, which is seen solvable within this thesis, even if a deeper cause is possible. Otherwise it would go beyond the scope of this work.

2 BASIC INFORMATION: LITERATURE RESEARCH

2.1 Mozambique: Water Supply Framework

2.1.1 History and General Information

Until 1975 Mozambique was a Portuguese colony, with an agrarian dominated economy, almost no infrastructure and a very low educational level. The 300,000 Portuguese settlers controlled the economy, the private sector and public administration. After FRELIMO[4] took over power in 1975, they adopted a one-party government system and centralized planning to solve the crisis caused by 95% of the Portuguese settlers leaving the country (van Woersem et al. 2007). Also water supply was centralized and became dependent on central government's investments (Triche 2009). As FRELIMO was supported by the UdSSR former Rhodesia and South Africa supported RENAMO[5] as a counterpart. This led to a 16 year lasting civil war, dislodging over 25% of the population. In 1990 the liberal constitution was enacted what resulted in a peace agreement between both parties in 1992 FRELIMO and RENAMO are the main political parties today. From this moment on, rebuilding the country is expedited (van Woersem et al. 2007). A more detailed description of the events can be found in van den Bergh 2009 and Hupe & Vachal 2010, among others.

Mozambique lies in south-east Africa and covers an area of 786,000 km² with a 2,700 km coastline on the Indian Ocean. The capital Maputo is situated in the south, close to the South African border and has 1.8 Million inhabitants. The country has 11 provinces, subdivided into 128 districts (Triche 2009).

The population of Mozambique was estimated at 22.9 Million in 2009 and is estimated to grow to 26 Million until 2015. The population growth rate between 2005 and 2010 was 2.4%, the fertility rate at 5.1 is one of the highest in the world (WHO 2011) and (UN 2010b).

Mozambique's climate is mostly tropical with the exception of the highlands on the northern and western borders. The coastal areas are strongly influenced by the monsoon rains of the Indian Ocean (Encyclopædia Britannica, Inc. 2011).

With a per capita GNP of US$ 440 in 2010, Mozambique is still one of the poorest countries in the world. The annual GDP growth rate of the last three years was 6.8% with an the inflation of 8.8% in the same period. The Agricultural sector generates 32% of the GNP, Industry 23% and Services 45%. Mozambique strongly depends on Aluminium (CIA 2011), making one third of the exports.

Actual data regarding the MDG, and of all sectors, are available in (Government of Mozambique 2010).

[4]Mozambique Liberation Front (Frente de Libertação Moçambique). Political and military movement that initiated Mozambican independence from Portugal (Encyclopædia Britannica, Inc. 2011).

[5]Mozambican National Resistance, (Resistência Nacional Moçambicana), guerilla organization that sought to overthrow FRELIMO (Encyclopædia Britannica, Inc. 2011).

2.1.2 Water Supply in Mozambique

2.1.2.1 General

The main goal of the National Water Policy and the Water Law is to increase access to water supply services, especially for poor and rural population and to decentralize these services. The service entities shall be autonomous and financially self-sustaining through cost recovery improvement. Water is seen as an economic and a social good, the private sector shall have a bigger role while the state role shall be reduced. Further, focus on capacity building shall be extended just as beneficiary participation (van Woersem et al. 2007) and (Triche 2009). The goals of the Mozambican water supply also refer back to the MDG. Consequently the national aim is to increase the supply with safe drinking water up to 70% till 2015 (The World Bank 2009a). The objective of increased service delivery is to ensure satisfaction of the basic human needs, to reduce rural poverty and increase people's well-being (Government of Mozambique 2010).

Expenditures in the water sector rely on donor funding with 70 – 80 % of the 45.5 Mio € budget in 2006 (van Woersem et al. 2007). This shows to what extent water supply depends on foreign aid.

2.1.2.2 Access to Improved Drinking Water

The access to improved drinking water sources (definition see Preface) increased from 42% in 2000 to 47% in 2008. However, there is a big difference between urban areas, where 2008 77% had access, and rural areas, where only 29% had access (Figure 2 and 3)(UN 2011). Also wealth plays an important role in the access to safe drinking water. In the lowest quantile of wealthy people, only 13% have access, while in the highest quantile 85% have access. In the province of Sofala, where the three targeted small towns are situated, the consumption of safe drinking water is at about 48% (Instituto Nacional de Estatística 2009).

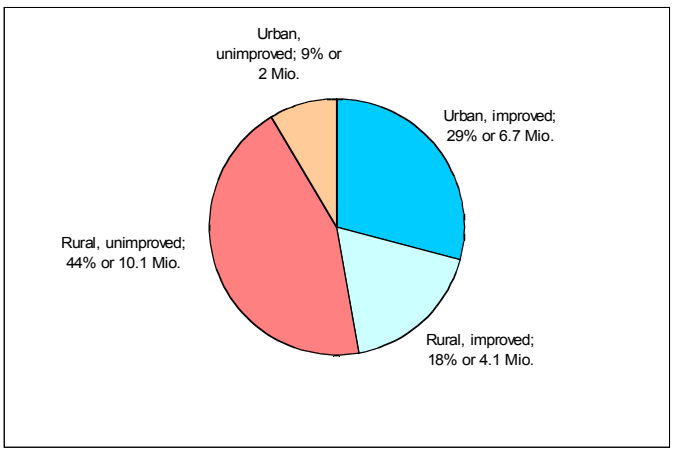

Figure 2: Portion of access to improved and unimproved water sources in Mozambique 2008 (UN 2011)

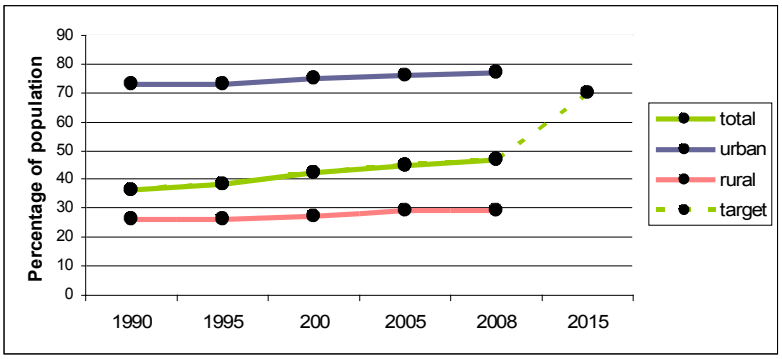

Figure 3: Development of access to improved drinking-water in urban and rural areas of Mozambique 1990 - 2008

2.1.2.3 Legal Framework and Policy Principles

The main legal and policy instruments in Mozambique are

- The Water Law '91: Water is an issue of public interest and the the Ministry of Public Works and Housing is responsible for water management
- The National Water Policy Resolution '95 and the decree from 2007: Change from a supply-driven to a demand driven approach
- The FIPAG decree '98: To establish the Water Supply Investments and Assets Fund (FIPAG)
- The CRA decree '98: To establish the Water Regulatory Council (CRA)
- The Delegated Management Framework (DMF) decree '98 to establish a legal base for the DMF (The World Bank 2009b)
- DMF decree 2009 for expand the DMF to town water supply systems with the new institutions AIAS, CPAS and SPAS and a wider mandate for CRA (Lazarte & Macário 2010)

Box 1: The Delegated Management Framework

The DMF foresees transfer of asset management and operators oversight to municipalities and began reform of urban water supply in 1998. It was set up to separate asset management and operation. Asset management is centralized to FIPAG, responsibilities are decentralized to the municipalities. Further DMF target is full cost recovery tariffs in urban areas. Before adequate infrastructure can exist, autonomous water companies must be institutionalized and the municipal staff should be able to handle asset management and contracting. Before the decentralisation, the GoM has to develop infrastructure, make service operation viable and make sure municipalities are ready for planning, financing and contracting operators. Since the DMF was introduced, performance of water service staff has improved step by step. The DMF brought up credible institutions and significant service improvements. Anyway, activities with clients as well as management skills of the middle management level needs further improvement (Triche 2009). The DMF has been valid for small towns since 2009 and the newly funded AIAS will be responsible for executing it(see below) (Lazarte & Macário 2010).

2.1.2.4 Institutional Framework, Roles and Responsibilities in the Water Supply Sector

The water sector in Mozambique is sub-divided into four categories. Integrated resource management, rural water supply and sanitation, urban water supply and sanitation and irrigation development. The first three are under directorate of Ministry of Public Works and Housing (MOPH) and within there under the directorate of National Directorate of Water (DNA). The last one is under the directorate of Ministry of Agriculture. Through decentralisation FIPAG, CRA and the ARAs were founded and responsibility transferred from DNA to them (van Woersem et al. 2007).

The institutional roles and responsibilities are subdivided into national level, provincial level and district or municipal level. On national level the MOPH is the responsible ministry for water supply and sanitation. Entities under MOPH directorate are DNA, CRA and FIPAG. On provincial level DPOPH is the governmental body with DAS as its water supply entity (van Woersem et al. 2007). Also every unit has responsibilities delegated by the DMF or other decrees, in reality they often are not able to fulfil their duties. The following figures show the former institutional framework as well as a framework with the recently funded agencies and the resulting change of responsibilities.

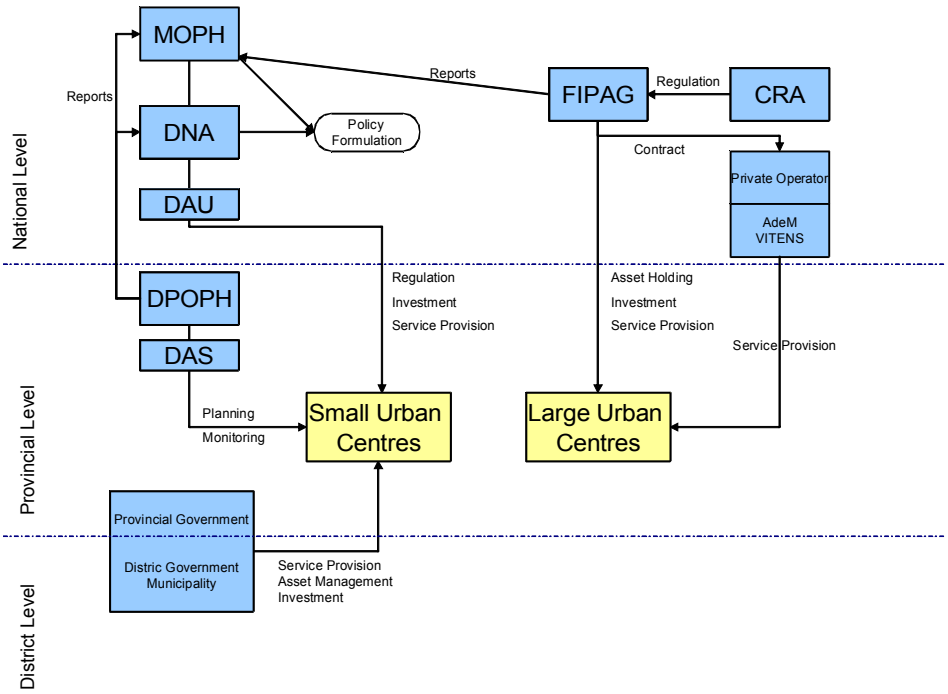

Figure 4: Institutional framework of the urban water supply sector in Mozambique before implementation of the new agencies.

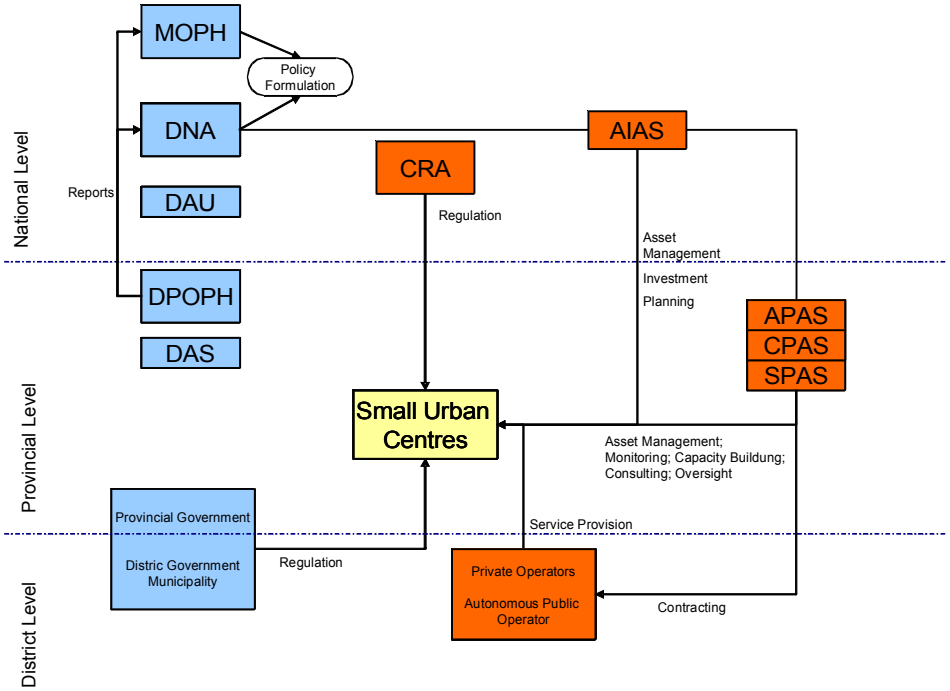

Figure 5: Institutional framework of the small town water sector in Mozambique with recently established agencies.

Responsibilities on National Level

The Ministry of Public Works (MOPH) is responsible for implementation of the Water Law and the National Water Policy (van Woersem et al. 2007).

The National Directorate of Water (DNA) mandate referring to the National Water Policy (NWP) is the definition of policies, stock taking of water resources, preparation and control of implementation of general schemes, execution of investments in studies and projects and preparation of legislation and inspect enforcement (van Woersem et al. 2007). DNA is also doing regulation (The World Bank 2009b) and investments in urban WS not within the FIPAG mandate and the rural areas (Triche 2009). Further, DNA promotes the establishment of private operators in small town water supply (The World Bank 2009b).

Under DNA, the **Rural Water Department** (**DAR)** and **Urban Water Department (DAU)** are active in water supply. DAR coordinates rural water supply, DAU is responsible for urban water supply not covered by FIPAG. Both promote water supply and create conditions for stakeholder participation in their mandated area (van Woersem et al. 2007).

The Water Supply Investments and Assets Fund (FIPAG) is the governments asset holding company and responsible for investing in the large urban water supply. Sustainable economy of these systems is a further task, as well as their development and the monitoring and delegation of management to private operators (Lazarte & Macário 2010). FIPAG reports directly to MOPH (van Woersem et al. 2007). Further, FIPAG has to adjudicate and supervise contracts with the contracted private operator. FIPAG operates the services in towns not transferred yet on a temporary basis. The most important and largest towns are under FIPAG control.

These are Maputo, Beira, Nampula, Pemba, Quelimane, Xai-Xai, Chokwe, Inhambane, Maxixe, Chimoio, Gondola, Manica, Tete, Moatize. Maputo WS is done by Agua de Mozambique (AdeM), Beira, Nampula, Pemba, Quelimane water supply by FIPAG on a temporary basis, and the last eight run under Vitens (s. Box), a Dutch entity. FIPAG still depends on donor funding. They receive funds from the WASIS program[6], from GPOBA[7] and from the Millennium Challenge Cooperation[8] (Triche 2009).

Box 2: Vitens: A large private operator of urban water supply

Vitens does not expect profit. Its contract with FIPAG is more of a management partnership. Vitens is responsible for developing management systems, carrying out delegated works, producing business plans and operational manuals and training staff. 80 % of technical assistance costs are funded by the Dutch Government. The Vitens team is composed as follows: Headed by a resident full-time project manager, six expatriate Vitens specialists each spend 9 weeks a year in the service area. The local team consists of local college students or recent graduates, mentored by the expatriate staff. The whole Vitens team supports the local FIPAG directors. Thus, local talent is developed and responsibilities of FIPAG managers is promoted, too. With their work, Vitens offer a preparatory model, maybe an alternative for cases in which a conventional private model is not fitting yet (Triche 2009).

The Regulatory Board of Water Supply (CRA) is the regulation agency. It is a public entity with administrative autonomy, reporting to MOPH. It shall hold balance between interests of service providers and users. It also shall control the rates charged for water and the economic sustainability of water supply systems. At the moment, CRA is only active in FIPAG areas. Plans exist to expand their responsibility to other towns (van Woersem et al. 2007). CRA was funded as after lease and management contracts service monopolies arise and an independent regulatory agency become necessary (Lazarte & Macário 2010). CRA also promotes delegated management arrangements and mediates between contractor and operator (Triche 2009).

The Administration of Infrastructure for Water Supply and Sanitation (AIAS) shall be responsible for asset management of non-FIPAG Cities and is part of DNA. AIAS is associated with the Provincial Water Boards (APAS). It was recently founded and will be responsible for urban water systems not under the DMF. It will have administrative, financial and asset autonomy, the power to mobilize, plan and manage funds, to plan and oversee investment execution, to promote PPP and to delegate managing, contracting and supervision to APAS (Lazarte & Macário 2010). AIAS will not borrow money and contract operators (which is both done by FIPAG). It is a project management unit. But still responsibilities have to be defined and coordinated with APAS (The World Bank 2009b).

[6]WASIS US$ 30Mio.: Network expansion in four provincial capitals, institutional strengthening, enable DNA to extend DMF to smaller towns and institutional support for CRA

[7]GPOBA US$ 6 Mio: subsidize low income households WS connection in peri urban areas

[8]Millennium Challenge Cooperation: US$ 35 Mio for FIPAG service areas; US$ 160 Mio to extend reforms to ST (Triche 2009)

Responsibilities on Provincial Level

On provincial level the **Provincial Directorate of Public Works and Housing** (**DPOPH)** and its **Department for Water & Sanitation (DAS)** are responsible for Water Supply. DAS has four sub-sections: Boreholes and wells, small piped water systems, sanitation, and community education and public awareness. DAS is responsible for water supply and sanitation projects and monitoring. DPOPH is accountable to the Provincial Government as well as to DNA (van Woersem et al. 2007).

Provincial Water Boards (APAS) will be created and then compose of district and municipality representatives. APAS is found to streamline the relations between the different levels and shall help in future decentralisation and de-concentration.

Implementation of AIAS and APAS is founded with the help of the World Banks WASIS Project (The World Bank 2009b).

Provincial Water and Sanitation Council (CPAS): A yet to be consultative agency established (Lazarte & Macário 2010).

Provincial Water and Sanitation Services (SPAS): To be founded and consequently responsible for contracting, oversight and capacity-building of operators (Lazarte & Macário 2010).

AIAS, APAS, CPAS and SPAS are implemented with the new DMF 2009 made the envisaged institutions of the Small Piped System (see Box below) Manual, Provincial Water Forum (responsible for institutional coordination of model implementation and the social integration of the services) and Independent Provincial Regulator (responsible for tariff updates, consumer interests), redundant (Lazarte & Macário 2010). At the moment there is no legal clarity for AIAS and APAS, but it is on its way. The role and relation to other stakeholders, local governments and consumers has to be taken into account. Right now, the implementation is tested as a pilot project (The World Bank 2009b).

Responsibilities on District or Municipal Level

On district and municipal level **district administrations** are responsible for O&M of the water supply. With decentralisation, the local government is also responsible for rural water supply planning and implementation. Some districts have a water technician, who is accountable to the District Administrator and the DPOPH (van Woersem et al. 2007).

At the moment, there is a lack of clarity of institutional arrangements for small towns. Currently, the plan is to establish the local governments as indirect regulators (The World Bank 2009b).

2.1.2.5 Historical Development of Small Town Water Supply in Mozambique

After the declaration of independence in 1975, most of the skilled Portuguese water supply staff left Mozambique and the water utilities tumbled down over time. Therefore Central Government took over responsibilities and utilities become dependent on the Central Government's investments (Triche 2009). Infrastructure and organizational structure were not maintained until today. Today, district governments run the water supply in small towns. Their revenue base is quite limited and investments are barely feasible. The operational costs and the level of

service are lower than in large towns (The World Bank 2009b). Theoretically DNA is responsible for small towns, but DNA cannot fulfil this duty. To bring small town water supply forward, AIAS was founded (The World Bank 2009b).

District governments are in charge in 58 urban areas, not all with a piped system. Still not much is known about these systems. It is assumed that they operate under the rural organizational arrangement with district government and DPOPH and that revenue is collected in these towns (The World Bank 2009b).

Referring to van Woersem et al. 2007 there are about 300 small towns with a SPS. 25 are managed by the municipality or the local government. About 75 % of them are not functional or need urgent rehabilitation. DNA developed a Manual for Small Piped Water Systems[9]. It is planned to implement service provision by private operators. Supervision of construction and operation is done by a local regulatory committee. The Manual is tested in four towns at the moment.

Field visits done by (Lazarte & Macário 2010) indicate the need of expansion investment, as a great demand and the capacity to pay is existent.

6 northern municipalities still are under DNA control. Theoretically these should be independent. They do not run successfully but they cover costs with revenues. However, it is not enough for rehabilitation or new infrastructure. All six lack of management capacity. 13 municipalities manage their water supply on their own, in 52 small urban centres without municipal councils DPOPH and progressively the district government is responsible for water supply. 2 municipalities and 6 small towns have a private operator, contracted by DNA, DPOPH or the municipality, see following chapter (The World Bank 2009b). This mixture of processes and conditions shows a lack of continuity and coordination.

Box 3: The Small Piped Systems Manual

Following the municipal framework legislation only municipalities and small rural centres are allowed to invest in WS systems. However, water legislation permits delegation of public WS management to the private sector. But this has not yet taken place.(The World Bank 2009b).

As the DMF did not consider small towns, the Manual for Implementation of SPS Management Models is developed. It sets out the roles and responsibilities of the stakeholders. The Implementation Manual sees DNA responsible for rehabilitation and expansion of small towns. The principal reason for the new DMF were insufficient funds.

SPS are categorized into three Types of which all have a borehole/well, transportation, storage and distribution through public standpipes and household/yard tap connections

Type 1: less than 50 household/yard tap connections
Type 2: between 50 and 150 household/yard tap connections
Type 3: more than 150 (and even more than 500) household/yard tap connections

Private operators and autonomous public operators are the two management forms, defined by the manual to be used.

Private operators are responsible for operation, maintenance and management via a lease contract with a duration of five years. The autonomous public operator option was not tried yet. Municipalities have the option to establish an autonomous public operator, referring to the Implementation Manual and the DMF. (Lazarte & Macário 2010).

[9]The manual could not be obtained during the research.

2.1.2.6 Pilot Project of Private Sector Participation in Small Town Water Supply in Mozambique

Many privately run systems exist where public enterprises do not provide water and are informal. 300 - 400 are known around Maputo. These are theoretically supervised by DAS and municipality authorities. However, no clear regulation and mechanisms are set up to clarify roles and responsibilities. Besides the formal private operators, informal small scale providers are spread all over the country (The World Bank 2009b). Right now, 8 SPS are operated by a private operator in a pilot phase, described below (Lazarte & Macário 2010). Their characteristics can be found in Table 1.

Town	Total Pop 2005	Coverage Estimated %	No. of Clients incl. Standpipes	No of house connections or yard taps	No. of functional standpipes
Magude	12,791	47	6,006	532	7
Manhica	14,011	82	11,544	1,068	12
Massinga	22,318	34	7,684	694	10
Quissico	7,713	60	8,070	307	11
Namaacha	13,510	86	8,392	910	9
Nametil	9,809	66	5,126	549	16
R. Garcia	9,913	53	5,240	530	4
Vilanculo	25,206	54	13,488	1,520	8
Average	14,409	60	8,194	779	9
Total population served is calculated as follows: 22.9% of urban population is served with household connections, 17.8% by neighbours and 19.7% by standpipes (Instituto Nacional de Estatística 2009). With (1+17.8/22.9) 1.8 households are served or 8 persons. A standpipe should serve 500 persons, however, field data shows an average of 250 persons.(Lazarte & Macário 2010)					

Table 1: Characteristics of the pilot project towns

Actual results of the pilot

After water supply was operated privately, the number of connections increased. This was partly because of the profit motive of the operators. Prices per month range from MZN 42 (Magude, R. Garcia) to MZN 200 (in Maputo MZN 156). The low tariffs are cheaper because the systems were handed over with many technical deficiencies and supply was very irregular. At standpipes, 20 l cost MZN 0.5. Connection fees lie between MZN 200 and MZN 1,500 within 50m, depending on whether the client provides material or not. Also service quality improved and in some neighbourhoods a 24/7 service is possible. Nevertheless, in some cases the monthly fee was charged but no water delivered, as happened in Namaacha. Also consumption rates are sometimes low (3 - 6 m³ per family and month) and billing practice has to be rethought, mainly for intermittent services.

Private operators opened customer service counters and used mass media such as radio and television for communication.

Operation and financial performance varied in all pilot towns. O&M costs are mainly composed of salary and energy costs with at least 60% of the whole expenses. The number of staff per 1,000 connections varied also, and lies between 6 in Manhica and 44 in Nametil. The global benchmark is 2 or 3, in developing countries 20. In 5

of the 8 pilot projects, O&M costs are covered by revenues. Their ratio varies from 0.7 to 0.93[10]. In Vilanculo high costs for technical assistance increased the ratio. After adjustment, the ratio would be 0.81.

The stability of the contracts indicates a potential for private operators in the water sector. For a further success, individual characteristics of the towns' infrastructures have to be taken into account.

Further strategy of the SPS Management Model is decentralization of responsibilities for planning, promotion, investment, regulation, supervision, implementation, and monitoring of operator performance to local levels. The contracts of the pilot projects first were signed with DNA, then with DPOPH (Lazarte & Macário 2010).

Design and Terms of the Contracts with the Private Operators

The lease contract model[11] was chosen since the local private sector is not able to make big investments in construction and rehabilitation. Aspirations to recover O&M costs would be a step forward, as under the district government led water supply, resources are always short.

The operator has to collect, treat and distribute water, make small extensions and reinforcements and maintain and overhaul equipment. Reports on administrative, technical, financial and operational performance have to be submitted two times a year to the lessor. This also includes review of the activity plan and budget. The lessor has the right to inspect, request and disseminate information and has to approve tariffs, the activity plan and the budget.

Contract duration is five years, making a sustainable O&M recovery more probable. The operator has to pay 10% of his gross monthly revenue to the lessor, 1% to the regulatory entity and 2% has to be deposited for extraordinary maintenance (Lazarte & Macário 2010).

Challenges that came up during the Pilot Study

A weak point is that neither service level goals nor technical-financial performance goals were established. Another issue is the lack of clear investment definitions. Before a private operator is contracted, a public investment is necessary to make the SPS operational at all. But investments during operation is not well-defined, as it only mentions small investments have to be done by the operator. No limit is given what small exactly means. As no formal regulatory body was established for the SPS, informal ones emerged through tariff increases respectively changes in the pilot project towns. Technical assistance is needed to train the members. At the moment monitoring is only carried out when problems arise. Main areas for required technical assistance are the decentralization of contract management as there was a lack of financing throughout the process as well as training of local governments in integrated planning, management, tariffs etc. (s. Specific Model) (Lazarte & Macário 2010).

[10] A ratio of less than one means revenue is higher than O&M costs, ratio 0.8 is seen as normal for a water company, as it allows a profit margin and depreciation.

[11] The operator gains the right on the Infrastructure, but no real property right. He is responsible for O&M and certain asset rehabilitation (Janssens 2011)

Specific Model for Technical Assistance

The model foresees one provincial operator managing several systems as done by FIPAG and Vitens in areas with inhomogeneous size, risk and profitability. This is to create economies of scale and scope. Support service on provincial level assists local operators directly or by contracting through the private sector (Lazarte & Macário 2010).

2.1.2.7 Challenges for Small Town Water Supply

A fundamental challenge is to design a consistent framework for water supply. In small towns, municipal councils and local governments operate the WS system but they are not defined as the authorities by law. Only the municipal legislation indicates a shared responsibility for municipalities. DNA is responsible for water supply by law. Roles had to be clarified between government and agencies (The World Bank 2009b). The responsibility transfer was not well prepared. It was done only verbally and not completely understood by the local governments. As there is no legal instrument right now, local supervision and guidance is weak. With AIAS and the Provincial Water Councils it will be necessary to clarify competencies of protection, ownership, control and implementation. An entity which deals with local investments is needed and which is also able to develop local capacities for supervision, planning and regulation. It is hoped that with performance contracts between AIAS and SPAS, with lease contracts between SPAS and operator and performance contracts between SPAS and local government, economy of scale and supervision can be attained (Lazarte & Macário 2010).

Funding is mostly channelled to larger towns, small towns receive little. A guideline to prioritize investments is needed. Further, the municipal-run systems' tariffs are probably too low for cost recovery and adequate technicians are needed to keep operation costs low in small towns. Also AIAS funding will become a challenge (The World Bank 2009b).

2.1.3 Mozambique Small Tow Water Supply: Summary

The situation of small town water supply is critical. Systems are old and not maintained. There is no legal clarity about who is responsible for operation, maintenance and investment. Local administrations mostly operate the systems. This situation led to a fundamental change in the policy for small town water supply:

- The DMF was extended to small town water supply
- A new agency, AIAS, was established to act as the national asset holding agency for water supply assets in small towns (Similar to FIPAG, the water supply asset holder for large towns)
- Operation shall be handed over to private operators. These will be contracted, monitored and supported by further agencies (APAS, CPAS, SPAS) on provincial level

Small town water supply is piloted in eight towns at the moment. Preliminary results show an increase of service security and increasing economic efficiency. The pilots also show the need of a strong framework with clear responsibilities within the agencies. Contracts with private operators also have to define clearly and detail the responsibilities of the contract partners.

2.2 Small Towns

2.2.1 General

Small towns are important to create economies for provision of goods and services such as health care or schools but also for commercial and industrial enterprises (Pilgrim et al. 2007). They are central in reducing the stress on urban slums and in supporting rural areas by social and economic development (UNDESA 2010). But they lie in a grey area between rural areas and urban centres, where neither community management nor utility-based solutions are fully suitable. There is growing consensus that small towns need better services (Pilgrim et al. 2007).

Urbanisation in developing countries is happening, also in small towns and medium sized towns (Martine 2007). 20 – 40 % of the urban population live in towns. The population in Africa, Asia and Latin America is expected to double from 2000 to 2015 and double again from 2015 to 2030 (Triche et al. 2006). These three regions will shift from a 60 % rural - 40 % urban distribution to 25 % rural - 75 % urban, like in Europe or North America. This shift will take place mostly in favour of small towns. For every large town (50,000 – 200,000 Inh.) there are about 8 - 10 small towns (2,000 – 20,000 Inh.) and 2 - 3 medium sized towns (20.000 – 50.000 Inh.). However, the growth rates of single towns and their development are difficult to predict, which makes planning of services complicated (Pilgrim et al. 2007). Consequently new approaches are necessary to provide basic services like water supply in small towns (Harvey 2010).

The income of a small town's population originates from small scale trade, peasant farming and agro-based industry (Mugabi 2006 in WaterAid/BPD 2010). Larger towns have fewer of its inhabitants in the agricultural sector and it is more likely that there are sophisticated markets and more administrative functions (Pilgrim et al. 2007). Small towns in developing countries normally have a core trading centre around which densely populated areas and scattered settlements can be found (Mugabi 2006 in WaterAid/BPD 2010). One type is the market town, also nodal points on transportation routes are possible (Pilgrim et al. 2007). A small town is a centre of selling agriculture products, production and distribution of products and services to surrounding areas and for non-agriculture activities by developing small enterprises among which are copy shops, tailors or bicycle work -shops, for example (Mugabi 2006 in WaterAid/BPD 2010).

2.2.2 Definition

There is no general definition of s*mall town* and it differs from country to country. Definitions often define what small towns are *not,* rather than what they are (Harvey 2010). Use by population size as an indicator is common, as done by (Pilgrim et al. 2007). Small towns are defined by 2.000 – 20.000 inhabitants, 20.000 – 50.000 inhabitants means medium-sized. Large towns have 50.000 – 200.000 inhabitants. For every large town there are about 8 - 10 small towns and 2 - 3 medium sized towns. But definition also differs between countries. In Bangladesh, small towns have up to 200.000 habitants, Ugandan or Nepali define a small town with 15.000 habitants. Taking only the number of habitants ignores the diversity and dynamic of a small town. Nepal, for example, takes the relative percentage of non-agriculture of

the local economy as an indicator, Bangladesh the relative percentage of men not working in agriculture-related jobs (WaterAid/BPD 2010). The availability of infrastructure, or population density could be used for a more precise definition (Samarasinghe 2007). In Table 2 some other definitions can be found, sorted by country. Besides, the classification ”Small Town” seems to be used only in the water supply and sanitation sector. Other classifications like merging towns or market towns focus more on the function rather than on the service needs (WaterAid/BPD 2010). An alternative definition for rural was described in (SDC 2009), taking all areas as rural which are not under the main service provider in charge in urban areas. In Mozambique, this would mean all areas outside FIPAG's responsibility are rural.

Study Country	Existing Classification of small towns	Population range	Other considerations
Bangladesh	Range of different classifications – more based on administrative determinations than local population or others	5,000 – 50,000	Urban criteria: Majority of male working population in non-agriculture (75%). A central place where amenities and infrastructure services are provided. Population density.
Madagascar	Different classifications. Urban centres: when 5,000 inhabitants are reached (National Institute of Statistics), 10,000 are required according to the urbanisation law to develop a strategic document for district management.	10,000 – 80,000 (district capitals and urban communes)	The labels national, regional or secondary urban centre are allocated by analysing the socio-administrative benchmarks of a town (administrative function, population size, size of urban area, economic function, future development)
Nepal	Government administrative classification	5,000 – 40,000	Density greater than 10 people/hectare, less than 50% of population involved in agriculture, connection to a strategic road, basic infrastructure.
Tanzania	Based on population size	5,000 – 50,000	
Uganda	Based on population size	5,000 – 50,000	From 1,000 – 5,000 urban growth centre

Table 2: Definition of small town in different countries (WaterAid/BPD 2010)

2.2.3 Issues of Small Towns

Small towns have to deal with numerous issues, which avoid or decelerate development.

- As brought up above, small towns are often neglected, not only by policy makers, but also by donors or practitioners (Harvey 2010)
- The administrative classification in urban and rural is an improper oversimplification. A settlement at the margin between rural and urban is neither one or another (Pilgrim et al. 2007)
- They often grow unplanned and the number of low income residents increases
- Basic infrastructure does not exist or is degenerated

- Traditional way of decision making is eroding and power vacuums are generated
- Unique recipes for each small town are expensive and clustering towns together into one bigger lending program can be necessary (WaterAid/BPD 2010)
- Small towns suffer from a shortage of professionals and it is difficult to tie these long-term (Pilgrim et al. 2007)

The two methods of top down approaches and bottom up approaches are not satisfying for small towns. Top down approaches often fail when settlements become too small. Bottom up approaches fail when systems are more complex and larger. A settlement between urban and rural risks an under-designed system when the population is growing or an over-designed one, if too large and expensive to maintain. Specific approaches for small town are required, taking into account the characteristic of the individual town is indispensable (Pilgrim et al. 2007).

The demographic changes, the function of a town and all the links and relationships between decision maker, rule maker and the service receiver can influence the success or failure of an approach. Because of this, towns should not all be treated the same. The decisive characteristics of small towns have to be found (WaterAid/BPD 2010).

2.2.4 Characteristics of a Small Town

The most critical determining factor that makes a small town different from being rural or urban is its connectedness. Urban centres are more self reliant, rural settlements are mainly dependent on a physical connection, like roads or resources and the exchange between rural and urban centres. Peri-urban settlements are strongly connected to the cities they surround.

The connectedness consists of three tiers

- The Macro Tiers: External connectedness
  These are linkages and influences with and from outside the town, like laws, rules, regulations, policies. They are generic, but depending on the situation, can isolate or support a small town. They affect the degree of migration to small towns.
- The Town itself: Internal connectedness
  This addresses how the different factors of the town are interlinked. Linkages are, for example, how a town is affected by migration and the impact of this migration on land prices, attitudes in the population, interaction between elected and public officials, or between government and business elites or business elites and the rest of the population. These informal connections between all the stakeholders are crucial factors in finding solutions.
- The households
  Here are the linkages between the demography, the economy and the participation channels of the individual in the household.

All three tiers are influenced by demographics, economy, autonomy and decision-making (WaterAid/BPD 2010).

2.2.5 Water Supply in Small Towns

2.2.5.1 General

During the past years, water supply gained increased recognition as a driver of development and a key factor in poverty alleviation. Efforts to increase the numbers of people benefiting from improved water services have focused on two main areas: rural areas and urban centres. In rural areas the favoured approach is community-based management. In urban centres public or private utilities operate a range of services tailored to different customers. In small towns, neither community management nor utility-based solutions are fully suitable. Better services will require greater attention to the selection of management models, engineering designs, financing arrangements and professional support options that offer services which can be expanded incrementally and sustained long -term (Pilgrim et al. 2007). Negligence of small towns is intensified by the uncertainty about which approaches can bring small town water supply on track. If donors and the government decided to assist small towns, profound analysis and capacity while planning or constructing are missed. So, small towns are all treated the same. They get the same financing, technology and management capacity training (WaterAid/BPD 2010).

2.2.5.2 Organisation, Management and Operation of Small Town Water Supply

The community should be involved and stakeholders consulted to gain input about consumers needs and what they can afford. It is necessary to balance the demand of consumers with the management and operational capacity, required investment and revenue potential. To prevent conflicts, the operation unit and the regulatory oversight body have to be separated, legally and operational. Support service for regulatory oversight have to be contracted separately from operational functions (Pilgrim et al. 2007). (McIntosh et al. 2009) have a similar opinion. A separation of the roles and responsibilities of the different stakeholders like regulator, governance body, service provider and policy maker is envisaged. However, in small towns this is difficult due to the simple system and low human resources. Technical solutions for small town water supply need a cost effective design and affordable operations, which both have to fit the local capacity, If the town is growing or the revenue increasing, the system should be expandable. Due to small town growth being hard to predict, it is advisable to invest sequentially in system components over short design periods. Through this it is possible to react to demand changes (Pilgrim et al. 2007).

2.2.5.3 Key Factors for successful Small Town Water Supply

Pilgrim et al. 2007 figured out the following key factors for successful small town water supply.

- Autonomy of the water supply service provider
- Transparency and accountability
- Demand Responsiveness
- Cost effective design and operation
- Professional Capacity
- Ability to expand

Autonomy of the Water Supply Service Provider:

Ring fenced revenues to ensure costs are covered and prevention of using the revenues for other sectors in town. Competence to hire and fire staff, set salaries, disconnect non-payers, offer incentives and improve or extend service should lie in the hand of the service provider.

Transparency and Accountability:

Transparency and accountability are important when service provision is done by just one provider. It means to clarify roles and responsibilities, independent audits and monitoring, disclose information and consultation with costumers. It means further that regulation and oversight are separated. Agreements between the corporate oversight and the owner and agreements between the local regulation body and the operator are to improve transparency and accountability.

Demand Responsiveness:

This means providing house connections on demand (also to increase revenue), financial assistance to reduce connection fees and responding to the needs of the poor, e.g. by like sharing connections or public kiosks.

Cost effective Design and Operation:

The systems in small towns are often over-designed which increases operational costs. Technical design, operation and management has to consider the local conditions, capacity and culture to satisfy the needs of the consumers. Business plans need realistic financial calculations and have to base on demand assessments. Also the investments for future water sales and revenues have to be considered for sustainable operation.

Professional Capacity:

Operators underrate the time and effort to manage water supply facilities or they lack the capacity to do all by themselves. Experienced professionals are needed to run the water supplies or to eventually extend them. An approach is necessary to secure service by means of little revenue and few human resources.

Ability to Expand

When demand is increasing by a growing population, expansion to serve this demand is necessary. This requires a sophisticated implementation plan with regards to access to additional water and financial resources, a legal and regulatory framework, designated service options and areas, technical and financial expertise, performance targets as well as incentives.

2.2.5.4 Challenges for Small Town Water Supply

Challenges within the water supply in small towns are financial challenges, challenges through aggregation, and challenges by decentralisation.

Financial challenges

In small towns, water supply is mainly done with kiosks and standpipes. This restricts water consumption and the revenue is too low to expand or even to sustain. In larger towns or cities it is common that about 25 % of the costumers are responsible for 75 % of the revenue. Hence high connection rate brings benefit for

wealthy customers, whose higher water demand is met. The increased revenue then can cover the cost of the utilities (Pilgrim et al. 2007). However, small towns will need public financing because they have to invest in expensive equipment, like deep boreholes, water tanks and primary networks first (SDC 2009). A small customer base with a low revenue basis and little major industry or few commercial clients also incur financial risks (Pilgrim et al. 2007).

Interviewed policy makers and practitioners mentioned a danger in offering funds directly to small towns. Their main reason was the incentive for consultants, construction companies, politicians and donors to install an infrastructure, which will be, not manageable and/ or affordable. The bigger the more the consulting and construction companies can earn, politicians use it as prestige projects and donors get more money to meet their macro targets. If the town is left with over-designed projects and programs, it will get financial problems. Many of the systems which a WaterAid team visited were too complex for community operation and too small for an urban water utility management (WaterAid/BPD 2010).

Furthermore, there often is no business plan, the operation is not on a commercial basis and service delivery functions are not shared with other towns. The management works by crisis reaction and not by design (Pilgrim et al. 2007).

Challenges through aggregation

If the service responsibilities of small towns are aggregated, decisions about investment or management cannot be made directly any more or the town cannot follow their own priorities due collective decision making. Also high transaction costs are possible. If the revenue is not ring-fenced in the towns, conflicts are possible. A further risk is reduced competition through less individual contracts and reduced chances for small contractors to develop their business (Pilgrim et al. 2007).

Challenges by decentralisation

Issues by decentralisation could be a lack of in-house capacity to run O&M of water supply sustainable. If this is the case, the next question is, is there local knowledge and capacity to outsource service delivery to providers to deliver this services. If this is not possible either, are there regional or national providers of the services? Another issue is, whether the town has the authority to make decisions. Also the question of sufficient financial resources must be asked and if the government provides funds and under what conditions (Pilgrim et al. 2007). The decentralisation by transferring ownership and service management to local actors or authorities overwhelm them often due lack of capacity and financial funds (WaterAid/BPD 2010).

2.2.6 Summary Small Towns

Small towns are important for national development and there is growing consensus that better service within small towns is necessary. They grow unplanned because of a lack of professionals. Approaches which are tailored for each town are needed because characteristics differ strongly from town to town.

Small town water supply faces challenges because of lack of financing, as well as aggregation and decentralisation. Experts see a solution within sequential investment to react to demand changes and in a separation of responsibilities.

2.3 Water Supply Organisation Models

2.3.1 Relevant Management Models

There are 6 main types of management models for small town water supply: Management by the community or the municipality, via delegated management, privately owned models as well as a national utility model and a regional management model (SDC 2009).

2.3.1.1 Community Management

This model is very dominant in developing countries. Users form a group in their village or town and create an elected water committee (WC). This committee manages the water service as O&M, providing house connections, extending networks and so on. It was developed to increase the level of ownership at community level but often the central or local government still is the true owner of the assets. In some cases the WC turned into privately run services, which worked, but without any legal status. Trends tending to see WC as a professional operator rather than a community body (SDC 2009). Community Based Organisations (CBO) are operating systems in Kenya, Uganda and Senegal (WSP 2010).

2.3.1.2 Local Government Management

Water supply is done by the municipality, commune or district council. This is common in many developing countries. Although just few cases are known where it is done successfully. Main difficulties are to retain good professionals in the municipal departments, to ring fence revenue and to create incentives for expanding service and invest in new facilities. These difficulties arise often from stressed district or municipal budget (SDC 2009). Through decentralization, the Local Governments became responsible for many tasks, and among these, water supply. In Ethiopia, Mozambique and Tanzania municipal management is standard (WSP 2010).

2.3.1.3 Delegated Management

Delegated Management (DM) means a separation of function and responsibility. This is seen as the core of a sustainable service. DM is a contractual relationship between the operator and the contracting authority (WSP 2010). Contractor entity can be a company, an individual or a community based organisation. The owner is usually central or local government or a Water User Association (WUA). This model is quite successful within small towns and with piped networks as the private sectors capacities are used to increase access and improve management services (SDC 2009). The authority owns the assets and is responsible for a secure water supply. The operator has to provide the services, specified in the contract conditions. It is seen as an alternative to the community based management which did not fulfil the expectations, mainly in functionality, quality improvement and expansion. It is estimated that about 25 % of the SPS in Africa are under delegated management. One form of delegated management is the Privat-Public-Partnership (s. Chapter 2.3.2), which is also the majority form of the signed contracts (WSP 2010).

Examples can be found in Rwanda, Mauritania, Niger and Uganda (SDC 2009). Table 3 shows the option for DM in several African countries.

Country	Private	CBO	MM
Benin	x	o	
Burkina Faso	x		
Ethiopia		x	o
Kenya	o	x	
Mali	x		
Mauritania	x		
Mozambique	x	o	o
Niger	x		
Uganda	x	o	
Rwanda	x	o	
Senegal	o	x	
x: Promoted Option o: Other Option; Private: Private Management; CBO: Community Based Organisation; MM: Municipal Management			

Table 3: Delegated management in different African countries

Regulation is seen as the weakest link within DM. Often regulation is only active for larger urban water providers. The absence of regulation impedes discussions between operator, consumers and local authorities or disputes become unnecessarily long and then cause an impairment of operability. Local authorities should not act as regulator as they are often the operator and they also represent the consumers. Although, in Mozambique, Mauritania and Rwanda regular agencies are now working with small scheme operators too. But geographical dispersion of facilities and stakeholders make their work difficult. A mix of local and central regulation is seen as an useful solution. The central structure of a legal mandate for regulation should cover improvement of the regulatory framework and of performance indicators, production of data, development of benchmarks as well as monitoring and review. The local structure should regulate conflicts, enforce regulatory compliance and oversee services. It is important that the regulator can act independent with enough funding and information. In Mozambique and Mali, the regulation fee paid by the operators to the local regulator is 1% of his revenue (WSP 2010).

2.3.1.4 Privately Owned Management

Here a private investor builds and operates water points or a small piped system. Often close neighbourhoods without any access to water services are supplied. They mostly can be found in peri-urban areas, where also occur problems about how to regulate them without putting them out of business. For example, in Benin over 500 boreholes are privately operated (SDC 2009).

2.3.1.5 National Utility Management

In this model a national umbrella entity is responsible for managing the water services. This can be done if the main service provider also provides service to rural areas. the advantage is a possibly high service quality for rural dwellers. Disadvantage is that cross-subsidizing is necessary as operating in rural areas is done at very high marginal costs. This model is used in Ivory Cost (SODECI) and Burkina Faso (ONEA). Another model is a nationwide umbrella organization that hosts management or lease contracts. Cross-subsidizing between profitable (urban) and small towns or villages is possible. This is done in Mauritania (ANEPA) (SDC 2009).

The national utility model has the advantage of a possible cross-subsidizing between small towns and the more profitable, larger settlements (SDC 2009).

2.3.1.6 Regional Management

In this model an umbrella organization provides the water supply service to local managers or providers like WUA, private operators or cooperatives. Support ranges from technical support to common management of saving funds or a maintenance contract between the regional organization and its members. The regional organizations are usually civil society organisations (SDC 2009).

2.3.2 Private Public Partnerships (PPP)

2.3.2.1 Why focusing on PPP

As shown in Chapter 2.1.2 Water Supply in Mozambique, it is envisaged to hand over the operation of small town water supply to private operators. In the Mozambique Policy Framework, including the private sector in water supply services is a main target. Further, there are pilots with private sector participation for water supply in Mozambique.

The World Bank is an active funder in Mozambique. It gives strategic guidances and influences the development of Mozambique. The water sector is shaped through the trust fund WSP[12]. They do surveys in small towns and support the newly funded AIAS (see chapter 2.1.2.4). Funding is done amongst others trough the WASIS[13] program (The World Bank 2009c). WSP strongly promotes PPP in water supply all over the world (Triche et al. 2006).

To come to a proper and applicable solution, it is advisable to keep on the general conditions given by the Government of Mozambique and WSP. That led to focus on PPP, as it is the model of choice for small town water supply in Mozambique (see Chapter 2.1.2.3). Therefore it is envisaged to find the solution for small town water supply within the PPP model for this thesis.

[12]The Water and Sanitation Program (WSP) is a multi-donor partnership administered by the World Bank to support poor people in obtaining affordable, safe and sustainable access to water and sanitation services. WSP works directly with client governments at the local and national level in 25 countries through regional offices in Africa, East and South Asia, Latin America and the Caribbean, and in, Washington D.C.

[13]WASIS US$ 30Mio.: Network expansion in four provincial capitals, institutional strengthening, enabling DNA to extend DMF to smaller towns and institutional support for CRA

2.3.2.2 General

When small piped systems (SPS) were built up in the early 1980's, they were managed by village management committees, similar to the water point committees attending hand pumps. These village committees lacked legal recognition, skills and formal management practices and operation of SPS failed in many cases. Community Based Organisation (CBO) was developed as an alternative, to entrust the SPS management to formal and legal organizations. Good practice was introduced, sale of water by volume and replacement funds. But besides relative success in Senegal, the model did not meet expectations. In-transparency, citizen accountability, cost recovery and implementation capacity were main problems leading to unreliable services. Hence, governments began to let private organizations operate the SPS and by this, PPP was introduced in rural WS, although the communities were sceptical (Hoang Gia & Fugelsnes 2010)[14]. The lease contract model of PPP should separate asset management from operation and at the same time it should create close collaboration of both (Triche 2009).

In general, local government contracts a private operator, who manages the system. The most common forms of contracts are management and affermage-lease contracts. Operators have to finance only small investments. A further but more complex PPP is built-operate-transfer (BOT), build-own-operate (BOO) and rehabilitate-operate-transfer contracts. Operators are contracted in most countries after a competitive tender (WSP 2010). Some countries initiate tenders with focus on local private operators within PPP (McIntosh et al. 2009).

Box 4: Business Development Services

A relatively new instrument to improve service is the business development service (BDS). Third parties offer customer know-how or facilities to operators to enhance their services. BDS are active in Senegal, Mali, Niger and Mauritania as technical and financial audits. In Senegal, also preventive and curative maintenance is done. In Uganda BDS is done as a umbrella organization and relies on public funding.

Umbrella Organization BDS in Uganda			
Members of the general assembly	**Services**	**Funding**	**Coverage**
Each Water Supply and Sanitation Board District Water Offices Umbrella National Secretariat at Dept. of Water Development	Technical Support Capacity Building Organizational and Community Development	WSSBs: 10% Government: 90% Other Revenues through Umbrella Organization activities	4 Umbrella Organizations covering ¾ of Uganda, operating through Regional branches

A support of regulation exists in Mali and Niger. The BDS provider produces technical and financial data. But the viability of BDS providers in all cases is still weak. Possible solutions could be the integration in the institutional and regulatory framework, granting concession for cluster schemes and extension to other areas like transaction and financing (WSP 2010).

[14] As the sources of their review are only mentioned in the end of their field note, no exact citation of the sources was possible. Therefore all sources cited by Hoang Gia & Fugelsnes are listed separately after the regular bibliography.

2.3.2.3 PPP Structure

The asset owner is the contracting authority, who goes into a contractual agreement with the operator. A third party is the regulator. The regulator has to ensure contract compliance, arbitrate disputes, give guidance on mitigation measures and monitor operation. Operational data is collected and analysed by the monitor or business agent,who also provides decision making inputs and advices. This data is also used for regulation (Hoang Gia & Fugelsnes 2010).

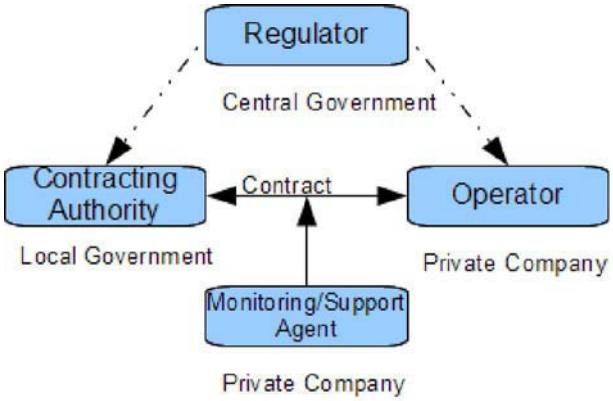

Figure 6: Schematic figure of the PPP structure

Most of the PPP is done by affermage-lease contracts, where operators financial responsibility is low. The operator takes the operating risks and its rewards. He has to bill, do the payment collection and cover expenditures on energy, maintenance, repairs and staff. Besides, he pays a monthly lease fee, based on the sold amount of water. The fee is deposited in a replacement and extension fund under the contracting authority's name. Then it is used for replacement, depreciation, network extensions, business development service (BDS) (see Box 4), monitoring services or to pay taxes (Hoang Gia & Fugelsnes 2010).

2.3.2.4 Achievements of PPP

Experience showed that with participation of the private sector, the professionalism increased, and with this some positive affects occur. Better management improved the O&M costs as well as the control of physical and commercial losses in Uganda, Niger and Burkina Faso. Finances were kept on track with strict billing, revenue collection and operation, reduced energy consumption, preventive maintenance and staff management. Table 4 shows development within 5 years in 14 Ugandan privately run SPS. In Burkina Faso and Benin, improved service quality increased water consumption and consequently revenue (WSP 2010).

Billing	50% →	95%
Billing Recovery	40% →	85%
Total Water losses	>50% →	21%
O&M coverage	<50% →	84%
Revenue increase	+ 500%	

Table 4: Development of privately run SPS in Uganda within 5 years

Private commercial enterprises often have better capacity of billing, collection, loss control and connection building as communities or municipalities. It is easier for them to attract qualified personnel (Lazarte & Macário 2010). Deliberate and monitored contracts with private operators lead to more autonomy and accountability (McIntosh et al. 2009). Kome 2007 compared different cases of small operators. These show that institutional capacity of municipality and well developed participation structures play a more important role for good management than the capacity of the operator himself.

2.3.2.5 Challenges for PPP

There remain challenges and an the need of ongoing development and monitoring of the approach. Main challenges within PPP are

- Contracting
- Capacity Building
- Regulation
- Financial Viability
- Stakeholders and
- Infrastructure

Specific topics within these main challenges can be found in Table 5 below.

Contracting	
Data Base	Tenders are carried out without an assessment of technical functionality and profitability. Proposals are created without or little operational data and problems are discovered after starting the service (WSP 2010). Data gaps (about infrastructure or user demand, for example) are used by bidders to submit low bids. After winning the bid, they are not able to fulfil their duties. This leads to delay of investments through renegotiations, delay of rehabilitation and financial losses on side of the contractor and the operator (WSP 2010).
Contracting Duration	Contract duration is an important factor to make operators investment worthwhile for them. In comparison to Rwanda or Uganda (1 – 3 Years), in Mozambique contract duration was prolonged from 3 to 5 years. Nevertheless, investment in network and equipment renovation is still weak as 5 years are not enough to recover the investments (Lazarte & Macário 2010). Besides, it is important to clarify the type of investments and who is responsible to execute them. This concerns mainly the long term small and large investment (Lazarte & Macário 2010).
Incentives	Contracts lack incentives to fulfil a target or lack financial penalties for missing targets (Triche et al. 2006). With longer contract duration and an incentive system where an operator earns more for improving service and for setting standards for minimum service quality could be possible methods to improve service (Lazarte & Macário 2010).
Monitoring	Local Government should monitor contracts, if they are the contracting authority. Often it is only made sure that the lease fee and taxes are paid. PPP is not to relief local governments of water supply responsibilities (Hoang Gia & Fugelsnes 2010).
Responsibilities	Contracts are often unclear and interpretation conflicts emerge. This affects major repairs and replacements. A solution could be specific but simple model contracts. The contractor could be assisted technically during the contracting process (WSP 2010).
Service Area Bundling	Bundling service areas to reach economy of scale and scope hold risks, too. Safeguards to ensure every service area receives appropriate resources are necessary, contracts should define the degree of decentralization, and use of incentives and penalties to ensure minimum standards in all service areas has to be included in such contracts (Triche 2009).
Capacity Building	Even if private operators have gained experience within the water supply sector before they start operating a SPS, they still need training. Operators priority training-areas are water treatment and reduction of losses, billing, documentation, use and filing of operational data, customer service, improved partnership with public sector and preparation of business plans. An approach to achieve the envisaged improvements in the above mentioned areas could be low-cost capacity building and technical assistance model. Professionals are used where needed. It could be done directly by the government agencies or by the private sector (BDS). Also bundling service areas and technical training in partnership with more experienced operators is possible. Capacity building has to be subsidized by government or donors, as it is hard enough to cover O&M costs (Lazarte & Macário 2010).

Table 5: Topics within the main challenges of PPP

Regulation	Effective regulation is essential. Arbitration and mediation is done, but also litigation through monitoring and performance indicators is necessary. Contracts are not regulated because no national data collection exists. Institutional set ups are inappropriate and regulation staff lacks of training (Hoang Gia & Fugelsnes 2010).
Financial Viability	The absence of business plans in PPP is a further constraint. The operators often simply do not know how to prepare a business plan, nevertheless a business plan is an important basis to operate in a financially viable way. Also, some schemes are simply too small to generate profit. During the wet season free alternatives to the SPS drop revenue and can undermine its viability. Extension or rehabilitation is necessary. If an operator identifies investment needs, lack of funding can cause problems. Banks sometimes lack water sector experience or the loan period exceeds the contract duration. Unaudited accounts, lack of data, guarantees, or collateral can avert engagement. Finance of PPP has to be integrated into a comprehensive strategy as done by the K-Rep Bank in Kenya and the Bank of Africa in Mali. Public funding is difficult, as it focuses on construction of new infrastructure and budget is not controlled by local authorities. A solution could be a combination of operator or community equity with a commercial loan and grant funding. The loan forces operators to market discipline, the grant ensures that the poor are not excluded by increasing taxes to burden debts. Output Based Aid could be an incentive too (WSP 2010).
Stakeholders	Stakeholders have to be involved as there can be resistance against private operators. In some cases the communities saw out-contracting as unfair as they had managed the assets for many years and a tariff increase was feared (WSP 2010). Community involvement should be considered during preparation and design, as well as for demand and tariff calculations and service option development (Lazarte & Macário 2010).
Infrastructure	Alternative water sources, like wells and hand pumps are a competitor Preventive maintenance barely exists and access to spare parts and technicians is essential, but often denied. Investment in infrastructure is limited. Governments cannot hold promises or the private operator is not able to provide funds. Local governments offload difficult cases, which need rehabilitation and high investments, to the private sector. Furthermore it is necessary to install leverage mechanisms to facilitate project preparations, co-finance investments and to limit the impact on tariffs (Hoang Gia & Fugelsnes 2010).

Continuation of Table 5 : Topics within the main challenges of PPP

2.3.2.6 The PPP Action Plan

To meet the challenges described above, an intervention framework has to be developed: The PPP Action Plan. The action plan sets objectives and time lines for activities and consists of

- improvement contracting practices
- strengthening enabling environment
- strengthening the PPP stakeholder capacities and
- strengthening services and built up service platforms (Hoang Gia & Fugelsnes 2010)

Improvement of contracting practice

The operator must be able to generate reasonable revenue and has to to provide affordable service. To achieve this, it is necessary to have PPP pre-feasibility studies with business plans and technical diagnostics. Size optimization can be an option, too. Bundling of SPS under one contract if the SPS are too small to be financially viable or offer little revenue. Costs can be rationalized and shared between the SPS.

Operators should be in the position to carry out investments according to their experience and skills while operating their own supply system. But as contract duration is short, operators do not invest their own resources. Prolonging contract duration to 10 to 15 years with concession elements to let operators participate in investments in all kind of facilities is a possible solution. Another model are build-operate-transfer contracts. The advantages is that infrastructure is constructed by the operator who then has a better understanding of the system. Relationships to consumers and stakeholders can be established earlier, while construction is still under way. Transfer conditions after the contract ends will keep the assets public.

Strengthen enabling environment

To strengthen an enabling environment, it is necessary to strengthen regulation, access to financing and professional maintenance services. Regulation needs frameworks as there are often not enough resources and lack of skills. In Mali for example a regulatory framework for PPP is adopted.

Local finance sectors have to show interest to invest and governments have to develop a system to provide guarantees to cover financing. This is done in Kenya, Benin, Mali and Senegal. An advantage of local financing compared to donor funding is that donor funding is often ad hoc and depends on how national governments fulfil commitments. Also the availability of lubricants and spare-parts in good quality is essential, the same is valid for skills for complex maintenance services.

Strengthen PPP stakeholder capacity

Water User Associations can be transformed to the consumers' voice and act as a representative in investment planning and water quality monitoring. Asset holders must be strengthened in their role and in their capacity of tender carry-out, contract supervision and fulfilling their obligations. Operators have to be professionals, but often technical, administration and management skills are limited. Training should be offered by existing training organizations and operators should pay a contribution fee. In Rwanda pilot training uses standardized tools and learning materials. Effective regulation is often not in place and the regional water service department acts as a regulator. Roles and functions have to be defined and capacity building has to be set up.

Information platform and service strengthening

PPP needs a reliable information flow and business support. In Mali and Niger, accounting and technical advice service are provided on cost-recovery basis. Information and monitoring services are essential for regulators, which need skilled personnel for data collection. Financing to meet operational expenses is essential and can be done by adding the cost to the users bill. The information and monitoring services have to be adopted by authorities and stakeholders officially. The business

development services (BDS) in Mali, Niger and Senegal run well and can serve as a model. Also public information platforms can be used as in Senegal PEPAM or the African WATSAN platform.

Pilots of the Action Plan exists in Burkina Faso, Niger and Rwanda. Mali developed a three year action plan in 2008. The PPP Action Plan established in Mali has four key components. Local government support for carrying out bidding; regulation with a framework, tools, procedures, monitoring and control measurement, scale up BDS as well as financing, rehabilitation and expansion in partnership with micro finance institutes and local banks.

2.3.3 Case Study: PPP for Small Piped Systems Management in 8 African Countries

This chapter describes water supply in small towns in 8 African countries by means of a review on PPP for small piped systems (SPS)[15] management done by Hoang Gia & Fugelsnes 2010[16].

2.3.3.1 Actual Situation of the SPS in the reviewed Countries

About 25% of the small town and rural population in the reviewed countries - Benin, Burkina Faso, Mali, Mauritania, Niger, Rwanda and Senegal – are served with SPS under PPP. These are about 13 Million people. In Senegal 56% are supplied with SPS and it is envisaged to reach 80% till 2015. The 4.800 SPS in these countries can be categorized according to size and complexity (s. Table 6).

Hand pumps and modern wells are often used when groundwater is rare and shallow, while SPS are used in dense settlements as more water and deeper boreholes are needed. Usually these different types of water supply are used in a town and its surrounding area at the same time. Wells, hand pumps and surface water are competing to SPS as they are for free or less expensive. They have a negative impact on the level of piped water production and the effectiveness of a SPS. SPS with high water production tend to raise the number of connections, and per day consumption per capita and makes possible more affordable user prices as well as a productive use for livestock and irrigation. Energy for water supply is mainly produced with diesel engines or generators (~ 60%) and made up 30 – 50% of the expenditures. About 20 % of the SPS are supplied with a photovoltaic pumping system, less than 10% use low voltage grid connections. This will improve as in many countries electrification programs exist, like in Senegal, Mali and Burkina Faso. This will reduce operating costs as a litre of diesel costs up to US$ 2 in some areas. An exception is Rwanda, where through its mountainous position mostly gravity fed systems are in use.

[15] Small Piped Systems are water supply sytems supplying maximum several thousand inhabitants.

[16] Sources are not mentioned explicitly in their paper. They are only added in a bibliography at the end of their paper. This bibliography is added to the bibliography of this thesis.

Type	Characteristics	Population served	Network length	Storage Capacity	Production Capacity
single distribution point	No distribution network, only one borehole with limited storage (underground or low elevation)	500 – 1,000	< 0.1 km	2 - 10 m³	5 - 10 m³/day
multiple communal distribution points	Limited reach of the network, stand posts only with limited storage capacity at low elevation	500 – 2,000	< 2 km	10 – 50 m³	5 – 40 m³/day
multiple distribution points and household connections	Extended network, stand posts and household connections, higher capacity storage at higher elevation	2,000 – 10,000	2 – 10 km	10 – 50 m³	20 -300 m³/day
multiple village scheme	Larger piped schemes with transportation of water to up to dozens of villages	5,000 – 200,000	10 – 250 km	10 -50 m³	100 – 2,000 m³/day

Table 6: Categorization of SPS according to size and complexity

2.3.3.2 Finance of the SPS

Tariff parameters are the kind of service (standpipe, house connection), production costs (energy, maintenance, personnel, taxes, etc.), amount of sold water and depreciation charges. Tariffs vary between US$ 0.5 – 1 per m³. Depreciation costs in Rwanda, Burkina Faso and Mali are reflected in the tariffs, according to their national policy framework. In Senegal, Mauritania, Benin and Burkina Faso they are included only depreciation costs for equipment and facilities with less than 20 year lifespan.

Tendency is heading towards consumption dependent billing, as meters become more and more common and fixed fee bills become less common. Tariffs vary from the distribution point type, with cheaper ones for house connections as the users often pay the installation costs. In Senegal these were about US$ 200. Kiosk vendors pay the same as private users. They then have to sell at higher prices to cover their costs.

Per capita consumption from SPS in the reviewed countries ranges from 3 to 25 litres per day, which is less than the 35 litres per day standard of the WHO. But often other sources are used, too. Designing for 35 litres would lead to oversized schemes.

2.3.3.3 Institutional Frameworks

In six of the reviewed countries (except Senegal), theoretically the local government is the contracting authority. In practice, this is only the case in Mali, Rwanda and Benin. In Niger it is the Water User Association (WUA). In Benin the contracting is between local government, WUA and private operators. In Mauritania the central government still is the contracting authority as in Senegal, too. The transfer to the

local government is done only in some cases. In all countries private sector participation is central (s. Table 7) (Hoang Gia & Fugelsnes 2010).

Country	First PPP in place	Asset holder	Regulator	Provider Profile	No of PPPs in 2009	Performance Monitoring system
Benin	2006	LG	MIN	PSP	130	No, tbi
Burkina Faso	2009	LG	MIN	PSP		No, tbi
Mali	2006	LG	MIN/REG	PSP	20	Yes
Mauritania	1994	CG	REG	PSP; ANEPA	350	Yes
Niger	1990	LG	MIN	PSP	298	Yes
Rwanda	2004	LG	REG	PSP	230	No, tbi
Senegal	2000	CG	MIN	PSP	183	Yes
LG = Local Government; CG = Central Government; MIN = Ministry; REG = Regulator; PSP = Private Service Provider; tbi =to be implemented; ANEPA = National Agency for safe water and sanitation;						

Table 7: PPP stakeholder overview (Hoang Gia & Fugelsnes 2010)

Regulation is done in most of the reviewed countries by the ministry responsible for water supply, in Mauritania & Rwanda by a regulator and in Mali by both. In Benin, Burkina Faso, Mali, Niger and Senegal regional water service departments play a role as advisor and arbitrator and as a local regulator. In Senegal the division of O&M (DEM) of the water ministry acts as regulator additionally to its contractor role. None of the observed countries has a nation wide regulator. No national analysis and evaluation system is in place.

Business development services (BDS) exist in Mali and Niger, a pilot study is ongoing in Senegal and Mauritania. In Mali, BDS providers provide technical and accounting assistance and advisory services to local governments, contracting authorities and operators. BDS are cost recovered and the operator's cost for BDS is included in the water tariff. In Niger a similar service exists, the Bureau de conseil et controle (BCC). BDS in Mali offers additional co-management of infrastructure replacement, monitoring control and advisory services. ANEPA monitors the private operators performance in Mauritania.

2.3.3.4 PPP in the reviewed Countries

In all surveyed countries about 25% of the SPS are under PPP, with a tendency to one third when ongoing projects are completed. In Mauritania the rate is 100%, in Niger 50%, as both started early. In the other countries, the majority schemes are managed by WUA or village committees.

In Benin, Mauritania, Mali and Rwanda the contracts range from 1 to 5 years. These countries also have no cash depreciation charges on pumping and energy

equipment and operators are not responsible for replacing critical equipment. In Burkina Faso, the operator is responsible for energy and pumping equipment. Besides tax, no leasing payments are due. In Rwanda PPP is done according to sectoral policy and procurement guidelines. In Mauritania the signed contracts between ANEPA and the private operator fall under a contract between state and ANEPA.

Operators in the study countries are entrepreneurs, NGOs or very small businesses, which are preferred, because they are not foreign economic interest groups. Small businesses are often funded especially for the PPP and consist of former WUA representatives. In Niger 40% of the schemes are run by a small business, 60% by multi-scheme operators. Besides small operators, large companies are also active. In Rwanda are two consulting companies with an international business partner. The large operators run 10% of the SPS, only in Burkina Faso all SPS are run by one large operator. The large operators are mainly interested in bundled schemes as in Niger, Burkina Faso, Mauritania and Rwanda. In Burkina Faso and Niger one operator manages 5 – 10 schemes.

In Mauritania and Rwanda the household connections were built without external subsidies, but by self-employed scheme managers. In Burkina Faso international companies won build-operate-transfer tenders without an increase of water prices. The PPP strengthened local governance, increased transparency while generated funds are ring-fenced.

2.3.4 Besides PPP: Public-Public Partnerships (PUP)

There are many approaches aside from the PPP. The alternative PUP approach is introduced in this chapter.

2.3.4.1 Definition of PUP

In a PUP at least two domestic or international partners, both defined as public and working on a non-profit-basis, work together to improve and promote public service delivery. Table 8 shows the different combinations possible within organisation level (public authority and non-state-entity) and spatial-geographical level (Boag & McDonald 2010).

		Spatial-geographical scale		
Organisational Scale		Intra-state (domestic partners)	Inter state (North-North, South-South)-	Development (North-South)
	Public Authority – Public Authority	Municipal water provider and national water department	National water departments from two different countries	Municipal water provider from the south and north
	Public Authority – non-state entity	Municipal water provider and a trade union	National water department and a foreign NGO	Southern municipal water provider and northern union
	Non-state entity – non-state entity	Water cooperative and NGO from the same municipality	Unions from different countries	Northern NGO and southern community group
	Multi partnerships	Municipal water provider, local union and local community group	Regional water utility and more than one national government	Southern municipal water provider and northern NGO and municipal government

Table 8: Combinations possible within organisation level of PUP

2.3.4.2 Objectives of PUP

Lobina & Hall (2006) divided the objectives into broad goals and specific goals. The broad goals are water service improvement, promote water service as a public good and engaging non-profit partnerships. Table 9 shows details of the PUP objectives. Further the trend of corporatisation of state-owned water utilities is seen critical. To include municipal or citizens in the decision making process is seen necessary to enhance the public nature of water services and the validity of public partnerships.

PUP goals	PUP Objectives	PUP Targets
Socio Political	- Empower and strengthen public utilities and non governmental partners - Protest against privatization - Provide accountability and transparency for citizens - Make services more democratic and equitable	- Develop recognition that private operators are not more effective than public providers - Build solidarity amongst public utilities and/or non-governmental entities - Garner increased support from the local community as well as feedback on how to improve services - Encourage local community groups to participate in improving water services - Expand water service connections to low-income and marginalised communities
Infrastructure	- improve water service quality and quantity - introduce new technologies	- Increase efficiency by reducing leakages and improving water conversation - Strategies about utility response to effects of climate change
Capacity	- develop human resources in the utilities and the non-governmental entities - improve utilities administration and management	- Build knowledge among utility workers and consumers through development workshops - Expose utility management to inter-cultural experiences - Increase pride and confidence among workers for the delivery of water as an essential service - Further develop effective managerial skills - Consolidate administrative duties and find new ways to make customer service and general administration more efficient
Financial	- improve system financing - determine appropriate cost/revenue structures for water services as a public good	- Develop alternative financing mechanisms - Use partnerships with other municipal services to achieve economies of scale and scope - Improve social tariff setting

Table 9: Detailed PUP objectives

2.3.4.3 PUP Benefits

Actual benefits are the

- improvement of operator capacity at lower costs than with PPP or the public entity through the non-profit aspect (E. Lobina & D. Hall 2006)
- promotion of democratic and equitable water services through participation in decision making and extend connections to unserved areas (Suresh & Nayar 2007); (Brennan et al. 2004), and building solidarity amongst municipal operators (Cann 2007)
- new focus on public sector utilities as PPP is not the only solution (Boag & McDonald 2010)
- de-construct the opinion that private sector provides better service. There is evidence that public sector partnerships outperform the private sector (Boag & McDonald 2010)

2.3.4.4 Challenges for PUP

As in every international and multi-scalar partnership different cultural, technological and management strategies of each partner can lead to complications. Financing PUP is just as critical as in other models.

Besides these common issues, three main shortcomings within papers describing PUP were explicated by (Boag & McDonald 2010).

- Little methodological rigour: Methodological explanations and contextualization is often missed and no clear interview data, no clear survey instruments, no clear sources and no clear reliability of secondary material make firm and comparative conclusion difficult.
- Normative suppositions: The case studies point out numerous of ideals coming with PUP, among equity, democracy, transparency and solidarity. But there is little discussion about their practical meaning and how they can be investigated and measured.
- No clear definition of public: There is difference between public as ownership and public as citizenship. The first one is the more common, with the state owning facilities and resources. But it also includes community ownership, communal ownership and other non-state non-profit actors. It lacks an explanation of how these models are configured, what constraints or incentives exist and how the relations to the larger public service objectives are (Boag & McDonald 2010).

2.3.5 Summary Water Supply Organisation Models

Among numerous management models, the Delegated Management Model (DM) is the preferred one for small towns. DM proofed to be successful and it is estimated that 25% of small piped systems in Africa are under DM. DM separates function and responsibility. That is seen as the core of sustainable service. A form of DM is Private-Public-Partnership (PPP). A main weakness within DM is regulation. A mix of local and central regulation is seen as a solution to overcome this weakness.

PPP separates asset ownership, regulation and operation. This approach proved to be successful in many countries. Improved O&M, improved control of water losses and billing recovery are one of them. Challenges within PPP lie in contracting, capacity building, regulation financial viability, stakeholders and infrastructure. To meet these challenges a PPP action plan was set up recently by WSP.

PUP can be seen as a counterpart to PPP within DM. Instead of private, profit oriented companies, public partners work on a non profit basis.

3 FIELD STUDY IN MARROMEU, INHAMINGA AND BÚZI

3.1 Overview to Marromeu, Inhaminga and Búzi

To find an answer on the first research question it is necessary to collect fundamental data about the actual situation of small town water supply. To gain a broad and sophisticated picture of small town water supply in Mozambique, three towns were chosen with different economical and infrastructure situation.

3.1.1 Province Sofala

The towns of Marromeu, Inhaminga and Búzi are in the province of Sofala. Sofala is situated in the centre of Mozambique (Figure 7). In 2009, Sofala had 1,769.000 habitants and a population density of 26 inhabitants/km². Sofala is 68.018 km² wide and consists of 13 districts [Figure 8 (Instituto Nacional de Estatística 2010a)].

Figure 7: Provinces of Mocambique (freewebs.com, 2011)

Figure 8: Districts of Sofala province (Sofala Government, 2011)

There were 339,000 families in Sofala in 2007. Water supply was mainly done with open wells without pumps – *poco sem bomba ceu aberto* – (34.2%) and secured wells – *furo protegido* – (19.3%). 15.4% received their water from rivers or ponds, 13.3% from public taps. Canalized drinking water was received by 13.5% to the yard and by 3.7% directly into the house (Instituto Nacional de Estatística 2010b).

Marromeu and Búzi are named as the particular districts, while Inhaminga lies in the district of Cheringoma (Figure 8). Table 1 and Table 2 show key population facts of Sofala Province and the visited towns.

	Habitants in 2007 [No.]	Size [km²]	Population density [Inh./km²]	Families in 2007 [No.]
Sofala Province	1,769,000	68,018	26	339,000
Marromeu District	118,000	5,761	20	25,400
Búzi District	160,000	7,225	22	31,800
Cheringoma District	34,000	7,108	5	6,300

Table 10: Basic data of the province and the analysed districts (Instituto Nacional de Estatística 2010a, b and c)

	Water Supply [%]					
	Open wells without pumps	Secured wells	Rivers or ponds	Public Taps	Canalized Water	
					Yard	House
Sofala Province	34.2	19.3	15.4	13.3	13.5	3.7
Marromeu District	42.5	32.9	9.7	11.7	2.2	0.9
Búzi District	45.9	29.1	18.2	5.5	0.8	0.3
Cheringoma District	41.7	29.0	19.3	8.0	1.9	0.2

Table 11: Way of water supply of the province and the analysed districts (Estatisticas do distrito Marromeu, Búzi and Cheringoma 2008)

3.1.2 District Marromeu and Marromeu Town

The district of Marromeu had 118,000 inhabitants in 2007, is 5,761 km² wide and has population density of 20 Inh./km². The average temperature is 26.3°C, with an absolute maximum of 42.0°C, an absolute minimum of 10.0°C and an average precipitation of 77 mm per month (Instituto Nacional de Estatística 2010d).

The district of Marromeu is subdivided into three administrative posts (*postos administrativos*); Marromeu-Centre (*Marromeu-Sede*), Malingapansi and Chupanga. Marromeu-Centre again is subdivided into five localities (*localidades*) (Ministério da Administração Estatal 2005).

In 2007, water supply in the 25.400 families was mainly done with open wells without pumps – *poco sem bomba ceu aberto* – (42.5%) and secured wells – *furo protegido* – (32.9%), 9.7% fetched water from rivers or ponds. 11.7% had their water from public taps. Canalized drinking water was received by 2.2% to the yard and by 0.9% directly into their house (Instituto Nacional de Estatística 2010d).

Marromeu town is a municipality, with 19,000 inhabitants in 1997 and 40,000 in 2007 and an average population growth rate of 8% per year (Brinkhoff 2011). It consists of 7 districts (*bairros*). Marromeu lies at the Zambesi river, about 65 km from the delta. The Sena Sugar company has its seat in Marromeu, employing 3,000 people in regular times and up to 8,000 during the harvest season, according

to the Head of Intermón Marromeu[17]. Intermón has an office in Marromeu, working in the WASH Program[18]. Once a week a train is going to Beira.

3.1.3 District Búzi and Búzi Town

Búzi district had 160,000 inhabitants and a population density of 22 Inh./km² in 2007 and it is 7,225 km² wide. The average temperature is 25.4°C, with an absolute maximum of 40.0°C, an absolute minimum of 10.5°C and an average precipitation of 116 mm per month (Instituto Nacional de Estatística 2010b).

The district of Búzi is subdivided into three administrative posts (*postos administrativos*); Búzi-Centre (Búzi-Sede), Estaquinha and Sofala. Búzi Centre again is subdivided into its three localities (*localidades*); Búzi-Centre, Bandua and Grudja (Ministério da Administração Estatal 2005).

Of the 31,800 families in Búzi district, 45.9% used open wells without pumps – *poco sem bomba ceu aberto* –, 29.1% secured wells – *furo protegido* – and 18.2% rivers or ponds. Public taps were used by 5.5%. Just a minority had access to canalized drinking water to the yard (0.8%) or directly into the house (0.3%) (Instituto Nacional de Estatística 2010b).

Búzi town which is the locality Búzi-Centre had about 14,000 inhabitants in 1997. This number didn't changed until 2007 (Brinkhoff 2011). Búzi lies at the Búzi river, which divides the town in a bigger main part on the northern bank, and a small part on the southern bank. Both parts consist of 5 districts (*bairros)* each. In the southern part are the buildings of the rehabilitated Búzi Sugar Company located. Also the National Oil company ENH (Empresa Nacional de Hidrocarbonetos) is active in Búzi through natural gas sources near the town (ENH 2011). Búzi is governed by the district administration, based in Búzi.

3.1.4 District of Cheringoma and Inhaminga

In 2007, the Cheringoma district, in which Inhaminga is situated, had 34.000 inhabitants and about 4,8 Inh./km². The district is 7108 km² wide. Its average temperature is 26.3°C, the absolute maximum 42.0°C, the absolute minimum is 10.0°C and the average precipitation is 77.0 mm per month (Instituto Nacional de Estatística 2010c).

Cheringoma is subdivided into two administrative posts (*postos administrativos*); Inhaminga and Inhamitanga. Inhaminga again is subdivided into four localities (*localidades*); Inhaminga-Centre (Inhaminga-Sede), Maciamboza, Mazamba and Josina Machel (Ministério da Administração Estatal 2005).

41.7% of the 6,300 families used open wells without pumps – *poco sem bomba ceu aberto* –, 29.0% secured wells – *furo protegido* – and 19.3% rivers or ponds. 8.0% used public taps, while 1.9% had access to canalized drinking water to the yard and only 0.2% had a water connection directly into the house (Instituto Nacional de Estatística 2010c).

Inhaminga town had about 10,000 inhabitants in 2007. With about 1,700 inhabitants in 1997, the population growth was nearly 19% per year (Brinkhoff 2011). It consists

[17] Intermón is an NGO and part of the Oxfam Federation of international NGOs

[18] WASH promotes public hygiene and develops water infrastructure by constructing wells for the communities as well as latrines for private, public and school use (Intermón 2011)

of thirteen *bairros*. Inhaminga lies on a rehabilitated railway line, connecting Beira with, amongst others, the railheads of Marromeu and Caia. In Inhaminga, a wood processing company and a tourist company are situated. The National Railway Company Caminhos de Ferro de Mocambique (CFM) has a building complex in Inhaminga, close to the hospital. Electricity has been available for about 4 years now.

3.2 Results of the Survey in Búzi Town

Interview partner in Búzi was Mr. Bernardo Bufaunde, the technician for water supply and sanitation of the SDPI (district office for planning and infrastructure). He was trained from 1994 till 1996 by DNA in water supply systems like small piped systems, boreholes, manual boreholes, well construction, sewer systems and more. The interview was held on 6th of May 2011.

3.2.1 Organisation Structures of the Water Supply in Búzi Town

Responsibilities and Hierarchy

Water supply is organised by the district government. The technician for water supply and sanitation of the SDPI is responsible. Four employees take care of the water supply in Búzi; a technician, a plumber and two operators. If required, a mechanic is hired to help out. Figure 9 shows the hierarchical structure within the water supply sector. The technician for water supply and sanitation instructs the two operators and the plumber, while the technician receives his instructions from the director of SDPI. The administrator acts as a supervisor[19].

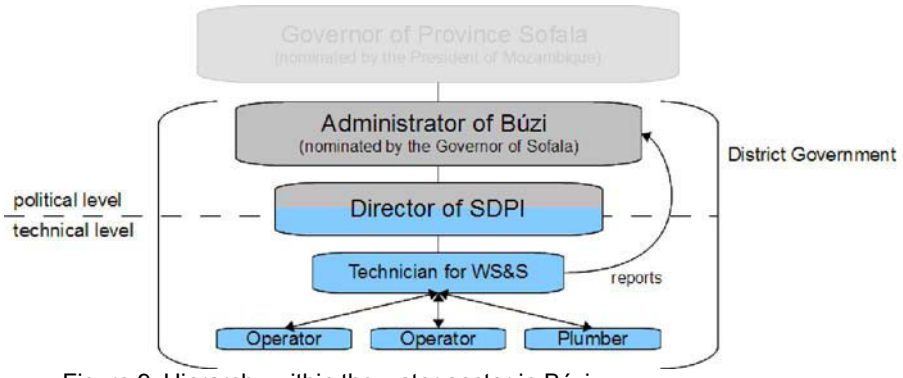

Figure 9: Hierarchy within the water sector in Búzi

The technician is responsible for budget control, supervision, planning and reporting and acts as water supply manager. The plumber is responsible for general maintenance and new house connections. The operator controls the whole pumping process, like turning the pumps on and off.

[19] Besides the SDPI, there are other offices with similar structures, all supervised by the administrator.

3.2.2 Technical Aspects of the SPS in Búzi Town

Infrastructure of the SPS

The SPS is supplied with groundwater, gained in an open well with a volume of 65 m³. The groundwater level depends on the tide[20] and on the season. The well is operational and always has water but during dry season and ebb tide the level is low. Because of the groundwater being influenced by the Indian Ocean, the water from the open well is brackish. The pump building was not accessible.

The transmission pipe under the main street was laid in 2004, with a length of about 500 m. It is fully operational. There are two storages, both made of concrete: One cistern and one tower, both with a volume of about 100 m³. The age of both is unknown[21]. At the moment, just the cistern is in use. The distribution network was rehabilitated in 2004, with a length of about 4 km, all in operation. The discharge is estimated by the technician with 50 m³/d. There are also 13 public tabs. Of these, 9 are in operation. Due to low pressure in the distribution network, 4 of the public tabs are closed, to guarantee enough pressure for the house connections. Taps often got stolen and sold with scrap metal. The SPS supplies about 100 buildings, including all governmental buildings, schools, the hospital and some pensions (these pensions also have private wells or boreholes). One school in the western area of Búzi cannot be supplied, due to low system pressure. The service connections are yard taps or in-house connections. Exact numbers are not available. These connections were rehabilitated in 2004. Before the water is pumped into the distribution network, it passes a meter. All households have a meter available. The meters are not read as the information is not necessary for accounting the provided water (Chapter 3.2.3).

No maps or other documentation about the supply system were available from the technician. Figure 16 in Annex 7.4.1 gives a overview about the main structures location.

Operation and Maintenance of the SPS

The hours water is pumped from the well to the cistern depend on the tide, but , mostly from 7 p.m. to 5 a.m. as well as from 11 a.m. to 4 p.m.. When the level in the cistern is low, the pump is also turned on. The cistern never becomes full. Reasons are said to be distribution while storing as well as a weak pump or engine. The pump is turned off from time to time, as it is said to be weak. Water is supplied intermittent, from around 5 or 6 till 12 o'clock and again from 4 p.m. to 7 p.m.. The system has been electrified since 1998. No information about intervals of tower cleaning or network inspection could be gathered.

Water Quality, Treatment and Testing

As mentioned above, the water is brackish. But no detailed information could be given about its composition, like the exact salt content. Water is treated automatically with chlorine before water is distributed. No further information about the intervals in which they receive new chlorine by the ministry of health or how they calibrate the pump was given.

[20] The nearby Indian Ocean influences the water level in Búzi river and through this also the groundwater level.

[21] The structures were built under Portuguese colonisation. Thus, they are at least 40 years old, supposedly much older because it is unlikely that the Portuguese built new structures during the independence war 1964- 1975.

Future Planning

The technician sees no further issues and underlines that everything is well organised. He mentioned that the system could supply up to 10,000 people, but at the moment about 500 people are served with house connections and about 2,000 via public taps.

3.2.3 Economical Structures of the Water Supply Sector in Búzi Town

Budget of the WS Sector

There is no regular water supply entity and no regular budget for water supply. The salaries are paid by the local government, chlorine is provided by the ministry of health. Small repairs and spare parts are paid out of the local budget, if possible.

The plumber and each of the two operators earn MZN 2,379 per month. The technician did not want to tell about his salary, but mentioned he is earning the standard technician salary. Acting on this assumption, he earns the same salary as the technician in Marromeu, his salary would be about MZN 7,540. With this, the monthly personnel costs are MZN 14,677, the annual personnel costs are MZN 176,124.

In 2010 about MZN 2 Million were spent for cleaning the well, the storage and the cistern, for valve substitution, repairing pipes and for spare parts. The exact source of finance was not mentioned. Through the now explored gas field close to Búzi, the ENH is taking part in the rehabilitation of the water supply system of Búzi. They contributed in the rehabilitation of the well and its building, the cistern, the pumps and at least one public tap[22]. The financial accountant was not available, so no specific data about ENHs contribution, electrical costs and further spendings could be gathered.

Tariff System

Each private household connected to the SPS pays MZN 50 per month. Public institutions pay MZN 100 and the hospital MZN 150. Water is not metered. The exact number of private households and public institutions was not known. The tariff is charged via a bill delivered monthly. If the payment is not given in time, the household receives a reminder with a fee. If th household also not paying again, the connection will be cut. The revenue is used in the local budget.

For using the public tap, there is a fee of at least MZN 1 per month. Some users pay more. These public taps are administrated by 13 committees, for each tap one. The committees collect the fee, of which 20 % stays within the committee and 80 % are going to the local administration and thus in the local budget.

3.2.4 Water supply besides SPS in Búzi Town

A lot of manual hand pumps are in use. There is also an other small piped system on the other side of the river which is not in use any-more. The system was owned by the Búzi Sugar Company, which built a private system for them selves.

[22] Not all public taps were visited and no exact number could be stated by the technician.

3.2.5 Summary Water Supply of Búzi Town

In Búzi the district government operates the SPS. The water technician of the SDPI is responsible. The SPS is working and pipes were renewed in 2004 with certain constraints: Low system pressure, brackish water, intermittent service and not all connections and standpipes are in operating state. A deficient powerful engine does not fill the cistern completely and automatic chlorination is the only treatment. How annual rehabilitation and operation and maintenance is financed could not be found out. There is no regular budget for water supply.

100 buildings and 9 stand pipes are supplied but consumption is not metered although meters are installed. There are no maps and documentation and no data about the amount of water distributed and consumed, The monthly fee for a house connection is MZN 50. Revenue flows into a general budget. Besides SPS, hand pumps are used.

3.3 Results of the Survey in Marromeu Town

Interview partner in Marromeu was Mr. João Armando, the head technician of the municipality. Actually he is a topographer. He received training during the PAARS Project[23]. After the PAARS Project ended, he and his position were integrated into the Local Administration. The interview was held from 27.04.2011 – 29.04.2011. The operator of the SPS and the director of Intermón and the WASH officer of Intermón Mr. Giovanni Cerón were interviewed, too.

3.3.1 Organisation Structures of the Water Supply in Marromeu Town

Responsibilities and Hierarchy

The Directorate of Urbanisation, Water and Sanitation (Vereacao de urbanização, água e saneamento de meio basico) of the municipality is responsible for water supply in Marromeu. The directorate is also responsible for urbanisation and is subordinated to the mayor (Presidente de Vila). Two people are directly responsible to take care of the water supply in Marromeu, a plumber and an operator. The technician, the mechanic and the counsellor are not involved full time in water supply issues. The technicians spend about 5 h a week for water supply. The counsellor acts as supervisor and controller between the directorate and the Major, who also appoints him.

[23]PAARSS was funded by the Austrian Development Cooperation in partnership with DPOPHS. Since 1999 a demand responsive W&S program is implemented in 5 districts in the Sofala province (SIWI 2007).

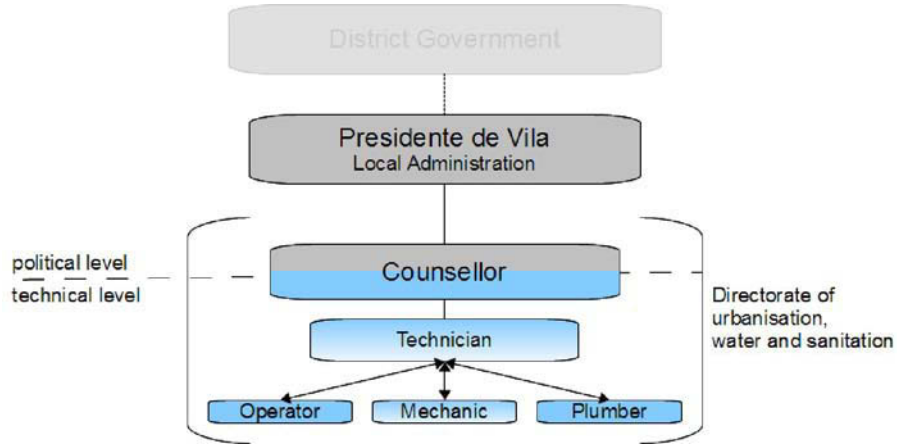

Figure 10: Hierarchy within the water sector in Marromeu

Needs and Future Planning

The technician mentioned, that a water technician and another one for planning would be essential. Because he is a topographer, he is interested to work in this field. Besides restoring the second well, no further future plan is known.

3.3.2 Technical Aspects of the SPS in Marromeu-Town

Infrastructure of the SPS

There are two open wells. While one is in operation, the other needs rehabilitation and is not in use since it was destroyed in the civil war. Both wells are recharged with groundwater. After the rainy season, groundwater level is high and close to the surface. During the dry season, the level is lower. A lift pump (parameters were not known) transports water from the well to the storage tower. Theoretically, the pump needs 8 hours to fill the tower. But after a short circuit, they are afraid that this could happen to the new engine as well, bought just last year. The technician as well as the operator said the pump *burned. So now*, the operator turns the engine off for a while when it turns hot. Even though the engine is not powerful enough, a replacement is not planned due lack of financials.

The pump and engine building is nearly collapsed. A new building situated near the old one, is finished. It will be in use as soon as the chlorine pump, which should be funded by Intermón, arrives. A second engine procured by Intermón is not in use, because it has not enough output power. A third submerged pump (parameters unknown) is placed in the open well, but broken.

The transmission pipe to the storage is about 70 m long. Its age is unknown as it was built during the Portuguese colonization (q.v. footnote 21).

The transmission storage is a tower, also built by the Portuguese at an unknown date and has a capacity of 50 m³. Due to the weak pump it is not possible to fill the tower completely. The full level stops at 20 to 30 %. This is mentioned to be the reason for low system pressure. When the submerged pump was in use, they were able to fill the tower.

The distribution network, gravity fed by the storage tower, is about 2,500 m long and fully operational. The network has two extensions, connecting districts further away to to the central SPS. The lengthening to Doe is additionally supplied by a spring,

but could not be visited. Within the network are 7 valves, all new and operational. Network inspections are not done regularly.

11 public taps are connected to the SPS. Their usage is organised by user committees. The number of people which are supplied via standpipes is not known.

Besides public taps, 202 house connections are existing, serving about 1,000 people[24]. Most of these connections are yard taps, some are in-house connections, all made of plastic. How many of these connections are private, commercial or for public buildings is not known. Commercial connections normally also are used privately. About 50 of all connections are older than 10 years, the others are relatively new. Most also have a small private storage. As there is no meter in the system, there are no numbers of distributed water. In Annex 7.4.2 a schematic map of Marromeu's relevant water infrastructure can be found.

Operation and Maintenance of the SPS

Water is stored from 11 a.m. to 3 p.m. (in summer 5 p.m.) and from 2 to 8 a.m. (in summer 9 a.m.) in the water tower and is then supplied intermittently from 3 to 6 p.m. and from 6 to 10 a.m. There is always enough electricity to run the system satisfyingly. However, it often comes to water supply restrictions, when the pump is falling out or the like. The tower is cleaned by three workers two times a month.

Water Quality, Treatment and Testing

According to Intermón and the owner of a guest-house the iron content in the groundwater is very high.

There is no automatic or regular water treatment. If chlorine is available, the operator adds chlorine manually. According to the technician, the chlorine content is measured but irregularly once a week and with aid and instruments of Intermón's WASH Officer. Referring to the technician, the operator overdoses the amounts of chlorine, which is added directly at the open well. So then, stock is consumed quickly and when the chlorine is depleted water is not treated. Usually chlorine is distributed via the Ministry of Health but from time to time, Intermón helps out with chlorine. When the chlorine is depleted, the technician also asks at the hospital for chlorine.

3.3.3 Economical Structures of the Water Supply in Marromeu Town

Budget of the WS sector

There is no regular water supply budget. The salaries are paid by the Local Government. The salaries of the plumber, the mechanic and the operator are MZN 2,495. The technician earns MZN 7,540. MZN 400 are paid three persons twice a month for cleaning the tower. There are no numbers on the exact electrical costs for the pump. In 2010 the local authority spent MZN 7,500 for the new pump, MZN 12.000 for spare parts, like valves and taps (due vandalism and stealing certain taps have to be renewed every month), MZN 33,561 for maintenance and MZN 2,5 Million for rehabilitation. The maintenance is financed by the Local Authority, the construction by the government and the P13 project[25], which funded the total

[24] Assuming five persons per household, made by the technician.

[25] 13 towns in North and Centre Mozambique benefit from the P13 initiative of SDC (SDC n.d.).

restoration of the SPS in 2010. The numbers are derived from the financial accountant of the local authority.

An annual finance plan for maintenance has to be worked out. This plan is handed over to the council, with the mayor as chairman. If accredited, the plan is handed over to the National Government, which provides financial means.

Tariff System

For a house connection MZN 75 have to be paid per month. There is no metering and no restriction of the amount of water consumed. The fee for a new house connection is MZN 750. The collected revenues and fees are used in the Local Administrations budget.

Every family using a public tap pays MZN 5 monthly for the usage. The money is used for small rehabilitation, like buying new taps. These often get stolen and sold as scrap metal.

3.3.4 Water Supply aside from the SPS in Marromeu Town

Population with no access to the SPS are supplied with 74 hand pumps. Some small private suppliers distribute water from their boreholes or wells to the surrounding neighbourhoods.

The Sena Sugar Company has its own well and distribution network for its higher employees, schools, guest-houses and restaurants, the private and public hospital and the nurse building complex. All these buildings are situated within the fenced area of the sugar company. As far as known, the company does not supply the population of Marromeu with water.

3.3.5 Summary Water Supply in Marromeu Town

In Marromeu the municipal directorate for urbanisation water supply and sanitation manages the water supply. There is no position for a water technician. The SPS is working with certain constraints like low pressure, low water quality and intermittent service. Storage is limited to 50 m³. There are no meters in the system. Manual and irregular chlorination is the only treatment and a deficient engine does not allow filling the tower completely. A short circuit last year destroyed the former engine. 202 buildings and 11 stand pipes are supplied but consumption is not metered. There is a map of the pipes but it is not very detailed. No data about amount of water distributed and consumed is available. Annual rehabilitation, operation and maintenance are financed by the National Government and donors. Monthly fee for a house connection is MZN 75. Revenue flows to the general budget. Besides SPS there are 74 hand pumps and numerous private self suppliers. Sena Sugar Company supplies itself with water.

3.4 Results of the Survey in Inhaminga

Main interview partner in Inhaminga was Mr. Salvo Nur Mamao Jessub, director of SDPI in Cheringoma district. He had a 4 week training in pump repairing and NWP in 2006. Besides this, he had had five more trainings in supervision, building boreholes, wells and more. The manager of the Amai Apa Banda training centre[26], Mrs. Elsa da Glórici and a Catholic Priest, Padre Amadeu were interviewed, too. The interviews were held 2nd and 3rd May 2011.

3.4.1 Organisation Structures of the Water Supply in Inhaminga

Responsibilities and Hierarchy

Responsible for the SPS in Inhaminga is the SDPI of the district government. Besides Water Supply, the SDPI is also responsible, among others, for mapping, streets and general infrastructure. Resources have to be shared between these fields of activities. From end of 2010 till the beginning of 2011 a head technician for water supply was employed. Because the system is out of order (details chapter 3.4.2), he quit his job early 2011. The current plan envisages passing the responsibilities for water supply and sanitation (and buildings) to the technician responsible for streets. At the moment, the director of SDPI is responsible for water supply (Figure 11). The persons directly linked to water supply at the moment are the two operators. Theoretically, they execute their operation function in shift-work. One is working as a mechanic, the other as a plumber. However, he did not receive training as a plumber. The former plumber is retired. As soon as a new plumber is employed, the former one will instruct him. Right now, it is not possible to finance a new plumber.

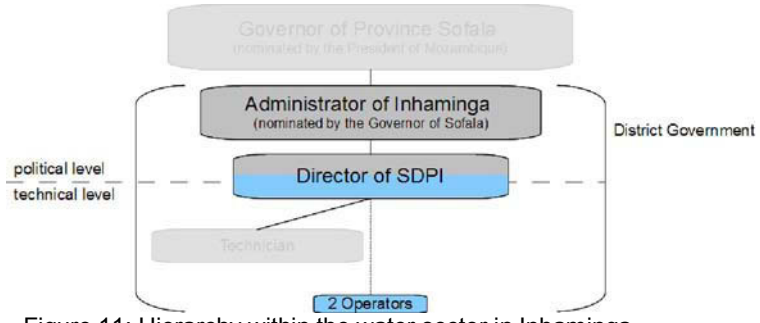

Figure 11: Hierarchy within the water sector in Inhaminga

3.4.2 Technical Aspects of the SPS in Inhaminga

Infrastructure of the SPS

During the field work, the SPS has not been in operation since early 2010. When the SPS was reactivated in 2003, all pumps were supplied with energy generated by diesel generators. After the engines had been supplied by the electrical network in the beginning of 2010, all had had a short circuit within two months. The technician said the pumps burned. It was planned to reactivate the SPS in December 2010. But

[26] AMAIAPA BANDA was a project for war widows. Nowadays it is a agriculture training centre.

the pumps and engines ordered in South Africa have not arrived yet. Full particulars about the current water supply situation can be found under 3.4.4.

Normally, the water is gained in Dimba, 3 km linear distance in the north west of Inhaminga, in a valley about 100 m lower than Inhaminga. There are three boreholes and one spring in Dimba, feeding a 80 m³ cistern, also located in the valley (see Figure 12). The spring feeds the cistern by gravity. From the cistern, the water should be pumped to a storage tower 500 m onward, which is also the highest point in the system. Before this is done, chlorine is added with an automatic pump. The tower is able to store 60 m³. From here on, water is distributed via gravity another 3 km to a storage tower in Inhaminga with the same volume and a height of about 20 m. This tower also should be supplied by four smaller boreholes, distributed around Inhaminga. Downstream the cistern and the two towers each have a valve, downstream from the first tower there is a meter. Close to the tower in Inhaminga is a cistern with a volume of 100 m³. When regular operation starts again, it is not intended to be used. The storage capacity is 300 m³, of which 200 m³ will be used. The pipes between the cistern and towers were laid in 2007. Distances can be seen in Figure 12. The cisterns and the towers were built during the Portuguese colonisation (q.v. footnote 21). Theoretically the cistern and towers are cleaned once a month.

The distribution net was renewed in 2003. Because no plans were left by the construction or planning company, no further exact numbers can be given. But the technician guesses the length to be 3 or 4 km. The mains are said to be laid under the streets, equipped with four valves. The technician does not know where these are located exactly. Five public taps are connected to the SPS. Two are operational, three need rehabilitation.

There are 67 house connections, of which 12 would supply public buildings, one hotel, the hospital and the teacher training school. In total, 52 private households are supplied. These house connections were renewed in 2003.

The ordered pumps are Pedrollo[27] submerged pumps. For the boreholes in Dimba three, and for the boreholes in Inhaminga four pumps were ordered. They all shall have a pumping height of 100 m and an output of 2 m³/h. Two more pumps were ordered for the pumping house in Dimba. These shall have a pumping height of 200 m and an output of 14 m³/h. When the system is running again, it is estimated to be able to supply about 2,000 people, about 1,400 people via standpipes and 600[28] via house connections. The technician estimated the maximum abstraction rate with 120 m³/d as an annual average, considering dry and rainy season. The target supply, however, is 60 m³/d. It was not mentioned what kind of engines were ordered. In Annex 7.4.4 a schematic map of Inhaminga's relevant water infrastructure can be found.

[27] http://www.pedrollo.co.uk/

[28] The technician calculated with about 10 persons per household.

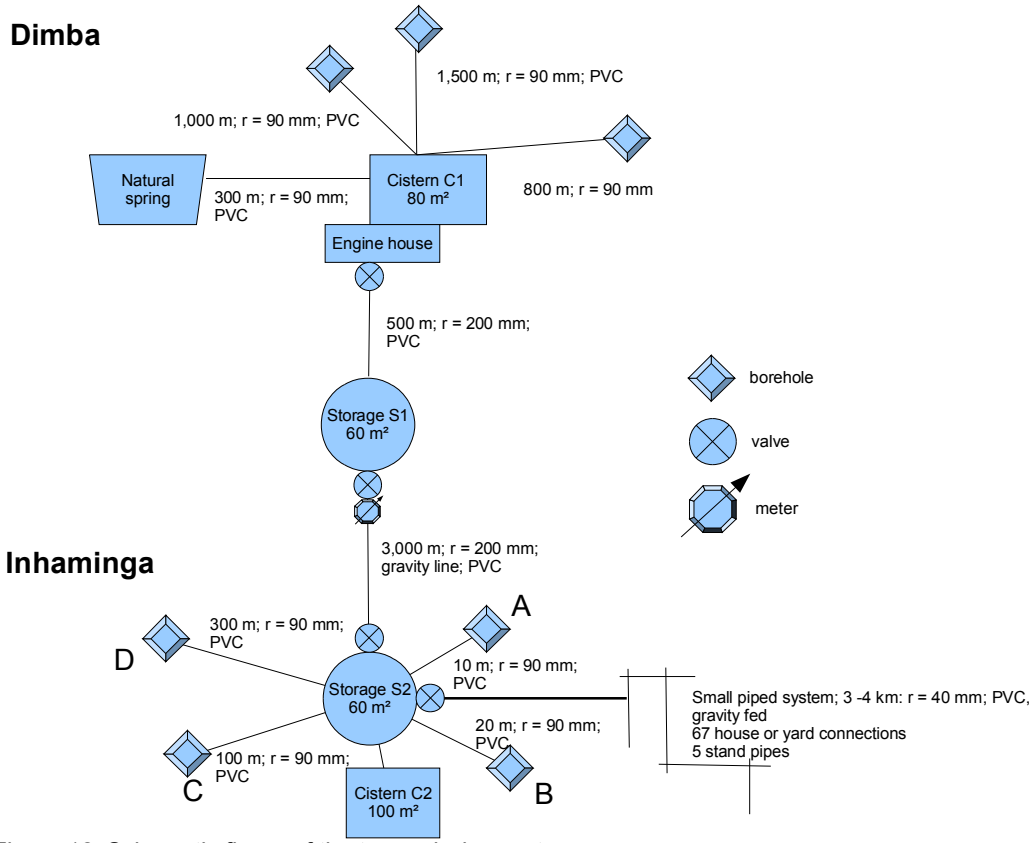

Figure 12: Schematic figure of the transmission system

Operation of the SPS

If in operation, the system is running intermittently. Theoretically, the distribution network is supplied from 7 till 9 in the morning and from 5 till 6 in the evening. The storage tanks will be filled as follows (see Figure 12). The cistern C1 in Dimba will be filled from 2 till 4 by the three boreholes and the natural spring. This will be done fully automatically. One operator will be there to assure the procedures. From there, water is pumped to to Storage S1, from were the water is flowing to the Storage S2 in Inhaminga. Referring to the technician it will take about two hours to fill the storage S2. Storage S1 shall always be full, for emergency cases. Storage S2 also can be supplied with the additional 4 boreholes A,B,C and D, spread around in Inhaminga. These four boreholes are to be used for emergency use only. Cistern C2 in Inhaminga will not be in use. During the dry season, filling the tanks can take longer, due to boreholes replenishing slowly.

There are no plans to establish an evidence documentation of the operation. During the rainy season, electrical power outages can disturb the water distribution once or twice a week.

Water Quality

As there was no water, no information about water quality could be given. Even if the system would run, no quality tests would be done.

Future planning

There is hope to connect the 24 km off Nhamantabe to the water supply system soon. It is estimated that this source could provide up to 100 m³/h. There was a tender and bids are awaited. It is indicated that the planning and construction will be done with funds from the Government and donors. O&M then will be handed over to a private operator. Additional standpipes and house connections are desired, too.

3.4.3 Economical Structures of the Water Supply Sector in Inhaminga

Budget of the WS Sector

There is no entity solely responsible for water supply and no separate water supply budget. Salaries are paid by the District Government, chemicals are provided by the Ministry of Health.

The monthly salary of the two operators is about MZN 2,600 each. Theoretically the plumber earns MZN 2,700, but as mentioned before, this position is not taken at the moment. The unmanned position of the technician is remunerated with MZN 7,540. If all positions are taken the monthly costs would be MZN 15.440, the annual costs MZN 185,280.

The costs for the new pumps, valves, pipes and the rehabilitation of the tanks accounts for about MZN 1,4 Mio, paid by the government and the PAARS project. Besides these two financial backers, the Rotary Club was mentioned to have contributed money.

There is no actual budget for water supply, budget planning is done every year to gain funds for O&M from the government.

Tariff system

Before the the breakdown of the water supply system, a tariff system existed. This tariff system is planned to be reformed by the Government when water supply system is restored. The tariff at the standpipes will remain constant with MZN 1 for 20 l, paid directly at the standpipe. Owners of house connection will receive a bill, paid at the accountancy.

But these generated revenues were not enough to break even and funds from the government are still needed.

3.4.4 Water Supply besides the SPS in Inhaminga

At the time of the field work, the private boreholes of Amai Apa Banda training centre were the main source of drinking water for Inhaminga and the surrounding villages.

Three boreholes, 80 m deep and carrying water year-round are all situated on the estate of Amai Apa Banda. For about two years, a electrical pump has been in use. In case of an electrical power cut, the diesel generator from before still can be used. The tank, about 4 m above ground, has a capacity of 20 – 25 m³[29]. There is no time schedule for filling the tank. When it is nearly empty, the pump is turned on. Water is distributed via three standpipes, operated by an employee of the Amai Apa Banda.

[29] Own estimate. The tank is about 2m high, and 2m to 6m broad.

He also collects the fee of MZN 1 per 20l. In case of damage, the Beira office will be informed and a plumber will be assigned to solve the problem.

By means of the accounting, following assessments were made by the manager. In the rainy season from December till March their daily revenue is MZN 40 to 200. This is equivalent to 0,8 to 4 m³ water per day. In this period, people mostly supply themselves with water. After the rainy season from April till June, groundwater level is high and rivers or other sources are available. The daily revenue is about MZN 2,000, or about 40 m³. When reachable sources run dry between July and November, daily revenue can increase up to MZN 6,000, equivalent to 120 m³. In this period, Amai Apa Banda is the essential water source in Inhaminga.

Further alternative sources to the SPS

Besides Amai Apa Banda, three more bigger private sources are serving water to the public. These are the teachers school, the CFM (National Railway Company of Mozambique), as well as the catholic church, which also has a 80 m deep well. The CFM serves the public and very likely the hospital vis-à-vis with water from a tap. More information about the CFM and the teachers school could not been generated. There are also a number of private wells up to 20 m deep. But these do not provide reliable water and in dry season they are often waterless.

3.4.5 Summary Water Supply in Inhaminga

In Inhaminga the district government manages the water supply via the SDPI. The position of a water technician is vacant. The SPS, rehabilitated in 2003, has not been operational since early 2010. Shortly after change of energy supply from diesel aggregates to electrical grid, pump engines had short circuits within two months. The town is completely dependent on private resources and hand pumps until the SPS is rehabilitated. Theoretically storage capacity is 200 m³ and 67 house connections and 5 public taps exist. No maps of the SPS are available. Efforts are under way to tap a further groundwater scheme.

3.5 Analysis of the Field Study Results

In the following chapter, the results of the field study are summarized and analysed referring to the research questions. Focus lies on the availability of data and the small piped systems. Then, general constraints of water supply in the visited towns are listed and put into context.

3.5.1 Availability of Data

Most of the points in the questionnaire and in the IWA check-list were not answered. Data is not available because

- information is not collected, as it seems not important, like in Búzi were meters are installed but not read as it is not necessary for billing
- information is not collected, as it is not possible, due to lack of know-how or equipment which is relevant for measuring water quality
- reluctance to give information. The Reason could be that it is not known what happens with the information offered. As technicians are mired in local politics, they don’t want to denigrate others, or themselves

The IWA check-list was not usable or suitable. For this kind of survey the check-list is too detailed. Consequently, indicators are not calculable. In the following table, the main open questions are listed.

Technical Questions	Theoretical abstraction capacity per year Water distributed per day and per year Water losses per day and per year System pressure Water consumption • per person per day • per service connection per day • per public tap per day Exact number of • clients served with service connections • clients served with yard taps or in house connections • private clients served with service connection • clients served with public taps Types of clients (Private or Commercial)
Organisational Questions	No documentation • of electricity failures • of pump failures • of water interruptions
Economical questions	Annual costs for water supply Costs for electricity Annual budget

Table 12: Main open questions during the field search

It has to be noted also that if numbers were given, it is not certain these data reflect the truth. It appears interview partners offered numbers because they were asked for them. This is assumed to be the case with the

- Amount of water gained per day
- Storage Capacity
- Length of distribution network
- Abstraction hours
- Distribution hours

In Annex 7.3, an extensive table with the collected data of the towns' water supply can be found.

3.5.2 Analysis of the Small Piped Systems (SPS)

SPS range of coverage

In all visited towns a small piped system existed. All the SPS are built on the basis of old Portuguese water supply systems. There is interest to preserve the SPS, as there are regular investments. Service connections and standpipes are limited to the former Portuguese buildings and their surrounding area. New buildings around this old nucleus of population are not connected to the SPS. Most people still are supplied with hand pumps. In towns with a fast growing population, like Inhaminga and Marromeu, water supply becomes difficult.

Consequently, the SPS is not the main source of water in a small town. This becomes apparent when the number of service connections and standpipes is correlated with the number of inhabitants of each town.

- 140 Inhabitants per connection in Búzi, 150 in Inhaminga and 200 in Marromeu)
- 1,550 Inhabitants per public tap in Búzi, 2,000 in Inhaminga and 3,640 in Marromeu)

With 8 persons supplied by each service connection and 250 user per standpipe[30], the percentage of reached inhabitants is 22% in Búzi, 18% in Inhaminga and 11% in Marromeu. These are just rough estimates, but they show SPS are not the main source of water, especially in Marromeu.

Town	Population 2007	Coverage estimated %	No. of clients incl. standpipes	No. of house connections or yard taps	No. of functional standpipes	Inhabitants per house connection	Inhabitants per standpipe
Búzi	14.000	22	3250	100	9	140	1550
Inhaminga	10,000	18	1920	67	5	150	2000
Marromeu	40,000	11	4770	202	11	200	3640

Table 13: Characteristics of the field study towns

Amount of water distributed by SPS

A further limiting factor is the amount of water generated and distributed. There are no measured numbers of how much water is generated or theoretically could be produced[31] but additional sources have to be prepared. This is mainly valid for Marromeu and Búzi, were water is generated with open wells. These run out of water quickly during the dry season, quality is not secure and water can only be distributed intermittently.

A further limiting factor is the possibility of storage. Taking the number of supplied population from Table 13 above, storing capacity varies between 10l – 19l per inhabitant in Marromeu, 31l - 54l in Búzi and 104l -184l in Inhaminga. In Inhaminga a short breakdown shall be bridged, in Búzi this also seems feasible. In Marromeu however, this is impossible. Asides its size of 50 m³ which limits storage potential, the tower in Marromeu cannot be filled completely, as the engine has insufficient power. Thus, it loses its role as a storage and its role as a pressure tank is restricted, too. In cases of a gravity fed system like in Marromeu and Inhaminga a tower also acts as a pressure tank. In Búzi the network is supplied from the cistern with an insufficient engine. This causes low system pressure, resulting in unsupplied service connections and public taps. Besides investments in the network, funds also should be used to invest in storage, pumps and engines.

Operation and Maintenance

Only the absolute necessary is done. Even if there is motivation to do something, lack of funds, knowledge and responsibilities still hampers every commitment. The position of water technician is vacant or not existing in Inhaminga and Marromeu.

[30] Total population served is calculated as follows: 22.9% of urban population is served with household connections, 17.8% by neighbours and 19.7% by Standpipes. With (1+17.8/22.9) 1.8 households are served, or 8 persons. A standpipe should serve 500 persons, however, field data shows an average of 250 persons.(Lazarte & Macário 2010)

[31] The technicians estimated their daily amount distributed, but these numbers seemed not sound.

Water quality, treatment and testing

Water quality is low and contamination with faeces is a threat, primarily in Marromeu and Búzi with their use of shallow groundwater. Additionally, in Búzi groundwater is brackish and in Marromeu iron content is high. Sole treatment in all towns is chlorination, in Marromeu just manual. Testing was only reported in Marromeu (turbidity), and irregular. Consequently, a connection to the SPS is no guarantee for safe drinking water.

Budget of the Water Supply Sector

Funds for water supply have to be requested annually from the Government. As these funds are little, service quality cannot can be improved. In all three towns no exact data about the financial situation was available. There were numbers about expenditures, but no detailed calculations for what exactly how much was spent.

Tariff System

Tariff systems are similar in all towns. All have a flat rate for their service connections (between MZN 50 and MZN 150 per month) and a fee of at least MZN 1 to MZN 5 per month and family for using the public tap. The revenue in Búzi is estimated at MZN 5,800 per month, in Marromeu with MZN 16.500. In Marromeu the revenue breaks even with the salary paid for full time staff, in Búzi about 40% of the salary is covered. As there is no tariff system in Inhaminga only theoretical calculations can be done. With MZN 15,440 for salaries, if fully staffed, the monthly fee for a service connection should be about MZN 115 to cover 50% of the salaries.

Box 5: The issue of burned pumps

Obviously, not the pump burned, but the engine. Although, technicians and operators always talked about *burned* pumps.

As in both Inhaminga and Marromeu it was reported that the pumps *burned*, there could be a coincidence. A possible reason could be fluctuations in the electricity supply. Engines have a range of voltage within which they are working. If the voltage is too high or too low, they could *burn*. Main evidence is Inhaminga, were all engines burned within two months, after the water supply got connected to the electrical grid. Also the engines of the catholic church in Inhaminga burned twice (see Chapter 3.4) and in Marromeu an engine burned and the submerged pump is out of order (see 3.3). In all cases, the engines are supplied with electricity from the grid. The origin of the issue in every case was unknown by the operators and therefore, not solved (besides through ordering new engines).

As mentioned in Lazarte & Macário (2010), in Magude a private operator had to install an electricity surge protection for the pumps. This also is an indication for suspecting the source of the issue within the electrical supply grid.

3.5.3 Constraints of Small Town Water Supply

Decentralisation transferred responsibility of operation and management to town or district administration. These lack funds, capacity and know how to fulfil their duty. Local governments are overstrained with the duty to operate, manage and maintain the SPS and numerous constraints make proper water supply difficult. These constraints within the town can be divided into organisational constraints, technical constraints and knowledge constraints.

Organisational constraints	• Local Government takes care of water supply, financing however strongly depends on sources from the national government and donors • The position of the water technician is not occupied in all towns
Technical constraints	• Some parts or the whole system do not work • Networks are limited to the town's core • Generated amount of water is too little to supply the majority of the towns • Only intermittent supply is possible • Water quality is not secured • Equipment (pumps and engines) is not adequate and inefficient • Access to replacements (pump and engines) is limited • System pressure is low
Knowledge constraints	• Data collection and documentation is not done • Operational staff is not able to handle more difficult technical issues • Organisational and management skills are barely existing • Operation and Maintenance skills are limited

Table 14: Constraints of small town water supply

Without the alternatives to the SPS (hand pumps and small private distributors), water supply would not be possible. On the other hand these alternatives act as competitors towards the SPS. Wealthy habitants have their own water supply. These solvent clients are hard to reach as long as public water supply is insufficient. This shows how urgent a new approach and a proper institutional and legal framework for small town water supply is.

3.6 Interpretation of Field Work Analysis

3.6.1 Interpretation of Availability of Data

As described above, a lot of data could not be collected. This refers back to a lack of basic knowledge of staff on how to operate a water supply entity and lack of sensitisation to how important data acquisition is. Staff has to be educated and trained in data generation and usage. It is necessary to make staff aware that data generation and the usage of data is a key element for a successful water supply entity. As long as information and data are not collected by the water supply entity, smooth progress is not possible. Security of supply is not guaranteed. Furthermore, it is unlikely to receive loans or grants to invest without operational data.

3.6.2 Interpretation of the SPS Analysis

Organisational Constraints

The vacant position of the water supply technician has its reason in lack of funds to fill the vacancy, and within the administration, which sees no reason to employ a skilled person. Also lack of qualified personnel is a reason (see “knowledge constraints” below).

Technical Constraints

The technical constraints described have their main reasons within

- the lack of know-how of staff (see knowledge constraints below)
- the lack of responsibility of the local government through lack of respective laws and policies or lack of will to implement these laws and policies
- the lack of incentives to develop small town water supply
- the lack of entities with qualified personnel to regulate and monitor the implementation of the law and policy

A framework with clear responsibilities, incentives and penalties is necessary, as well as institutions which are responsible for checking whether laws are followed.

Knowledge constraints of staff

Knowledge constraints are a crucial problem, as the example of burned engines shows. First, there is no differentiation by the interviewed staff between pumps and engines. This shows lack of basic technological knowledge. Second, they do not question the reasons why the engines burned. Only new pumps were ordered. This lack of questioning reasons indicates lack of knowledge in problem solving techniques and management skills. As the respective administrations do not pay the new engines but the national government or donors do, the will to maintain and take care of equipment is low.

Knowledge constraints in small towns refer back to lack of education and experience. The possibilities to gain education are restricted in Mozambique and the market for highly educated staff is thin. Young professionals who recently enjoyed higher education recently lack of experience in operating, managing and maintaining a water supply system or they are not willing to work in small towns. These towns are not attractive for well educated young professionals. Small towns offer little infrastructure and leisure opportunities. Maputo and the provincial capitals are more attractive to them. Young professionals also prefer private companies as these pay better than the government.

Possibilities to gain proper education have to be extended and small towns have to be made attractive for the young urban professionals. This shows the dilemma in which small towns are caught. They need qualified personnel to develop themselves. But these in turn demand a certain standard of living and prefer to stay in the urban centres.

4 EXPERT INTERVIEWS

In this chapter the results of the expert interviews held in Maputo and Beira are documented. They were held to explain the actual situation of water supply in small towns with a special focus on small piped systems (SPS). The experts interviewed are all working in areas related to water supply in Mozambique, but from different institutions. Ms. Lazarte is working for WSP, and is a foreign expert. Mr. Juizo is a teacher at the Eduardo Mondlane University. Mr. Jossefa is working for DNA and Mr. Abel for DAS of Sofala.

4.1 Categorization of Small Piped Systems (SPS) in Mozambique

Lazarte and Jossefa et al. mentioned a definition for SPS, which categorises them into three levels. Level one are very small systems with a maximum of 50 households connected. Level two systems have 50 – 150 household connections and level three 150 – 400. According to Jossefa et al., this definition is valid for small towns in Mozambique.

Piped systems which are not rural and not under FIPAG could be seen as SPS. These systems are under the newly founded AIAS. All have at least 50 house connections and can be seen as SPS (Lazarte 2011).

Juizo (2011) described another three level categorisation. Category A means well run and with a good infrastructure. There are 12 - 20 in this category, most of them under FIPAG. Category B systems have certain challenges, like age and losses. These towns are under AIAS now. There are about 15 - 20 in Category B. In Category C are towns with a barely functional system, with worse performance and many losses. These towns should also be under AIAS (see Chapter 2.1.2.4) or PRONASAR[32], but their number was not known.

Number of SPS in Mozambique

According to the respective definition, the number of SPS varies. Nationwide, there are 128 SPS under AIAS. But also political decisions had some influence. Sustainable systems could be transferred to the responsibility of FIPAG, due to FIPAG having to serve debts and needing further income. But there are also smaller municipalities, which are not registered at AIAS (Lazarte 2011). Juizo assesses the number of towns with one network supplying the whole town between 20 and 40 SPS, Jossefa et al. estimated 270 SPS, mostly level three types. Thereof 128 are in main villages.

In Sofala Province, there are 62 SPS. 48 are functional, 14 are not working. Of these 62 SPS, 45 working with solar power of which again 35 are working and 10 are not functional. But also the 48 functional SPS have common problems. Equipment is old and supply systems are too small for the growing population (Florencia 2011).

[32]National Rural Water Supply Program. Main activities are rehabilitation of wells, boreholes and water points as well as SPS construction

4.2 Actual Situation within SPS in Mozambique

The systems mostly were built in the 1960's and 1970's for 2,000 – 5,000 inhabitants. Today, the population has increased to 10,000 or 20,000, sometimes to 50,000 inhabitants. The systems are undersized and need rehabilitation. An ongoing maintenance and rehabilitation has never been done. As a result, informal private wells or rivers are used to secure water supply. In some towns rehabilitation has started with the aid of foreign funds, for example in Ilha de Mocambique, Maxixe or Vilankulo (Lazarte 2011).

Most small towns are in transition. Before water sector reforms, every settlement outside the big cities was considered to be rural. Because of this hand pumps were installed in towns with up to 7,000 inhabitants,. Most of them broke or groundwater level was too deep for using hand pumps effectively. Today, the extension of the power network made energy supply of SPS easier, as they often depended on fuel (Juizo 2011).

The water sector is financed mostly through donor funds (up to 80%). But investments are often punctual. A broken pump gets fixed or a new one will be installed, but the network itself is not rehabilitated. Due to the lack of meters, losses are unknown, but they are estimated to be at 70% (Lazarte, 2011). With PRONASAR, rehabilitation of 25 small piped systems per year is scheduled. It is estimated that half of the systems are working (Jossefa et al. 2011).

The revenue flows into the general budget of a town and is invested somewhere else instead. The opinion of the mayors concerning this change differ. Some see the revenue as an addition to their regular budget. They are not interested in spending money for expensive O&M or even extension. Others know how expensive O&M is and are interested to spin off O&M (Lazarte, 2011).

With the growing population, the challenge of, how to expand the systems arose. New assessments for SPS are needed (Florencia 2011). Some systems are run with the help of photovoltaic, independent micro systems (IMS). These IMS are used in small towns with 3,000 to 10,000 inhabitants, but also in peri-urban areas. These systems have a well with storage and supply nearby households or standpipes and are mostly privately run. They are used when groundwater level is to deep for hand pumps. There is no formal driver, who promotes IMS (Juizo 2011).

Composition and Operation of a SPS

The main source for a SPS is groundwater, some use surface water. During the rainy season surface water is often unusable through contamination. In general, water is gained with pumps. Some SPS have basic treatment, done manually by adding chlorine and in case of surface water, by adding aluminium sulphate. Both is inaccurate. All systems usually have a storage, standpipes and a certain amount of house connections (Lazarte 2011 and Jossefa et al. 2011).

Usually SPS are run as a unit within the local administration (Lazarte 2011). Some are run by district administration, about 20 by private operators (Jossefa et al. 2011). Of these private systems, some were handed back to public institutions, because of low revenue and high operation of costs (Juizo, 2011). Some are operated as autonomous or semi-autonomous companies, but there are few incentives for them to invest or increase supply. If a SPS is not working, hand pumps or surface water are used instead (Jossefa et al. 2011).

Costumers and Financing of a SPS

Most costumers are private households. Also schools, small companies, restaurants, canteens and businesses are served. Hospitals, commerce, industry and hotels mainly supply themselves because they rely on a steady water supply (Lazarte, Jossefa and Juizo 2011).

SPS are supposed to be self sufficient but this does not apply. Staff is directly employed by the local or the district administration and systems are passively financed (Juizo 2011). Lazarte describes this in detail. SPS under local administration are financed by revenues and governmental funds. Most of the staff is working for different units. Their salaries are not part of the water budget. Often only technicians, plumbers and operators are accounted for the water supply budget.

Private companies should finance their O&M by revenues. These systems always have meters, which are funded by donors. Within autonomously run SPS, O&M is paid for with revenues and sometimes maybe with subsidies from the government. In all cases assets and equipment is paid for by donors and national government (Lazarte 2011). The long term objective is, to privatise the O&M of the systems (Josssefa 2011).

Development needs of SPS in Mozambique

Technical investment needs strongly depend on each system. In general the primary and secondary network should be extended, the capacity increased, treatment plants built and meters installed (Lazarte 2011).

The above mentioned creation of an autonomous SPS is fundamental. A fundamental change in the organisational structure is needed. Unqualified staff should be replaced and only needed staff should be hired or employed. A better and more careful use of financial resources is necessary and roles and responsibilities in the departments should be improved (Lazarte 2011). A further issue is lack of professional management. Training were held a long time ago or just training on the job was done. Some water directors do not know how to manage a water supply system. Increased education of staff, from technicians to directors, is urgent. However there are no resources. It is important that expansion of systems and education are going hand in hand. Expansion is worthless, if nobody is there to manage the system (Lazarte, Jossefa at al. and Juizo 2011).

An economical need is cost recovery. It should be done by local and national government as well as with revenues. At the moment the systems under-perform (Lazarte 2011).

Business plans do not exist. Planning is limited to asking for help when a problem already occurred. Some entities have a template to declare financial ratios. WSP is trying to find out, if there are notes of financial data at all (Lazarte 2011). It is important to show that an investment can be sustainable. There are barely any investments as investors, donors or banks are of the opinion that in small towns, cost recovery is not proven. A solution could be splitting the risk between the government of Mozambique and the investor (Juizo 2011).

People are not wiling to pay for low service. But without revenues via tariffs, the service cannot be improved, as investment from the government is rare (Jossefa et al. 2011).

4.3 Relevance of SPS for the Mozambique Water Sector Strategies

A new urban water supply strategy was set up a few years ago. The official line of the Government is small towns need to be developed. Basic services are necessary as small towns are seen as the key for the whole national development, especially towns with more than 40,000 inhabitants. As Mozambique is still largely rural, small towns also are thought to relieve peri-urban areas from migration to the cities. Estimates come to a conclusion that about 200 Mio US$ are needed to invest in small towns' water supply (Lazarte, 2011).

The newly founded AIAS shall be responsible for construction, rehabilitation and extension of water infrastructure. Before rehabilitation or extension, a feasibility study shall be done by a consultant. If approved, AIAS contracts construction companies and will own the assets constructed. O&M as well as management of the system shall be contracted to a private company (Jossefa et al. 2011).

4.4 Analysis of the Expert Interviews

SPS are categorized after two definitions. The first categorization is done by means of number of house connections. The second categorization defines the systems according to their actual state. These categorizations helps to define responsibilities of the national agencies and to understand which systems need rehabilitation.

There are about 270 SPS in Mozambique, 130 systems (with more than 50 house connections) are under AIAS. In Sofala are 68 SPS, 48 of them operational. The number of SPS shows the importance to develop them. If these systems work proper, they will supply a large number of people with water and the standard of living will increase. But it must be clear, that all these towns need customized approaches, as it can be assumed that in every town different terms will be found.

The expert interviews describe certain issues within the small piped systems (SPS). The SPS are old and too small to supply the population, investments are done only selectively and water losses are huge. SPS are financed by donors and the national government. Revenue collected is not ring fenced but used in the general budget of local administration. Staff lacks professional management skills and they had their training a long time ago. This was also observed in the field study. The interviews show aborted attempts to implement new approaches like privatizing water supply. This proves the urgent necessity of a change within the water supply framework.

Development needs of SPS in Mozambique can be found within technical investment needs like treatment plants, meters and extension of the network. Organisational development needs are autonomous SPS, reasonable staffing, and reasonable budgeting. Further needs are seen in training of staff, cost recovery and the establishment of business plans. All these measures have to be taken simultaneously to increase the likelihood of success. These needs were discovered in the literature research and during the field study.

The Government of Mozambique recognizes the importance of small towns as they are meant to relieve peri-urban areas from migration pressure. First step was the foundation of AIAS which will contract consultants and companies for feasibility studies and construction. O&M will be contracted to private operators. This confirms the information about AIAS gained within the literature research.

Generally speaking, the expert interviews confirmed the literature research and what was documented and seen in the small towns while doing the field study.

EXCURSUS: PRACTICAL RESEARCH: INFLUENCES, DIFFICULTIES AND OBSTACLES

This chapter goes into reasons and occasions, which delayed and/ or complicated the field work and the expert interviews. This is considered to be giving helpful information on the duration of the stays in each town and why some interviews were not held and the data is sometimes weak and/ or little. Also it gives a rough picture of the circumstances which influenced the work in a significant way.

Co-operations

Eduardo Mondlane University

It was envisaged, to do the field work together with a student of the Eduardo Mondlane University. The collaboration with a local student was thought to bring advantages because a local knows the Portuguese language, the rules, behaviours and laws of Mozambique, a foreign scientist barely can. Information and knowledge was thought to be transferred clearer from the interviewee to the interviewers because communication with local staff and citizens will be easier and more direct. This is not just practical and makes the field work more efficient. Also it was thought, that the results will be more sound and significant. Besides, it was also planned to organise transportation and accommodation with help of the university.

However, the planned cooperation with the Eduardo Mondlane University didn't materialize. After certain failed attempts of Mr. Jung, to contact Mr. Juizo by e-mail to build up a cooperation, this plan was rejected after about 6 months in March 2011. As proved later in the interview with Mr. Juizo, Mr. Jung had had a wrong email address of Mr. Juizo. Instead, a privately financed interpreter was organised and accommodation and transport was found on one's own account.

WSP

Another planned cooperation with the WSP also didn’t work out as expected. It was hoped to benefit from their network. But as WSP is not an official institution in Mozambique, they were not in a position to initiate something. Furthermore, no additional financing from our site made a cooperation for them less attractive. Also differences between the Government of Mozambique and International Organisations during the field work, restricted WSP's field of activity[33].

Infrastructure

Akkommodation

As the planned cooperation with the Mondlane University didn't materialise, accommodation was organised privately. While the accommodations in Maputo and Beira were found from Austria via couchsurfing.com, the places to stay in Marromeu, Inhaminga and Búzi were always just organised directly after arrival in each town. In Marromeu the guest-house had to be left on the last day, because all rooms were rented out to the trains staff every Saturday.

Public Transportation

Transportation was the most time intensive challenge. Between Maputo and Beira, a regular private bus is operating. But to all other visited destinations, possible transportations first had to be sorted out. Main means of transport in Mozambique are privately run mini buses (Chapas). They are, for western standards, quite uncomfortable and are far to meet western safety standards, too. The buses are going from central stations in every town and city to different destinations. But only when enough clients

[33] Due to lack of cooperation on the side of the Mozambique government, international funds were not paid. In return, conditions for international organisations become stricter and their work was hampered (WSP 2011).

appear. By this the travel from Beira to Inhaminga delayed for about 5h and from Marromeu to Inhaminga for one day, because not enough clients appeared. As a result, also for short distances of 200 km, a whole day or more had to be planned for travelling.

As the train was more comfortable and safer than the mini buses (but still far from western standards), the train was the mean of choice from Marromeu to Inhaminga and from Inhaminga to Beira. However, the train only runs once a week from the respective destinations to Beira. Transportation forced us to stay one day longer in Marromeu[34], while we had to leave Inhaminga earlier.

From Beira to Búzi we were scheduled to go by boat, as it was meant to be the fastest transport. But at the harbour we were told the next boat would not leave in the morning but in the late afternoon. As alternative, a mini bus was taken.

Following from all this, transportation was one of the limiting factors, claiming way more time than expected and dictated the amount of time which could be spent in each town.

Interpreter

Instead of doing the field work with a local student, a privately financed interpreter was organised. As budget was small, no professional interpreter but a local English student was hired. Although his English was good, a lot of vocabulary was missing, especially technical terminology of water supply. This resulted in misunderstandings during the interviews[35]. Different translations were given for one Portuguese word, mainly for institutions and technical vocabulary, some information was not conveyed. In Inhaminga his commitment decreased noticeably by trying to prolong brakes, frowzy translations or taking a walk while waiting for an interlocutor. Additionally, this was the first time he was working as a interpreter and he was not used to this work. Back from Inhaminga in Beira to extend the visa, the interpreter was not willing to stay on to work in Búzi, except, under unacceptable conditions. Luckily, another interpreter was found through the accommodation in Beira. The teamwork turned better again and the assessment in Búzi could be done.

Cultural and social differences

The cultural difference between the interviewee and the interviewer, and between interviewer and the interpreter had a large influence on the amount and form of information collected. A cultural difference was expected, but the details were unpredictable, of course. For example the first interpreter had never worked with a white, respectively western, person before and he had to get used to white/ western behaviour first[36]. The same was valid for me. Being the only white/ western person for most of the time can be strange, too, sometimes. The second interpreter refused to ask certain questions, because it was impolite. Also barely any appointment was kept and a lot of time was spent just waiting. Sometimes the interlocutor never showed up or it was said he or she were out of town[37].

Also some interlocutors were apparently uncertain about the interviews. As integration and dependency are common and wide spread, people feared to say something wrong about a superior or a politician. The reason was that they were unsure about what will happen with the information they give.

[34]Although it was promised there will be a mini bus on Saturday morning to Inhaminga, there was no bus on this day and the train on Sunday had to be taken.

[35]For example he often mixed pump and pipe.

[36]Like not sharing one room with him to share the saved money with him. Also the question, if it is possible to eat vegetarian was a mystery for him, as a white person is assumed indubitably rich and would have no (monetary) reason to eat vegetarian.

[37]In Inhaminga and Búzi the accountants were said to be in Beira.

Presidential campaign tour

The President of Mozambique had a campaign tour in the Sofala province at the same time as the field work was done. The fewer human resources available in the towns were utilized already days or weeks before the arrival of the president. This had significant influence on the field work in Marromeu and Inhaminga. The above mentioned appointments that were not kept were often caused by this campaign tour. The technicians were bound in preparations and meetings. The field work in Búzi had to be rescheduled, because the appointment coincided with the presidential visit in Búzi. So, the field work in Búzi started two days later on a Thursday. As on weekends it is difficult to meet anybody, the field work had to be done in two days.

5 DISCUSSION OF THE RESULTS

Within the discussion, it is aspired to analyse the collected data to find the answers for the research questions , recapitulated below.

The two sub research questions are

- **How is the framework for small town water supply in Mozambique organised and which processes within this framework can guarantee successful small town water supply?**
- **Which management and organisational model is to be favoured for small town water supply in developing countries and especially in Mozambique?**

The main research question is

- **How can small town water supply be organised successfully, according to national water supply policy and according to the situation in small towns?**

5.1 Institutional Framework for Small Town Water Supply in Mozambique

To answer the first of the two sub research questions a discussion of the former and actual framework is necessary as well as an analysis of the literature research concerning institutional frameworks.

5.1.1 Discussion of the former Institutional Framework for Small Town Water Supply

In Chapter 2.1.2 the responsibilities and actions within the former framework were shown. Weaknesses and deviations were mentioned. These are shown in Figure 13. DAU, the entity responsible for urban water supply within DNA should invest in small towns' water supply. Also regulation should be their task. However, both is barely done. DNA provides service in 6 towns although this is not part of their tasks by law. DAS neglects its duty of planning and monitoring, as the local administrations (LA) invest only to a very moderate extent. On the other hand, asset management and service provision carried out by LA is not defined by law.

The main reasons for these issues are

- **the lack of incentives** to develop small town water supply for all responsible stakeholders (LA, DAS and DNA). This has its reason in the lack of respective legislation and the lack of financial resources to finance an incentive-based structure.
- **the lack of knowledge** about how water supply is organised and managed. Here a weak educational sector and the historical background are crucial.
- **the lack of capacity** within the entities. This lack refers back to financial reasons and also educational reasons.
- **the lack of resources, including human resources, financial resources and assets**
  - Human resources: Here issues can be found education and history.

- Assets: This lack also has a historical background as well as financial reasons.
- Financial resources: Here policy, economy as well as corruption and organisational deficits can be seen as reasons.

- **the lack of legal certainty and obligations,** as no legal basis exists or this basis is neglected or not executed.

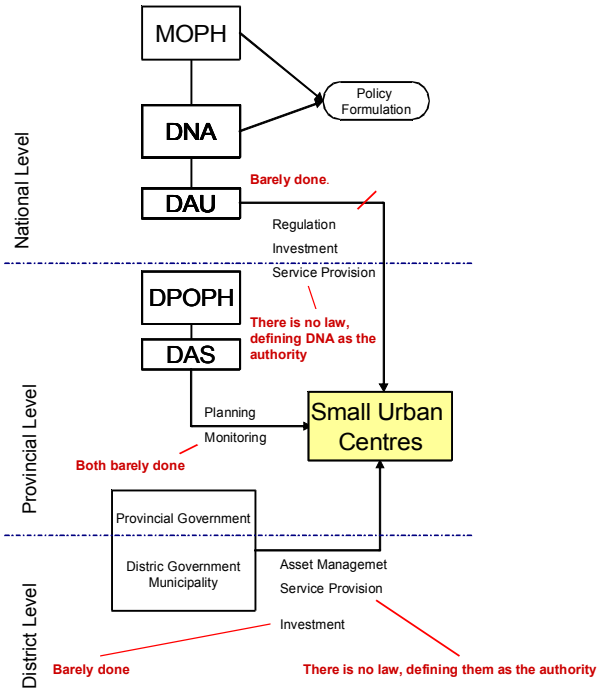

Figure 13: Deviations and weaknesses of the actual framework

A possible solution can be setting incentives for responsible stakeholders, so that they fulfil their duties. To increase knowledge, capacity and the availability of human resources, the educational sector has to be strengthened and business development services have to be established. To mitigate the issue of financial resources the little funds available have to be used more carefully and mismanagement as well as corruption within the water sector have to be contained. For legal clarity, responsibilities of all stakeholders must be clarified and scopes of action have to be defined in laws or ordinances.

A first approach to overcome these issues was the set-up of the new institutional framework for small town water supply, described below.

5.1.2 Discussion of the new Framework for Small Town Water Supply

The new institutions recently founded and their responsibilities were explained in chapter 2.1.2. But as the actual framework explained above, the new framework is not fully developed and many questions remained unanswered (Figure 14).

Yet, there is no law or decree defining the entities, their responsibilities and their linkages as they were only recently founded. Learning from the development in the past, it can be assumed this process will take time. Also if a law or ordinance is

passed, the question is, whether it can be executed as desired. It is uncertain, that the issues described under 5.1.1 will disappear within the new framework immediately, above all funding and staffing. However this framework is a step to solve issues with the old framework. Service provision shall by legally carried out be private operators and regulation shall be done by CRA and the municipalities. The local governments are unburdened within the new framework as it is not foreseen to involve them directly in the small town water supply. Asset ownership will be transferred to AIAS and its sub-entities. An unanswered question is the relationship between DPOPH and DAS and the new entities on provincial level (APAS, CPAS, SPAS). If they act directly under AIAS, it would be an act of recentralisation. As the national target is decentralisation it is assumed, that they will at least cooperate with DAS. Also organisation of regulation has to specified, as before DNA was the responsible entity, but execution was not done. Further, the tasks of APAS, CPAS and SPAS have to be defined clearly and it must be ensured functions do not overlap (as contracting is said to be the responsibility of SPAS and APAS at the moment).

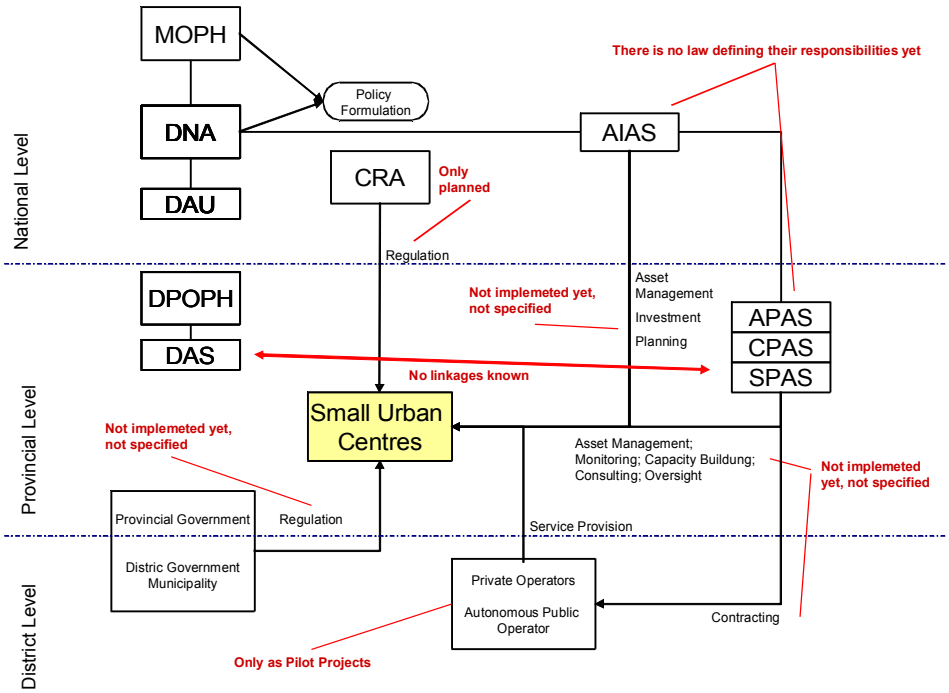

Figure 14: Deviations and weaknesses of the new framework

The table below shows changes within the institutions of the small town water supply framework.

Institution	Responsibility or carried out task within the old framework for small town water supply	Responsibility within the new framework for small town water supply
MOPH	Policy Formulation Acts through DNA	Policy Formulation Acts through DNA
DNA	Regulation; Investment; Service Provision	Acts through AIAS
AIAS	non-existent	Asset Management; Investment; Planning
CRA	-	Regulation
DPOPH	Acts through DAS	not specified
DAS	Planning Monitoring	not specified
APAS; CPAS; SPAS	non-existent	Asset Management; Monitoring; Capacity Building, Oversight, Supervision
LA	Asset Management; Service Provision; Investment	Indirect Regulation
Private Operator	not existent	Service Provision

Table 15: Changes within the institutions of the small town water supply framework

Final results of the pilot projects have to be awaited too, as these results will have a significant influence on further development of and within the new institutions.

5.1.3 An Institutional Framework to guarantee successful small town water supply

An successful institutional framework should fulfil the following frame conditions:

According to the literature research, following agencies should exist:	• Asset Owner • Regulator on local and central level, strictly separated from operation • Oversight Body • Monitoring Body • Independent Operator • Business Development Services (BDS) • Governance Body • Policy Maker
To guarantee a successful framework it has to be ensured that	• all responsibilities have to be clarified • asset owner, regulator, operator and governance body have to be separated • the revenue generated by small town water supply is ring-fenced • the consumers has to be involved, not only informed (with mass media)

Table 16: Frame conditions for a successful institutional framework

Taking the conditions from Table 16 and comparing them with the actual institutional framework (see Chapter 5.1.2), it becomes clear that the policy makers are on the right path. Most agencies recommended exist and regulation is separated from operation. But shortcomings still exist and have to be overcome to guarantee a successful working framework. It is not secured if SPAS and CPAS are meant to fulfil the role of BDS. Further it is not defined which agency will be responsible for

monitoring. The regulator could take this role. Responsibilities of all agencies are not settled yet. This is the main issue which has to be overcome to prevent overlapping duties or absence of certain responsibilities. Ring-fenced revenue is ensured by including the independent operator. It does not say to which extent the institutional framework foresees including the consumers. However, this is essential, especially for small town water supply. Figure 15 shows the actual responsibilities within the institutional framework for small town water supply in Mozambique compared with the agencies and their roles recommended in the literature.

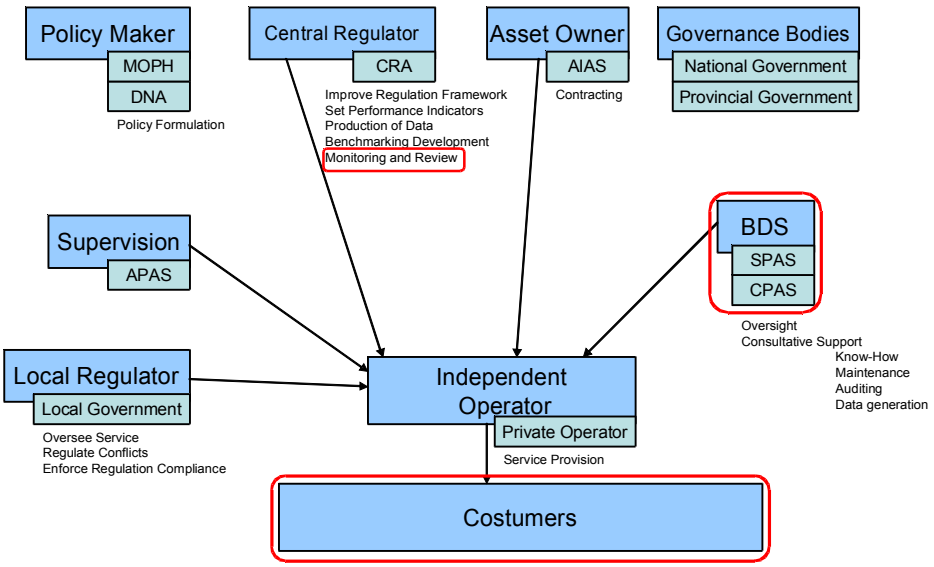

Figure 15: Combination of the Mozambique small town water supply framework and the recommendations from the literature

5.2 Management Model for Small Town Water Supply

The field study showed that local administration is overstrained with its duties. Financing depends on central governments, responsibility to supply the inhabitants with quality drinking water is not noticed, investment in deficient infrastructure is barely done and staff lacks capacity and know how. In the literature research and the expert interviews similar issues were described. Operation is not on a commercial basis, revenue is not ring-fenced and management works by crisis reaction. Service providers have to be autonomous to fulfil their duties. The literature research shows a clear trend towards PPP within small town water supply. 25% of the small piped systems are under PPP in the reviewed countries of Chapter 2.3.3, with a tendency to rise.

This shows the urgent need to change the actual organisational model of the small town water supply. Therefore the policy makers in Mozambique envisage to establish private operators for small town water supply. Private operators are set as operator in the new institutional framework. The first pilots run in Mozambique with PPP show a positive impact on the service situation (Chapter2.1.2.6).

Consequently, the PPP management model will serve as a basis for answering the main research question.

5.3 Organisation of Small Town Water Supply in Mozambique

In this chapter the main research question will be answered:

> **How can small town water supply be organised successfully, according to national water supply policy and according to the situation in small towns?**

5.3.1 National Water Supply Policy

As described above, the national policy in Mozambique is to how the private sector carry out small town water supply. Consequently the current way of organisation within the small towns water supply observed in the field study (Chapter 3.6) will disappear. The framework in which the private company will operate small town water supply is described under 2.1.2 and discussed in chapter 5.1.

5.3.2 Situation in Small Towns

It has to be considered, that every town has different preconditions and different development chances and possibilities. It is not the purpose and in addition not expedient to develop a single master plan for small town water supply. More reasonable is a frame on which small town water supply is built up and organised. (WaterAID/BPD 2010).

In small town water supply it has to be considered that the following points are taken into account:

- National policy, laws and frameworks (see above)
- Operation has to be affordable and cost effective
- The network has to be expandable to react to demand increase, for example through migration
- Supply has to be responsive to demand
- Local conditions, culture and capacity has to be considered

The water supply systems are old, run down and too small to supply the population, as seen in the field study. Huge investments are necessary to establish the small piped systems as the main source for drinking water.

5.3.3 Organisation and Management for successful Small Town Water Supply

Key Factors for successful Water Supply

Considering the key factor brought up by (Pilgrim et al. 2007) in chapter 2.2.5.3 and adapting them for PPP shall help to establish a proper water supply organisation. Autonomy of the service provider is given by the PPP model. Transparency and accountability can be achieved by the framework, described above. Demand responsiveness has to be established in the contract between contractor and operator. Feasibility studies before infrastructure is built or extended, training in generating sound business plans will help to establish cost effective design and operation. The ability to expand has to be estimated with demand assessments and spatial assessments. Professional capacity can be reached with educational trainings in management, operation, maintenance and economy. The field study showed clearly the ignorance of operators towards importance of data. Thereby it is

important to increase a sense of responsibility and to increase the awareness of how important data collection, evaluation and maintenance is.

Stakeholder Involvement

All stakeholders have to be involved during preparation, design, tariff calculation, demand calculation and service development. This is important to assess customers' needs and what they can afford. Heterogeneous customer base is and needs of very different social classes have to be met. When construction is finished and service is provided it is important to communicate with customers. Service counters have to be established. Information (via mass media) shall not be mistaken with communication, like it happened in the pilot in Mozambique. Well developed participation structures are necessary to ensure demand-responsive supply.

Financing Investment and Operation

To overcome the challenge of an over designed and expensive supply system detailed assessments as described above are reasonable. Also, a combination of grant and loan could be possible. The grant ensures investment is even done, the loan forces operators to market discipline.

Priority within the PPP model has to be an affordable service with a reasonable revenue generation for the operator. To guarantee a sound water supply under a private operator preconditions have to be fulfilled. Before tender, a comprehensive assessment of the actual situation in the small town and its water supply has to be done. Among others this includes the actual state of the supply system, number of customers and potential customers, their needs and income structure. Pre-feasibility studies have to be carried out to assess demand. Draft business plans have to be developed and the technical condition of the local SPS has to be detected (Hoang Gia & Fugelsnes 2010).

The financial challenges described in 2.2.5.4 could be met by including national banks in the funding and loaning process. The risks of investments could be split between the government of Mozambique and an investor, as proposed by Juizo 2011. As wealthy customers consume more water (in large towns 25% of the customers are responsible for 75% of the revenue) it is inevitable to issue compulsory connection to water services. Of course this is delicate, as these people have their own private water supply and are often people with political, social and economical influence. On the other hand these who supply themselves from natural and often unsecured sources need access to the water supply system, too. Selling to neighbours and shared connections could be a solution to increase coverage. In case of selling, regulation is necessary.

Contracting of the Operator

Contracting is mainly done with lease contracts. In case of large infrastructure investments built-operate-transfer or rehabilitated-operate transfer contracts are possible. This could not only be done by national entities but also as a capacity building measure by an international company or agency (see below). As contract duration below 5 years proved to be too short to be profitable, a duration of at least 10 years is recommended. If the operator takes out a loan for investments it has to be ascertained the period does not exceed contract duration.

Contracts have to include targets, like supply coverage, and incentives to reach these targets. They have to clarify the responsibilities of contractor and operator in

case of investment and rehabilitation. Specific but simple model contracts could be a solution (WSP 2010).

Bundling of small supply systems can be useful to overcome the lack of skilled personnel and to reach an economy of scale. But it has to be ensured that the resources are equitably spread among the small towns.

Capacity and Knowledge

Operators need comprehensive knowledge in billing, documentation, use and filing of operational data, water treatment, loss reduction, customer service, improve partnership with public sector and in preparation of business plans. Before they start operation they need extensive training in these areas. This could be done with the help of business development services, which could also assist the operators after signing the contract (Lazarte & Macário 2010). BDS could be built up as an umbrella organisation to provide know-how and help in accounting, business planning but also in cases of repair, operation and maintenance. They could be run by a big external entity for the first years to building up capacity (as the Vitens approach).

Contracted Operators

Generally the operation of the small town water supply have to be done on a tendering procedure basis. However, number and capacity of professionals is low in Mozambique and alternative approaches could be necessary. A solution could be that an international water supply entity (Private or Public) opens a local branch in a district or small town. Staffing could closely follow the Vitens approach (see Box 2). A local director and young graduates are supported by international consultants gaining experience and know how. After the contract ends, the international entity could retreat, leaving the local staff as a new own entity, running the system on their own. Seed funding and investments could be financed by donors.

5.4 Summary and Conclusion

Small towns are important for national development and there is growing consensus that better service in small towns is necessary. This is also valid for water supply. However, small towns grow unplanned and there is a lack of professionals. Solutions tailor-made for each town are needed as characteristics differ strongly from town to town.

According to the situation described, the research question arised: How can small town water supply be organised successfully, according to national water supply policy and according to the situation in small towns?

To answer the research questions, three methods of research are utilised: literature research, expert interviews and a field study, done in three small towns in the province of Sofala, Mozambique.

The literature research highlighted the crucial situation of small town water supply. In Mozambique this crucial situation led to a change in small town water supply policy:

- The DMF (Delegated Management Framework) was extended to small town water supply

- A new agency, AIAS, was founded to act as the national asset holding agency for water supply assets in small towns (Similar to FIPAG, the water supply asset holder for large towns)
- Operation shall be handed over to private operators. These will be contracted, monitored and supported by further agencies (APAS, CPAS, SPAS) on provincial level

Pilot studies show the need of a strong framework with clear responsibilities within the agencies.

Among numerous management models, the Delegated Management Model (DM) is preferred for small towns. A form of DM is Private-Public-Partnership (PPP). PPP separates asset ownership, regulation and operation. This approach proved to be successful in many countries and was chosen as the future model to organise and manage small town water supply in Mozambique.

The field work showed constraints with respect to organisation, technical equipment and staff knowledge. A framework with clear responsibilities, incentives, and penalties is necessary, as well as institutions which are responsible for monitoring whether laws are followed.

Knowledge constraints are crucial, like lack of basic technological knowledge and knowledge in problem solving techniques and management skills. Knowledge constraints in small towns are a consequence of a lack of education and experience. Possibilities to gain proper education have to be extended and small towns have to be made attractive for young urban professionals. This shows the dilemma in which small towns are caught. They need qualified personnel to develop themselves. But these professionals in turn demand a certain standard of living and prefer to stay in urban centres.

During the field work a lot of information could not be obtained. As long as no information and data are collected, smooth progress is not possible. Security of supply is not guaranteed. Furthermore, it is unlikely to receive investment loans or grants for investments without operational data.

The experts interviewed described the issues with small piped systems (SPS) and confirmed the literature research and what was documented and seen in the small towns while doing the field study.

In the discussion, the research questions were highlighted. The new institutional framework for small town water supply in Mozambique was analysed and compared with the former framework. The new framework is a big step towards autonomous water supply and complies with most requirements proposed in the literature. Shortcomings are a lack of monitoring, clear definition of responsibilities and no clear statement about how customers should be involved.

For a successful small town water supply, the different circumstances and development chances and possibilities of each town have to be considered. The water supply systems are old, run-down and too small to supply the population, evidenced by the field study. Huge investments are necessary to establish the small piped systems as the main source for drinking water.

As it was explained in the introduction, urbanisation in developing countries cannot be stopped. To reduce pressure on urban slums it is urgent to strengthen small towns. A fully operative water supply system and organisation is part of this strengthening process. In this context, the thesis showed the precarious situation of

small town water supply in Mozambique. Lack of knowledge, organisation, responsibilities, technique and financing are common issues. This shows the urgency of needing to act. With the reform of the institutional framework for small town water supply, a first step has been made.

The results can be taken as further evidence of how important fully operative organisational structures and extensive training of staff are for orderly operation of the facilities.

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7 ANNEX

Content Annex

7.1 Expert Questionnaire

1. Personnel Information:

a) Name:
b) Position:
c) Institution:
d) Date of Interview:
e) e-mail address:

2. Problems and special tasks in small piped system (SPS)

a) What is your definition of a SPS?
b) What is the actual situation within SPS?
c) What is the Relevance of SPS in the Water Sector Strategy?
d) How many SPS are existing in Mozambique?
e) Are plans existing to extend the number of SPS?
f) How are SPS are operated? private, by municipality or other?
g) How are SPS are financed? With governmental funds, by donors or self-financed
h) Who are the customers? Medical Station, Private Community,...
i) What kind of systems are in place? How is the water collected, treated, stored and distributed?
j) Which development needs would you specify for SPS?
    i. Technical Investment needs
    ii. Organisational needs
    iii. Economical needs: Who is taking care or who could taking care for coverage of the costs?

7.2 Stakeholder Questionnaire

1. Personnel Information:

a) Name:
b) Position:
c) Institution:
d) Date of Interview:
e) e-mail address:

Organisation assessment

2. General description of municipalities

a) How many habitants
b) How many villages
c) How many enterprises and commercials

3. Which area is supplied by small piped systems (SPS)

4. Existing Organisation

a) Number of employees
b) Structure of Staff (Organigram: Directors, Engineers, Technicians, Workers)
c) How is the organisation of the water supply incorporated in the local administrative? Is there an own directorate of water services, or is it within an other directorate (like Infrastructure)
d) Which positions and functions are present in the organisation structure of water supply (Director, Vice Director, Engineer,...)?
e) What are the job profiles of each? What are their tasks and responsibilities, in general and on the day by day business?
f) Which person of the Municipal Administration gives instructions to the director of water supply?
g) How is communication organized? Is there an reporting chain?

Technical and Operation Assessment

1. System specification assessment

I. Water abstraction

a) Where are the wells? (*locate them on the map)*
b) Where is the water is coming from (groundwater, river, rainwater,...)?
c) What is the groundwater level?
d) What kind of wells do you have?
e) What kind of pumps do you have? Technical Specification; type, maximal head, maximal capacity, fabricate, age
f) How many wells are in operation/ not in operation? (*locate them on the map)*
g) How many wells are functional/ dis-functional? (*locate them on the map)*
h) What are the reasons for defects?
i) Is enough water produced?

II. Transmission pipes (between water abstraction and storage)

a) Out of which Material are they constructed?
b) How old are they?
c) What diameter have they?
d) How long are they (accumulated)? (*locate them on the map)*
e) What is the average flow?
f) What is the maximum flow capacity?
g) How many pipes are in operation/ not in operation (in km)? (*locate them on the map)*
h) How many pipes are functional/ dis-functional (in km)? (*locate them on the map)*
i) What are the reasons for defects?

III. Transmission storage

a) Out of which Material are they constructed?
b) How old are they?
c) How much can be stored (m^3)?
d) How many storage tanks are in operation/ not in operation? (*locate them on the map)*
e) How many storage tanks are functional/ dis-functional? (*locate them on the map)*
f) What are the reasons for defects?

IV. Distribution Network

a) Out of which Material are they constructed?
b) How old are they?
c) What diameter have they?
d) How long are they (accumulated)?
e) What is the discharge?
f) How many pipes are in operation/ not in operation? (*locate them on the map)*
g) How many pipes are functional/ dis-functional? (*locate them on the map)*
h) What are the reasons for defects?
i) How many public taps are existing? (*locate them on the map)*
j) How many public taps are in operation/ not in operation? (*locate them on the map)?*
k) How many public taps are functional/ dis-functional? (*locate them on the map)*
l) What are the reasons for defects?
m) How many valves are existing? (*locate them on the map)*
n) How many valves are in operation/ not in operation? (*locate them on the map)*
o) How many valves are functional/ dis-functional? (*locate them on the map)*
p) What are the reasons for defects?

V. House connections

a) How many house connections are existing? (*locate them on the map)*
b) What kind of house connections are existing?
c) Are these connections formal/ informal?
d) How old are the house connections

2. Description of technical operations of the facilities

a) Is the system working continuous or intermittent

If it is intermittent:

b) What are the intervals of pumping at the well?
c) What are the intervals of opening the valves to the distribution network?
d) What are the intervals the storages becomes filled?
e) Is there a sequence operation of supply pipes?
f) In which sequences the individual supply areas are supplied
g) What is the operation of sequence of the day by day management
h) Which parts of the system are well supplied, which are not well supplied?
i) Are there areas which are not supplied?
j) Are there public taps which are not supplied?
k) Why are these public taps not supplied?
l) Is there an evidence documentation of operations?
m) If no, why? If yes, how is this done?

3. Problems in the technical operation

a) Are there non functional facilities or components?
b) Has the system or have parts of the system insufficient dimensions (to big, to small; Pipes, Pumps, Storage,..)?
c) Is there enough electricity to run the system satisfying?

Economical assessment

1. What are the costs of the operation of the system

a) Personal costs
b) Electricity costs
c) Chemical costs (for disinfection)
d) Repairing costs
e) Financial costs for Investment
f) Other costs

2. What sources of income are existing

a) External income (government, donors)?
b) How are revenues charged?
c) Is there a tariff system?
d) How are tariffs calculated?
e) Who is charging the tariffs?
f) How are tariffs charged?
g) How much income is generated
h) How much income could be generated theoretically?
i) If collection rate is low: What are the problems of the collection system
j) Are there any financial retentions for repairs?

7.3 Summary of Collected Data

	Unit	Búzi	Inhaminga	Marromeu
Habitants	No.	14,000	10,000	40,000
Administration		District of Búzi	District of Cheringoma	Municipality of Marromeu
Districts (Bairros)	No.	5	13	7
Water supply				
Institution responsible for water supply		District Office of Planning and Infrastructure, SDPI	District Office of Planning and Infrastructure, SDPI	Directorate of Urbanisation, Water and Sanitation
Public Taps	**No.**	**13**	**5**	**11**
in operation	No.	9	0	11
not in operation (broken)	No.	4	5 (3)	0
Service Connections	**No.**	**100**	**67**	**202**
in operation	No.	100	0	202
not in operation (broken)	No.	0	67	0
Public Hand Pumps	No.	n.s.	n.s.	74
Other (Private wells, or boreholes)	No.	n.s.	Amai Apa Banda, Catholic Church National Railway Company small selve suppliers	private self suppliers, Sena Sugar Company
People supplied via				
Public Taps				
With 250 persons per public tap	**No.**	**2,250**	**1,250**	**2,750**
Coverage with Public Taps	%	16	13	7
Total amount with 30l/person/d	m³	68	38	83
With 150 persons per public tap	**No.**	**1,350**	**750**	**1,650**
Coverage with Public Taps	%	10	8	4
Total amount with 30l/person/d	m³	41	23	50
Inhabitants per Public Tap	No./Tap	1,556	2,000	3,636
Taps per Inhabitant	No./1.000Inh.	0.6	0.5	0.3
Service Connections				
With 10 persons per connection	**No.**	**1,000**	**670**	**2,020**
Coverage of Service Connections	%	7	7	5
Total amount with 30l/person/d	m³	30	20	61
With 5 persons per connection	**No.**	**500**	**335**	**1,010**
Coverage of Service Connections	%	4	3	3
Total amount with 30l/person/d	m³	15	10	30
Inhabitants per Service Connection	No./Tap	140	149	198
Connections per Inhabitant	No./1.000Inh.	7	7	5
Range Population supplied with SPN		**1850 – 3250**	**1085 – 1920**	**2670 – 4770**
		23	**19**	**12**
		13	**11**	**7**
Range Coverage with SPN	**%**	**13 – 23**	**11 – 19**	**7 – 12**
Range total amount with 20l/person/d	**m³**	**56 – 98**	**33 – 58**	**80 – 143**
		98	**58**	**143**
		56	**33**	**80**
Amount generated (estimate by technician)	**m³**	**50**	**60**	
Public Hand Pumps	No.	n.s.	n.s.	18,500 (roughly estimated with 250 persons per public tap)
Coverage with public hand pumps	%	-	-	46
Other	No.	n.s.	n.s.	n.s.

Small Piped Network				
Sources	No.	1	4 in Dimba 4 in Inhaminga	2
in operation	No.	1	0	1
not in operation (broken)	No.	0	8 (8) 7 boreholes 1 natural spring (Dimba)	1 (1)
sort	-	open well	groundwater	both open well
origin of water	-	groundwater	groundwater	groundwater
volume	m³	65	-	n.s.
Groundwater level	m	high (close river)	20 - 30 m in Dimba 60 - 70 m in Inhaminga	high (close river)
abstraction capacity	m³/a	n.s.	n.s.	n.s.
Water abstracted	m³/a	n.s.	n.s.	n.s.
Pumps	No.	2	0	3
in operation	No.	2	0	1
sort	-	n.s.	-	lift pump
not in operation (broken)	No.	0	0	2 (1)
sort			-	lift pump (submerged pump)
Transmission Network				
length	m	500	7,500	70
material	-	PVC	PVC	fibre cement
diameter	Inch	4	3.5 from borehole to storage 7.8 from storage to storage	6
Age	a	2004	2007	unknown ("old")
Storage				
Cistern	No.	1	2	0
in operation	No.	1	0	-
not in operation (broken)	No.	0	2	-
Capacity	m³	100	80 in Dimba 100 in Inhaminga	-
able to fill completely	yes/no	no	n.s.	-
Material	-	concrete	concrete	-
Age	a	unknown ("old")	unknown ("old")	-
Cleaning Interval	per month	n.s.	1	-
Tank	No.	1	2	1
in operation (i.o.)	No.	0	0	1
not in operation (broken)	No.	1	2	0
Capacity	m³	100	each 60	50
able to fill completely	yes/no	n.s.	n.s.	no
Material	-	concrete	concrete	concrete
Hight	m			
Age	a	unknown ("old")	unknown ("old")	unknown ("old")
Cleaning Interval	per month	n.s.	1	2 times
Total storage capacity	m³	200	300	50
in operation	m³	100	200	50
not in operation (broken)	m³	100 (0)	100 (0)	0
Capacity (i.o.) per Inh.	l/person	7.1	20.0	1.3
Capacity (i.o.) per supplied Inh.	l/person	31 – 54	104 – 184	10 – 19
	low est	54	184	19
	high est	31	104	10

Distribution Network				
length	m	4,000	3,000 – 4,000	2,500
material	-	PVC	PVC	
diameter	Inch	4	1.6	3
Age	a	2004	2003	
Service Connections	No.	100	67	202
Private and Commercial	No.	n.s.	53	n.s.
Public Institutions	No.	n.s.	14	n.s.
In-house Connections	No.	n.s.	n.s.	n.s.
Yard Connections	No.	n.s.	n.s.	n.s.
length	m	n.s.	n.s.	n.s.
material	-	PVC		PVC
diameter	Inch	¾	n.s.	n.s.
Age	a	2004	2,003	varies (50 are over 10 years old)
Metering	yes/no	no	no	no
Density	No./km	25	17 – 22	81
Public Taps	No.	9	5	11
distance to household	m	n.s.	n.s.	n.s.
Valves	No.	n.s.	8	7
Meters				
System Meters	No.	1	1	0
Customer flow meters	No.	100	0	0
Customer meter reading intervall	per a	0	-	-
Treatment	yes/no	yes	yes	yes (irregular)
sort		automatic chlorination	automatic chlorination	manual chlorination
Quality Tests	yes/no	no	n.s.	turbidity (irregular)
Abstraction				
Automatic or Manual Start	-	n.s.	Automatic	Manual
Continuous	yes/no	no	no	no
Intermittent	yes/no	yes	yes	yes
hours	o'clock	19 – 5 11 – 16	2 – 4	2 -8 (9 in summer) 11 -15 (17 in summer)
pressure	bar	low	n.s.	low
abstraction capacity	m³/a	n.s.	n.s.	n.s.
Water abstracted	m³/a	n.s.	0	n.s.
Distribution				
Continuous	yes/no	no	no	no
Intermittent	yes/no	yes	yes	yes
hours	o'clock	5 – 12 16 – 19	7 – 9 17 – 18	6 – 10 15 – 18
Sequence Operation	yes/no	no	no	no
hours	o'clock	-	-	-
consumption per person	l/person d	n.s.	n.s.	n.s.
consumption per service con.	l/person d	n.s.	n.s.	n.s.
consumption per public tap	l/person d	n.s.	n.s.	n.s.
pressure	bar	n.s.	n.s.	n.s.

other				
SPN is electrified since	a	1998	2010	n.s.
Map of the SPN available	yes/no	no	no	yes
Active Mapping of the SPN	yes/no	no	no	yes
Active leakage detection	yes/no	no	no	no
Informal house connections	yes/no	no	no	no (since last year)
Detailed Failure documentation				
Electrical failer documentation	yes/no	no	no	no
Pump failure documentation	yes/no	no	no	no
Water interruption documentation	yes/no	no	no	no
Documentation of operation	yes/no	no	no	no
Service Complain Record	yes/no	no	no	no
Staff involved in water supply				
Administrator	No.(full time)	1 (0)	1 (0)	0
Counsellor	No.(full time)	0	0	1 (0)
SDPI Director	No.(full time)	1 (0)	1 (0)	0
Technician	No.(full time)	1 (1)	0, fully manned 1	1 (0)
Plumber	No.(full time)	1 (1)	0, fully manned 1	1 (1)
Mechanic	No.(full time)	1 (0)	0	1 (0)
Operator	No.(full time)	2 (2)	2 (2)	1 (1)
Total Staff	No.(full time)	7 (4)	4 (2), fully manned 6 (4)	5 (2)
Management and Planning Staff	No.(full time)	3 (1)	2 (0), fully manned 3 (1)	3 (0)
Operation & Maintenance Staff	No.(full time)	4 (3)	2 (2), fully manned 3 (3)	3 (2)
Full Time Employees per Connection	No./10 conn.	0.40	0.3, fully manned 0.45	0.01
university staff	No.(full time)			
skilled staff	No.(full time)			
staff with other qualification	No.(full time)			

Economics				
Public budget for Water Supply	MZN/year	n.s.	None, but annual finance plan	None, but annual finance plan
Tariff System				
Public Taps	MZN/Person	at least 1, flat rate	1 MZN / 20 l	at least 5, flat rate (per family)
Service Connections				
	MZN/m³	flat rate	flat rate	flat rate
Private and Commercial	MZN	50	-	75
Public Institutions	MZN	100 hospital 150	-	75
Fee for a new house connection	MZN	n.s.	n.s.	750, non recurring
Public Hand Pumps	MZN	n.s.	n.s.	n.s.
Other	MZN	n.s.	n.s.	n.s.
Revenue Income Service Connections	MZN/month	5,800 own estimation with 85 private, 14 public and one hospital connection	5,025 own estimation with MZN 75 per connection and	16,500 only service connections
Theoretical tariff system				
(1 MZN per 20l or 50 MZN per m³)		146,250	86,400	214,650
250 persons per public tap	MZN/month	101,250	56,250	123,750
10 persons per service connection		45,000	30,150	90,900
		83,250	48,825	119,700
150 persons per public tap	MZN/month	60,750	33,750	74,250
5 persons per service connection		22,500	15,075	45,450
Usage of revenue				
Public Taps		20% committee 80% local administration	n.s.	100 % committee
Service Connections		100 % local administration	n.s.	100 % local administration
Public Hand Pumps		n.s.	n.s.	n.s.
Monthly Salary				
Administrator	MZN/month	n.s.	n.s.	-
Counsellor	MZN/month	-	-	n.s.
SDPI Director	MZN/month	n.s.	n.s.	-
Technician	MZN/month	7,540	7,540 (not manned)	7,540
Plumber	MZN/month	2,379	2.700 (not manned)	2,495
Mechanic	MZN/month	on fee basis	-	2,495
Operator	MZN/month	2379 (2x)	2600 (2x)	2,495
Well Cleaner	MZN/month	n.s.	-	800
Sum	MZN/month	14,677	15.440 if fully manned	15,825
Operation & Maintentance 2010	MZN/year	2 Million		33,561
Rehabilitation 2010	MZN/year	see O&M	1.4 Million	2.5 Million
Electrictricity 2010	MZN/year	n.s.	n.s.	54000 (for all public institutions)
Chemicals 2010	MZN	n.s.	n.s.	n.s.
Other 2010	MZN	n.s.	n.s.	12000 for spare parts 4.500 for a new pump
Annual Costs for Water Supply 2010	MZN	n.s.	n.s.	n.s.

n.s.: not specified

7.4 Maps of the small piped systems (SPS) of the visited towns

7.4.1 SPS of Búzi

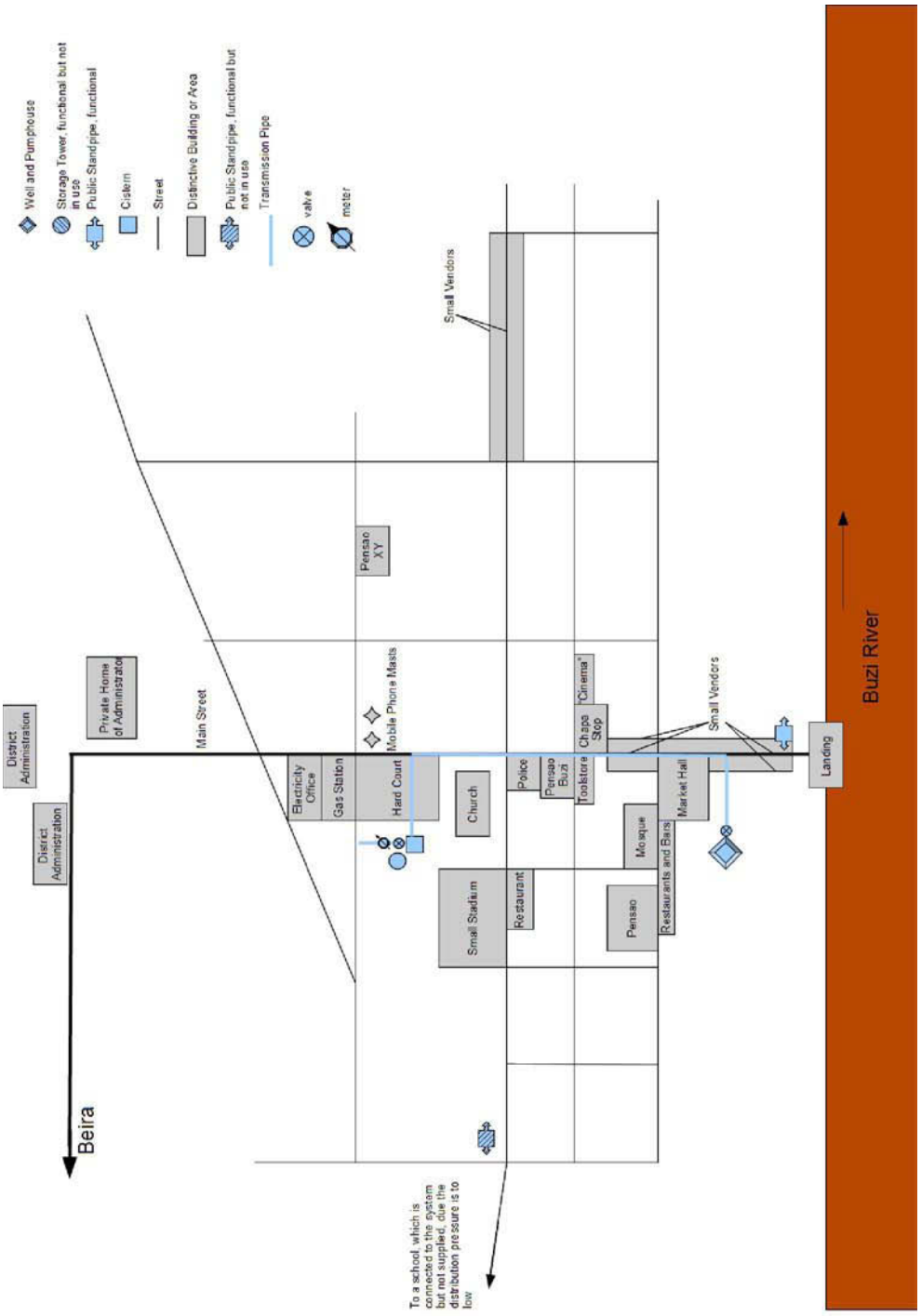

Figure 16: Schematic Map of Búzi with relevant water infrastructure

7.4.2 SPS of Marromeu

7.4.3

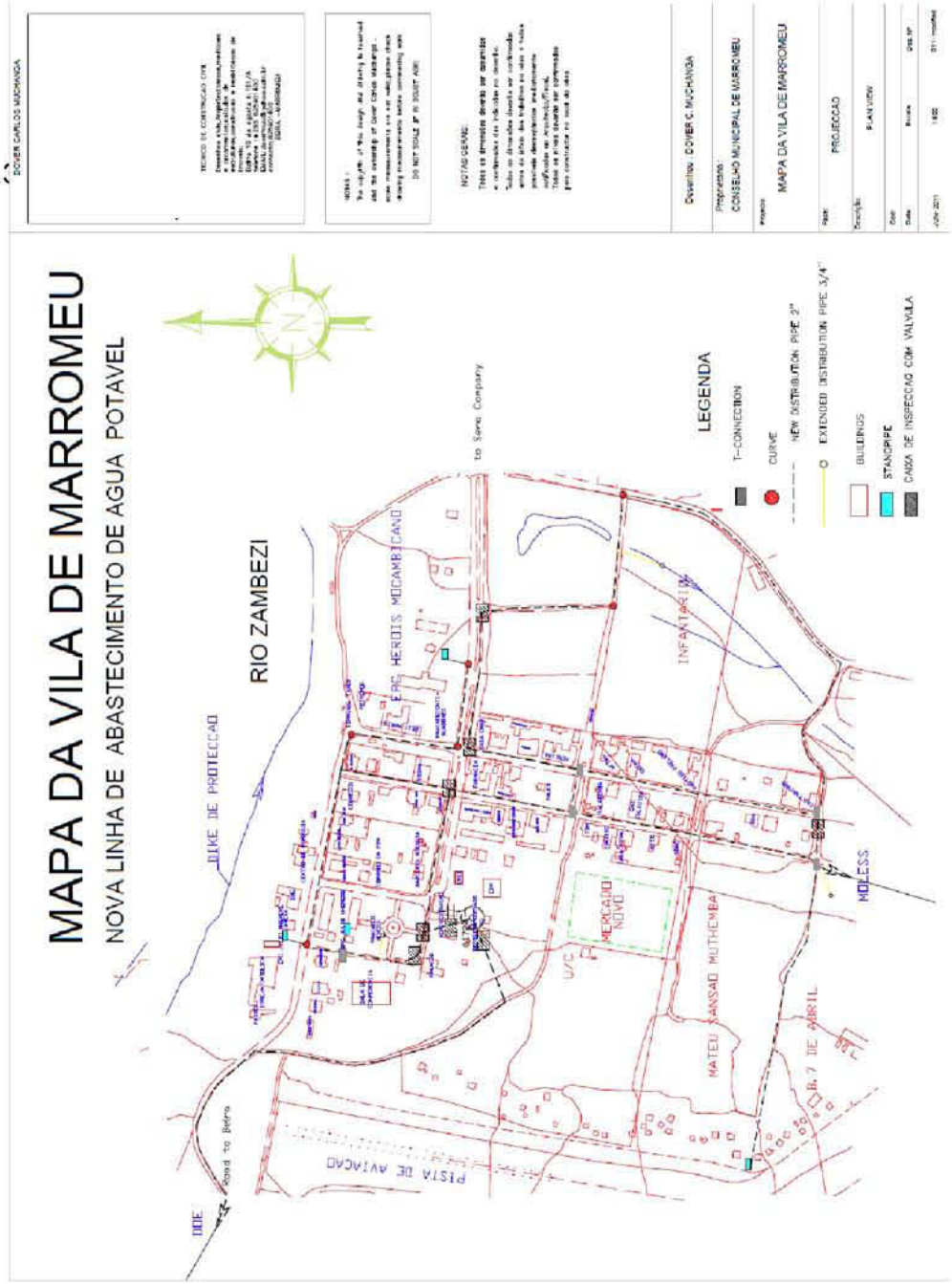

Figure 17: Schematic Map of Marromeu with relevant water infrastructure

7.4.4 SPS of Inhaminga

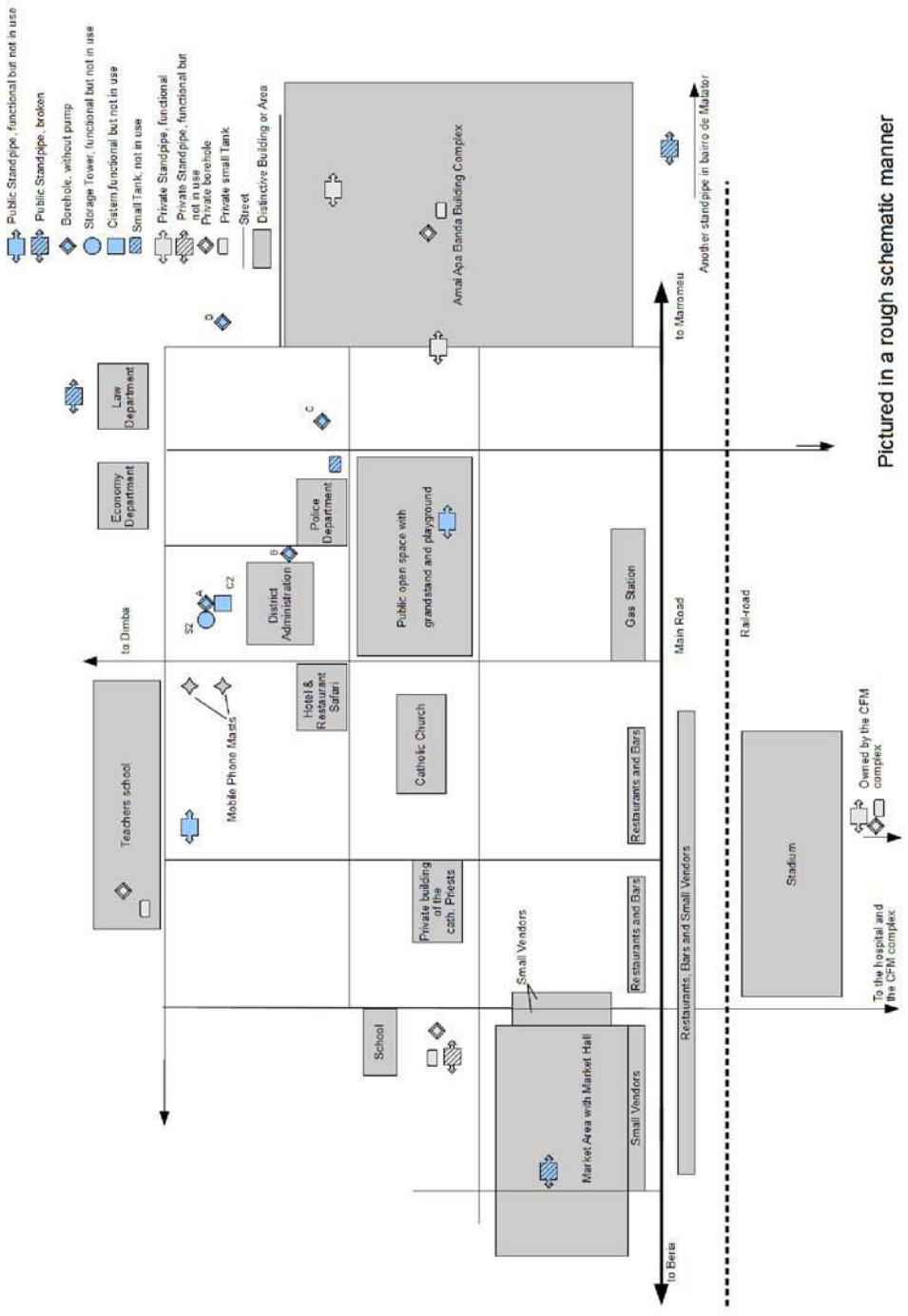

Figure 18: Schematic Map of Inhaminga with relevant water infrastructure

8 CURRICULUM VITAE

1. **Name:** **STRAHL Marc Sebastian**
2. **Date of Birth:** **21.04.1984**
3. **Nationality:** **Germany, South Africa**
4. **Family Status:** **Married, one child**
5. **Contact:** **strahl.marc@gmail.com**
6. **Education:**

Institution **[Date from – Date to]**	**Degree(s) or Diploma(s) obtained:**
University of Life & Sciences, Vienna, [2009/04 - 2012/04]	**M.Sc. (Dipl.-Ing.):** Water Management and Environmental Engineering
University of Stuttgart and University of Life & Sciences, Vienna [2003/10 - 2009/04]	**Individual Bachelor (BA):** Water Management and Environmental Engineering
Gymnasium Aulendorf, Germany [2000 - 2003]	Diploma qualifying for university
Pro Gymnasium Bad Schussenried, Germany [1994 - 2000]	General Certificate of Secondary Education

7. **Employment Record:**

Company **[Date from – Date to]**	**Occupation or position held**
GWCC General Water Consult Corp, Vienna [2010/09 - ongoing]	Junior Consultant / Assistant
MA 48, Vienna [2007/04 - 2008/12]	Advisor for Waste Water
Denkstatt Umweltberatung und Management, Vienna [2006/04 - 2006/08]	Intern
Daimler Chrysler, Esslingen [2004/11 - 2004/12]	Assembler