sustainable sanitation alliance

Greywater tower gardens at household level Kitgum, Uganda

Fig. 1: Project location

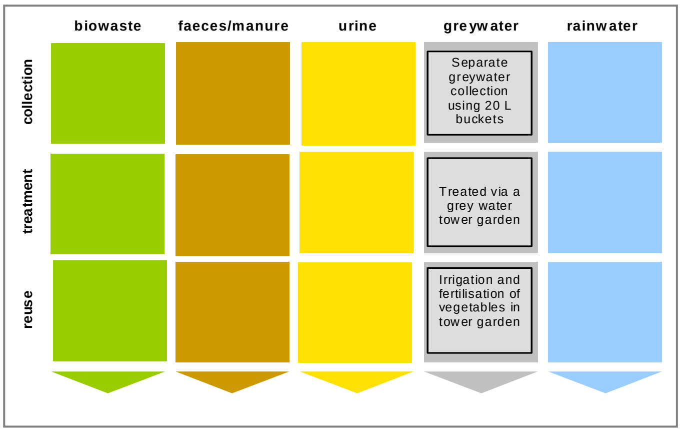

Fig. 2: Applied sanitation components in this project

1 General data

Type of project:
Pilot scale construction of household based greywater reuse systems.

Project period:
Start of construction: January 2009
End of construction: February 2009
Start of operation: February 2009
Ongoing monitoring period planned for: August 2009
Project end: March 2010

Project scale:
Number of inhabitants covered: 40 (7 households)
Total investment EUR 63 per tower garden (including labour) for 21 greywater towers, giving a total of EUR 1323

Address of project location:
Kitgum Town council, Uganda

Planning institution:
ROSA Project Uganda: Kitgum Town Council, Makerere University and Ecosan Club, Austria

Executing institution:
Kitgum Town Council

Supporting agency:
European Union

The work was carried out within the project ROSA (*Resource-Oriented Sanitation concepts for peri-urban areas in Africa*; Contract No. 037025-GOCE; duration: 1.10.2006 – 31.3.2010), a Specific Target REsearch Project (STREP) funded within the EU 6th Framework Programme, Sub-priority "Global Change and Ecosystems".

2 Objective and motivation of the project

The overall objectives of the project were:

1. to contribute to the current efforts for promoting resource-oriented sanitation concepts as a route to sustainable sanitation,
2. to research the gaps for a successful implementation of resource oriented sanitation concepts in peri-urban areas,
3. to develop a generally applicable and adaptable framework for the development of participatory strategic sanitation & waste plans (SSWPs), and
4. to implement resource-oriented sanitation concepts in four pilot cities in East Africa (Arba Minch, Ethiopia; Nakuru, Kenya; Arusha, Tanzania; Kitgum, Uganda).

Specific objectives included:

- implementing the system described to demonstrate the treatment and reuse of greywater generated at households and
- scaling-up of this approach to improve nutrition and productivity and thereby contributing to poverty eradication.

Fig. 3: Two greywater towers in garden in Kitgum (photos by J. Kinobe, 2009).

3 Location and conditions

Kitgum Town is the administrative centre of Kitgum District which is located in Northern Uganda, approximately 450 km north of Kampala, the capital of Uganda. Kitgum Town covers an approximate area of 30 square km and is situated at an altitude of 937 meters above sea level at the bank of River Pager.

The climate is hot throughout the year, with two marked rainy seasons from March to June and August to November, whereas the rest of the months are dry and windy. The mean annual maximum temperature is 31.8 ˚C and the mean annual minimum temperature is 17.3 ˚C, giving an overall mean annual temperature of 24.6 ˚C. The average annual rainfall adds up to 1130 mm.

The current population of Kitgum Town is approximately 62,000 inhabitants living in 8,500 households spread in 11 parishes and 32 villages.

Prior to 2006, the situation in Kitgum Town was characterised by three major factors:

a) exponential growth of the population, worsened by an influx of people – both semi-permanent residents and night commuters – fleeing from insecurity in the villages due to a precarious security situation (rebellion)

b) extremely low per capita income and inadequate access to external funding (donor funding)

c) lack of human resources as a result of the insecurity

Starting from a sanitary situation mainly based on the use of pit latrines, altogether these framework conditions led to the present situation where only a minority of people have access to sanitation facilities.

Kitgum Town Council (KTC) ranks solid waste management top on their list of sanitation problems followed by uncontrolled wastewater discharge in the central areas of town. However, the lack of adequate sanitation facilities, like toilets for excreta disposal in the peri-urban areas of the town, seems to be equally or even more important, particularly when considering the number of people concerned.

The rebellion ended in 2007, since then Kitgum Town is growing and numerous constructions are taking place in the area. Currently, there are efforts of people investing in sanitation systems and especially in ecological sanitation systems (such as urine diversion dry toilets (UDDTs), greywater tower gardens and composting).

Agriculture is the major source of income in Kitgum district with more than 85% of the population relying on sales of agricultural products. Not only in Kitgum, but also in a nationwide context is agriculture contributing largely to the economy despite mostly being carried out at subsistence level and a low degree of industrialisation.

Both cash and food crops are grown in Kitgum Town and surrounding areas. Food crops comprise beans, maize, peanuts, sweet potatoes, cassava, bananas, soya beans, sorghum, millet, cabbages, sesame seed and rice. Cash crops include: maize and sun-flower. Also grown on small scales are fruits like papaya, mangoes and oranges. Animals kept include cows, goats, sheep, pigs and poultry. People in the central part of the city, are engaged in commercial activities such as wholesale and retail business, vending in markets, and petty businesses including brick making.

In Uganda, the under-five child mortality rate[1] is currently 130 children per 1000, which is very high but at least there is currently a clear downward trend towards fewer child deaths.

4 Project history

The ROSA project started in October 2006. The first activity of the project was to conduct a baseline study, which was concluded by March 2007 in order to get basic information about the sanitation situation and the status of reusing nutrients from excreta, wastewater and greywater (ROSA, 2007).

The baseline study was carried out using local community maps, questionnaires and checklists. Focus group discussions, key informant interviews and interviews with the local community were held. The data was analysed using SPSS and EPI Info software packages. Local/international laws/regulations relevant to ROSA were reviewed, town wide data was collected, key features geo-referenced and plotted on the town map.

The baseline study findings were disseminated in a workshop for local/opinion leaders, technical and NGO staff working in KTC. In order to select system types for piloting, to carry out research and later implementation, local leaders, being the decision makers on behalf of the communities, were trained on a Multi-Criteria Decision Support System (MCDSS).This is a decision making tool that takes into account different criteria, such as various components and characteristics of a sanitation system enabling the user to make informed choices on sanitation options suitable for individual areas and develop a Strategic Sanitation and Waste Plan (SSWP).

5 Technologies applied

Tower gardens are a user-friendly and innovative way of using greywater for gardening in low and middle income countries and have been implemented for example in Kenya, South Africa and Ethiopia.

Three greywater tower gardens were set up at each of the selected seven households (a total of 21 towers). The study households were trained by the research team on how to set up the tower gardens as well as on the operation and maintenance aspects for effective performance.

To show the effects of this irrigation/fertilisation method, a control tower garden set up in exactly the same way as the other greywater towers and planted with the same vegetables, was irrigated with groundwater instead of greywater.

6 Design information

For setting up a tower garden, a circle with a diameter of 0.8 m was marked on the ground (Fig. 4a). This circle was excavated to a depth of about 0.5 m to form the base of the tower garden.

Wooden poles (2 m high) were planted firmly into the surrounding soil and a plastic bag (slightly lower than the

[1] The under-five mortality rate is the probability (expressed as a rate per 1,000 live births) of a child born in a specified year dying before reaching the age of five if subject to current age-specific mortality rates (http://www.childinfo.org/mortality.html).

poles) with its base removed was tied around the poles to create a cylindrical sleeve (Fig. 4b).

After that, a bucket, also with its bottom removed was placed in the middle of the poles (Fig. 4c). Stones were carefully packed in the centre of the modified bucket (Fig. 4d), the remaining space between stones and bucket was filled with a soil mixture (Fig. 4e). The reason for placing the stones in the centre of the bucket was to create a vertical column, ensuring an even distribution of greywater throughout the surrounding soil mixture.

The soil mixture itself consisted of three parts of soil, two parts of animal manure and one part of ash (Fig. 4f). After reaching the upper rim of the bucket, the same had to be pulled out almost entirely in order to fill the inside again with stones and soil (Fig. 4g). The same had to happen with the bag - it was also pulled upwards to the same level as the bucket.

The whole procedure of filling and pulling bucket and bag upwards was repeated until a certain height of the tower garden (about 1m above ground) was reached (Fig. 4h – 4j).

Fig. 4: Setting up a tower garden with a height of approx. 2 m. Photos a –j are described in text above (photos by J. Kinobe, 2009).

7 Type and level of reuse

The baseline study indicated that there was no greywater reuse in the study area before (ROSA, 2007). The generated greywater was either disposed of in open places, open channels crossing the area and where possible in soak pits (68%, 11%, 21% of households, respectively) (ROSA, 2007).

These findings were corroborated by the interview results of the study where 76% of responding households disposed of laundry and 61% kitchen wastewater on the ground, while 71% discharge their bathroom wastewater into soak pits. Interestingly, 11% of responding households were already using the kitchen greywater as irrigation water in their gardens.

Interviews with locals indicated that they were not aware of any greywater disposal best practices but expressed a willingness to reuse greywater if taught how. The respondents from the study households indicated that there was no objection against having a demonstration unit for greywater reuse set up at their homes.

8 Further project components

Another project component consisted of gathering information about the impact of greywater on the soil. For that, soil samples were collected from each sample household prior to greywater application and analysed for pH, organic matter, nitrogen, phosphorus and potassium content.

After the application of greywater, soil samples were taken from the tower gardens on a monthly basis for a period of three months and analysed for the same parameters at the Soil Science Laboratory, Makerere University in Kampala, Uganda.

Additionally to that, sensitisation efforts targeting different parts of the community were carried out. On the one hand they were applied to raise interest, inform the community and recruit stakeholders, on the other hand in order to assist and accompany the process of implementation.

9 Costs and economics

The investment cost for a tower garden is approx. EUR 63[2] (Table 1). The total investment costs were covered entirely by the ROSA project.

Table 1: Cost estimates for a tower garden.

Items	Costs in UGX	Costs in EUR[3]
Labour	50,000	18.50
Gravel	40,000	14.80
Buckets	45,000	16.70
Bamboo sticks	15,000	5.60
Plastic bags (e.g. second hand fertiliser or seed bags)	5,000	1.90
Compost	10,000	3.70
Ash	5,000	1.90
Total	**170,000**	**63.10**

10 Operation and maintenance

Tower gardens were operated in such a way that collected greywater from bathing and washing clothes was applied on a daily basis. The daily amount of greywater produced per household varied between 48 and 60 litres. Some of this greywater was used for cleaning the house as well as pit latrines, hence, not all of it was used for the tower gardens.

On average each greywater tower could receive about three litres of greywater per day (or 9 litres per household which had 3 greywater towers). Over the weekend, the greywater towers were rinsed with two buckets (about 10 litres) of clean water to wash away the soap residues.

The control tower garden received about three litres of water per day which had been collected from a spring commonly used as a source for water for domestic purposes such as washing, cooking and drinking. To allow gradual percolation, the greywater is slowly applied to the tower garden from a 500 ml container. The tower gardens are used to grow vegetables, mainly tomatoes and onions.

11 Practical experience and lessons learnt

The main sources of greywater in Kitgum town council are laundry, bath areas and kitchen. The effect of greywater application on the soil characteristics was not significant with respect to potassium, organic matter and nitrogen content. However a slight decrease in phosphorus content, possibly due to plant uptake was visible.

Tomato and onion plants grown in the tower gardens thrived with the greywater. Due to an infestation by pests, it was recommended to additionally apply pesticides on the plants.

Informal interviews with locals from Paradwong village in Kitgum Town Council revealed that knowledge about greywater towers was generated by the sensitisation measures and the residents were interested in constructing the units at their homes.

A walk through the area revealed fifteen additional households that set up greywater towers after realising the benefits associated with the study units. As no such systems existed in Kitgum before initiating and conducting the project, the knowledge had to be acquired from the same (cf. ROSA, 2007).

This success was also confirmed by the people involved in constructing the towers. Through the introduction of tower gardens people got an understanding of the advantages of reusing greywater. In consequence, more households set up small vegetable gardens on their land and applied greywater directly to the plants, probably motivated by the fact that there was no extra investment required compared to that for a tower garden costing EUR 63.

The clear advantage of a tower garden is the reuse of greywater for vegetable growth where there is limited land and a family cannot have a big garden like the one shown below (fig. 5).

Fig. 5: A boy applying greywater from washing his legs on tomato plants (photo by Samuel Olweny, 2009).

12 Sustainability assessment and long-term impacts

A basic assessment (Table 2) was carried out to indicate in which of the five sustainability criteria for sanitation (according to the SuSanA Vision Document 1) this project has its strengths and which aspects represent weaknesses.

[2] The investments cost estimations have to be considered as "pilot project costs". E.g., buckets only have to be purchased one time serving for the construction of several greywater towers. Also other construction materials can probably be obtained from the environment for a minimum price. Furthermore it has to be considered that the biggest cost fraction "labour costs" can probably be provided for free by the users.

[3] Exchange rate: UGX 2,700 = EUR 1 (dated: 04.06.2010)

Table 2: Qualitative indication of the system sustainability. A cross in the respective column shows the assessment of the relative sustainability of the project (+ means: strong point of project; o means: average strength for this aspect and – means: no emphasis on this aspect for this project).

	collection and transport			treatment			transport and reuse		
Sustainability criteria	+	o	-	+	o	-	+	o	-
• health and hygiene	X			X			X		
• environmental and natural resources	X			X			X		
• technology and operation		X		X			X		
• finance and economics	X				X		X		
• socio-cultural and institutional	X			X			X		

After the end of this ROSA project, it is planned to undertake more investigations on tower gardens in peri-urban areas in Kampala in order to optimize the performance of the tower gardens, to assure a certain vegetable yield per soil volume as well as to further monitor the impact of the treated greywater on grop growth and on the general livelihood of the people. In general, tower gardens appear to be a promising option for solving the greywater disposal problem in peri-urban areas.

Sustainability criteria for sanitation:
Health and hygiene include the risk of exposure to pathogens and hazardous substances and improvement of livelihood achieved by the application of a certain sanitation system.
Environment and natural resources involve the resources needed in the project as well as the degree of recycling and reuse practiced and the effects of these.
Technology and operation relate to the functionality and ease of constructing, operating and monitoring the entire system as well as its robustness and adaptability to existing systems.
Financial and economic issues include the capacity of households and communities to cover the costs for sanitation as well as the benefit, such as from fertilizer and the external impact on the economy.
Socio-cultural and institutional aspects refer to the socio-cultural acceptance and appropriateness of the system, perceptions, gender issues and compliance with legal and institutional frameworks.

For details on these criteria, please see the SuSanA Vision document "Towards more sustainable solutions" (www.susana.org).

The main long-term impact of the ROSA project is improving public health, which can be extended by improvements regarding the nutritional situation and poverty eradication, when the aspect of reuse takes off.

Regarding improvements related to public health (such as reduced rate of diarrhoea incidences in children), the effects of the entire ROSA project will be evaluated from the disease surveillance reports of the town council and the district, at least on an annual basis.

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Case study of SuSanA projects

Resource-Oriented Sanitation concepts for peri-urban areas in Africa (ROSA)

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