Developing Sanitation Options to Protect the Water Quality of the Drinking Water Source of Herat City, Afghanistan

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Abstract
The Navin Well-Field Area is the source of water supply for Herat City, Afghanistan. The existing sanitation systems in the fast developing well-field area pose a threat to the groundwater quality and hence to the water source of the city. Herat Water Supply and Sewerage Company with the support of GIZ-Rodeco is implementing two alternative sanitation systems to protect the groundwater. These are: the household biogas sanitation system and the urine-diverting dehydration toilet system. The key factors in being able to implement new sanitation systems to protect water quality have been the highly progressive local leadership supporting the complete process, involving women during the dialogue and decision-making process, constructing first a demonstration sample of each sanitation system, and subsidising the construction cost of the new systems.

Keywords
Demonstration, leadership, subsidy, sustainable sanitation, water quality, women's participation.

INTRODUCTION

In the aftermath of war, Afghanistan is immersed in rebuilding its basic service infrastructure. In the urban water sector, this includes adopting a new water law, corporatizing its water supply and sewerage utilities, and building up an operational piped water supply network in the main cities. The water utility of Herat city is especially notable for its achievements in providing access to piped drinking water to more than 90% of the city (pers. comm. Nematullah Abbasi, GIZ-Rodeco, Herat, Dec. 2010).

Herat, situated in western Afghanistan close to the Iranian border, is visibly one of the well-developed cities in the country, having a metalled road network, functioning power supply, health and educational facilities, progressing economic activity and well-maintained city environs. The population is estimated to be greater than 600.000; in the absence of a recent census and with the return of a large number of refugees in the recent years, it is difficult to ascertain an exact number (pers. comm. Nematullah Abbasi, GIZ-Rodeco, Herat, Dec. 2010).

The drinking water for Herat city is supplied from deep water wells. The main groundwater source lies at the southern outskirts of the city in the villages of Navin and Torkan, which are collectively referred to as the 'Navin Well-Field Area'. Here, water is extracted from the aquifer at 75 – 90 m below the surface through ten deep wells. The Navin Well-Field Area was largely farmland only a few years ago, but due to rapid settlement of returning refugees and expanding population, construction of new houses is mushrooming. This rapid urbanisation around the deep water wells is posing a potential threat to the water quality of the city's drinking water source.

While the national Water Law clearly states that water service providers must provide quality water for drinking and domestic purposes, that the National Environmental Protection Agency must set the pollution tolerance limit for water resources, and that no person is allowed to pollute water resources (SSS/EIRP/FAO, 2009), there are as yet no procedures in place guiding the implementation of water resources protection measures (pers. comm. Najibullah Patan, GIZ, Kabul, April 2011). In the absence of any such mechanisms, the Herat Water Supply and Sewerage Company (known as the Herat water utility) has taken its own initiatives to protect the water quality of the Navin Well-Field.

Each of the deep wells in the Navin Well-Field is physically protected by a 50 m^2 fenced-off area around the well. During and after the period of establishment of the well-field (2002 – 2008) (BMZ, 2010), the water utility tried to add a further protection zone of 30 m x 30 m around each well where no construction and agricultural activity would be allowed. In the absence of sufficient hydro-geologic data, it adopted this figure from an example elsewhere in the country. Unfortunately, the utility was not able to purchase the privately-owned pieces of land in the vicinity. Rather, in complete contrast to the objective of establishing protection zones, the construction of a new road to the area resulted in the start of an uncontrollable building frenzy around the wells.

In 2009, the Herat water utility, with the support of GIZ-Rodeco (GIZ, previously GTZ, is the Deutsche Gesellschaft fuer Internationale Zusammenarbeit), decided to start a project to address the biggest threat posed by the rapid urbanisation, namely the sanitation systems which were emitting pathogens and nitrates directly into the surroundings and had the potential to contaminate the deep water wells in the long-term. It was determined that, keeping within a limited project budget, the 42 houses located inside a 70m radius of the ten wells would be supported technically and financially to change their sanitation systems with the primary objective of protecting the groundwater.

The aim of this paper is to describe the process of identification and implementation of improved sanitation systems within the local socio-cultural-economic context of Navin Well-Field Area and to highlight the mediators of change which were crucial to the task of disassembling existing sanitation systems and introducing unknown technologies. It should be noted, however, that the paper does not give a technical description of the sanitation technologies.

NAVIN WELL-FIELD AREA

Excerpts for this section have been taken from the internal GIZ report describing the assessment of sanitation options for the Navin Well-Field Area and updated with current information (Khawaja, 2010).

Local Context

Geo-physical context. The Navin Well-Field lies in the villages of Navin and Torkan in District Injeel, the boundaries of which merge with Herat city. A survey in 2009 showed that the two target villages comprised almost 600 households with a population of approximately 4.500. The 42 households identified within the direct vicinity of the wells had almost 400 inhabitants.

The landscape of the Navin Well-Field Area is flat. The underlying soil type is mostly gravel with interspersed clay lenses (pers. comm. Dietrich Guett, GIZ-Rodeco, Herat, Nov. 2009); the gravel gives the soil a high hydraulic conductivity and hence a higher risk of ground water pollution. The shallow groundwater table in the area is high, ranging from about 3 – 8 m below the surface. The deep aquifer starts at 25 m below the surface. The annual temperature range is -5 to 38 °C; however, in extreme winters, temperatures can fall down to -10 to -15 °C. Precipitation occurs mostly during the winter and summers are hot and dry.

The villages are connected to the city's power supply which is currently a secure source from neighbouring countries and provides electricity most of the time. Energy for heating and cooking is taken from biomass and fossil fuels. Animal manure is collected, dried and burnt for cooking; people with surplus manure sell it as fuel. Alternatively, gas is purchased in cylinders and used for cooking. Coal and wood are used for heating.

In 2010, the area was linked to the water supply network of Herat city (i.e. benefiting from the deep wells in their locality) and the households are in the process of obtaining connections. The households are however retaining the shallow water wells which are found in most yards and were previously the main source of drinking water. During the summer, families with fields nearby may dig their shallow wells deeper and use the water for irrigating the crops. The irrigation period extends from early April to end of September. There are also irrigation channels running through the two villages, which divert water from the river upstream and then re-connect to the river downstream. There is no wastewater canalisation network and each house has an independent toilet system. For bathing, families typically go to the local community bath if possible or use a make-shift bathing area at home.

Socio-economic context. Navin and Torkan villages, including the project target households directly around the wells, have a mixture of socio-economic classes and different types of housing complexes. Many families live in traditional compounds with residential rooms made in the local, mud construction style surrounded by spacious yards having trees and vegetables. They may also keep animals such as cows, goats, poultry and a donkey in the compound and have a section for the animals that may include a winter enclosure and an open summer area. The upcoming houses in the area tend to be made on smaller plots with many being the typical city-type brick and concrete houses; they also have some yard area which is often all paved with concrete. There are a few very poor families in the villages living in abandoned structures; they were however not found in the direct project area.

Farming fields are interspersed through the villages and this land belongs to families living there (approx. 40% of the families) as well as to those who now live in Herat city. Most of the people rely on an income from work in the city. Even the farming households tend to earn a partial income from non-agricultural sources.

Village development processes are guided and implemented by the village *shura*, a local body of village representatives. The *shura* system is a traditional set-up in Afghanistan. In the past, the representatives were unanimously selected. With the start of reconstruction in Afghanistan in the last decade, the Ministry of Rural Rehabilitation and Development adopted the system for the rolling out of its large-scale reconstruction program under which the village *shura* became a Community Development Council (CDC) and the representatives became elected for a limited term. The CDC also comprises a sub-committee of women representatives. Navin and Torkan villages have their own CDC each. In local reference, the CDC is known as the men's *shura* and the women's sub-committee is known as the women's *shura* of the village.

In the well-field, women follow a veiled culture. The household is the domain of the women and activity outside this domain is segregated by gender. The *shura* actively represents the concerns of the women; however, their presence in public is veiled.

The most powerful person in the Navin Well-Field area is the *Arbab*, or the local leader, of Torkan village. The *Arbab* is a traditionally allocated title, through unanimous selection, to an able leader for the village. The *Arbab* of Torkan is not a member of the village *shura* but he retains an unofficial presence and is able to represent the village at various levels. He also receives compensation for his work and effort, typically as an annual share of agricultural goods produced in the area. Navin village also has an *Arbab*, but he does not pursue village affairs and by default the *Arbab* of Torkan has much influence with the inhabitants of Navin village.

Sanitation Situation

Existing sanitation systems. The household sanitation systems found in Navin and Torkan villages are basically of two types – a raised-pit dry latrine or a pour-flush toilet connected to an open sewage well. The raised-pit dry latrine is the traditional system of Afghanistan and is used throughout the country in different forms in the rural as well as urban areas. Linked to the pit latrine, is the age-old practice of reuse of excreta for enhancing soil fertility. In fact, excreta are still valued as an important source of crop nutrients for farmers, in both dry and wet forms. In urbanising areas, economic development is often a reason for people to discard the traditional latrine and upgrade to a 'flush out-of-sight system' which is considered cleaner and with less maintenance hassle.

In Navin and Torkan villages as a whole, only a small percentage of the total households have a pour-flush toilet. However, many of the target houses around the deep water wells have been newly constructed and the owners have invested in the aesthetically appealing pour-flush toilet system. Hence, the majority of households identified for the sanitation project (29 out of 42) are using this system. The two types of systems are described below.

The raised-pit dry latrine is an above-ground raised vault that has a height of 1 – 3 m. The upper level of the vault is the floor of the toilet and has a hole for defecation. The bottom base is open ground and liquid gathered in the vault can flow into the soil and ground water. These containment units have an opening on one side of the vault and are usually emptied out manually at an interval of 1 - 6 months depending on the latrine depth and family size.

The pour-flush toilet is connected to an underground, off-set sewage well. The sewage well has an open base and the walls are assembled using vertically-stacked, 40 cm wide concrete rings; some houses support only the mouth of the well with a single concrete ring. These underground wells are between 3 - 8 m deep and are emptied out at intervals of 2 months to 3 years, usually by a tanker service; a few households empty it out manually as a tanker is not able to have access to the sewage well in some places.

The excreta emptied out from the latrines and sewage wells are considered useful for the land around the villages. The waste excreta is mixed with soil and dried in the open for a few months, and then spread on to land cultivated with cereal crops. Families who do not have yards or their own fields request neighbouring farmers to accept the human manure on their lands. Tanker services that empty out the waste from the sewage wells also dispose of the excreta onto farmland.

The men and women have distinct roles related to sanitation. The task of manually emptying out the excreta from the sanitation units or arranging for its removal belongs to the male members of the family, while the women are responsible for the upkeep of the toilet.

The grey water production is about 25 - 30 l per person per day. The grey water is fed to plants and trees in the yard, guided to an irrigation channel outside the housing compound if available, or simply discharged outside the home boundary wall into the street.

Threats from the sanitation systems. The most critical threat from the two sanitation systems found in the Navin Well-Field is the contamination of the underground water resources. Both the dry pit latrine and the sewage well are open to the ground and hence pathogens and nitrates from excreta are able to migrate through the surrounding soil and water. Notably, the sewage wells are made underground and are very close to the shallow water table, often the depth of the wells being restricted by the level of the groundwater.

The shallow drinking water wells found in many of the home-yards are reported by the community to have a hygienically poor water quality, and the women pointed out that children suffered from diarrhoea and stomach aches when drinking this water. They attributed this poor quality directly to the close proximity of the latrines to the shallow water wells (often less than 10 m horizontal distance).

At the time of construction, the deep water wells in the Well-Field were tested for nitrate and microbiological content and were found to be within drinking water guideline limits. Since then no testing-at-source system has been put into place. However, the basis of the sanitation improvement project is that the largely gravel substratum has a high hydraulic conductivity and thus the deep water resource is at a risk of contamination in the long-term.

In addition to the aspect of water resources protection, the existing sanitation systems need to be assessed from the aspect of health and environment. For the toilet user, a well-maintained pour-flush toilet provides a comfortable environment with no smell and flies, whereas the dry pit latrine attracts a lot of flies, is malodorous, and is also visually unappealing with the old excreta clearly visible. The emptying process of both types of toilet systems, however, creates a nuisance. An open sewage well emits a lot of smell into the surroundings. The manual cleaning-out of the dry latrine puts the person doing the job in direct contact with fresh excreta and the associated smell.

DEVELOPING SUSTAINABLE SANITATION OPTIONS

Technology Selection Process

Information for this section has been taken from the internal GIZ report describing the assessment of sanitation options for the Navin Well-Field Area and updated with current information (Khawaja, 2010).

Preliminary discussions. Preliminary discussions were held with the community of the Navin Well-Field Area to be able to gauge the existing sanitation situation, which has been described earlier. Additionally, these discussions were important in order to understand the perceptions of the community about water quality and sanitation issues and to identify their sanitation needs. Information was gathered through separate focussed-group discussions with the men's and women's *shuras* respectively; these sessions also included other interested community members.

The men and women were well aware that the cause of pollution of the shallow water wells in their homes was their existing toilet systems. They were hence also able to understand the possible risk of contamination to the deep water wells in their neighbourhood from the sanitation systems. Moreover, the households with the raised-pit dry latrines particularly complained of the associated smell and flies, and the households with the underground sewage wells said they had a higher economic burden because they had to pay a tanker service, on average 600 - 700 Afghani ($12 - $14), for emptying out a well (they also had to deal with the nuisance of smell during this operation). Hence, the people were receptive to improving their sanitation systems if they would be supported in doing so. To their knowledge, however, the only means of meeting the objective of groundwater protection was by installing leak-proof sewage holding tanks, but this would have too high a maintenance cost because of the frequency of emptying out required.

In the process of identifying criteria considered as important by the community for any new sanitation system, the men and women had very different reactions. Tired of the unpleasant responsibility of emptying out smelly excreta chambers, the men very simply wanted a technology where excreta would be out-of-sight and were especially against any system which would be similar to their traditional pit latrines and require handling of excreta. The women, on the other hand, were willing to engage in detailed discussions about options.

The women pointed out that while exposure to fresh excreta was dangerous for health, it nevertheless was beneficial for the soil and cultivation of crops. They considered that a toilet which could eliminate the health and environmental hazards of the traditional pit latrine but retain the nutrient value of the excreta would be a useful system even if it required manual maintenance and handling of some form of excreta. The women felt that they would be able to convince the men of their family to participate in operating such a system albeit the men’s resistance to handling excreta.

Technology short-listing. A list of criteria for the selection of alternative sanitation systems for the well-field was made based on the discussions with the community, the local context and the primary objective of water quality protection. The criteria can be summarised as follows: no contamination; protect health; user-friendly (no smell or flies); both washing and wiping systems for anal cleansing acceptable; single household or small-scale decentralised system; operation and maintenance requirements within the technical and economic capacity of the users; economically and practically feasible; and reuse of excreta considered beneficial (energy, fertiliser, water).

Four sanitation systems were selected based on the above criteria. These are listed below with descriptive phrases for each system (Tilley et al., 2008):

1) Double-vault urine-diverting dehydration toilet system (UDDT)
   Dry ventilated toilet; two raised faeces collection vaults used alternatively in a six-month rotation; squatting pan has separate parts for the flow of urine, faeces and anal cleansing water respectively; faeces collection vault emptied out once a year; dried faeces mixed with soil and used on fields; urine collected in containers and used as urea fertiliser after storage; anal cleansing water infiltrates through a soil filter.
2) Fixed-dome biogas sanitation system (for toilet waste and cow manure)
   Black water from pour-flush toilets and cow manure enters an underground concrete dome digester; biogas produced from anaerobic bacteria in the digester stored in the dome; biogas used in the kitchen for cooking; digested slurry exiting from digester separates into solids and liquids through a sand filter; liquid used for irrigation and solids used as fertiliser.
3) Septic tank with constructed wetland wastewater treatment system

Preliminary treatment of combined wastewater through septic tank; treatment of septic tank outflow through a planted, gravel bed; treated effluent containing nutrients used as irrigation water.

4) Septic tank with off-site subsurface infiltration wastewater treatment system
Preliminary treatment of combined wastewater through septic tank; treatment of septic tank outflow through infiltration in shallow, sub-surface ditches.

The first two systems would be single household units, whereas the latter two systems would treat the combined wastewater of a group of houses.

A workshop was held in the local mosque to present the four systems to the community and analyse the suitability of each system according to the people's needs. With the consent of the village representatives and the *Arbab*, both men and women attended the workshop; special arrangements were made for this mixed public gathering by using a curtain to divide the two genders such that they could hear each other but not see each other. The overall result of the workshop was that the first two options - the UDDT and the biogas unit - created interest, the last two systems were completely discarded, and some participants felt that none of the proposed technologies were suitable.

The UDDT was generally considered a suitable option for the houses in the area that had the traditional raised-pit dry latrine. The women in particular were in favour of the system, and after seeing a video on the system, the men were no longer resistant to this type of dry toilet. One of the men raised the point that even if the UDDT would be suitable for and properly used by a household, family guests would not know how to use the urine- and water- separating squatting pans. A woman replied that guests would have to be informed about using the toilet, and in this way, the neighbourhood and other people would also soon learn about this new system. The main concerns about the UDDT were that it required more space than a traditional latrine because of the two vaults and that a system of managing the collected urine for non-farming houses would have to be made.

The concept of biogas production from a sanitation unit was new for the community and it created a lot of interest because of the possibility of using biogas as a cooking fuel. However, since this system was only a possibility for households having at least two cows and enough space in the yard for making the construction underground, its application was limited to a few (about four) of the target houses near the wells (in the wider community of Navin and Torkan villages, it had a higher potential).

The septic tank linked to either a constructed wetland or an off-site subsurface infiltration system had been presented as an off-site technology for treating the wastewater of clusters of the newly-built houses which had small yards and were using sewage wells. However, these two options were considered as impractical by the participants because of the issue of land required and because of the need for joint management. The landless people felt they could not negotiate with surrounding farmers for obtaining land even if the farmer would be able to use nutrient-rich water for irrigation. The most notable issue was that the men were not interested in any system in which they would have to work together with other households. Each person wanted an individual household system, and therefore they were not willing to consider any combined system. Hence some of the smaller houses having flush toilets with sewage wells did not feel any technology was suitable for them.

Implementation Process

The technology selection workshop showed that the UDDT and the sanitation biogas system were possible solutions for the area. However, the process of disassembling the existing toilets of the target households living in the vicinity of the deep wells and replacing them with a new system required still further community preparation after the workshop. The biggest hurdles were that the households with the comfortable, new pour-flush toilets were sceptical of replacing these with something which may be less user-friendly and, in general, people did not want to take a risk with a system which they had not seen working before.

Owing to these concerns, the project decided to first construct demonstration units for each of the two systems. The target households would then be able to decide if either of the system was suitable for them, and the project would provide full subsidy for all of the target households interested in adopting one of the systems. The project would however not force any household to change their system. The *Arbab* identified the two families willing to install the demonstration units and the water utility arranged for a construction company to build the systems based on designs made by GIZ-Rodeco. An important characteristic of these two families was that they were willing to serve as learning centres for the project and the community.

The demonstration units were successful in achieving their aim of showing functioning systems. Their success was largely attributable to the support of the families, but in particular, to the women of the two households. The UDDT, under the care of the female head of the family, became an excellent example of a clean and well-operated toilet and a novelty item. Before the project could even organise a formal community visit to the UDDT, people were turning up at the door of the house after the 5 am morning prayers to have 'a look' at this new system. The biogas family was patient with the three-month implementation time of the unit as it was the first such unit in Herat and thus also a learning experience at all levels from the design engineer to the mason. After the construction was completed, the women ensured the correct input and mixing of the cow manure and the school-going girls maintained a daily cooking chart for monitoring purposes. The two functioning demonstration systems, combined with the motivational efforts of the *Arbab*, resulted in convincing many households, including those having pour-flush toilets, to adopt the dry UDDT system; biogas was limited to the few houses with livestock.

From the start of the first survey of the Navin Well-Field Area in late 2009 to the time of completion of the demonstration units in November 2010, the area saw a rapid pace of construction activity and approximately 30 additional houses started building in the project target area directly around the ten deep water wells. Since not all of the houses originally found in the project area were willing to change their system (only about 30 out of the 42 were interested), the project decided that the new houses would be included in the support package on a 'first-come-first-serve' basis, keeping within the available budget. In the final count, the project has been able to support the establishment of 37 UDDTs and two sanitation biogas systems in the target area. From June 2011 onwards, all of these systems will be operating.

Next Steps

The immediate follow-on steps in this process of implementing non-polluting sanitation systems are to provide continuous support to the households with the new systems; this is important in order to ensure the proper use and maintenance of these systems, especially the proper management of all the by-products (the dried faeces and urine from the UDDTs and the biogas and slurry from the biogas units). Only after proper use, can they be considered as fully successful and suitable technologies for the area.

Following this, other measures need to be taken which include: considering further financial support for the remaining houses in the target area (who are also interested in the new systems); addressing the issues of the houses which do not want to change their systems; creating mechanisms (institutional and/or social) to prevent new developments from polluting the ground water; and supporting the up-scaling of such technologies for other interested community members who live outside the direct project target area.

MEDIATORS OF CHANGE

Considering the local context of the Navin Well-Field Area, the mediators of change critical in the development of sustainable sanitation options for protecting the drinking water source have been the progressive leadership, women's involvement, creating a demonstration effect, and providing subsidy. These are summarised below.

Progressive leadership. The leadership in the area is being provided by the *Arbab* of Torkan village. His acceptance has been the entry point for the project into the community. His forward thinking approach has been the catalyst for focussing people on to the issue of resource protection. His social power has been the means of motivating the community and pushing a significant number of households in adopting unfamiliar systems. His time and effort have been essential in facilitating the project and for triangulating information. His inclusive attitude has ensured that women were made an integral part of the process.

Women's involvement. The women living in the Navin Well-Field Area are mostly care-takers of household activities and the cultural norm dictates public segregation from men. Albeit having limited access to the outside world and few educated women in the area, they surprisingly had a high level of awareness on the links between health, hygiene, water quality and sanitation.

The women have been vital in the adoption of new, unfamiliar sanitation systems; they were open to new ideas where the men were hesitant. The women were crucial for the collection of accurate information during planning and monitoring; in particular, where specific information was needed for design purposes, the men tended to exaggerate whereas the women described the real situation. Finally, the successful demonstration of the first UDDT and biogas units was a result of the efforts of the women of the household.

Demonstration effect. The men and women were well aware about the issues of ground water contamination through their own experiences and through the guidance of the *Arbab*. Further, the presentation and video in the workshop helped to illustrate non-polluting sanitation options. However, these factors were not enough to overcome the scepticism about new technologies. The turning point came with installation of the demonstration units when people were able to personally see and experience the new technologies.

Subsidy. Completely subsidising the construction cost of the sanitation systems has had three main effects. Firstly, the Herat water utility was able to orient the community towards the primary objective of resource protection in an area where people already had existing toilet facilities. Secondly, the people could be persuaded to implement a technology they had not seen before. Finally, many of the households with the attractive new pour-flush toilets could be convinced to replace even these appealing units.

CONCLUSION

The national Water Law provides a framework for the protection of water resources. However, the procedures for guiding implementation are lacking. The Herat water utility, with the support of GIZ-Rodeco, has taken the initiative of minimising the risk of contamination to the water supply source of Herat city, by targeting the polluting sanitation systems. The experience shows that, on the one hand, characteristics within the community are essential to create the environment for change, notably a strong and progressive leadership and harnessing women as internal change agents; on the other hand, external support elements such as creating demonstration effects and providing financial incentives are necessary to enable people to implement protection-oriented measures.

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