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SOLID WASTE AND WASTEWATER MANAGEMENT IN AUSTRIA AND ITS POSSIBLE APPLICATION IN RESOURCES-ORIENTED SANITATION SYSTEMS IN EAST AFRICA

Masterarbeit

zur Erlangung des akademischen Grades

Diplomingenieur

eingereicht von:

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01.10.2010

Acknowledgements

During my studies, numerous people supported me. I want to thank Raimund Haberl at the University of Natural Resources and Applied Life Sciences in Vienna (BOKU) and Graeme Buchan at the Lincoln University in New Zealand (LU) for supervising. Special thanks go to Günter Langergraber, my co-supervisor at the Institute of Sanitary Engineering and Water Pollution Control at BOKU, who's expertise and ideas helped me to stay on track throughout my working period. Especially, on waste related issues, Roland Linzner, from the Institute of Waste Management at BOKU, provided valuable advice. Markus Lechner from EcoSan Club Austria came up with the idea to carry out this work. In the run-up of my thesis, Ernest Mayr helped me to find possible topics and supervisors. Thanks to all of you!

I want to thank my parents for their constant support, not only during my studies, but all through my life.

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Acronyms

ACR – Association of Cities and Regions for Recycling and Sustainable Resource management
ARA – Altstoff Recycling Austria
ASKNet – African Sanitation Knowledge Network
AUWSA - Arusha Water and Sewerage Authority
BMV – Burgenländischer Müllverband
CBO – Community Based Organisation
EAWA – East African Water Association
EcoSan – Ecological Sanitation
EcoSanRes – Ecological Sanitation Research Programme
ERP – European Recycling Platform
EWA – European Water Association
EWC – European Waste Catalogue
GDP – Gross Domestic Product
GSA – Gemeinschaft Steirischer Abwasserentsorger
GTZ – Deutsche Gesellschaft für Technische Zusammenarbeit
HWC – Hazardous Waste Catalogue
IHP – International Hydrological Programme
IRC – International Resource Centre
ISSUE – Programme – Integrated Support for Sustainable Urban Environment
ISWA – International Solid Waste Association
IWA – International Water Association
KAN – Kanal- und Kläranlagen Nachbarschaften
KTC – Kitgum Town Council
MBP – Mechanical Biological Pre-treatment
MCN – Municipal Council Nakuru
MDGs – Millennium Development Goals
NAWASSCO – Nakuru Water and Sanitation Company Limited
NEC – Nakuru Environment Consortium
NEMA – National Environment Management Authority
NGO – Non Governmental Organisation
ÖWAV – Österreichischer Wasser- und Abfallwirtschaftsverband
PE – Population Equivalent
PPP – Public Private Partnership
ROSA – Resource -Oriented Sanitation concepts in peri-urban areas in Africa
RUSZ – Reperatur und Service Zentrum
SEAWASTE – Southern and East African Waste Management Network

SIDA – Swedish International Development Cooperation Agency

SSWP – Strategic Sanitation and Waste Plan

SuSanA – Sustainable Sanitation Alliance

SWM – Solid Waste Management

TOC – Total Organic Carbon

UBA – Umweltbundesamt

UDB – Umweltdienst Burgenland

UDDT – Urine Diverting Dry Toilets

UN – United Nations

UNESCO – United Nations Educational, Scientific and Cultural Organisation

UNESCO – IHE – Institute for Water Education

UNICEF – United Nations Children's Fund

WATSAN – Water Supply and Sanitation

WEEE – Waste Electrical and Electronic Equipment

WHO – World Health Organisation

WISA – Wasserinformationssystem Austria

WWTP – Wastewater Treatment Plant

Abstract

The present work was written at the Institute of Sanitary Engineering and Water Pollution Control at BOKU University in Vienna.

Within the 6th European framework programme for “sustainable development, global change and ecosystems”, a project for “Resource-Oriented Sanitation in peri-urban areas in Africa” (ROSA) has been carried out. Strategic Sanitation and Waste Plans (SSWPs) were developed for four East African cities to find the best solution for the respective pilot city. The institutional settings of the introduced systems, however, turned out to be a problem. In this context the question arises whether strategies or recommendations can be derived from existing organisational structures in the Austrian solid waste and wastewater sector. Examples are given to demonstrate the current situation, with respect to different political levels in Austria. To describe the situation in East Africa, the four pilot cities of the ROSA project, namely, Arba Minch (Ethiopia), Nakuru (Kenya), Arusha (Tanzania) and Kitgum (Uganda), serve as examples. A comparison between Austria and East Africa shows not only huge differences, but also what mistakes can be avoided in development cooperation. Especially, concerning the financing of conventional sanitation systems, alternative concepts as promoted within the ROSA project seem more sustainable. This research shows that Austria is very effective in solid waste and wastewater management, but that systems can only be sustained with high financial effort. To make sustainable sanitation viable, a market needs to be developed for the recycling products. Then, value can be added at all stages of a resources-oriented sanitation system. Networks and associations play an important role in the organisation of solid waste and wastewater management. In this regard a lot can be learned from the Austrian system, as various associations and networks exist. To improve the quality of operation and maintenance in Africa, cooperation between businesses is a success factor. For collection and transportation it is important to develop a system which involves existing structures to efficiently use available equipment. Prerequisites to successfully introduce resources-oriented sanitation systems are, besides education and involvement of the local population, legally binding regulations as well as the support of public private partnerships.

German Abstract

Die vorliegende Arbeit wurde am Institut für Siedlungswasserbau, Industriewasserwirtschaft und Gewässerschutz an der Universität für Bodenkultur in Wien geschrieben.

Im Rahmen des sechsten europäischen Forschungsprogramms zum Thema „Nachhaltige Entwicklung, globale Veränderung und Ökosysteme“ wurde ein Projekt über “Resource-Oriented Sanitation in peri-urban areas in Africa” (ROSA) durchgeführt. Strategische Sanitär- und Abfallpläne wurden für vier Städte in Ostafrika entwickelt, um die beste Lösung für die jeweiligen Bedingungen zu finden. Hierbei traten organisatorische Probleme auf. In diesem Zusammenhang stellt sich die Frage, ob für diese Städte Strategien oder Empfehlungen von bestehenden Organisationsstrukturen im österreichischen Abfall- und Abwassersektor abgeleitet werden können. Die gegenständliche Arbeit veranschaulicht beispielhaft die Situation in Österreich auf verschiedenen politischen Ebenen. Um die Situation in Ostafrika darstellen zu können wurden die vier Städte des ROSA-Projektes Arba Minch (Ethiopien), Nakuru (Kenia), Arusha (Tansania) und Kitgum (Uganda) als Beispiele gewählt. Ein Vergleich zwischen Österreich und Ostafrika zeigt nicht nur große Unterschiede auf, sondern auch welche Fehler in der Entwicklungszusammenarbeit vermieden werden können. Speziell in Bezug auf die Finanzierung konventioneller Sanitärsysteme erscheinen Alternativen, wie sie im Zuge des ROSA-Projektes angestrebt wurden, nachhaltiger. Österreichs große Effektivität bei der Abfall- und Abwasserentsorgung, aber auch der große finanzielle Aufwand welcher dafür nötig ist werden gezeigt. Um ressourcenorientierte Sanitärsysteme rentabel zu gestalten, muss sich ein Markt für die entstehenden Recyclingprodukte entwickeln. Gelingt das, kann in allen Bereichen des Systems Wertschöpfung stattfinden. Netzwerke und Verbände spielen im Bereich der Organisation von Abfall- und Abwasserbewirtschaftung eine wichtige Rolle. Diesbezüglich kann vieles vom österreichischen System gelernt werden, da unzählige Verbände und Netzwerke existieren. Um die Qualität des Betriebes und der Wartung optimieren zu können, gilt Kooperation als Erfolgsfaktor. Um Sammlung und Transport zu verbessern, ist es wichtig, schon bestehende Strukturen zu berücksichtigen, um vorhandenes Equipment effizient zu nutzen. Voraussetzungen für eine erfolgreiche Einführung ressourcenorientierter Sanitärsysteme sind, neben Bildung und Aufklärung, die Einbeziehung der lokalen Bevölkerung, rechtlich wirksame Bestimmungen sowie die Unterstützung von Public Private Partnerships.

1. Introduction

Reports of the World Health Organisation (WHO) indicate a highly problematic situation regarding sanitation in many developing countries. Usually water supply projects are favoured and sanitation and solid waste management have lower priority. The Millennium Development Goals (MDGs) of the United Nations aim, amongst other things, to halve the proportion of people lacking safe drinking water and basic sanitation by 2015. As a contribution, within the 6th European framework programme for "sustainable development, global change and ecosystems", a project for "Resource-Oriented Sanitation in peri-urban areas in Africa" (ROSA) has been carried out. Strategic Sanitation and Waste Plans (SSWPs) were developed for four East African cities to find the best solution for the respective pilot city. In this context, the institutional settings of the introduced systems turned out to be a problem.

In a highly developed country like Austria, the situation is obviously very different due to a long history in both solid waste management (SWM) and wastewater management. Therefore, it seemed reasonable to examine structural and organisational circumstances in Austria and to put them into context with the situation in Africa. The main challenge of this work was, to find out, whether it is possible to deduce strategies or at least recommendations from the comparison of the two entirely different regions. Furthermore, it is important to know how highly technical systems, as used in Austria, are financed and what options in this regard may be applied for African countries. Apart from the differences in both regions, cooperation between stakeholders seems to have a stimulating impact in the field of solid waste management (SWM) and the wastewater sector. To what extent networks and associations can contribute to improved quality and efficiency in the organisation of SWM and sanitation is part of this work. In this regard, public private partnerships (PPP) are commonly believed to enhance efficiency. Moreover, legal regulations in both regions are of importance. Especially, the enforcement of the respective law can make a considerable difference in the organisation and implementation of new systems.

At present, numerous papers exist about development cooperation projects in all parts of the world. Not only with respect to sanitation, but especially concerning drinking water supply. For many of these projects, problems occur after the period of implementation is over and foreign help organisations have left. In fact, only when a system can be operated and maintained by the local population, without or with conceivable help, it can be categorized as successful. In the last years, it became obvious, that it is not enough to put a working (technical) system in place, but it is necessary to provide an integrated and sustainable approach of development cooperation. Best effort is needed to achieve such a result. A holistic view of the problem, makes sanitation a socio-cultural, economical and ecological issue rather than a strictly technically solvable task.

In the field of sustainable sanitation, many projects provided important information and continuously yield new experiences and knowledge. The Sustainable Sanitation Alliance (SuSanA) is an evidence for how multipresent the issue is in countries all over the world.

The present work is mainly based on research on the situation in Austria, existing networks and associations on the one hand, and available data from the ROSA project and literature research on sustainable sanitation on the other hand. The main working period extended between October 2009 and April 2010.

2. Aims and Objectives

As the title indicates the aim of this work is to debate the possible application of Austrian solid waste and wastewater management practices in development cooperation in East Africa. Structures and organisation practices are investigated rather than technical issues. Within the framework of the ROSA project (Resource-Oriented Sanitation concepts for peri-urban areas in Africa), carried out by several institutions in Europe and Africa, strategic sanitation & waste plans (SSWPs) for the city areas of four African cities in Ethiopia (Arba Minch), Kenya (Nakuru), Tanzania (Arusha) and Uganda (Kitgum) are developed. Problems occur concerning the management of the introduced systems. Because Austria has a long history in solid waste and wastewater management and systems are working well, a comparison of the different situations could help to find better solutions for East Africa. As a basis, background information about the importance of sanitation and solid waste management, and the concept of sustainable sanitation as promoted in the ROSA project, is meant to be given.

Obviously, huge differences exist between the situations in East Africa and Austria. Objectives are to provide detailed information of both and to compare similarities. The organisation in Austria in both the solid waste and the wastewater sector are described before the situation in the four pilot cities concerning sanitation and solid waste is laid down. As networks and associations can help to improve management practices and are widely in use, examples of international and national cooperation are shown. Another important issue is the legal framework in which solid waste and wastewater management practices are carried out. Therefore, the legal situations in Austria and in the different areas of East Africa are shortly described.

For resources-oriented sanitation, other institutional settings are needed than for sewer-based sanitation. Therefore the idea of this work is, to learn from existing operational and management systems in Austria. For resources-oriented sanitation systems other conditions apply as for conventional sewer based sanitation systems. Still, conventional sewer-based systems, as existent in Austria, are described as a reference for Europe and to show possible constraints regarding financing. Solid waste management (SWM) practices can, however, help to improve the operation of resources-oriented sanitation systems, which strongly rely on good organisation of storage, treatment, transport, and reuse of sanitation products. For a waterless sanitation system with urine diversion, possibilities for applying best practices from solid waste and wastewater operational and management structures in Austria are discussed.

3. Fundamentals

To get an idea about the current situation, general information on sanitation and solid waste management is given in this chapter. The concept of sustainable sanitation is described in more detail, as it is the basis of the ROSA project, which is described subsequently.

3.1 Importance of Sanitation

In 2008 the World Health Organisation (WHO) reported that about 2.6 billion people lack access to improved sanitation and about 1.8 million people die every year from diarrhoeal diseases. Of the latter, 88 % can be related to unsafe water supply as well as inadequate sanitation and hygiene. 90 % of these deaths are children under the age of five, mostly from developing countries. Furthermore, improved sanitation is estimated to reduce the risk of contracting diarrhoeal diseases by 32 %. Very important are also hygiene education and promotion of hand washing (WHO and UNICEF, 2008). The main messages and corresponding key points of the WHO and UNICEF (2008) concerning improved sanitation are:

- Sanitation is Vital for Health
    - Reducing diarrhoeal diseases
    - Reducing child mortality
    - Improving health
    - Improving nutrition
    - Improving cognitive development
- Sanitation is a Good Economic Investment
    - Reducing lives lost
    - Reducing medical cost
    - Reducing lost time and productivity
    - Increasing tourism
    - Increasing female literacy and GDP (gross domestic product)
- Sanitation Contributes to Social Development
    - Improving learning and retention
    - Improving human development
    - More privacy and dignity
    - Increasing gender equity
    - Increasing self-respect
- Sanitation Helps the Environment
    - Reducing loss of biodiversity
    - Reducing water pollution
    - Reducing nutrient loading
    - Reducing air pollution
    - Reducing environmental degradation and unsustainability

- Sanitation is achievable
    - Modest costs, huge benefits
    - Many actors
    - Media counts
    - Get the message out
    - Act now

The main focus of sanitation in developing countries is laid on the reduction of health risks and environmental pollution in urban and peri-urban areas as theses regions are most affected of sanitary problems.

Compared to sanitation, SWM is usually less appreciated on political agendas. Priority is given to the most pressing issues. Even sanitation has been pushed into the shadows of water supply projects and is therefore often neglected on political agendas. Concerning health, waste creates significant problems and a very unpleasant living environment if not disposed of safely and appropriately. Unsafe waste deposits can provide breeding sites for insects and vermin (e.g. rats). Both increase the likelihood of disease transmission and can attract pests. Without proper management, waste can also pollute water sources and the environment (WHO, 2010).

Combating both sanitation and solid waste problems, the concept of resources-oriented sanitation, as promoted in the ROSA project, applies an ecological view to the problem by perceiving waste as a resource within the system (ROSA KITGUM, 2007). In the following chapter this concept, also known as ecological or sustainable sanitation, is described more detailed.

3.2 Sustainable sanitation

As sustainable sanitation plays an important part in the concept of the ROSA project, in this chapter, the main features are outlined. Its relevance, in both developed and developing countries will be described first. After that, conventional systems are compared to sustainable sanitation systems. For the implementation of sanitation systems and the different possible stakeholders in such projects, four basic project types are specified at the end of this chapter.

There are several specific terms used in connection with sustainable sanitation. In the ROSA project, which will be described later on, sanitation is described as “resources-oriented”. Ecological sanitation, or EcoSan for short, is also very popular, but is sometimes only used to address certain technologies, e.g., urine diverting dry toilets (UDDTs). In this text all three terms (resources-oriented sanitation, ecological sanitation, and sustainable sanitation) are used and defined, as described by the sustainable sanitation alliance (SUSANA, 2008). When applying a new sanitation system, the main objective is to protect human health by providing a clean environment and breaking down the cycle of disease. To be sustainable, such a system has to be economically viable, socially acceptable, technically and institutionally appropriate and environmentally sound. Sustainability criteria related to the following aspects are according to SUSANA (2008) essential when developing or upgrading a sanitation system:

- Health and hygiene: Includes the risk of being exposed to pathogens and hazardous substances at all points of a sanitation system (toilet, collection, treatment and reuse). This topic also covers aspects such as hygiene, nutrition and improvement of livelihood achieved by the application of certain sanitation systems, as well as downstream effects.
- Environment and natural resources: Involves water, energy and other natural resources required for constructing, operating and maintaining a system, as well as potential emissions. It also includes the degree of recycling and its positive effects on natural resources (wastewater reuse, nutrient recycling or production of biogas).

- Technology and operation: Describes the functionality of the entire system, including collection, transport, treatment and reuse and the ability of local communities to construct, operate and monitor the system. Furthermore, the robustness, the vulnerability, the flexibility and the adaptability are important.
- Financial and economic issues: Relate to the capacity of households or communities to pay for sanitation systems. Again, construction, operation, maintenance and possible reinvestments are considered. Beside these direct costs also direct benefits (e.g. improved health, production of soil conditioner or reclaimed water) and external costs (e.g. environmental pollution or health hazards) are considered.
- Socio-cultural and institutional aspects: In this category socio-economic acceptance and appropriateness of the system are evaluated. That includes the convenience and perception of the system, gender issues and impacts on human dignity, or food security and compliance with the legal framework and institutional settings.

The concept of sustainability can be rather seen as a direction than a stage to reach, as there is probably no system which is absolutely sustainable. There is no one-for-all sustainable sanitation system available and the consideration of existing environmental, technical, socio-cultural and economic conditions is crucial when planning and implementing a new system. In this regard some basic principles were already developed some years ago by a group of experts as the “Bellagio Principles for Sustainable Sanitation” during a global forum in 2000 (SUSANA, 2008):

- Human dignity, quality of life and environmental security at household level should be at the centre of any sanitation approach.
- In line with good governance principles, decision making should involve participation of all stakeholders, especially the consumers and providers of services.
- Waste should be considered a resource, and its management should be holistic and form a part of integrated water resources, nutrient flow and waste management processes
- The domain in which environmental sanitation problems are resolved should be kept to the minimum practicable size (household, community, town, district, catchment area, city).

3.2.1 Relevance of Sustainable Sanitation

In developed countries training and education about sustainable sanitation can contribute to a broader application, especially where so far no sewer systems exist. This concerns e.g. single houses, small remote settlements or places with irregular wastewater accumulation as in tourist areas (IHP and GTZ, 2006). In many cases, the political will to support decentralized alternative sanitation systems is relatively low. There is still a tendency to apply conventional systems based on sewers and wastewater treatment plants.

In the context of development cooperation, alternative systems play an important role as the application of conventional systems, which are usually applied in technically highly developed countries, often fail in countries lacking this level. In many cases small items or local circumstances are unconsidered and lead to total shipwrecking. Reasons can include the mere lack of spare parts, the missing of technical know how or simply ignorance about local conditions and requirements. Therefore, the involvement of local communities and an accurate evaluation of the respective circumstances seem to be crucial for success in the long run.

3.2.2 Conventional Sanitation vs. Sustainable Sanitation

To show the differences between conventional and sustainable sanitation, the respective main features and principles are highlighted in the following paragraphs.

Conventional Sanitation

During the last hundred years conventional systems, like the “flush and discharge” or the “drop and store” practise, have been perceived as the ultimate solution for sanitation. The former needs about 15 000 litres of water to flush away about 500 litres of urine and 50 litres of faeces per year. Additionally, some 15 000-30 000 litres of greywater (water from kitchen, bathroom and laundry) and often rainwater and industrial wastewater are collected in the sewer. A relatively small proportion of potentially harmful substances (faeces) are mixed with large amounts of water and relatively harmless urine. At the end of the sewer, in the wastewater treatment plant (WWTPs), the beforehand added water is purified and separated. In many cases, however, especially in developing countries, no WWTPs exist and wastewater is discharged untreated (SIDA, 1998). In addition to that, the costs for construction and operation and maintenance of a conventional flush and discharge system are enormous. Cross subsidies are common, even in developed countries and systems are far from financial sustainability. Costs are, however, not the only disadvantage of conventional systems. Besides the over-exploitation of limited drinking water resources, especially in countries with no adequate wastewater treatment, pollution of soil and groundwater and the loss of nutrients are the main problems (ROSA, 2010).

On a global perspective, pit toilets are the most common sanitation system. This drop and store system is based on containment and storage of human excreta. No water is needed for flushing and the technology is simple. However, pit toilets are only appropriate for areas with enough space and soil, no periodical flooding and a low groundwater level to avoid contamination. Disadvantages are not only bad odours and fly breeding but the possibility of soil and groundwater pollution if the pit collapses or flows over due to heavy rainfall (SIDA, 1998). Often, full pits are abandoned and new ones are dug, which implies a loss of nutrients and a high risk of contamination. In agriculture the loss of nutrients is compensated by the application of mineral fertilizers (ROSA, 2010). That is not only disadvantageous for the environment but often makes local communities dependent on fertilizer companies even from outside the country. Beside that, abandoned pits are a source of contamination. In most of the poor rural and peri-urban areas shallow groundwater is used for water supply. These water sources are especially endangered to be contaminated by surface pollution of solid waste or sanitation facilities. In many cases the pits are situated not far enough from wells and pathogens can easily enter the food chain (IHP and GTZ, 2006).

Conventional systems are designed linear with liquid and solid waste to be disposed (Figure 1)

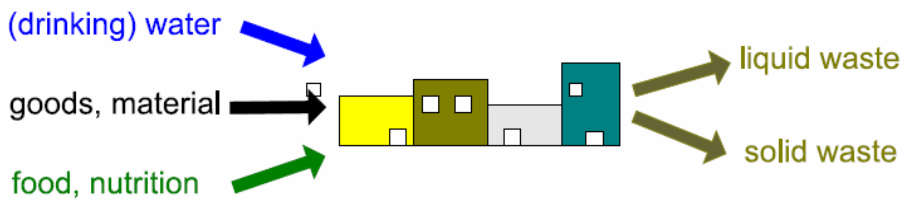

Figure 1 Schematic flow chart of a conventional sanitation system (LANGERGRABER and MUELLEGGER, 2005)

WERNER et al. (2003) state that conventional wastewater management systems have the following shortcomings:

- Unsatisfactory purification or uncontrolled discharge of more that 90 % of wastewater worldwide
- Pollution of water bodies by organics, nutrients, hazardous substances, pathogens, pharmaceuticals, hormones etc.
- Health risk and spread of disease
- Severe environmental damage and eutrophication of the water cycle

- Use of precious water for waste transportation (flush and discharge)
- High costs (investment, operation, maintenance)
- Frequent subsidisation of prosperous areas, neglect of poor settlements
- Loss of valuable nutrients and trace elements (no recycling)
- Depletion of agricultural soils and increased dependency on (mineral) fertilizer
- Problems with contaminated sewage sludge when using combined central systems
- Linear end-of-pipe technology

Sustainable Sanitation

Sustainable sanitation goes beyond the principles of “flush and discharge” or “drop and store” and follows an approach, which can be characterized as “sanitize and recycle” (SIDA, 1998). These systems try to avoid the disadvantages of conventional systems, which have been described earlier, by closing material flow cycles (Figure 2). Human excreta and wastewater from households are recognised as resources rather than waste and meant to be made available for reuse (ROSA, 2010).

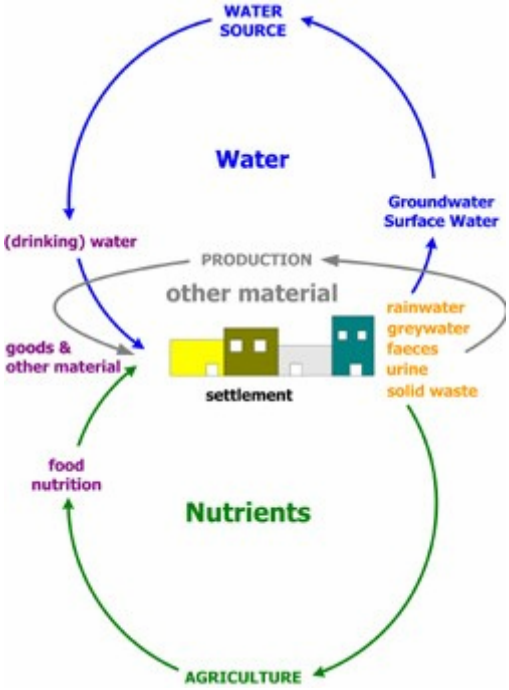

Figure 2 Schematic flow chart of resources-oriented sanitation concepts (LANGERGRABER and MUELLEGGER, 2005)

Therefore, the management of different wastewater flows in a system is important. Sanitisation and the proper handling of the material are further essential. Stages of a sustainable sanitation system usually include collection, storage, transfer and transport, treatment and the management and the reuse stage. In practice that means faeces, urine and grey water are usually collected and treated separately, which helps to optimize the sanitisation processes according to the requirements of the specific fraction (Table 1).

Table 1 Treatment and utilisation of different separated substances (IHP and GTZ, 2006)

Substance	Urine (yellowwater)	Faeces (brownwater)	Wastewater from household (greywater)	Rainwater	Organic waste
Treatment	Hygienisation by storage or drying	Composting, drying, anaerobic digestion	Constructed wetlands, ponds, gardening, boil. treatment, membrane techn.	Filtration, biological treatment	Composting, anaerobic digestion
Utilisation	Liquid or dry fertilizer	Soil improvement or biogas	Irrigation or groundwater recharge	Water supply or groundwater recharge	Soil improvement, biogas

The recovered material from human excreta can generally be used in agriculture. Urine can be directly used as a liquid fertilizer after storage as it is usually sterile and hygienically uncritical. Health risks concern however, possible faecal cross-contamination with pathogens and possible contamination by medical residuals and hormones (ERTL, 2004). Especially, concerning grey water alternative options are feasible, e.g. the use as service water in industry or to recharge groundwater aquifers. Rainwater can serve as resource for water supply or groundwater recharge and organic material can be used for the generation of biogas or as general soil amendment (IHP and GTZ, 2006). WERNER et al. (2003) state that ecological sanitation has the following advantages:

- Improvement of health by minimizing the introduction of pathogens from human excreta into the water cycle
- Promotion of save and hygienic recycling of nutrients, trace elements, water and energy
- Conservation of natural resources through lower consumption of water and fertilizers and resulting minimisation of water pollution
- Preference for modular, decentralized systems for more appropriate, cost-efficient solutions
- Possible integration of on-plot sanitation into households and better comfort and security for users
- Preservation of soil fertility
- Increased agricultural productivity and contribution to achieve food security
- Promotion of a holistic, interdisciplinary approach
- Material-flow cycle instead of disposal (Figure 2)

The importance of improved sanitation and its positive impact on human health have been described already in chapter 3.1. Regarding that, it is crucial for sustainable sanitation systems to assure the proper sanitisation of the faeces. Different species of pathogens have varying die-off rates (time needed for organisms of one type to die). The dying of faecal pathogens usually increases after leaving the body, with exceptions like e.g. salmonella. Several changing parameters, like increased temperature, intense sunlight, pH-value, decreased moisture, content of nutrients and micro organisms, further help sanitizing the faeces. EcoSan concepts utilize these factors and therewith try to enhance the sanitisation process by dehydrating or composting the excreta.

Figure 3 shows the main ways of spreading diarrhoea through faecal pathogens and necessary barriers to prevent the spread of pathogens (SIDA, 1998). At best UDDTs also prevent flies from accessing the faeces and therefore from the possibility of contaminating food.

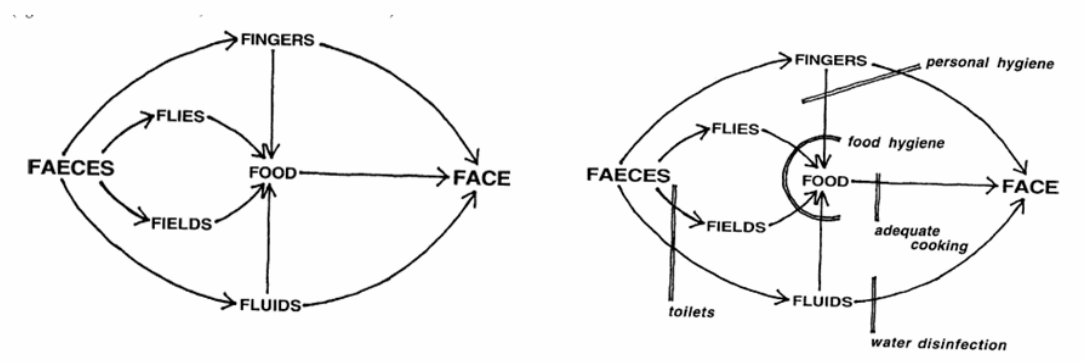

Figure 3 Possible pathways of spreading diarrhoea from faecal pathogens and necessary barriers to prevent the spread of pathogens (SIDA, 1998).

Ecological sanitation is a highly interdisciplinary approach. This is demonstrated in Figure 4, drawing on a wide range of expertise, which according to IHP and GTZ (2006) include:

- Integrated water management and other natural resources
- Resources protection and recycling
- Sustainable agriculture, soil conditioning and replacement of fertilisers
- Public health enhancement and reduction of children mortality
- Food security
- Job creation and unemployment reduction
- Climate change and variability

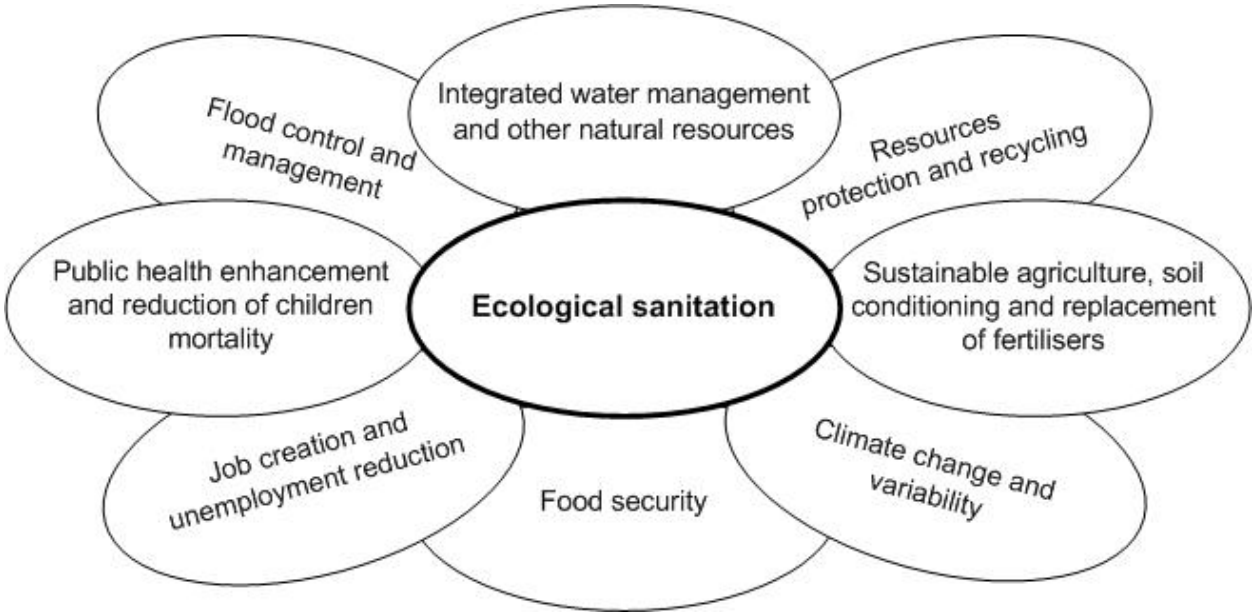

Figure 4 Interdisciplinary character of ecological sanitation (IHP and GTZ, 2006)

3.2.3 Four Basic Project Types

IHP and GTZ (2006) differentiate between four basic types of EcoSan projects, which are listed and described in the following.

- Rural upgrading: Establishment of an EcoSan system for farming households. Usually the system is run by the household itself and sanitations products are used on fields as soil conditioner or fertilizer. The initiative for such projects can come from local CBOs or NGOs (micro level) or can be part of political development programme (macro level).
- Urban and peri-urban upgrading: Conversion of existing sanitation system into closed loop systems. Depending on the situation this approach is likely to be very complex and technically sophisticated. Also problems of space can occur due to the high population

density of such areas. Furthermore, storing or transport of the sanitation products is a problem to be solved as households can only partly use them by themselves. The initiative for such projects can be put forward either on a minor scale for single households and smaller communities or on a major scale for larger areas from political initiatives for improvement projects or bigger areas.

- New development areas: Construction of new dwellings by authorities or private businesses or citizen groups. Depending on the design of the facilities, sanitations products are used by each household itself or collected and treated by private or municipal service providers and passed to end users. The initiative for such projects often comes from the investors and can be assigned to a macro level.
- Non residential areas: Construction of EcoSan facilities in areas which are not primary residential. Examples can be public institutions like schools, hospitals, private offices or hotels in sensitive areas or places where no sewer system exists. The handling of the recyclates can be carried out by the users of the building or external service providers. Initiatives to use EcoSan can come from a micro or macro level.

3.2.4 Stakeholders in Sustainable Sanitation

"A sure recipe for failure of an ecological sanitation programme is to put it in place without the participation of the intended users and without proper instruction." (SIDA, 1998). To avoid mistakes like that, the involvement of different interest groups into the intended process is very important. The number of stakeholders in a development project for sanitation and their background can be quite large depending on the scale and the type of the project. In the following, possible stakeholders of a project are listed and shortly described (IHP and GTZ, 2006).

- User of facilities: This group, the individual households, includes all who are meant to use the established facilities. Therefore, the involvement of this group is to be considered as very important. Depending on the area the involvement can range from single households to settlements.
- User of the sanitation products: In some cases the households are using the sanitation products themselves. However, in urban or peri-urban surroundings not all of the material can be used on site. In this case, sanitation products can be distributed by collectors and used by private farmers, foresters or on a municipal level in gardens or parks.
- Community Based Organisations (CBOs): Organisations of that kind usually involve households and help them to exchange experience, knowledge and concerns. In some cases these groups are created in response to certain projects. CBOs are important because they often involve users of facilities and sanitations products and service provision can emerge from them for operation and maintenance.
- Non-Governmental Organisations (NGOs): For information and awareness raising NGOs play and important role. Furthermore, they can support households in forming pressure groups, getting access to financial support or cooperating with municipalities or producers.
- Local Authorities: The positive role of local authorities and governmental institutions can be seen in two ways. They can either act as initiators of a project and actively promote EcoSan, or they can account for the necessary framework conditions to implement a system. Here also the legal situation is important.
- Service providers: This is a very heterogeneous group and can include planners, consultants, construction companies, private as well as academic institutions or municipal businesses for collection, transport and treatment. Also users of the sanitation products can act as service providers if they collect and treat material from EcoSan facilities.
- Developers and investors: Public or private they are initiating the construction of EcoSan facilities. Quite often, both developers and investors are also planning and implementing their projects themselves.

- Financial institutions: Depending on the scale of EcoSan projects, it might be necessary to introduce subsidies or other financing schemes. Therefore the involvement of financial institutions like local or international banks or donor agencies may be important. Funds are not only needed to cover the construction costs but also to carry out pilot studies. During the financial planning of a system, the phase after the construction, respectively operation and maintenance, has to be taken into account to allow continuing functioning.
- Research institutions: Universities or similar institutions can provide important advice for initiators, municipalities or NGOs. Their expertise and newest research output can be valuable for particular information, advocacy or lobbying among the different stakeholders. Therefore, these institutions should be consulted and even asked for cooperation. Occasionally, EcoSan projects may also serve for research purposes and scientific progress.

3.3 ROSA Project

The Institute of Sanitary Engineering and Water Pollution Control in Vienna is coordinator of the ROSA-project, funded by the European Union. The abbreviation ROSA stands for “Resource-Oriented Sanitation in peri-urban areas in Africa”, and describes a specific target project funded within the EU 6th framework programme for “sustainable development, global change and ecosystems”. The ROSA project, carried out in the four pilot cities of Arba Minch (Ethiopia), Nakuru (Kenya), Arusha (Tanzania) and Kitgum (Uganda), shown in Figure 5, promotes resources-oriented sanitation concepts as a sustainable and ecologically sound way of meeting this target. Strategic Sanitation and Waste Plans (SSWPs) are developed for the whole city areas and show the best solution for the respective pilot city. According to the local requirements, the SSWPs combine several techniques resulting in hybrid systems. As implied in the project title a focus of research is laid on the peri-urban areas of the cities. ROSA also develops possible financing strategies, together with the existing international network for programmes and projects in East Africa. The project started in October 2006 and was finalized end of March 2010. The main scientific and technological objectives of the project are (LANGERGRABER et al., 2008):

- to promote resources-oriented sanitation concepts to help fulfilling the UN MDGs by eliminating pathogens, preventing environmental pollution and recycling nutrients and water from wastewater,
- to implement resources-oriented sanitation concepts for the four pilot cities in East Africa where a lack of sanitation as well as waste management and high population growth are present,
- to research gaps for the implementation of resources-oriented sanitation concepts in peri-urban areas, especially concerning the use of waste and excreta in agriculture, and
- to develop a general applicable, adaptable framework for the development of SSWPs

Particularly important for the development of sustainable sanitation concepts is the involvement of local stakeholders. Therefore, ROSA involves municipalities as consortium partners and makes them work together with local universities. Also local people work for the ROSA project in each pilot town and their European partners act merely as advisors. Therewith, contact to the local population is given and at the same time capacity building can proceed. Around members of municipalities and universities, wider networks were formed by inviting authorities, NGOs and CBOs to participate. Research topics are demand driven in the ROSA project and defined by the local partners when challenges concerning operation and maintenance or financing occur. As main research topic an implementation study of the updated WHO guidelines for the use of waste and excreta in agriculture in peri-urban areas is conducted. All these practices are important to gain acceptability and as a consequence help to introduce a sustainable system (LANGERGRABER et al., 2008).

Figure 5 in red, the four pilot cities of the ROSA project (ROSA, 2010).

4. Solid Waste and Wastewater Management in Austria

This chapter provides information about the organisational and structural situation in the Austrian solid waste and wastewater sector. An overview about regulations and responsibilities of different players in the Austrian law is outlined in the first part. Regarded as important in connection with sustainable sanitation, a focus is laid on the different state laws for the use of sewage sludge in agriculture.

4.1 Legal Framework

The legal situation in Austria is relatively complicated because responsibilities are distributed between the nation (federal law), the federal states of Austria (state law) and the municipalities (municipal law). Additional, EU legislation has to be taken into account or is directly valid. Especially, in the solid waste sector legislative differences can be relevant. Wastewater is regulated by the national Water Act (federal law) and differences result mainly from ordinances for the treatment and disposal of sewage sludge, which again is related to solid waste. This chapter is meant to give an overview of the legal situation in Austria with a focus on the differences for the use of sewage sludge in agriculture.

4.1.1 Solid Waste

According to the federal constitution law of Austria, hazardous waste and waste oil are a national matter, whereas non-hazardous waste are in the responsibility of the nine federal states (B-VG, 2009). Austrian legislation has to consider existing guidelines of the European Union for landfills, packaging or for old vehicles and Waste Electronic and Electric Equipment (WEEE) that are meant to standardize the quality of waste management in Europe. The guidelines are not directly legally effective but have to be incorporated into national law within a set timeframe. An EU-guideline for hazardous waste exists as well. EU-regulations are directly legally effective and exist for the shifting of waste (e.g. WEEE) within EU member countries, between them and from EU-countries to third nations. For the future, a uniform European Waste Catalogue (EWC) and a Hazardous Waste Catalogue (HWC) is planned, which categorizes the different waste after its origin (AK, 2009 and SALHOFER, 2009).

The main legal basis for solid waste management in Austria is the federal law for sustainable solid waste management (AWG, 2002). It aims to manage solid waste in such a way that humans, animals and plants are protected from adverse or harmful effects, that the production of greenhouse gasses is minimized, and natural resources are spared. The principles of the law are firstly, waste avoidance, secondly, waste utilisation, and thirdly waste disposal. In addition to the main law, many nationwide ordinances exist, e.g. regulating waste incineration (ABFALLVERBRENNUNGS VO, 2009), waste treatment responsibilities (ABFALL-BEHANDLUNGSPFLICHTEN VO, 2009), separate collection of organic waste and its composting (GETRENNTRE SAMMLUNG BIOGENER A, 2009 and KOMPOST VO, 2009), the regulation and treatment of hazardous waste (FESTSETZUNGS VO, 2009) or landfills (DEPONIE VO, 2008). The regulation for landfills is especially important because it forbids the deposition of untreated waste. Following that, it is necessary to either incinerate the waste or to undertake a mechanical biological pre-treatment (MBP), whereby thermal useful fractions are separated. Then, the rest of the material is decomposed before it is landfilled.

At least every six years a solid waste management plan has to be elaborated for Austria. Here the current situation is described, information about existing treatment facilities is given and optimisation strategies are formulated (AWG, 2002). For businesses with more than 20 employees it is compulsory to elaborate a waste management concept every five years with important information about the current waste situation and future developments. If there are

more than 100 employees in a company a commissioner responsible for waste issues has to be employed (SALHOFER, 2009).

All of the nationwide regulations affect, if they are changed, the regional legislation of the federal states of Austria and result in changes in state law as well. For example, the ordinance for separate collection of organic waste entailed additional waste collection facilities. The ordinance concerning landfills had even more impact, as new treatment plants needed to be built. In both cases, the population is also affected since costs are rising (AK, 2005). Furthermore, people and other "waste owners" have duties to fulfil. These duties concern separate collection, recording of waste flows or hazardous waste (SALHOFER, 2009).

As mentioned earlier, legislation of the nine federal states of Austria is very much influenced by federal law and also EU-legislation. However, there are fields where differences occur. Generally, the federal states are responsible for residual and bulky waste from households and non-hazardous waste from businesses (SALHOFER, 2009). Because a detailed description would go beyond the scope of this work, in chapter 4.1.3 the use of sewage sludge in agriculture will serve as an example to show the complexity and differences in state law. As an important part of solid waste management state law also instructs responsibilities for waste consulting, public relation in the field of waste management as well as the elaboration of a regional waste management plan (AK, 2005).

On a third political level within Austria, the respective municipalities can independently set legal regulations for collection- and treatment charges or the collection scheme of solid waste (AK, 2005).

4.1.2 Wastewater

EU-guidelines for communal wastewater (91/271/EWG), hazardous substances (2006/11/EG) and the Water Framework Directive (2000/60/EG) exist and have to be taken into consideration by Austrian legislation (UBA, 2010). However, the main legal basis for communal wastewater treatment is the Austrian Water Act (WRG, 1959). Additionally, a general wastewater emission ordinance and many particularly specific wastewater emission ordinances for different industries like paper production, livestock breeding or waste treatment exist. These restrictions help to minimize the pollution of wastercourses. The limits for emissions are always orientated at the best available technology.

The water information system Austria (WISA) is part of the Water Act and serves to monitor the water situation in Austria. It also includes information of wastewater disposal. The Austrian Water Act furthermore arranges for the creation of water associations with different purposes to guarantee water supply and wastewater management. To keep the water quality high or to improve the water quality of polluted surface water, municipalities of affected regions can build alliances and elaborate strategic remediation plans (WRG, 1959).

Compared to the situation of the solid waste sector, the legal framework conditions for wastewater are relatively simple, apart from the numerous emission restrictions. That mainly results from the fact that one nationwide law regulates all water related issues. Due to trans-boundary catchment areas, different state laws would not be reasonable.

The residuals of the wastewater treatment, the sewage sludge, enter the solid waste cycle as non-hazardous waste and therefore fall under the responsibility of the different federal states.

4.1.3 Agricultural Use of Sewage Sludge

On European level the directive 86/278/EEC on sewage sludge sets thresholds for heavy metals in soils to which sewage sludge is meant to be applied, and for sewage sludge considered to be used in agriculture. In Austria the legal situation for the agricultural use of sewage sludge is regulated through federal law as well as through different state laws and ordinances in the federal states. Relevant on a national level are the federal law for sustainable

waste management (AWG, 2002), which generally claims to organize waste management in such a way that:

- harmful impacts on people and environment are kept low,
- natural resources and energy are saved,
- landfill space is saved and
- only inert residuals are deposited.

The thresholds of the landfill ordinance, which only allow a deposition of material with a total organic carbon content (TOC) < 5% or a gross calorific value < 6 000 kJ/kg, can usually not be met by drained or composted sewage sludge. The federal ordinance for compost (KOMPOST VO, 2009) sets quality requirements and orders a labelling of compost from sewage sludge. Only certified compost of a certain quality is allowed for agricultural use. The Austrian Water Act sets thresholds to prevent hazardous substances from entering the wastewater treatment system. The Austrian Forestry Act (FORSTGESETZ, 1975) forbids the use of sewage sludge in the forest.

Beside the national regulations, the federal states are responsible for sewage sludge. Vienna, Tyrol and Salzburg actually forbid the agricultural use others allow the use of sewage sludge, or at least some of its products under different circumstances. Ordinances for sewage sludge exist in each federal and will be described later on. In all cases the quality of the used sludge and the soil parameters are of high importance. The responsibility for soil protection lies with the federal states and therefore different legal regulations apply.

Figure 6 shows how the total amount of 264 000 tons of dry matter (DM) of sewage sludge is utilized and disposed in Austria. Sewage sludge contains potentially valuable nutrients, especially phosphorus and nitrogen, and organic matter. Using the right quantity in agriculture could therefore improve the quality of the soil. However, there are also potentially harmful substances which can accumulate in the soil and enter the food chain. An important pre-condition for the successful use of sewage sludge in agriculture is to generate benefit. Furthermore, fertilisation has to be adapted to the plant growth and seasonal conditions and must not lead to contamination of water or soil. There are different thresholds for heavy metals in sewage sludge for agricultural and non-agricultural use like revegetation (BMLFUW, 2006). In the following, an overview about the legal differences in the nine federal states of Austria is given.

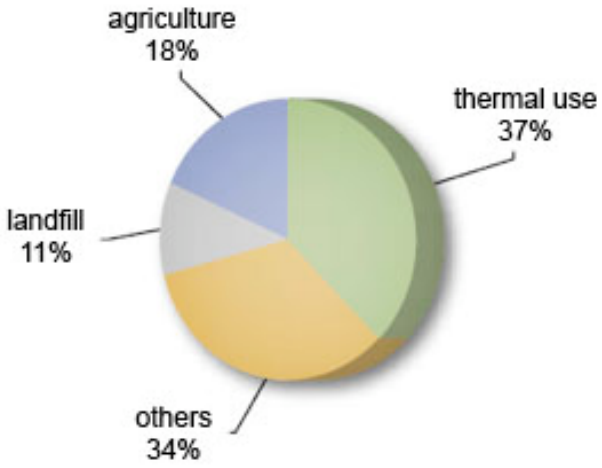

Figure 6 Utilisation and Disposal of Austrian Communal Sewage Sludge (BMLFUW, 2006)

In Vienna, Tyrol and Salzburg it is not allowed to use sewage sludge or sewage sludge compost in agriculture or for revegetation. The sludge is mostly incinerated; sometimes landfilled and small portions are also exported to other federal states to be disposed there.

Burgenland

The ordinance for compost from sewage sludge and municipal waste (BGLD. KLÄRSCHLAMM- UND MÜLLKOMPOST VO, 2009), regulates the measurement of parameters and sets thresholds for water content, minerals, metals, heavy metals and pH-value. Hygienic parameters are only compulsory if the sludge is used on grassland. Before use, the sewage sludge has to undergo a rotting process to decompose easy degradable organic substances. Depending on the size of the wastewater plant different timeframes for quality control of the sewage sludge are valid.

If an area is fertilized with sewage sludge for the first time measurements of soil parameters have to be very detailed. After that, not all parameters need to be re-evaluated. Still, before every time of sewage sludge fertilisation measurements have to take place. Thresholds for all kinds of important parameters further regulate the sludge quality and also the time and the way of use underlie specific rules. Papers of quality and amount of used sewage sludge have to be archived for ten years.

Carinthia:

The ordinance for the use of treated sludge, organic and green waste (K-KKV, 2009) regulates the situation in Carinthia. The use of treated sewage sludge in agriculture is allowed, if the quality is proofed. Certain thresholds for important soil-, sludge- and epidemic parameters yield information in this matter. If the sludge is brought directly into the ground or is covered with soil immediately after application, fractions with defined lesser quality are also allowed. All measurements have to be carried out by authorised laboratories.

A general statement of the law says that the use of sewage sludge must not harm the health of people or animals, result in shortcomings for agriculture, natural conservation or water conservation and has to keep the soil in fertile condition. The amount of used sewage sludge underlies very detailed restrictions and also the condition, locality and the kind of use of the intended area of use are relevant. Moreover, many exceptions for special circumstances exist.

Lower Austria

To evaluate the suitability of soils in Lower Austria for the use of sewage sludge, areas are categorized. Measurements involve heavy metals and soil-specific parameters like the pH-value and the content of nitrogen, phosphorus, magnesium or organic substances. Furthermore, measurements for chlorinated organic compounds, pathogens and radioactivity are carried out. For every hectare one sample has to be analyzed in a certain way. The quality of the used sewage sludge is measured and strict thresholds have to be considered. Changes in the treatment process of a sewage plants often require new measurements (NÖ KLÄRSCHLAMM VO, 2005). Besides the sludge directive a soil protection law further restricts the use of sewage sludge in agriculture.

Upper Austria

The Upper Austrian sludge directive (OÖ. KLÄRSCHLAMM VO, 2006) is pretty simple in its structure. Certain thresholds for the quality of sewage sludge and soil condition are listed and specified. For measurements and probing the law refers to Austrian and German standards or the Upper Austrian soil protection law. Certificates have to be compiled in a given form.

Styria:

In Styria the use of sewage sludge in agriculture is generally allowed. Before it can be used, however, various parameters have to be measured by official institutions and thresholds have to be considered. Important parameters are: water content, total nitrogen, dry substance, phosphorus and other minerals as well as metals and heavy metals. Furthermore, hygienic parameters and the pH-value are essential. For sludge from wastewater plants with a population equivalent (PE) of 30 000 or more, additional measurements are compulsory and also the frequencies of measurements are higher.

Besides the quality of the sewage sludge the area of use has to fulfil specified requirements. The groundwater level, soil type, soil layer volume or pH-value are only examples of important parameters. A long list of thresholds specifies the requirements very detailed. To make the use of sewage sludge in agriculture traceable, farmers have to keep papers of the last ten years (STEIERMÄRKISCHE KLÄRSCHLAMM VO, 2007).

Vorarlberg:

In the most westerly federal state, sewage sludge can only be used in agriculture if composted in such a way that easy available organic substances are minimal or if the dry matter is at least 70 % due to thermal pre-treatment. Furthermore, the product has to contain specific amounts of fertilizing substances and must not excess thresholds for heavy metals. Measurements have to be accomplished by qualified laboratories and evidence has to be compiled. General requirements for the use of sewage sludge compost include the protection of human and animal health, the fertility of soils and waters in general. Furthermore, regulations exist for amounts and physical and chemical condition for the area of use. Special conditions apply for grassland and for some areas use is generally prohibited (VORARLBERGER KLÄRSCHLAMM VO, 2009).

It can be summarised that many similarities exist between the different sludge directives although every federal state has a self-contained legislature. Apart from total banning or general allowance of use, the measured parameters are similar in most federal states of Austria. Still, some differences exist concerning allowed thresholds. Also most of the regulations have their basic structure in common and general statements as described for Carinthia can be found for the other federal states as well.

4.2 Waste Sector

In the following, an insight into the organisation of the Austrian solid waste sector is provided. After a general overview of collection, recycling, treatment, disposal and financing, examples describe strategies in more detail and schemes on different political levels in different federal states. Here the involvement of different stakeholders including private and public companies becomes apparent.

4.2.1 Organisation

This chapter is meant to exemplary show how collection, treatment and disposal of waste are being organized in Austria. Due to legal regulations many similarities exist between the federal states. Some of the differences are described. On a household level the solid waste sector is dominated by public institutions. Solid waste management is a service for the public and therefore municipalities are committed to collect the waste of every business and every household. In return people are bound to pay for this service. As an alternative, companies can also task private companies to dispose of their waste. Private companies play an important part in the Austrians solid waste sector. The involvement and inter-linkage between private operating companies, consulting companies, holding companies or subsidiaries, make it hard to understand who is really doing what. Often alliances are built between companies to have a competitive advantage. These alliances can include collectors as well as recycling or disposal companies. Some bigger enterprises carry out all stages of waste management by themselves. Regarding waste treatment and disposal, different ordinances apply, which will only be mentioned.

Collection

As mentioned before, legally the collection is the duty of the municipality and is often seen as service for the public. However, the private sector gets more and more involved and partnerships between municipalities and private disposal companies are popular. The main driving force behind the involvement of the private sector is to be more efficient and to reduce

costs. However, it is important to provide service to all at reasonable costs and avoid the disadvantaging of areas lacking in infrastructure. Therefore, the involvement of private companies only seems to be reasonable, if limited to a certain degree with predominance of public institutions. In practice, municipalities sometimes commission private companies to carry out certain steps of waste management on their behalf. The collection of recyclables like paper, glass, metal or plastics is often done by the producer of secondary raw material itself or intermediary retailers.

Recycling

In the federal law for sustainable solid waste management it is requested that waste is to be recycled as long it is ecologically advantageous, technically possible and additional costs are not disproportional compared to other waste treatment techniques. Furthermore, a market has to be established for the produced secondary raw material (AWG, 2002). Recycling can be described either as the production of secondary raw material from recyclates, or the use of thermal energy gained from burning material with high caloric value. Paper is used to produce paper again, metal is used in the respective production industry, glass replaces primary raw material in the packaging industry and so do some plastic fractions. As many different types of plastic exist, material recycling is sometimes difficult and thermal use is generally favoured. However, material recycling of PET (polyethylene terephthalate) has been increasing during the last years. An important player on the Austrian recycling market is the Altstoff Recycling Austria (ARA), which is described in more detail in chapter 6.3.1. In Austria, the separate collection of organic waste is compulsory, unless it is composted in the household or wherever it accumulates. The composting ordinance regulates the processing of the organic waste, sets qualitative thresholds and classifies different compost qualities.

Treatment and Disposal

In the hierarchy of the federal law for sustainable solid waste management, disposal is ranking last behind avoidance and recycling, however, a reasonable fraction (especially, municipal solid waste) has to be treated and disposed. The already mentioned Austrian landfill ordinance gives a clear framework concerning the disposal of solid waste. Only waste with a total organic carbon content (TOC) of <5 % is allowed to be landfilled. One exception is granted for waste from mechanical biological pre-treatment (MBP), which is defined after a gross calorific value of less than 6 000 kJ/kg. In practice, the ordinance allows only the disposal of treated municipal waste (ÖWAV, 2004). That makes sufficient capacities for waste treatment in form of incineration- and MBP-plants necessary. Strict regulations concerning the technical and geographical requirements of landfills have to be fulfilled. At the moment there is enough space available on Austrian landfills and no requests for developing new sites exist.

Financing

Collection, treatment, and disposal of municipal waste are generally financed via the waste collection fees, paid by the users – the households or companies. AK (2005) carried out a study on waste collection fees in Austria and was confronted with a manifold variety of collection- and charging schemes. It turned out that waste collection fees varied between +/-40 % to +/- 70 % for the same service. Research showed that different factors influence the costs for waste treatment and disposal and therefore the waste collection fees. Possible factors are listed below (AK, 2005):

- Service level (emptying frequency, degree of separate collection, collect- or bring system, etc.)
- Structure of the catchment area (topography, population density, municipal area, distance from treatment plant, etc.)
- Organisational structure (municipal or private operation, membership in waste association, business management etc.)

- Collection scheme (collect or bring system, collection from inside or outside the house, number of collection points and recycling centres, etc.)
- Type of waste treatment (MBP or incineration of waste, own facilities e.g. for composting, dues for remediation of contaminated sites, etc.)
- Financial management (different interpretation of cost-covering waste collection fees, estimation of costs, possible cross subsidies, self-financing versus external financing, etc.)
- Fee calculation system (per container, volume, person, household, etc.)
- Different classification and interface-regulation concerning municipal waste from households and similar waste from businesses result in 10-15 % of overall variation of waste collection fees. Elimination of household-like waste from businesses from the municipal disposal scheme is estimated to result in a raise of fees up to 30 %, especially in tourist areas.
- Consideration of existing structures and involvement of available facilities and free capacities usually leads to lower fees

4.2.2 Lower Austria (state level)

The example of Lower Austria was chosen, as a similar situation can be found in nearly all other federal states. Exceptions are Vienna, which is separately managed and Burgenland. In Burgenland waste management is centrally organized and all municipalities are members of one state-wide association, which sets fees and is, together with a subsidiary, responsible for all stages of waste management. Upper Austria, Styria, Carinthia, Salzburg, Tyrol and Vorarlberg are, like Lower Austria, organized in waste associations with districts or municipalities as members. Ordinances usually regulate the membership of the municipalities and districts in certain waste associations. In many cases, they cooperate with companies active in the field of waste recycling and disposal.

In Lower Austria the provincial government is responsible for the planning of waste management, waste legislation, non-hazardous waste, landfills, abandoned sites and expertise. For the implementation of waste management on municipal level either the different waste associations or the unassociated municipalities themselves are responsible. Waste management includes:

- waste avoidance, which focuses mainly on avoidance of hazardous substances in products and the awareness raising among the population,
- waste separation, which covers usually fractions like paper, metal, plastics, glass organic and hazardous waste and is due to historical reasons differently organized among municipalities,
- recycling, which includes material recycling resulting in the production of secondary raw material and energy recycling and the generation of heat and electricity,
- treatment and disposal, which includes both incineration and MBP and the deposition on an adequate landfill, and
- consultancy and PR, which tries to raise awareness among the population and industries and actively promotes sustainable waste management (NÖ ABFALLVERBAND, 2010).

As mentioned above, municipal waste in Lower Austria is collected differently in the municipalities. In some cases the containers are provided by the municipality and the collection outsourced to a private company. Collection can be also entirely outsourced or completely done by the municipality. Also the collected fractions can be organized differently and collected, recycled and disposed by private or public companies. About 59 % of the total amount of waste is collected separately in Lower Austria (NÖ AWB, 2008). Then the waste is brought to one of

the ten transfer stations. From there, transport goes by train to the incineration plant in Zwentendorf/Dürnrohr or to one of five MBP plants, situated in St. Pölten, Wiener Neustadt, Breitenau, Fischamend and Stockerau. The total yearly capacity of the five MBP plants is about 460 000 tons. The plants are often operated by public and private companies in cooperation (NÖ ABFALLVERBAND, 2010).

The incineration plant in Zwentendorf is operated by a subsidiary, which was established by a multi-utility company in cooperation with the provincial government of Lower Austria. In 2010 the yearly incineration capacity will reach 500 000 tons (EVN, 2010).

The Beteiligungsgesellschaft für Abfallwirtschaft und Umweltschutz (BAWU) is the responsible company to check and evaluate all arrangements taken for the professional treatment and disposal of residual waste in Lower Austria. Focus is laid on waste incineration, waste logistics and WEEE collection. The BAWU can be seen as the main waste management corporation in Lower Austria regarding municipal waste. It is owned by the major stakeholders for waste management in Lower Austria, respectively nineteen district associations and the cities of Krems and St.Pölten.

4.2.3 Graz (city level)

The example of Graz was chosen to show how waste management can be organized on a larger scale, comparable to other federal state capitals like Linz, Salzburg City or Innsbruck. Graz, with about 290 000 inhabitants is the second largest city of Austria.

The Abfall-Entsorgungs und Verwertungs GmbH (AEVG) is a limited liability company, responsible for the disposal and recycling of the waste generated within the city and a few municipalities surrounding Graz. The AEVG is owned to 99 % by the public utility company of the city (Graz AG) and to 1 % by the city of Graz itself. A subsidiary called “Servus – Abfallgesellschaft” is supporting the AEVG as a waste business and is shared by the AEVG (51 %) and private waste disposal companies (49 %), combined in a conglomerate called “Entsorgungsbeteiligung Graz GmbH”. The collection of waste from the 117 000 households and 12 000 businesses is performed by both, the AEVG and the subsidiary (Servus). The municipal waste is processed centrally and valuable fractions brought to recycling. Plastics are used in the cement industry as combustibles; metals are used as secondary raw material in the metal industry. Residual waste is brought to a MBP-facility, operated and owned by Servus, where it is pre-treated and subsequently deposited (AEVG, 2009).

The recycling centre of the AEVG is the biggest in Austria, collecting 20 different fractions. Due to separate collection the waste amount can be reduced to more than 55 % and makes up about one fourth of the business volume. Organic waste is collected by Servus and centrally processed. Green and organic waste is hackled and mixed in the right proportion and then handed to farmers who compost the material on their own behalf. Also sewage sludge from the wastewater treatment plant of Graz is de-watered and dried by the AEVG and then incinerated (AEVG, 2009).

4.2.4 Stockerau vs. Mödling (municipal level)

The examples of Stockerau and Mödling are chosen to oppose to differently organised municipalities and to show possible strategies, which can be applied under federal law.

The situation on the municipal level can be very different all over Austria. Some municipalities have their own waste management strategies, whereas others undertake this service also for neighbouring areas. In Burgenland solid waste is centrally managed for the whole federal state. Private companies can be commissioned to collect, treat and/or dispose waste or municipalities have their own facilities and manpower. On a district level municipalities often built associations for solid waste management and organize it centrally. However, the pricing for the services is in most cases the affair of the municipalities. This unequal situation, even in the same federal state, arises from historically developed structures and makes comparison very difficult.

A short questionnaire was the basis for the case study on the municipal level in Lower Austria. Responsible persons were contacted via telephone and then asked several questions. Many requested to prepare the answers in a written form via email. Issues covered by the questionnaire were:

- Membership of the municipality of any waste association
- Catchment area of the municipality
- Type of organisation of waste management in the area (decentralized/centralized)
- Number of persons/households served
- Parties responsible for the collection; number of trucks in use; number of people employed; outsourcing of areas.
- Whereabouts of waste (especially municipal waste); parties further processing the waste. Types of processing (sorting, incineration, MBP, land filling)
- Position of solid waste management in municipal organisation. Budgetary autonomy. Other duties and responsibilities.
- What are other responsibilities and services (collection points, recycling centres, composting, street cleaning)?
- Yearly amount of waste from the catchment area
- Fees charged for waste disposal and basis for calculation
- Coverage of future investment costs by fees. Possible other financial sources for cost intensive projects (e.g. public funds)

Ten municipalities around Vienna were chosen and questionnaires delivered via email. Eight municipalities were willing to answer some of the questions. A problem was that comparability between the municipalities was limited due to different statistical approaches and incomplete answering. As a result, two comparable municipalities are described in the following. The two examples have been chosen to show entirely different municipal waste management approaches.

Stockerau

Stockerau is a town north of Vienna with about 15 500 inhabitants. The so called environmental service of Stockerau is responsible for the municipal solid waste. Its aims are to dispose all waste of households, industries and businesses securely and environmentally sound. After a phone call with responsible persons at the bureau of the environmental service a questionnaire with open questions was sent via email and returned.

Stockerau is not connected to any association but working autonomous with various contractual partners. About 19 300 persons in 7 900 households are served in the catchment area of the town and two surrounding municipalities. Additionally, Stockerau takes over the organic waste of two other municipalities in Lower Austria near Vienna. Waste management for the area is centrally organized. The town collects the waste and has its own trucks and containers for that purpose. Fifteen persons are employed for waste collection. The collection of waste glass is sourced out to a local company. The further treatment of the municipal waste was tendered by 18 municipalities and assigned to a limited liability company called “BSU” which is equally shared by three waste disposal businesses (Brantner, Saubermacher and UEG). The mechanically biologically pre-treated waste is landfilled. The contract with BSU runs until 2013. Within the municipality, waste management is separately organized and financed. Besides the waste collection from households also 25 collection points for recyclables and two recycling centres are operated. Another recycling centre with a sorting plant and storage for hazardous waste from households exists. Furthermore, a composting plant is operated and street cleaning is done. Residual waste treated in the catchment area is about 3 340 t/y with fees of € 5,52 per

collection for a 120 l container. Collection of organic waste from households is free of charge. Future investments are covered by the fees if necessary. Public funding is not seen as to be expected.

Mödling

In Mödling, a town south-west of Vienna with about 20 500 inhabitants, the situation is very different. The municipality is member of the Lower Austrian Waste Association. Together with the worldwide acting waste management company "Saubermacher" the municipality equally shares a limited liability company (Mödlinger Saubermacher GmbH) which is responsible for all collection activities in the town. The municipality therewith fulfils the duty of waste disposal for the population. Industries and businesses can negotiate contracts with private disposal companies like Saubermacher. The municipality itself operates recycling centres and collection points. A composting plant existed until 2009. Since then, Saubermacher is responsible for organic waste as well. The catchment area is limited to the municipal area with about 23 000 inhabitants and 10 500 households. The company provides containers for all fractions , collection trucks, and is also responsible for the further treatment and disposal of the waste. Fees are calculated as required in the Lower Austrian Waste Management Act and laid down in the municipal ordinance of Mödling. Saubermacher charge € 4,07 per collection of a 120 litre container of residual waste or organic waste. Investments are transacted by Saubermacher.

The above described examples of Stockerau and Mödling were chosen to oppose two differential situations. Although higher level legal regulations are valid for both municipalities, there is still latitude to apply different strategies for waste collection. Both of the two solid waste management schemes are more or less limited to the area of the town. Concerning the size major differences do not exist. Strategies, however, are different as in Stockerau the municipality is responsible for the whole solid waste management, while Mödling commissions a private company. Looking only at the fees for collecting residual waste, Mödling appears to be cheaper. However, when organic waste is included in the costs, the situation is very different. Table 2 shows the important differences and similarities between Stockerau and Mödling.

Table 2 Comparison of municipal waste management in Stockerau and Mödling

	Connected to association?	Collection and treatment	Inhabitants served	Collection 120 l municipal waste	Collection 120 l organic waste
Stockerau	No	Private Company	19 300	€ 5,52	€ 0
Mödling	Yes	Municipality	23 000	€ 4,07	€ 4,07

4.3 Wastewater Sector

At the end of the year 2006 about 640 WWTPs with more than 2 000 PE were in use in Austria. The total capacity was about 20 million PE and 91 % of the population was connected to a public sewer (UBA, 2010). These numbers show the high technical standards in Austria's wastewater sector. As a matter of course a lot of effort is necessary to keep the systems running and modernize the state of technology. The involvement of private companies is marginal, compared to the solid waste sector concerning the organisation. For development of new solutions and construction work private companies are of course essential, but the organisation is mostly in public hands. After the treatment of wastewater sewage sludge is generated. It is treated as solid waste and therefore underlies all circumstances of the sector. After dewatering and drying, the sewage sludge is incinerated, landfilled or used in agriculture. On a small scale WWTPs often work together and cooperate in form of so called "neighbourhoods", initiated by the Austrian Waste and Water Association (ÖWAV –

Österreichischer Wasser- und Abfallwirtschaftsverband). Small associations can be found where several municipalities, situated close to each other, share a WWTP and together operate a sewer system. Associations have often pollution abatement of waters as a collective target.

As shown before, conventional wastewater treatment systems are dominant in Austria. There are, however, also approaches promoting other options, especially in areas with low population density. In many cases the costs are very high for conventional systems with a relation of construction costs of 80 % for the sewer and 20 % for the WWTP. Additionally, also operation and maintenance costs are not to be neglected and decentralized systems are believed to save costs. Not only financially but also from an ecological point of view these systems are therefore disputable. Legally, treatment facilities have to be state of the art and certain emission standards have to be respected. There is, however, no obligation to extend sewer systems. How water is treated is the matter of the municipalities and there is even financial support for on-site solutions like constructed wetlands or small biological treatment plants (BMLFUW, 2010a).

4.3.1 Organisation

Besides relevant EU-directives, wastewater management in Austria is mainly regulated by the federal Austrian Water Act, general emission ordinance and specific emission ordinances, which set thresholds for wastewater of different origin. Also within the Austrian wastewater sector people are bound to use the system provided by the public sector in most cases. If no public system is available, decentralized systems have to be constructed according to legal guidelines. Sewer systems and wastewater treatment plants of different sizes dominate the Austrian wastewater sector and therefore differences are marginal. Conventional systems are highly promoted and decentralized alternatives are only relevant for very remote areas. Compared to the solid waste sector, wastewater is organized rather decentralized. Only few facilities for several hundred thousand population equivalent (PE) exist. A particular case is Vienna where a WWTP is operated designed for 4 million PE.

For private persons, wastewater is in most cases a matter of money to cover costs for the connection to the public system and the amount discharged. Financing sanitation is usually only a negligible part of household expenditures in Austria. Only if no connection to a public system is provided, people need to find solutions to dispose of their wastewater in a proper way.

Cesspits

Cesspits are still in use in Austria in some places. Especially, remote areas often lack a connection to a sewer and need to find other solutions. Suction trucks de-sludge the cesspits and bring the material to a nearby treatment plant, where the wastewater is conventionally treated. In such a case, the management is very close to that of solid waste, as material has to be collected and treated somewhere else. In order to minimize the fees for de-sludging, the construction of cesspits is often manipulated in a way that wastewater can percolate into the ground and frequencies of emptying are reduced. Especially, in growing settlements this misuse can have severe effects on the groundwater, and if combined with on site wells even on the drinking water. In some cases, farmers are allowed to use the material from the household cesspit as manure on their own property. As development strategies show, e.g. in Lower Austria show, the aim is to reduce the number of cesspits as far as possible and invest in conventional sewer systems.

Wastewater treatment plants (WWTPs)

The EU-guideline for communal wastewater (91/271/EWG) is incorporated into Austrian law. It prescribes that all settlements with more than 2 000 inhabitants have to be connected to a sewer system and sets standards concerning the cleaning capacity of WWTPs. The treatment capacity for nitrogen is about 79 % and for phosphorus about 89 %. Unlike the situation in many European member states, Austria has almost no eutrophic surface water, which proofs the effectiveness of phosphorus elimination from wastewater. About 1 600 WWTPs with more than

50 PE are operated with a total capacity of about 21 million PE. The number of WWTPs with a capacity of more than 2 000 PE is about 630, only 18 plants exceed 150 000 PE. With respect to the EU-guideline for communal wastewater, Table 3 shows a classification of the size of WWTPs with more than 2 000 PE in Austria and the share of the total number (BMLFUW, 2009).

Table 3 Size range and number of WWTPs >2 000 PE in Austria (BMLFUW, 2009)

Size range	**Number of WWTPs**	**Percentage of Number of WWTPs**
2 000 – 10 000	377	59,1 %
10 001 -15 000	46	7,2 %
15 001 – 150 000	196	30,9 %
>150 000	18	2,8 %
Total	**638**	**100 %**

Usual treatment stages include a mechanical stage and biological treatment. Tertiary treatment involves advanced purification of wastewater beyond the biological stage providing additional nitrogen and phosphorus reduction (UBA, 2010).

Sewage sludge

Sewage sludge is the link between the wastewater and the solid waste sector. After the sludge is separated from the wastewater it is usually defined as a non-hazardous waste. Exceptions can be industrial sewage sludge with a high content of hazardous substances. Entering the waste cycle, sewage sludge can be used in different ways. In chapter 4.1.3 the situation in Austria concerning the use of sewage sludge in agriculture has been described; other ways are incineration or disposal.

Financing

In the last years, investments to improve sanitary engineering were primarily used for the extension of sewer systems and WWTPs. However, especially in sparsely populated areas a lot of effort is still necessary to improve the situation. Investments are considered not only to improve the water quality but also to give incentives to the economy and the labour market. In the year 2005 government aids for sanitary engineering made up about 280 million euros, most of it supporting communal wastewater treatment (BMLFUW, 2010b).

The service, usually provided by the Austrian municipalities, includes wastewater drainage, its treatment, and the discharge of purified water. A certain price has to be paid by the end users except they provide somehow for their own wastewater treatment and can proof it. The estimation of cost coverage in the wastewater sector is limited by varying accounting systems and the lack of information about what is considered in the balance. Nevertheless, in 2002 a level of cost coverage of 84 % was estimated. Depending on the area (urban or sparsely populated rural area), the level of cost coverage can widely range. The fees for wastewater treatment are differently calculated all around Austria and are set by the municipalities regarding to the legal situation of the federal state. Basically, municipalities are engaged to cover costs, but at the same time operate under restriction of commensurability. Furthermore, they are bound to the principles of water saving, cost effectiveness, and utility. The fees for users are split into one part for the connection and another for the running costs. The latter, usually imply a basic fee and a variable. An average price for wastewater was calculated with € 1.69/m^3 with ranges between € 1.29/m^3 and € 2.33/m^3. As shown before, most of the running costs are covered by the fees, additionally public grants are provided for investments relevant to the environment (BMLFUW, 2005).

SCHMITZ (2002) compared fees for wastewater treatment among European countries. Top of the list was Austria with about € 155 per person and year. However, it is important to look at the basic parameters for evaluation. The inclusion of storm water treatment, sales tax, connection fees or cost coverage, topographic condition and public funding can lead to biased results. Also the quality of wastewater treatment in the member states is very different. Whereas in Austria the wastewater is treated on a higher level than demanded by EU-legislation, about 150 major cities in other European counties have no or inadequate wastewater treatment (SCHMITZ, 2002).

4.3.2 Lower Austria (state level)

Again Lower Austria was chosen as an example, as it represents Austria's wastewater management strategies. Except for alpine regions, the situation on state level is similar to the one in Lower Austria.

The construction of proper wastewater treatment facilities results from the legal regulations in the Austrian Water Act and various emission ordinances which also apply for the federal states. Lower Austria has about 420 WWTPs with more than 50 PE. The largest facilities have about 300 000 PE. Altogether, communal WWTPs with about 3.9 million PE treat wastewater from households and partly from businesses. The degree of households connected to a sewer varies between 59 % and 99 % with an average of 88 %. Investments for the construction and upgrading have been high in the last decades and resulted in very good water quality in most rivers. For the following years, the extension of the sewer system is planned to reach a total connection degree of 95 %. Small scale WWTPs and cesspits cover the residual 5 % (NÖ, 2010). Residents in Lower Austria pay a wastewater fee, which is calculated from the usable living area as a basis. Because not the actually discharged amount of wastewater is taken into account, this calculation method is often criticised. Particularly single households of older solitary people are financially disadvantaged. The calculation of the wastewater fees varies among the federal states. In many other federal states the amount of discharged wastewater is estimated via the used freshwater.

4.3.3 Graz (city level)

Graz, as the second largest city in Austria, represents the city level. Therefore it is chosen as an example.

The city of Graz is responsible for the sewer system and the WWTP, being the owner of both. The sewer construction bureau assures the proper collection, discharge, and purification of the wastewater for the whole city area and some surrounding municipalities. Different organisational units exist for estate drainage, planning and construction as well as operation of the sewer and the WWTP. The sewer has a total length of about 800 km. In the WWTP of the city of Graz all wastewater is treated biologically. Furthermore, also the content of some grease separators and cesspits is delivered by authorized collectors and treated. The accumulating sewage sludge (about 200 000 m^3/year) is taken over by the AEVG (disposal and recycling company of Graz), which dewaters, dries and incinerates the material (STADT GRAZ, 2010). In other capital cities like Vienna or Linz sewage sludge from WWTPs is also incinerated.

4.3.4 Stockerau vs. Mödling (municipal level)

The examples for the municipal level were chosen to oppose two different situations in wastewater management. Although Stockerau and Mödling are similar in size, because of the surrounding, big differences exist. These differences are described in the following.

Compared to the solid waste sector, the wastewater sector is generally more decentralized. Especially, in areas with a low population density or special topographic conditions like in alpine areas, often only small treatment systems are applied. Big systems exist in larger towns and particularly in Vienna.

As for the solid waste sector, a short questionnaire delivered to about ten municipalities, was the basis for the case study in Lower Austria. Responsible persons were contacted via telephone and then asked to answer the questions. Many requested to prepare the answers in a written form via email. Again problems occurred as not all questions were answered and comparison was not always possible. As for the study on solid waste management, Stockerau and Mödling were chosen as examples. Issues covered by the questionnaire were:

- Ownership and operator of the sewer
- Ownership and operator of the wastewater treatment plant
- Catchment area; volume treated; number of people served
- Number of people employed in the field of wastewater treatment
- Existence of cesspits in use; degree of coverage by the sewer system; number of cesspits; number of suction trucks in use.
- Funding of wastewater treatment.
- Charged fees for wastewater disposal and basis for calculation.
- Financing of big projects, like the extension of a treatment plant; availability of public funding.
- Treatment and disposal of sewage sludge and responsible parties.

Stockerau

The municipality owns and operates both the sewer and the wastewater treatment plant. The catchment area covers about 17 000 people of Stockerau and a small neighbouring municipality. The treatment plant is designed for a population equivalent (PE) of 33 000. Six people are employed in the field of wastewater treatment in Stockerau. Nearly the whole catchment area is covered by the sewer system, only a few cesspits exist in more remote areas. Therefore, a suction truck of the municipality is in use, which brings the sludge to the treatment plant. Wastewater treatment is financed by fees, which are calculated from the usable living area as a basis. Investments are refinanced by the fees. The sewage sludge of the treatment plant is taken over by a private company for humification and used in agriculture.

Mödling

Similar to Stockerau, also in Mödling the municipality is owning and operating the sewer system and the wastewater treatment plant. The catchment area covers the town and seven other municipalities. The wastewater treatment plant is designed for 130 000 PE. Seven people are employed for operating the sewer system and nine people work in the treatment plant. 99, 9 % of Mödling is covered by the existing sewer system and the sludge from two still existing cesspits is treated in the wastewater treatment plant. Wastewater treatment is financed by the fees, which are calculated from the usable living area as a basis and are laid down in the respective ordinance. Future projects are financed by temporarily raising the fees. The sewage sludge from the treatment plant is used humified either in agriculture, as an upper layer in landfills or is deposited.

The organisational structure in the Austrian wastewater sector often does not stick to the political organisation. Often small associations are formed between a few municipalities from different political districts or even states. The situation within a catchment area is here the decisive factor for cooperation, rather than political boundaries. In most cases districts are too extensive to be covered by a single wastewater treatment system. Therefore, most associations are situated between municipal and district level. Exceptions are densely populated areas. The two examples of Stockerau and Mödling show some differences. Stockerau has a sole system for the town and a small nearby municipality only, whereas Mödling operates a big WWTP

which also treats the wastewater of other municipalities. Big WWTPs exist mainly around Vienna and in the bigger cities of Austria. The remaining systems are rather small and decentralized.

5. Solid Waste and Wastewater Management in East Africa

The following part of this work engages with the situation in East Africa. As main information source served the baseline studies of the ROSA project, which were prepared in 2007 and are believed to be the most recent documentation of the situation in these areas. The four cities, Arba Minch, Nakuru, Arusha and Kitgum are shortly introduced and then special focus is laid on sanitation and solid waste.

5.1 Arba Minch – Ethiopia

Arba Minch is located about 500 km south of the capital city Addis Ababa and is one of the fast growing towns of Ethiopia with about 80 000 inhabitants. Water is relatively abundant in the region with two lakes not far from the town. However, water quality decreases due to deforestation and the inflow of sediments and exposed shorelines indicate sinking water level. In the northern part of the town a perennial river is used for irrigation and carries therefore very little water during the dry season. Water levels rise rapidly during rainfall events. The river is also used as a recipient for domestic sewage from the surrounding parts of the town. There are a number of springs in Arba Minch of which not all are tapped and are estimated to satisfy the demand of the town only up to the year 2015. In some areas the groundwater table is relatively high and the drilled boreholes are productive with acceptable water quality. The water is considered to come from a groundwater aquifer recharged by streams and regional sub surface flows. The water quality of the ground water is within the Ethiopian standards for potable water quality, whereas surface water needs disinfection and removal of suspended solids. Water in the lakes show high salinity and evidence for bacterial pollution (ROSA ARBA MINCH, 2007).

5.1.1 Sanitation

There are several problems related to sanitation in Arba Minch. One of the biggest issues is the rapid growth of population in the town and that no regular service exists to de-sludge the commonly used pit latrines. This combination leads to hygienic problems from manually emptied pits and open defecation in jungles or gorges. Only about one third of the toilets for residents are cemented, the majority uses shallow dug pits with wood logs for squatting. These basis facilities are much endangered to collapse during recent flooding in the rainy season. The responsible city municipality lacks to provide infrastructure, man power, budget and organisational setup. Further, like in most secondary cities of Ethiopia no facilities for wastewater collection and treatment exist. Greywater is usually spilled and only seldom used to water gardens. Larger water users like hotels use soak pits for their grey water disposal but often have problem to get rid of their black- and brown water, as no vacuum trucks are reliably available. The municipality Arba Minch and the local health bureau are formally responsible for the proper disposal of solid waste and wastewater (ROSA ARBA MINCH, 2007).

Two UDDTs have been built by Ecological Sanitation Ethiopia before the ROSA project started. Since the soil in Arba Minch is not very stable, the potential for the introduction of UDDTs is high. Also the fact that little space is needed and latrines are permanent is an advantage for the local conditions. Agriculture could benefit from qualitative compost if latrines are kept dry by full urine diversion, protection against water inflow from outside and adding of dry material such as lime, sawdust or soil. Social acceptance is, however, very important and not always a matter of course (ROSA ARBA MINCH, 2007)

Administrative framework

The Ethiopian Ministry of Health state increased access to sustainable sanitation as a goal in their National Sanitation and Hygiene Strategy. Following that, a reduction of water borne and water washed diseases and such related to faecal contamination is expected. In Arba Minch proportion of water borne and water washed diseases are above the national average.

Therefore, appropriate facilities have to be installed at public places like schools or markets and communal latrines in peri-urban areas and slum areas, where space is limited due to high population density. Facility management can be carried out by local communities as well as the private sector and should promote reuse and recycling by considering ecological sanitation options or biogas production from liquid waste. The responsibility for implementation lies at the Ministry of Health and the Regional Health Bureaus. Tasks include water supply, rural community development and administration, municipal and urban health departments for on-site sanitation, hygiene and solid waste management, environmental protection agencies, education for schools on sanitation and hygiene and the development of agriculture for biogas production and sanitation development. Legally, the Ethiopian Water Resources Management Regulations concern holders of waste water discharge permits. They need to install and use a wastewater treatment method and allow regulatory authority to take samples. Furthermore, the permission allows only a certain type and volume of wastewater discharge (ROSA ARBA MINCH, 2007).

To promote sanitation and hygiene different programs exist. The health extension program is one and is meant to advance sanitation and hygiene on a municipal level by appropriate excreta, solid and liquid waste disposal, water quality control, food hygiene, proper housing, vector control and personal hygiene, health education and promotion. Also UNICEF supported WATSAN programs exist, which focus on disease prevention on community level especially for women and children. Decentralisation and sustainable sanitation management by the community and public private partnerships are seen as critical factors for success. The World Bank supports a programme called WASH, which focuses on rural water supply, sanitation and hygiene in communities. Additionally, different local non-governmental and community based organisations are active in the field of sanitation and hygiene promotion (ROSA ARBA MINCH, 2007). Community based organisations (CBOs) have very different backgrounds, but often go beyond their original goals. They can be especially valuable as a platform of discussion and education on issues related to sanitation and hygiene. Communities are often the ones who communicate their problems to local administration or NGOs and therewith trigger sanitation interventions (DWENKO and OTTERPOHL, 2008). Involvement of the private sector contains of technical development for e.g. biogas production facilities, but also capacity building among the population. Further, the production of latrines and parts for urine diversion toilets could be carried out by private local companies. That would also stimulate the local economy (ROSA ARBA MINCH, 2007).

Stakeholders

DWENKO and OTTERPOHL (2008) state, how important the consideration of different stakeholders is. In the past, especially the private sector has been neglected. Besides the provision of spare parts and a lack of training of local sanitation providers the financing of sanitary systems is a major problem is. Private companies do not see much potential to profit from this sector. Therefore, financing schemes would help to make investments into sanitation more attractive. Many stakeholders are involved and complicate progress especially in urban areas. Producers of plastic products are interested in getting involved into the sanitation sector as their products could practically replace the more expensive and difficult to transport heavy cement pans (DWENKO and OTTERPOHL, 2008).

The communication between the government of Arba Minch and superior governmental offices is good. The local government works together with different NGOs, which provide financial support for training, and projects like Community-Led Total Sanitation (CLTS). Ideally, a NGO acts as a bridge between the government and communities, which can be of great value. Also CBOs are sometimes involved and can help to reach the local population. As they meet on a regular basis and trust each other CBOs can be a valuable environment for discussion and raising of awareness (DWENKO and OTTERPOHL, 2008). As women play an important role with respect to water and sanitation they are the ones to be persuaded and supported (ROSA ARBA MINCH, 2007). Generally, interventions are more likely to be working sustainable when the initiative comes from the communities themselves. Also cooperation and partnerships

between NGOs are considered to be important as they allow a sharing of knowledge and experiences (DWENKO and OTTERPOHL, 2008).

5.1.2 Solid waste

Many problems exist concerning solid waste management in Arba Minch – the coverage is minimal. Overall, waste is disposed in an unsatisfactory manner; either thrown away in compounds, gorges, and rivers or burned. Main fractions of waste are ash, paper and vegetable peelings, but plastics get increasingly problematic especially with rising income. The awareness of the population concerning negative effects related to solid waste is generally very low. Illiteracy and poverty further reduce their concern. The municipality Arba Minch and the local health bureau are formally responsible for the proper disposal of solid waste but legal backing and administrative support is lacking and so are coordination between different environmental activities. Appreciation of solid waste management as part of sanitation and potential to reduce health risks is minimal. The little solid waste service, provided by the municipality, covers only a few houses on main roads of the town. Problems arise in finding a proper disposing site for the waste. Financing of solid waste management is a big task and the municipality is operating on loss (ROSA ARBA MINCH, 2007). Legal backing and awareness raising about health related problems related to solid waste seem to be important too.

As in most developing countries, recycling and reuse of waste is mainly informal but highly organized. Most of the material is brought to Addis Ababa and sold there to local dealers and further to recyclers. The informal sector gives employment to many people and products serve as alternative to industrially produced goods. Integrating the informal recyclers in the sector could help to improve the current situation. On household levels useful recyclables are collected separately and sold. Especially, in poor households reuse is common practice. Because most of the solid waste is organic, organized composting could be beneficial. However, no such organisation exists (ROSA ARBA MINCH, 2007).

Administrative framework

The Solid Waste Proclamation of the federal government of Ethiopia states that urban administrations shall improve conditions to promote investments on the provision of solid waste management services. The proclamation clearly authorizes urban administrations to outsource solid waste management services to the private sector. Implementations of urban administration or regions are meant to be reported in solid waste management plans. Urban administrations can also transfer responsibilities for solid waste management, formulation implementation, installation of public service places, collection or awareness raising activities to lower administrative units. The Proclamation further states that manufacturers and importers of glass containers need to establish a recycling and collection system, that restaurants are required to implement a waste management system and an environmental audit, that households are required to segregate their waste and administration is responsible for the collection and disposal sites. Littering is prohibited where collection facilities are in place and penalties are charged for improper disposal of waste (ROSA ARBA MINCH, 2007).

The Environmental Policy and Proclamation of Ethiopia aims to enhance the health and quality of life of all Ethiopians and to promote sustainable social and economic development. Furthermore, a proclamation for pollution control exists and the polluter pay principle is stated. Regarding the management of municipal waste, urban administrations are responsible for collection, transport, treatment, recycling and disposal and in cooperation with regional environmental agencies also for the monitoring, evaluation and effective implementation of waste management systems. Again it is stated that solid waste management services may be outsourced if it is considered feasible (ROSA ARBA MINCH, 2007).

Stakeholders

Many different stakeholders are related to issues of solid waste management. The federal government with its proclamations and the city municipality as responsible unit are important to

drive legal backing in form of regulations and to prioritize the related problems in their agendas. Similar to the sanitation sector, NGOs and CBOs can play an important role in communicating with the local population and setting awareness raising activities. NGOs are often necessary to financially support pilot projects. As already mentioned, recyclers of the informal sector should be embraced as they already work in functioning networks and can help to set up a sustainable system. Also the involvement of youth groups seems to be promising. They have already worked with the city administration but have not been invited to work with NGOs yet (DWENKO and OTTERPOHL, 2008).

5.2 Nakuru – Kenya

Nakuru, with estimated 500 000 inhabitants the fourth largest city in Kenya, is located at the floor of the Great Rift Valley about 160 km North West of the capital city Nairobi. Nakuru lies at an altitude of 1 859 m above sea level and the hinterland provides fertile soils for agriculture. Nearly two thirds of the city urban area is covered by the Lake Nakuru National Park. The population is increasing, which leads to rising demands in infrastructure for housing, water supply, sanitation and traffic. Especially, in peri-urban areas, where land is cheap, new settlements expand. The Nakuru Water and Sanitation Company Limited (NAWASSCO) aims for supplying the whole city area with water and provide distribution networks to deliver sanitation. The water supplying the city comes from two rivers and the underground. In the recent past water shortage became a major problem. Apart from the insufficient quantity supplied, also contamination of the drinking water is a problem. The coverage of the sewer system is relatively low and the use of pit latrines is common, especially in low income areas. Furthermore, the existent sewer is frequently blocked and overflowing. Solid waste management is inadequate, although generally the responsibility of the Municipal Council of Nakuru. The main sectors of the economy are tourism, agriculture and agro based industries like dairy farming (ROSA NAKURU, 2007).

General environmental problems are competing interests such as urban development, agricultural use, and natural conservation. The environmental awareness among the population is low and legal regulation is insufficiently enforced (ROSA NAKURU, 2007).

Stakeholders

The main stakeholders in the sanitation and solid waste sector are institutions like the Municipal Council Nakuru (MCN), the NAWASSCO, the Nakuru Environment Consortium (NEC) and “Practical Action” a NGO. Within the MCN, committees are in charge to formulate policies for different sectors. Public health and environment, water and sewerage or town planning are only examples. For sanitation and solid waste the public health department is important. It is “charged with the responsibility of ensuring good health, sanitation, hygiene and comfort to all residents of Nakuru.” (ROSA NAKURU, 2007).

The NAWASSCO takes over the responsibilities of the central Ministry of Water and Irrigation and the MCN. The facilities are in public possession and only leased to the company. The aim of the involvement of the private sector is to make the sewer system more efficient (ROSA NAKURU, 2007).

The NEC is a voluntary association of member organisations with various backgrounds. Local and municipal government organisations are represented as well as NGOs, or formal and informal private sectors. The idea behind the NEC is that for an improvement of environmental conditions in Nakuru, different disciplines and organisations have to participate. Three working groups on water and sanitation, catchments conservation and solid waste management exist. The water and sanitation group develops strategic plans for the town or introduces alternative technologies like UDDTs or rainwater harvesting (ROSA NAKURU, 2007).

Practical Action is a NGO working mainly in Africa and Asia with focus on alleviating poverty through the use of intermediate technologies. In Nakuru, poor households are supported to improve their livelihood. Sanitation and solid waste management are part of their work in

cooperation with CBOs, private sector, and local governmental institutions. Practical Action also gives access to micro credits (ROSA NAKURU, 2007).

One of the key players in introducing sustainable sanitation is the ROSA project Nakuru. The Egerton University and the MCN are working together to develop a Strategic Sanitation and Waste Plan (SSWP). ROSA is also part of NEC (ROSA NAKURU, 2007).

Beside the beforehand described main stakeholders the Ministry of Local Government, the Ministry of Agriculture, the Kenya Wildlife Service, CBOs or the Nakuru Environment Management Project can be described as secondary stakeholders (ROSA NAKURU, 2007).

5.2.1 Sanitation

Only a small fraction of the city area is served by sewers, whereas the majority uses septic tanks, cesspits and pit latrines. Connected areas are served by NAWASSCO and collected blackwater (water, urine, faeces) is discharged into Lake Nakuru after some treatment in stabilisation ponds. Operation and maintenance is also the responsibility of NAWASSCO. The cesspools and septic tanks are mainly common in high-income areas. In low income areas with high population densities, pit latrines are the standard solution for sanitation. However, these facilities imply a high risk in pollution of the groundwater, which supplies for 70 % of Nakuru's drinking water. Settled sludge from pit latrines is sometimes disposed in Lake Nakuru but in most cases the latrines are abandoned and new ones are dug. Liquids leaking from unlined latrines are believed to reach the lake via geological fault lines. In many cases, 15 or more people are using one facility, which can be up to 30 m away from the houses and are therefore rarely used at night times due to safety concerns. Also open defecation is common for many. Operation and maintenance of sanitary systems lie within the responsibility of the landlords or plot owners. Water for hand washing is often not provided in or nearby sanitation facilities, being especially dangerous for children. Generally, poor people are rather investing their money for drinking water supply than for sanitation (ROSA NAKURU, 2007).

There are four public toilets in Nakuru. Three of them are managed by private operators and one by the MCN. The MCN's toilet can be used free of charge and problems occur regarding cleanliness. Where the facilities are privately operated and fees are charged for the service the toilet condition is better. Also drinking water can be purchased and laundering and bathing is possible. Further, waterless urinals are in use and new projects plan the gas production from bio-digesting human waste (ROSA NAKURU, 2007).

Greywater is in most cases discharged into the environment. Some people who grow vegetables also use it for irrigation. Pit latrines are usually kept free of water, to extend their period of use. Using wastewater for irrigation purposes is prohibited by law. The perception towards the re-use of treated human excreta among the population is relatively high, which is a positive initial position for the implementation of resources-oriented sanitation systems (ROSA NAKURU, 2007).

Administrative framework

The Ministry of Health, Water and Irrigation and the local government are in charge of the provision of sanitation in Nakuru. Within the legal framework – the Water Act of 2002 – which focuses mainly on improving water supply, sanitation is only a sub-clause to help conserve water. The Local Government Act empowers councils to provide for sanitation, but no guidelines how to sustain such systems exist. All sectors of economy can be inspected regarding hygiene standards by the Ministry of Health. The National Environmental Sanitation and Hygiene Policy from 2005 calls for the creation of working groups between civil society and the Ministry of Health, to develop national strategies, resolve inconsistencies in regulations, monitor the implementation or call for amendments. The Nakuru Municipal Council (MCN) is responsible to provide water and sanitation. In practice, the NAWASSCO, which is owned by the MCN, is taking over this responsibility under execution of the new Water Act. Concerning the water quality, regulations from 2006 are relevant (ROSA NAKURU, 2007).

5.2.2 Solid waste

Solid waste flows usually from households, businesses or markets through discharge, storage, collection, and transportation to a final official or illegal disposal site. In some cases recycling is performed. The approximately 200 t/day of solid waste are collected from the Municipal Council (30 %), managed by the private sector (30 %) and about 40 % is indiscriminately disposed. At the council the Department of Environment manages solid waste and is also responsible for public bins set up in the city area. The operation and maintenance of the system is poor and no information regarding the number or capacity of bins is available. The low environmental awareness of the population calls for educational programmes to keep the streets clean (ROSA NAKURU, 2007).

Solid waste collection by the council is only done in the very centre of the town. Problems exist concerning the collection and transportation due to a lack of vehicles and manpower but also fuel funds. Two vehicles are in use but about 12 are believed to be needed to serve the whole town. Existing container systems are often poorly operated and maintained after their introduction and therefore can not be used for a long period. Areas outside the city centre are either served by individual initiative or private companies. Private waste collectors mostly operate in middle or high-income settlements. Households have contracts, and garbage is collected directly from each house. The private collectors pay fees to dispose the garbage at the dumpsite. Collection companies usually are licensed by the MCN and registered by the government of Kenya. Problems exist, because households are sometimes not willing to pay for the service and illegally dump waste in the streets (ROSA NAKURU, 2007).

The MCN operates one official disposal site on the western side of the town. The disposal system is based on open dumping in an abandoned quarry. A major problem is the uncontrolled dumping and the use of illegal dumpsites, especially by private collection companies, where the waste is burned or left unattended. The dumpsite is near an area where many private boreholes exist. The disposal of all kinds of waste, including hazardous, industrial or medical waste and the lack of equipment to assure basic arrangements to reduce percolation into the groundwater, makes this a dangerous situation (ROSA NAKURU, 2007).

Because considerable amounts of biodegradable organic material entered the dumpsite a composting plant was set up with the support of Practical Action and Egerton University. This helped to reduce the used volume on the site and at the same time produce valuable organic fertilizer. Education to promote separate collection among the population could further yield improvement of this system. Different groups in Nakuru work on recycling plastics, metal, bones, glasses or paper. Plastic is smelted and posts are produced for fencing. Bones are burned and ashes are used for deflouridation of water. Glass manufacturing is performed in Nairobi. Especially, in recycling and separation of waste, street people play an important role as they are selling the material to middlemen, who later supply the recyclers and manufacturers. Although they play an important role most of them are not happy with their work and status and feel exploited by the middlemen (ROSA NAKURU, 2007).

Administrative framework

At the moment there is no comprehensive sectoral law on SWM in Kenya. The Local Government Act and the Public Health Act regulate SWM besides some by-laws of Municipal Authorities. The two Acts demand for implementation of systems for collection, storage, transportation and disposal of solid waste. The National Environment Management Authority is the main driving force trying to implement regulatory systems for SWM. The Department of Environment in the Municipal Council of Nakuru was created to target all environmental concerns and also gives technical advice to the council (ROSA NAKURU, 2007).

In summary, most of the problems with SWM concern or result from inadequate operation and maintenance. This applies to the use of containers as well as the availability and functioning of vehicles for collection. Another big issue is the lack of public awareness concerning the environment and relations between solid waste and human health.

5.3 Arusha – Tanzania

Arusha is situated about 90 km South West of Mount Kilimanjaro at an altitude of about 1 400 m. It is the capital city of the region, one of 26 administrative regions in Tanzania, which is rurally dominated. About 340 000 people live in the town. Beside rural industries, tourism plays an important role in the economy. Water supply comes mainly from springs (60 %), boreholes (27 %), and rivers (13 %). Generally speaking, there is a need to increase the number of people with access to clean and safe drinking water. In some regions only 30 % of the population have water supply. Concerning sanitation, the situation is not good. Only 12 % of the city area is served by the sewer and most people have no money to connect to the system. This leads to about 94 % of the population using pit latrines for sanitation. Further problems exist concerning the emptying of hardly accessible latrines, situated in very densely populated areas with no streets. Also collapsing of pits, due to high water tables are problematic. The management of solid waste is unsatisfactory, as < 50 % of the generated waste is collected and properly disposed (ROSA ARUSHA, 2007).

5.3.1 Sanitation

Most residents in Arusha are not connected to the sewer system and on-site solutions are commonly used. Only central parts of the city have a sewer. To treat the wastewater from the city centre stabilisation ponds are used. The system was designed for about 40 000 PE. The wastewater is treated in an anaerobic pond and two following facultative ponds. Then the effluent is further polished in maturation ponds before being discharged into the Themi River. Consumption of water is used as a basis to calculate the fees for the wastewater disposal (ROSA ARUSHA, 2007).

According to statistics of the municipality and the Arusha Water and Sewerage Authority (AUWSA) about 92 % of the population use on site sanitation and 1 % practice open defecation. Household surveys show even higher proportions using pit latrines or similar sanitations facilities. The use of flush toilets is subject to only 5 % of the population. In many cases, toilets are shared with other households (60 %). The same proportion indicates that they do not empty their pit but rather dig new ones when full. The condition of latrines varies, but in many cases they are badly maintained with no cleaning or cover (ROSA ARUSHA, 2007).

Administrative framework

The AUWSA is responsible for operation and management of the whole water supply and sewerage system in the municipality. The Technical Services Department is divided into sections responsible for sewerage, water network, planning and construction, maintenance and repair. On site systems like pit latrines are not included in the duty of the AUWSA. However, pit emptiers can dispose the sludge from pits into the sludge pond of the authority. The health department of the municipality is responsible to coordinate sanitation activities and also operates two suction trucks for emptying pit latrines. Additionally, two private operators provide service, using in total five suction trucks (ROSA ARUSHA, 2007).

5.3.2 Solid Waste

The SWM in Arusha is poor and the collection capacity only covers about 50 % of the generated waste. Primary waste collection is carried out as a door to door service by private companies or individually. Additionally, secondary collection from collection points, which are distributed throughout the town, exists. Collection service from the households is inappropriately organized and therefore, about 60 % of the population do not have any service at all. At places where a service is available, the willingness to pay for it is generally low. Furthermore, separating of waste is not popular among the people although about 75 % of the waste is biodegradable and composting would help to reduce the amount. However, a few households practice recycling and reuse of waste material. Other problems are the lack of trucks for collection and transportation, insufficient secondary collection points and available funds to address solid

waste management activities. The level of private sector participation is low in the solid waste management sector of the municipality. This grievance leads to improper disposal methods like burying, burning or illegal dumping (ROSA ARUSHA, 2007).

Treatment of solid waste does not take place in most cases. Even hazardous and medical waste is not handled separately but disposed together with all other types. A few hospitals separate medical waste, which is burned or buried on-site. Normal waste is brought to the dump site. Industries are supposed to organize waste disposal themselves, but insufficient legal regulations lead to illegal dumping, burning or burying and hazardous waste enters the environment untreated. The official dumpsite is located about 8 km from the town centre and was originally designed for proper landfilling. Recycling is not done officially and the lack of waste separation makes it more difficult. However, metal, plastics tyres or paper are sometimes recycled and reused by the initiative of individuals or groups (ROSA ARUSHA, 2007).

Administrative framework

The Health Department is responsible for the SWM in the Arusha Municipality. Poor SWM was already identified as a major environmental issue with relation to human health. To address the issue, since 2003 the involvement of private companies was promoted. Altogether, four private organisations, two companies, one CBO and one NGO, have been contracted by the council (ROSA ARUSHA, 2007).

5.4 Kitgum – Uganda

Kitgum Town Council (KTC) is the capital of the Kitgum district and is located about 450km north of Kampala, the capital city of Uganda. About 42 500 inhabitants live in Kitgum where urban, peri-urban and rural settlements can be found. After decades of instability, resulting from civil war, poor sanitation and lack of safe water are the main problems in town. The main water source are boreholes, serving 89 % of the population. Only 9 % are connected to a central water system and about 2 % receive water from shallow wells. Water is believed to be safe and people do not boil it before use. However, chlorination tablets are in use. Problems related to water supply are (i) shortages, especially for those who are connected to the central system and (ii) the appearance of water borne diseases like typhus. Sanitary facilities include traditional pit latrines, ventilated improved pit latrines (VIPs), as well as flush and dry toilets. 93 % of the population have access to a sanitation facility, mainly pit latrines, while 7 % practice open defecation. Two public sanitation facilities are owned by KTC. Full pit latrines are often abandoned, implying a potential risk of groundwater contamination. If sludge is removed from sanitary facilities, it is done by one of four private emptiers. The faecal sludge is disposed untreated outside town on a piece of land. Drainage systems for storm water and wastewater are often clogged and insects find a breeding place in the stagnant waster. The management of solid waste is the responsibility of the KTC, but collection is done improperly and so waste is accumulating at the road side, in drainage channels and on compounds. If waste is collected, it is brought to the official dump site of the council. However, communities often dispose their waste at illegal dump sites. Some people compost the biodegradable material, while many others just burn the mixture of solid waste to reduce the volume (ROSA KITGUM, 2007).

Administrative framework

Several policies, legal regulations and institutions deal with water sanitation and solid waste management. Hereby, the main problem seems to be the implementation and enforcement of regulations. The National Environment Management Policy from 1994 has the promotion of sustainable economic and social development as an overall goal. Following this policy, water pollution has to be controlled and waste has to be soundly managed. Another national policy controls the loss of wetland as a valuable resource in the water cycle. The National Health Policy focuses on the improvement of sanitation. The Constitution of the Republic of Uganda is the supreme law for environmental protection, conservation, and sustainable management of land, air, and water. The Public Health Act delegates duties on urban and local authorities to set

standards for housing sanitation or preventing water pollution. The National Environment Act establishes the National Environment Management Authority (NEMA) as the overall authority managing environmental issues. NEMA can set guidelines or standards to manage and conserve natural resources. Main objectives are to provide relevant data on resource use, integrate environmental issues to all educational levels, and to promote international co-operation between Uganda and other nations. Concerning solid waste, the National Environment Statute includes the "polluter pays" principle. There are several further regulations and acts on solid waste, water or environmental impact assessment. Relevant institutions are the Ministry of Water and Environment, the NEMA, the Directorate of Water Development, the Ministry of Agriculture, Animal Industry and Fisheries, the Ministry of Health, the Environmental Health Division, the Ministry of Education and Sport, the Town and Planning Board, and, of course, institutions on district level, the private sector and NGOs (ROSA KITGUM, 2007).

5.4.1 Sanitation

Different types of sanitary facilities can be found in Kitgum. Traditional pit latrines are the most common. Most households have access and either own a toilet or use the facilities of their neighbours. A small proportion of people practice open defecation. The depth of pit latrines varies, with a majority between three to six metres. In many cases toilets are shared with neighbours and a number of people between 20 and more that 30 using it. Some people believe faeces of children are harmless and let them therefore practice open defecation. Full pit latrines are in 80 % abandoned or demolished, as they can not be used anymore. From the two public toilets, one is near the bus park and one at the main market. There are separate areas for men and women and users are charged a fee. The management of the toilets is outsourced to private operators or caretakers by the council. Faecal sludge from the public facilities is brought to a piece of land, which is owned by one of the private emptiers, and is dumped in open pits. Private toilets are usually operated and maintained by the households themselves, occasionally by the landlord. The emptying, if practiced, is in most cases done by private emptiers. The main problems with the existing facilities in Kitgum are (i) poor construction and management of the facilities resulting in heath risks and risk of groundwater contamination, (ii) open defecation and again related health risks, (iii) insufficient availability of emptiers and public facilities, and (iv) inadequate operation and maintenance (ROSA KITGUM, 2007).

5.4.2 Solid Waste

Sources of solid waste are households, commerce, industries, and refuse from street sweeping. Waste can be classified as municipal, industrial or hazardous. Municipal waste mostly consists of plastics, kitchen waste, and paper. Other fractions in KTC are glass, batteries, old clothes or metals. 96 % of the people do not separate their waste and commonly it is burned. House to house collection does not occur in KTC. The main reason is the unwillingness to pay for such a service. This situation results in highly congested areas within the council and the development of several illegal dumpsites along streets or elsewhere. Only 10 % of the household waste ends up on an official dumping site. This is a result of a lack in manpower and transportation facilities to collect and carry the waste. The growing population contributes to and increases this problem. The official landfill, located about 2.6 km out of town, is operated as an open dump. That results in a potentially high risk of groundwater contamination through leachate. Kitgum Town Council usually contracts private collectors for waste disposal. The problematic situation concerning SWM has various reasons. A major problem seems to be the unawareness of the local population to the situation and the necessary sanitary steps for improvement. Another issue is the almost complete absence of private sector involvement. Only a few enterprises are engaged in recycling and that on a very small scale. Therefore, SWM in Kitgum is challenged in the following issues: collection, proper disposal, funding of equipment and manpower, further providing relevant information and education for the people to raise environmental awareness (ROSA KITGUM, 2007).

6. Networks and Associations

There are several reasons to form alliances of any kind. This chapter shows the different advantages in various fields and with a special focus on capacity building. An overview is presented on international networks and a in the field of wastewater and solid waste management. More detailed information is provided on the situation in Austria. There, on all levels of wastewater and solid waste management alliances are developed in joint forces, making systems more effective, and to develop platforms for information exchange and capacity building. Associations on different political levels dominate the structure of the Austrian solid waste sector. Often larger umbrella organisations exist in federal states and smaller district associations pool municipalities. The organisation in the wastewater sector is more decentralized. However, there are examples for organisations on federal state-level. Examples for nationwide organisations, the ARA-corporation and the Austrian Water and Waste Organisation are described in chapter 6.3.1. Also in Eastern Africa different networks, especially in the field of water and sanitation are active and collaborate in exchanging knowledge. Some of the relevant organisations are shortly described.

The development of networks can be divided into three main phases (Figure 7). In the first, the structure of the network is centralized and one-sided information flow dominates. In the second, bilateral and more equitable relations emerge from one-sided relations. A centralized network structure is still dominant. In the third phase, structures become more and more decentralized because participating players build up relationships between each other and not only via the central node (SYDOW, 1992).

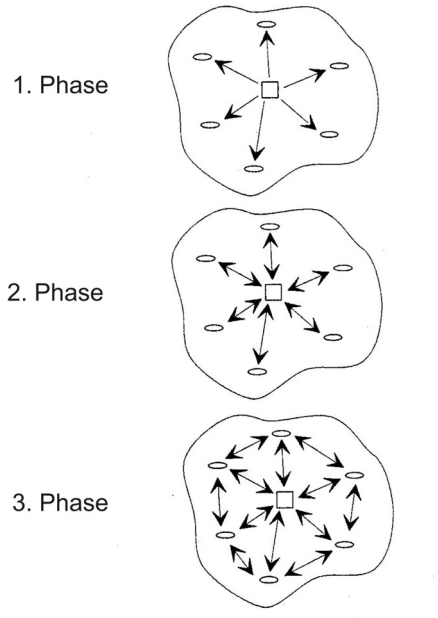

Figure 7 Three main phases of network development (SYDOW, 1994)

6.1 Motivation for Cooperation

The cooperation between companies and/or organisations yields several benefits. From an economical point of view, cooperation between businesses can reduce costs and lead to better market access. Further benefits are the pooling of resources and knowledge about technology, management or legal aspects. Risk can be reduced by cooperation, as not only one but several players are involved and free resources of partners can be used if required. These benefits can be described as synergy-effects (KLAMT and JANKE, 2001).

6.1.1 Information

Mutual information is probably the most important benefit of cooperating and at the same time very challenging. The difficulty here is to achieve a dialog and not only inform unidirectional. Information can improve the performance and efficiency and results from the knowledge about possibilities, gained from the exchange in experiences, e.g. available technologies, suppliers and consultants (STRÖMER, 2006). Particularly, information about the legal situation appears to be very important, especially in the field of waste and wastewater treatment, where various regulations apply. On a lower level, information for and from consumers play also an important role and should not be neglected.

6.1.2 Management

For the management of solid waste and wastewater, cooperation in form of networks or associations means having the possibility to introduce strategies and optimise operating processes. Benchmarking or strength- and weaknesses-analysis can help to detect potentials for improvement. Cooperating partners orientate themselves on the current state of the art and examples for good or better practice (STRÖMER, 2006). Within a network, management means to have more resources available, but at the same time to share them with others. Therefore, communication is essential to efficiently use the advantages of cooperation.

6.1.3 Capacity Building

Within a cooperation, capacity building can enhance the ability of workers or the knowledge of people about their area of expertise. In the context of networks, mutual exchange between stakeholders can optimise training and education for people by providing a wider range of learning opportunities.

Especially, in relation with development, capacity building plays an important role. Capacity building can not be viewed in isolation from a wider social, economic and political environment as it is concerned with social and political relationships. Stakeholders are governments, markets and the private sector as well as CBOs, NGOs, communities, households and even individuals. Embracing players from different levels, fields and backgrounds can provide for an appropriate surrounding for building capacity. Further important is the fact that each project has to be assessed individually and universally, since valid concepts do not exist. Table 4 shows central objectives of different capacity building programmes. Development in a sustainable way is rather solving problems by working on them than by spending money to solve them (EADE 1997).

EADE (1997) defines what capacity building as an approach to a people-centred development should not be, as follows: Capacity building

- should not create dependencies e.g. by creating systems which depend on ongoing external financial or technical support for operation and maintenance.
- can not result in the enforcement of new systems which do not really fit into the local context.
- does not mean weakening the state. Governance should be included in the process rather than left apart in favour of e.g. NGOs.
- can not be seen as a separate activity.
- is not only concerned with financial sustainability. Not all activities can be entirely self-funding, although reducing dependencies is critical to gain sustainability.

Table 4 Central objectives of different capacity building programmes (EADE, 1997)

	Capacity building as means	**Capacity building as process**	**Capacity building as ends**
Capacity building in a NGO	Strengthen organisation to perform specified activities e.g. building capacity among primary stakeholders	Process of reflection, leadership, inspiration, adaptation, and search for greater coherence between NGO mission, structure, and activities	Strengthen NGO to survive and fulfil its mission, as defined by the organisation
Capacity building in civil society	Strengthen capacity of primary stakeholders to implement defined activities	Fostering communication: process of debate, relationship building, conflict resolution, and improved ability to deal with its differences	Strengthen capacity of primary stakeholders to participate in political and socio-economic arena according to self-defined objectives

Capacity building should be designed inclusive. For example in ecological sanitation, a field of highly interdisciplinary character, disciplines like resource management, sustainable agriculture, food security or unemployment reduction have to be integrated. Additionally, EcoSan is a relatively new approach and therefore its promotion, compared to conventional systems, plays an important role besides education in capacity building (IHP and GTZ, 2006).

6.1.4 Lobbying

As the representation of interests plays an important role in a complex sector with various stakeholders, cooperation can help to strengthen the opinion of smaller players. If a sector's organisation is hierarchical and a new strategy is meant to be implemented top down, for example, it makes sense for aggrieved parties to speak up for their interests as a group. Especially, in a bureaucratic surrounding, lobbying plays an important role. As legal regulations are constantly changing in Austria, affected persons or operators have to adapt as well. In the decision making process of legislature, representation of interests is therefore very important to allow indirect public participation. As examples, the Austrian Waste and Water Association is consulting governments in environmental legislation and the Altstoff Recycling Austria represents interests of stakeholders of the packaging industry.

6.1.5 Tools

Workshops

Workshops can be very useful, as they enable people to work together on a common concern in a structured but informal setting. Often people from different backgrounds and levels of experience work together, which can boost creativity. At the same time, language barriers can impede communication. Workshops can be an exciting and creative way for adults to learn from each other and to develop new ideas (EADE, 1997).

Conferences

International conferences can offer major opportunities for networking, coalition building and lobbying. Especially, NGOs can participate, prepare and represent their concerns and interests. However, interest groups, with few funds and influenced are underrepresented and can hardly deliver their message (EADE, 1997).

Web-Based Networks

Electronic networks play a huge role nowadays. Information flow is nearly unlimited even between continents and makes networking very easy. Internet platforms can provide information to an unlimited number of interested persons. Therefore, nearly no one is excluded aslong as he or she has internet access. It should be stated however, that electronic networks can not replace the importance of direct communication. The main benefit is probably the instant access to information.

6.2 International and European Networks and Associations

As the waste sector and especially the recycling business is operating across boarders, some international and European networks will be mentioned in the following. Also in the water and sanitation sector umbrella organisations have formed, especially when it comes to development cooperation. Many international organisations work in the field of sanitation as well as solid waste management.

SuSanA – www.susana.org

SuSanA stands for “Sustainable Sanitation Alliance”. The overall goal is to contribute to the achievement of the MDGs by promoting sanitation, considering all aspects of sustainability. SuSanA mainly serves as an information platform. Regarding sustainable sanitation, it aims to raise awareness around the globe, to highlight the importance of several MDGs, and considering the involvement of various stakeholders to present proper planning information (SUSANA, 2010).

IWA – www.iwahq.org

The most important institution on the water sector is the International Water Association (IWA). Individuals and corporations with different backgrounds can join and collaborate with each other. IWA offers a wide range of publications considering science, research, technology and practice and organizes conferences on various topics. Also partnerships with institutions working in developing countries exist and activities focus particularly on peri-urban surroundings, larger cities and smaller towns. Initiatives include amongst others the development of local action plans and the strengthening of regional networks (IWA, 2010).

EWA – www.ewaonline.de

The European Water Association (EWA) is a non-governmental organisation that focuses on water management and the improvement of the aquatic environment, covering the whole water sector. EWA consists of most European Union Member States as well as Croatia, Romania, Ukraine, Serbia and Montenegro, Norway, and Switzerland. Close contacts are maintained with the European Commission, the European Committee for Standardisation (CEN), the European Environment Agency (EEA), and the European Parliament. Through the exchange of knowledge, EWA intents to contribute to a sustainable water management, safe water supply, and the protection of water and soil (EWA, 2010).

IRC – www.irc.nl

The International Resource Centre on water supply, sanitation and hygiene is also known as International Water and Sanitation Centre. The organisation provides facilities for the sharing, promotion, and use of knowledge supporting poor people in developing countries to obtain water and sanitation services they will use and maintain (IRC, 2010)

ISWA – www.iswa.org

The aims of the International Solid Waste Association are efficiency in terms of environmental practice and economic viability. Furthermore, education and training is meant to advance waste management. Within the ISWA development programme, education and training programmes focusing on sustainable waste management as well as the transfer of knowledge to developing countries and economies in transition, are funded. Regional development networks aim to

promote sustainable waste management by carrying out activities and developing programmes, focussing on specific needs and challenges in certain regions. However, so far no such network has been established in Africa (ISWA, 2010).

ERP – www.erp-recycling.org

Following the development of the European Directive for Waste Electronic and Electrical Equipment (WEEE) the European Recycling Platform (ERP) was founded in 2002. It is a European collection- and recycling system for WEEE and waste batteries. Its aims are to incorporate interests of producers and the claimed idea of producer responsibility. Furthermore, the platform tries to clear the way for pan-European recycling possibilities and transboundary competition in this sector (ERP, 2010).

ACR+ – www.acrplus.org

"The Association of Cities and Regions for Recycling and Sustainable Resource management (ACR+) is an international network of around 90 members who share the aim of promoting sustainable resource consumption and waste management through prevention at source, reuse and recycling." (ACR, 2010).

6.3 Austrian Networks and Associations

6.3.1 Nationwide active Networks and Associations in Austria

There are some networks and associations, which operate all over Austria. Some of them are organized as non-profit organisations, some are profit-oriented

The Austrian Water and Waste Association (ÖWAV)

The Austrian Water and Waste Association (ÖWAV – Österreichischer Wasser- und Abfallwirtschaftsverband), independent and neutrally working, is the umbrella association for all actors in the field of water and waste. Thus it is one of the most important organisations in Austria. It represents all players in water wastewater and solid waste management. The main aims are to act as a platform for the exchange of interests, building of capacities by educating, informing members and the public, and by consulting governments in environmental legislature (ÖWAV, 2009).

Members of the associations include municipalities, federal states and the nation, other associations of smaller scale, private businesses of different fields, universities and other research institutions. There are several groups of specialists working on important issues like:

- Wastewater technique and surface water protection
- Waste management and remediation of contaminated sites
- Environmental protection in businesses
- Quality and hygiene
- Law and economics

As a member of the association it is possible to get early information about technical, legal or economic development. Furthermore, gained experiences can be shared and contacts to important decision makers used.

A very important part of the ÖWAV portfolio is the education and training program. Regularly, seminars and conferences on relevant topics are organised as well as workshops. Furthermore, trainings are offered for operating personnel of

- waste treatment plants,
- wastewater treatment plants,
- sewage systems,

- barrages, and
- artificial snow production facilities.

Additional courses exist for executive personnel. The education and training program also provides a basis for the exchange of experience of waste and wastewater treatment plant operators. To promote co-operation between operators of smaller municipal sewer systems and sewage plants a network of so-called “neighbourhoods” (Chapter 6.3.3) was installed and often accepted (ÖWAV, 2009).

Another activity to optimise the operation of sewer systems and wastewater treatment plants is the benchmarking system of the ÖWAV. Processes within the own system are here investigated and compared with other companies to detect potential for improvement. This tool is especially appropriate to optimise cost effectiveness of operating processes. The so called “benchmark” is the optimum value in this comparison (ABWASSERBENCHMARKING, 2010).

ARA – Waste Recycling Austria

Waste recycling Austria (ARA – Altstoff Recycling Austria) is a nationwide active stock corporation in the field of recycling. Established by the Austrian economy in 1993 it provides services for all affected by the then new packaging directive. All packaging material from households, businesses or industry is collected, separated and treated conform to the Austrian law. ARA concludes license contracts with its customers and carries the responsibility for the proper treatment and disposal of their waste. Holders of the stock corporation at one-third each are:

- Representatives of commerce
- Importers, bottlers and packagers
- Packaging producers and recycling associations for paper, plastics, iron, aluminium, and wood (ARA, 2009).

With its collection- and utilisation facilities spread all over the country, it allocates together with the AGR (Austrian glass recycling) a dense and convenient network of collection vessels. To achieve that goal, co-operations with more than 200 regional waste disposal companies, municipalities, and waste management associations exist. ARA works economically as a non-profit corporation and stands for performance orientation, cost-efficiency, and ecological tenability. The company aspires for acceptance from consumers, businesses, administration, and politics and therefore informs the public and negotiates with decision makers and stakeholders (ARA, 2009).

ERA – Electro Recycling Austria

The ERA – Electro Recycling Austria is a subsidiary of ARA and works non-profit orientated. It takes over the responsibilities for waste electrical and electronic equipment (WEEE) following the legal requirements (ERA, 2010).

PET to PET Recycling Austria

In the last years, due to some changes within the legislation concerning reusable bottles on the Austrian beverage market, the number of reused bottles has dramatically decreased. An alternative is seen in the separate collection and the material recycling of PET bottles (polyethylene terephthalate). In the sustainability agenda for beverage packaging, the beverage industry sets its aim for material recycling of bottles sold at 80 %. Therefore, five major corporations work together and are shareholders of “PET to PET” recycling Austria (PET to PET, 2010). The ideal cycle for PET bottles would be:

- Retail sale
- Consumption and separate disposal
- Collection via the ARA-system

- Sorting and compaction
- Material processing
- New bottles

While the ÖWAV acts as a platform of information exchange, lobbying, and education, recycling businesses in Austria are more profit oriented organised. In addition to that, several private companies are involved in the field of solid waste collection, treatment, and disposal. Often European and international companies operate smaller subsidiaries in Austria.

6.3.2 Networks and Associations in the Austrian Solid Waste Sector

Legally, non-hazardous waste is defined as a responsibility of the federal states, and therefore associations mainly exist within these boundaries. Smaller associations exist on district- or municipal level.

Upper Austria

The Upper Austrian Waste Association is a good example for a well-structured organisation, which incorporates all important players on all political levels. It is a non-profit organisation with public institutions as members and works together with local disposal companies. Sustainable waste management is its core principle, which requires considering ecology as well as economy. Information of the public and consulting companies also plays an important role. The main duty lies in representing interests of the 15 district waste associations, the three cities of Linz, Wels, and Steyr as well as the coordination of information between these members (OÖ LANDESABFALLVERBAND, 2010).

On a lower level, district associations play an important role in advising municipalities in their waste management practices and for reaching public awareness. At the same time district associations receive valuable information from the subordinate municipalities. In Upper Austria the districts are all self organized and so services are different. In most cases, consulting for companies and private persons as well as courses for schools and kindergartens are offered. Detailed information is provided for separate waste collection and composting including a list of the different fractions that are collected (OÖ LANDESABFALLVERBAND, 2010). It is conspicuous, that structures in the waste management stick to the organisation of political hierarchy. That makes sense, as already existing connections allow better communication.

Burgenland

The Waste Association of Burgenland (Burgenländischer Müllverband – BMV), is an example for a very centralized organisation. It is responsible for the waste management in the whole state and organises all waste management practices. Owners are the 171 municipalities with almost 280 000 inhabitants. Umweltdienst Burgenland (UDB), an environmental service subsidiary, is operating market oriented in the private sector. UDB is responsible for collection, treatment, utilisation, and disposal of all municipal and commercial solid waste. The BMV lays down uniform fees and announces them to the public. Furthermore, educational background is given for schools and events are organized to help interested people to attend and gain insight into waste management practices. Collection centres, set up all over Burgenland, now make professional collection and contact to the public possible. Personnel working at collection centres are continuously trained and educated (BMV, 2008).

Most of the Austrian federal states have comparable institutions to support local waste management, to raise awareness in the public and to educate people. The associations are generally very close to public institutions as waste management is seen as service of general interest (SGI). The extent of cooperation is already relatively high in this sector and generally

sticks to the structure of political levels in Austria (federal level, federal state level, district level and municipal level). Often close relations exist to local disposal companies.

RUSZ- Centre for Repair and Service

The Centre for Repair and Service (RUSZ - Reperatur und Service Zentrum) in Vienna is of special interest, as it is organised as an association promoting social economy. Here long-term unemployed or disabled people become re-integrated into a working environment and at the same time they create value by repairing electrical equipment and providing second hand products or spare parts from disassembling WEEE. Disassembling further enables the separation of various waste fractions, which can be recycled or safely treated and disposed. Therefore, RUSZ is also ecologically beneficiary as it extends the life of products and significantly reduces waste, especially hazardous waste. Together with the Austrian standardisation institute and others, RUSZ created an eco-design label for durable and repairable electrical devices. However, with financing problems occur. At the moment, the market situation makes profitable business on the basis of labour intensive repairing and recycling impossible (RUSZ, 2010).

6.3.3 Networks and Associations in the Austrian Wastewater Sector

The wastewater sector, compared to the solid waste sector, is relatively decentralized because of the circumstances and not only the will to cooperate. In the following examples will show the possible benefits of cooperation.

Association of Styrian Wastewater Disposal Companies

The Association of Styrian Wastewater Disposal Companies (Gemeinschaft Steirischer Abwasserentsorger – GSA) has cities, municipalities, smaller wastewater associations and other cooperatives in this field as members. The main objective is to support them with technical, economical, organisational, and informal information and to represent their interests in the public. Synergy effects are expected through cooperation with each other and the Austrian Water and Waste Association. Other important issues are quality control, further education in form of excursions, courses and informative meetings, and public relations (GSA, 2010). The well designed web page of the association invites to browse through the different areas with information about events, projects or education and in forums discussions take place to recent topics. There are no comparable platforms on a federal state level. Most other networks and associations consist only of a few operators of sewers or WWTPs or provide a basis for pollution abatement in a certain catchment area.

Wastewater Treatment Plant Neighbourhoods

The Austrian Water and Waste Association organises so called neighbourhoods for operators of industrial, communal or private sewers or WWTPs. The aim of a neighbourhood is to keep skills and knowledge of the operational staff up to date, concerning technical progress and legal requirements. The consultation between neighbours and the mutual exchange of knowledge and experiences assures professional and economical handling. One neighbourhood consists of about 10-20 facilities of different sizes. Presently, more than 900 treatment plants are part of 57 neighbourhoods covering about 90 % of WWTPs in Austria. For sewer operators a similar coverage is aspired (KAN, 2010). Main topics of the neighbourhoods are:

- Optimising system operation
- Reducing operating costs
- Treatment and disposal of sewage sludge
- Maintenance and repair
- Inspection of facilities

- Monitoring
- Legal regulations
- Safety and health

Austrian Water

Austrian Water is a network of businesses active in the water sector. The members of the network mutually support each other in their specific field of knowledge. Austrian Water aims to better the quality of water systems in other countries with the help of integrative technologies. Furthermore, trainings exist for the management and operating staff of the members of the network. The network is organised as a NGO, which helps in cases of emergency. Fields of competence are planning, research, financing and operation in the water and wastewater sector. Austrian Water considers the water management of a country as holistic (AUSTRIAN WATER, 2010).

6.4 (East) African Networks and Associations

There are a number of international associations, often with different backgrounds and approaches as well as regional NGOs active in arranging aid programmes on water, sanitation or solid waste. Associations and networks in the field of solid waste management are rare. The CWG (Collaborative Working Group on Solid Waste Management in Low- and Middle-income Countries) is worldwide active and has also projects running in Africa. To enhance the quality of SWM practices, an African SWM training programme was developed, to build capacities locally. A focus was laid on considering special conditions and requirements of the region (CWG, 2010). In general it can be said that solid waste management is of minor priority on political agendas. Ideally, solid waste management networks could emerge from organisations dealing with sustainable sanitation. If it comes to collection and transportation, similar facilities could be used for solid waste from EcoSan facilities and e.g. biodegradable waste from households. Also the collection of recyclates like plastic or paper would be possible.

Below, some relevant African and East African networks and associations are shortly described.

EAWA – East African Water Association

In 2003, the East African Water Association was launched in cooperation with the Austrian Development Agency. The main objective was to provide a platform for information exchange and building up collaborations in the field of water and education. Workshops are held to bridge research, technology and development towards a sustainable water resource management, which helps improving the situation. Very important seems to be the fact, that research is demand driven. Information and experience, shared between scientists and persons concerned, help to develop appropriate solutions (IAM, 2007).

IWA Africa

IWA set up five regional offices to accelerate the global uptake of the outreach programmes. They serve as regional platforms for coordinating exchange activities and connecting more effectively with members, stakeholders, and the water communities in order to develop sustainable water management in the regions. The African regional office in Uganda was established in 2009 and focuses on the improvement of services in the water sector. The office tries to build up relationships with governing members, to recruit IWA members in the region, to implement global IWA programmes regionally level or events in the regions (IWA AFRICA, 2010).

ASKNet – African Sanitation Knowledge Network

ASKNet is an association of individuals, groups and organisations with the aim to enhance the ability of academics and professionals across the disciplines to contribute to the mainstreaming and up-scaling of sustainable sanitation, to the benefit of livelihoods, health, and environment.

Members of ASKNet seek for collaboration with each other and like-minded organisations to advance the performance and sustainability of sanitation services, the development of sanitation policies, professional education and research in these areas. ASKNet was founded by UNESCO-IHE, EcoSanRes, ISSUE-2, and ROSA (ASKNET, 2010).

EcoSanRes Knowledge Nodes

The Ecological Sanitation Research Programme is funded by the Swedish International Development Cooperation Agency (SIDA) and aims to develop and promote sustainable sanitation in the developing world through capacity development and knowledge management as a contribution to equity, health, poverty alleviation, and improved environmental quality. A so called knowledge and expertise node is an organisation or network of organisations that is taking a leading role in the promotion and development of sustainable sanitation in a specified region or country (SEI, 2010)

SEAWASTE

The Southern and East African Waste Management Network mainly focuses on water pollution issues. The network is meant to serve as platform for information exchange and cooperation of pollution that has an impact on aquatic environments. It represents an informal forum for dialogue and capacity-building in waste management research, policy development and implementation and wider public education. Members of 13 different African countries are participating, among them Kenya and Tanzania (SEAWASTE, 2010).

7. Possible Application in Resources-Oriented Sanitation in East Africa

The final part of this work, attempts to derive a strategy for the management of a resources-oriented sanitation system for East Africa by integrating the knowledge from organisation in the Austrian solid waste and wastewater sector. This shall be done using an abstract example of a sanitation system that fits in the East African context. Figure 8 shows a schematic sketch of a sanitation system with urine diversion as defined in the SuSanA "*Compendium of Sanitation Systems and Technologies*" (TILLEY et al., 2008). Figure 9 and Figure 10 show the simplified sanitation systems with urine diversion using a double-vault and single-vault UDDT, respectively, that have been used in this work.

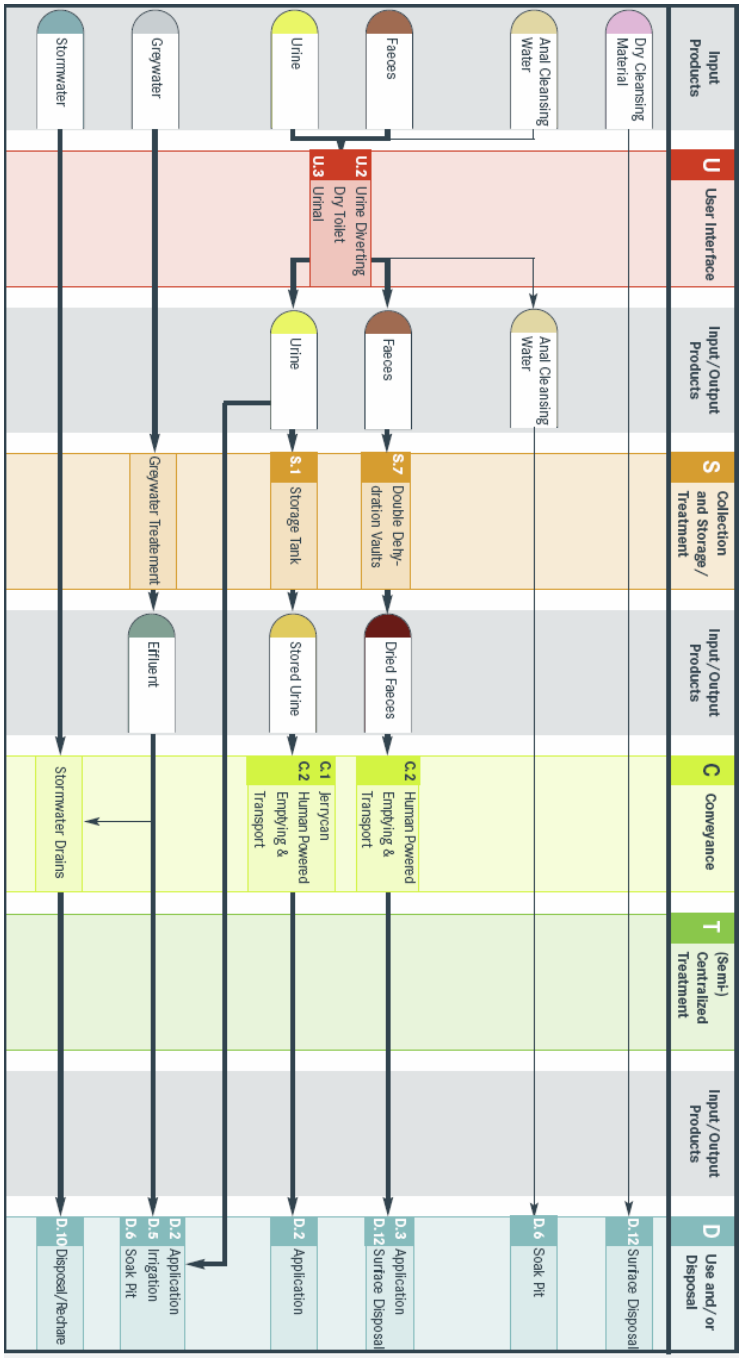

Figure 8 Sanitation system with urine diversion (TILLEY et al., 2008)

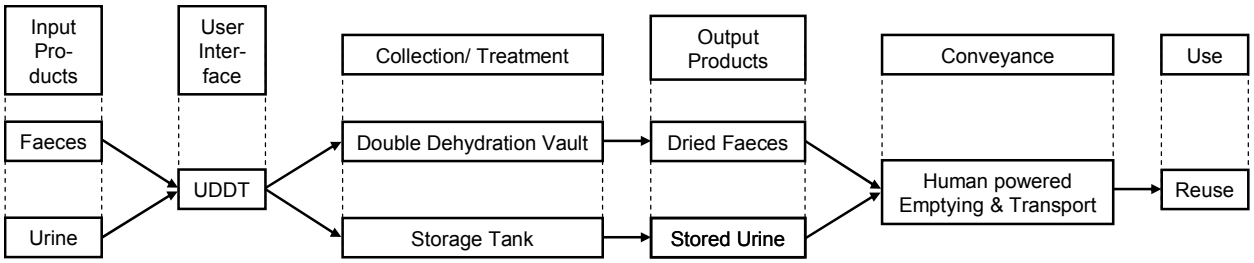

Figure 9 Simplified sanitation system with urine diversion toilet (double-vault)

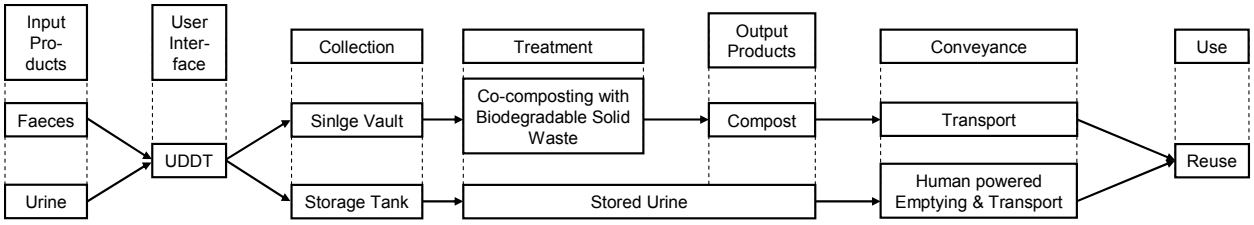

Figure 10 Simplified sanitation system with urine diversion toilet (single-vault)

7.1 What can be learned from the Austrian System?

In Austria a strong interconnection between private companies and authorities exist. Also for resources-oriented sanitation systems that would be advantageous because authorities can control developments in the sector and at the same time private businesses can create efficient options for organizing sustainable sanitation systems.

Ideally, an umbrella association on national level provides a platform for the exchange of knowledge and experiences but also for the representation of interests of different stakeholders. An association like that encourages the mutual exchange between the private sector, regional authorities, research institutions and NGOs. Besides enabling information exchange, also effective capacity building following the model of the ÖWAV would be desirable. Here, an advantage is the possibility to share resources in terms of highly educated staff. As in resources-oriented sanitation also SWM can be easily incorporated. The umbrella organisation should care about both of these issues.

On a regional level, smaller associations should be developed and connect private companies, local CBOs, authorities, and the superordinate umbrella organisation. This connection is very important to make the transfer of information from top to bottom and vice versa functioning. The regional associations provide a platform for this. To strengthen the connection between involved private companies working for resources-oriented sanitation systems, partnerships on the model of “neighbourhoods” for treatment plant operators in Austria seem promising.

The following paragraphs describe possible strategies for different areas of resources-oriented sanitation, taking into account lessons learned from the Austrian system.

Construction

Noticeable about the Austrian systems is the strong financial support for the construction of infrastructure by the government. Especially, wastewater management relies on this support. In sustainable sanitation this is not necessary, as facilities are simple in design. However, to promote the implementation of such systems, co-financing of private companies and authorities can be a good opportunity to involve the private sector on the one hand and to control development on the other hand. Bigger enterprises might invest on their own behalf, without support of the authorities. The effectiveness of newly constructed facilities can be increased by licensing and certification by the government. If only licensed construction companies are allowed to build facilities in a city, quality standards can be controlled by certificates. Furthermore, the involvement of the government is important to avoid the neglect of poor and underdeveloped regions of a city. Part of the regional planning is also the consideration of

accessibility of the facilities to ease operation and maintenance. In some cases the initiative to construct a new facility can come from the population or a CBO. In this case, the government should support the intentions at least by providing necessary information. Such demand driven projects are very promising to be successful. At some places, like markets or bus stations, public toilets are necessary. Ideally, such facilities constructed by municipalities act as role models for private investors.

Operation and Maintenance

There are various ways of operating a sustainable sanitation facility. On a household level, the users will look after the toilet, clean it and if required change jerrycans for urine collection. Of course also the emptying can be done on household level, especially if recycling products are used on the compound.

If facilities are used by more households, operation should be organised by the responsible landlord or representatives of the community. In some cases CBOs initiate the construction of sanitation facilities and also organize operation and maintenance by themselves. Beside a toilet, such facilities can also provide for laundering, bathing or drinking water supply. Communities or landlords can contract private operators to do the cleaning, e.g. daily, and the necessary maintaining, e.g. adding lime or soil. Usually they also empty or change storage tanks of the toilet and make the recycling products ready for transportation. Similar operation and maintenance can be applied for public toilets. With the promotion of sustainable sanitation new businesses could emerge to serve for operation and maintenance. It is important for the operating companies to stay flexible in their service to be able to meet various needs and standards. A diverse offer of services can help to compensate less profitable but necessary activities.

To allow the exchange of experience and knowledge, a platform for operating businesses can be useful. Also engineers, producers and authorities can contribute here by bringing in new ideas. On a smaller scale, CBOs or private operators can exchange information after the model of WWTP-neighbourhoods in Austria.

Collection and Transportation

Transportation is a common problem in everyday life, not only in resources-oriented sanitation. Therefore, it is important to utilize already existing institutions and facilities. Trucks or carriages are usually not designed to transport only one specific load and can be used in different ways, e.g. biodegradable waste from food preparation could be brought back to farmers by market salesmen. To make collection and transportation effective, the creation of a logistic network is necessary. Especially, for smaller units in densely populated areas, human powered emptying and transportation might be inevitable. Strategic intermediate points, where recycling products are gathered for further transportation, can help to increase efficiency. A similar strategy is also applied in Austrian solid waste management. Farmers in possession of transportation equipment can buy recycling products directly from these points. For others a bring service can be organised.

Transportation is also necessary to re-distribute recycling products after treatment. Farmers might be able to purchase products directly from the composting plant; other customers depend on a distribution service, which could be carried out by the same companies responsible for collection.

Non-biodegradable solid waste material such as plastics, metals or glass, often can not be recycled nearby. Production facilities are often situated in major cities only. The intermediate collection in central points is advantageous again, as either producers can directly collect recycling material or trucking companies can provide for the transportation.

With the implementation of sustainable sanitation systems, enterprises in the field of transportation will develop and generate income for the local population. Especially, human powered collection and transportation has the potential to reach the poorest of the poor and improve their situation.

Treatment

If a single vault system is in use, treatment of the faecal sludge is necessary after emptying. Here co-composting with biodegradable solid waste is a good option. Composting plants can be either run by private collecting and emptying companies or by farmers producing compost for their own use. In both cases external quality control and a support from local authorities is important to establish a good perception towards the products. If collectors and emptiers produce compost, they can profitable sell it to farmers, municipalities or gardeners. Another option is to cooperate with farmers in such a way, that they overtake the raw material and produce compost for their own use. It depends on the possibilities and abilities of the emptiers and collectors, whether they want to produce compost by themselves and try make profit in this field or whether they place their main focus on emptying and/or collecting and gain their profit via the charged service fees.

Urine can be directly used as a liquid fertilizer after storage as it is usually sterile and hygienically uncritical. Health risks are however, possible faecal cross-contamination with pathogens and possible contamination by medical residuals and hormones (ERTL, 2004). For the reuse of urine, cooperation with farmers can be very meaningful. Especially, regarding storage, farmers can play an important role, as they usually have enough space. The distribution again depends on the available facilities for transportation. Risks emerge from the possible contamination of urine by hormones, pharmaceuticals or

Cooperation between all participating stakeholders is very important here. To make compost-business profitable, supply has to go hand in hand with education programmes and the promotion of locally produced fertilizer. In this regard, local authorities play an important role. Furthermore, also financial aid to set up composting plants might be necessary in some cases. Very important is however, that operation and maintenance are not dependent on financial support. As for operation and maintenance, smaller platforms can help to exchange information and knowledge about composting techniques or other treatment options as well as marketing of compost.

Reuse

Dried faeces from the Double Dehydration Vault can either be used directly as a soil amendment or can be co-composted together with biodegradable solid waste. That makes sense when the acceptance of the end product is enhanced by co-composting. If a Single Vault is used and faeces are not sanitised through dehydration, co-composting with biodegradable solid waste is required to produce safe and high qualitative compost. To assure good quality of the compost, certification by external institutions or authorities is useful. As in Austria different quality grades can help to reach a certain standard for agricultural use. Labels with estimated nutrient content and origin help marketing the products.

Urine can be used in agriculture as liquid fertilizer after storage. Assured sanitisation can be achieved by the labelling of jerrycans and containers with date and origin. Problems may occur due to contamination with pharmaceuticals and hormones and faecal cross-contamination with pathogens. Storing big amounts of urine can be a challenge as well as the before mentioned distribution to the end user.

A network to enhance the image of locally produced fertilisers and to provide a platform for both producers and consumers can provide a supportive environment to create a functioning compost market. It also lies with local authorities to promote the use of these products among the population and within the municipalities. Sustainable sanitation concepts have the potential to turn faeces and urine into valuable fertilizer while helping the local economy and generating income for the people.

Financing

Resources-oriented sanitation systems have to be sustainable also by economical means and therefore independent of financial support.

A weaker approach is to “allow” financial aid in the start up phase but to require self-running operation and maintenance.

In every case it is necessary to develop a market for treated faeces and urine. If there is demand for natural fertiliser, also production will be stimulated and all connected areas will follow. Also demand for better sanitation and a cleaner and healthier environment is a driving factor for the development of sanitation systems. Still, financing a sanitation system remains a very difficult issue. Also in Austria, where technical standards and acceptance are high, financing remains a problem. Here, public aid preserves systems from failing.

As mentioned before, resources-oriented sanitation not only aims at disposing waste and wastewater. Valuable recycling products such as liquid and solid fertilisers have the potential to be marketed and to make waste and wastewater management an affordable if not profitable business.

Assuming that improved sanitation positively influences the health of the population and healthier people can better contribute to strengthen the economy of a nation, investments into resources-oriented sanitation systems quickly pay off. The money for the construction and the start up phase should therefore be provided by the authorities responsible for health issues. However, also the environment and urban development are positively influenced. Instead of shifting responsibilities and avoiding expenses, authorities would do well to contribute and allow the wise sharing of costs. Money can also be provided by international NGOs, private investors or donors. At the latest, after overcoming the high initial costs, the introduced system has to be financially self-running. At all stages of resources-oriented sanitation systems there is potential for generating income. After first profits are made, initial costs will become less significant.

The value chain in a resources-oriented sanitation starts with the fees for

1. the use of the provided facilities. To reach the users, acceptance and affordability are very important. If landlords care for the sanitation facilities for the residents, a higher rent can be charged to finance the service. For public facilities fees can be charged per use.
2. The operation of facilities (e.g. public toilets) creates income and employment for workers but at the same time expenses for the owners of the facility.
3. Private sector companies can be functional involved in collection and transport. Fees can be charged for the emptying of the facilities. Depending on the market value of compost, the fees will vary.
4. For single vault facilities or where the acceptance of compost from faeces is low, further treatment is necessary. Through co-composting with biodegradable solid waste also the SWM sector can be involved. Composting plants can charge for the takeover of the raw material again depending on the market value of quality compost.
5. The selling of compost depends on the acceptance and the quality of the product. A functioning market for compost is essential for the introduction of a resources-oriented sanitation system.
6. Finally, the reuse of quality compost can yield in a rich harvest and an improved situation for farmers and the population. The possible money flow in resources-oriented sanitation is shown in Figure 11.

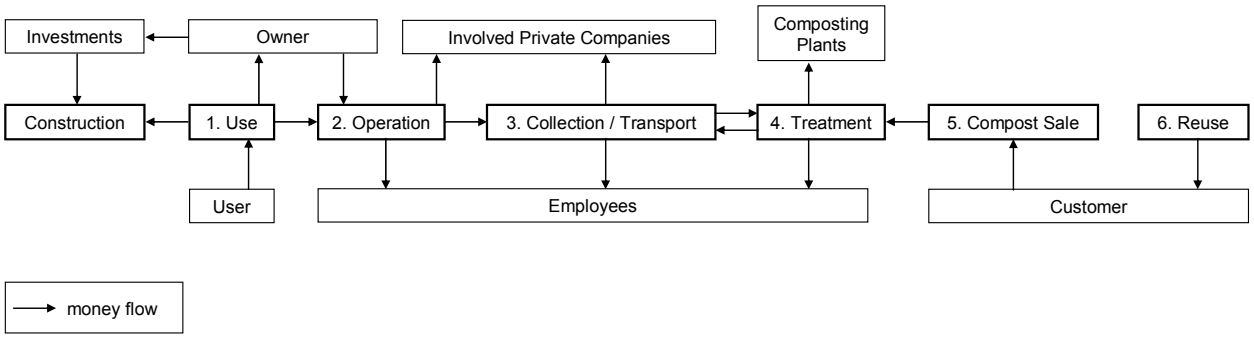

Figure 11 Possible money flow in a resources-oriented sanitation system

As a precondition for the practicability of the abovementioned ideas, a supportive environment based on education, cooperation, and institutional support is necessary.

8. Discussion

During this investigation a lot of information was gathered and put into context. In many cases examples are given to describe and illustrate the current situation in the solid waste and wastewater sector of a region. This also implies that conditions can be different with regard to some aspects. Generally however, the examples characterise the overall situation.

There is no question about the importance of proper sanitation, to provide for a healthy living environment. Also other environmental aspects such as soil and water pollution and resource consumption are essential to be considered. Nevertheless, the way how sanitation should be performed is seen differently by experts. Some advocate centralised systems based on sewer and wastewater treatment plants, others think on-site solutions are the appropriate way to solve the problems. In the end certainly no overall solution is applicable. In development cooperation role models can serve as a basis for different success criterions, but still local circumstances have to be assessed. The present work focuses on the successful implementation of resources-oriented sanitation concepts.

In Austria, the legal situation is very complex. It is legitimate to talk about overregulation in some areas. This complexity mainly results from historical grown structures and diverted responsibilities between the federal government and the federal states. The example about the use of sewage sludge in agriculture highlights the need for better coordination in this regard. Apart from the lack of uniformity however, legal regulations have a great impact on solid waste and wastewater management. Regulations of the European Union apply to Austrian law.

Solid waste management has a long history in Austria. All collection, recycling and treatment systems work very well. During the last decades, the involvement of private companies became more frequent, resulting from a demand for better efficiency in public organisations. Total privatisation of public sectors, however, often entails severe problems. Profit maximisation, as striven in strictly private companies, often leads to disadvantages for certain areas, if e.g. waste collection in remote settlements is abandoned as it is not profitable. In contrast to that, public private partnerships, i.e. the partly involvement of private companies with sovereignty of public institutions, can often stimulate for better performance.

To boost recycling on European level, quotas for different fractions are set and have also relevance for Austria. Especially, the recycling of plastics is still not fully developed and incentives are needed to make the production of secondary raw material competitive. Although separate collection is obligate, on the household level, sanctions are generally not to be expected. The deposit system for e.g. beverage bottles or cans is in contrast to other European countries having a weak performance. The use of one-way packaging in Austria is therefore strongly increasing.

Concerning wastewater treatment, Austria is dominated by conventional and highly technical systems. It can be suspected, that alternative systems, often remained unconsidered in the last decades even if such options would be probably more sustainable, also by economical means. Recent developments, however, seem to take alternative options into account especially for remote areas. To further promote this trend, decision makers are responsible to act open-minded and avoid sticking to traditional, conventional techniques. The same is true for the use of sewage sludge in agriculture, which is inhibited by legal regulations. Legal settings should be adapted in such a way that potential risks are eliminated and at the same time valuable nutrients and organic material can be reused.

It is always easy to give good advice for regions where the situation is difficult. Of course countless reasons, ranging from global politics to local socio-cultural circumstances or micro-economic problems, have to be considered to value such complex and sensitive issues. The

focus in this work is laid on sanitation and SWM in four particular cities of East Africa. The situation is comparable in all these areas and similar problems exist. Sanitation has to be improved by all means. Therefore, different approaches can be taken into consideration. The importance of SWM is often neglected in political agendas.

Referring to the legal situation, the enforcement of the existing law would change a lot in Africa. There are several Acts which claim for environmental protection, also with respect to sanitation and SWM. However, in many cases vague formulations are dominating. Action initiated by the local government and ministries would be desirable in this context. Cooperation between ministries and other organisations such as CBOs or NGOs can improve the contact with the population and its involvement. This can lead to demand driven initiatives in the field of sanitation and SWM. Bottom up approaches are often the most successful ones and here education plays a crucial role. The environmental awareness is often very low, as other problems dominate social life. An understanding of the situation and connected problems, such as human health, demand for environmental education in all areas of life.

The involvement of the private sector seems to be a chance to bring dynamics into the sanitation and solid waste sector in East Africa. Many peri-urban settlements are the result of migration from rural areas to the cities. Often people look for work and leave their home in search for a better living. Therefore, enough labour should be available. However, to start the process, incentives have to be given by the local government and other stakeholders involved.

To make recycling in both solid waste and sustainable sanitation profitable it is important to provide a market for the respective secondary raw material. For solid waste management this means that production companies have to be involved. Only if collectors and middleman can sell their goods, it will be possible to create a functioning market based recycling system. Especially, for more valuable material fractions, sometimes an informal sector already exists. The authorities can strongly benefit from the formalisation of such sectors, as structures are usually very efficient. At the same time people could benefit, as they get a chance for better working conditions.

The production of quality compost from biodegradable solid waste fits well into the concept of sustainable sanitation, as carried out in the ROSA project. After sanitisation of the faeces, they can also be co-composted with other material such as biodegradable fractions of solid waste. Concerning liquid fertiliser from urine, problems occur when it comes to storage and transportation of greater amounts. The development of functioning logistic organisation will be necessary here. Beside others, transportation represents a major challenge in this regard. Often no vehicles are available or a lack of spare parts and technical know how makes repair impossible. Apart from that, also here, the users of the recyclates, e.g. farmers, foresters or municipalities, are essential.

A direct comparison between Austria and East Africa shows two totally different situations. In both regions, however, networks and associations can play an important role. To what extent cooperation can help to improve a situation depends on the involved parties. If strong decision makers are not willing to participate, they can inhibit progress. The potentials of cooperation are, however, promising, as usually decisions are based on consensus resulting in a higher acceptance.

In Austria, associations are often formed to gain a competitive advantage or to represent interests of a certain group of people. But networks and associations also serve as platforms for the sharing of knowledge and experience. In East Africa, networks are often built to tackle certain problems. Such networks can consist of CBOs, representing the local population and calling for action, NGOs, research institutions, and governments. Also foreign NGOs may participate and often provide for financial support. In the end, however, a system is only sustainable if financial support is not necessary. That can be only achieved through demand-driven approaches. The development of knowledge sharing networks is necessary to get important information. Also in this context, local universities play an important role, as they

usually have contact to both, the authorities and the population, and can authentically represent local problems and people.

The question of what can be learned from the Austrian system resources-oriented sanitation systems in East Africa can be discussed in different ways. On the one hand, the Austrian system works well and can serve as a model, e.g. regarding the legal situation. On the other hand, it is important to avoid mistakes or developments, leading to problems which have been already experienced in Austria.

A clear advantage for Austria is the presence of a rooted legal system. Nearly all fields are covered, and new laws are put forward continuously. As mentioned before, overregulation can also be a disadvantage. Therefore, authorities in East Africa can learn, that laws have to be applicable and enforceable to be effective.

In Austria, solid waste management and wastewater treatment are two different systems which are linked only through the production and disposal of sewage sludge. In some cases the same public institution is responsible for both sectors. In most cases a strong interconnection exists between private companies and authorities. Also for resources-oriented sanitation systems that would be advantageous because authorities can control developments and private businesses can create effective options for organising sustainable sanitation systems. Ideally an umbrella organisation following the model of the ÖWAV can provide a platform for exchange on a national level and link all necessary stakeholders. Such an association can also effectively build capacity. On lower regional levels smaller associations are important to transfer information from top to bottom and vice versa. Also cooperation between small businesses can be very useful. If sustainable sanitation systems are applied, incorporating SWM into sanitation can be very meaningful. This is demonstrated by the strategic sanitation and waste plans (SSWPs) of the ROSA project (2010). A good portion of solid waste is biodegradable and can be more or less directly used to produce compost. An umbrella association should therefore also care about issues of SWM.

Regarding the construction of facilities, co-financing by the authorities can be a good opportunity to control the development and at the same time involve private sector companies. The effectiveness of newly constructed facilities can be increased by licensing and certification by the government. Public toilets can serve as role models for private investors and businesses. For operation and maintenance, an association providing a platform is again very important. On the one hand, experience and knowledge among operators, on the other hand authorities, technicians, and producers can bring in new ideas. A major challenge is the collection and transportation of solid waste, and the storage and transportation of urine. Therefore, it is important to utilize already existing structures. Such structures can be existing informal sectors but also equipment for transportation from other businesses not related to sanitation and SWM. Available facilities have to be shared and efficiently used. In densely populated areas, human powered emptying and transportation will be necessary. Material can be brought to intermediate collection points, which are also common in Austria's SWM. Also the re-distribution of compost after possible treatment has to be organised. Treatment is necessary when a single vault system is in use. Co-composting with biodegradable solid waste is a good option to incorporate SWM into resources-oriented sanitation. To allow the save reuse of the recycling products, certification by external institutions or authorities is useful. Together with an estimation of nutrient content of the compost, that helps marketing the product. As in Austria certain grades of quality can be set. To support sustainable sanitation systems and to make them financially viable, the creation of a market for quality compost is necessary. That can also solve financial problems and make sustainable sanitation an affordable if not profitable business. The initial costs are, however, often a problem. Therefore, co-financing of private companies and local authorities can encourage the implementation of a new system. Especially, because improved sanitation results in a healthier population and higher productivity, financial support by the government quickly pays off. After overcoming the high initial costs, the system has to be financially self-running. Value can be generated at all stages of sustainable sanitation systems (use, operation and maintenance, collection and transportation, treatment, reuse). Ideally, the

implementation of a sustainable sanitation system results in positive feedback loops. An example is shown in Figure 12.

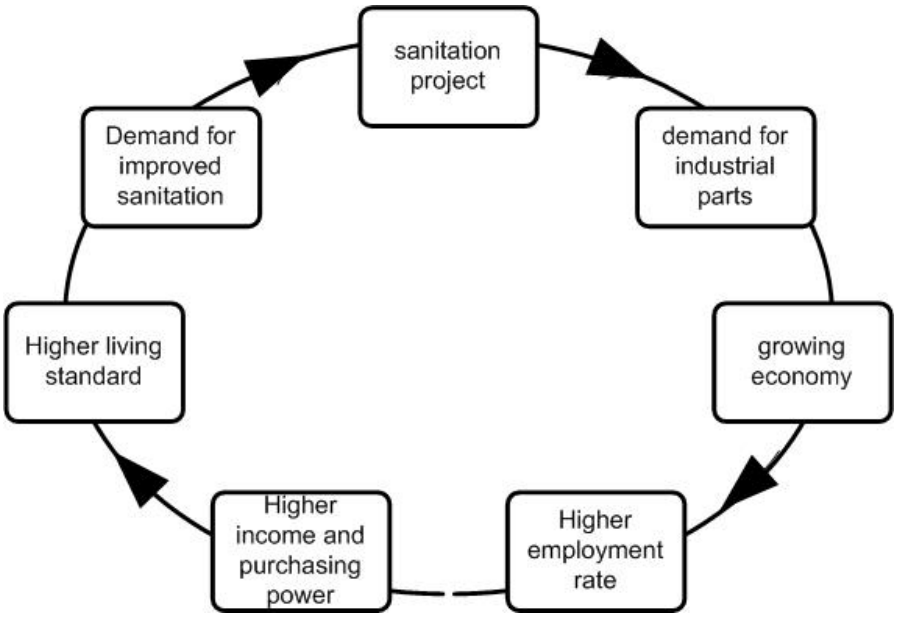

Figure 12 Possible positive feedback loop resulting from a sanitation project

Resulting positive effects are:

- growing local production economy (e.g. plastic industry, service sector)
- higher employment rate
- higher income and purchasing power
- employment of low skilled labour to maintain the systems
- production of valuable fertiliser
- higher productivity
- less dependence on mineral (expensive) fertilizer
- saving natural resources
- raising environmental awareness among the population

Conditions, helpful to achieve the former are:

- clear legal regulations
- sanctions for disregarding laws
- support of local businesses
- cooperation between public institutions, NGOs, CBOs and the private sector
- involvement of the local population through CBOs
- financial support by local governments for O&M
- financial support by NGOs for investment costs and pilot studies
- knowledge transfer between industrialised and developing countries
- environmental and health related education

9. Summary and Outlook

The idea to carry out this work goes back to the initiative of Markus Lechner from the EcoSan Club Austria. Together with Günter Langergraber from the Institute of Sanitary Engineering and Water Pollution Control, who acted as my co-supervisor, and Roland Linzner from the Institute of Waste Management, the content of the work was discussed and specified. Getting an idea about possibilities to derive strategies or recommendations for the organisation of solid waste and wastewater management to better the situation in East Africa was the reason to write this thesis.

Information about the situation in Austria was gathered from different institutions related to the field of solid waste and wastewater management. Internet platforms turned out to be very informative and direct email and telephone contact allowed research in more depth. For East Africa, information about the four pilot cities investigated within the ROSA project served as a basis. For both Africa and Austria, examples demonstrate the characteristics of the respective region.

After the introduction and the formulation of aims and objectives of the thesis, fundamental information about the importance of sanitation in general and a description of sustainable sanitation concepts is provided in chapter 3. Also the main features of the ROSA project, carried out by the University of Natural Resources and Applied Life Sciences, Vienna and several other European and African universities and institutions, are described here.

Following that, the situation in Austria is outlined and examples are specified in Chapter 4. Information about important legal regulations related to solid waste and wastewater management is provided. A focus is laid on the agricultural use of sewage sludge in the nine federal states. This part shows the complexity of Austrian legislation and possible shortcomings because of overregulation.

As solid waste and wastewater management are separately organised, they are also dealt with separately in chapter 4.2 and 4.3. The organisational main features of collection, recycling, treatment and disposal in the waste sector are described as well as the financing of the system. Subsequently, examples of different political and organisational levels (state-level, city-level, municipal-level) illustrate how solid waste management is organised in practice. The examples reflect characteristic features of the Austrian system. The same cases were used for the chapter about the organisation of wastewater management in Austria. Systems are dominated by sewer and wastewater treatment plants, but especially the organisation of existing cesspits seem interesting with regard to the situation in East Africa. A major issue in Austria is the treatment and whereabouts of sewage sludge and its possible use in agriculture. This fits well into the concept of resources-oriented sanitation, as promoted within the ROSA project. Further, available information about the financing of the Austrian system was compiled.

Chapter 5, about solid waste and wastewater management in East Africa is divided into four parts. The situation in each pilot city of the ROSA project is outlined with respect to sanitation and solid waste management and related administrative responsibilities. General information about Arba Minch (Ethiopia), Nakuru (Kenya), Arusha (Tanzania) and Kitgum (Uganda) helps to get a clue about circumstances there. Although certainly differences exist between each of the cities, they have similar problems in common: A lack of proper sanitation and solid waste management. Problems can range from inconvenient living and hygienic conditions to serious threats such as contaminated drinking water and pollution of the environment. Whereas the health related problems resulting from inadequate sanitation are generally familiar among the population, the proper disposal of solid waste is not perceived as necessary. Within the ROSA project, resources-oriented sanitation concepts were implemented and strategic sanitation and waste plans were provided for each city to tackle both, solid waste and sanitation related problems.

As cooperation in the field of solid waste and wastewater management can be very beneficial, special focus is laid on networks and associations around the world, in Austria, and in Africa (Chapter 6). Different advantages of collaboration concerning information, management, capacity building and lobbying, as well as tools such as workshops, conferences, and electronic networks are discussed. Furthermore, examples of international and European networks and associations in the field of solid waste and wastewater management or sanitation are given. Because in Austria institutions are strongly cross-linked, structures are described in more detail. In East Africa, some networks and associations have established but enhanced activities would be desirable. Some of the existing institutions are listed and shortly described.

In chapter 7, a strategy for the management of a resources-oriented sanitation system in East Africa by integrating the knowledge from organisation in the Austrian solid waste and wastewater sector is attempted to be derived. Therefore, a sanitation system with urine diversion has been used as an example. Similar to the situation in Austria, a strong interconnection between different stakeholders would be desirable for Africa. That could help to develop an umbrella association on national level, following the model of the ÖWAV, for both SWM and sanitation related issues. This umbrella organisation can serve as a platform for information exchange and capacity building. Also on a lower level (regional level) associations can help to improve the information flow. To strengthen the connection between private companies working in resources-oriented sanitation, partnerships on the model of "neighbourhoods" for treatment plant operators in Austria seem promising. Implementing a new sanitation system can be supported by co-financing strategies of authorities and private investors and companies. That helps to control development on the one hand and to support private sector involvement on the other hand. In the field of operation and maintenance new businesses will emerge and generate income for the local population. Especially, facilities for more than one household can be looked after by contracted service providers. To optimise operation and maintenance, knowledge exchange between businesses active in this field plays an important role. When it comes to collection and transportation, it is crucial to utilize already existing institutions and facilities. A logistic network of human powered emptying and transportation to intermediate collection points for further transportation has to be developed considering local circumstances. That is also relevant for re-distribution after possible treatment. Here, co-composting can be a good option to reduce biodegradable solid waste. In this field, cooperation between companies active in collection and transportation and farmers seem promising. Farmers can either produce their own fertilizer from raw material or purchase it from a composting plant. External quality control is important to allow the save use of recycling products in agriculture. For farmers the natural fertilizer can serve as a substitute of mineral fertilizer and result in lower cost and rich harvest. Depending on the current market value of compost and liquid fertilizer prizes for all stages of sustainable sanitation will differ. To make the system affordable/profitable education is important to create a positive perception towards the recycling products. Investments by authorities quickly pay off as improved sanitation results in a healthier and more productive population. Financially, a resources-oriented sanitation has to be self-running. After overcoming initial investment costs, the value chain starts with fees for the use of the facilities. Private companies can especially contribute by efficiently operating and maintaining the facilities and organising a system for collection, transportation, and treatment. Solid and liquid fertilizer can be sold and reused in agriculture and help to improve the situation of farmers and the local population.

At the end, in the discussion (chapter 8), gathered information is brought together with regard to the aims and objectives formulated at the beginning. Here also the main characteristics of solid waste and wastewater management and related problems are discussed and interpreted. To improve the organisation of newly implemented systems in East Africa, the following recommendations to achieve favourable framework conditions can be given:

- Provide stimuli to allow the controlled involvement of private sector companies in the field of solid waste management and sanitation,

- Promote cooperation between all possible stakeholders related to solid waste management and sanitation,
- Support public participation and the involvement of CBOs in decision making processes,
- Develop networks and associations to share knowledge and experiences about solid waste management and sanitation strategies
- Establish legally binding regulations
- Establish a market for recycling products from resources-oriented sanitation systems

As research about East Africa was strictly literature based, and information about Austria did not make travelling necessary, most of the work was done at the Institute of Sanitary Engineering and Water Pollution Control at BOKU University Vienna. The main working period extended between October 2009 and June 2010.

In the future, further projects will hopefully provide valuable knowledge and experiences to better the implementation of sustainable sanitation systems not only in East Africa, but all over the world. Desirable are therefore the expansion of cooperation between and within industrialised and developing countries and the fair sharing of knowledge and expertise. Beside continuous technical development, successful implementation strategies for solid waste management and sanitation concepts in development cooperation will be crucial. To be sustainable solutions will have to be holistic approaches, including interdisciplinary cooperation.

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11. Curriculum Vitae

Name	Fritz KLEEMANN
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Education

Since 10/2007	International MSc. Natural Resource Management and Ecological Engineering at BOKU University, Vienna
04/2009	Training as environmental educator at the Institute for Applied Environmental Education, Steyr
06/2008 – 11/2008	International MSc. Natural Resource Management and Ecological Engineering at Lincoln University, New Zealand
Since 03/2006	BSc. Sport Science at Vienna University
02/2005	Training as snowboard instructor at Vienna University
10/2004 – 10/2007	BSc. Environmental and Natural Resource Management at BOKU University, Vienna
2003	A-levels at Oberstufenrealgymnasium Marianum in Vienna
1990 – 2003	Rudolf Steiner-Schule Pötzleinsdorf in Vienna

Working Experience, Internships

Since 2008	Environmental educator for schools
Since 2006	Photographer for advertising Agency „Marketing & Planung”
Since 2005	Tour guide for „Winternet Sportreisen“ Valmorel, France
Since 2005	Snowboard instructor - Josef Schöffel Schule Mödling
09/2003 – 08/2004	Compulsory community service at several integration schools in Vienna
2002 – 2003	Organisation of youth winter sport tours Planning, advertising and guidance (40 participants)

Language skills

German	Native Language
English	Fluent
Russian	Basics