Greywater treatment in an oasis town Béni Abbès, Béchar, Algeria

Fig. 1: Project location

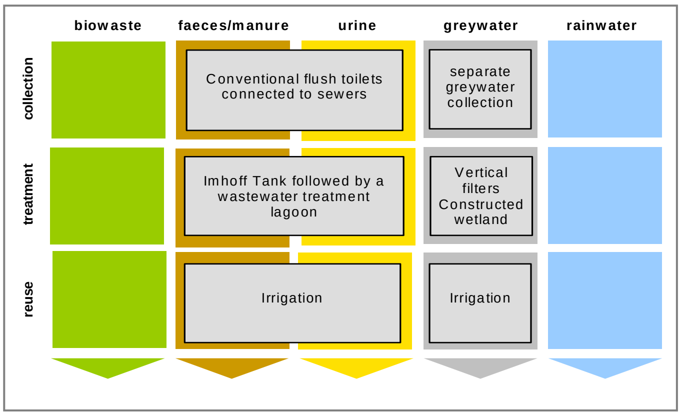

Fig. 2: Applied sanitation components of the overall project. (This case study focuses only on the greywater component.)

1 General data

Type of project:
The sanitation interventions took place within a larger GIZ Integrated Water Resource Management (IWRM) project for the efficient management of water resources in oases towns in Algeria. The sanitation component includes:

- The design of an black water collection, treatment and reuse system for the entire town
- The design and construction of appropriate on-site greywater treatment and reuse systems for domestic and institutional users.

This fact sheet presents only the greywater part of the wastewater concept.

Project period:
Start of construction: March 2011
End of construction: September 2011
Start of operation: March 2011
Project end: October 2011

Project scale:
Number of inhabitants covered: 2 private households, 2 public offices and a hotel
Size of treatment plant:
Greywater filters designed to treat a maximum of 150 l/day
Total investment: approx. 1,000 EUR

Address of project location:
Application and Diffusion of an Integrated Water Resources Management System in Oases Towns,
Béni Abbès

Planning institution:
AHT GROUP AG

Executing institution:
AHT GROUP AG

Supporting agency:
Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

2 Objective and motivation of the project

Water resources are limited in the oasis town of Béni Abbès (see Fig. 3). Efficient resource planning is complicated due the deficit of reliable data on demand, supply, and use of water. To improve the data collection, the GIZ introduced an IWRM project at the oasis in order to get a sufficiently account for all demands on the available water resources. IWRM is defined by the Global Water Partnership as "a process which promotes the co-ordinated development and management of water … in order to maximise the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems".

The range of stakeholders in this project includes the Directorate for Water of Béchar Wilaya (Province) and its sub-division, the Directorate of Agricultural Services and its sub-division, the municipality and the farming and non-farming population of the oasis.

Fig. 3: The oasis town of Béni Abbès (source: AHT GROUP AG, 2008)

The main objective of the sanitation activities of this IWRM project is to support the elaboration of an overall strategy for the future management of all wastewater, ensuring the collection and treatment of the generated wastewater within the oasis and to maximise its reuse potential.

A central sewer exists for the collection of domestic wastewater which should be treated at an appropriate treatment plant. The effluent is reused for irrigation in accordance with national law. Slightly polluted greywater from households and public buildings should be collected and treated on-site and used for the irrigation of gardens and the interior courtyards of houses, thus reducing the consumption of drinking water for this purpose.

3 Location and conditions

The oasis town of Béni Abbès is located in the catchment basin of the Oued Saoura in the North-Western Sahara. In this area the average annual precipitation is generally below 100 mm and falls over a six month period of the year. In 2006 the town had a total population of 10,898 with 2,000 households.

Béni Abbès first settlement was around a 40 ha palm grove where traditional three tier agriculture was practiced and date palms, fruit trees and vegetables were cultivated. The main water source was the Sidi Othmane spring which had an average flow of around 25 l/s in recent years. This is now supplemented by three wells and a series of foggaras (groundwater collection systems) providing additional 10.5 l/s.

Until the mid-1960s, when the population was still only a few hundred inhabitants, agriculture was the largest consumer of water. However around this time a fundamental change took place in water use patterns as a result of a rapidly growing population and the completion of the asphalt road to the national road network. Domestic water use became the largest consumer of water and agricultural production decreased. The provision of drinking water has now the highest priority.

Today Béni Abbès has no significant industrial production and most employment is generated by 26 public establishments include primary, secondary and academic high schools, local administration of Ministries (Water resources, Agriculture), municipality, district council (Daira), mosques, fire service, hospitals, hotels and a slaughterhouse. The palm grove still plays a very important role in the life of the town, although no longer as a centre of agricultural production. Instead it serves to improve the quality of life in the oasis and provides a recreational area and refuge for the inhabitants from the extreme heat of the desert. The palm grove thus remains for the population an essential element of the life in the oasis.

4 Project history

Following the dramatic population increase in the last 50 years and the change in water demand from a primarily agricultural use to primarily domestic use, competition for the limited water resources has led to a conflict between the two sectors.

This conflict was compounded by poor and inefficient management of the water resources.

The main approach of the project focused on medium-term demand management within the different use sectors of drinking water and irrigation of the palm grove.

To improve resource use efficiency, efforts were put into improving wastewater treatment systems and the reuse of purified wastewater for irrigation. Improved water supply management practices were also promoted to introduce 24 hours supply, thus reducing losses and peak consumption.

In order to improve the water supply situation in the palm grove, irrigation management has been improved. This includes strengthening socio-cultural traditions, clarifying “water rights", i.e. sharing available water between land owners based on delivery over a fixed time period every four days. Farmers proposed the construction of retention basins, which are filled according to the “water right”, while irrigation is managed more efficiently according to plant water requirements.

5 Technologies applied

The greywater collection, treatment and reuse system was implemented as a pilot project. It was intended to test the technology at household / decentralised level and to raise awareness of the potential of the household greywater treatment and reuse.

Greywater is collected directly from the kitchen sinks and the wash hand basins in the households and flows to the single compartment sedimentation tank / grease trap, to separated solids and grease from the greywater. The liquids flow into an unplanted vertical-flow filter and will be treated physical, biological and chemical processes. After that the effluent flows through a pipe into the plants. The pilot implementation was based on a strict demand responsive approach. The first activity was to construct a first system in the office of the project as demonstration pilot. This filter was connected to the discharges of the kitchen sink and the handwashing facilities of both the male and female toilets and treated approximately 80 l per day. This served to sensitise project partners and other key actors to the possibility of treating and reusing greywater in home gardens.

The initial pilot system at the project office, used by the served to provide some valuable lessons for the construction of subsequent systems (see Fig. 4). Future users approached the project and demanded support in having their own on-site greywater system. Initial demands were made by private households, a local hotel, the offices of a local NGO and from a local sport centre.

Fig. 4: The first pilot greywater filter and reuse system installed at the project offices (source: AHT GROUP AG, 2011).

6 Design information

The greywater treatment and reuse systems used in the project were designed to collect, treat and reuse greywater coming from kitchen sinks and wash hand basins.

The greywater coming from the kitchen sinks is collected initially in a grease trap / sedimentation tank, allowing fat and larger solid material to be separated from the greywater before it flows into the filter media. Here the greywater is treated by a series of complex physical, chemical and biological processes before being collected at the base of the filter and piped directly to the roots of garden plants (see Fig. 5).

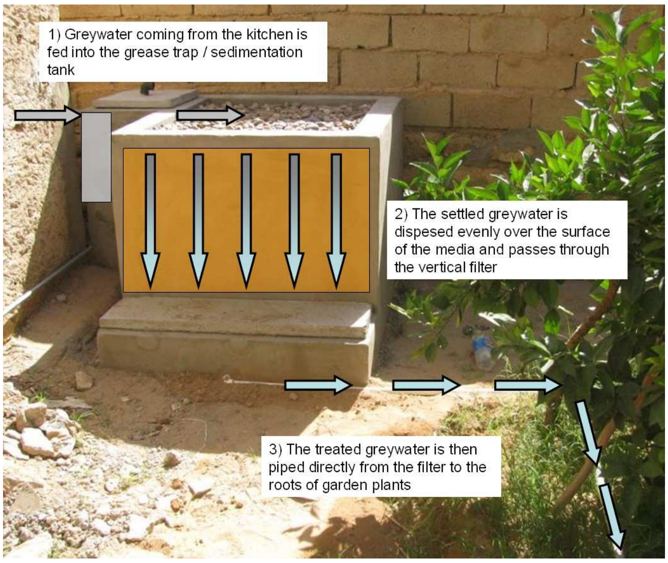

Fig. 5: Schematic of the greywater flow from the kitchen sinks, through the treatment system, to the garden plants.

The volume of greywater was estimated using the results of a survey carried out in households and institutional buildings in 2006 (see Table 1).

Table 1: Volumes of water used as a basis to estimate expected filter flows

Use	Volume (l/day)
Drinking and cooking	70 (summer) / 45 (winter)
Laundry (hand washed)	46
Personal hygiene	350 (summer) / 50 (winter)
Dishes	33

The estimated quality of the greywater was based on the data from experiences in Kenya and Germany as no specific data for the project area were available (see Table 2).

Table 2: Estimation of the quality of the greywater for the design of the filter

Source	Kenya * (mg BOD/l)	Germany ** (mg BOD/l)	BOD values used (mg BOD/l)
Kitchen	445	536–1,460	400
Laundary	449	48–472	400 (rinçage 200)
Shower	-	50–300	200
Simple hand washing basin	-	-	100

* Kraft (2009) ** Li et al. (2009)

The size of the grease tap and sedimentation tanks has been designed rather small due to the relatively low flows expected in all of the filters (generally around 80 l/day with a maximum estimated flow of 150 l/day for a filter to be installed in a hotel) with an average hydraulic retention time of over 10 hours. A BOD reduction of 20% was assumed for the grease trap. The tanks were built by a mason using cement blocks and finished with a high dosed smooth cement plastering. The grease tap/sedimentation tank and the filter have been constructed in one block. For the filter the general design parameters are shown in Table 3.

Table 3: General design parameters used for the filters

Design parameter	Value
Organic loading rate	25 g BOD/m²/day maximum (to prevent clogging)
Hydraulic loading rate	5 - 10 cm/day
Filter depth	> 0.8m
Filter material	Sand, coarse sand, pea gravel and gravel

The settled greywater is distributed across the filter media surface through a series of perforated pipes to ensure a relatively homogeneous distribution of water. If possible these pipes were placed on a layer of fine gravel to further disperse the greywater before entering the sand layer (see. Fig. 6).

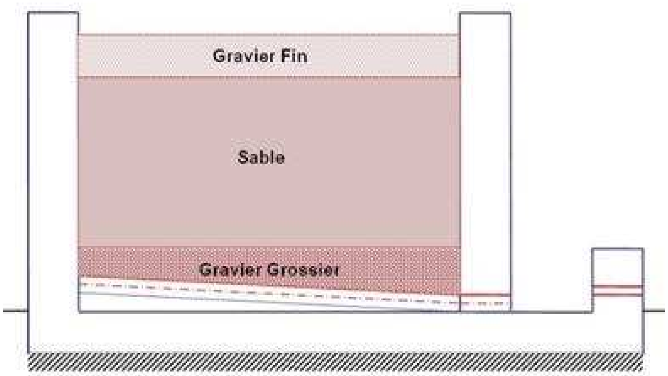

Fig. 6: Profile of the filter with the different layers (source: AHT, 2011)

This was carried out in order to reduce possible problems of plug flow and clogging once the filters were in operation. These pipes were then covered with a layer of coarse gravel.

Fig. 7: Settled greywater is distributed across the surface of the filter medium using a series of perforated pipes (source: AHT GROUP AG, 2011)

The filter media itself was made up of this initial layer of coarse gravel (10 - 20 cm thick), a sand layer (< 50 cm thick) and a bottom layer of gravel (10 cm thick) (see Fig. 7).

A priority in the design and construction of the filters was that all material should be available locally to keep the costs low and to demonstrate that local solutions are available for local problems. However sourcing a suitably porous sand proved to be a problem as the sand from the surrounding dunes proved too fine and required thorough sieving before a suitable grade was obtained.

7 Type and level of reuse

The irrigation of the gardens in the inner courtyards and in front of the houses consumes a significant amount of the total water consumption of a household. In general drinking water from the tap is used for this purpose. The treated greywater is a substitution of drinking water for the irrigation in the gardens.

The largest system is located at a household of 8 family members. The filter is connected to a storage tank that is necessary due the larger volume of treated greywater. The water is used for irrigation of the vegetable garden (see Fig 8).

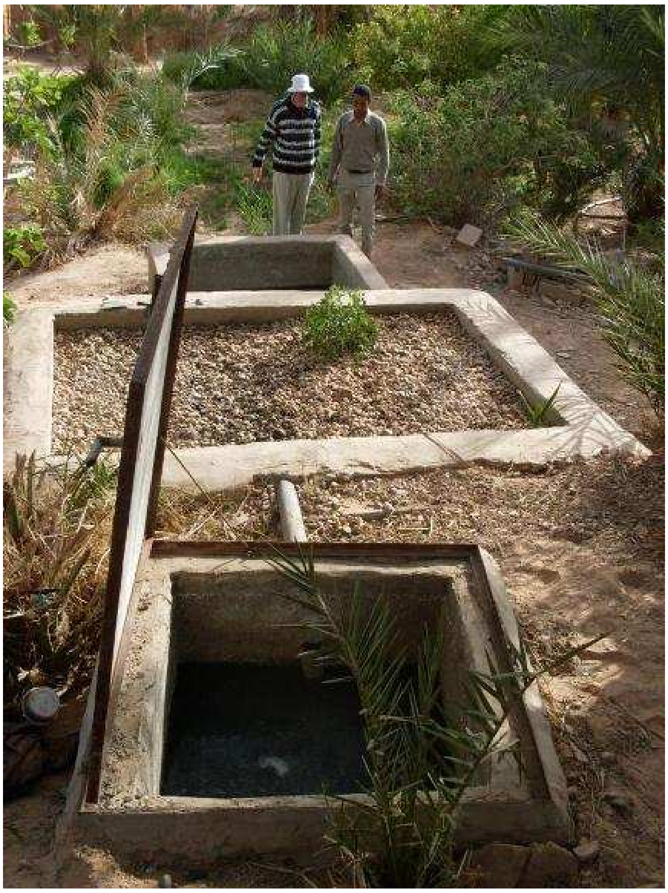

Fig. 8: The grease trap /settlement basin, filter and storage tank for the irrigation of the vegetable garden and the house of Mr. Boussouri (garden visible in the background) (source: AHT GROUP AG, 2011).

8 Further project components

The project also aims to support the development of the design, construction and operation of an appropriate wastewater treatment plant where the treated wastewater will be used for irrigation to substitute the use of freshwater.. This component of the project is currently in the design phase and is awaiting further implementation by the local authorities.

In addition to the sanitation component, the project also had drinking water supply, irrigation and water resources management components and developed an information management system to facilitate water management. This system allows an easy consultation of all pertinent data for the project and was used as a tool to present key information in map form.

9 Costs and economics

The largest filter treating 150 l/day of greywater has been installed at a small hotel. The total construction costs were 195 EUR. Smaller filters for the treatment of approx. 80 l/day had average construction costs of 150 EUR.

The treatment and reuse systems were also intended to have a demonstrative function. They illustrate the possible ways in which closed loop water saving systems can be used in urban areas using available resources. They were installed either in areas where the public could see them or at the houses of influential members of the community. As such the project financed these awareness raising activities with the householders and responsible institutions accepting responsibility for the operation and maintenance.

10 Operation and maintenance

Whilst the unplanted vertical filters in some ways require less maintenance than a planted filter. A minimum amount of regular maintenance is necessary to ensure the correct operation of the system. The operators of the systems were therefore informed of a minimum number of checks and measures to be taken to maintain the system. These were:

- Regular emptying of the grease trap / sedimentation tank, with the period being determined through regular control of the tank;
- Visual control of the quality of the effluent;
- Regular control of the filter media to foresee and correct possible clogging caused either by plug flow or through general blocking of the media.

Households and institutions were charged with carrying out this maintenance themselves. The possible replacement of the filter media after an extended period of operation is possible by using locally available material available.

11 Practical experience and lessons learnt

The main lessons learnt regarding the operation and maintenance of the greywater filters were obtained from the small pilot filter installed in the project offices.

This filter was first installed using a bucket distribution system, a relatively small surface area, a filter depth of around 30cm and a layer of geomembrane below the sand layer.

Fig. 9: Excavation of the completely clogged filter media in the original (source: AHT GROUP AG, 2011).

After one year of operation the filter was leaking. Excavation of the filter material showed that the filter was entirely blocked and the coarse gravel layer at the bottom of the filter, below the geomembrane was completely dried (see Fig. 9).

From this observation and a review of the design capacity of the original filter following changes have been decided for new filters (See Fig. 10):

- The addition of a grease trap / sedimentation tank before the filter to remove problematic material;
- The use of a series of pipes to distribute the greywater more evenly over the filter surface;
- The use of a maximum design organic loading rate of 25 mg BOD/m²/day to minimise the risk of clogging;
- An increased filter depth to at least 0.8m whenever possible;
- The introduction of a regular maintenance programme to monitor filter operations (including visually checking the quality of the filtrate and the state of the filter media;
- Removal of the geomembrane in order to have a filter model that could be easily replicated by local masons using readily available material on the local market.

Fig. 10: The rebuilt greywater filter at the project offices in Béni Abbès (source: AHT GROUP AG, 2011).

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12 Sustainability assessment and long-term impacts

A basic assessment (Table 4) 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 were not emphasised (weaknesses).

Table 4: Qualitative indication of the sustainability of the system. A cross in the respective column shows assessment of the relative sustainability of 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		

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 fertiliser 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 use of the on-site greywater treatment and reuse system in households and institutions in the oasis town of Béni Abbès results in the substitution of the use of precious and limited drinking water for garden watering purposes, through the use of treated purified greywater. This contributes to an improved integrated management of the available water resources and together with the implementation of the appropriate centralised wastewater treatment plant, would result in closing the wastewater loop for the town, dramatically increasing the efficiency of water use.

13 Available documents and references

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14 Institutions, organisations and contact persons

AHT Group AG (executing/planning authority)
Dr. Anja Stache, Project Manager / Agricultural Engineer
AHT GROUP AG
Management & Engineering
D-45128 Essen, Huyssenallee 66 - 68, Germany
E-Mail: stache@aht-group.com

Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH (supporting organisation)
Dr. Gabriele Kessel
Directrice Programme Lac Tchad
Deutsche Gesellschaft für
Internationale Zusammenarbeit (GIZ) GmbH
P.O. Box 123
N'Djamena, Tchad
E-Mail: gabriele.kessel@giz.de

Case study of SuSanA projects

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Authors: Patrick Bracken (AHT GROUP AG, bracken@aht-group.com)

Editing and reviewing: Dr. Jürgen Rambow (AHT GROUP AG, rambow@aht-group.com), Amel Sadoun, Philipp Feiereisen (GIZ, ecosan@giz.de)