Optimizing sewage management in urban settlements in sub-Saharan Africa:

A contribution to urban development planning

Thesis

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Acknowledgement / Preface

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A personal thank goes to my **parents** who enabled me to study and to my **friends** who supported me in manifold ways.

“At the turn of the second millennium the balance of the world’s population shifted from being rural to being urban, with the majority of the world’s urban populations living in the so-called developing countries of Africa, Asia, and Latin America. By 2005, for every one urbanite living in a developed country, two will reside in developing countries (...) As urban populations have grown and the consumption and production of goods has become increasingly concentrated in or driven by urban industrial centers, we have become more aware of the role of cities as engines for transforming the environment and as places of great vulnerability to environmental risk“ (Pelling, Mark (2003): Toward a political ecology of urban environmental risk. The case of Guyana, in: Zimmerer, Karl S./Bassett, Thomas J. (Publisher): Political Ecology. An integrative Approach to Geography and Environment-Development Studies, New York, London, p.73).

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BMZ	Federal Ministry for Economic Cooperation and Development of Germany (Bundesministerium für Wirtschaftliche Zusammenarbeit und Entwicklung)
BORDA	Bremen Overseas Research and Development Association
DED	German Development Service (Deutscher Entwicklungsdienst)
GIS	Geographical Information System
GPA	Coordination Office for the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities (at UNEP)
GTZ	German Technical Cooperation (Deutsche Gesellschaft für Technische Zusammenarbeit)
IRC	International Water and Sanitation Centre
IWA	International Water Association
KfW	Credit Institution for Reconstruction Germany (Kreditanstalt für Wiederaufbau)
MDG	Millennium Development Goal
Netwas	Network for Water and Sanitation
ODA	Overseas Development Assistance
Sanicon	Sanitation Connection
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UN-Habitat	United Nations Human Settlements Programme
UNICEF	United Nations International Children's Education Fund
WBG	World Bank Group
WEDC	Water Engineering Development Centre
WHO	World Health Organisation
WSP	Water and Sanitation Programme
WRI	World Resource Institute
WUP	Water Utility Partnership
w.y.	without year

Abstract

Urban sewage management is a complex issue, particularly in sub-Saharan Africa where urbanisation rates are among the highest in the world and innovative solutions are required. Although the focus in urban infrastructure development is laid mostly on water supply, appropriate hygienic and affordable sewage management is at least as important to maintain public health and ecological sustainability. Beyond that, insufficient sanitation services affect social status, school attendance and working performance. International organisations, especially the United Nations, the World Health Organisation, the World Bank etc. address sewage-related challenges in various programmes and plans, but setting standards at an international level is a difficult task due to regional features, a limited basis of reliable data and the definition of 'adequate' service levels. In this essay the author tries to specify the particular situation in two South African cities (Durban and Windhoek) and two East African cities (Dar es Salaam and Nairobi) as a comparative study and to develop approaches to enhance the sewage management. Since it does not seem a viable option just to import conventional western technologies (due to their high costs and because they are not regarded as the best example because of the high amount of hazardous waste they generate), the benefits of on-site sanitation and small-scale networks are analyzed. Dry toilets avoid the mixture of domestic sewage with urban runoff and industrial sewage and provide the opportunity of recycling nutrients. Communal sanitation facilities can be an alternative where people are unwilling to invest in domestic infrastructure due to a lack of tenure rights. Interviews with different stakeholders from municipalities, water and sewage utilities and representatives of the above named organisations combined with the author's own observations suggest that the two cities in East Africa face serious challenges concerning its sewage disposal and treatment closely related to insecure landownership. In the two South African countries the technical and organisational standard is high with Windhoek even treating sewage to the level of potable water. – The findings refer to legal, political, organisational, social, technical and economical issues. Time-consuming and costly allocation of land contributes to the high proportion of informal settlements for which the utilities do not have a mandate to serve. Political neglect in many cases outweigh technical problems, fair financing means a must. Without participation, information for users and a certain freedom of choice between costs and convenience, sanitation upgrading projects are doomed to fail. Conditions for successful privatisation are discussed and regulations for urban agriculture with sewage are examined. The essay concludes with an outlook on how far the findings can be generalised for other cities in the regions.

1. The complex issue of urban sewage management in sub-Saharan Africa - Introduction

1.1 Background and effects of insufficient sanitary services

Water is an essential good and the supply of fresh water is frequently discussed. Particularly in cities where high amounts of water are consumed within limited space challenges for sustainable water management arise. Water is permanently being used and polluted, especially in cities the natural self purification potential is by far exceeded. For this reason sustainable water supply can only be achieved in combination with sufficient sewage disposal and treatment. A large variety of programs, guidelines and agendas of international organisations address this problem and suggest improvements in handling natural resources. Mostly their focus is on covering the needs from - admittedly limited - but apparently clean „resources“. This seems unrealistic given the huge amount of sewage that is generated daily – especially in cities – which is too often the only „resource“ for further uses. (An example in this context is *urban agriculture* where mostly sewage is used.) This study aims to contribute to the enhancement of urban sewage management. Because:

- The demand for sanitary services is given everywhere and especially with rising population numbers and in dense settlements.
- Particularly in regions where hardly any conventional sewage systems are existent there is the opportunity to establish sustainable facilities.
- Conventional ways of sewage disposal and treatment like in Germany are *end-of-pipe*-solutions, the generated sludge is hazardous waste (because chemical and biological components are mixed) which accumulates more and more.
- *Ecosan* (Ecological Sanitation) in contrast provides circulation systems with the opportunity to recycle nutrients as fertilizer or to generate biogas.

Sewage management should therefore be implemented in an integrated way along with water supply and in the context of urban planning. As a basic principle water supply should only be put into practice along with sufficient means of sewage management (UNEP/GPA 2001b:10).

Why are sewage issues so important?

In Germany where it goes without saying that sanitary hardware is installed in private and public buildings and that sewage is being piped subterraneously to functioning treatment plants it is easy to forget the effects that lacking provision of these services cause. As a matter of fact insufficient sewage management has far-reaching consequences. Daily water demand and pollution are so high and the fraction that is treated so small that in many cities water is only available in contaminated form. Concepts of water supply must therefore be preceded by considerations of its treatment. According to the Water and Sanitation Programme (WSP), an international partnership of the World Bank, UNDP and different governments (WSP 2000:14f.) insufficient water supply, hygiene and sanitary facilities cause 1.6 Million deaths per annum worldwide. Positive health effects are reached rather with improved sewage disposal than with improved water supply and those effects are stronger in urban than in rural settlements (Bartlett 2003:66). Additionally, the number of people without sanitary provision is twice as high as the number of people without access to safe drinking water. Studies attest that improved sanitary conditions reduce the mortality caused by diarrhoea by 32% (BORDA w.y.a). Diarrhoea weakens especially children in manifold ways: Besides the direct water- and nutrient loss they mostly cause reduced nutrition-intake while the demand for energy by the immune system is increased and therefore make the body more vulnerable for other diseases (Bartlett 2003:60f.). Additionally there are diseases that are independently from water supply caused by insufficient sanitary provision like helminths, conjunctivitis and cholera (UNDP 2005). Waste-blocked sewers and gullies leads to stagnant sewage pools and flooding, leading to an increased risk of spreading pathogens. An existing HIV infection - and in the surveyed areas, there are high infection rates - makes the outbreak of a disease more likely (BMZ 2005).

Besides the medical aspects there are also social issues. Where sanitation facilities that offer privacy are lacking, women and girls often only dare to alleviate themselves in darkness, although the risk of assault or rape are particularly high at night. During the day they partly take less food and water in order to avoid this need until the evening, which entails health risks, especially in the hot climates in which these circumstances predominantly prevail. Also, school attendance - especially from girls - suffers due to a of sanitation facilities in schools (UNICEF/WHO 2004:21). More potential for conflicts can be found at the political level. When downstream users along rivers suffer from water pollution, this can trigger or amplify political conflicts.

Therefore improving sanitation conditions has more advantages than just the medical aspects:

- better comfort/more privacy
- lower risk of sexual harassment for women and girls
- reduced risk for children to fall in poorly constructed latrines
- less embarrassment towards visitors
- enhancement of dignity and social status
- time savings through improved accessibility/shorter queues (especially in the morning) in public sanitation facilities (UN-Habitat 2003b).

In addition to these human-related factors there are also environmental benefits (through decreased pollution of soil, surface water and groundwater), as well as economical (through less non-productive time due to diseases or care of sick relatives, higher productivity, greater attraction of clean cities for tourism), and educational (due to increased school attendance) and decreased health care expenditure (for medicines and doctors) (Department of Water Affairs and Forestry 2002c). Studies show that because of these advantages, a large number even of very poor people is even willing to pay for basic needs in sanitation (WSP 2004b:2) (Practical Action 2005:36). It is discussed controversially to what extent costs for sanitation should be divided between more and less affluent city dwellers, as well as between the public sector and private companies, which will be discussed in the course of the study.

The attempt to solve sewage-related environmental and health problems in developing countries with stricter standards and conventional sewage treatment plants, offers few financial incentives for local governments and is also seen as the reason for the low coverage of sewer systems (Nhapi/Gijzen 2005:134). Therefore in cities of developing countries there are usually two parallel sanitation systems prevailing: in the center and in more affluent neighborhoods the municipality manages sewage through sewer systems, while marginal areas and poorer settlements maintain private on-site systems (without connection to a sewer system). According to Pugh, however, considerable parts of the population cannot participate in any of the two systems (Pugh 1996:87). Due to poor construction, maintenance and emptying, the prevailing latrines which are not connected to a sewer system cause serious health problems (Asian Development Bank/IWA 2003:67).

The focus of this study is on sanitation management, in terms of a holistic approach also attention will be paid to the mutual linkages between water supply and disposal. The type of water supply determines, if and to what extent sewage is generated: In informal settlements with water supply via canister, tank trucks and holding tanks without sewage collection

systems there is none of that goes to sewage treatment plants; roof tank water supply usually generates 20-100 liters of sewage per capita per day; with centralized water supply there are 10-800 liters of sewage per capita per day (in South Africa) (Ruhr-University Bochum 2005:313f.).

Why is sub-Saharan Africa selected as the study area?

Here the problem is particularly evident: In 2000, over 300 million people lack access to safe drinking water and 500 million lack access to adequate sanitation in Africa. The problem is exacerbated by the urbanization rate of 5% per year, which is among the highest worldwide. Here local authorities are particularly challenged to provide adequate infrastructure (UN-Habitat w.y.). Especially poorer countries are characterized by particularly high urbanization rates. As figure 1 shows, in most major regions the urbanization rate decreases, whereas in Africa it hardly changes much, so that 2000 the highest values are reached. The graph shows the annual percentage of increasing urban population worldwide from 1972 to 2000 and in various geographical regions.

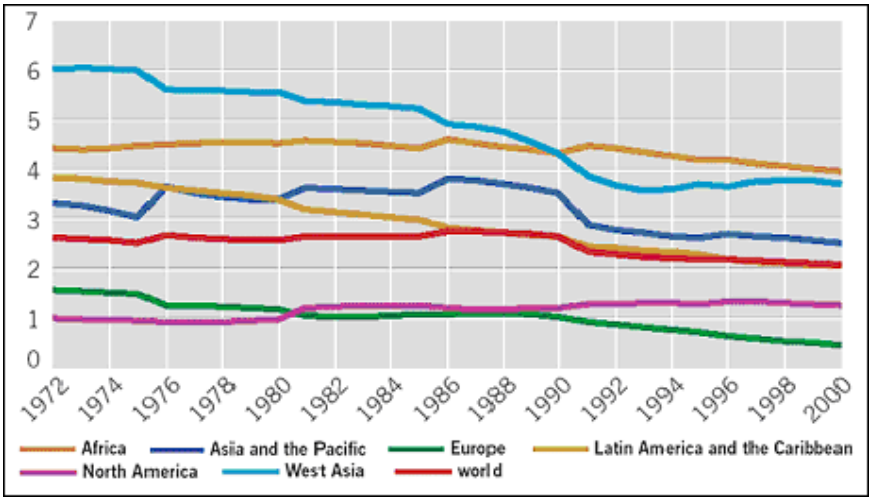


Figure 1: Urbanization rates in the world and major regions

Source: UNEP 2002, p. 241

High urbanization rates are the major challenges for local governments with regards to providing public services such as electricity, water supply and sanitation. The low share of households in sub-Saharan African cities, which are connected to public supply and disposal networks, reflects this. Figure 2 shows that the connection rate to the sewage network in Africa (along with Oceania) ranks among the lowest in the world. But even an existing sewer connection does not necessarily mean that the sewage is also treated, often it is only drained from the city. Figure 3 shows that this is especially the case in Africa. Rain water should not enter the sewer system (separation system), which is especially true for countries with distinct rainy and dry seasons, as the strong flow fluctuations may lead to overflow of sewers or disturbances in the sewage treatment process, and in the dry season, the sewage may stagnate in the pipes (National Environment Commission Secretariat 2000) (Ruhr-University Bochum 2005:424ff.).

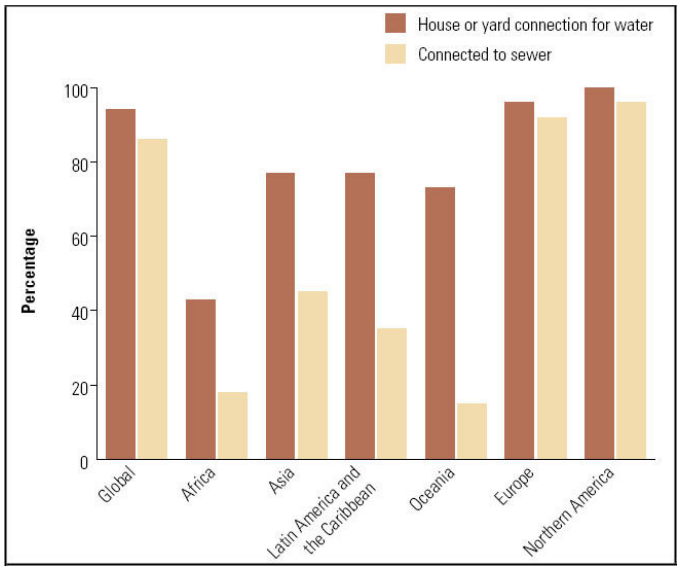


Figure 2: Percentages of household connections for water and sewage

Source: UN World Water Assessment Programme 2003, p. 173

Region	Population (%) in large cities that has sewer connection	Sewered sewage (%) that is treated to secondary level
Africa	18	0
Asia	45	35
Latin America/Caribbean	35	14
Oceania	15	Not reported
Northern America	96	90
Europe	92	66

Figure 3: Percentage of population with connection to the sewer system and the degree of sewage treatment

Source: WHO/UNICEF (2000): Global Water Supply and Sanitation Assessment 2000 Report, New York, p. 57.

Despite the often used argument of urbanization, it would be a simplification to explain the low connection rates only with this. Extreme inequality of incomes and the lack of urban planning are other important aspects (Pelling 2003:76). Another special aspect in sub-Saharan Africa is - as shown in figure 4 - that especially in southern and eastern Africa there is hardly any potential in terms of renewable fresh water resources, which highlights the need for a holistic water management.

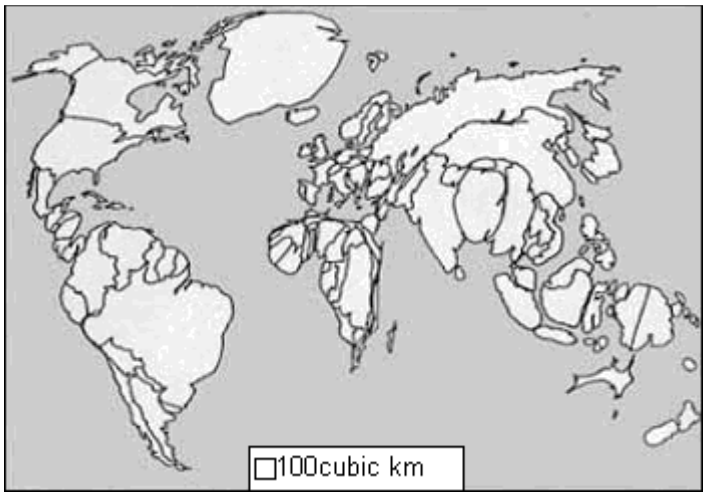


Figure 4: Renewable water resources per country in the early 1990s, the countries' sizes are shown according to their amount of renewable water
Source: WRI 1996

A simplified idea is that the main reason for the spread of diseases in countries south of the Sahara is to be found in drinking contaminated water. The **Agenda 21** for example states that about 80% of all diseases and over a third of deaths in developing countries are caused by drinking contaminated water. This statement not only overestimates the impact of diseases that spread by drinking contaminated water, but also simplifies the ways in which these diseases are transmitted. Almost all the diseases that are transmitted by drinking contaminated water can also be transmitted through intake of contaminated food and contact with infected people as well as through direct contact with faeces (UN-Habitat 2003b:138). Therefore various means of transmission of pathogens and the associated risks are explained below:

- Intake via drinking and bathing: Pathogens and diseases that are caused by toxic chemicals
- Lack of personal hygiene due to water shortage: conjunctivitis and scabies
- Insanitary domestic and agricultural conditions: Transfer of pathogens between persons, or via faecal contaminated food and the use of contaminated water for irrigation and for cleaning
- Transmission via contact with water during bathing and standing in water or mud (bilharzias) and
- Transmission by carriers that live in standing water: Malaria, nematode (UN-Habitat 2003b:61).

This list is designed to counter the idea that global water stress is directly responsible for inadequate water access in urban areas and for poor sanitation and the spread of disease. Sanitation and health care depends on additional local variable factors that significantly influence the nature of health risks. Other reasons and possible solutions will be discussed in the course of this study.

Why are residential areas, not rural areas analyzed, and in cities not the industrial areas?

Because of their high population density and often rapid, uncoordinated growth, urban settlements in sub-Saharan Africa need particularly sewage solutions. In rural areas there is more likely the possibility for an agricultural reuse of sewage. - Industrial areas are also excluded from the study, as depending on the type of industry very different qualities and quantities of sewage occur, which require specialized technologies for avoidance or treatment. Industrial sewage often contains non-biodegradable material, in which often only with great technical effort certain ingredients (such as chromium) can be extracted and reused. For this reason it appears useful as far as possible to separate domestic sewage from industrial sewage, or at least to treat them separately (UNEP/GPA 2001b:34).

Region	Proportion of slum dwellers (%)
Developing regions	43,0
Sub-saharan Africa	71,9
North Africa	28,2
South-central Asia	58,0
East Asia	36,4
West Asia	33,1
Southeast Asia	28,0
Latin America and the Caribbean	31,9

Figure 5: Proportion of slum dwellers in selected regions
Source: UN-Habitat (2003a): The Challenge of Slums. Global Report on Human Settlements, London.

The settlement areas of the analyzed cities usually comprise a small proportion of middle-income residential areas and a majority of low-income and/or informal residential areas. The study puts a special focus on them, as here the majority of the population of these cities reside (see figure 5).

Does the „European model“ in countries of sub-Saharan Africa make sense?

Analog to the domestic fresh water connection, the domestic sewer connection provides the highest degree of comfort. This solution is expensive in construction and maintenance and requires a lot of water for the transport of human waste, about 6-15 liters per toilet flush (Water Utility Partnership, 2002). Conventional sewer systems in developing countries often have problems with blockages or malfunctioning pumps. This is partly because the composition of the sewage is different than in developed countries: There is often a high proportion of sand, if roads are not paved or thinner sewage in areas with dry toilets, which modifies the requirements for sewage treatment (Ruhr-University Bochum 2005:316). Therefore the question is controversial whether - given the high capital and operating costs, the requirement of professional qualification in the construction and maintenance of western infrastructure with channels that drain sewage to conventional sewage treatment plants plus the difficulty to dispose of sewage sludge that those treatment plants generate - establishing or expanding such systems in cities of sub-Saharan Africa is at all realistic and reasonable and what alternatives there are. - Michael Rouse, president of the World Water Association, thinks that plans - to achieve the Millennium Development Goals by 2015 to halve the number of people without sanitation – to build sewer systems for 1.2 billion people, are not realistic. He calls instead for a more widespread use of toilets, where human waste is collected and used as fertilizer, which would simultaneously reduce the need for expensive chemical fertilizers (Brown 2003).

Given this context, the question arises for alternatives to conventional sewage management, which are adapted to the conditions in sub-Saharan Africa with regard to water availability, climatic conditions, financial capacity, etc. (Asian Development Bank/IWA 2003:67). In this regard also community sanitation facilities can play a useful role, as they already exist especially in Asia. Examples of the analyzed cities will however also point out the problems of neglect and vandalism of such facilities. Combined approaches that link small local networks as well as on-site sanitation and sewage prevention with conventional sewer systems, can be reasonable alternatives (UNEP/GPA 2001b:3f.).

Though an improvement of the (sanitation) infrastructure alone will not solve health and environmental problems of a city, as part of sustainable urban development they still are an important basis for achieving further goals in poverty reduction, etc. (Pugh 1996:85). When introducing infrastructural measures therefore also practices of personal hygiene need to

have special focus, as infections, particularly faecal-oral diseases are not prevented by the mere presence of sanitation facilities.

Hypotheses and objectives

Given these considerations three hypotheses arise to be substantiated during this study through literature and empirical research:

1. Sewage disposal from urban areas in sub-Saharan Africa is a diverse problem that is growing in urgency.

The above described aspects of urbanization and city growth suggest that the sewage situation is worsening. The proportion of urban dwellers without sanitation in sub-Saharan Africa is greater than the proportion without water supply. This is partly because the cost of providing one m^3 of potable water are lower than to treat one m^3 of sewage (Nhapi/Gijzen 2005:134). The issue of sewage disposal is characterized by a variety of stakeholders and affected parties, it has impacts on all residents of urban settlements, the local municipality, government and Non-Governmental Organizations (NGOs). It will be examined: What are the decision criteria, indicators and methods (e.g. of the World Bank and WHO) exist for urban development planning with regards to sanitation? To what extent are they being implemented in various cities? What is their planning basis? As outlined in the introduction, the field of sanitation is also thematically diverse and touches on various areas of public interest such as health, water supply and environmental quality. The first step is to take stock of the sewage management in selected cities through on-site research. This was done through interviews and discussions held with representatives from municipal governments and representatives of national and international stakeholder sectors, with also taking into account the different geographical set-ups of the cities and their impacts on the sewage management.

2. Between the recommendations and guidelines for sewage management from international organizations such as UN, WHO, etc. and the situation on the ground in many cities there is a difference.

There are many suggestions and guidelines, which mainly focus on water supply and only marginally to sanitation. Most remain very general in their statements. The key suggestions and guidelines will be presented, while it will be assessed, which planning proposals are available from WHO, World Bank and the UN. It will be examined to what extent they deal with problems which the interviewed governmental and non-state representatives face in their work. The preparatory literature review, discussions and experiences in the analyzed cities suggest that there is a difference between theory and practice. It is investigated, why

this is the case and how the gap between theory and practice might be reduced. As a second step, through empirical research the planning proposals will be compared with the situation on the ground in selected cities.

3. Sewage management needs specific solutions, because it leads to a significant improvement of hygiene, comfort and social status and is, in contrast to water supply whose urgency is usually obvious, often neglected.

In contrast to (1) economic assets, and even in contrast to (2) water *supply*, sanitation needs other approaches. 1. Its special position compared to economic assets is given, because water supply and sanitation are invaluable services to people and there is a consensus that all people should have access to it. 2. But the measures (organization, financing, administration, etc.) on water *supply* cannot just be copied for water treatment, as the daily need is for clean water is more obviously necessary for the people than a proper sewage disposal, because the consequences of inadequate water supply have a direct health impacts, while inadequate sanitation however has indirect impacts (Asian Development Bank /IWA 2003:67). Another reason why sewage management requires special measures, is the more difficult cost allocation compared to water supply: While water supply is immediately necessary and consumption can be measured according to the acquired canisters fillings or installed meters, the sewage disposal is quantitatively difficult to measure, because there is an incentive for users to bypass infrastructure they have to pay for. Also the pollution that results from non-existent sanitary facilities charge, impacts the whole community, so that for individuals there is little incentive to break this cycle. It will be examined, what perspectives exists for improving sewage management in the examined cities, to develop a concept for the optimization of urban sanitation in the cities of sub-Saharan Africa.

Scope and definitions

Since in the course of the study the sanitation management is investigated, this chapter provides an overview of the key terms used in this area. One important note on the concept of **sanitation**: In the English literature the term "sanitation" is used, which refers not only to the field of sewerage or treatment plants, as is the case in the German concept of the term sanitation, but rather includes all aspects of what can be called "water management in human settlements", which also comprises domestic sanitary facilities and independent systems that are not connected to a public sewer grid (hereinafter referred to as on-site sanitation). Wright defined "Sanitation" as follows: "Sanitation has been defined in various ways in different countries and by various organizations. To some it embraces the management of excreta, domestic sewage (or sludge), solid wastes, and storm water

drainage. To others, it refers only to one service, namely, the management and disposal of excreta. As used in the MDGs (Millennium Development Goals), however, 'sanitation' embraces two services, Namely, the management of excreta and sludge or the management of domestic wastewater "(Wright 2005). For this reason this study uses the term sanitary services or sanitation, which also includes washing-, toilet-/latrine- facilities as well as the disposal of sewage in sewers to an appropriate treatment plant and its treatment or the collection of sewage in tanks or else for their final disposal or reuse.

The term **urban areas** refers to human settlements in cities, in this study the analyzed cities are Windhoek, Durban, Dar es Salaam and Nairobi, which, according to their administrative boundaries, also comprise some quite rural areas at the margins of their city boundaries. As mentioned industrial areas are not considered, because depending on the type of industry these areas have different problems and compositions of sewage, which require a separate investigation. Additionally in Africa domestic water consumption (and sewage generation) accounts for a much larger share than industrial water consumption. While agricultural is still by far the largest water consumer, this use causes no ‘wastewater’ in the sense that it needs treatment and is usually (except if chemical fertilizers are used) not environmentally harmful (Rekacewicz 1993).

Sub-Saharan Africa: The study focuses on the four cities of Windhoek, Durban, Dar es Salaam and Nairobi, while the further discussion also includes considerations on the transferability of problems and solutions to other urban areas in countries south of Sahara.

The topic sewage management in urban areas relates to issues of **urban development planning** not only directly (in terms of the construction of sewers and treatment plants), but also touches on a number of other questions of urban planning, such as land ownership, status of settlements (illegal, informal, planned), etc., which will be discussed in the course of this study.

A **pit latrine** is a latrine on a collecting and composting pit, whose contents also infiltrate into the soil. In a **pour-flush latrine**, however small quantities of water are flushed by hand into a collection pit. A **septic tank** is a water-tight receptacle in which primary treatment takes place and which must either be regularly emptied or needs to drain into a receiving water body. A ventilated improved pit latrine **(VIP latrine)** has a superstructure and vent pipe (National Environment Commission Secretariat 2000:32f.). **Small-bore** or **condominial sewer** systems are often used by small units like a neighborhood, where the system of low-priced sewers drains the sewage, these systems are often built by the residents in

collaboration with a Non-Governmental Organization (NGO) (Water Utility Partnership 2002). These systems are characterized by thinner sewers, which are laid out shallowly under the earth, which drain into a tank or pond. It is possible to connect these small networks to a regular sewer system, if the last is being extended. Seed money and tolls are usually collected by a self-organized *sanitation committee*.

1.2 Structure of the study

After in the introduction the need to consider the sanitation of urban settlements in sub-Saharan Africa was discussed, the second chapter presents existing programs of international organizations, which set the theoretical basis and framework, while the further chapters will investigate in how far those comply with the challenges described by the interviewed stakeholders. The empirical part starts with a definition of the methodological approach of this study and the choice of the research design, according to which the study was conducted. Also the selection of the four analyzed cities will be explained that form the basis for the comparative study, as well as the two interview guides will be introduced – one for decision makers of the respective municipalities for sewage management and the other for representatives of international organizations. Chapters four and five form the heart of the study: Chapter four presents the four case studies Windhoek, Durban, Dar es Salaam and Nairobi in terms of sanitation, analyzing the collected data and identifying the characteristics of the different cities. Possible proposals for action are developed, but also their critical points and risks are discussed. In chapter five the results of the empirical study of the analyzed cities compared with and contrasted against the programs of the international organizations. The study is completed with a synthesis of the obtained findings and a view on their transferability of results to other cities; the synthesis also links the results of theoretical and empirical parts back to the initially identified hypotheses. The Annex shows the guides for the interviews with decision makers in the field of sanitation and the representatives of international organizations (Annex A), followed by a list of interviews and discussions conducted (Appendix B). Finally, the currency table (Annex C) provides information on the exchange rates used for the currencies in the visited countries into the euro and the U.S. dollar, for each country the rate of the date of arrival was used.

2. Proposals and guidelines of international organizations – their contribution to the development of solutions

2.1 Conceptual Approaches

While a wide literature exists on the water supply of regions and cities, the number of contributions to options of urban sewage disposal and treatment is surprisingly low (Commission of the European Community 2003). Even programs and organizations that include the words *Water and Sanitation* in their title, the focus is often on water supply (even on business cards of the Nairobi Water and Sewerage Company the words 'and Sewerage' are missing). Exceptions are the publication *Sustainability, the Environment and Urbanization*, in which Pugh notes that the big conferences such as 1992 in Rio, focused on "green" issues such as biodiversity, climate change etc., but much less than the "brown agenda" with topics such as sanitation, water- and air pollution (Pugh 1996:84). Another important publication is *Water and Sanitation in the World's Cities*, which deals with four central themes:

1. the fact that governments and international organizations underestimate the number of urban dwellers who do not have access to adequate water and sanitation and the health consequences that result from that,
2. the insufficient attention from governments and international organizations that result from this underestimation, while examples show that the obstacles to adequate services are less technical or financial rather than institutional and political,
3. the need for solutions that are tailored to the needs of communities and the local environmental conditions, and
4. the need to create conditions for *good governance*, as competent authorities are the prerequisite to improve the services for the poorer parts of the population (UN-Habitat 2003b:xvii).

This chapter will first present the proposals from international organizations on water and sanitation. Based on this topics will be discussed that are closely related to the subject of sewage in urban areas of sub-Saharan Africa, such as privatization and urban agriculture. The focus is how the theoretical proposals can be implemented practically and what the challenges arise from this. But firstly it will be discussed, why environmental problems have a special position among policy and planning aspects.

Why do environmental problems require special measures?

The Environment is a public good, it cannot be protected solely by the individual (free-rider problem), nor by the "market". This is illustrated by Pugh: With poor sanitation, insects breed in standing water between the houses, seeping sewage contaminates groundwater and rivers, which are used for washing and rinsing. Thoroughly cooking all food for hygiene reasons in turn exposes women and children to unhealthy smoke from burning material. "Under such circumstances, it is clear that individuals and households cannot choose a cleaner home and neighborhood environment, as they might choose a normal 'good'. Their environmental problems arise mostly from other people's choices and actions. (...) Children, who are those most affected by faecal-oral diseases, often move freely from house to house in the course of their play, reducing the importance of the child's own home environment still further "(Pugh 1996:124). For this reason the state authority is given a regulatory role to protect health and the environment. But not necessarily, as claimed by Malthus, the joint use of the environment must lead to their destruction (Gulbrandsen 2003:201) (Askildsen 2003: 158). This argument is sometimes used by state authorities, where arguments of environmental protection are used as an excuse for the government to take control of land or resources. (That the joint use of a resource does not necessarily lead to overexploitation and environmental degradation is illustrated by Leach and Mearns with various examples (Leach/ Mearns 1996).) - In the field of sewage however usually there are no such interests to take control, because sewage is not seen as a resource by the state. This raises the question, to what extent and by what means the state can implement a successful sanitation management.

A state has a broad range of options to enforce environmental objectives, from "hard" measures such as laws on sanitation policies, via partnerships with non-governmental organizations and industry to "soft" to measures such as environmental and hygiene education, and public awareness programs. All have advantages and disadvantages: Hard measures are likely to implement minimum environmental and hygienic standards and to ensure clear thresholds and standards, but usually provoke defensive reactions, and often there is a lack of enforcement (Storm 2002). A particular risk in sub-Saharan Africa is that too strict standards might lead to their complete neglect, which might for example be the case, if European standards for sanitation are just copied to other regions, which are not feasible for local conditions. Soft measures are an important basis for long-term behavioral changes, but can hardly be used for specific, short-term goals due to their lack of bindingness. Usually a mix of different instruments is used. For the assessment of environmental damage – and to

set a fine for a polluter - the most common problem is that environmental goods or damages such as loss of biodiversity or the beauty of a landscape can hardly be quantified in monetary terms (UNEP/GPA 2001b:5ff.).

Proposals and guidelines of international organizations

The **International Health Regulations** of the **World Health Organization** were adopted in 1951 as the *International Sanitary Regulations*, they comprise rules to prevent the spread of infectious diseases. 2003-2005 they have been revised, and the previous disease-centered approach (in relation to cholera, plague and yellow fever) has been amended in favor of a *public health risk approach*, which also takes the transmission dynamics of diseases through advancing mobility and new diseases into account (Fidler 2004). The **Water Safety Plan** of the World Health Organization gives specific advice on how to organize water management:

- The composition of water management teams should be multidisciplinary and comprise different professional groups including engineers, administrative and executive staff for public health and hygiene, water quality inspectors, environmental specialists, as well as consumer representatives,
- continuous quality checks to be conducted in a laboratory,
- the quality checks to include tests regarding biological, chemical, physical or radiological pollution, and
- be an assessment of risks from and consequences of identified pollutants (WHO 2006).

Even in the **Millennium Development Goals (MDGs)**, which were launched at the *United Nations Millennium Summit* in 2000 by 147 countries, the sanitation aspect was not included from the beginning. Only goal 7 of MDGs, target 10 is to halve the number of people without sustainable access to safe drinking water by 2015. Only in 2002 during the **World Summit on Sustainable Development (WSSD)** a further aspect was added to target 10: halving the number of people without access to adequate sanitation (UN-Habitat). What is meant by adequate supply is still to be discussed. - Indirectly, sanitation has an impact on most of the other MDGs though: The achievement of Goal 1 "extinction extreme poverty and hunger" is facilitated by improved sanitary conditions due to lower infection rates, which enables people to pursue productive activities. The achievement of Goal 5, the "reduction of child mortality under 5 years by two-thirds" is also related to the presence of hygienic washing and toilet facilities. Improving the lives of 100 million slum dwellers (target 11) is apparently also linked with it (WEDC 2006). - To reach these water and sanitation targets it would be necessary to supply an additional 260,000 people per day with access to fresh water and an additional

370,000 people per day with access to improved sanitation facilities until 2015 (World Water Council 2005). This target will be very challenging to reach, already 1981-1990 it had been aimed to provide all people with adequate access to water and sanitation during the **International Drinking Water and Sanitation Decade**, which would have meant to provide supply to additionally 650,000 people per day over 10 years. This goal was not achieved, but major efforts in this direction had been made (UN World Water Assessment Programme 2003:24ff.).

To achieve the above objectives, the **UN Millennium Project Task Force on Water and Sanitation** was established, focusing on 10 fields of action, which are kept quite general though:

- Moving up sanitation issues on the government agenda.
- Specific attention should be given to the different needs of men and women by policies and institutions that deal with water and sanitation issues.
- Investments and reforms must be pursued in parallel by governments and aid organizations.
- Rather than on mere infrastructure improvements, the focus should be to introduce sustainable water supply and sanitation.
- The organization of water supply and waste disposal should take place at the local level, the relevant institutions should be accordingly entrusted with human and financial resources.
- Implementing fair payment systems are ensured that those who can pay do pay, while also covering the needs of poor households.
- To achieve the Millennium Development Goals national poverty reduction strategies need to include water management plans.
- Governments and their partners should support a wide range of different techniques in the field of water and sanitation.
- Institutional, financial and technical innovations must be supported.
- The United Nations should support the achievement of the water and sanitation target (WHO/UNICEF 2005:34).

Water management in the **EU cooperation policy** (according to the "2003 Annual Report of the Commission to the Council and the European Parliament on the development policy and external assistance in 2002") is very similar to the *UN Millennium Project Task Force on Water and Sanitation*, also here the main need for action is seen in moving up this topic on the political agenda along with awareness raising and strengthening of institutions to expand and modernize sewage systems and ensure their effective maintenance. Balanced

partnership between public and private stakeholders should ensure high environmental standards, while taking into account local conditions in terms of health risks, customs, knowledge and ownership situation. Financial sustainability is to be achieved by aiming at cost recovery, but not compromising the service for weaker parts of the population (Commission of the European Communities 2003). Achieving these partly conflicting goals will be a large challenge, while the document remains relatively vague regarding the implementation of these goals.

The **United Nations Environment Programme (UNEP)** (and also very similar Nhapi) formulated the following to be part of sewage strategies in its *guidelines on urban sanitation*:

- Firstly, measures should be utilized to minimize water consumption and waste generation, and therefore the amount resulting sewage. Focus to only use the necessary quality of water (e.g. exemplary in Windhoek, as there is a channel system of used water for irrigation purposes).
- Secondly, efforts to treat and reuse water and nutrients should be carried out on the most decentralized geographical level possible, while domestic and streams of domestic, industrial and rain water should not be mixed, because otherwise recycling of contained substances is hardly possible.
- To implement the first two points, cost-effective and on-site sanitation facilities should be used as much as possible and alternative techniques be included.
- Opportunities to recycle sewage should be exploited as much as possible (e.g. for agriculture, aquaculture, as cooling water in industry).
- To identify and take advantage of these opportunities, the cooperation with other sectors such as water supply and land use planning should be seeked.
- Only when these opportunities are fully exploited, consideration should be made to charge sewage into natural systems, taking care through dilution of sewage that the regenerative capacity of lakes, rivers and seas should not be exceeded.
- All activities need to take into account the function of the space in which measures are applied: e.g. in industrial areas, the focus would be on pollution control and health protection, while in coastal areas and city centers also aesthetic considerations matter (UNEP/GPA 2001b:12) (Nhapi/Gijzen 2005:133ff).

On the *Regional Consultative Meeting on Municipal Wastewater in the Eastern Africa Region* in Dar es Salaam in 2001, organized by the **UNEP/GPA**, representatives from Kenya, Madagascar, Mauritius, Mozambique, Tanzania and the Seychelles participated. The sewage strategy established there includes the following proposals as a decision framework:

- Water supply and sanitation need to be organized in conjunction, as they are related in many ways.
- Cost recovery should be achieved principally through the application of the polluter pays principle, including a fair and enforceable pricing system.
- Technical solutions need to be environmentally sound.
- Alternative approaches should be tested for their applicability.
- Mass media provide opportunities for awareness raising and education of larger parts of the population.
- NGOs and local groups can make a useful contribution, but few deal with sanitation issues.
- Long-term planning should include urban growth, the location of existing industrial facilities and establishment of new industries.
- Cost-benefit analysis can provide important input for decision, although accessing complete and reliable data is a challenge (UNEP/GPA 2001a:4ff.).

To improve data situation the author included questions about the costs of different sanitation options in the interviews.

The **World Bank** has tried to create a **method** to evaluate and compare water and sanitation facilities, emphasizing, however, is that comparability is difficult to produce because of the regionally very different data situation and because common indicators can only be kept very general due to the vastly different situations of different countries. The method is based on the following **indicators**: Water and sewer channel coverage, state of the channel network, staffing, service quality, water consumption, methods used to identify water consumption, unpaid water (due to supply network losses and unpaid bills), billing system, financing of water and sanitation facilities in investments made. These indicators are broken down into the following criteria:

- *Country information*: GDP per capita;
- *Information on the water/sewage municipality*: Name, location, contact person and address;
- *Coverage area of the municipality*: number of citizens serviced and rate of total population which is supplied;
- *Financial Information*: expenses and revenues broken down by sector, maintenance costs, staff costs, annual reports;
- *Tariff information*: Overview of tariff amount and structure, connection charges, basis tariff amount and/or consumption-related costs (World Bank/International Bank for Reconstruction and Development 1996); (World Bank 1999:3ff.)

- *Specifically for sanitation*: total length of the sewer system, number of domestic service connections, number of connected persons; rate of sewage from total amount that is treated.

As these questions build a useful base for the interviews to be conducted under this study, they have been incorporated into the discussion guidelines for the empirical part of the study.

The **Water Supply and Sanitation Collaborative Council** has identified the following aspects from experience:

(a) Sanitation systems of industrial countries are not ecologically sustainable;
(b) Non-utilization of organic waste is seen economically wasteful;
(c) The high population pressure exerted on water resources exacerbates the need to recycle sewage and waste;
(d) Without the inclusion and participation of the population sanitation projects are doomed to fail;
(e) There is a lack of linkages between water supply, sewage treatment and utilization of (human) waste and rain water;
(f) Without sanitation and hygiene education, the benefits of improved water supply are not fully being reached, and
(g) The transfer sanitation systems from developed countries into regions with water scarcity is unfavourable (Schertenleib/Morel/Kalbermatten et al. 2004:93ff.).

Sustainable development

As the term sustainability was mentioned several times, the signification of this term with regards to urban development will be outlined here in brief. The **concept of sustainable development** dates back to the first report of the Club of Rome in 1972, it does not try by explaining of current (under)development to identify "what to do with the rest of the world to develop it, but most of all: what should not be done so that the whole world remains viable for development" (Thiel 2001:16). The presented proposals are also aiming into this direction. Considerations should however not solely focus on the question how to cover basic needs with lower resource consumption, but instead "how could an economic system function as a whole, which is based on the concept of resource conservation. If we decided, for example, to produce only durable goods - how would this affect the labor markets? What will steer and regulate the markets en lieu of prices and capital investment?" (Thiel 2001:17).

A visionary outline of sustainable cities which – in contrast to today´s cities in industrialized and developing countries - meet human needs in a better way, which do not incentivize the

waste of resources, but promote sustainable ways of living and producing (in terms of housing, transportation, consumption goods, basic services etc.) is provided by Korten. The fact that certain global problems persist in spite of long-term interventions by international organizations shows that these problems have to be addressed in a completely different way. According to him, the obstacles to challenge are rather of institutional than financial nature. He notes that basic human needs can best be met at the local level (Korten 1996:36). With regard to sanitation, this can be met with decentralized, locally adapted solutions, which save water and offer options for recycling of the various components.

The question of „adequate" supply

When assessing the number of people in need of sanitation, this cannot be determined by analyzing who so far does *not* have access to it. Strictly speaking, all city dwellers have access to some kind of sanitation, at worst it means that residents have to relieve themselves on the street or in the bushes. So the question is not *whether* there is access, but if the access is *adequate* in terms of safety, hygiene, personal needs, accessibility and affordability (UN World Water Assessment Programme, 2003:166). For a promising approach urban areas need to be analyzed differently than rural regions. This starts with the definition of when regions are served adequately or not adequately. While many governments define as a rule of thumb a freshwater source within 200 meters of reach as an adequate supply, it makes a significant difference if this water source is located in the country side with 00 people sharing it or in a densely populated urban squatter settlement, where 5,000 people share it. By analogy, also for sanitation different solutions must be found in cities with their high population density than in the countryside. The census data, which national governments generate through surveys regarding water and sanitation issues, often do not ask the critical questions, and hence they cannot answer who has adequate supply: Regarding sanitation it is often queried what type of toilet is available, but the health risk is more dependent on how many people share one toilet than on the type of toilet. It is also not checked how long it takes to reach such a (community) toilet or to wait for one's turn, how often they are cleaned, what the using fee is etc. But all these aspects are relevant for determining adequate supply (UN-Habitat 2003b:xviiiff) (Satterthwaite 2003:184f). – Because of the variety of definitions that are being used (spatially and temporally), also numbers and figures are not very comparable. Thus, the increase in the percentage of residents of sub-Saharan Africa without access to "safe" water supply (1.58 billion in 1990 compared with 1.2 billion before) is, among others, explained with the fact that later surveys used stricter definitions of the term (Najlis 1996:9).

It is difficult to determine the “adequate” supply with water and sanitation facilities and to do so at best based on data that can be simply accessed. According to the World Health Organization a connection to the sewer system or septic tank, pour-flush latrine, ventilated improved pit latrine and even a simple pit latrine considered as improved sanitation. In contrast, public or communal latrines, open pit latrines and bucket latrines are defined as non-improved sanitation (UNICEF/WHO 2004:4). The reviewed literature and the interviews conducted for this study show however that there can be considerable hygienic problems with simple latrines and ventilated improved pit latrines, while communal latrines and bathrooms on the other hand can also work. Figure 6 illustration the distribution of non-adequate supply under this definition shows that particularly sub-Saharan Africa has a low percentage of improved sanitation.

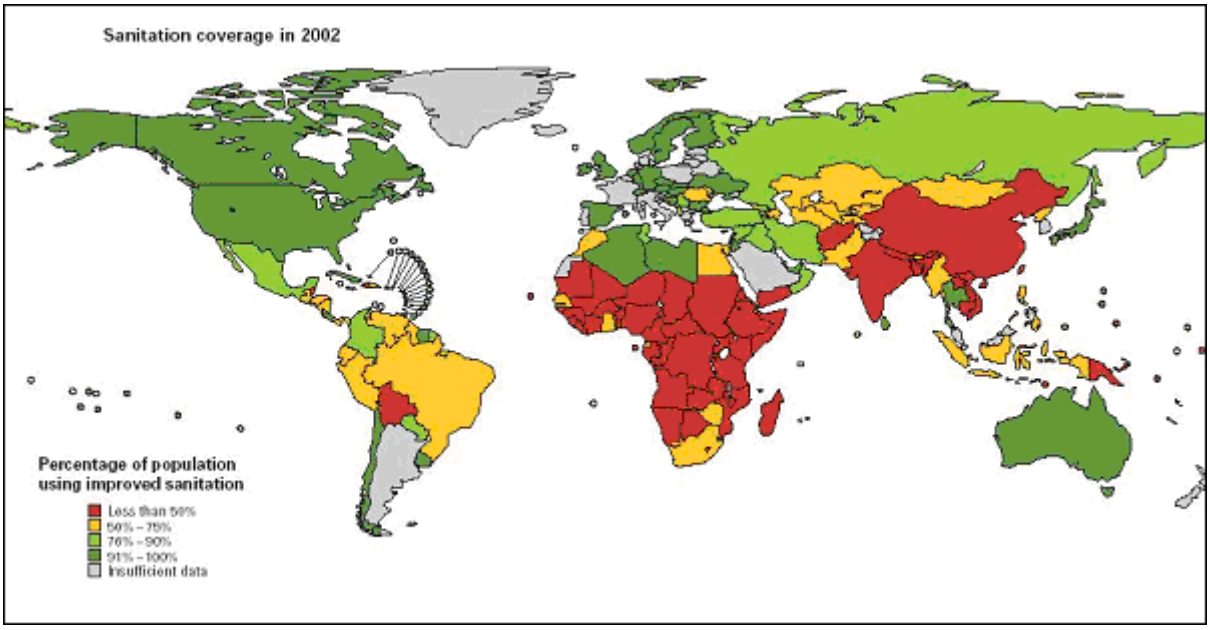


Figure 6: State of sanitation at the country level
Source: UNICEF/WHO (2004): Meeting the MDG Drinking Water and Sanitation Target. A Midterm Assessment of progress, New York, Geneva, p. 12

Forms of privatization and its role in the water and sanitation sector – increased efficiency or surrender to large companies?

In the discussion about overwhelmed on regional and local municipalities the benefits of **privatization** is discussed in an ambivalent way. Before elaborating on the different views on this issue, initially the various forms of privatization, *private sector participation* and *public-private partnership* will be presented, which in spite of their frequent utilization are often used with different meanings. In this study the terms are used as defined in the document *Water*

and Sanitation in the World's Cities. Privatization is characterized by the increasing participation of private companies in water supply and sanitation, which includes, but does not necessarily involve, the transfer of property. The term *public-private partnership* (PPP) describes according to this document the cooperation of public institutions with (one or more) private companies, for services which were previously provided solely by the public counterpart, while the risk distribution is settled contractually (UN-Habitat 2003b:162f.).

The following list describes a variety of different forms of risk sharing and the participation of the private sector in water and sanitation infrastructure and services:

Service contract: temporary agreement according to which the private company carries out a specific task (installation of water meters, repair of pipes)

Management contract: with this the public counterpart transfers the responsibility of operation and maintenance (such as the sewer system) to a company

Lease contract: similar to the management contract, but the private company has also responsibility for the technical and commercial management, and the revenue is exclusively generated from levied fees

Concession Agreement: the private contractor bears the full economic risk

Build-own-transfer (BOT) contract: similar to concession agreement, usually used for projects where the private company builds the infrastructure from scratch

Full Privatization: so far almost only used in England and Wales, a private company not only bears the full economic responsibility, but acquires the assets and infrastructure permanently (UN-Habitat 2003b:169)

Franchising: the private contractor receives support from the public counterpart for maintenance and operation for a fee (Ginneken/Ryler/Tagg 2004).

According to the World Development Movement concession contracts are rarely used and with little success, lease agreements - in which expansion of the network coverage are carried out by the public counterpart - however, had more chances of success. Overall, however, 80% of the contracts would be terminated prematurely (World Development Movement, Public Services International 2006:17).

What interest do public authorities have to involve the private sector? – Mostly there are financial reasons to advertise for private sector involvement, possibly also the hope to improve the service situation. Large companies can have a longer financial breath than local municipalities when it comes to large investments. Small entrepreneurs however may be able to individually respond to the needs and situation of their special clients.

What interest does the private sector have to engage in this area? - The private sector has its own strategies and goals which are not necessarily congruent with those of the international development organizations. The main criterion is profit with economies of scale and a manageable level of political and financial risk represent major considerations. This is most likely the case with build-own transfer contracts or concession agreements, as these fit better into their considerations than for example management and lease contracts. Companies avoid regions with a weak economy or unstable governments, characteristics usually also applied to sub-Saharan Africa. If certain more promising business areas get extracted for privatization from usually less profitable public services (so-called cherry picking), there is the risk for the remaining areas to further drop in their service situation (UN-Habitat 2003b. 171F).

In addition to the considerations regarding large companies that are active in the water sector, also small and smallest businesses are playing an important role in sub-Saharan Africa, for example:

- for the emptying of latrines and septic tanks with special vehicles,
- for the manual emptying in inaccessible places,
- for the sale of sanitary equipment,
- for the construction of latrines and septic tanks, and
- for the maintenance of public showers and toilets at railway stations, markets, sports facilities and universities (UN-Habitat 2003b:182).

Solo argues that the "other" private sector of small businesses does not only offer bad or over-priced service. Instead, it is noted that particularly small businesses in the field of sanitation have a number of advantages compared to large companies and municipalities: Their service is demand driven, it is offered at market prices, it operates at full cost recovery and serves yet the poorest. Their competition among each other avoids monopoly issues, benefits could further be seen in their adaptability (Solo 1999:123). The Sanitation Connection of the International Water Association (IWA) states on its website that still little is known about activities in this area, despite the valuable information small businesses have regarding what sanitation options are promising and where action is necessary (Sanicon 2002b).

Urban agriculture in low income countries: The role of sewage for irrigation of agricultural products – health risk or necessary for subsistence?

Sewage is used to a considerable extent in cities of sub-Saharan Africa for irrigation purposes in the context of urban agriculture. Mougeot defines urban agriculture as “an industry located within or on the fringe of a town, a city or a metropolis, Which grows or raises, processes and distributes a diversity of food and nonfood products, (re-) using Largely human and material resources, products and services found in and around that urban area, and in turn supplying human and material resources, products and services Largely to that urban area” (Mougeot 2000:4). Urban agriculture takes place on private or public land (Dongus 2001:27ff.). Especially in (semi-) arid areas the use of sewage for irrigation is widespread, through the nutrient supply the use of chemical fertilizer can be reduced or completely replaced, additionally leading to cost savings. For the regions assessed in this study particularly in East Africa urban agriculture plays an important role for food and income security, which is often underestimated by governments and international organizations. On the other hand this practice often leads to the transfer of harmful bacteria, viruses, intestinal worms, as well as chemicals from industrial sewage to humans. Apart from health risks and this practice also pollutes groundwater and soil. The complete treatment of waste according to the World Health Organization is in many places illusory, so that locally appropriate regulations are needed in order to minimize the health risks (UN-Habitat 2003b: 226). Options are described in chapter 5.6.

2.2 Options of decentralized sewage management

In this chapter a series of options for decentralized sewage treatment are presented with a focus on the disposal of human waste, as this poses the biggest challenge in the disposal of domestic sewage.

On-site Options

Figure 7 illustrates different dry and water-based techniques. The on-site options require (if the material cannot be used elsewhere as with urine diversion/ composting toilets) collection services, which discharge the latrine or tank contents into a sewage treatment plant or a pond system, with specialized motorized vehicles, in less accessible areas with hand-drawn machines or in least accessible areas manually. Providers of such services are municipalities and (licensed) private entrepreneurs.

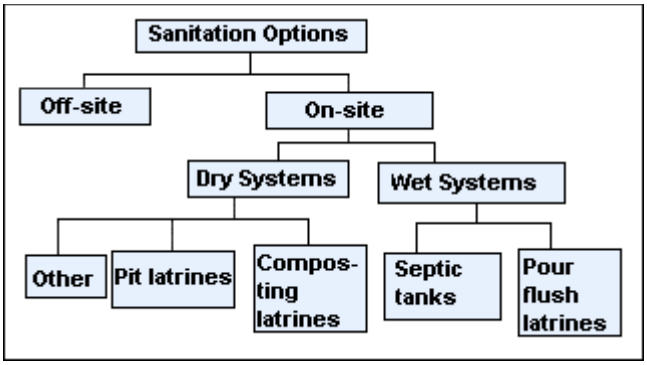
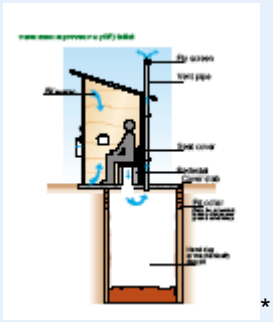
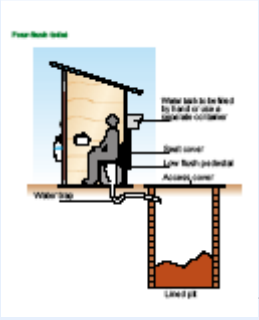
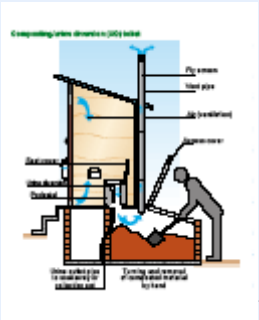


Figure 7: Overview of different sanitation options
Source: Scott 2005

Advantages and disadvantages of a selection of the multiple on-site sanitation options are compared here:

Sanitation option	Advantages	Disadvantages
pit latrine	- inexpensive - does not require water - does not require a fixed superstructure - requires little space	- pit has to be emptied regularly - problems with flies, cockroaches and stench
ventilated improved pit latrine  *	- inexpensive - does not require water - requires little space - fewer flies and stench	- costs occur for superstructure and vent pipe - pit also has to be emptied regularly
pour flush latrine (manually flushed)	- inexpensive - no smell and flies - pit content not visible	- costs occur for water tank - requires reliable water supply - pit fills rapidly with water if insufficient drainage

 *		opportunities
septic tank	- no smell and flies - pit content not visible - full comfort of a flush toilet	- high costs and space requirements - not feasible in densely populated areas - reliable and ample in-situ water supply needed
communal/shared facilities (VIP, pour flush and full flush/ WC)	- probably only option in densely populated low-priced housing areas with insufficient water supply	- risk of lacking responsibility of installation and maintenance - when badly operated not accepted by users - with an increasing number of users becoming less comfortable for users - insufficient safety especially at night
urine diversion/composting latrine (figure 8)  *	- separate further use of (composted) solid and liquid components - seat is fitted alternately to both chambers, with composting and removal taking place in the unused chamber	- a cooperation with further users needs to exist, e.g. for urban agriculture  *Figure 8: Urine diversion toilet* *Source: Frank Stevens*

Source: Nairobi City Council, Water and Sewerage Department (1998): Nairobi Master Plan for Sewer, Sanitation and Drainage, Nairobi, p.203f.

* Figure sources: Department of Water Affairs and Forestry (2002): Sanitation for a Healthy Nation. Sanitation Technology Options, Republic of South Africa.

Community Based Sanitation (CBS)

Where on-site systems at the household level require more space than available or are too unhygienic in densely populated areas and sewer systems are too expensive, small sewage networks (CBS, Shallow sewer, Small Bore or Condominial) can be a feasible option: The construction of such networks is carried out by settlement dwellers in collaboration with a non-governmental organization, the costs are shared by a private or public organization and the users. Costs are saved by the labour carried out by the users, a lower water consumption than in conventional sewer systems and the use of cheaper small diameter pipes that are installed less deep in the ground. Pipes often run through private land, which makes it possible to have shorter pipe connections, but can also pose legal problems in areas with unresolved land ownership, or when land is sold. The advantages are that users often generally assume a greater responsibility during operation of these systems constructed by themselves, and the fact that these systems are also applicable in relatively densely populated areas. For construction, operation and maintenance an efficient self-organization of users is necessary, as well as a reliable in-situ water supply. Trainings are crucial to enable the users to build and maintain the systems by themselves. Treated water can be used for irrigation, generated biogas used for cooking. Sludge treatment facilities should be planned for accordingly, especially for large CBS systems. After drying or composting the material can be used as fertilizer. The various components of the toilets, sewage collection, treatment and recovery offer options for combination to customize the system to local needs (BORDA w.y.a).

Three popular forms of community-based sanitation systems are (see figure 9):

1. "Simplified sewerage systems for settlements: Low-diameter sewer system that collects and discharges household-sewage from houses of settlement into one low-maintenance sewage treatment plants.
2. Shared septic tank system: A number of houses are connected to one septic tank.

Systems 1 and 2 are appropriate for smaller and larger poor areas where houses are privately owned and households are willing to invest to upgrade sanitary hardware.

3. Community Sanitation Centres: Consist of public water points, toilets, bathrooms and laundry areas. Most Appropriate in settlements where majority of residents live in rented accommodation and where space is limited for in-house sanitary hardware." (BORDA w.y.a)

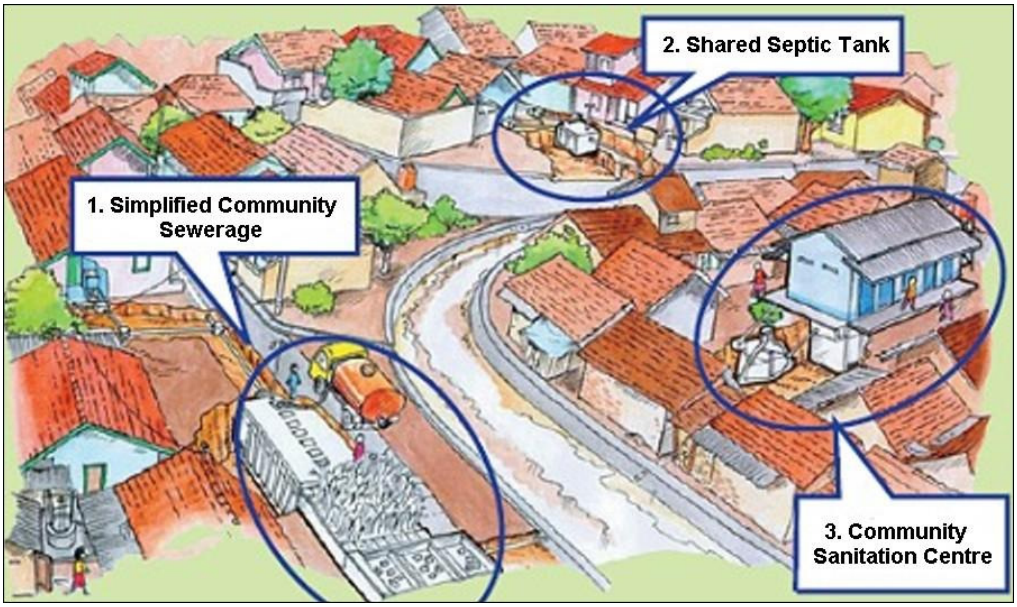


Figure 9: Three forms of community-based systems Sanitation

Source: BORDA w.y.a

Decentralized Wastewater Treatment Systems (DEWATS)

For small units such as hospitals, schools, small and medium businesses and communities also DEWATS, decentralized wastewater treatment plants, can be a solution. DEWATS are built from local construction materials, require no electricity and therefore cannot suffer from power failure or be switched off. DEWATS consist of four treatment phases, which can be adapted as needed (figure 10): 1 Sedimentation tank (settler) for the sedimentation of components that are heavier or lighter than water, 2 Anaerobic treatment in anaerobic baffled reactors: sludge settles in slow flow and nutrients are removed through microorganisms, 3 Solid filter made of plastic elements on which turf processes further purification (anaerobic filter), 4 further purification and separation by settling of sludge under aerobic conditions in polishing ponds. The first to third phase can be carried out underground, allowing an alternative use of space, e.g. for roads or parking lots. Subsequently, the nutrient-rich water can be used for irrigation, e.g. in urban agriculture (BORDA 2005:35ff.).

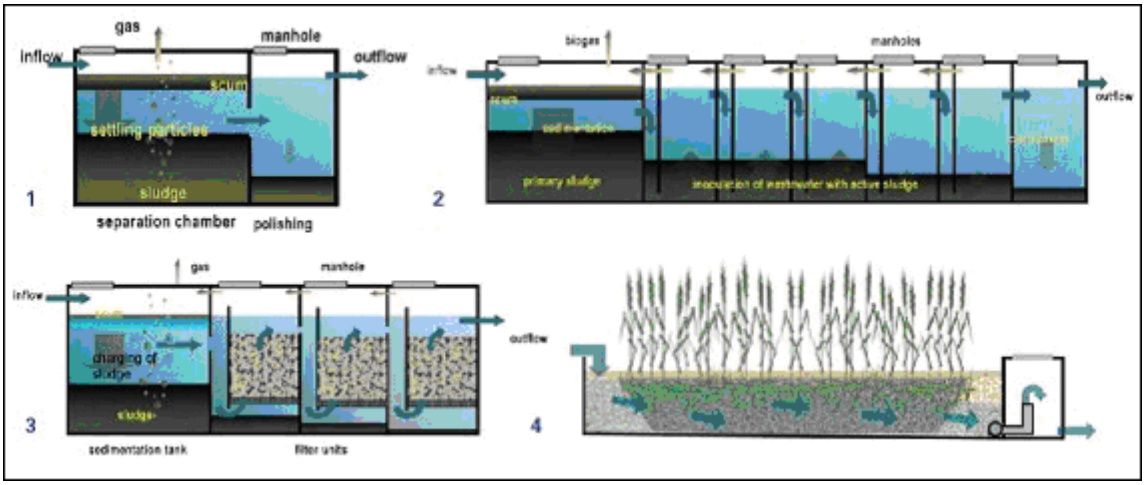


Figure 10: The four purification phases of DEWATS

Source: BORDA w.y.b

Wastewater Stabilization Ponds

Because of their simplicity and low capital and operating costs Wastewater Stabilization Ponds are the preferred option for sewage treatment in Tanzania and Kenya (Nairobi City Council 1998:XXXII). Through a series of anaerobic, facultative (either anaerobic or aerobic) and maturation ponds (aerobic), the sewage is treated by microorganisms and natural UV radiation in ponds and subsequently introduced into a natural water body.

In sewage treatment, anaerobic processes have the advantage over aerobic processes that five times less sludge and less CO_2 are generated, but more methane, which can be used for domestic or industrial heating. In addition, anaerobic systems have lower construction and energy costs as they require a smaller pond volume than aerobic systems where the sewage must completely be in contact with oxygen and therefore needs to be swirled with fans. Through the sale of biogas anaerobic plants can even

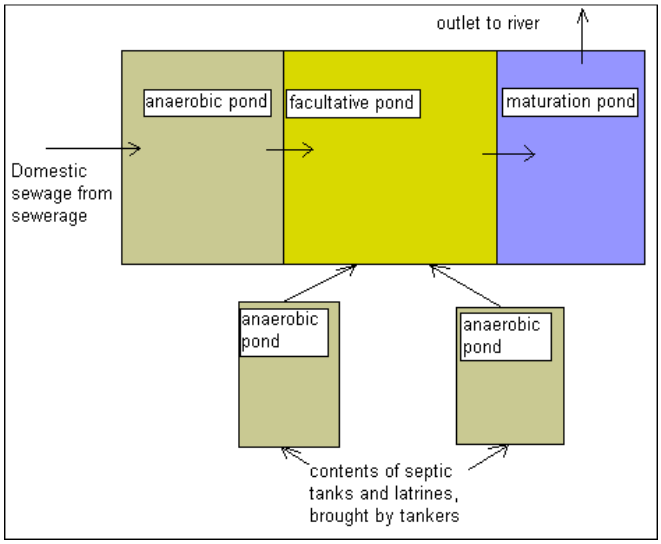


Figure 11: The pond system in Msasani with 5 oxidation ponds

Source: Author

generate income. Duckweed and water hyacinth growing in sewage can be fed to cattle (Nhapi/Gijzen 2005:137). An example of a Waste Stabilization Pond System is shown in figure 11 from Dar es Salaam.

Ecological Sanitation (Ecosan)

Conventional treatment systems that generate sewage sludge that is hazardous waste and discharges nutrients and pathogens into rivers and seas are seen as a source of environmental problems in the Ecosan approach, in industrialized countries as well as in developing countries. According to the principle that there is no waste in nature, Ecosan systems strive towards fully recycling all waste constituents and to close nutrient cycles, to use water economically and to minimize pollution (Werner 2001). Ultimately this can help preserving soil fertility to contribute to food security. Biological treatment processes substitute those requiring electricity. Treated sewage and solid components find their reuse in the production of biogas, fertilizers and irrigation. In some cultures in China and East Asia these principles have been applied for centuries. They can also make an important contribution to achieve the MDGs (Werner/Fall/Schlick et al. 2004, p.23). This approach should not be regarded as a second choice for areas without sufficient capital to construct a conventional sewage system, but rather as an opportunity in regions where sanitation systems are still developing to implement sustainable technologies upfront (Austin 2002).

3. *Methodological approach – a comparative study*

3.1 Selection of cities – a comparative approach using case studies

"In a comparison two or more subject areas are related to each other to determine aspects which are the same and which are not. In a second step the causes of these equalities and inequalities are assessed: The researcher analyzes what those countries with certain common features otherwise also have in common. In a third step, these results are then framed into more general findings" (Bell 2005:50).

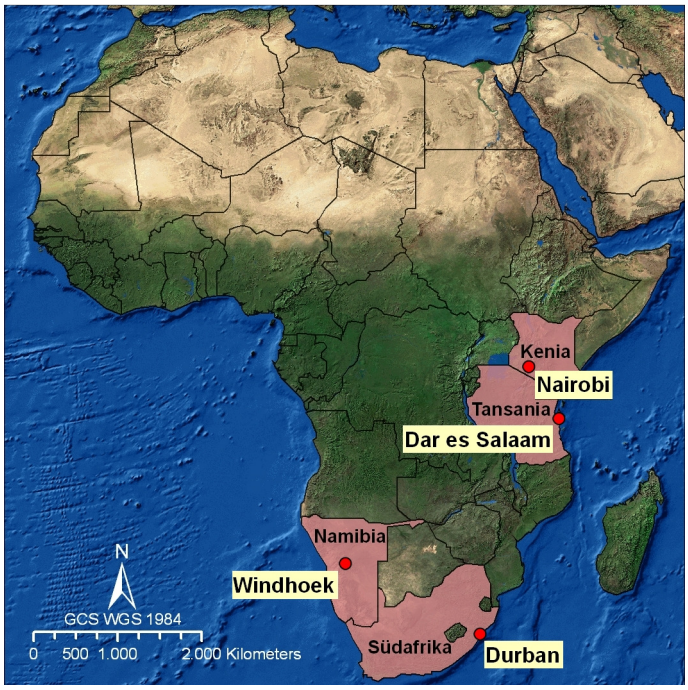


Figure 12: Overview of the situation of the countries
Source: Own compilation based on ESRI

Since sub-Saharan Africa is a very diverse region with respect to formal development, climate, water resources etc., a case study approach has been selected for the analysis. By comparing selected cities that are representative for their region, certain recurring problems are identified as well as the various strategies and approaches that have been developed in these cities. Two different regions were selected, which feature different conditions and circumstances: Southern Africa and East Africa. Countries were selected whose political situation allows for an empirical study and in which at least basic sewage infrastructure is in place that can be analyzed. Within the Southern African region South Africa has the highest urbanization rates as well as the largest cities due to rural-urban migration (mainly because of search for job opportunities, fleeing political and family conflicts (Smit 1998. 80) and population growth (Bird 2002). Based on its very small population size and density Namibia is an interesting contrast to this. Therefore for *Southern Africa* Namibia and South Africa were selected, with the capital **Windhoek** being selected for a case study. In South Africa the city of **Durban** was

selected for reasons of accessibility of interviewees. In *East Africa* the requirements were met by Tanzania and Kenya; for Tanzania **Dar es Salaam** - is not formally the capital, but largest city, seat of government and business hub – was selected for a case study, while for Kenya the capital **Nairobi** – one of the largest cities in East Africa - was selected. The selected cities are intended to be both representative of their region and to represent different living standards (Ruhr-University Bochum 2005:1). As with the countries in Southern Africa also in East Africa one city is situated at the coast and one in the hinterland, providing a further aspect for the comparative analysis. The location of the analyzed cities is illustrated in figure 12.

3.2 Selection of methods – interviews and observations

This section presents the methods and approaches applied in the study, which were used to verify the hypotheses. Depending on the type of research question and the degree to which a subject has already been examined different methods of empirical social research are favourable. Choosing between quantitative and qualitative methods, qualitative appear to be more applicable in this context, because "*qualitative* methods (...), as we shall see, are not focused on figures, but on the action itself and the rules behind actions" (Girtler 2001:35ff.). This seems to be an appropriate approach for the present topic. Atteslander distinguishes 4 methods of social research: content analysis, observation, *interview* and experiment (Atteslander 1993:72). In this study interviews were carried out in the form of guided interviews, because the topic of analysis represents a less explored area and can therefore be better captured by an open form of an interview. Lamnek categorizes five types of qualitative interviews: narrative interview, focused interview, in-depth interview, receptive interview and *problem-centered interview*: "The problem-centered interview is often used to analyze social problems, while main aspects of the problem have been assessed by the interviewer before the interview phase (Mayring 1999:46). In this case the problem-centered interviews were used to assess the various aspects of sewage management and to relate them to each other. This requires thorough preparation through literature review and preliminary discussions to clarify the overall context and to design the scientific concept of the study. This included research (via internet, libraries, phone calls and visits to organizations such as the German Technical Cooperation, the Bremen Overseas Research and Development Association, the Chair of tropical water management at the University of Lüneburg), as well as contacts not only by email but also via telephone to the selected city municipalities and related agencies. Adapted behaviour to regional customs and - at least in East Africa – the launch of the discussion in Kiswahili were useful in the selected cities to

encourage potential interviewees to provide an interview and the disclosure of information. In the sewage authorities of the municipalities the respective managers were contacted, which usually gave an interview and also made additional interviews with other employees possible. In addition, representatives of international organizations were contacted that are active in sanitation issues in the selected cities.

Guided expert interviews – Preparation of the 2 guides

The interview guides were developed to operationalize the hypotheses, and investigate the three topics stocktaking (hypothesis 1), international context (hypothesis 2) and approaches (hypothesis 3) further. Semi-structured interviews with open questions were chosen to combine the advantages of standardized and unstructured interviewing techniques.

Two different interview guides have been developed: 1 A more elaborated guide for representatives of sewage authorities covers a wider range of aspects of sewage management. To ensure a good flow of the interview as Bellers proposes, the core aspect of interest, the problem complex of the waste disposal itself, dealing with the various sanitation options (centralized via a sewer system and on-site), was placed at the center of the interview after an introductory stocktaking of the financial and human resource context and followed by a section on the legal and planning context as well as aspects of quality standards (Beller 2005:66). Main aspects of interest included the stocktaking of existing sewer networks, treatment plants and on-site systems as well as to explain what type of facilities exist where and to assess the costs of different options in relation to each other. 2. The focus of the shorter guide for representatives of international aid organizations is to analyze their work in the sewage sector in each city in relation to the overall context, including a stocktaking of organization structure, relevant actors and problems. Additionally, by querying some parameters that have also been discussed with the municipalities, the answers of both municipalities and international organizations could be cross-checked and relativized where necessary.

Note to the importance of different question sets: It is crucial to assess the various cities in their environmental context, because e.g. climate and water availability have an impact on the feasibility of sewage treatment processes. The number and level of capacity of staff can provide indications, which technologies based on the conditions are promising. The question set on costs and financing provides information about when, to what extent and with which technologies an upgrade of services may be possible. When querying costs it is important to keep in mind that the sewage fees paid by consumers in most countries are not identical with the actual costs that arise with disposing and treating sewage. The usual practice is that the

fresh water tariff includes a certain fee for the sewage disposal and treatment. The information gathered from interviews has been supplemented by various other sources, including legal texts, annual reports from plant operators, etc.

Selection of interviewees and conduction of interviews

To interview residents of all four cities regarding their level of service was unrealistic for a number of reasons (size of cities and the very different type of service level within each city would have required very large sample numbers). According to the research question it was considered best to interview representatives responsible for sewage management as well as other stakeholders with commitment and relevant background knowledge, including representatives of sewage associations in the selected cities, research institutions and international organizations. “Experts are knowledgeable people who - as stakeholders in the respective field - possess specific knowledge and experience. They are therefore interesting less as individuals, but rather as representatives of a group” (Flick 1995:109).

The selection of interviewees was conducted according to the *purposeful sampling* approach (Baxter, Eyles 1997:513) to ensure that various relevant perspectives are recognized. At the end of each interview it was also asked for other potential interviewees. The fact that most proposed individuals had already been included as interviewees can be considered as a confirmation of the coverage of relevant persons. Nevertheless each new hint was followed to ensure that the group of interviewees is not limited to one group of individuals that know each other. – Significantly more literature and information is available in countries with higher service standard (southern Africa) compared to Eastern Africa. In turn in countries with a lower level of sewage services (Eastern Africa) there is a much broader landscape of governmental and non-governmental organizations that are active in the sewage sector, which explains the higher proportion of interviews in these cities (see interview list in Annex B). This seems to be the result of overwhelmed municipalities struggling to provide sanitation services, which leaves demand for further commitment of other agencies and organizations. - The interviews were held in mid-April to mid-May 2006, the discussion guidelines are in Annex A. In Windhoek eight interviews were held, in Durban nine, in Dar es Salaam and 12 in Nairobi ten. Two interviews per city were conducted based on the longer guide for sewage authorities (Windhoek: Mr. Brinkmann and Cronjé, Durban: Mr. Stevens and Macleod, Dar es Salaam: Mr. Mulagwanda and Midala, Nairobi: Mr Mugo and Kimani), the others using the shorter guidelines for international organizations.

Validity of the results

To take stock of potential problems, a more subtle form of an assessment seemed necessary than including a question set on “problems”, this would have most likely rather led to a rejection or downplaying of challenges (Hantschel/Tharun 1980). Therefore, questions touching upon potential challenges were distributed throughout the discussion guideline where they fit thematically. Girtler addresses the problem that in interviews there is the chance that the interviewee tries to create a positive image through his responses (Girtler 2001:139). Therefore the interviews were supplemented by visits to challenged neighborhoods, informal settlements, slums, sewage treatment plants, public sanitation facilities, sea outfalls (pipes draining sewage into the sea) etc. to detect any discrepancies compared to information from interviews. Reasons for partly differing representations of issues between respondents may be the attempt of a possible positive representation by the municipalities (shedding a positive light on the responses of international organizations), on the other hand the municipality as the main responsible agency may have more accurate information e.g. on the sewer network and treatment plants (shedding a positive light on the responses of municipalities). The ranges of responses are set out in the case study chapter and commented if necessary.

Analysis of the interviews – methods of data processing

The analysis of the interviews requires an abstraction of the questions of the interview guide in order to evaluate the initially identified hypotheses (Hantschel/Tharun 1980:73). Note is to be taken that "the statements received through a open discussion in the context of a free field research [are] not necessarily to be used literally, but they are to be interpreted by the researchers according to the social context" (Girtler 2001:57f.).

During the research stay in Windhoek and Durban all interviews were recorded with the consent of respondents and then transcribed directly to include further information provided after the interview, e.g. in subsequent visits to treatment plants, construction sites, etc. During the transcription filler words, non-verbal elements, etc. were omitted, since the focus was on the content of the statements (Flick 1995:264). In Dar es Salaam and Nairobi only a few interviews were recorded, which was due to the circumstances under which the interviews were conducted: In some cases interviews were conducted in offices with a lot of through-going traffic of people (e.g. by customers who complained about water bills), or because despite a separately detached office area of the interviewee there was a large volume in the adjacent shared office, or at another interview, because after the first minutes

of the interview a power cut occurred and a generator started, which was standing right next to the interviewee's desk – therefore making a recording pointless because of background noise.

The content analysis was performed according to the qualitative content analysis. "The content analysis is a method of systematic text analysis that seeks to avoid the criticism of the arbitrariness of hermeneutics by dividing texts into arguments and to identify their nature and frequency" (Beller 2005:73). The construction of types is one of the "most important non-quantifiable means of knowledge-gaining of the social sciences" (Fox Heinritz 1995:690). The qualitative content analysis tries to assess the attitudes and interpretations that are transported in statements to determine an impression of the actual social context through an analysis that goes beyond the mere statements of the interviews. According to the content analysis, the collected material is divided into arguments and statements and split into categories (Reuber/Pfaffenbach 2005:170). Mayring distinguishes three approaches: the *summary*, the *explication* and the *structuring*, in this case the explication was used, which aims at interpreting certain passages regarding text and attitude/interests of its author through the use of additional material (Mayring 1999:85f.). Critics accuse the qualitative content analysis to be non-scientific, particularly the inductive approach is criticized not to generate universal axioms, whereas its supporters respond that this is not the primary goal of the approach, but rather the classification of action patterns (Lamnek 1995:172ff.).

While the analyzed cities feature very different national contests emphasis it put to ensure a certain comparability among the different case studies. For this reason the evaluation is structured along the top issues of the first (longer) interview guide. In order to differentiate the situation in each city, a map has been acquired for each city categorizing the areas where individual full supply, public sanitation facilities, on-site systems or no service is available, known as *sanitation mapping*.

Critical evaluation of the methodological approach

Impartiality in the preparation of qualitative research is important, otherwise there is danger of a self-affirmation effect. It refers to the tendency to notice information that confirms own hypotheses more easily than that information that contradict them (Baxter/Eyles 1997:505ff.). This applies to the preparation, literature search and selection of interview partners as well as the tone, facial expression and gestures, with which the questions are asked. The influencing of respondents towards what is anticipated by the interviewer is called "Rosenthal Effect". To avoid this, it is advisable to become conscious of own background knowledge and

potential bias, and explicitly not to look only for confirming information (Holweg 2005:186). Regarding the background knowledge this was addressed by the author through reflecting the impressions of the situation on the ground in two of the four selected cities from previous visits, and to challenge these initial impressions with a broad literature review. As for the selection of interviewees it was tried to achieve a balanced mix of representatives from municipalities, German and international development organizations. To avoid content-related bias each interviewee was given the opportunity to raise any additional points that were not covered in the interview guide in order to do justice to the varying national circumstances. These points are referred to in the evaluation as "challenges". Additionally the author remained alert for any excursions during discussions that were not covered by the guide to avoid any important aspects to remain undetected.

Regarding the snapshot problematic: Due to a lack of comparable information from the past no observation or survey over a longer time periods was possible for this study. To consider the development over time to a certain extent, any additional information in literature and internet research on events in the recent decades has been included in the analysis.

3.3 Special aspects and difficulties

1. Cost information from interviews and literature included the four currencies of the countries studied, as well as figures in U.S.$ and €. For better comparability, they were all converted to one currency, the choice of the exchange rate was a challenge, especially the U.S.$ exchange rate fluctuated in Tanzania during the investigation period due to global political conflicts over Iran. For this reason all financial information has been reported as equivalent in €. But still the comparability of financial information is limited, because the values do not reflect the purchasing power in each city (e.g. a fee of 20€ can be more affordable for an average income earner in Durban than one in Dar es Salaam).
2. The lack of information and information validity: As also the International Water Association elaborates, it can be difficult to gain access to current reliable data. To remedy this, it established a website *Sanitation Connection* www.sanicon.net, the information of which has also been used to supplement this study. – In the analyzed cities it was particularly difficult in Eastern Africa to access basic information such as the extension of the sewer system or the existence and type of on-site sanitation. Additionally information varies greatly between service providers and users (WHO/ UNICEF 2000:77). Structural measures are insufficiently documented in

administrations, collected data quickly becomes outdated. As a result especially for Dar es Salaam and Nairobi the sanitation mapping can only present the situation in relatively broad terms.

3. Also information material was screened that lacks information on authors and years of publishing, which – though not quotable – provides a valuable insight into the topic, e.g. flyers and self-promoting material of various organizations.

4. Sewage management in selected cities

This chapter features four case studies that illustrate the current sanitation situation in the respective cities, with a focus on the various mutually conditional challenges, the next chapter assesses possible approaches for solutions. Information marked as “from … to …” indicates the range of responses of different interviewees.

4.1 Windhoek

Figure 13: Location of Windhoek in Namibia
Source: Own compilation based on ESRI

Windhoek is located in the center of Namibia (figure 13) 1654m above sea level, because of its height the temperature is 15°C to 25°C average. The average rainfall is 260mm per year, which mainly falls between January and March (Pack/Pack 2002:165). (In comparison Germany has approx. 800mm precipitation annually.) Water shortage is considered one of the main limiting factors for development (Arya 2006). Because of Namibia’s water shortage in Windhoek the need for sanitation is closely linked with an efficient reuse of treated sewage. – In 2001 38.7% of Namibia’s population lived in Windhoek (Republic of Namibia 2003), 233.530 inhabitants (2001), with an urbanization rate of 4.44% in 2001 (GTZ/Government of Namibia 2005:1ff.). Though according to its average per capita income Namibia would classify as a middle-income country, the income distribution is one of the most unequal in the world with a Gini coefficient of 0.7. During the colonial era and the apartheid regime unequal land ownership manifested to the detriment of the native population, which suffered from scarcity of land and insecure tenure. After the abolition of the ban for factory workers to bring their dependants to the cities they worked 1977 and independence in 1991, urbanization processes accelerated, leading to a rapid growth of informal settlements on the outskirts of cities (Seckelmann 2001:1ff.). Informal settlements are those that are inhabited without prior passage through the legal procedure for land acquisition or rental. These are usually not connected to the public supply and disposal networks and inhabitants do not have the opportunity to take out loans on their land or house, nor are there incentives to develop infrastructure on their own, as they may have to leave the land at some point (GTZ/ Government of Namibia 2005:1ff.).

In addition to the sewage authority also the water utility *Namwater*, representatives of the *Gammams Wastewater Treatment Plant*, managers of public sanitation facilities in the city, staff of the *Vocational Training Center*, the *Desert Research Foundation*, workers in the poor district Katutura and the GTZ, as well as two persons (Mr. Kozonguizi, UN-Habitat Program Manager, UNDP Namibia and Mr. Rust, Department of Planning, Urbanization and Environment, City of Windhoek) were surveyed via email. Their statements and visits in these places built the basis for the following analysis.

Expert interviews in Windhoek

Organizational matters

In Windhoek, the **Department of Infrastructure, Water and Technical Services** of the City of Windhoek (*City of Windhoek*) is responsible for sewage management, which is run according to commercial criteria.

The Department receives its **finance** from the sewage fee, if a profit results from its operations it must be submitted to the City of Windhoek.

This organization also manages the **water supply**, the water is received from Namwater (60%) in Okahandja as well as from groundwater and treated sewage.

A **privatization** of areas of sewage management is not an issue at the moment to avoid a loss of control, the focus is on the protection of groundwater resources (Gerhard Cronje).

Objectives and guidelines

According to the **Windhoek Integrated Environmental Policy** the municipality has committed itself to environmentally sound practices. Environmental challenges with relation to sewage include groundwater and soil damage caused by leaking sewers, septic tanks and French drain systems (stone trenches for drainage) as well as the eutrophication of surface waters from discharge of sewage treatment plants. The following measures have been adopted to address these challenges: The establishment of a monitoring system for leakage from canals and treated water from treatment plants, pollution is supposed to be minimized at their source including hospitals, industry and households, as well as the introduction of a

land use management system with the identification of specific groundwater protection zones, in which only limited activities are allowed. – For the implementation of these measures future sanitation projects in groundwater extraction areas are supposed to be regulated, water quality standards will apply to all sewage treatment plants, leaking sewers and septic tanks to be repaired and possibly extended to required capacity while applying environmentally sound techniques will be applied; for continuous monitoring and evaluation of measures the municipality participates in an auditing program (City of Windhoek 2004b. 26ff).

Staffing

The Department has **172** employees composed of **various professionals**, mostly engineers (specialized for water and sewage, mechanics, electrics), managers, staff for the maintenance of sewers and small local sewage treatment plants, etc. (Geographical Information System (GIS) matters are under the responsibility of the Department of Information Technology, in this Department one person is responsible for GIS and Computer-Aided Design (CAD) applications).

It is **difficult** to find suitable staff, especially engineers and trained technicians with experience in water and sewage issues, for other disciplines such as road construction it is easier (Ferdi Brinkman).

Financing

Due to technical problems with water meters in residential areas the **sewage fee** is not charged according to the freshwater consumption, instead the fee is assigned depending on the lot size its estimated value. (For industry and business the tariffs are determined according to water consumption and degree of pollution.) This may at first look arbitrary, but the approach behind it is to distribute the fees fairly: Owners of larger properties are usually also able to pay higher fees, additionally experience shows that larger lots often coincide with higher water consumption for garden irrigation or swimming pools. The fee is staggered widely, more or less as a rising block tariff (within certain consumption classes the fee is constant, but rises with higher consumption class): e.g. for a plot of between 400 and 899m^2 the fee is €6.44.

The **collection** of sewage fees is done in conjunction with other fees (water, electricity, waste collection), therefore it is difficult to identify the exact amount that is unaccounted for sewage services, if e.g. the combined fee is not paid fully by the user. Internally however, the received fees are usually allocated in favour of sewage treatment, as unaccounted fees for electricity and water are less difficult to demand from users through the interruption of electricity or water through the city of Windhoek (Ferdi Brinkman).

Management of disposal and treatment

Regarding the questions of investment and operating costs, management and maintenance costs of infrastructure and the advantages and disadvantages of **on-site options (dry and water-based)** compared to **centralized systems**, there was no answer possible, because the municipality of Windhoek does not plan or want on-site sanitation options in any case. Most settlements are connected to the sewer system (figure 14), except for areas in the far north of the city, which cannot drain into the public sewer system due to their geographical situation, because they are situated on the other side of a crest and therefore sewers cannot drain across the crest due to the slope, also rocky ground hinders the creation of sewers and which host informal settlements (figure 15). The municipality plans to keep on-site systems at a minimum to protect its limited groundwater resources, which are located under the city, from pollution through leaking latrines. The municipality of Windhoek therefore wants to keep the full control over as much of the sewage volume as possible and also ensure this control in the northernmost part of the city through the construction of another small treatment plant, which will be located on the other side of the crest to enable the northern settlements to discharge their sewage there. This is to maintain equally high quality standards across the city (Gerhard Cronje). Figure 15 shows that in the north of the city shared sanitation facilities predominate, which are connected to the sewage network, while in the far northeast there are still pit latrines.

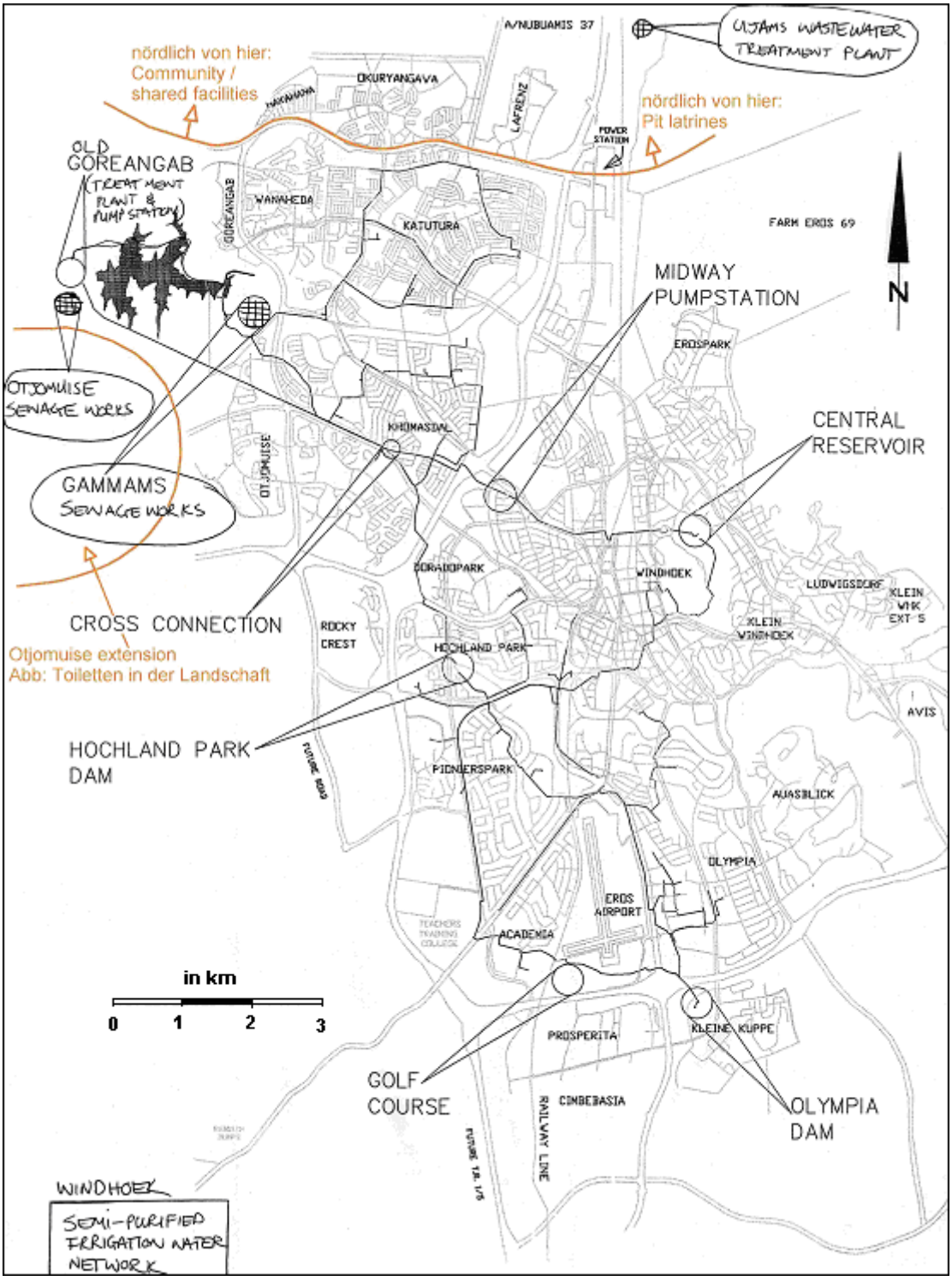


Figure 14: Coverage of the raw water network of the city of Windhoek, which coincides largely with the sewer network

Source: Material provided by Gerhard Cronje

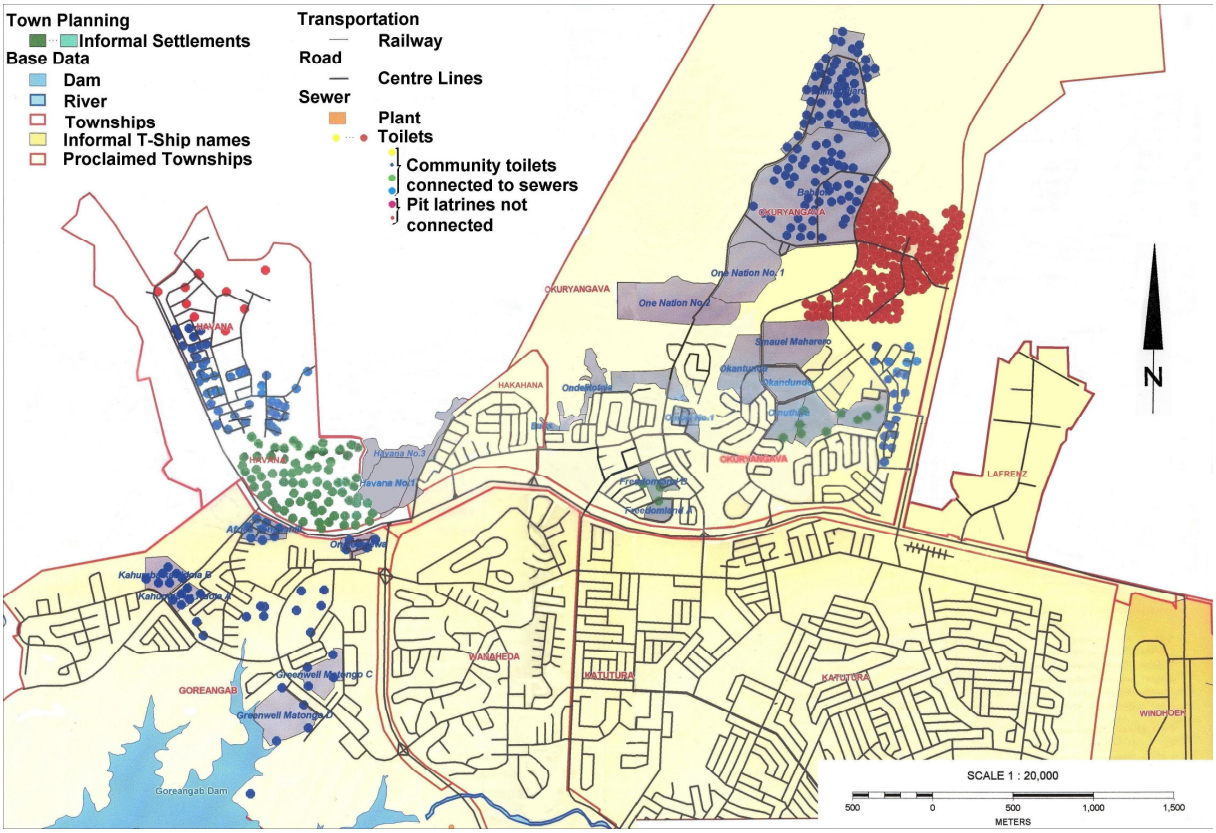


Figure 15: Northern part of Windhoek, which is serviced with on-site sanitation facilities
Source: Material provided by Gerhard Cronje

Public sanitation facilities that drain into the sewage system are installed in informal settlements where the inhabitants are either not able or not willing to invest (because land tenure is not safe) into their own sanitary facilities (Hugo Rust).

Special features of the **sewer and channel network**: In addition to the sewer and channel network for freshwater that services private, industrial and commercial users in Windhoek exists a raw water channel network, which provides recycled, non-potable raw water that is being used for irrigation of public green areas (cemeteries, parks, sports grounds) in order to save the scarce drinking water. About 85% of the residents of Windhoek are **connected** to the sewer system, the rest lives in the northern region, which is not connected to the main grid due to the above mentioned reasons. 17% of the residents of Windhoek use simple latrines and VIP latrines, partly as shared facilities (UN-Habitat, 2003b:29). - There is no other **sewage managing agency** in the city.

The city has five **sewage treatment plants**:

1. Gammams Wastewater Treatment Plant - treats domestic sewage for reuse and irrigation (figure 16).

2. Otjomuise Wastewater Treatment Plant - treats domestic sewage for irrigation.
3. Ujams Wastewater Treatment Plant - Industrial sewage treatment for irrigation of rolled sod that is sold.
4. Old Goreangab Water Reclamation Plant - Water treated for irrigation of sports grounds, receives treated water from the Gammams Wastewater Treatment Plant, the Otjomuise Wastewater Treatment Plant and water from the Goreangab Dam.

Figure 16: Gammams Wastewater Treatment Plant
Source: Author's photo

5. New Goreangab Water Reclamation Plant - the first facility in the world and still one of the very few that processes pre-treated sewage (from Gammams Wastewater Treatment Plant and water from the Goreangab Dam) up to *drinking water* quality. A membrane filtration technique removes bacteria, viruses and pathogens from water. Mixed with fresh water from the stream Dam the water is fed into the public supply grid. The **recycled water** is subject to regular quality control (according to World Health Organization guidelines, national and South African standards); no cases of adverse health effects are known since the introduction of this practice in 1968, (City of Windhoek, w.y.). Together with the raw water system for irrigation and artificial groundwater recharge, these are the components of an integrated water management approach, which reduces Windhoek's water demand from conventional sources (dams and groundwater) to one third if fully utilized (Merwe, 2000:381). Figure 17 gives an overview of the complex network of sewage treatment plants in Windhoek.

The **sewage sludge** from the treatment plants is composted and sold and utilized as fertilizer for sports grounds.

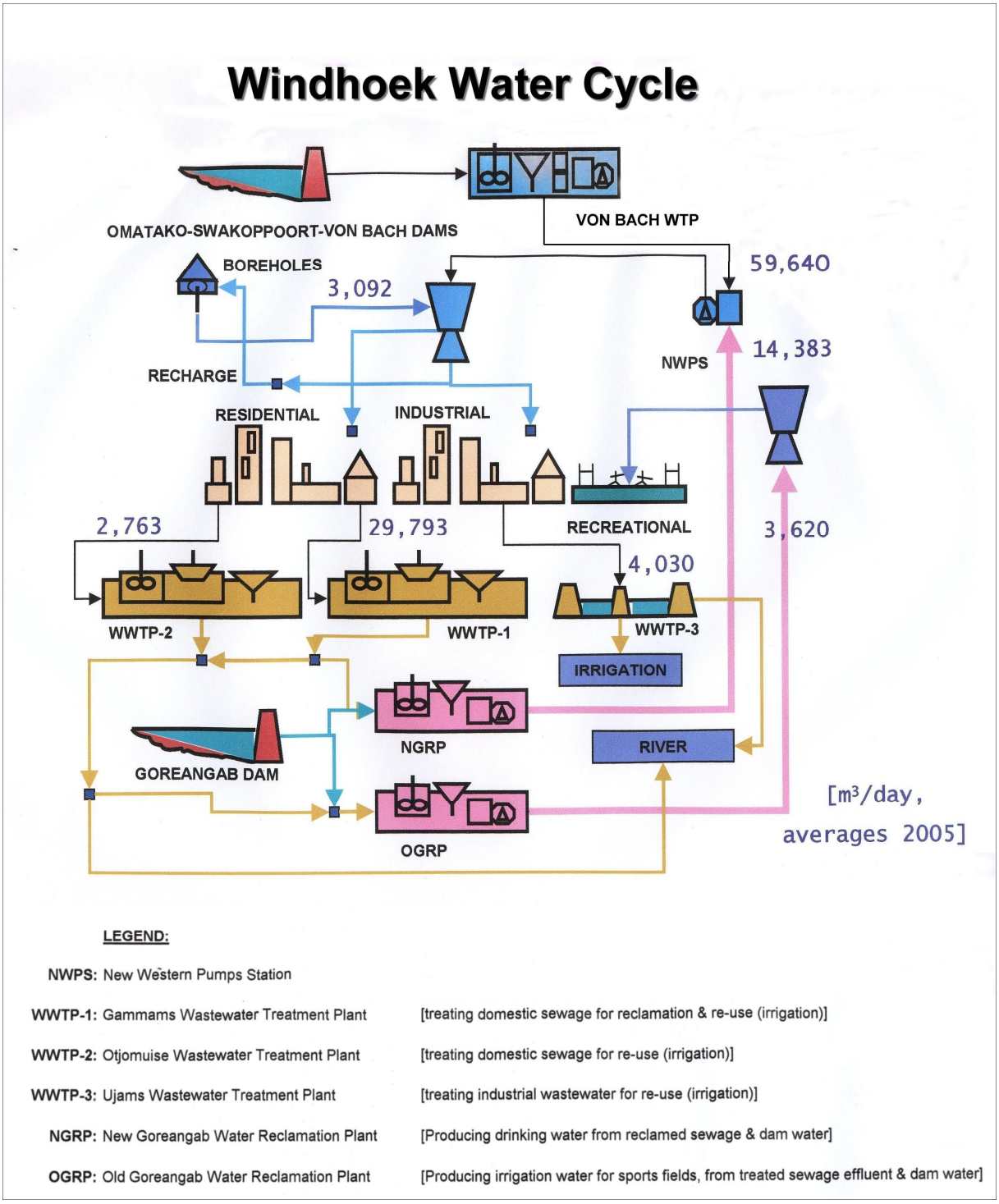


Figure 17: The network of sewage treatment plants in Windhoek

Source: Material provided by Ferdi Brinkmann

Legal framework

The national *Department of Water Affairs* establishes certain standards for water laws, the identification of thresholds is carried out in accordance with the legislation in South Africa.

The legal basis is set out by the **National Water Act**, which is undergoing revision, and which identifies the *Department of Infrastructure, Water and Technical Services* of the municipality of Windhoek City Council as the agency responsible for sewage management. The latter in turn determines Drainage Regulations, which have to be followed by its customers, both industry and households.

The **Drainage Regulations** had been first established in 1930, since then construction work and repairs must be carried out by registered professionals only. Owners of septic tanks have to give notice to the municipality as soon as their tank is filled to three quarters in order to ensure timely emptying. The municipality may demand owners of septic tanks to switch to the sewer network within one month, if their estate has been connected to the sewer system. Connections to the sewer system may be carried out only after receipt of written permission. Planning need to be carried out by engineers, land surveyors, architects and architectural draftsmen (Municipality of Windhoek, 1930).

Planning base

Regarding the question what information on special distribution and volume of sewage generation builds the basis for **planning**: The department doesn't plan independently, sewage services planning is integrated in the overall housing and settlement planning carried out by the Town Planning Department, which calculates need for expansions of the existing sewer network and treatment plant capacities when planning new settlements (Ferdi Brinkman).

Figure 18: Otjomuise extension, formal and informal sanitation
Source: Author's photo

In a newly district Otjomuise that is still under development and in which low-income residents are supposed to settle, it was observed that there were hardly any buildings yet, but the landscape was already riddled with toilets and hydrants (figure 18). Representatives of the GTZ noted, however, that some toilets overflow and some of the estates are located "in a river" (or rather in a wadi of a non-perennial river). The allocation of compensation areas however took so long that the residents rather stayed on these areas.

Quality control

The **quality control** of the sewage treatment is being carried out by a respective laboratory, where regular tests are performed regarding all sewage parameters identified in the water law. For the case of emergencies a **contingency plan** exists with a stand-by team to repair leaking channels, etc. To be prepared for the event of a power cut it is planned to build absorption reservoirs, in which the sewage can be stored until the power is restored and the water can be let into the treatment plants again (Ferdi Brinkman).

Challenges

In surveys about necessary improvements in informal settlements in December 2003 the point noted second-most often among the general comments and concerns in Kahumba ka Ndola, Greenwell Matongo, is the need for toilets (most noted was the need for more stations and third-most noted were schools and hospitals (City of Windhoek, 2004a:20).

Conclusions

The sewage management of Windhoek with 85% of households served good, the other 15% will partly be connected to a new sewage treatment plant. Since the municipality wants to retain full control over the urban sanitation management, the extension of the sewer system is the only option. In informal settlements however, there is still a large gap between settlements, which are connected to the grid and those that still use "the bush" (George Kozonguizi). In these cases more public sanitation facilities that are connected to the grid may be an option.

In the informal settlements the informality is the main obstacle to a connection to the sewer network, the *Shack Dwellers Federation* is an NGO committed to assist residents of informal

settlements, helping them to acquire the land on which they reside legally. *The Habitat Research and Development Centre*, the *Namibia Housing Action Group*, *Polytechnic of Namibia*, the *Self-Help Group Twahangana*, the *Ministry of Lands and Resettlement* and the *Ministry of Regional, Local Government, Housing and Rural Development* are also active in this area. The formalization of informal settlements is also part of the achievement of the 11th target of the 7th MDG, improving the lives of 100 million slum dwellers significantly by 2020. To reach this, the following measures are being taken by the municipality Windhoek:

Households with a low income often have lot sizes of about 150m^2 only and therefore fall below the minimum lot size of 300m^2 in Windhoek (GTZ/Government of Namibia 2005:6). For this reason the municipality allows the purchase of land by groups of citizens, while these groups do not have to pay for the land itself, but only for the connection to the public facilities and connection to the road network. The reason given for this is that otherwise many urban dwellers cannot afford a lot with individual service connections to their houses or flats. A lot of 180m^2 for example costs about 196€. These costs may be paid back with an annual interest rate of 15% over 5 years. Member groups of the *Shack Dwellers' Federation of Namibia* have access to its funds, e.g. to lay out connections from public shared sanitation facilities to individual houses or to upgrade huts into concrete houses (UN-Habitat, 2003b: 247). – The minimum lot size required for the registration of land ownership is difficult to meet by low-income individuals. Only if a group acquires joint *title deeds* of a property, they may also get a mortgage (e.g. from the National Housing agency) based on this land ownership. However, individual members of the group don't have their own right to the land and must be paid or reimbursed by their group in case they wish to move.

These more flexible regulations were introduced in 1997 by the *Ministry of Lands and Resettlement* together with GTZ as a *flexible land tenure system*, whereby new forms of land ownership and transfer were created. The previous land transfer system was more bureaucratic, involved high fees and therefore excluded poorer parts of the population from legitimate land acquisition (GTZ/Government of Namibia 2005:6). The three-tier system foresees to gradually remove barriers to land registration: 1. *starter title*: the transferable right to an undefined piece of land within a common land ownership, this cannot be used to get a mortgage; 2. *land hold title:* the right to a defined piece of land within a common land ownership, which is pre-registered, but not yet in the cadastral register; 3. *freehold title:* registered ownership. Local offices handle administration and certification of the titles (Tanya Pickardt) (Hackenbroch/Kozonguizi 2005:8).

4.2 Durban

Figure 19: Location of Durban in South Africa
Source: Own representation, based on ESRI

The city of Durban is located at the east coast of South Africa in sub-tropical climate. In three phases the administrative area was extended from 300km^2 before 1996 to 1.366km^2 and then to the Durban Metropolitan Area of 2.297km^2 in 2000 by including large rural areas (figure 20) (Roberts/Diederichs, 2002:195). The Durban Metropolitan Area (Ethekwini) has nearly 3 million inhabitants, is one of the country's fastest growing cities and stretches 120km in north-south direction and 70km inland. A large proportion of the population lives in former townships and peri-urban rural areas with lower level of supply of public services than the inner part of the city, where the sewage is treated with advanced technologies (e.g. using biological phosphate removal) (Water Utility Partnership/WSP 2003:22) (Ruhr-University Bochum, 2005:295ff). Because of the partly extreme water scarcity - the average annual rainfall is 497mm in the country (Durban Metro Council, 1996:ii) - industrial companies do not have additional withdrawal rights for water and are increasingly making use of recycled water.

In Durban no international organizations were found, which are active in the field of sanitation, interviews include various departments of the Water and Sanitation Unit, such as the Pollution and Environment Department and the GIS Department and also the Veolia treatment plant. Marginal urban areas were visited as well as a construction site for a new sewage draining system at the harbor, further research was carried out in the Don Africana Library. The following analysis is based on these sources of information.

Figure 20: Durban city center and surrounding settlements
Source: Frank Stevens

Expert interviews in Durban

Organizational matters

In Durban the **Department of Water and Sanitation** of the City Council *Ethekwini Municipality* is responsible for sanitation management. In addition to the sewage disposal and treatment it also maintains a comprehensive Geographic Information System, building an information base which is also used by other departments.

The sanitation management is **financed** by resources of the City Councils of Durban, there is no fee on domestic sewage. On industrial sewage there is already a fee, for private consumption is yet being planned. Apart from the general financial support, the government also pays for specific projects, such as for the *Municipal Infrastructure Grant* for the expansion of infrastructure.

The department is also responsible for the **water supply**, freshwater is received from Umgeni Water in Pietermaritzburg. A potential fusion of Umgeni Water with the Ethekwini Municipality might lead to a better efficiency and cost control, since so far the Ethekwini Municipality depends with its pricing on the price at which it buys the water from Umgeni Water. Price fluctuations of Umgeni Water have a significant impact on the financial planning of the Ethekwini Municipality (Frank Stevens).

Certain areas have been **privatized** successfully, e.g. sewer maintenance is partially carried out by contractors, the sewers are planned by consultants, private companies empty pit latrines. The privatization of the entire department however, is not seen as a viable option. Instead, public-private partnerships are being developed, such as with Veolia, an international company for water supply and sanitation services. After a pre-treatment of sewage, Veolia treats 40,000,000 liters per day up to a standard, which the adjacent industry uses for its processes, especially the paper factory Mondi Paper Mill (85%) – which has a high water consumption. For the paper factory pays for this water a lower price than for freshwater and therefore saves €3,981,300 per year. Veolia buys the pre-treated water for just under €0.04 per m^3 and sells it for €0.26. More freshwater remains for the supply of the city and the treatment Veolia provides cannot be carried out by the Department for Water and Sanitation at this price. The municipality has agreed with Veolia on a contract that passes the ownership of this treatment plant to the municipality after 20 years, who can operate if after that, which is seen as advantageous as the upfront investment would have been hard to provide for the municipality. The international partner makes its profit during the first 20 years (Neil Macleod).

Objectives and guidelines

According to **South African Water Services Act** of 1997 the Ethekwini Municipality has three objectives: 1. to reach the poor and so far unserviced parts of the population in an affordable and sustainable manner, 2. to operate in an efficient and cost-oriented way and 3. to protect water and the environment. - The **Department mission statement** is: "to provide affordable and acceptable sewage disposal and treatment using environmentally sound and health-protecting technology." This aspect will be discussed further in the section "legal framework".

Staffing

1,200 staff members of various **professions** (engineers, technicians, electricians, surveyors, finance administrators, GIS personnel, chemists, biologists and construction workers for sewer repairs) are working in the department.

At the moment it is **difficult** to find suitable staff. There is a shortage of trained personnel in the country, especially for engineering and science-related positions (Frank Stevens).

Financing

There is no **sewage fee** for residential consumers, only industrial users. For the fresh water consumption the fee depends on the type of water supply: Tap water (full pressure), roof tank (semi-pressure) or ground tank (low pressure) as well as on the water consumption, with the first 6,000 liters (200 liters per family and day are assumed as basic consumption x 30 days per month) per month being free of charge. As an incentive for the regular payment of fees in less wealthy settlements, where residents often have debts at the municipality, households who regularly pay their invoices get a 2% debt relief on accumulated debt (Simon Scruton).

Management of disposal and treatment

When assessing the investment and operating costs of on-site options (dry and water-based) compared to centralized systems the following information was provided:

a) **On-site options (dry and water-based)**:

Investment costs: the construction of pit latrines is no longer recommended, around €331-398 € is the estimated cost of a VIP, around €398-597 to construct urine diversion, depending on size, type of ground and accessibility. For the construction of a septic tank the costs are approximately €928 (Department of Water Affairs and Forestry 2002c:4).

Operating costs: complementary to ground tank water supply are pit latrines. At the time of the interview about 30,000 full pit latrines need to be emptied (which are largely difficult to access), which is costly: with emptying costs of in average €88.90 per latrine, depending on location and accessibility, total costs of approximately €2,786,910 (Neil Macleod). Depending on the number of users and pit size, they need to be emptied every 5-10 years. Due to poor design however a number of self-built collapse when being emptied, which increases "operating cost" then. Emptying a VIP or a septic tank costs €133 every 5-8 years, with a urine diversion the costs are only €3.30 to €4.65 per year.

For b) **Centralized systems** the costs are estimated as follows:

Investment costs: In central areas, where sewerage is available or the network is being expanded, the costs of a connection is at least €265, mostly around €1,061-1,327 (based on an average of one connection per 25m of sewer), with increasing distance from city center and sewage treatment plants, the cost rise up to €3,981-5,308 for a connection (based on an average of one connection per 500m of sewer); based on these calculations a boundary was defined around the city, the so called waterborne edge (figure 21), a boundary beyond which the sewer system is not planned to be extended for the next 20 years. Within this boundary it is planned to expand the sewer system coverage.

Operating costs: The consumer only pays a freshwater fee, as there is no sewage fee (the first 6,000 liters per month and connection are free, beyond that there is a rising block tariff). According to experience annual costs are approximately €53 per connection (Department of Water Affairs and Forestry 2002c:4).

In addition, infrastructure management and maintenance costs are described below:

a) **On-site options (dry and water-based)**:

Management and maintenance costs: The latrines usually do not require maintenance until they need to be emptied (Frank Stevens).

b) **Centralized systems**:

Management and maintenance costs: Sewage treatment costs in treatment plants amount to €1.06 per m^3 in small treatment plants to €0.26 per m^3 in large treatment plants. The management and maintenance costs of the treatment plants themselves were not identifiable, as they vary greatly depending on their need for repair or renovation. Some pipes in areas that have been "inherited" after the expansion of the municipal area are said to be 50 years old and should have been renewed in the meantime (Neil Macleod).

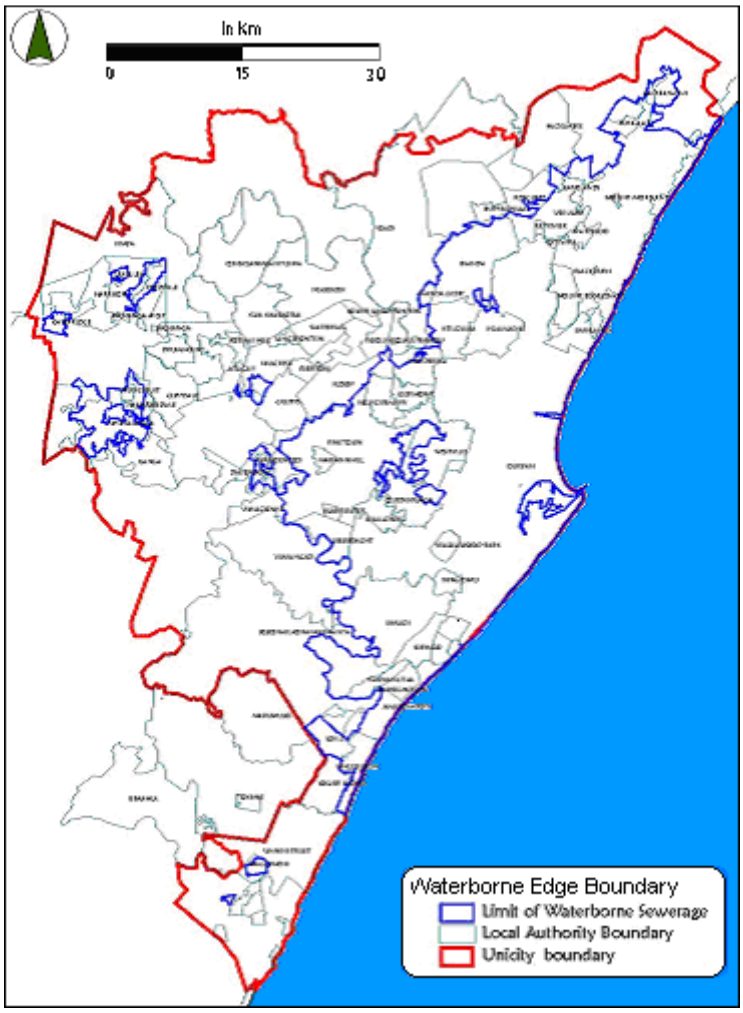


Figure 21: Ethekwini Municipality Metropolitan Area, planned boundaries of the sewer network expansion (waterborne edge boundary) in blue, June 2002
Source: Material provided by Frank Stevens

Regarding the final evaluation of the advantages and disadvantages of both options:

a) **On-site Options (dry and water-based)**:

Disadvantages: On-site options mean a loss of control for the municipality, because it is responsible for sanitation management within the entire city, while existing on-site facilities do not meet the required standards in many cases however. On-site systems are on the one

hand work-intensive to manage and on the other hand required upgrades are difficult to enforce. Usually the emptying process is labour-intensive and often associated with abasing work, since locations in densely populated settlements or on steep terrain are not accessible to the specialized emptying vehicles and hence often have to be dug out by hand. Several experts in the Ethekwini Municipality affirmed that no further pit latrines or ventilated improved pit latrines are planned to be built for that reason. - Challenges are also being encountered from some 60 so-called *package plants*, small treatment plants outside the waterborne edge, which are usually operated by more affluent small settlements or e.g. golf- or hotel facilities. Also for these the Ethekwini Municipality is responsible. The so treated water sometimes does not reach the required standards, but sanctions are hard to make as the commercial revenues of the operators are valuable. This sewage may either cause a hazard to the environment if being discharged into a river after its preliminary treatment, or may affect the functioning of a sewage treatment plant (e.g. by killing micro-organisms) if the sewage is introduced from holding tanks into a municipal sewage treatment plant (Frank Stevens).

Advantages: Instead the construction of urine diversion toilets is encouraged, where both separately collected components can be reused as fertilizer, with solid matter drying and composting first, which makes these systems much more hygienic than latrines. In addition, urine diversion facilities have significantly lower operating costs than pit latrines and VIPs (Frank Stevens). The distribution of various sanitation systems is shown in figure 22, making it clear that the unserviced areas and those using on-site sanitation are located outside the *waterborne edge*. Septic tanks are used north and west of the city center.

b) **Centralized Systems**:

Advantages: Central systems are considered the safest and most hygienic. Even with water supply via roof tank WCs are the standard because of hygienic reasons, only when the water supply is organized via ground tanks pit latrines are common. No matter what sort of sanitation system is constructed however, emphasis is put on finding a solution in collaboration and upon the advice of the user, both prior to construction, but also on a visit 4-5 months later.

Disadvantages: The construction costs per unit connected increase with decreasing population density up to a point where the construction becomes unprofitable. This boundary is featured in Durban by the *waterborne edge* (figure 21) (Neil Macleod).

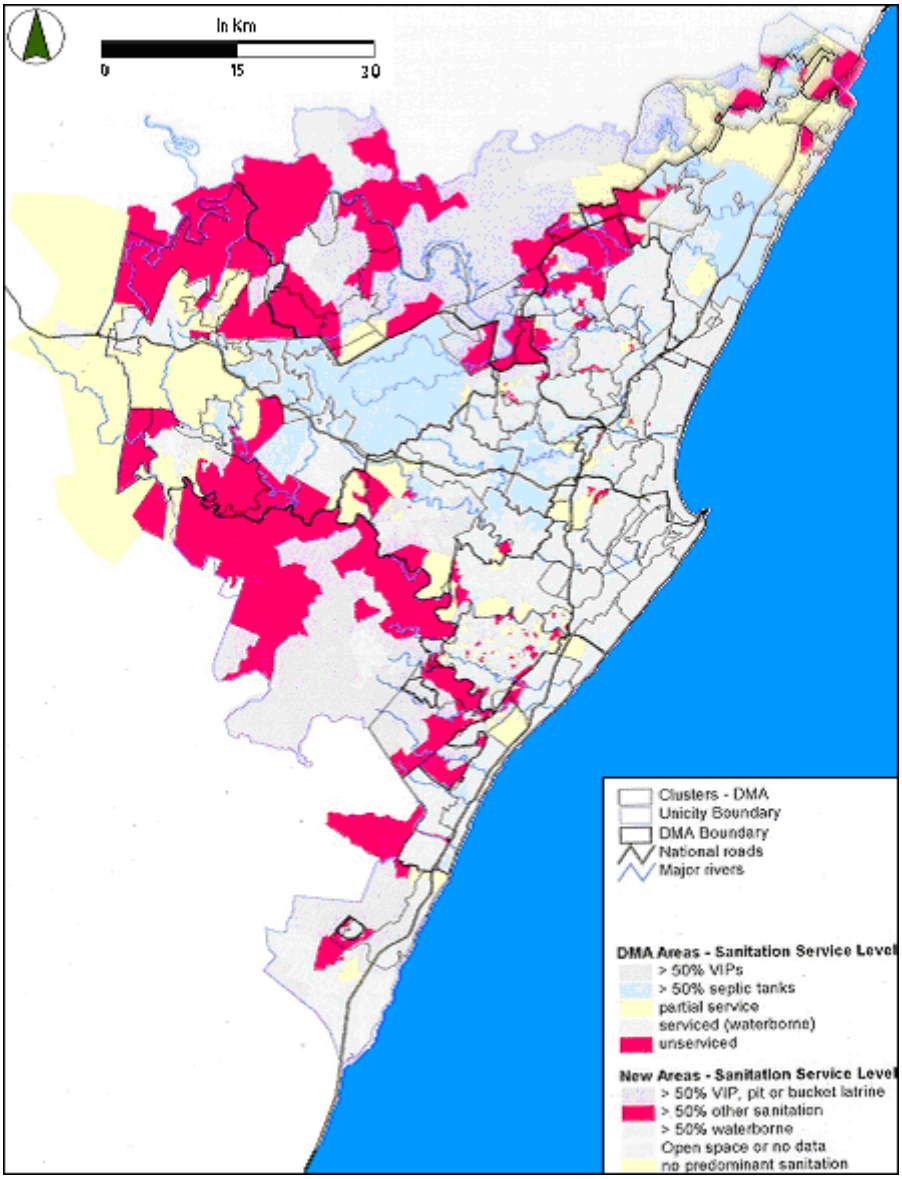


Figure 22: Durban Metropolitan Area – Sanitation service levels
Source: Material provided by Frank Stevens

About 20 **public sanitation facilities** exist in areas that have been “inherited” by the Durban Metropolitan Area through the merging of previously separately administered regions, e.g. in residential areas of factory workers, the facilities are being run by residents. Problems exist particularly in terms of security, particularly for women and children at night and in terms of vandalism (Frank Stevens).

The **sewer** network comprises 5650km. Almost 50% of the city are **connected** to the sewer system, 10% have satisfactory on-site options, 40% have no formal sanitation services. - In the city there are no **other sewage management agencies** in terms of sewer operators, but private companies are involved in some areas, such as emptying latrines with specialized vehicles (Neil Macleod).

490,000,000litres of sewage are treated per day in 29 sewage **treatment plants**, which have at least one mechanical and one biological (biofilter) treatment stage. Domestic and industrial sewage is mixed in a ratio where the amount of industrial sewage does not exceed 15-30%, otherwise the microorganisms in the sewage treatment plants are endangered to die due to the high concentrations of toxic substances (Sagren Govender). The approach is therefore based on the principle of dilution of pollutants, which is also reflected in the disposal of the sewage sludge into the sea, although this approach is starting to be viewed critically (Ethekwini Municipality w.y.:26). Figure 23 shows the second treatment stage of the Veolia Wastewater Treatment Plant before the water is treated to the standard required by the industry that reuses the water.

Figure 23: Veolia Wastewater Treatment Plant in Durban
Source: Author's photo

Via two sea outfalls 200-236,000,000litres of **treated water** daily are being discharged into the sea, the water is treated according to lower standards than the water that is discharged into rivers. It is only cleared mechanically and is then being channeled through an outlet pipe from the coast to the deep-water zone of the swiftly-flowing Agulhas Current (Frank Stevens), leading the pollutants to dilute there. Annual reports on the measurements of contaminants are published, interesting is this: Although South Africa considers itself generally as an emerging nation with developed economy, in the environmental report it is noted that the findings of the contamination monitoring are comparable with other developing countries like India and Malaysia (Ethekwini Municipality 2004:145). Treated water is also fed into rivers. Due to lacking sewer system coverage and partly insufficient on-site facilities pollution accumulates in rivers in the Durban Metropolitan Area (Durban Metro 1995:xiii).

The **sludge** from the Veolia treatment plant is passed via the sea outfall into the sea. The improvement in recent years consisted of the introduction of a press, which has reduced sludge emissions by 10%, but this only regards the volume of the sludge. The press removes the respective amount of water, the sludge that is discharged into the sea is then the more concentrated (Sagren Govender). Sludge from other treatment plants is deposited, cannot be

used further and poses a challenge. It is being considered to dry the sludge in the future and to use it as fertilizer. Contents from the 100,000 pit latrines of the town are channeled to the nearest the sewer, buried, composted or incinerated. Efforts are underway to reduce the number of pit latrines and to compare the costs with other improved options (Frank Stevens).

Legal framework

Current legislation is fragmented between departments (water, health, environment) and hierarchy levels (national, provincial, local) and also suffers from a lack of enforcement. Parallel legislation in different sector also involves the risk to just move pollution from one medium to another (from water into the soil or to the air) (Durban Metro Council 1996:ii).

The City Council is bound by some 200 laws, guidelines and regulations, most important in terms of water is the **Water Services Act 108** of 1997. Its three main objectives are: 1. to reach the poor and so far unserviced parts of the population in an affordable and sustainable manner, 2. to operate the sanitation management in an efficient and cost-oriented way, keeping in mind cost-benefit ratios, and 3. protect water and the environment. – This relates to the three dimensions of sustainability and touches upon the social, economic and ecologic aspects of sewage issues. However the three objectives are not without conflict among each other (Frank Stevens). – The national Act is complemented y regional regulations (such as the **Sewage Disposal Bylaws** of 1995) of the Ethekwini Municipality, which regulate e.g. that rain water is to be discharged in a separate channel network, that no foreign matter is to be put into the channels and sewers and that connections to the sewerage require a certain fee and authorization by the municipality.

Planning base

Geographical Information Systems (GIS) are playing a key role in all planning areas, including design, implementation, monitoring and analysis, e.g. how many citizens live in which distance to service offices of the municipality? (Durban Metro Water and Wastewater Department w.y.). Once a year aerial surveys are being conducted by plane over 2,300km^2 for €39,813, from these results also other departments profit for their planning. These aerial surveys are less expensive than buying aerial photographs by commercial providers: Due to the coastal gradient from southwest to northeast, a substantial proportion of aerial photographs from commercial providers - that are usually images with a long North-South

extension - cover a large part of sea surface, which then needs to be paid though not being utilized (Steve Peterson).

Necessary for comprehensive **planning** is to gather reliable information on the expected spatial distribution and volume of sewage, which requires a broad set of challenges to be mastered: Census data are not very reliable - often census interviewers do not find citizens at home during the day, while at night many areas are unsafe, so that no interviews can be conducted. In addition, governmental census data are aggregated to the *local district* level and are thus too inexact for sewage planning issues. So the department conducts own surveys to complement the census data. It is assumed that an average household comprises 4.1 persons. Another challenge is that some families live in more than one house (e.g. one house in town, one out in the suburbs or rural areas for the partial subsistence), and thus there is a significant amount of houses that are vacant some time of the year. Therefore in some cases the whereabouts of people have also been identified via their cell phones (Steve Peterson).

Quality control

For the **quality control** of sewage treatment, regular sampling and testing of all sewage parameters identified in the water law is performed. A *pollution control team* verifies compliance with rules and standards and intervenes in case of infringements. In that case the consequences are higher fees (for industrial dischargers) and more frequent sampling (Sharveen Maharaj). A team to repair leaking sewers may intervene in an **emergency**. Repair is necessary, among others, when sewers have been vandalized to make unauthorized connections to the sewer system or to withdraw sewage for irrigation (Neil Macleod). The perils and opportunities of irrigation with sewage are discussed in section 5.6.

Challenges

The amalgamation of the former 14 *water authorities* into the Durban Metro Area increased the area of responsibility of the Ethekwini Municipality in 1996 and 2000, from 1 first to 2, then to 3 million people in two steps, and by this also added areas of very different sanitation standards, as well as even rural areas. Since in these marginal areas of responsibility with low population densities the expansion of the sewer system is costly and not planned for at least 20 years, individual solutions such as improved on-site facilities (urine diversion) and decentralized sewage systems for small communities are needed.

The construction of *shallow sewers*/*small bore* may be a chance, but can also cause legal problems, e.g. this technology is not included in the National Building Regulations on sanitary matters in Durban, while the requirements for regular sewer systems are more restrictive and cannot be met by *shallow sewers*. Also land ownership plays an important role: Out of two areas with decentralized sanitation, in one (Briardale) land is owned as community ownership, while in the other (Emmaus) individual property ownership prevails. Since e.g. in Emmaus the pipelines cross private land, each owner has to agree individually, and in the case of a sale of the plot the obligation to accept the pipes cannot be transmitted to the new owner, so that there is always a certain risk that the new owner removes them (WSP/World Bank 2001:6f.). Since shallow sewer otherwise represent an promising option for these areas, standards are being developed based on best practices in other places and the respective laws and standards to be integrated into the national legal and policy framework.

There are conflicting views on whether the different supply level is larger along the urban-rural margins or rather along formerly white or formerly-black neighborhoods (Durban Metro 1995:xvi) (Frank Stevens). - In regions with low incomes and partly newly constructed sewer system sometimes toilets and sewers clogged at short intervals due to their improper use for garbage disposal. To meet this challenge, the Ethekwini Municipality runs a comprehensive education programme since 1997 with street theater (in places where many people get together: bus and taxi stops, shopping malls, hospitals etc., with about 550 performances per year), events in schools and national television spots, designed to provide information on the use of such infrastructure, to create awareness for hygiene and to increase the appreciation of such infrastructure to eventually also improve the payment record (so far only for water *supply*). The fact that in the respective areas the number of incidences decreased is attributed to this programme (Frank Stevens). While the educational programme is important, it is crucial that the enhanced awareness can actually be implemented by making available improved infrastructure, otherwise it may be rather disillusioning for residents to be told the importance of hygiene if they are not given the chance to change something in terms of facilities to use.

Conclusions

The responsible *Ministry of Water Affairs and Forestry* intends to pursue a mix of measures of awareness raising activities for hygiene and health, training programs for decision makers and brokering craft skills of local contractors, the construction of demonstration toilets, as

well as further development of infrastructure (Department of Water Affairs and Forestry 2002a:6).

To date there is a lack of mandatory requirements for real estate and home owners renting living space in low-priced areas to provide a minimum of supply and sanitation facilities. The municipality tries to encourage converting rented living space in owned living space since 1996, to provide residents with an inventive to invest (Mohamed 1997. 102ff).

It is also questionable whether an approach of *free basic sanitation* analogous to *free basic water* is feasible and desirable, as conflicts may arise in its implementation. If the sanitation improvement was met with water-based on-site systems or sewer connections, a significant part of the free water will be used for flushing toilets and hence water consumption will substantially rise (Department of Water Affairs and Forestry 2001. 6f). Due to improved hygiene, lower costs and water consumption, as well as lower efforts for emptying, *urine diversion* toilets may be introduced to replace pit latrines or VIPs in the regions outside the *waterborne edge*, especially in the regions that are so far serviced with pit latrines and the currently unserved areas in the extreme west of the Durban Metropolitan Area.

4.3 Dar es Salaam

Figure 24: Location of Dar es Salaam in Tanzania
Source: Own representation, based on ESRI

Dar es Salaam is located on the Tanzanian coast at the Indian Ocean, it has a tropical climate with a dry season in summer and is the largest city in the country, the seat of government and commercial center (the capital is Dodoma). Population estimates vary between 1.5 million (Hofmeier 2004:616) and 2.5 million inhabitants in the three administrative areas of Ilala, Kinondoni and Temeke. With a growth rate of around 4.3%, it is one of the fastest growing cities in sub-Saharan Africa (Dar es Salaam Water and Sewerage Authority, 2005:1). Unplanned settlements arise before infrastructure in terms of streets sewers and water supply is constructed. More than 70% of inhabitants live in unplanned settlements and therefore have inadequate sanitation services (Lusugga 1995. 78f). The trend of urban development in Dar es Salaam is considered to be representative for sub-Saharan Africa (Timo Basteck). Figure 25 shows that the unplanned

areas of the city, which are most severely affected by lacking sanitation services, are primarily located along major arterial roads.

In addition to the responsible authorities DAWASA and DAWASCO, further interviews were held with the World Bank, the University College of Lands and Architecture, representatives of WaterAid, GTZ, the SPRING Initiative (Spatial Planning for Regions in Growing Economies) - a research project of the University of Dortmund (Germany) - and a consultant of the *Millennium Challenge Cooperation*. Also one of the treatment pond systems and the sea outfall were visited. The following analysis is based on these sources.

Expert interviews in Dar-es-Salaam

Organizational matters

The **Dar es Salaam Water and Sewage Authority** (DAWASA) is the sewer network owner and responsible for the sewer system, on-site sanitation facilities are privately operated. The **Dar es Salaam Water and Sewage Corporation** (DAWASCO) is the sewer network operator and has a 10-year lease agreement with DAWASA (Jackson Midala).

The organizations DAWASA and DAWASCO are partly **financed** by the City of Dar es Salaam. For the expansion and upgrade of infrastructure however there are almost no financial means, instead a number of international institutions including the *World Bank* under the *World Bank sanitation programme*, as well as the *African Development Bank* and the *European Investment Bank*. In particular DAWASA is financially supported by the World Bank (Nathaniel Paynter).

Water supply is organized by the same institutions, surface water and ground water from 31 sites is conditioned in three treatment plants (Lowa Rhuvu: 182,000m^3 per day, Upper Rhuvu: 82,000 m^3 per day and Mtoni: 9,000m^3 per day) and fed into the supply network. A contamination of well water from illegal sewage discharge and *Wastewater Stabilization Ponds* is considered unlikely by respondents DAWASA (Mathias Mulagwanda), however at the University College of Lands and Architectural Studies this is considered likely (John Lupala).

Privatization in the context of sanitation services are viewed negatively by employees of DAWASA and DAWASCO, a previous attempt by the government 2003 to outsource the full

sanitation management to City Waters Services Ltd. (with shareholders from the UK, HP Gauff from Germany and the registered Tanzanian company Superdoll Trailer Manufacturers Ltd.) with a 10 year lease contract did not result in the desired improvements of supply and disposal situation. In 2005 the contract was terminated prematurely by the Tanzanian counterpart, the City of Dar es Salaam. The contractor City Waters Services Ltd. However claimed the agreed preconditions were not provided, so their work could not be conducted as it was planned. The High Court of Tanzania, who confirmed the claims of the government, refused to take note of the decision of the *London Court of International Arbitration*, which was in favor of the City Water Services Ltd. and against DAWASA (Mathias Mulagwanda). Following this, the new *Dar es Salaam Water and Sewage Corporation* (DAWASCO) took over the work.

Objectives and guidelines

The Government has set itself the goal to connect **30% of households** in Dar es Salaam to the sewerage by 2010. However, poorer parts of the population hardly receive any attention from the authorities, because on-site sanitary facilities do not fall within the responsibility of DAWASA.

Staffing

DAWASCO employs about **1,200** staff from different **professional groups** including technicians, craftsmen, engineers, managers, financial personnel and additional support staff (such as drivers, secretaries) for sanitation management.

Difficult: It is a challenge that around 70% of employees are in the same age group of 50-60 years, so it is expected that they will all retire within a short period of time. At the moment, no new staff is recruited to buffer the expected gap, hence a loss of experience is likely to occur during the next years during the upcoming major turnover of staff (Mathias Mulagwanda).

Financing

In urban areas with reliable piped water supply, water meters monitoring consumption exist. The amount of **sewage fee** is calculated by: €0.10 x 80% of water consumption in m^3, since it is assumed that 20% of water consumed evaporates via the body or when cooking, etc. while 80% is assumed to reach the sewer system as sewage. Our of the €0.10 per m^3, €0.02

go to DAWASA to partially cover the investment costs, while €0.08 go to DAWSCO to partially cover the operating costs (Jackson Midala). A large part of the fee is required for the maintenance of numerous pumps, because due to the even city area in many places water and sewage is being pumped to a higher level to ensure continuous flow in pipes and sewers. A smaller part of the fee is used for the water treatment in the Wastewater Stabilization Ponds however. In urban areas with irregular water supply a frequent problem is that the water meters tend to rotate when only air flows through. Unrealistic water bills are the result: Sometimes only three times a month tap water was available, but still a large water bill is issued. For this reason in the respective areas with irregular water supply (e.g. in Kariakoo) *flatrates* have been established, in this case a certain water consumption is assumed according to the service level provided and the rate is calculated accordingly, but often the flatrates lead to excessive water consumption and hence create new problems (Mathias Mulagwanda).

Toll collection: Approximately 50% of water consumption (based on which the sewage fee is calculated) is not registered because of leaking pipes, illegal connections, etc. Out of the invoiced fees only around 45% are paid for the above mentioned reasons (Jackson Midala).

Management of disposal and treatment

When assessing the investment costs and operating costs of on-site options (dry and water-based) compared to centralized systems, the following information was provided:

a) **On-site Options (dry and water-based)**:

Investment costs: In contrast to the water supply, the construction of sanitation infrastructure is considered a private matter (Water Utility Partnership/WSP 2003:66f.). Depending on size and type a pit latrine costs €6.24 to €32.37 and the superstructure €9.17 to €93.55, totaling €15.40 to €125.93 depending on the model (John Mfungo). WaterAid assumes that average cost of €198.32 per household occur for sanitation in urban areas in order to meet the Millennium Development Goals (WaterAid w.y.:1).

Operating costs: In urban areas costs to empty a latrine are €3.12 to €18.71 depending on the distance, which is necessary every 1-3 years (this is mainly carried out by licensed private companies, as the public disposal authorities come only 2 weeks after notification, while others empty their latrines privately into a near river. So the costs are €18.71 at highest (at €18,71 per emptying and annual collection) (Jackson Midala). According to the Water Utility Partnership/Water and Sanitation Programme, the competition among the officially licensed disposal contractors made the fees stabilize at €6.24 to €9.35 and reduced waiting times for emptying services (Water Utility Partnership, 2002). For the emptying of the

specialized collection vehicles into the Wastewater Stabilization Ponds per a fee of €1.87 is charged per trip (Water Utility Partnership/WSP 2003:76).

b) For **centralized systems** the costs are estimated as follows:
Investment costs: When requesting a connection to the water supply and sewer system €55.53 have to be paid (of which €19.83 are a connection fee and €35.70 area a deposit for the water meter that is installed with the connection). The pipe connection from the nearest sewer to the house costs €93.55 (with a 150mm diameter pipe) or €124.74 (with a 200mm diameter pipe) (Simon Chale).
Operating costs: According to the formula €0.10 x 80% of water the consumption in m^3 an average water consumption of 35-50m^3 per household and month the sewage fee totals €4 per month at most (Jackson Midala).

The management and maintenance costs of infrastructure have been described as:
a) **On-site Options (dry and water-based)**:
Management and maintenance costs: Maintenance costs for pit latrines are calculated as zero, as usually nothing is done on them until they require emptying (Nathaniel Paynter).

b) **Centralized systems**:
Management and maintenance costs: Existing infrastructure and substance is being lived on, costs for maintenance of the sewerage could not be quantified, for the sewage clarification in the treatment ponds only staff costs occur for those who supervise the ponds and excavate the ponds about every 10 years, we well as drivers and the specialized vehicles that bring the latrine contents to the ponds (Venant Luta).

Regarding the final evaluation of the advantages and disadvantages of both options:
a) **On-site Options (dry and water-based)**:
Disadvantages: The sandy soil and high groundwater level is problematic for latrines, many of which are emptied illegally in order to save costs for the disposal, or because they are inaccessible for emptying vehicles. Standard practice is *Kutapisha*, digging a dump next to a full latrine, the contents of which are being shoveled into the dump, which is then sealed with gravel and used as habitable space (UCLAS DPU-2003:27). In addition, latrines or septic tanks require relatively much space on usually already small plots. Another disadvantage is that the devices have to be paid by the users (Nathaniel Paynter). Surveys show that (public) sanitation facilities are not very promising when they consist of water-based devices, since there is a frequent lack of water to operate them (Government of Tanzania 2004).

Advantages: In spite of the disadvantages on-site solutions are predominant in Dar es Salaam, because without a connection to the sewer system residents often do not see another choice and the necessary steps (as digging the dump) can be carried out by themselves. However, in 1992 around 380,000 inhabitants of Dar es Salaam did not even have this (UCLAS DPU-2003:46).

b) **Centralized systems**:

Advantages: A sewer connection is a more hygienic and convenient solution (Mathias Mulagwanda).

Disadvantages: The planning effort is high, requires financial and human resources and coordinated action for both construction and maintenance, upgrading systems (e.g. from 150mm to 200mm pipes) are difficult, if existing sewers that need to accommodate higher sewage volumes lead through densely populated settlements. Furthermore, in existing unplanned settlements, which are often characterized by a very high population density, it is practically impossible to install sewers retroactively (Jackson Midala).

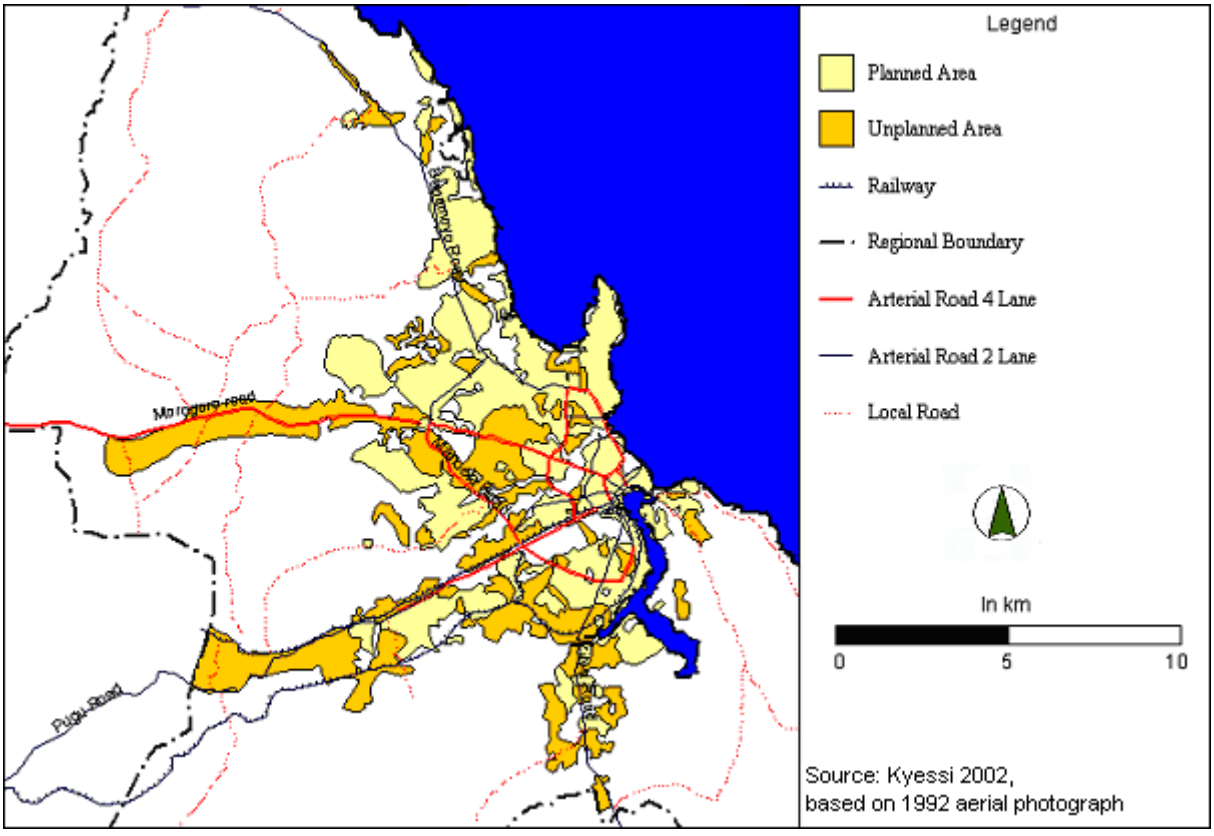


Figure 25: planned and unplanned settlements in Dar es Salaam

Source: Material provided by John Lupala

Public sanitation facilities exist in the downtown area in proximity to the market for the traders and at the main bus terminal in Ubungu, however there are less of these facilities in

low-priced neighbourhoods, as these facilities are operated by small businesses according to profit considerations (Water Utility Partnership/WSP 2003:73). WaterAid funds public toilets in Kigambaoni (John Mfungo).

The existing **sewerage system** consists of 11 independent subsystems (built between 1948 and 1952) with approximately 130km of sewers that discharge into Wastewater Stabilization Ponds, covering parts of the downtown area, Kariakoo, Msasani, Mwenge and the industrial area of Ubungo. The city center discharges via a sea outfall, a pipe leading into the Indian Ocean (UCLAS DPU-2003:37ff). The most essential new installations of sewers in the inner city (funded by the World Bank) are being carried out by a Chinese company that drills horizontally along the roadsides to lay pipes, which requires no opening of the road surface. This is feasible here only because there almost no other cables or pipes located underground that could potentially be damaged through this practice. The new sewers are constructed along the road*side* to protect the shallowly placed sewers from damage through road traffic (Simon Chale). Information on the extent of the city that is **connected** to the sewer system ranges from 5% (2004) and 15-30% (2006) (John Lupala). In 2000 30% of the population had septic tanks, 63% had latrines and 2% were completely unserviced (UN-Habitat 2003b). – Are there any **other sewage disposing entities** in the city? NGOs such as WaterAid operate demonstration facilities on a small scale, in the *Kipawa ward* in Ilala an Ecosan project was initiated (Shayo, 2004:245), further ones exist in Keko, Kurasini and Yombe. UNICEF has launched 45 composting toilets in Mogo and Stakishari, which were however not accepted by the residents.

Sewage treatment plants exist in the city only in the form of pond systems, into which the surrounding areas drain independently either via sewers or to which latrine contents are brought by vehicles. Figure 27 features the catchment areas of existing ponds in red and the respective ponds in blue, which shows that the coverage is by no means comprehensive. The downtown area drains via a sea outfall into the sea. The sewage only passes through a coarse screen and then seeps on the beach, since the first few meters of the sea outfall are missing (figure 26). - Many ponds are not working satisfactorily due to lack of maintenance (especially regarding sludge removal) and

Figure 26: Sea outfall Dar es Salaam
Source: Author's photo

congestion (although only about 35% of the sewage enters the ponds, the rest sent into rivers or the sea), the ponds are not desludged until they are full. Since the ponds do not have sealed bases, sewage seeps into the ground, and the fish living in the ponds are caught and eaten by nearby residents. The water leaving the ponds usually does not meet the standards of the *Tanzanian Water Utilization Control* and the *Regulation Amendment Act* of 1981 (UCLAS DPU-2003. 41ff). Information on how the functioning of ponds may be improved is given in the chapter "Nairobi".

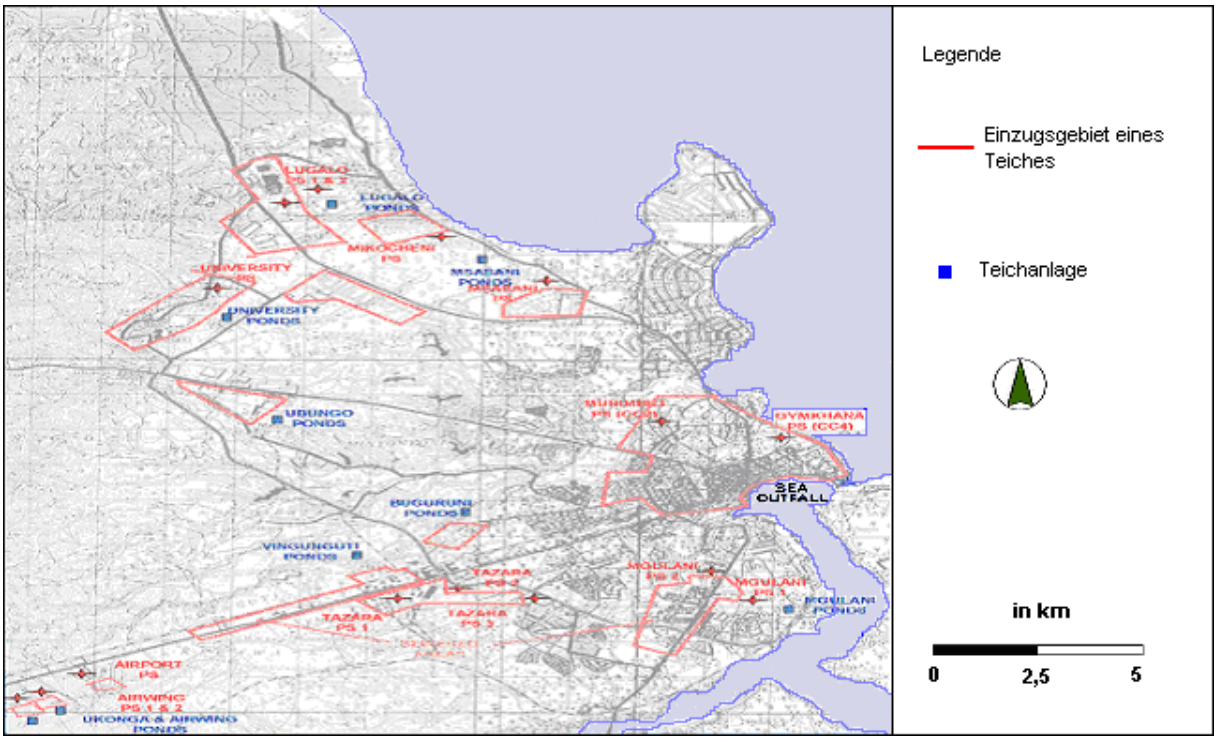


Figure 27: Catchment areas of the various treatment ponds in Dar es Salaam
Source: Material provided by Simon Chale

The **treated water** flows into rivers, closeby ditches that drain into the sea, or directly into the sea.

Only when the ponds are full to the rim with **sludge** and dense growth they are being excavated (figure 28). So far the material had been dumped at undefined locations where sufficient space was found since a few years the sludge needs to be stored at designated landfill sites (Venant Luta).

Figure 28: Silted anaerobic pond and overgrown the pond Msasani
Source: Author's photo

Legal framework

The legal framework is outdated, the colonial law on sewage and drainage dates back to 1955. The Ministry of Health drafted **guidelines for waste and sewage management** in 1993 and guidelines for sanitation and health as well as how to handle sewage sludge in 2004. Local **sewage bylaws** exist that set the standards treated sewage must comply with, but the legislation is fragmented and characterized by a lack of enforcement (Nathaniel Paynter).

Planning base

Planning proceeds "demand-driven", settlements with wealthy residents apply to be connected to an existing pond system or an own separate system (Simon Chale). Challenges to expand the sewer system include: 1. the absence of a planning basis on the spatial distribution and volume of sewage generated, as a result residents are often forced to construct their own on-site solutions until the municipal planning for a settlement allows to construct the official sanitation facilities. 2. Another challenge are the high costs of transporting sewage, as on the even terrain numerous pump stations are necessary to ensure the flow, and 3. The unplanned growth of the city makes it difficult to forecast which parts of the existing sewer network needs to be replaced with larger diameter pipes and sewers, e.g. because new settlements were connected (Jackson Midala).

Quality control

The University College of Lands and Architectural Studies monitors **Biological Oxygen Demand** and **escherichia coli** as an indicator for the pollution with pathogens. The prevention of cholera outbreaks is the main focus of concern (Nathaniel Paynter). In an **emergency**, if cholera bacteria are found in sewage, the Water Ministry is warned (Mathias Mulagwanda).

Challenges

The University College of Lands and Architectural Studies distinguishes between illegal and informal settlements: While in informal settlements land is sold to another owner without a

formal registration of this transfer in the municipal cadastre, illegal settlements are characterized by the fact that they are occupied without permission of the land owner. In spite of its informality in Dar es Salaam there are not as many settlements with illegal status as e.g. in Nairobi, as in Dar es Salaam land ownership can be relatively easy transferred through a private contract, which is officially acknowledged even in the case of lawsuits. Only e.g. to get a mortgage from a bank on one's estate to build a house an official registration in the municipal cadastre is required, however few estates are registered, as this is associated with a lengthy administrative process between 2 and 4 years (John Lupala). Figure 29 shows informal settlements in the outskirts and in the center of the city.

Figure 29: Suburban informal settlement and densely inhabited informal central settlement
Source: Material provided by Timo Bastek

High land prices are a challenge. Although land can be acquired a low costs from the municipality – a practice designed to fight this problem – but the land is sold in a corrupt way, without social and economic influence there is little chance to get an estate through this procedure. For this reason most of the land is resold at a multiple price among private people that are brought together by agents. Fighting corruption is an important task to avoid land to be traded at high prices informally, additionally there are plans to establish a Fund for land access for the poor and the legalization of land purchase by groups of people (Lusugga 1995:78ff.). Since many people live in rented accommodation, tenants lack incentives to invest into sanitation facilities, while the owners so far do not have a legal obligation to provide serviced accommodation (Nathaniel Paynter).

The failure of previous attempts to improve sanitation is attributed to a lack of participation opportunities for the affected population, the establishment of too complex and inflexible instructions as well as a lack of funding and consideration of environmental aspects (John Lupala).

Conclusions

Even in the longer run the urban sewage management of Dar es Salaam cannot be solved with centralized infrastructure. Therefore it is recommendable to strengthen the decentralized structure, the existing ponds may be extended or new ponds be constructed, and above all, the pond systems need to be maintained and operated in a way so that they can fulfil their function (see chapter “Nairobi” for more information on pond systems). In those settlements that are currently unserved, introducing DEWATS techniques may be useful, since three of its four treatment steps are underground and therefore most of their ground space can be used otherwise. Public sanitation facilities may be recommendable especially in the informal settlements along the arterial roads due to the high proportion of rented accommodation there (figure 25). The World Bank plans to introduce *condominial sewerage* (see introduction under "Scope and definitions") for 20 households as a pilot project in Kilembeni (Nathaniel Paynter). These small networks can also be connected to the sewer systems that drain to the treatment ponds, in case they expand. In settlements located distant from the city center and treatment ponds, particularly where the groundwater level is high, Ecosan or urine diversion may be advisable instead of VIPs. – In this context DAWASCO should channel the financial means coming from non-governmental organizations in a coherent way and take a coordinating and monitoring role in terms of quality and price of sanitation services (Ernst Doering).

GTZ is engaged in policy advice towards a decentralization and commercialization of public services along with a reform of local government structures: Since sanitation services are not easy to offer in a commercialized way, as e.g. the willingness to pay for water is higher than for sanitation services, both water supply and sanitation services are merged organizationally. As part of current strategy development and consulting efforts it is planned to raise the profile of sanitation issues and to assign them to one single department of responsibility. In July 2005 a call for submissions was made to hire a consultant to design a *Strategic Sanitation Plan*. One of the main ideas for the plan is to extend the sewer system compared to on-site solutions (Dar es Salaam Water and Sewerage Authority, 2005:11). – One best practice from Burkina Faso may also be a chance for Dar es Salaam: In 1990 a fee was successfully introduced on water bills that was used specifically to improve on-site facilities. Experience shows that the autonomous administration of this money through the local municipality and the focus on specific sanitation aspects was beneficial, as well as establishment of verifiable success indicators, the information of all stakeholders about the purpose of the fee, the cooperation between the municipality and the sewage disposers, as well as the use of low-priced sanitation options in close coordination with local needs and the

maintenance of constructed infrastructure (WSP 2004:1ff.). For information exchange, research and networking the organization *Network for Water and Sanitation* (Netwas) offers a web-platform at http://www.netwas.org/who_we_are/ for Kenya and Tanzania.

The World Bank and WaterAid are engaged in consultations and *sanitation marketing* with the idea to create a demand by users for sanitation facilities, as there is no government subsidies for the expansion of services. For this reason sanitation facilities need to be advertised such as other goods. WaterAid runs an information center for sanitation matters in Kekomanga area with information on models and prices of sanitation facilities, in addition demonstration facilities are installed in 10 areas of the city to encourage residents to construct or buy such equipment (Nathaniel Paynter) (John Mfungo).

4.4 Nairobi

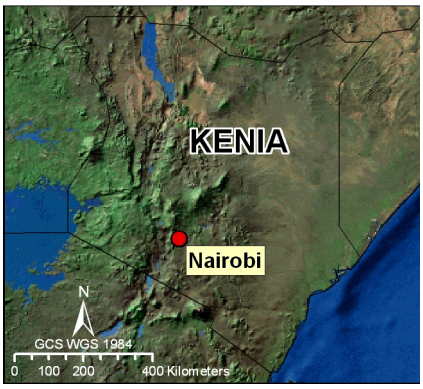


Figure 30: Location of Nairobi in Kenya
Source: Own representation, based on ESRI

Nairobi is located near the equator in the southern part of Kenya and has average daily temperatures between 21 and 26°C due to its elevation of 1600m above sea level and about 950 mm of annual precipitation. The population of nearly 3 million (2004) grows annually by 6.9%, and 94% of the residents do not have adequate sanitation facilities (Mwaura, 2004). 90% of families in slums live in rented accommodation of 9-14m^2 for 3-5 persons (Mwangi 1997:145ff.). As in Dar es Salaam many informal settlements emerged in the early 60s after independence. The municipality responded to this development repeatedly with the demolition of illegal settlements. Attempts by international organizations to provide *sites and services* (plots with access to public utilities), rarely benefitted the poor, mostly they have been replaced by middle-income population in the course of gentrification processes.

In addition to the responsible authorities *Athi Water Services Board* and *Nairobi Water and Sewerage Company* further interviews were held with UNESCO, UNEP, GTZ and DED. In addition the Dandora sewage treatment plant and the Kibera slum were visited. The following analysis is based on these sources.

Expert interviews in Nairobi

Organizational matters

In Nairobi, the **Athi Water Services Board** (AWSB) is the network owner and the **Nairobi Water and Sewerage Company** (NWSC, NaWaSCo, Ltd. Is a company owned by the City Councils) is the operator. The NWSC was separated in late 2004 from the City Council of Nairobi (Kathuri 2004) and is now run commercially as an independent unit. This process was supported by the World Bank and the French Development Agency (Jens Jeitner).

Nairobi's sewage management is **funded** by the City of Nairobi with a strong financial commitment of the World Bank: Based on a decision 2004, the Athi Water Services Board receives €4,400,000, the Nairobi Water and Sewerage Company receives €8,800,000. Operating and maintenance costs are being covered by consumer fees, the investment costs by the World Bank (J.P. Kimani). Also the KfW (Credit Institution for Reconstruction Germany) provides financial means for sanitation management in Nairobi (Athi Water Services Board/WBG 2005:4).

NaWaSCo also manages the **water supply**.

On the subject of **privatization**: In the Ministry for Water, efforts towards a water sector reform are underway to improve the efficiency and the service level of water supply and sanitation through commercialization. This included the step to separate administration and services from each other (hence, the Nairobi Water and Sewerage Company is a Ltd. company) and to increase the degree of self-financing successively (Roland Werchota).

Objectives and guidelines

Under the **Nairobi Water and Sewerage Institutional Restructuring Project** it is planned to created conditions under which the organization can offer safe, clean and affordable services that are economically and environmentally sustainable to all parts of Nairobi's population. The vision of Sellestine Kiuluku, Director of Human Resources and Administrative Services for NaWaSCo is: "To be the leading provider of reliable quality water and sewerage services in Nairobi and its environs" (Athi Water Services Board/WBG 2005:4).

Staffing

2,000 staff, composed of **professionals** including engineers, technicians, managers and financial staff, human resource developers, administrators and support staff (secretaries) are working together in the Nairobi Water and Sewerage Company.

NaWaSCo does not offer vocational training, jobs are advertised in newspapers and assigned according to rules of competition, according to James Karanja it is not **difficult** to find adequate staff.

Financing

At a water consumption of up to 10m^3 the **sewage fee** is €0.98, beyond that the fee rises with every additional m^3 by €0.09 (James Karanja).

Regarding the **collection of the fee** problems exist with unrealistic invoices and resulting lack of payment willingness: Meters monitoring water consumption also turn when air flows through them instead of water during service disruptions (Athi Water Services Board/WBG 2005:4). Since the sewage fee is linked to water consumption, its calculation is affected as well.

Management of disposal and treatment

When evaluating the investment costs and operating costs of on-site options (dry and water-based) compared to centralized systems, the following information was provided:
a) For **On-site Options (dry and water-based)**:
Investment cost: The average costs of a simple pit latrine are estimated to be €110, for a VIP to be €550-605 (Practical Action 2005:30). For a septic tank the cost are €1,430 and € 1,628 for Ecosan at a size for 5 persons (Ministry of Water and Irrigation, 2006:44).
Operating costs: 1. In those areas where also a sewerage system is available €38.50 are charged per collection to encourage users to connect to the sewerage grid, 2. in areas without sewerage system and residents of middle to high income €27.50 are levied per collection, and 3. In slums without sewerage system €22 per collection are charged (Mburu Kiemo).

b) For **Centralized systems** the following costs are being estimated:

Investment cost: The cost of connecting to the sewer system vary according to the population density: 1. At low population density (65 persons/ha): €5,720 per ha, €88 per person, 2. with medium population density (150 persons/ha): €13,651 per ha, €91 per person, 3. with a high population density (280 persons/ha): €14,509 per ha, €51.81 per person (Nairobi City Council, 1998:277).
Operating costs: For most users, the fee is €1.08, the cost of sewer maintenance and operation of sewage treatment plants are provided under "costs for management and maintenance" (Malaquen Milgo).

The cost for management and maintenance of infrastructure has been described as:
a) **On-site Options (dry and water-based)**:
Management and maintenance costs: for pit latrines usually no work is done and therefore no costs arise until they are full and need to be emptied (James Karanja).

b) **Centralized systems**:
Management and maintenance costs: Approximately 20 sewer sections and the sea outfall are mentioned in the *business plan* for 2004/05 to 2006/07 for cleaning, repairing and restoration work, for each of which between €16,500 and €220,000 were allotted per year. For the maintenance of the two sewage treatment plants and pond systems 9 projects are mentioned for the same time period, for each of which between €5,500 and €55,000 were allocated per year (internal business plan for 2004/05 to 2006/07).

Regarding the evaluation of advantages and disadvantages of both options:
a) **On-site Options (dry and water-based)**:
Disadvantages: The emptying of latrines and septic tanks is an unpleasant and difficult work, due lacking accessibility many have to be emptied manually, and some collapse while being emptied. Latrines often overflow due to overuse or rain, often they are opened purposely during rain to flush their contents. At worst the walls of former latrines are integrated into new residential buildings (Mitullah 1999).
Advantages: Latrines can be constructed by users themselves (James Karanja).

b) **Centralized systems**:
Advantages: The connection to the sewer system brings convenience to users.
Disadvantages: In already densely populated areas sewerage systems are difficult to retrofit (James Karanja).

Public sanitation facilities for urban residents exist e.g. in Kitui-Pumwani in the southeast of Nairobi, in the Mukuru Kayabaa settlement in the industrial area and in the Mathare Valley southeast of Nairobi (Wegelin-Schuringa/Kodo 1997:182ff.). Where no permanent presence of operators or owners can be ensured, in some cases street children gained control over the facilities and required fees from users, while in other cases adjacent property owners or residents locked the facilities for their exclusive use. Many public sanitation facilities suffer vandalism and clogged sewers (Water Utility Partnership/WSP 2003:69).

Sewers carry the sewage to the conventional treatment plant Kariubangi and surplus sewage is further channeled to the Dandora pond system. En route a large share of sewage is diverted for *urban agriculture* or leaks through broken or missing channel parts (Jacob Mwaura Ngonga). Also, clogging of sewers through entry of garbage, soil or vegetation growth through holes is a big problem. In 2001 about 30% of the city center residents are **connected** to the sewerage network, but hardly residents in Kibera, where up to 150 people share a latrine (Water Utility Partnership/WSP 2003:65). Approximately 16% of inhabitants have septic tanks, 11% have latrines connected to the sewerage, while 43% have VIP and simple latrines (JP Kimani) (UN-Habitat, 2003b). Figure 31 shows that pit latrines are most common in Nairobi's informal settlements. Public sanitation facilities exist in Kitui Village, and a shared facility of a common residential area I in Korogocho. In Kibera and Korogocho approximately 69% of the population use what is known as 'flying toilets', defecating into plastic bags which are thrown onto the street (Practical Action 2005:2). – Numerous initiatives exit relating to sanitation, but these are no independent **other sewage disposers**, instead these are usually projects for the construction of latrines, which are funded e.g. by the Lions Club or the *Hindu community*, the Indian minority groups in the country (James Karanja).

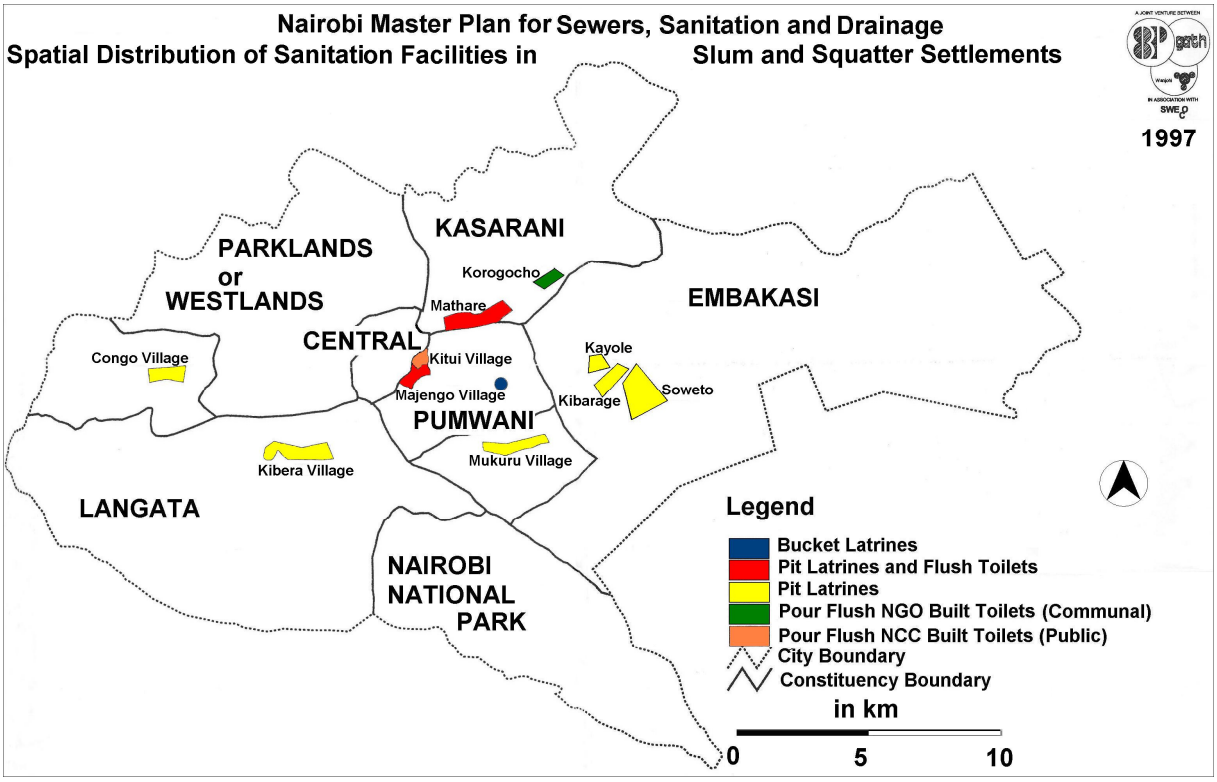


Figure 31: Spatial distribution of on-site sanitation in informal settlements in Nairobi 1997
Source: Nairobi City Council (1998): Nairobi Master Plan for Sewer, Sanitation and Drainage, Nairobi, p 59.

There are two main **sewage treatment plants** and additionally two smaller plants, which are mostly decommissioned (Mburu Kiemo): The largest I the *Dandora Estate Sewage Treatment Works* located 20km out of the city (figure 33), the screen system is out of order except for the coarse screen, beyond follows a pond system starting with an *anaerobic pond* (4.6m deep, 16m x 16m, planned sojourn time 100 days) and a *facultative pond* (1.75 m deep, 300m x 700m, planned sojourn time 35 days), followed by three *maturation ponds* (0.75m deep, 300m x 300m, planned sojourn time 5, 50 and 5 days). Then the water is channeled into the Nairobi River. When discharged into the Nairobi River the water is anaerobic (figure 32) (Jacob Mwaura Ngonga). Since only half as much sewage is treated as the treatment plant is built for (it is designed for 80,000m^3 per day, while about 42,000m^3 per day arrive), the sojourn time approximately doubles (JP Kimani). The plant was built by Duncan Mara, a pioneer in the field of natural sewage treatment (see figure 33) (Mara 2002). Why is the clarifying effect not achieved? - The correct sojourn time in the pond is important. If less sewage arrives at the treatment plant than required by its size (due to leaks in sewers or withdrawal for urban agriculture), the sojourn time in the pond increases. This may become a problem because the bacteria present in the ponds need a sufficient nutrient supply to survive. Another problem arises when the sewage sludge is emptied too rarely, it

also consumes oxygen. Sewage amount, pond volume, sojourn time and amount of sewage sludge need to be in a certain ratio to each other to ensure an efficient clearing effect occurs.

Figure 32: Facultative pond of the Dandora treatment pond system and discharge into the Nairobi River

Source: Author's photos

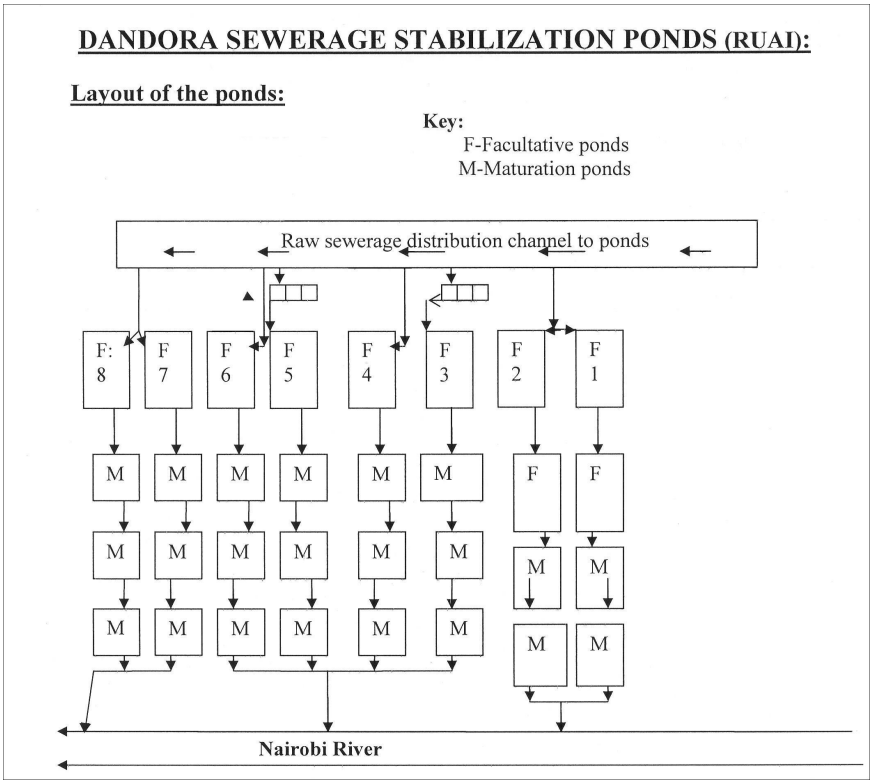


Figure 33: Dandora treatment pond system

Source: Material provided by James Mwaura Ngomga

The second largest sewage treatment plant *Kariobangi Sewage Treatment Works* has a conventional design with a biofilter and methane gas production. The capacity of 32,000m^3 per day is almost fully being used, but the clarification power of the facility is severely limited due to poor maintenance (JP Kimani, James Mwaura Ngonga).

The **treated water** is discharged into the Nairobi River.

The **sewage sludge** from the Dandora Sewage Treatment Work is dumped into landfills (the ponds are emptied only every 15 years), whereas the sludge from the Kariubangi Works is dried and sold as fertilizer, although also here industrial and domestic sewage are mixed and the sludge is therefore toxic (Jacob Mwaura Ngonga).

Legal framework

For water and sewage matters the **New Water Act** of 2002 is important, which sets the national guidelines in the water sector (Anthony Muriu). – The guidelines, which treated sewage needs to meet when it is released into the environment, have been set by the Nairobi City Council based on the UK Royal Commission to a biological oxygen demand after 5 days (BOD_5) of <20mg/l and suspended solids (SS) of <30 mg/l.

According to the **Public Health Act**, local authorities are responsible for the enforcement of legal regulations in the area of sanitation, such as e.g. the provision of domestic sanitation facilities by property owners, but in practice local authorities are overwhelmed with the enforcement (Mwangi 1997:145ff.). Additionally, illegal settlements are excluded from the service mandate of the municipality (Practical Action 2005:2).

Planning base

The Athi Water Services Board is responsible for the expansion of the sewer system, **planning** is carried out "demand driven". New connections must be requested by the user, settlements with higher standards are connected preferably. In poorer neighborhoods and slums sewerage is only extended through international donor agencies as the Credit Institution for Reconstruction Germany and the World Bank (James Karanja). It is planned to connect the whole downtown area of the city to the sewerage system in future (Nairobi City Council 1998:xxxi).

Quality control

In the Dandora Sewage Works there is a laboratory, where compliance with the national standards is monitored. In particular the **Biological Oxygen Demand** is often too high (F.K.

Mugo). The BOD_5 in the Nairobi River was 271mg/l in 1995 and in the Ngong River 400mg/l (Nairobi City Council in 1998. XXVf.). The threshold is set as <20 mg/l (see above under "legal framework"). There is no **emergency** plan for the failure of the treatment plant, leaks in the sewers, unforeseen events etc., such cases are the norm (James Karanja and own observations).

Challenges

Although with only 26% of the population living in urban areas, East Africa is the least urbanized region in Africa, it still has the highest expected urbanization rate over the next 15 years of 4.5%, therefore rapid changes are anticipated here. So far Nairobi is one of the few metropolises in the region with more than one million inhabitants. Urban growth and urbanization have outstripped economic development, the increasing demand for accommodation and public services already poses a large challenge (Bird 2002).

In Nairobi, land cannot be transferred via private contracts like in Dar es Salaam, the only way is through the official registration, which is time-consuming and expensive. Many settlements that have not undergone this process are classified as illegal. As a result for the municipality the inhabitants of these settlements are excluded from any entitlement to connections to the public infrastructure. The municipality reserves the right to vacate the respective streets or settlements after a warning and to tear them down with bulldozers. Further investigation is needed, in how far plots or accommodation with appropriate infrastructure are available at a price that is affordable for slum dwellers.

Up to 90% of the housing situations in Nairobi are tenancies. Tenants fear that their rent will increase if they install sanitary facilities, which would make them pay double for this effort in effect. Any savings are rather spent for the secondary residence upcountry. In Kangemi, Kawangware and Githurai individual ownership prevails, but still the willingness to invest is low, because the one hand it is expected that the municipality guarantees sanitation services and on the other hand because there is too little social coherence that is required for the establishment of community facilities. Water-based systems are not common because they require continuous water supply as well as investments in pipes, pumping stations and pond systems, which residents cannot afford and also do not even want to afford because of the "temporary" nature of the settlements. The requirements of water availability and accessibility limit the possible building sites to locations at the margins of settlements along roads, where they compete for space with more profitable uses such as kiosks and market stalls. Dry

toilets are more independent, but their sustainable usefulness depends on functioning emptying options (Wegelin-Schuringa/Kodo 1997:181ff.).

To meet the challenge of emptying latrines in inaccessible locations (dirt roads, erosion-damaged, narrow or steep paths, inaccessible, deep latrines with hardened contents) a specialized collection vehicle Vacutug was developed in 1996, which is inexpensive, locally buildable and repairable, and which is used in the slum Kibera. The vehicle has a vacuum tank with a capacity of 500 liters, and a gasoline engine. When connected to a vacuum pump tanks and latrines can be emptied. Experience shows that especially the institutional link of the vehicle operators to existing sewage disposal services and sewage treatment plants or ponds, as well as providing funding options are crucial factors for sustainable success (Water Utility Partnership/WSP 2003:75). The application of this approach could also be promising for the other analyzed cities.

Not only toilet facilities are scarce, many villages also do not have facilities for bathing or showering, in Mukuru 85% of the population are affected, 65% in Korogocho, 55% in Kawangware and 54% in Kibera (Alder 1995:88ff.). Men use to shower outside at night, women usually move furniture to the side in the limited rooms and shower inside, leading to a quick fraying and damage of housing space and furnishing (UN-Habitat, 2001:119). Public shower facilities are only successful, if the areas for men and women are clearly separated and security is guaranteed.

In the *Nairobi Master Plan for Sewer, Sanitation and Drainage* is proposed to respond to the limited financial resources, donor fatigue in international organizations and changing policies in a way that in the future the construction and maintenance of sanitation facilities in informal settlements is carried out *by the people themselves* (Nairobi City Council in 1998 XXXIIIf.). The Master Plan does not outline any other measures to improve the sanitation situation in informal settlements. – Significant is also the statement in the Nairobi Master Plan for Sewer, Sanitation and Drainage regarding international standards: “Since the WHO recommendations are worldwide figures, they are considered to be less applicable than those determined in local studies and are therefore not recommended for this Master Plan” (referring to water quality) (Nairobi City Council, 1998:123). This raises the question how far the creation of international non-binding standards is useful. This question is seized again at the end of the study.

As can be seen in the information-scarce map (figure 31), it is a challenge to gain reliable spatial information regarding the sanitation services of Nairobi. Various types of sanitation

seem to exist in scattered patterns without clearly recognizable zonation (Nairobi City Council 1998:XXVII).

A particular problem is corruption, which affects the sanitation situation negatively in various areas such as land allocation, fee collection, etc. Adequate payment of civil servants is an important contribution against corruption, as well as transparency in administration, cutting down bureaucracy and campaigns against corruption, as are currently initiated.

Conclusions

Due to the availability of the very large Dandora pond system, it seems a sensible approach to restore its performance through an adequate sewage input according to the number of ponds and regular desludging. The connection of at least the downtown area to the sewer system should effect hygienic improvements, along this the reparation of sewers is necessary at large scale, which would mean taking an important source of irrigation water from those engaged in urban agriculture. Re-using treated water from the Dandora plant for urban agriculture however seems difficult, as the facility is located 20km out of the city.

According to the *Nairobi Master Plan for Sewer, Sanitation and Drainage*, septic tanks are suggested for the less densely populated areas in the outskirts of Nairobi. In the western and northern parts of the city *red coffee soils* predominate, which are permeable to water. In the southern and eastern part of the city however *black cotton soils* with poor water permeability prevail, which makes the use of tanks that drain into the ground problematic. - To improve the sanitation infrastructure in Kibera immediate and long-term measures are recommended: an awareness-building information campaign on health and sanitation is to be initiated, existing latrines and shower facilities are supposed to be repaired by NGOs with participation of residents and the emptying of latrines through vehicles of the municipality or small suction devices of the *Kenya Water for Health Organization* is planned to be realized. In the longer term public toilets are planned to be constructed in places where a permanent water supply permits, it is foreseen to entrust private groups with the maintenance. In addition it is envisaged to set up pour-flush toilets where a sewer connection is possible, but no reliable water supply available (Nairobi City Council, 1998:103ff.).

To avoid the problem of investment and planning insecurity in informal settlements, one approach can be to construct community sanitation facilities at least at the margins of these settlements on ground with clear ownership in cooperation with village residents, which are accessible for them and operated by them with clearly defined responsibility.

5. Comparing the results with the international recommendations – analogies and differences

The research showed that the empirically analyzed topics (in bold below) revolve around certain areas that are relevant in the different towns, which will be presented in this chapter building on the initially presented “proposals and guidelines of international organizations".

5.1 Legal challenges related to insecure land tenure, lack of planning base and legal framework

In the analyzed cities the formation of informal settlements increased, particularly after reaching independence. It turned out that insecure land tenure is a major impediment to the expansion of infrastructure. Secure legal land ownership fosters the motivation for investment of residents, provides access to credit and the inclusion of settlements in public planning. This aspect yet receives little recognition in the guidelines and actions of international organizations.

Even with officially fixed low land prices, complex and costly land-registration and -transfer processes close out the poor “because they can’t work the system” (UNDP 1989:5). These circumstances foster the emergence of an informal market for land. Especially in East Africa a solid planning base is lacking. UNDP’s *Urban Management Program* proposes to improve the **planning base** through a comprehensive mapping of existing settlements and land tenure and their registration in the official cadastre. To achieve this it is planned to develop new methods for land registration and to simplify the transfer of land ownership as well as to debureaucratize rules and regulations (UNDP 1989:5). In low-priced residential areas not only regular mapping, but also sanitation mapping is important: The mapping of public and domestic water supply locations and –types as well as locations of showers, washing places and toilets as well as their types is important when e.g. a slum is to be equipped with sanitation facilities, to locate and identify needs and deficiencies as it was attempted by the author with the compiled maps of analyzed cities. In East Africa it can be seen that technical equipment including computers and know-how of relevant software is scarce, an information and map base is still under construction here. The “demand-driven” planning approach indicates that planning activities are yet carried out not very anticipatory, but rather responsive to already occurring nuisances.

Regarding the **legal base** of the analyzed cities the international guidelines and standards are at highest mentioned marginally. The national legislation is fragmented, especially in East Africa, and also in Durban the divided responsibility among the Ministries of Water, Health and Environment are seen critically. The legislation in Windhoek is oriented along that of South Africa. Content-wise the standards in Windhoek are very close to the international suggestions and guidelines.

5.2 Political decision-making - a prerequisite for effective action

Political obstacles seem to outweigh technical hurdles, because it is primarily a political process that decides what topic appears on national and local agendas and what does not. Sewage management is - although as demonstrated a widespread and serious problem - under-represented in these agendas. National and local plans do hardly pay attention to it and international standards are rarely implemented. In terms of **objectives and guidelines** ambitious targets are identified that are quite compatible with the recommendations of international organizations, however particularly in Dar es Salaam and also to a lesser extent in Nairobi there is a lack of strategies to implement them. An exception is the *Windhoek Integrated Environmental Policy*, whose standards to reduce sewage generation and comprehensive sewage treatment are consistent with UNEP's *guidelines on urban sanitation*. In addition, the sewage that is treated up to drinking water quality is subject to inspections according to WHO guidelines. – Well-**staffed** implementing agencies are crucial for this: The composition of multi-disciplinary teams for sanitation management is generally fulfilled as it is recommended in the *Water Safety Plans* of the WHO. In Windhoek and Durban it was noted that qualified personnel is hard to find, which may indicate that vocational training regarding sewage disposal and treatment still have potential for optimization.

Contrary to popular belief that especially those living in rural areas that are particularly vulnerable as in urban areas services, infrastructure and economic goods are available, Pelling contradicts by saying that particularly urban settlements are at risk. Due to malfunctioning or non-existing social networks, the necessity to earn money for food purchases (integration into the *cash economy*), a greater range of health risks (exposure to industrial waste products, easy infection via sewage and waste due to high population density) special hazards exist to health and food security (Pelling 2003:75). The analysis of selected cities has shown that the poor are particularly vulnerable to poor sanitation.

5.3 Organizational - sanitation infrastructure as a means of sustainable urban development

Link to urban development

A prerequisite for the strengthening of political institutions as recommended by the *EU cooperation policy* is first of all the aggregation of skills and responsibilities to one **organization**. The survey results show that water supply and sewage disposal are organized by one institution in each city, which is useful for joint accounting.

Experience of the World Bank shows that it is good: 1. to locate industrial facilities in designated industrial areas, so that the sewage generated there can be treated separately and is not mixed with domestic sewage, 2. to encourage *cleaner production* approaches as far as possible as they may save money, water, chemicals etc. and lead to sewage that is easier to treat (Frank Stevens) (UNEP/GPA 2001b:4). – This also raises the question, in how far the provision of sanitation infrastructure can be used as a means to direct urban development into sustainable ways.

Payment systems

Incurring costs of sewage treatment facilities for repairs, staff, electricity, water etc. are paid either per use, weekly or monthly. As the survey results regarding **financing** show, there are problems however with unpaid bills. An essential step to meet this challenge is to adjust the billing frequency to local income cycles. Generally, short billing intervals are preferable as it is difficult for many city dwellers to accumulate large sums of money. Since in many cities (e.g. in Nairobi, Dar es Salaam) cash remittance is not common and money is rather handed over in cash, it is recommendable to establish a sufficient number of cash collection points to shorten distances and queuing time for those willing to pay. While in cases of domestic water supply levying a consumption-based fee is recommendable (which requires functioning meters), for public sanitation facilities in residential areas rather a weekly fee should be collected to promote the continuous use of these facilities.

5.4 Social - Participation and the choice between cost and comfort

Sensitization of the population

Not to be underestimated in importance as accompanying measures for infrastructure expansion are fostering networks of involved actors, exchanging data and experiences, providing information to all stakeholders and particularly the affected population. Also then planning upgrades in sanitation services it is recommendable to offer several options so affected residents have a certain choice between costs and comfort. This requires that residents know the different options and are able to evaluate them. When communicating health issues it is interesting to note that in different African languages the word “health” did not exist until a few decades ago, but equivalent terms rather referred to a state of harmonious relations (to the living, the dead and the environment), this is the case e.g. with the Zulu in South Africa and the Swahili in Dar es Salaam (Eeuwijk 2002). This perspective on health and hygiene issues should be kept in mind in any attempts to communicate these issues.

Gentrification

The introduction of sewer systems in low-priced residential areas increases the risk of inducing gentrification processes. These can occur when the demand for accommodation rises in areas that have been connected to public services and thus the pot prices or rent levels rise as well, which can lead to the expulsion of local residents, who then have to move into unserviced areas (Water Utility Partnership, 2002). – Even the construction of public sanitation facilities with user fees leads on the one hand to improved hygienic conditions, but not all residents can afford the fee and some remain using latrines in the area if no private ones are available. However the land owners are often even more unlikely to construct latrines (or take even less care of emptying and maintenance), as the demand for latrines is declining. For the poorest the situation is deteriorating therefore and thus they may need to move into an area with only traditional pit latrines (Practical Action 2005:38).

Gender issues

Gender-related inequalities and differentiated needs are according to the *UN Millennium Project Task Force on Water and Sanitation* also relevant for sanitation matters. When

analyzing the payment ability and willingness it can be seen that particularly in East Africa women are responsible not only for water supply, but also for health- and hygiene-related issues, which are closely associated with sewage matters. In contrast especially in East Africa men administer family finance issues, therefore particular care has been taken with whom agreements on the implementation on improvements of sanitation are made, so the funding is tailored accordingly and women's needs are met (Actionaid International 2004:16). Since women usually look after children they also have to decide where to wash them and whether they can make their children use latrines due to the danger for them of falling in. Experience shows that women use communal bathroom facilities only if there are separate areas for men and women. - The provision of showers contributes also in particular to the hygiene of elderly people who have difficulties to bend over a washing basin. The option to use hot water for showers is welcomed by women and men alike (Practical Action in 2005. 13ff).

5.5 Technical - the nature and extent of sewer system expansion

According to the proposals of the *Regional Consultative Meeting on Municipal Wastewater in the Eastern Africa region* to conduct cost-benefit analyzes, this study assessed the costs of different sanitation options for the analyzed cities and its applicability to the different city areas was examined. – The retroactive installation of sewer systems is difficult, particularly in densely populated areas, also a certain minimum number of paying participants must be met so that the construction is payable. On the other hand an extensive sewer network offers the most convenient and health-preserving way to dispose sewage, especially for the inner areas of cities. However it needs to be decided carefully to what extent an expansion of the sewer system is useful, as in marginal areas of cities the **organization of disposal** seems to be more promising via alternative decentralized solutions, as it is also mentioned in UNEP's earlier presented *Guidelines for Urban Sanitation*. - The survey results show that in existing settlements the provision of latrines at household level is neither feasible for reasons of space nor desirable for hygienic reasons. In these cases urine diversion systems can be a useful alternative as they ensure less odor and more hygiene. In addition, water-based systems have higher maintenance costs than dry systems, which is another aspect in favour of dry systems, another being that in the analyzed cities water is available limited only. Small sewage networks may be of interest e.g. to boarding schools, hospitals, prisons and game lodges. In densely populated and to a certain extent also in informal settlements communal sanitation facilities may bring benefits, provided that ownership and distribution of responsibility in terms of maintenance and repair are clearly defined.

5.6 Economic - the dispute for and against privatization

Financing

The total economic costs associated with an adequate sanitation for urban residents critically depend naturally on which of the presented technical options are selected, the transfer of the Western model being the most expensive. Even with the customized low-priced approaches the cost amount $10billion per year to provide water and sanitation for all, according to Richard Jolly, chairman of the Water Supply and Sanitation Collaborative Council. Calculations by the World Bank that take into account conventional technologies result in figures that are several times above this amount. It is yet to be agreed whether these casts can be covered by national and local governments through priority shifts, or to be financed by increasing development assistance or through private investors.

To encourage funding through national and local means awareness is needed (particularly in East Africa) on the burden that a defective sanitation system causes for health and the environment, but also for the overall economic development. According to Niemczynowicz (1996) in the large cities of developing countries the costs of necessary investments for water supply and sewage disposal and –treatment exceed by far what can be covered by municipalities (Scott/Faruqui/Raschid-Sally 2994). Development projects in the area of sanitation (e.g. the initiatives presented in this study) exist with more or less success, the question is in how far they can and should be the main driver of improvement in this sector.

To meet the challenge of high connection costs for the poor, one approach can be a cross-subsidy, in which the more affluent users subsidize new connections with a regular fee. According to the *UN Millennium Project Task Force on Water and Sanitation* this can be a means to connect poorer districts to the sewerage system. The differentiation of tariffs based on different zones within a city has proved to be a useful approach. The usual procedure is to create groups of assumed common income, which is a more feasible approach than trying to identify individual payment capabilities. Particularly in Durban/South Africa, which has due to its apartheid past still quite demarcated neighborhoods, districts still correlate very strongly with certain income levels (Department of Water Affairs and Forestry, 2001:29). The financing of subsidies via local taxes is difficult, because there is a trade-off between funding sources and demand: The greater the proportion in a city is of those in need, the lower is the proportion of those who can afford to provide finance (Mehta 2003).

Privatization

Opportunities and risks of privatization of water agencies are highly controversial. While some see it as an opportunity to improve health and environment conditions through capital, experienced management and increased efficiency (especially the World Bank argues along these lines), critics reject this option mainly because of the danger of rising prices, as private companies are interested primarily in profit maximization and claim that the beneficiaries of such privatization are a small number of global companies. Specifically for the sanitation sector there is criticism against giving a fundamentally necessary and indispensable service out of the hands of the public administration, because private companies are in contrast not bound to the public welfare, but instead to business goals (Bird 2002). According to the World Development Movement, the efficiency does not differ significantly between public and private suppliers (World Development Movement/Public Services International, 2006. 10f).

In particular, the role of international organizations is seen more and more critical: Actionaid International complained that during the last two decades technical assistance and knowledge transfer was too much tied to conditions, which were oriented less on the needs of recipient countries but rather on those of the donor countries. The application of the ownership principle is seen as unrealistic, for example in Tanzania, where 41% of government spending is financed by donors and which is categorized as a Heavily Indebted Poor Country (HIPC), donor countries and organizations have a considerable influence on policy decisions, which led to the privatization of the water and sewerage authority. In particular the World Bank and the International Monetary Fund (IMF) may encourage Tanzania via financing programmes to privatize parts of the public administration. The World Bank's *Country Assistance Strategy* (1997) constituted that Tanzania receives €237,984,000 per year ("high case" scenario) if it pursues a more rapid privatization of state institutions, compared to a baseline scenario of €158,656,000 and € 79,328,000 with restricted privatization. For the indebted Tanzania this was an incentive of €158,656,000 to promote privatization. In 2000 particularly the privatization of DAWASA under a concession contract was set as a prerequisite for financial assistance and debt relief for HIPCs, which would reduce Tanzania's debt by a total of €2,379,840,000. It is said that there were limited consultations with affected groups, despite the emphasis of the World Bank's *Poverty Reduction Strategy* on participation. According to Actionaid International one of the aims (of World Bank and other agencies) of privatization is to prevent water policy to be instrumentalized for other purposes (Actionaid International in 2004:2ff). It has to be noted though that also the private sector is not apolitical, in the analyzed cities politics sometimes

tend to move along ethnic rather than political currents and certain population groups prevail in certain areas of business.

As for the involvement of private enterprises in the sewage sector, the ambivalent experiences and opinions in the analyzed cities seem to be rooted in the different approaches of privatization used: In Durban the cooperation between Veolia and the paper industry is used specifically to decrease freshwater consumption and costs while accessing high-priced technology (which the municipality would not have been able to finance out of its own resources). The contractually fixed transfer of the treatment plant from the French conglomerate Veolia to the municipality after 10 years does not cause dependence to the municipality, instead it envisages the municipality to possess this plant after the contract expires. - In Dar es Salaam however it was tried to transfer the entire sanitation management at one go to City Water Services Ltd., while the infrastructural conditions of the city are difficult to grasp and are not well documented. Both contractual parties later accused each other of non-compliance with agreed contractual conditions. Several hypotheses exist on the reasons for the termination of the contract with City Water from the Tanzanian side: 1. The local government wanted to regain control, 2. The local government never wanted to pass the control and did only so temporary for debt relief and aid access, 3. President Lowassa may have been interested to raise his profile before the next elections (Blanc-Brude 2005).

It obviously makes sense not to pass away the full responsibility over infrastructure and management, but rather regionally or sectorally limited areas, while coordination and responsibility remain in the public hand. Information and knowledge transfer should exist in both directions, not only in the way that a company gets insight into the processes of the relevant administration, while the latter does not gain experience through the privatization. This is particularly important in the view of future privatizations, in which such companies otherwise would have an advantage in terms of internal information (WSP/World Bank 2001:8).

For a successful privatization of areas or even the entire sewage management no vague tender should be made, which is aimed at the lowest price promise of applicants. Instead the agency offering the tender should request e.g. for the most extensive supply possible at a realistic fixed price or select the applicant that asks for the lowest subsidy to provide a fixed expansion of the sewer network. The achievement of targets should be measurable, which is rather possible when goals are formulated in absolute terms than in percentages. "The absolute number of new connections in a neighborhood is relatively easy to verify, if however

70 or 80% of residents have access to water is difficult to assess in areas without compulsory registration and defined property titles (Südhoff 2005:77f.).

Urban agriculture

A significant proportion of urban sewage in Nairobi and Dar es Salaam is used in urban agriculture for irrigation as a cheaper alternative to fresh water. In Nairobi urban agriculture is practiced in many urban areas, e.g. at the Mau Mau Bridge west of the city center: Irrigation is done by 34% with sewage, by 51% with (contaminated) river water, faecal coliform levels there are 10 times higher than the WHO thresholds. This affects agricultural products both for subsistence and for sale and export, spreading pathogens to places where these germs were previously unknown (Carr/Blumenthal/Mara 2004). The following section explores and discusses opportunities and risks of this practice.

Despite the associated health risks urban agriculture using irrigation with sewage contributes to food and income security not only of poorer population groups, while in spite of its considerable size there is little regulation in this area to reduce its risks. The demand that only fully treated water is used seems to be an unrealistic goal. There is a gap between standards, which require no measurable infection risk in the use of sewage versus the situation on the ground in the cities (Carr/Blumenthal/Mara 2004). At the same time the risks can be reduced when the sewage use is limited in certain ways. These limitations take into consideration the different modes of disease transmission, especially the consumption of foods irrigated with sewage and direct contact with sewage during irrigation or agricultural work on the field. Analogue to the discussion about adequate supply, it is important not to set unrealistic or unnecessary standards, but to define a tolerable degree of health risk taking into consideration how easily pathogens can be spread via other paths. E.g. it will have little impact to halve the number of salmonella cases linked to sewage irrigation, if 99% of cases are transmitted via other ways, e.g. via food (Bartram et al., 2001).

Two guidelines for dealing with sewage are: 1. by the WHO (1989): *Health Guidelines for the Use of Wastewater in Agriculture and Aquaculture* and 2. by the *United States Environmental Protection Agency*. Their applicability and feasibility in different developing countries is still controversial. While Fattal, Lampert and Shuval (Fattal/Lampert/Shuval 2004) recognized them as widely accepted by FAO, UNDP and UNEP, Scott, Faruqui and Raschid-Sally see difficulties on the one hand with the technical and financial implementation and on the other hand in the legal connection to existing laws and their enforcement (Scott/Faruqui/Raschid-

Sally, 2004). In any case the guidelines should be accompanied by awareness campaigns for health and hygiene.

Health-protective measures emanate from a *multiple-barrier* approach that includes five aspects:

1. Primary treatment of sewage (and separation of industrial sewage) – If no other methods are available at least simple means such as e.g. sedimentation in reservoirs should take place. (A good side effect of reservoirs is that they create a reserve of sewage for dry periods – when irrigation demand is highest.) (Cifuentes et al. 2000).
2. Restriction of crop types that are irrigated with sewage – Non-food products such as cotton, or products that are peeled or cooked like potatoes may rather bear being irrigated with sewage of poorer quality than those eaten raw or unpeeled. This measure however only protects the consumer, not the field workers and their families and therefore should be combined with other measures (Blumenthal et al., 2000).
3. Irrigation technology – Sprinkle irrigation spreads bacteria and viruses to neighboring settlements, a protection zone of 50-100m to houses and roads is recommended (Mara and Cairncross 1989). Field workers are also endangered by irrigation ditches and flood irrigation (Blumenthal et al., 2000). More advantageous, but also more expensive is drip irrigation, which brings the water directly to the plant (Vaz da Costa Vargas et al., 1996).
4. Restriction of human contact with sewage - For field workers this means wearing closed shoes and gloves while working (Mara and Cairncross 1989), opportunities for field and market workers to wash hands with soap, as well as using clean water for the common wetting of agricultural goods to keep them fresh. Consumers should wash or better cook food (Blumenthal et al., 2000).
5. Vaccinations - Although these are not preferred measures in the first place vaccinations may play a role in the prevention of diseases (Mara and Cairncross 1989).

5.7 Regional Differences

Difference East Africa – Southern Africa

The research has shown that in Durban and Windhoek higher technical and organizational standards are met for sanitation management than in Dar es Salaam and Nairobi. While in Windhoek sewage treated at a great expense up to drinking water quality in order to save

water, also in Durban the standard is high as well as collaborations with industry, which buys pre-treated water that meets their specific needs.

In Dar es Salaam and Nairobi however there are major technical and organizational challenges, which are related to the overall city development. Land ownership is an important factor for the connection to urban infrastructure. Land transfer can take place slightly easier in Dar es Salaam than in Nairobi, which leads to larger areas of informal settlements in Nairobi, the largest of which is the Kibera slum.

Difference Coast - Inland

Coastal landscapes are of special importance for people, as 60-75% of the world's population live less than 60km away from coasts and the state of coastal waters has a decisive influence on economic and social activities such as fishing and tourism. The coasts of the analyzed cities are characterized by sensitive ecosystems such as coral reefs near Dar es Salaam, municipal sewage is one of the most severe dangers for them. In Dar es Salaam a large part of the sewage is discharged into the sea untreated and even the water that previously went through treatment ponds is hardly clarified due to the limited functionality of the facilities, problems are caused by a high BOD and pathogens. Also Durban makes use of its seaside location and discharges water, which is treated to a lower level as well as sewage sludge into the fast-flowing Agulhas current. – To improve the situation on the one hand special indicators should be applied to monitor marine pollution, which are not necessarily exactly the same as for the protection of human health. In addition cities need to assume a greater responsibility for their discharges into the sea and to put more efforts into pretreatment (Sanicon 2002a). The increased use of dry or urine diversion toilets can be an important contribution.

6. *Applicability of the results for the optimization of sewage management – Do the international proposals help?*

The results of the various sanitation aspects in the analyzed cities, which were analyzed in the previous chapters, are in the following chapter linked back to the initially presented hypotheses.

Hypothesis 1: Sewage disposal from urban areas in sub-Saharan Africa is a diverse problem that is growing in urgency. - This hypothesis was related to the determination of 1) decision criteria, 2) indicators, and 3) methods based on which sewage management is carried out. In this context relevant suggestions and guidelines were presented, while the structuring into 1), 2) and 3) is most evident in the World Bank method for evaluation and comparison of water and sanitation facilities. To evaluate this hypothesis interviews were conducted with representatives from municipalities as well as national and international organizations in four selected cities, examining the different geographical conditions of the cities and their impacts on sewage management. The research showed that in Southern Africa largely anticipatory planning is employed (except for the areas “inherited” through the expansion of the urban area in Durban), while in East Africa the planning style is more characterized by responding to prevailing nuisances. – Windhoek and Durban have a strong GIS-based planning basis, the *University College of Lands and Architectural Studies* is making efforts to develop a comparable basis in Dar es Salaam. This requires to overcome staffing and technical challenges, as trained personnel and necessary software are not easily available and challenges with data collection exist in East Africa. - As outlined in the introduction, the issue of sanitation is thematically diverse and touches on various areas of public interest such as health, water supply and environmental quality. As shown based on the research, sanitation management is often spread over different departments such as Ministries for Water, Health and Environment etc., as well as over different hierarchical levels (national, regional, local), resulting in parallel, partly overlapping and conflicting regulations, which makes implementation difficult. This aspect was particularly found in East Africa. How many other areas relate to sewage concerns was shown in chapter 5, where in addition to legal and technical aspects also the socio-economic context is assessed, because is relevant to identify whether sanitation options are adequate or inadequate or the presence of certain pathogens should be classified as a risk.

Hypothesis 2: Between the recommendations and guidelines for sewage management from international organizations such as UN, WHO, etc. and the situation on the ground in many cities there is a difference. – Regarding the question on the planning base in the analyzed cities and whether they apply the international proposals and guidelines it can be noted that they are rarely explicitly referred to. Content-wise the planning in Windhoek is most aligned with it. It should be examined further in how far this is the case and how the gap between theory and practice can be reduced in future. The research shows for East Africa that the practice in the analyzed cities differ from the guidelines: The Nairobi Master Plan for Sewer, Sanitation and Drainage does not recommended the use of international standards because since they are global guidelines they are considered not to be adaptable to local conditions (Nairobi City Council 1998:123). In Dar es Salaam officially the WHO standards have been adopted (Government of Tanzania 2004), but between the official plans and the reality on the ground is a large gap. In Windhoek exceptionally high standards prevail, which are mainly motivated by the water scarcity, because of which sewage is treated with such technical and financial effort. In Durban the situation is less definite: On the one hand also here high standards prevail (Durban is leading in the phosphate elimination (Ruhr-University Bochum in 2005. 295ff)), on the other hand sewage sludge is discharged into the sea and in the annual environment report the resulting environmental impact is compared to that of “other developing countries" (Ethekwini Municipality 2004:145). – Some of the previous measures in the field of sanitation failed because of a lack of inclusion of the affected population (WHO/UNICEF 2000:34). To reduce the gap between proposals and practice flexible guidelines should be used and basic regulations for the operation of on-site of decentralized sewage systems be included into national legislation so that these receive a clear status regarding standards and transferability. Awareness-raising measures appear to be necessary to convince city dwellers of the benefits of functioning sanitation facilities, and to convey related hygienic practices, while the means of communication should be compatible with different languages as well as not exclude illiterates. For the construction of infrastructure it is necessary to involve the affected residents into planning, as this will rather safeguard sustainable use than expensive projects without participation.

Hypothesis 3: Sewage management needs specific solutions, because it leads to a significant improvement of hygiene, comfort and social status and is, in contrast to water supply whose urgency is usually obvious, often neglected. – It should be investigated further, what scope of action exists for the improvement of sewage management in the analyzed areas to develop a concept for the optimization of urban sanitation in cities of sub-Saharan Africa. - The need for improved sewage management was particularly evident in the sewage discharges from Durban and Dar es Salaam into the sea and the inadequate organization of

sanitation in East Africa. The research provides the impression that sanitation is seen as secondary behind water supply in East Africa. In general inner city areas should be connected to either a centralized or decentralized (such as condominial- or small-bore systems) networks. Small networks have the option to connect to large networks later, which is however not a necessity, approaches such as in Dar es Salaam with several separate pond systems are also useful if the treatment systems function, because they usually have short sewer paths, which require less pumping stations and are thus less susceptible to failure. But with any system the downtown areas should be fully covered and the subsequent sewage treatment effective. In city margins, which already pass into rural areas as in Durban on-site systems (especially dry systems) can be a valuable addition.

To what extent are the findings typical for other countries in sub-Saharan Africa?

There are several reasons why a connection to the sewage system remains undone 1. Peripheral location – Although the focus of this study is on urban areas and the analyzed cities are characterized by a high population density, there are more or less wide "margins", which are administratively part of the city area, but are predominantly rural (particularly in Durban). Here is a connection to the sewer system usually is not carried out due to economic reasons, on-site sanitation facilities are built by residents themselves or in collaboration with NGOs. 2. Poverty - Poverty is another factor that hinders a connection to the public network, partly because the connection costs are often passed on to the end consumers, which may not affordable for them, and partly because low utilization would lead to low expected return through fees or providers fear shortfalls in payment. Experience shows that sewer systems in low-priced areas require more maintenance as e.g. clogging through waste entry into sewers may occur. 3. Informality/illegality - Apart from poverty the status of a settlement being informal/illegal has to be considered separately, since an organizational/legal dimension is the matter of focus here, a connection to a public network in the analyzed cities is only possible if land ownership is officially cleared. The three criteria often overlap, particularly 2. and 3. As the mentioned contexts and challenges also occur in the larger regions of the analyzed cities, also the transfer of results in terms of possible advantages and disadvantages of different sanitation options, possible reforming or privatization approaches of sewage organizations are possible to a certain extent. The specific planning steps however must always be adapted to the specific local context of a city.

Are the international guidelines practical and suitable to bring about an improvement of sanitation?

As for the setting of international guidelines, there seem to be two dilemmas: The first refers to the concretization or abstraction of standards: On the one hand concrete standards would be beneficial to orient planning efficiently, on the other hand the surveys show that this is practically not possible due to the very different conditions in the various cities. It is rather necessary to adapt standards to geographical circumstances and social priorities to ensure efficiency, reasonable costs and proportionality of measures. - The second dilemma regards the non-binding nature versus the potential bindingness of guidelines: The non-implementation of many international standards provoke demands for their legal bindingness but legally binding rules resemble an interference of international organizations in national legislation, which is problematic especially given the difficulties to formulate appropriate standards.

Therefore it is proposed to replace *vague goals and concrete instruments* with a principle of *concrete goals and flexible instruments*, while making monitoring success an integral part of any approach (Jänicke/Kunig/Stitzel:111). To develop specific targets geography can make a valuable contribution to integrate both scientific and social aspects.

7. References

Literature

Actionaid international (2004): Turning off the taps. Donor conditionality and water privatisation in Dar es Salaam, Tanzania, London.

Alder, Graham (1995): Tackling poverty in Nairobi's informal settlements: developing an institutional strategy, in: Environment and Urbanisation, Vol. 7, No. 2, October 1995, London, p.85-108.

Asian Development Bank/International Water Association (2003): Asian Water Supplies. Reaching the Urban Poor, London.

Askildsen, Jan Erik (2003): Adam Smith and the „invisible hand": The market mechanism, in: Larsen, Stein Ugelvik/Zimmermann, Ekkart (Publisher): Theorien und Methoden in den Sozialwissenschaften, Wiesbaden.

Athi Water Services Board/WBG (Publisher) (2005): Nairobi Water and Sewerage Institutional Restructuring Project. A mid-term review report of the Nairobi Water Company, Nairobi.

Atteslander, Peter (1993): Methoden der empirischen Sozialforschung, 7. edition, Berlin.

Bartlett, Sheridan (2003): Water, sanitation and urban children: The need to go beyond 'improved' provision, in: Environment and Urbanisation, Vol. 15, No. 2, October 2003, London, p.57-70.

Bartram, J./Fewtrell, L./Stenström, T.A. (2001): Harmonised assessment of risk and risk management for water-related infectious disease: an overview, in: Fewtrell, L./Bartram, J. (Publisher): Water Quality: Guidelines, Standards and Health. Assessment of Risk and Risk Management for Water-related Infectious Disease. International Water Association on behalf of the WHO, London, p. 1–16.

Baxter, Jamie und John Eyles (1997): Evaluating qualitative research in social geography: establishing 'rigor' in interview analysis. In: Transactions-Institute of British Geographers. Vol. 22 (4), p.505 – 525.

Bellers, Jürgen (2005): Methoden der Sozialwissenschaft. Kritik und Alternativen, in Udo Hagedorn (Publisher): Schriften des Faches Politikwissenschaft, Siegen.

Blanc-Brude, Frederic (2005): Biwater's Tanzanian blindfold, in: Global Water Intelligence. Market Leading Analysis of the International Water Industry, Vol. 6 Issue 6 June 2005.

Blumenthal, U.J./Peasey, A./Ruiz-Palacios, G./Mara, D. (2000): Guidelines for Wastewater Reuse in Agriculture and Aquaculture. Recommended Revisions Based on New

Research Evidence. WELL Study, Task No. 68, Part 1. Water and Environmental Health at London and Loughborough (WELL), London.

Bremen Overseas Research and Development Association (2005): Wasser für das Leben. Bremer Wege aus der Wassernot. Zugang zu grundbedürfnisorientierten Dienstleistungen, Bremen.

Bryant, Raymond L. (1992): Political ecology. An emerging research agenda in Third-World studies, in: Political Geography, Vol. 11, No. 1, January 1992, Bristol, p.12-36.

Bryant, Raymond L. (1998): Power, Knowledge and political ecology in the third world: a review, in: Progress in Physical Geography 22,1, p.79-94.

Carr, R. M./Blumenthal, U. J./Mara, D. D. (2004): Health Guidelines for the Use of Wastewater in Agriculture: Developing Realistic Guidelines, in: (Schott, Christopher A./Faruqui, Naer I./Raschid-Sally, Liqa): Wastewater use in irrigated agriculture. Confronting the Livelihood and Environmental Realities.

Cifuentes, E./Blumenthal, U./Ruiz-Palacios, G./Bennett, S./Quigley, M. (2000): Health risk in agricultural villages practicing wastewater irrigation in Central Mexico. perspectives for protection, in: Chorus, I./Ringelband, U./Schlag, G./Schmoll, O. (Publisher) Water Sanitation and Health, International Water Association Publishing, London, p. 249–256.

City of Windhoek (2004a): Windhoek Environmental Structure Plan, Windhoek.

City of Windhoek (2004b): Windhoek Integrated Environmental Policy, Windhoek.

City of Windhoek (w.y.):New Goreangab Water Reclamation Plant, Windhoek.

Cole, Joanna (1990): The magic bus at the waterworks, London

Cornish, G. A./Kielen, N. C. (2004): Wastewater Irrigation. Hazard or Lifeline? Empirical Results from Nairobi, Kanya and Kumasi, Ghana, in: (Schott, Christopher A./Faruqui, Naer I./Raschid-Sally, Liqa): Wastewater use in irrigated agriculture. Confronting the Livelihood and Environmental Realities.

Dar es Salaam Water and Sewerage Authority (2005): Preparation of a Strategic Sanitation Plan for Dar es Salaam, Dar es Salaam.

Department of Water Affairs and Forestry South Africa (2001): Free Basic Water, Implementation Strategy Document, Version 1, Pretoria.

Department of Water Affairs and Forestry (2002a): Sanitation for a healthy nation. Framework for a national sanitation strategy. Bringing sanitation up to speed, Pretoria.

Department of Water Affairs and Forestry (2002b): Sanitation for a Healthy Nation. Sanitation Technology Options, Pretoria.

Department of Water Affairs and Forestry (2002c): Sanitation for a healthy nation. The policy on basic household sanitation made easy, Pretoria.

Dongus, Stefan (2001): Urban vegetable production in Dar es Salaam, in: Habari 1/01, Topic: Urbanisation. Living in the city, Bielefeld, p.27-29.

Durban Metro (1995): Southern Metro Wastewater Disposal study. Environmental scoping study. Draft final report, Durban.

Durban Metro Council (1996): Environmental scoping study, Draft final report, Durban.

Durban Metro Department for Water and Waste (w.y.): Durban Water and Waste, Durban.

Eeuwijk, Birgit Obrist van (2002): Gesundheitsverständnis im Wandel. Perspektiven aus Afrika, in: Uni Press. Forschung und Wissenschaft an der Universität Bern, Vol. 112 April 2002, Bern, p.61-66.

Ethekwini Municipality (2004): Sea Disposal of Sewage: Environmental Surveys in the Durban Outfalls Region, Report No. 23, Durban.

Ethekwini Municipality (2005): Sea Disposal of Sewage: Environmental Surveys in the Durban Outfalls Region, Report No. 24, Durban.

Ethekwini Municipality (w.y.): State of environment and development. Sector reports. Vol. 2 Part 1, Durban.

Fattal, Badri/Lampert, Yael/Shuval, Hillel (2004): A Fresh Look at Microbial Guidelines for Wastewater Irrigation in Agriculture. A Risk-assessment and Cost-effectiveness Approach, in: (Schott, Christopher A./Faruqui, Naer I./Raschid-Sally, Liqa): Wastewater use in irrigated agriculture. Confronting the Livelihood and Environmental Realities.

Flick, Uwe (1995): Qualitative Forschung. Theorie, Methoden, Anwendung in Psychologie und Sozialwissenschaften. Hamburg.

Fuchs-Heinritz, Werner (1995): Lexikon zur Soziologie, Opladen.

Ginneken, Meike van/Ryler, Ross/Tagg, David (2004): Can the principles of franchising be used to improve water supply and sanitation services?. in: Water supply and sanitation sector board discussion paper series, paper no.2, January 2004, Washington.

Girtler, Roland (2001): Methoden der Feldforschung, Wien, Köln, Weimar.

Government of Tanzania (2004): CIUP Stage 2 Report. Volume 1. Findings and Recommendations. Community Infrastructure Upgrading Programme in Dar es Salaam under LGSP, Dar es Salaam.

GTZ/Government of Namibia (2005): Flexible Land Tenure System Projects. Workshop Proceedings 17. November 2005, Windhoek.

Gulbrandsen, Ørnulf (2003): Die Tragödie der Allmende: Gemeinschaftliche Ressourcen und individuelle Interessen, in: Larsen, Stein Ugelvik/Zimmermann, Ekkart (Publisher): Theorien und Methoden in den Sozialwissenschaften, Wiesbaden.

Hackenbroch, Kirsten/Kozonguizi, George (2005):Security of Tenure for Urban Areas in Namibia. A Preparatory Study for Implementation of the Flexible Land Tenure System, Windhoek.

Hantschel, Roswitha/Tharun, Elke (1980): Anthropogeographische Arbeitsweisen, in: Eckart Ehlers et al. (Publisher): Das Geographische Seminar, Braunschweig.

Hofmeier, Rolf (2004): Tansania, in: Mabe, Jacob E (Publisher): Das Afrika-Lexikon. Ein Kontinent in 1000 Stichwörtern, Wuppertal, Stuttgart, Weimar.

Holweg, Heiko (2005): Methodologie der qualitativen Sozialforschung, Bern.

International Water Association (Publisher) (2001): IWA Yearbook 2001, London.

Jänicke, Martin/Kunig, Philip/Stitzel, Michael (2000): Umweltpolitik, Bonn.

Kathuri, Benson (2004): Nairobi water set to go private, in: Financial Standard, 4. May 2004, Nairobi.

Korten, David C. (1996): Civic engagement in creating future cities, in: Environment and Urbanisation, Vol. 8, No. 1, April 1996, London, p.35-49.

Lamnek, Siegfried (1995): Qualitative Sozialforschung, Vol. 2: Methoden und Techniken, 3rd edition, Weinheim.

Leach, Melissa/Mearns, Robin (1996): The lie of the land. Challenging received wisdom on the african environment, Oxford.

Lusugga Kironde, J.M. (1995): Access to land by the urban poor in Tanzania. Some Findings from Dar es Salaam, in: Environment and Urbanisation, Vol. 7, No. 1, April 1995, London, p.77-96.

Mara, D./Cairncross, S. (1989): Guidelines for the Safe Use of Wastewater and Excreta in Agriculture and Aquaculture. World Health Organization, Geneva.

Mayring, Philipp (1999): Einführung in die qualitative Sozialforschung. 3rd edition, Weinheim.

Mehta, Meera (2003): Meeting the Financing Challenge for Water Supply and Sanitation. Incentives to promote reforms, leverage resources and improve targeting, Washington.

Merwe, B. van der (2000): Drought or supply shortage management. Integrated water resource management in Windhoek, Namibia, in: Water Supply, Vol.18 Nr 1, Windhoek.

Mitullah, W.V. (1999) 'Popular Urban Settlements and Environmental Strategies for a New Millennium' paper presented at a workshop organised by the Centre for Environmental Law and Policy Analysis (Cepla) on the City Environment Beyond 21st Century: Nairobi.

Mohamed, Sayed-Iqbal (1997): Tenants and tenure in Durban, in: Environment and Urbanisation, Vol. 9, No. 2, October 1997, London, p.101-118.

Mougeot, L.J.A. (2000): Urban Agriculture. Definition, Presence, Potentials and Risks, in: Deutsche Stiftung für internationale Entwicklung (DSE): Growing Cities, Growing Food - Urban Agriculture on the Policy Agenda, Feldafing, p.1-42.

Municipality of Windhoek (1930): Drainage Regulations, Government Declaration No. 208 in 1930, Government Gazette No. 389 on 1.11.1930, Windhoek.

Mwangi, Isaac Karanja (1997): The nature of rental housing in Kenya, in: Environment and Urbanisation, Vol. 9, No.2, October 1997, London, p.141-160.

Mwaura, John (2004): Kenyan urban dwellers face teething water woes, in: Pana press. The african perspective, 28.11.2004, Nairobi.

Nairobi City Council, Water and Sewerage Department (1998): Nairobi Master Plan for Sewer, Sanitation and Drainage, Nairobi.

Nairobi Water and Sewerage Company (1990): Tariffs, Nairobi.

Najlis, Pierre (1996): Supply and sanitation services for all?, in: Sterling Publications Ltd. (Publisher): New World Water 1996, London, p.9-12.

National Environment Commission Secretariat (2000): Environmental Codes of Practice for Sewerage and Sanitation Management in Urban Areas. National Environment Commission, Thimphu (Bhutan).

Nhapi, Innocent/Gijzen, Huub (2005): A 3-step strategic approach to sustainable wastewater management, in: Water South Africa, Vol. 31, Nr.1, January 2005, Pretoria, p.133-139.

Niemczynowicz, J. M. (1996): Megacities from a water perspective, in: Water International 21, p.198–205.

Pelling, Mark (2003): Toward a political ecology of urban environmental risk. The case of Guyana, in: Zimmerer, Karl S./Bassett, Thomas J. (Publisher): Political Ecology. An integrative Approach to Geography and Environment-Development Studies, New York, London.

Practical Action. Technology challenging poverty (Publisher) (2005): Livelihoods and gender in sanitation Hygiene and water services among urban poor. Maili Saba Research Report, Nairobi.

Pugh, Cedric (Publisher) (1996): Sustainability, the Environment and Urbanisation, London.

Republic of Namibia (2003): National Land Use Policy. Final Draft of September 2003, Windhoek.

Reuber, P./Pfaffenbach, C. (2005): Methoden der empirischen Humangeographie, Braunschweig.

Roberts, Debra/Diederichs, Nicci (2002): Durban's Local Agenda 21 programme: tackling sustainable development in a post-apartheid city, in: Environment and Urbanisation, Vol. 14, No.1, April 2002, London, p.189-201.

Satterthwaite, David (2003): The Millennium Development Goals and urban poverty reduction: great expectations and nonsense statistics, in: Environment and Urbanisation, Vol. 15, No. 2, October 2003, London.

Schertenleib, Roland/Morel, Antoine/Kalbermatten, John/Saywell, Darren (2004): Guidelines for the implementation of the Bellagio-Principles and the household centred environmental sanitation approach, in International Water Association/German Organization for Technical Cooperation (GIZ) (Publisher): Ecosan. Closing the loop. Proceedings of the 2nd international symposium on ecological sanitation incorporating the 1st IWA specialist group conference on sustainable sanitation 7th – 11th April 2003 Lübeck Germany, Eschborn, p.93-100.

Scott, Christopher A./Faruqui, Naser I./Raschid-Sally, Liqa (2004): Wastewater Use in Irrigated Agriculture: Management Challenges in Developing Countries, in: (Schott, Christopher A./Faruqui, Naer I./Raschid-Sally, Liqa): Wastewater use in irrigated agriculture. Confronting the Livelihood and Environmental Realities.

Seckelmann, Astrid (2001): Development of Urban Settlements in Independent Namibia. NEPRU Occasional Paper No. 20, Windhoek.

Shayo, Alfred J. (2004): Acceptance of ecosan concepts in Tanzania. A case study of 'piloting ecological sanitation Majumbasita Dar es Salaam', in: International Water Association/German Organization for Technical Cooperation (GIZ) (Publisher): Ecosan. Closing the loop. .Proceedings of the 2nd international symposium on ecological sanitation incorporating the 1st IWA specialist group conference on sustainable sanitation 7th – 11th April 2003 Lübeck Germany, Eschborn, p.245-254.

Smit, Warren (1998): The rural linkages of urban households in Durban, South Africa, in: Environment and Urbanisation, Vol. 10, No.1, April 1998, London, p.77-87.

Solo, Tova Maria (1999): Small-scale entrepreneurs in the urban water and sanitation market, in: Environment and Urbanisation, Vol. 11, No. 1, April 1999, London, p.117-132.

Storm, P.-C. (2002): Umweltrecht, Munich.

Südhoff, Ralf (2005): Dialog der Tauben, in: von Bonin, Konrad/Brock, Lothar/Füllkrug-Weitzel, Cornelia et al. (Publisher): Der Überblick 1/2005, Hamburg.

Swyngedouw, E. A. (1995): The contradictions of urban water provisoin. A study of Guayaquil, Ecuador, in: Third World Planning Review 17, p.387-405.

Thiel, Reinhold E. (2001): Zur Neubewertung der Entwicklungstheorie, in: Reinold E. Thiel (Publisher): Neue Ansätze zur Entwicklungstheorie. Deutsche Stiftung für internationale Entwicklung (DSE). Informationszentrum Entwicklungspolitik (IZEP). Bonn: DSE/IZEP 2. Edition 2001, Bonn, p.9-34.

UCLAS-DPU Research Project (2003): Service Provision Governance in the peri Urban Interface of the Metropolitan areas, Dar es Salaam.

UNDP (1989): Urban Management Programme. Overview of Programme Activities. A programme to strengthen Urban Management in developing Countries. Executed Jointly by The World Bank and UNCHS (Habitat), New York.

UNDP (2005): The sustainable difference. Energy and environment to achieve the MDGs, New York.

UNEP, Coordination Office for the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities (GPA) (2001a): Consultative Meeting on Municipal Wastewater, Dar es Salaam.

UNEP, Coordination Office for the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities (GPA) (2001b): Guidance on Municipal Wastewater, Delft.

UN-Habitat (Publisher) (2001): Nairobi City Analysis, Nairobi.

UN-Habitat (Publisher) (2003a): The Challenge of Slums. Global Report on Human Settlements, London.

UN-Habitat (Publisher) (2003b): Water and Sanitation in the World's Cities. Local Action for Global Goals, London.

UN-Habitat (2004): Water and Sanitation Trust Fund, Nairobi.

UNICEF/WHO (2004): Meeting the MDG Drinking Water and Sanitation Target. A Midterm Assessment of progress, New York, Geneva.

University of Bochum (Ruhr-Universität Bochum), Department for Urban water management and environmental engineering (Lehrstuhl für Siedlungswasserwirtschaft und Umwelttechnik) (Publisher) (2005): Anforderungen an die Abwassertechnik in anderen Ländern. Exportorientierte Forschung und Entwicklung auf dem Gebiet der Wasserver- und Entsorgung, Teil II: Abwasserbehandlung und Wasserwiederverwendung, Bochum.

UN World Water Assessment Programme (2003): 1st UN World Water Development Report. Water for people. Water for life, Paris.

Vaz da Costa Vargas, S./Bastos, R.K.X./Mara, D.D. (1996): Bacteriological aspects of wastewater irrigation. Tropical Public Health Engineering Research Monograph No.8, University of Leeds (Department of Civil Engineering) Leeds.

WaterAid (2005): $2 Billion Dollars – The Cost of Water and Sanitation. Millennium Development Targets for Tanzania, Dar es Salaam

Water and Sanitation Programme (2000): Water Supply and Sanitation Blue Pages. The world bank sector guide 2000, Washington.

Water and Sanitation Programme (2001): Durban Metro Water. Private Sector Partnerships to Serve the Poor, Nairobi.

Water and Sanitation Programme (2004a): Mobilizing Resources for Sanitation, Washington.

Water and Sanitation Programme (2004b): The Case for Marketing Sanitation, Washington.

Water Utility Partnership/Water and Sanitation Programme (2003): Better Water and Sanitation for the Urban Poor. Good Practice from sub-Saharan Africa, Nairobi.

Water Engineering Development Centre (WEDC) (2006): Sanitation Policy. Why it is important and how to make it work, Leicestershire.

Wegelin-Schuringa, Madeleen/Kodo, Teresia (1997): Tenancy and sanitation provision in informal settlements in Nairobi: revisiting the public latrine option, in: Environment and Urbanisation, Vol. 9, No. 2, October 1997, London, p.181-190.

Werner, Christine (2001): Ecosan. A holistic approach to material-flow-management in sanitation, in: Deutsche Gesellschaft für Technische Zusammenarbeit (Publisher): Ecosan. Closing the loop in wastewater management and sanitation, Eschborn.

Werner, Christine/Fall, Papa Abdoulaye/Schlick, Jana/Mang, Heinz-Peter (2004): Reasons for and principles of ecological sanitation, in: International Water Association/ Deutsche Gesellschaft für Technische Zusammenarbeit (Publisher): Ecosan. Closing the loop. .Proceedings of the 2nd international symposium on ecological sanitation incorporating the 1st IWA specialist group conference on sustainable sanitation 7th – 11th April 2003 Lübeck Germany, Eschborn, p.23-30.

World Bank/International Bank for Reconstruction and Development (1996): Water and Wastewater Utilities, Washington.

World Bank (1999): Benchmarking Water and Sanitation Utilities. A Start-Up Kit, Washington.

World Commission for Environment and Development (1987): Our common future. Brundtland report, Greven.

World Development Movement/Public Services International (2006): Pipe dreams. The failure of the private sector to invest in water services in developing countries, London.

WHO/UNICEF (2000): Global Water Supply and Sanitation Assessment 2000 Report. WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation, New York.

WHO/UNICEF (2005): Water for life. Making it happen, Geneva.

Wright, Albert M. (2005): Some practical sanitation alternatives and strategies that could support the achievement of the MGDs, in: UN-Habitat (Publisher): Water for Cities. Quarterly newsletter, issue 22, April-June 2005, Nairobi.

Websites

Arya, R. (Publisher) (2006): Namibia, in: SADC Trade, Industry and Investment Review, p. 181-195. Accessible at: http://www.sadcreview.com/pdfs06/namibia2006.pdf (Last accessed: 01.09.2006)

Austin, A. (2002): Ecological Sanitation. Accessible at: http://www.sanicon.net/titles/topic intro.php3?topicId=17 (Last accessed: 01.09.2006)

Bird, G. (Publisher) (2002): African Environment Outlook. Respective chapters accessible at: East-Africa: http://www.grida.no/aeo/209.htm, Southern Africa: http://www.grida.no/ aeo/213.htm (Last accessed: 01.09.2006)

BORDA (w.y. a): Community Based Sanitation. Accessible at: http://www.borda-net.org/modules/cjaycontent/index.php?id=28 (Last accessed: 01.09.2006)

BORDA (w.y. b): Decentralized Waste Water Treatment. Accessible at: http://www.borda-net.org/modules/cjaycontent/index.php?id=29 (Last accessed: 01.09.2006)

Brown, P. (2003): World sewage plans 'should be abandoned', in: The Guardian, 10.03.03. Accessible at: http://www.guardian.co.uk/international/story/0,3604,910998,00.html (Last accessed 01.09.2006)

Commission of the European Community (2003): Annual report 2003 of the Commission to the European Council and the European Parliament about the development policy and the ODA in the year 2002. Accessible at: http://eur-lex.europa.eu/LexUriServ/site/de/ com/2003/com2003_0527de01.pdf (Last accessed: 01.09.2006)

Federal Association of German Banks (1996): Currency converter - Exchange rates for 160 currencies. Accessible at: http://www.bankenverband.de/html/reisekasse/ waehrungsrechner.asp (Last accessed: 01.09.2006)

Federal Ministry for Economic Cooperation and Development of Germany (2005): Germany's contribution to the implementation of the Millennium Development Goals. Accessible at: http://www.bmz.de/de/service/infothek/fach/materialien/materialie 140.pdf (Last accessed: 01.09.2006)

Fidler, D. P. (2004): Revision of the World Health Organization's International Health Regulations, in: American Society of International Law (ASIL). Accessible at: http://www.asil.org/insights/insigh132.htm (Last accessed: 01.09.2006)

Mara, D. (2002): Wastewater treatment technology. Accessible at: http://www.sanicon.net/ titles/topicintro.php3?topicId=6 (Last accessed: 01.09.2006)

NETWAS International (2003): Network for Water and Sanitation – Kenya. Accessible at: http://www.netwas.org/who_we_are/kenya (Last accessed: 01.09.2006)

Rekacewicz, P. (1993): Water withdrawal by sector and by continent in the beginning of the 1990's. Accessible at: http://www.povertymap.net/mapsgraphics/index.cfm?data_id=23401&theme=water%20and%20sanitation (Last accessed: 01.09.2006)

Sanicon (2002a): Coastal Settlements. Accessible at: http://www.sanicon.net/themes/intro.php3?theme=20 (Last accessed: 01.09.2006)

Sanicon (2002b): Urban. Accessible at: http://www.sanicon.net/themes/intro.php3?theme=23 (Last accessed: 01.09.2006)

Scott, R. (2005): Urine-diversion composting latrines. Accessible at: http://www.irc.nl/page/22831 (Last accessed: 01.09.2006)

UNEP (2002): Global Environment Outlook 3. Accessible at: http://www.grida.no/geo/geo3/english/pdfs/chapter2-8_urban.pdf (Last accessed: 01.09.2006)

UN-Habitat (w.y.): Water and Sanitation. Accessible at: http://www.unhabitat.org/categories.asp?catid=270 (Last accessed: 01.09.2006)

Water Utility Partnership (2002): Water and Sanitation for all. A practitioners companion. Accessible at: http://web.mit.edu/urbanupgrading/waterandsanitation/levels/index.html (Last accessed: 01.09.2006)

World Health Organisation (WHO) (2006): Guidelines for Drinking-water quality, Vol.1, 3rd Edition. Accessible at: http://www.who.int/water_sanitation_health/dwq/gdwq0506begin.pdf (Last accessed: 01.09.2006)

World Resources Institute (1996): Countries are being distorted according to the values. Accessible at: http://www.povertymap.net/mapsgraphics/index.cfm?data_id=23399&theme=water%20and%20sanitation (Last accessed: 01.09.2006)

World Water Council (2005): Water Supply and Sanitation. Accessible at: http://www.worldwatercouncil.org/index.php?id=23 (Last accessed: 01.09.2006)

8. Annex

Annex A: Interview guideline

Expert interviews about sewage management in Windhoek, Durban, Dar-es-Salaam und Nairobi

Questions about the organization

- What kind of organization is it?
  - governmental: ...
  - semi-governmental: ...
  - private: ...
  - special type: ...

- How is it financed?
  - Through the government (public budget)
    - to what extent? (share in %)
  - Fees gained from sewage disposal
    - to what extent? (share in %)
  - other source of finance

- Does the organization also manage water **supply**?
  - yes (are the customers of supply and disposal the same or are there e.g. areas where there is supply, but no disposal, or vice versa?)
  - no

- How is the cooperation with the Municipality, Ministries, other suppliers or disposers etc.? Are there any organizational issues?

- What do you think about the privatization of water supply and waste disposal?

Objectives and guidelines

- Are there guidelines of your organization/company? What do they regulate?

- the quality of the sewage disposal itself (maintenance of the sewerage system)
- the connection of not yet connected neighborhoods
- the quality of the water treatment

Staffing

- How many employees does the organization comprise?

- From what professional groups are the teams composed?
  - Engineers
  - Laboratory technicians
  - IT and GIS staff
  - Human Resource for sewer maintenance
  - Human Resources for sewage disposal from small local/public toilets & showers
  - Staff to operate the sewage treatment plants
  - other

- Is it difficult to find suitable staff? Does staff has to be trained for a long time? Does the organization provide vocational training?

Questions about financing

- Is a sewer fee being charged?
  - How is it structured? (e.g. linear, progressive etc.)
  - How much is the fee?
  - Is the fee linked to the water price? If so, are water and sewage charges billed together?

- Does the funding through the government run smoothly?

- Does the collection of the sewage charges run smoothly?

Management of disposal

- How is the sewage disposal organized? What areas of service does it cover?
    - The two fundamentally different types of sewage management: On-site Options (dry and water-based) and centralized systems
        - How do you evaluate the *investment and operating costs* (quantify and describe)
            - On-site Options (dry and water-based):
                1. Investment cost
                2. and operating costs
            - Centralized systems:
                1. Investment cost
                2. and operating costs
        - as well as the *cost of management and maintenance* of infrastructure (quantify and describe)
            - On-site Options (dry and water-based):
                1. Expenses or management
                2. and maintenance
            - Centralized systems:
                1. Expenses for management
                2. and maintenance
        - assess the *advantages and disadvantages* of both options
            - On-site Options (dry and water-based):
                1. advantages
                2. and disatvantages
            - Centralized systems
                1. advantages
                2. and disatvantages

    - Construction and maintenance of **sewers**?
        - How many kilometers does the sewer system comprise?
        - What challenges are there?
            - Construction of sewers in densely populated areas
            - Maintenance: leaking pipes
            - Others

    - Construction, maintenance and operation of **public toilets and showers**?
        - In what parts of the city?
        - How many?

- What type of service
  - Only disposal
  - Also maintenance
  - Also construction
- What challenges are there?
  - Construction: Is there any interest of the organization to build public toilets & showers?
  - Maintenance: Is the maintenance of existing public toilets & showers carried out by the organization?
  - Operation: Does the organization carry out the sewage disposal from public sanitary facilities?

- Construction, maintenance and operation of **sewage treatment plants**?
  - What percentage of the sewage is being treated?
  - How many are treatment plants are there?
  - Of what kind are the plants?
  - Up to which degree do they treat the sewage? (For receiving water body, up to drinking water quality…)
  - Where is the treated water discharged to?
    - River
    - Sea
    - Feeding into a water system for non-potable purposes (does such a system exist?)
    - Other
  - What is done with the sewer sludge? Is it being used?
    - Put into landfill
    - Further use: fertilizer, fuel, biogas production
    - Other

  - What challenges are there?
    - Construction: Financing, design of type and size of plants, etc.
    - Maintenance: Funding, Staff
    - Operation: Quality of water treatment, disposal or recycling of sewage sludge (!!!), connection of not previously connected parts of the city

- What areas of the city are connected to the sanitation services of this organization/company?

- Are there any other providers of sanitation services in the city?

Legal basis

- According to which laws and regulations is the sewage being treated?
    - Laws
    - Voluntary regulations (with whom?)

Planning basis

- On what information basis is planning carried out (planning/gathering information about spatial distribution and volume of sewage volume)
    - Sewer paths and -diameter, size and type of sewage treatment plants (sewage volume)
        - Survey
        - Mapping
        - Geographical Information Systems (GIS)
    - Design of the sewer system, which residential areas are connected (spatial organization)
        - Survey
        - Mapping
        - GIS

- Is the management service adjusted to changes within the city (development of new settlements, informal settlements? In what way?

- What challenges exist in the planning/gathering of information about spatial distribution and volume of sewage volume to cope with?

Quality control

- Is quality control of services ensured in the organization?
    - Is there an appropriate laboratory for this? How is it equipped?

- Does an emergency plan exist (in case of treatment plant failure, leaks in the sewers, unforeseen events, etc.)?
    - What does it include (only technical measures – like repair or elimination of incurred (environmental) damage – or also notification of the population)?

Challenges

- Open discussion

Expert interviews with international organizations in Windhoek, Durban, Dar-es-Salaam und Nairobi

- How do you rate the sanitary situation of the city in general?
- What are problems and challenges?
- What regulations exist from national and international authorities?
- How to evaluate on-site sanitary facilities (water and dry) compared to central disposal via one/multiple channel systems?
    - Proportion of on-site sanitary facilities in the respective city
    - Advantages and disadvantages of both options
    - Investment and operating costs of the two options
    - Cost of management and operation
- Theme: Sanitation mapping: What is the basis for planning sanitation in the city and what should the planning basis look like?
- Where are further sources of information/libraries/contact persons on the issues raised?

Annex B: List of interviews & discussions

Date	**Appointment morning**
Tuesday 18. Apr	Flight Hamburg - Dubai
Wednesday 19. Apr	Flight Dubai - Johannesburg Flight Johannesburg - Windhoek
Thursday 20. Apr	8:00 Interview with Mr. Ferdi Brinkman, Department of Infrastructure, Water and Technical Services, Chief Engineer: Bulk Water and Wastewater, City of Windhoek, 63-65 Pullman Street, Windhoek
Friday 21. Apr	9:00 Interview and plant visit with Mr. Richard Kharuchab, Training Officer Water and Wastewater Treatment Okahandja
Saturday 22. Apr	10:00 Interview and plant visit with Mr. Willem Morkel at the Gammams Treatment Plant in Windhoek, Operator, City of Windhoek Treatment Plant
Sunday 23. Apr	Field trip to public sanitation facilities with Mr. Francis S. Nyathi, Chief editor of the magazine 'The African'
Monday 24. Apr	9:00 Visit at the Vocational Training Centre Windhoek, Interview with Mr. Ronny R. Khoi-Aob, Senior Liaison Officer 11 Rooivalk Street Khomasdal, Windhoek and Mr. Joe Blendan, Caretaker
Tuesday 25. Apr	11:00 Interview with Mr. Gerhard Cronjé, Section Engineer: Wastewater Treatment, Department of Infrastructure, Water and Technical Services, City of Windhoek, 63-65 Pullman Street, Windhoek
Wednesday 26. Apr	Flight Windhoek – Johannesburg Flight Johannesburg – Durban

Thursday 27. Apr	11:00 Interview with Mr. Sagren Govender, Process Manager of Treatment Plant, 2 Byfield Road, Durban
Friday 28. Apr	9:00 Interview with Mr. Frank Stevens, Deputy of Bill Pfaff, Manager Planning and Sanitation, Department Water and Sanitation Technical Support, Durban Metro, 3 Prior Road, Durban
Saturday 29. Apr	8:30 Research in the Don Africana Library, Liberty Towers, 10th floor, Pine Street, Durban
Sunday 30. Apr	Field trip to existing sanitary projects in Durban Metro Water in Umbumblu, Inwabi, Sawpitts
Monday 01. May	City exploration
Tuesday 02. May	9:00 Interview with Mr. Neil Macleod, Head: Water and Sanitation, 3 Prior Road, Durban 13:00 Interview with Mr. Chris Fennemore, Engineer - Pollution & Environment, Technical Services Department, Ethekwini Municipality Durban - afterwards: Interview with Mr. Sharveen Maharaj, Environmental Scientist, Pollution Chasing Team
Wednesday 03. May	Flight Durban - Johannesburg Flight Johannesburg - Dar es Salaam
Thursday 04. May	12:00 Interview with Mr. Nathaniel Paynter, World Bank Water and Sanitation Programme, Country Officer Tanzania, 50 Mirambo Street, Dar es Salaam 14:00 Interview with Mr. Prof. Dr. Francos F. Halla, Dean of the Faculty of Architecture and Planning, University
Friday 05. May	9:00 Interview with Mr. Matthias Mulagwanda, Ilala Dar es Salaam Water and Sewage Company (DAWASCO) Manager afterwards: Field visit to an oxidation pond in the city area (Interview with Mr. Venant Luta, operating engineer of pond) and to an Sea outfall with Mr. Mulagwanda

Saturday 06. May	10:00 Interview with Mr. Richard Noth, Millennium Challenge Cooperation Cosultant, from La Paz, Bolivia and field trip to University of Lands and Architectural Studies, afterwards: field trip to water vendors
Sunday 07. May	Field drip to public sanitation facilities in the city area
Monday 08. May	10:00 Interview with Mr. Issa Mizunguli, Water Production Manager, Dar es Salaam Water and Sewage Company (DAWASCO) 11:00 Interview with Mr. Jackson Midala, Chief Operations Officer, DAWASCO House, Sokoine Drive, Dar es Salaam
Tuesday 09. May	Flihgt Dar es Salaam - Nairobi
Wednesday 10. May	9:00 Interview with Mr. James Karanja, Corporate Affairs Officer, Nairobi Water and Sewage Company, Kampala Road, Nairobi
Thursday 11. May	9:00 Interview with Mr. Roland Werchota, GTZ Nairobi, Lenana Road, Kilimani, Nairobi
Friday 12. May	9:00 Interview with Mr. F.K. Mugo, Managing Director, and Mr. J.P. Kimani, Technical director, Nairobi water company, Kampala Road, Nairobi; afterwards: Field trip to sewage treatment plant, Interview with Mr. Jacob Mwaura Ngomga, Coordinator Ruai Treatment Works, Nairobi Water Company
Saturday 13. May	11:00 Interview with Ms. Akpezi Ogbuigwe, United Nations Environmental Programme, Capacity building branch, environmental education unit, UN Gigiri complex
Sunday 14. May	City exploration
Monday 15. May	Flight Nairobi - Dubai Flight Dubai - Hamburg

Date	**Appointments afternooon**
Tuesday 18. April	Flight Hamburg - Dubai
Wednesday 19. April	Flight Dubai - Johannesburg Flight Johannesburg - Windhoek
Thursday 20. April	12:00 Presentation in the Desert Research Foundation Namibia, 7 Rossini Street, Windhoek, Namibia, Topic: Organizing an improved awareness and knowledge regarding costs of water and sanitary services in the city margins of Windhoek afterwards: Literature research in the Desert Research Foundation
Friday 21. April	14:00 Field trip to the S. von Bach Dam near Okahandja with Mr. Levi Nakatana of the Windhoek Vocational Training Centre, 11 Rooivalk Street Khomasdal
Saturday 22. April	15:00 Field trip to the slum Katutura with Mr. Francis S. Nyathi, Chief editor of the magazine 'The African'
Sunday 23. April	City exploration
Monday 24. April	14:30 Interview with Ms. Tanja Pickardt from the GTZ-presence in Windhoek, 88 John Meinert Str., Windhoek afterwards: Literature research in the GTZ library – afterwards: not reached under the provided address: Dr. Anna Muller, Shack Dweller's Federation of Namibia, Mozart Street, Windhoek
Tuesday 25. April	14:00 Appointment with Mr. George K. Kozonguizi, Un-Habitat Programme Manager, UNDP Namibia, SANLAM House, didn't take place, he was on a sudden mission, questions were discussed later by email
Wednesday 26. April	Flight Windhoek - Johannesburg Flight Johannesburg – Durban

Thursday 27. April	Research in the Durban Municipal Library, Smith street
Friday 28. April	12:00 Field drip to the construction site of the new tunnel for sewage under the harbour of Durban, Interview with Mr. Andrew Officer, senior resident engineer
Saturday 29. APril	Research in the Don Africana Library, Liberty Towers, 10th floor, Pine street, Durban
Sunday 30. April	City exploration
Monday 01. May	City exploration
Tuesday 02. May	Afterwards: Interview with Ms. Shamine Francis, business administration, accountant – afterwards: Interview with Mr. Simon Scruton, Acting Manager Non-revenue Water, afterwards: Interview with Mr. Steve Peterson, Department for Geographical Information Systems,
Wednesday 03. May	Flight Durban - Johannesburg Flight Johannesburg - Dar es Salaam
Thursday 04. May	University College of lands and architectural studies (UCLAS): Interview with Mr. Prof. Dr. Msemakweli, Senior Lecturer, Geomatics Department, afterwards: Interview with Mr. Prof. Dr. Lupala, Urban Planner/Lecturer
Friday 05. May	13:00 Interview with Mr. Simon Chale, Civil Engineer, Dar es Salaam Water and Sewerage Authority, Malanga Road, Dar es Salaam, - Appointment with Mr. Julius Maira of the 'Sustainable Dar es Salaam Project'-Section des City Council, didn't take place due to his absence, 17:00 Interview with Mr. Ernst Döring, support to the water sector reform, GTZ, 65 Ali Hassan Mwinyi

Saturday 06. May	15:00 Interview with Mr. Timo Basteck, University of Dortmund (Germany), Faculty of Spatial planning, Department of Supply and disposal systems, August-Schmidt-Str. 10, 44221 Dortmund, Interview at the Department presence in Dar es Salaam, where a project is being conducted jointly between the University Dortmund and the Municipality of Dar es Salaam
Sunday 07. May	City exploration
Monday 08. May	15:00 Interview with Mr. John Mfungo, Programme Officer, WaterAid Tanzania, Old Bagamoyo Road
Tuesday 09. May	Flight Dar es Salaam - Nairobi
Wednesday 10. May	12:00 Interview with Mr. Anthony Muriu, Legal Coordinator, Nairobi Water and Sewage Company, Kampala Road, Nairobi afterwards: Interview with Mr. Mburu Kiemo, Design Engineer, Nairobi Water and Sewage Company, Kampala Road, Nairobi
Thursday 11. May	15:00 Interview with Mr. Emmanuel Naah, UNESCO, UN Gigiri Complex Nairobi afterwards: Discussion with UN-Habitat: Mr. Harrison Kwach and Mr. Graham Alabaster, UN Gigiri Complex Nairobi
Friday 12. May	14:00 Interview with Mr. Malaquen Milgo, GTZ Nairobi water programme, Water Sector Reform Programme, Ministry of Water and Irrigation, 4th floor Maji House, Ngong Road, Nairobi, - afterwards: 16:00 Interview with Mr. Jens Jeitner, Coordinator Local Government and Water Sector Programme German Development Service (DED), Lenana Road/Wood Avenue, Nairobi
Saturday 13. May	Field trip to the Kibera-slum
Sunday 14. May	City exploration
Monday 15. May	Flight Nairobi - Dubai Flight Dubai - Hamburg

Annex C: Currency calculations

Exchange rates of the date of arrival in each respective country:

Namibia (Wednesday, 19. April, 2006):

1 Euro = 7.61438 Namibian Dollar
1 Namibian Dollar = 0.13133 Euro

1 US$ = 6.20690 Namibian Dollar
1 Namibian Dollar = 0.16111 US$

South Africa (Wednesday, 26. April, 2006):

1 Euro = 7.53523 South African Rand
1 South African Rand = 0.13271 Euro

1US$ = 6.06163 South African Rand
1 South African Rand = 0.16497 US$

Tanzania (Wednesday, 3. May, 2006):

1 Euro = 1603.41 Tanzania-Shilling
1 Tanzania-Shilling = 0.0006237 Euro

1 US$ = 1271.95 Tanzania-Shilling
1 Tanzania-Shilling = 0.0007862 US$

1 Euro = 1.26059 US$
1US$ = 0.79328 Euro

Kenya (Tuesday, 9. May, 2006):

1 Euro = 90.91498 Kenyan Shilling
1 Kenyan Shilling = 0.01100 Euro

1 US$ = 71.38033 Kenyan Shilling
1 Kenyan Shilling = 0.01401 US$

Source: Currency converter ’Währungsrechner‘

9. Confirmation

I certify that I have written this study myself, that no other sources and resources than those indicated have been used, and that those parts of the study, which are taken from other sources in terms of wording or meaning, are in any case identified with their source as a citation. This also applies to charts, maps and figures.

Bonn September 2006.