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LESSON SERIES
JULY 2011

BIOGAS FOR SANITATION

Closing the Nutrient Loop through Sanitation, Hygiene, Environmental Protection and Food Security in Lesotho

SEI STOCKHOLM ENVIRONMENT INSTITUTE
BRIDGING SCIENCE AND POLICY SINCE 1989

TED
Technologies for Economic Development

EcoSanRes

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1 Introduction

In 2002, a group of technicians with strong interest in the link between environmental protection and human well-being, started to implement household biogas digesters for sanitation purposes in Maseru / Lesotho. Since then, biogas systems for decentralised wastewater treatment (or Biogas DEWATS) were constructed for individual households especially in urban and peri-urban settlements and at institutions like schools, orphanages, prisons and holiday resorts countrywide.

This document gives only an overview on the technology as it is implemented in Lesotho. It has to be emphasised in this context, that in other countries Biogas or Anaerobic Digestion Technology as well as Decentralised Wastewater Treatment Systems are implemented in locally adapted variations.

The case study contributes to the collection of information on sustainable sanitation technologies implemented in Southern Africa within the Southern African Knowledge Node on Sustainable Sanitation (SAKNSS) network.

2 Lesotho

2.1 Geography, climate, economy and culture

Small, landlocked, and mountainous, the Kingdom of Lesotho is the country with the highest lowest point in the world: the nation's territory located between latitudes 28° and 31°S, and longitudes 27° and 30°E lies all above 1,400 m above sea level. Over 80% of the country lies above 1,800 m; completely surrounded by South Africa, the national territory covers about 30,000 km^2, being home to about 2 million people, the Basotho. The most recent survey (source: CWIQ Survey 2002) identifies the level of urbanization in Lesotho at 23%.

Already in 2006, the number of inhabitants in the capital city Maseru was estimated at 350,000. The rapid expansion of the industrial and commercial base in recent years, and the poor performance of Lesotho's agricultural sector, has given an impetus to the migration of large numbers of the rural population to the City; thus resulting in an annual urbanization rate of 5.2% (source: WASCO & MCC presentation, Lesotho Water Week, 04.-07.04.2011).

Because of its altitude, Lesotho remains cooler throughout the year than other regions at the same latitude. Most of the rain falls as summer thunderstorms. Maseru and surrounding lowlands often reach 30°C in summer. Winters can be cold with the lowlands getting down to - 7°C and the highlands to - 18°C at times. Snow is common in the highlands between May and September; the higher peaks can experience snowfalls year-round.

The majority of households subsist on farming or migrant labor, primarily miners who remain in South Africa for 3 to 9 months. The western lowlands form the main agricultural zone. Almost 50% of the population earns some income through crop cultivation or animal husbandry, but droughts and floods – generally related to global climate change – impact on agricultural yields and livestock herding.

Besides subsistence agriculture, Lesotho's economy is nowadays based on diamonds exported all over the world, and water sold to South Africa, manufacturing, agriculture, and livestock. Exports include wool, mohair, clothing, and footwear.

Water and diamonds are Lesotho's significant natural resources. Water is utilised through the multi-year, multi-billion-dollar Lesotho Highlands Water Project (LHWP), under the authority of the Lesotho Highlands Development Authority, which commenced in 1986. The LHWP is designed to capture, store, and transfer water from the Orange River system to South Africa's Free State and greater Johannesburg area, which features a large concentration of South African industry, population, and agriculture. Completion of the first phase of the project has made Lesotho almost completely self-sufficient in the production of electricity.

Lesotho faces serious economic and social climate change related challenges and has been identified as one of the most vulnerable countries to climate change worldwide. (Source: Lesotho-Africa Adaptation Programme 2009).

The extreme inequality in the distribution of income remains a major drawback (source: www.cia.gov.library/publication/.../countrytemplate_lt.html April 13, 2011). Lesotho has signed an Interim Poverty Reduction and Growth Facility with the IMF. In July 2007, the government signed a Millennium Challenge Account Compact with the US worth $362.5 million. Economic growth dropped in 2009, due mainly to effects of the global economic crisis as demand for country's export declined and SACU revenue fell precipitously when South Africa went into recession; but growth returned to 3.5% in 2010.

2.2 Sanitation challenges and the MDGs

"Lesotho has water as its most important natural resource, second to her people. The ownership of all water within Lesotho is vested in the Basotho Nation. The Government of Lesotho has the duty to ensure that this resource is used in a sustainable manner and to the benefit of all users, and the responsibility to provide security of access to water sources and improved sanitation." (Lesotho Water and Sanitation Policy, MoNR, 2007).

One of the guiding principles of the Lesotho Water and Sanitation Policy formulates: "All the Basotho are entitled to have access to a sustainable supply of potable water and to the provision of basic sanitation services at an affordable cost". Statistics may show an encouraging trend with regards to water coverage, but sanitation coverage is still far below target.

According to WHO/UNICEF Joint Monitoring Report (JMP)[1] 2010, the use of sanitation facilities during 2008 reporting period was 25% in rural areas and 40% in urban areas.

Based on the most recent coverage data in 2008, Lesotho has seven years to raise sanitation coverage from 40% to 81% in urban areas and from 25% to 66% in rural areas[2]. The JMP does not count 'shared facilities' towards achievement even if they are of an acceptable technology. If shared facilities in Lesotho were assumed to provide safe, convenient access to sanitation, then a further 35% of the urban population would be covered, and Lesotho would be close to achieving the MDG sanitation target in urban areas.

[1] JMP data are presented as it reflects global monitoring of the MDGs and standardized definitions, while it is recognized that each country has its own targets and data.

[2] The rural – urban target breakdowns presented here are not official JMP, but are used to indicate what progress is needed in rural and urban areas separately to meet the overall MDG target. The sum will be met from a mixture of sources which include households as well as the government and donor budgets. Also, budgeting has to take into account program costs (program establishment, population sensitization, monitoring, and evaluation) which can be significant, but have been excluded here due to lack of data.

It is estimated that Lesotho requires a total expenditure of LSL 600 million (US$ 72 million) to meet the water and sanitation MDG targets, of which LSL 573 million (US$ 69 million) is for sanitation (data refers to an average of costs for a latrine and water supply). While the water MDG target is already met, spending is still required to maintain existing coverage and operate the services. This equates with roughly LSL 333 (US$ 40) per capita over a 10 year period, or LSL 33 (US$ 4) per capita annually. National water projects have in general at least 9-15% economic rate of return.

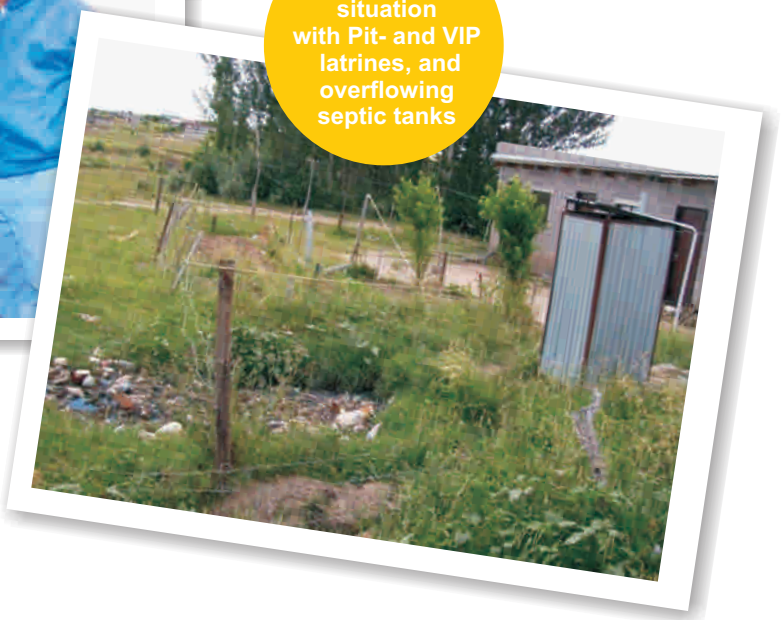
Health and child mortality are influenced by the lack of access to safe water supply, sanitation and hygiene. In 2007, 57,504 Basotho were officially reported to have suffered significantly from diarrhea and gastroenteritis. Diarrhoea and gastroenteritis were responsible for 14% of deaths of children twelve years and below. They also accounted for 3%male and 5%female deaths in the same year (MoHSW Annual Joint Review Report, 2009).

Factors related to water, sanitation and hygiene affect human rights to dignity and health, and children's right to education in many ways. In an ambiance of poor health, children are unable to fulfill their education potential. During the first quarter of 2007, 396 school-aged children were noted as having missed school days due to infections by intestinal worms (MoHSW Annual Joint Review Report, 2009).

Experience shows that it is hard to keep water and sanitation infrastructure functional as it often fails before its planned lifetime, thus being a massive waste of investment. Many water supply projects are implemented in isolation, ignoring important links with health and education. Children's learning is directly influenced by the quality of water and sanitation facilities in schools: low quality water supply, and dark and dirty latrines could never promote hygienic behavior, thus preventing children from acting as change agents within their communities and families towards a healthier life.

Wherever hand washing with soap in the critical moments – after defecation, before food handling and eating is not practiced, the transmission of diseases such as acute respiratory illnesses and diarrhoea related diseases like cholera and dysentery is promoted. Often, the initiatives that focus resources on improving the health of school-aged children, highlighting the need for hygiene promotion through secured water supply, improved sanitation and hand-washing facilities in schools are very limited.

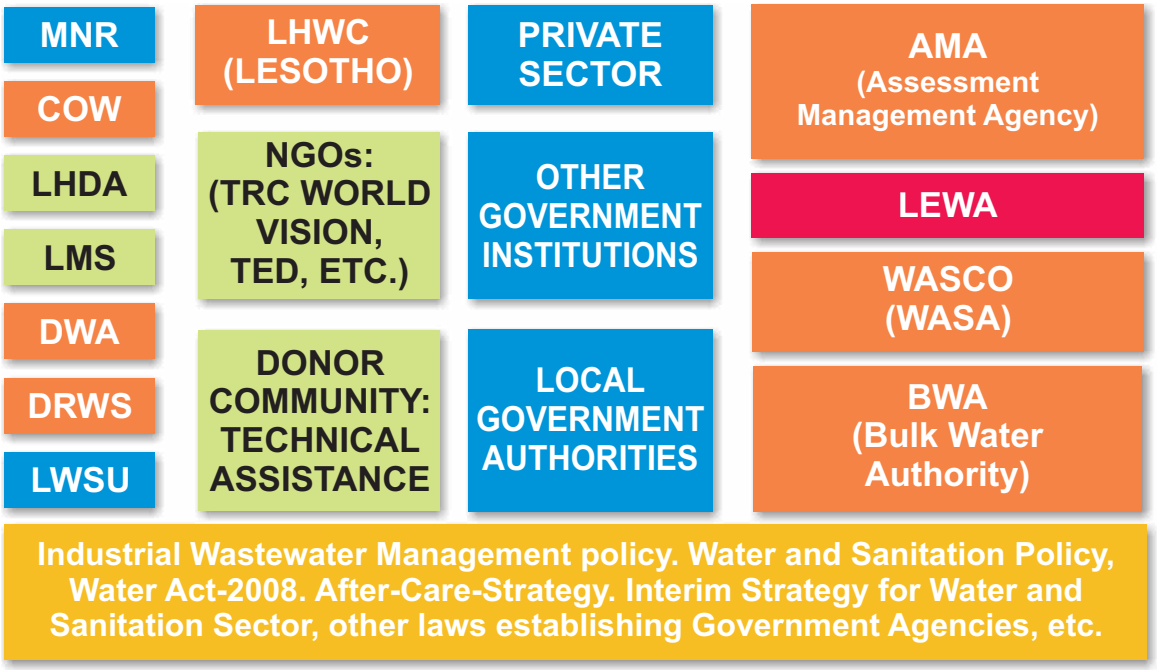
WASH UNITED-Handwashing campaign



Common situation with Pit- and VIP latrines, and overflowing septic tanks

2.3 Sector structures and policies

The Government of Lesotho "is committed to ensure effective and efficient management and development" of water resources "in order to maximize socio-economic benefits" according to its Water and Sanitation Policy 2007. "It aims to achieve this objective in an equitable manner without compromising the sustainability of vital environmental systems." The Policy Paper highlights programs to be set up "to allow particularly the poor to have access to potable water supply and improved sanitation facilities. In this regard a minimum standard of 30 litres per capita per day will apply."



Sector Structure and related Policies. Presentation of the Commissioner of Water during Lesotho Water Week April 04-07, 2011

One of the guiding principles of the Lesotho Water and Sanitation Policy formulates: "All the Basotho are entitled to have access to a sustainable supply of potable water and to the provision of basic sanitation services at an affordable cost". Of the 7 Statements, Policy Statement 2 details the envisaged Water Supply and Sanitation Services under the postulate "Ensure access to a sustainable supply of potable water and basic sanitation services for all Basotho".

The objectives of Policy Statement 2 define:

1. To accelerate the delivery of water and sanitation services to all Basotho in line with national development goals;
2. To promote increased investment in infrastructure development (reservoirs, conveyance structures) to meet the water demand in urban and rural areas for socio-economic development and for meeting basic consumption and hygiene needs;
3. To devolve provision of water supply and sanitation services to relevant institutions at National, District and Community Council levels;
4. To promote equity in access to water supply and sanitation services taking into account vulnerable and marginalized groups including women, girls and all those affected by HIV/AIDS; and
5. To ensure that the tariffs charged by water and sanitation service providers cover the actual cost, including the capital costs as well as the cost of overheads, of providing water and sanitation services.

These listed objectives of the Lesotho Government link many of the MGDs which, if they will be achieved, contribute to a more developed country and a stronger nation.

In the designated urban centers, sanitation is part of the mandate of the Water and Sewerage Company (WASCO – former WASA) which collects and treats wastewater. However, the rapid and unplanned urbanization affects the provision of sanitation infrastructure as the demand for services increases [3]. Settlements have developed at a rapid pace and provision of services has not matched this rapid development; WASCO services are to be provided in already settled areas resulting in projects that are more expensive and difficult to implement; therefore large areas are left unserved due to encroachment of private properties on service corridors or, as most of the settlements are not planned, there are no corridors for services.

In addition, settlements are home to different income groups thus resulting in the challenge that provision of sanitation services requires a mix of technologies taking into account the ability of households to pay for these services.

[3] "Sanitation and Water for ALL: A Global Framework for Action", "Lesotho WASH United Briefing Country Paper"

[4] www.mdgmonitor.org

[5] presentation of WASCO representative at Lesotho Water Week, April 04 – 07, 2011

The current situation reflects the "competition between water supply and sanitation services":

In Water Supply:

1. WASCO has three levels of service: (1) in-house connections, (2) tap-in-yard, (3) stand pipes.
2. Piped water supply coverage in Maseru and the further 11 designated urban centers achieves 66%
3. In April 2011, WASCO counted 47084 water connections classified into (1) domestic and (2) non-domestic, and (3) 106 stand pipes country-wide, including 39 in Maseru.

On the sewer side:

1. WASCO provides (1) sewer connections, and (2) emptying services for conservancy tanks and VIP latrines
2. In April 2011, the company provided 2141 sewer connections classified into (1) domestic and (2) non-domestic; and (3) emptying services to 12, 000 customers mainly in Maseru.
   Maseru sanitation service coverage according to the most recent MDG Monitoring Report (presenting data from 2009): 9.2% flush toilets; 45% ventilated improved pits; 43.1 % unsealed pit latrines; and 2.9% no sanitation facilities.

The focus in terms of resource allocation has always favored water supply; a large backlog has been created which requires a lot of resources to bring sanitation provision up to par with water supply.

3 Technologies for Economic Development TED

Technologies for Economic Development (TED) is a Lesotho based NGO, founded in 2004. Activities are covering the following areas:

- **Urban and Rural Sanitation technologies:**
  - Biogas & decentralised Wastewater Treatment Systems
  - Urine Diverting Dry Toilets,
- **Education on WASH:**
  - in schools and football clubs

- **A wide range of other technologies to protect health, environment and climate**
  - biomass conservation through efficient stove technologies
  - nutrient recycling for fertilizer application esp. in home gardening
- **Technical training**
- **Job Creation for skilled staff**
- **Consultancy Services**

TED identified most of its focus areas in the Lesotho Poverty Reduction Strategy Paper as relevant for overcoming poverty as they all relate to MDGs.

In cooperation with international partners like the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) ecosan project, the China Node on Sustainable Sanitation (CNSS), and the Water Supply and Sanitation Collaborative Council (WSSCC), TED developed and follows a defined approach to the requirements of urban sanitation, taking into consideration the specific challenges of urban settlements and key Parameter for an Urban Sanitation Strategy, which states that "All the Basotho are entitled to have *access to a sustainable supply of potable water and to the provision of basic sanitation services at an affordable cost".*

Challenges in Urban Sanitation
TED presentation during Lesotho Water Week April 04-07, 2011

This principle formulated in the Lesotho Water and Sanitation Policy of the Ministry of Natural Resources (2007) asks for specific details. TED's answer to this challenge is summarized in the following Key Parameter for a Sanitation Strategy which does not only focus on urban and peri-urban frame conditions:

1. Disease Prevention
2. Environmental protection
   a) Resource saving and reuse, b) Pollution Prevention,
   c) Climate protection & climate change mitigation
3. Nutrient Recycling (Food Security & Safety)
4. Acceptable by customers
5. Affordable by customers and municipality
6. Comfort & Simplicity
7. Convenient in Operation & Maintenance

4 Description of Biogas DEWATS technology

[5] GTZ Technical Fact Sheet Biogas Sanitation www.ecosan.de

Biogas Sanitation as decentralised Wastewater Treatment technology is in detail described in a number of publications, well summarized in a Technical Fact Sheet published by the German Technical Cooperation in 2010. The following information is therefore quoted[5].

"Anaerobic treatment units, as part of an on-site, decentralised or semi-decentralised wastewater treatment system, are a competitive alternative to centralised wastewater treatment plant systems due to their energy and soil conditioner production capacity, low-tech components and adaptability.

Sanitation has a strong link to agriculture, as the nutrients such as nitrogen and phosphorus contained in human excreta are needed as fertilizer, and the organics as soil conditioner. Excreta are a rich source of inorganic plant nutrients such as nitrogen, phosphorus and potassium, and of organic matter. Each day, one adult excrete in the order of 30 g of carbon (90 g of organic matter), 10-12 g of nitrogen, and 2 g of phosphorus and 3 g of potassium. Most of the organic matter is contained in the faeces, while most of the nitrogen (70-80 %) and potassium are contained in urine. Phosphorus is equally distributed between urine and faeces. It has been calculated that the fertilising equivalent of excreta is nearly sufficient for a person to grow its own food (Drangert 1998) … For the same reason, urban farmers in arid or semi-arid zones or during dry seasons, in addition to procuring water for irrigation are endeavouring to get access to wastewater, raw or treated. This allows them to renounce or minimize the purchase of chemical fertiliser …

The main advantages of anaerobic treatment systems are the generation of biogas and about 80% less sludge production compared to aerobic treatment processes. (W.W. Eckenfelder, J.B. Patozka and G.W. Pulliam, Anaerobic Versus Aerobic Treatment in the USA, 5th International Symposium of Anaerobic Digestion, proceedings pp 105-114, IWA Publishing, 1988) *The fact that the plant nutrients, nitrogen and phosphorus are not removed is an advantage as well if the effluent is applied in agriculture to replace chemical fertilizer. The phosphorous compounds remain a potential phosphate supplier, as phosphorus is removed with the bacteria mass in form of settled sludge.*

The described sanitation concept for brown or black water of faecal sludge (excreta) based on anaerobic technology has major advantages in terms of nutrient recycling, energy balance and CO_2-emissions reduction compared to conventional aerobic wastewater treatment systems.

The specific local circumstances must be taken into consideration when planning a biogas sanitation system; parameters are e.g. how much excreta, black or brown water has to be treated; the dilution factor of the influent with flush water; adding of other organic feedstock; the settle-able sludge content in the influent; the climate and soil temperatures; how much area is available for the intended reuse or disposal.

Biogas sanitation systems can purify a wide range of wastewater; this document deals with biogas sanitation treating mainly black and brown water, excreta or faecal sludge, sometimes mixed with

organic kitchen waste. The construction of biogas sanitation units is the same as for completely mixed wastewater treatment but it can be smaller if designed for black- or brown water, excreta or faecal sludge only, depending on the treatment target: (a) optimised energy output, or (b) optimised hygienization."

As kitchen waste, animal manure and human excreta for the most part consist of organic material, the anaerobic degradation takes place in four steps: hydrolysis, acidogenesis, acetogenesis and methanogenesis, involving different bacteria under different conditions like pH, temperature and impurities.

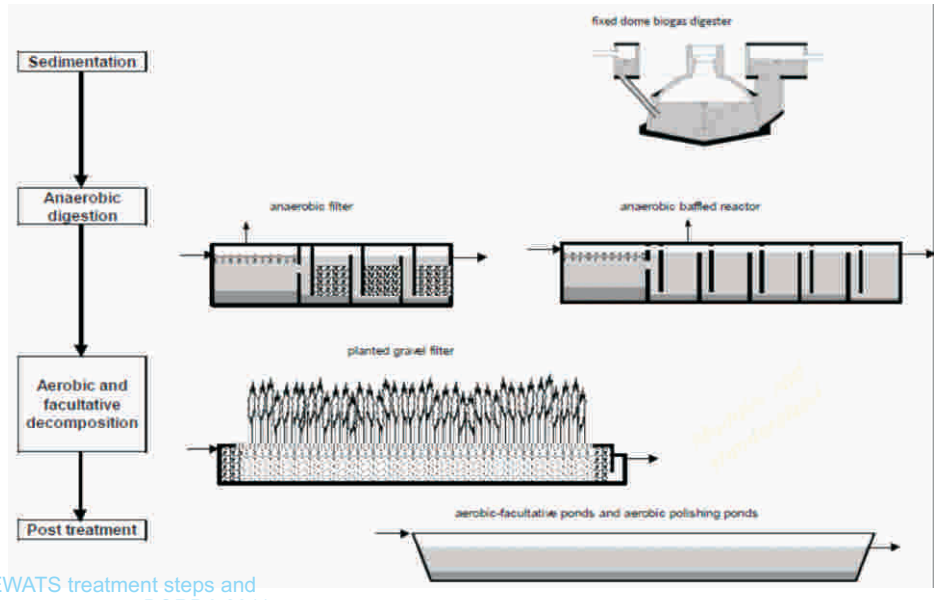
Each degradation step further requires appropriate containers - Biogas Digester, Baffled Reactor, Anaerobic Filter and Horizontal Filter: in combination these construction components represent the Biogas decentralised Wastewater Treatment System.

4.1 Biogas Digester

The Biogas Digester is an air and water tight dome shaped underground reactor. Its inlet is connected to the sewage pipes coming from the house. The outlet is connected to the next treatment step. The wastewater and eventually other organic material (kitchen waste) is retained in the digester for a defined period in order to allow micro-organisms to degrade the organic material into biogas, pre-treated wastewater and settled sludge that retains helminth eggs and other settle-able pathogens. The biogas is stored above the waste water level in the dome. From there it is led through a gas pipe to the kitchen for cooking purposes (it could also be used for lighting or cooling and in case of high production for he generation of electricity).

Biogas digester under construction

Depending on the number of people living in one household the volume of the biogas digester could be adapted.



Biogas DEWATS treatment steps and constructive components BORDA 2011

4.2 Baffled Reactor

The mostly underground constructed Baffled Reactor consists of a series of chambers. Pre-treated wastewater flows upstream into the chambers, thus facilitating the settling of solids still contained in the wastewater, and the accumulation of activated sludge at the bottom of each chamber. Yet anaerobic bacteria contained in this sludge continue to degrade the organic material as the wastewater is forced to pass through the sludge layer, cleaning the water step by step from chamber to chamber. The size of the chambers depends on the sewage flow rate, because the up flow velocity of the water should be less than the settling velocity of the solids.

The amount of chambers follows the treatment requirements: every additional chamber represents an additional treatment step.

4.3 Anaerobic Filter Reactor

The vertically working Filter Reactor is an optional treatment step, as it is adapted to the Baffled Reactor. Pre-treated water passes through a filter material like stones, gravel or recycled plastic material (bottles). These surfaces are proven to offer living space for bacteria dedicated to absorb organic particles. Like in the Baffled Reactor the water passes the filter vertically from the bottom to the top. The filter reactor can also consist of several chambers.

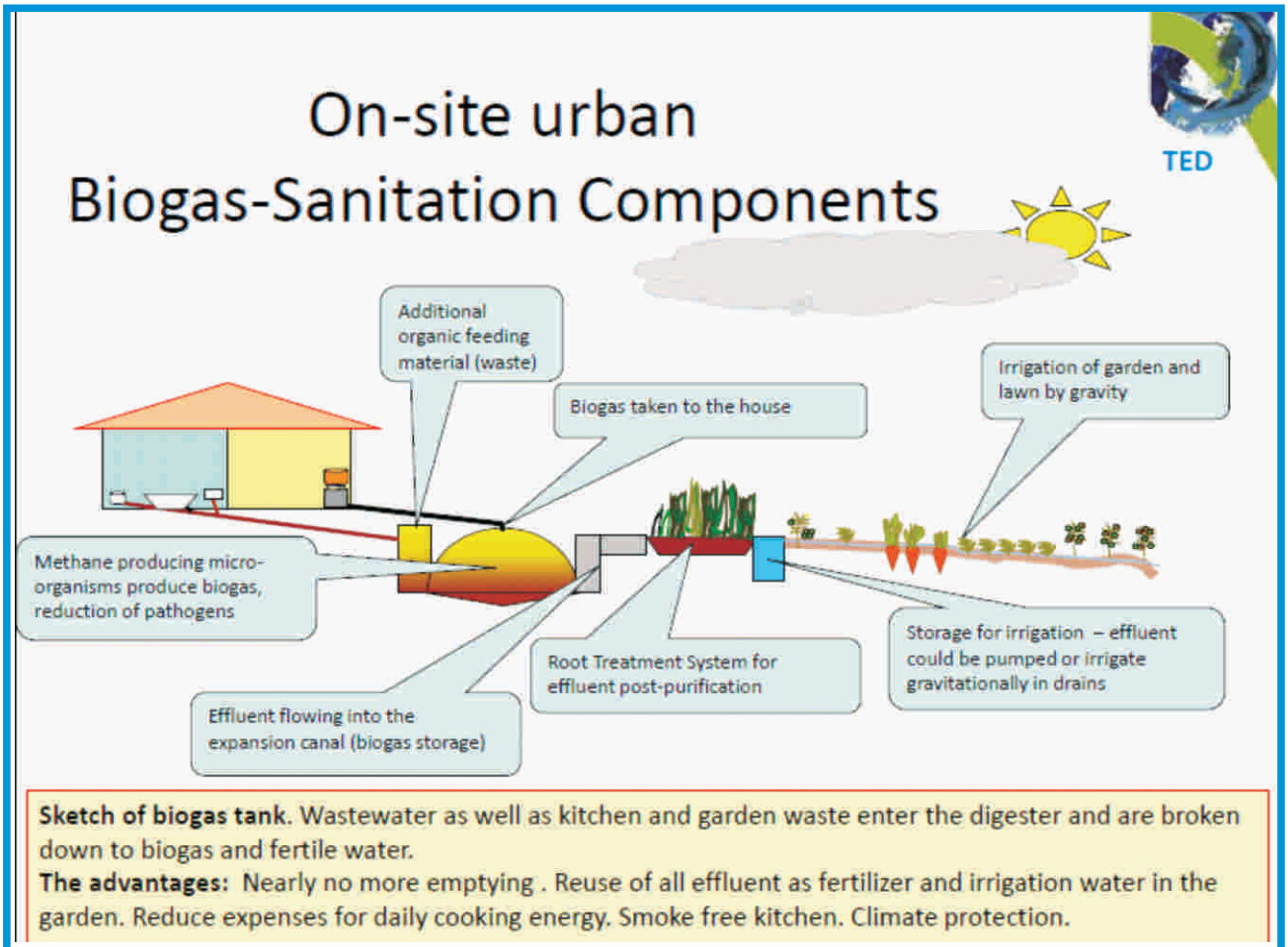
Approaching the final stage of construction – shortly before covering the system with soil and installing the Planted Gravel Filter
TED Lesotho 2011

4.4 Horizontal Filter

The Horizontal Filter, mostly constructed as Planted Gravel Filter, is filled with gravel and planted with aquatic plants. It functions as a post treatment system to prepare finally the treated wastewater for its reuse in irrigation. Biological conversion, physical filtration and chemical adsorption (pumice stones or gravel) and absorption (plant roots) are the four treatment mechanism taking place in this last treatment step. The water flows horizontally and slowly through the filter material. It is treated aerobically, the last remaining solid particles are filtered, and the concentration of phosphate is reduced to the desired level. The roots of the aquatic plants grow deep, spread wide and transport oxygen into the water. The plants provide a nice appearance to the whole system.

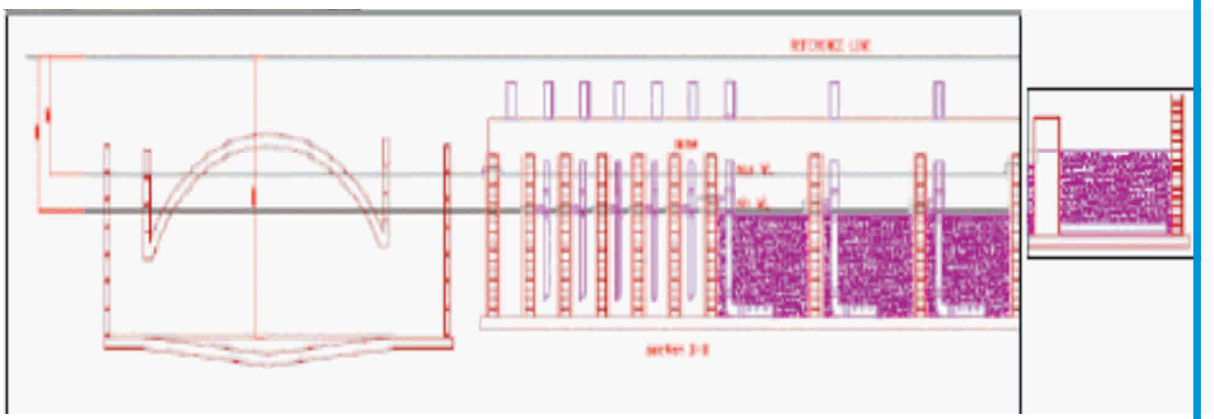
5 Biogas DEWATS implementation in Lesotho

Since 2004, TED has been engaged in the construction of Biogas sanitation and Biogas DEWATS technology in Lesotho. The construction is done with a team of trained and skilled foremen and masons. Sketch Nr. 1 shows the original TED design; Sketch Nr. 2 provides an overview on the currently mostly applied TED Biogas DEWATS principle.



Sketch of biogas tank. Wastewater as well as kitchen and garden waste enter the digester and are broken down to biogas and fertile water.
The advantages: Nearly no more emptying . Reuse of all effluent as fertilizer and irrigation water in the garden. Reduce expenses for daily cooking energy. Smoke free kitchen. Climate protection.

Sketch Nr. 1 Original TED system



Sketch Nr. 2 TED's Biogas DEWATS principle

TED is responsible for about 125 systems constructed since 2004. However, about 300 Biogas systems are known in Lesotho, due to the fact that several trainees and laborers, who left TED after some weeks of insights, set up their own business for constructing decentralised wastewater treatment systems. In a large number of cases, these systems are not performing as intended and promised due to quality problems in the craftsmanship, missing understanding of the biological processes taking place in the system, or simply having based the faulty construction on copied plans without knowing the engineering details.

6 Sustainability factors

6.1 Social and cultural sustainability: hygiene awareness; health and nutrition aspects; community and family participation

In order to achieve social and cultural sustainability of the promoted wastewater treatment technology in general and the installed Biogas DEWATS systems in each specific case, TED applies "Social Marketing Principles" adapted to sanitation requirements. The strategy is based on three pillars: (1) Stimulating demand, (2) Private sector involvement in supply chain, (3) Social status. Following the guideline "Social marketing works to help people change their behaviours positively", TED engages also in hygiene education, sanitation awareness raising, and sanitation marketing at all levels in Lesotho and abroad[6].

[6]Recognising that any genuine behavior change has to be voluntary; TED promotes hand washing with soap through the funny and sportive WASH United approach, coordinated country wide in 2010 by TED.

The creation of a Sustainable Sanitation Market involves 5 "P": (1) product, (2) price, (3) place, (4) promotion, and (5) people, whose quality of life is directly influenced by the improvement of sanitation and hygiene.

Biogas DEWATS after completion: the flowers (right) are blossoming on the Planted Gravel Filter

Up to now, TED's Biogas DEWATS product has several "unique selling points", as the NGO is still the only national organization to offer a real alternative to a conventional septic tank. Price comparison between the conventional on-site wastewater treatment system and Biogas DEWATS results currently in lower investment costs for the conventional system, but in significantly lower operational costs for Biogas DEWATS. Given the specific geophysical context of Maseru and its growth rate into peri-urban hilly areas, the connection to centralized sewer lines and wastewater treatment plants is for most of TED's clients just not possible.

The sustainable social and cultural integration of TED's Biogas DEWATS is also enhanced by the strong involvement of the future system owner in the decision on where to place the treatment system for the household's waste water and the technology choice on re-use options. Also, wherever possible, already existing septic tanks and VIP latrines are integrated into the new design of the treatment system. Due to these close and personal relations with its clients, TED's promotion strategy relies on "word of mouth" and clients' testimonies to interested households.

In cases where communities (villages, schools, orphanages) ask for upgraded sanitation systems, TED informs the communities about different options, including urine diversion dry toilets. Urine diversion technologies and Biogas DEWATS could be successfully combined.

Working closely with local partners, TED spreads the message about the importance of sanitation, hygiene and water for human well-being to different groups applying appropriate information and education material. Local authorities, civil society organizations, and media form already part of the still informal sanitation network TED is intending to set up in Lesotho.

6.2 Economic and financial sustainability: costs and benefits; contribution to household and community economic development

As mentioned above, the level of sanitation infrastructure in Lesotho is generally very low; a decentralised approach to sanitation services is a must. Biogas DEWATS is one alternative to septic tanks in Lesotho. Wastewater naturally produces biogas and purified water that still contains plant nutrients for reuse in the garden. Owners save money because they do not have to call a truck to empty the septic tank; they can use the biogas for cooking, and they can use the water for irrigation thus reducing the fresh water bill. The money saved within a reasonable time (some owners calculate a maximum of 3 years as period of internal return rate) can be used for further investments to develop the local economy.

The costs for a biogas digester and related wastewater post treatment steps are divided into **production costs, running costs and capital costs** (if needed).

Production costs include all expenses necessary for the erection of the plant e.g. land, excavation work, construction of the Biogas & DEWATS, piping and gas utilization system. The construction costs comprise wages and material. They depend on size and dimensioning of the biogas unit, amount and prices of material and the labor.

Running costs occur in same cases more often and in some cases rarely; they could include feeding and operating of the plant; supervision, maintenance and repair of the plant; storage and disposal of the slurry; gas distribution and utilization, and administration. The running costs of a biogas plant with a professional management are just as important as the construction costs, for example for operation, maintenance, expenses for painting, service and repair.

Capital costs consist of redemption and interest for the capital taken up to finance the construction costs. It has to be mentioned that many customers provide themselves with e.g. building material to cut their costs, therefore just a few have to borrow money.

In calculating the depreciation, the economic life-span of plants can be taken as 15 years, provided maintenance and repair are carried out regularly.

The money which is saved by using “waste” as energy source and irrigation water needs to be calculated for each specific case.

TED's clients have various problems and therefore various reasons why they want to have a Biogas DEWATS. That is why the “real” investment costs can be higher than the “real” outcome costs but the problem, for instance a septic tank which is always overfilled, is solved. On the other hand, it is true that one saves a lot of money by having this technology. There is just the question if the client can furnish the start capital to invest in this technology.

6.3 Environmental sustainability: management of water demand, protection and conservation; management of Renewable Energy

The waste water treatment systems provided by TED fit into the ecological sustainable circle. The following analysis refers to international experiences, as TED as small non-profit making NGO has not yet had the opportunity to analyse the environmental sustainability of its Biogas DEWATS in the Lesotho context:

- Wastewater and manure are naturally treated by bacteria which upgrade wastewater and stabilises sewage sludge. The system improves the fertiliser quality of human and animal waste.
- It reduces the greenhouse gas emissions by using the produced biogas instead of firewood or fossil fuels.
- Protected areas or the ecosystem are not at risk because of the construction which fits into the nature. As the system is underground, the landscape is not damaged or negatively influenced.
- Moreover, the treated water can also be reused for irrigation.
- When biogas is an alternative to fossil based fuels it is, on a national level, considered to improve the balance of payments since less oil products have to be imported.
- On a regional and local level, transportation and infrastructure for distribution of these products will not be required to the same extent.
- On the individual level it is true that systems' owners save money because of using waste water which is for free to produce their cooking energy and their irrigation water.

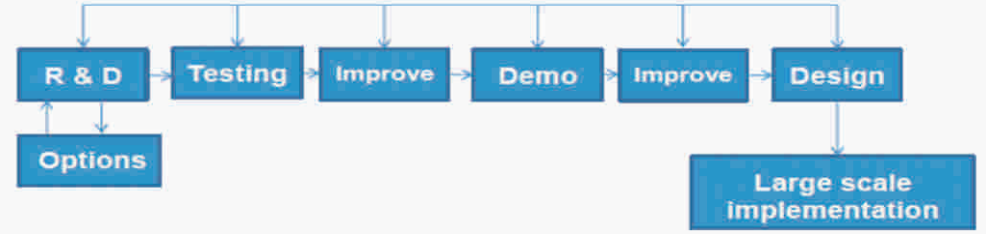
6.4 Technical sustainability

In order to assure technical sustainability and continuous updating of technical staff, TED applies the following approaches:

1. To be integrated into worldwide networks and close cooperation with technology and research partners like Bremen Overseas Research & Development Association (BORDA), University of Science & Technology Beijing – Centre for Sustainable Environmental Sanitation (USTB-CSES), and Water and Sanitation Association of Zambia (WASAZA).

2. To offer – in collaboration and consultation with cooperation partners - Service Packages to integrate the technology into an environmental sanitation concept. This includes e.g. School Sanitation, Community Based Sanitation, and Sanitation Systems for Hospitals, Hotels & Tourism Resorts, Military Camps, and for agricultural enterprises.

3. To include Research & Development into implementation in order to achieve safe up scaling of implementation; R&D includes the following topics (list not exhaustive):
   a. Sanitation & Renewable Energies
   b. Sustainable Environmental Sanitation
   c. Agriculture & Livestock



Flow Chart of R&D process

R&D is supported by regular monitoring of the system performance and external evaluation of the results by academic cooperation partners. TED thus offers future oriented researchers to gain experience in reuse oriented waste water treatment systems; this topic is still not very common in the curriculum of universities dealing with settlement infrastructure and wastewater treatment technologies.

4. To train system owners and operators, and to offer after-sales services:
   Well informed system owners and operators ask only in very critical situations for special maintenance activities provided by TED staff. Experience shows that owners, understanding that Biogas & DEWATS functions due to a well-maintained biology of micro-organisms, are operating their wastewater treatment system throughout the years without any problem, and without requiring additional maintenance support by TED.

   During the first 12 months after construction TED provides training to the owners and operators (in the case of school or enterprise connected systems) in order to familiarize the responsible person with all relevant details to maintain a successful wastewater treatment process for biogas production and irrigation water re-use.

7 Lessons learned: conclusions and recommendations for implementation up scaling in Lesotho and SADC

7.1 Success

TED's experience and “success story” shows that there are acceptable, affordable and ecologically safe Sanitation Technologies, already successfully installed in urban settlements in Lesotho. Given the fact that TED is implementing Biogas DEWATS without any subsidies but fully paid by the customers, it is clear that a sanitation market is viable.

Sanitizing wastewater on the compound, making it fit for irrigation, saving valuable drinking water and encouraging home gardening especially in an HIV & AIDS suffering country, clearly helps to improve the living conditions of the population. Turning organic waste (solid and liquid) into biogas for cooking is an important measure for climate protection, climate change mitigation and resilience.

7.2 Challenges & Lessons Learned

Challenges encountered and relevant for the way forward refer to craftsmanship's quality, expertise in Biogas & DEWATS construction, ownership and how to cope with the increasing demand. TED's way of dealing with these challenges is and was always developed in a very pragmatic manner due to its characteristics as a small non-profit-making NGO in a country with an endless number of constraints and limitations. The following overview should be read as an outline for “lessons learned” on how to upscale implementation of “Biogas for Sanitation” purposes.

i. Craftsmanship's Quality

TED engages in continuous quality control of its construction staff. In cooperation with international partners like BORDA, quality parameters have been established, in-house training is carried out and a quality management system related to Biogas & DEWATS construction is in place.

ii. Expertise in Biogas & DEWATS construction

Considering the limited labor market for specialised technical professionals in Lesotho, TED encounters difficulties in finding qualified civil engineers Engineering expertise in Biogas & DEWATS construction is currently provided by international cooperation partners, but contacts with national sector institutions are sustained and enforced to achieve knowledge transfer at a long-term.

iii. Ownership

When a Biogas & DEWATS has been sponsored by a third party and not – at least in a significant part – been financed by the system owner him-/herself, lack of responsibility and ownership often leads to system performance problems. This could also be observed in cases of community based systems. TED therefore developed a user training principle that includes not only the technically responsible person but also the person who will benefit most from a well-functioning Biogas & DEWATS – like the cook in a school or orphanage.

iv. Increasing demand

Increasing demand could only be answered by an increasing number of Biogas & DEWATS constructions; therefore TED applied for funds to train masons, who will become part of the TED construction team after an intensive on-the-job-training. This activity started in 2010 with financial support gratefully received form Levi Strauss Foundation.

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9 About TED

Technologies for Economic Development (TED), is a Lesotho based non-profit Non Governmental Organization, founded and registered on May 4th 2004 under Registration No. 2004/90 with the Law Office in Lesotho. It is a successor of the Biogas Technicians Self-Help Group established in 2003 by Biogas technicians who wanted to make sure that the environment especially the trees and the groundwater of their country are protected. Biogas digesters as reliable technology mainly for decentralised wastewater treatment and cooking gas production, tackle many of the most pressing problems faced by the people of Lesotho, like health, food, water, energy, environment and employment.

Since 2003, supported by the German International Development Cooperation and a fund from the German Embassy, the primary focus of TED has always been engineering and fine-tuning of appropriate technologies to foster their long-term adoption by Basotho. Since 2005, TED contributes to international knowledge sharing through consultancy work and lectures at national and international Universities.

Since 2006, TED cooperates with BORDA (Bremen Overseas Research and Development Organization), a Germany based NGO dealing with decentralised Wastewater Treatment Systems (DEWATS). In 2007 TED started working under a 7-year agreement brokered by the Programme for Basic Energy Conservation (ProBEC) and Climate Care Trust Ltd to roll out in alliance with the World Food Programme an efficient wood stove project earning finance on the international carbon trading market. The initiative aims to minimize wood fuel gas emissions; Pioneer Carbon Ltd (PCL), a UK-registered private-sector company, handles the carbon verification process and ensures the procedures for obtaining carbon credits. The programme is chaired by the Ministry of Natural Resources' Department of Energy.

In 2010 TED was appointed the Country Coordinator of the WASH United Campaign in Lesotho that uses sport and celebrities to promote Hand Washing with Soap, and water and sanitation as a human right.

Partners

- Action Contre la Faim Mongolia: NGO working in Social Marketing for Ecological Sanitation (ACF)
- Bremen Overseas Research & Development Association (BORDA)
- China Node on Sustainable Sanitation (CNSS)
- German International Cooperation – Centre for International Migration and Development (GIZ-CIM)
- German Toilet Organization (GTO)
- International Biogas & Bio-Energy Competence Centre and German Society for Biogas & Bio-energy Promotion (IBBK and GERBIO)
- International Water Association (IWA)
- Levi Strauss Foundation (LSF)
- National University of Lesotho (NUL)
- Southern African Knowledge Node on Sustainable Sanitation (SAKNSS)
- Sustainable Sanitation Alliance (SuSanA)
- University of Life Sciences (UMB, Norway)
- University of Science and Technology Beijing – Centre for Sustainable Environmental Sanitation (USTB-CSES)
- Water and Sanitation Association Zambia – professional association (WASAZA)
- WASH United: NGO coalition advocating for (the right to) safe drinking water, safe sanitation and proper hygiene
- WaterLex – International NGO working for the Human Right to Water and Sanitation
- Water Supply and Sanitation Collaborative Council (WSSCC)
- World Toilet Organization & College (WTO & WTC)

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About SAKNSS

The Southern Africa knowledge node on sustainable sanitation aims to fast track and accelerate the delivery of sanitation through sustainable solutions. The node aims to facilitate and coordinate capacity and skills development, knowledge sharing and collaboration.

Southern Africa knowledge node on sustainable sanitation

Benefits for members:

- Link and exchange information with peers
- Access to new information and experience
- Practical support and capacity building
- Lessons learned
- Analysis of policies and sector trends
- Documentation and sharing of best practice
- Facilitating platforms for sustainable sanitation dialogue
- Awareness raising and Networking

www.afrisan.org

The website aims to facilitate collaboration and information sharing among stakeholders in the SADC region. It serves as a SADC gateway to sustainable sanitation information. The website is the first regional website with dedicated on sustainable sanitation information. We encourage our stakeholders to register on the website and share with us any documents that will contribute to knowledge sharing and capacity building in the region.

The SAKNSS website consists of:

Document management system

The SAKNSS document management system is a user friendly component that allows users to search documents by Document Type, theme, country, keyword and advanced search

How to access SAKNSS items?

Users should first register their details before they can have full access to the SAKNSS items.

Contact management module

The contact management module provides an opportunity for the stakeholders to access their peers, contractors, suppliers, NGOs and government officials. It further allows stakeholders to advertise their own organisations/companies on the website.

Links database

The Links database provides access to organisations, private companies and government ministries working with the water and sanitation field.

SADC country information on sanitation

The country information page presents the status of sanitation in SADC countries with links to the responsible ministries and their contact details.

WIN-SA WATER INFORMATION NETWORK - SOUTH AFRICA -

EcoSanRes

WATER RESEARCH COMMISSION

The WIN-SA lessons series aims to capture the innovative work of people tackling real service delivery challenges. It also aims to stimulate learning and sharing around these challenges to support creative solutions. To achieve this, the lessons series is supported by ancillary learning opportunities facilitated by WIN-SA to strengthen people-to-people learning.

To find out more about these and other WIN-SA services go to the WIN-SA portal at www.win-sa.org.za or contact the Network directly.

This document hopes to encourage ongoing discussion, debate and lesson sharing. To comment, make additions or give further input, please visit www.win-sa.org.za or send an email to info@win-sa.org.za.

Our mission is to ensure the body of knowledge in the sector is well managed, readily accessible and applied, leading to improved decision-making and performance, especially of local government.

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