Case study of sustainable sanitation projects

Wastewater treatment in flood affected areas using constructed wetlands Nowshera, Pakistan -draft

Fig. 1: Project location

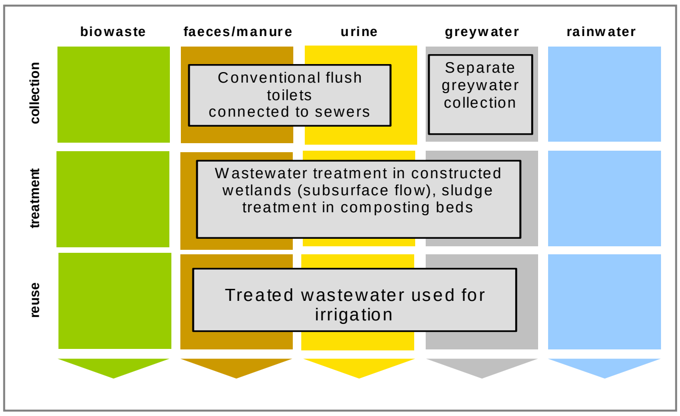

Fig. 2: Applied sanitation components in this project

1 General data

Type of project:
Full scale, rural project (constructed wetland and reuse) and demonstration project

Project period:
Start of construction: August 2011
End of construction: October 2011
Start of operation: October 2011
Project end: October 2012
Monitoring: Ongoing

Project scale:
Number of people covered: 1,100
Total investment: Approx EUR 40,900

Address of project location:
Baba Jee Kali Village, District Nowshera, Khyber Pakhtoonkhwa

Planning institution:
UNICEF, UN Habitat, Plan International Pakistan

Executing institution:
Consortium lead by Plan International Pakistan

Implementing Partners
- Integrated Regional Support Programme (IRSP)
- National Rural Support Programme (NRSP)
- Islamic Relief-Pakistan (IRP)
- Punjab Rural Support Programme (PRSP)
- Agha Khan Rural Support Pakistan (AKRSP)
- Lodhran Pilot Project (LPP)

Supporting agency:
UNICEF

2 Objective and motivation of the project

The devastating 2010 floods in Pakistan affected large populations, depriving them of the basic human needs; and led to extremely poor sanitation and hygiene conditions. To solve these problems, Plan International, Pakistan with the financial backing of UNICEF launched a program on "Scaling up Rural Sanitation programme'' in flood affected districts of Pakistan". The program is divided into three major phases, each phase handling a different aspect of the overall situation. On completion of all the three phases, a total of approximately 7 million people (from 32 flood affected districts of Pakistan including AJK and Gilgit-Baltistan) will benefit from the program intervention.

The primary objective of this rural sanitation program is to safeguard and protect the health of the flood affected population from water, sanitation, and hygiene related issues

This project envisages a total village sanitation concept, which will ensure a healthy environment in the Baba Jee Kali village and at the same time act as a model system for further replication in the KPK province.

Fig. 3: The final phases of the SSF-CW

The sanitation program is based on the Pakistan Approach to Total Sanitation (PATS) which has four main pillars/Stages:

a. Demand creation for sanitation resulting in open defecation free communities;
b. Sustaining the demand through supply side interventions;
c. Participatory health and hygiene promotion;
d. Attaining adequate drainage and wastewater treatment through constructed wetlands

3 Location and conditions

Baba Jee Kali village was selected as the first village for the end pipe solution in flood affected areas in KPK province. Baba Jee Kali is situated in Nowshera district near the Charsada District boundary. It is an old village with 110 houses and about 1100 inhabitants. This area is water logged with a ground water level of about 2-3 feet deep. Formerly no treatment facility for waste water existed in this village and untreated waste water was discharged onto open land or nearby drainage canals.

The prevailing situation in Baba Jee Kali village was very dire. Prevalence of water borne diseases including cholera, diarrhea, and dysentery in both adults and children was the norm. The children were more susceptible to these diseases as they played in contaminated stagnant waste water. This project envisages total village sanitation concept, which will ensure a healthy environment for Baba Jee Kali village and act as a model system for further replication in KPK province.

Fig. 4: Survey work for drains in progress

4 Project history

Pakistan approach to total sanitation seeks to undertake a series of measures aiming at ensuring 100% safe management of excreta, attaining open defecation free status, and the use of secondary barriers. The program also promotes the use of safe, hygienic latrines and other sanitation facilities and promotes improved hygienic behaviours as the main object is to attain total sanitation.

Integrated total sanitation model

Attaining 100% adequate drainage and waste water treatment

1. Advocacy for waste water disposal in a hygienic way
2. Advocacy for underground/covered drainage system
3. Advocacy for waste water treatment through oxidation ponds
4. Ensuring adequate drainage design with the support of PHED
5. Piloting the drainage and wastewater treatment in select village

Fig. 5:

In this project, construction of the village sanitation system was assigned to Integrated Rural Support Program (IRSP) and end pipe solution to NBS. NBS introduced its developed concept of Integrated Sanitation & Farming System (ISFS) for treatment of waste water as end pipe solution.

5 Technologies applied

A topographic survey of the proposed drain alignment was carried out, in order to achieve gravity flow of wastewater.

Thereafter, a network of covered drains was laid for the collection of household wastewater on gravity flow gradient leading to the proposed constructed wetlands site**.**

Prefabricated channels, measuring cross-section of 3*1.5*1 were used which proved to be very economical in terms of cost and laying time. Man holes at required distances were built for periodic cleaning and maintenance purposes

Fig. 6*:* Creating the drains

- Total number of the beneficiaries ranging up to 1100-1200 people who provided the land free of cost for the end of the pipe treatment facility.

- A village sanitation committee which was formed during the community triggering actively participated right from planning phase to the completion phase of the project. who will be responsible for operation and maintenance of the end of the pipe treatment facility

6 Design information

Layout Design

Fig. 7: Location of ABR clearly showed ground water level

Fig 8: Construction phase of ABR showed no sign of ground water seepage

Bioremediation technology was developed for 110 houses with an estimated 35,000 US gallons of waste water produced per day. The Layout design was made suitable for the next 20 years by keeping in mind a 2.5% population growth rate of the area and therefore a capacity of the project site is about 50,000 US Gallons per day with 7 days HRT having more than 95% treatment efficiency per day.

The different major components of the layout design are:

- Anaerobic baffled reactor (ABR) cum waste water storage tank,
- Sub-surface flow constructed wetland (SSF CW),
- Free surface flow constructed wetlands including facultative and maturation ponds,
- Water filter,
- Phytoremediation units,
- Fish pond,
- Integrated units include mushroom cultivation,
- Poultry farm for 50 birds, animal shed and biogas for animal sanitation,
- Herbal garden and horticultural crop unit.
- Administrative units including an office setup etc.

Anaerobic Baffled Reactor/ waste water Storage Tank

After screening and solid particle separation, the first technological component at Baba Jee Kali village is an Anaerobic Baffled Reactor (ABR) with 12 hour hydraulic retention time (HRT).

During construction of the ABR a 250 micron polyethylene sheet was used at the base to avoid any kind of mixing of ground water and waste water including construction of RCC bed by mixing of sodium bentonite and it ensured that no seepage occurred after completion. Three baffles were employed with activated sludge as initial seeding. ABR made sealed tight to ensure anaerobic conditions and prepared roof material was used with roof toping of soil.

Sub-surface Flow Constructed Wetland (SSF-CW)

A sub-surface flow constructed wetland was constructed with indigenous materials established by the NBS research team. The area of sub-surface constructed wetland was 1000 square feet with a capacity of 5000 cubic feet. The porosity of material 60:40 ratio and having 1% inclined slope. Have efficiency of 40% COD & BOD removal with 5 hour HRT. The SSF-CW was provided with microbial consortia prepared by NBS microbiologists for bio-film formation. Indigenous submerged aquatic vegetation was used for increasing treatment efficiency of constructed wetland. An Av Polyethylene sheet was used to check seepages and ensure that no leakages occurred during the project's lifetime. The ABR and SSF-CW ensured that there would be no foul smell from treatment site, which made project site as water garden

7 Type and level of reuse

The project plays an important role in promoting food security, health and household maintenance, and water-based livelihoods and livelihood diversification. The management of WSS systems and treatment of wastewater through constructed wetlands has important effects on ecosystems that support livelihoods. The intended benefits are;

a. Reclaimed irrigation water
b. Fish ponds for fish breeding and will also an indicator for treated water quality.
c. Herbal and mushroom garden- value added product income
d. Animal fodder and poultry feed from phytoplants
e. Compost from duck weeds and other water plants.
f. Biogas from anaerobic bio-digester (ABR)

8 Further project components

The project also aims to support the development of the design, construction and operation of wastewater treatment plants in all project areas. The initiative will create government buying where the treated wastewater will be used for irrigation to substitute the use of freshwater. This component of the project is currently in progress

It is projected that constructed wetlands will provide the following benefits:

- Village wastewater management and utilization
- Fish pond
- Treated wastewater utilization for irrigation
- Village organic solid waste matter management
- Cattle shed and biogasplant
- Integrated agro-based cottage industries for income generation
- Organic fruit and vegetable farming
- Fungi culture (mushroom farming)
- Poultry farming
- Improved health

9 Costs and economics

The construction cost for the constructed wetlands and other facilities are around EUR 40,900. The project has two components;

Collection of waste water :	EUR 15,000 approx
Constructed wetland:	EUR 25,900 approx

This consisted of material cost, labour, and training as well as for documentation and public relations costs. The remainder was spent on feasibility and other administrative permits.

10 Operation and maintenance

After completion, the project was handed over to a village sanitation committee (VSC) of the area, for ownership and sustainability. The project will itself generate income in order to meet operational and maintenance cost. VSC members were trained on the programme approach and also involved in the project initiation planning and execution.

The VSC is comprised of prominent locals with an equal male to female representation.

11 Practical experience and lessons learnt

In comparison to other waste water treatment techniques, this technology is less expensive and appropriate for community waste water treatment.

Once the facility is constructed no further technical capacity is required and as matter of fact proper community social mobilization and village WASH committee plays an important role in ownership and maintenance.

The facility can be further scaled up as a bio diversity site that provides shelter to migrant birds and other flora and fauna.

The technical design of Baba Jee Kali wetland is tolerant of fluctuating hydraulic and contaminated loading rates; it provides an opening for further research and educational opportunities.

Relatively large land is required for a constructed wetland. The water table in Baba Jee Kali is at 2-3 feet and in order to control buoyancy of ground water; large stones and gravel to put pressures on the sheets, this has increased cost of labor and material. If the water table continues to rise the functionality of this wetland will be affected. In Baba Jee Kali, a Biogas plant cannot be installed as the water table is high in the area

Not all potential vector concerns have been addressed
Design of constructed wetland varies from area to area, and there is no standard design that can be replicated by the other communities. In the coming years we need to address this issue in order to facilitate and empower communities in a better way

12 Sustainability assessment and long-term impacts

Table 1: Qualitative indication of sustainability of 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, e.g. 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).

13 Available documents and references

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14 Institutions, organisations and contact persons

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UNICEF Pakistan
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