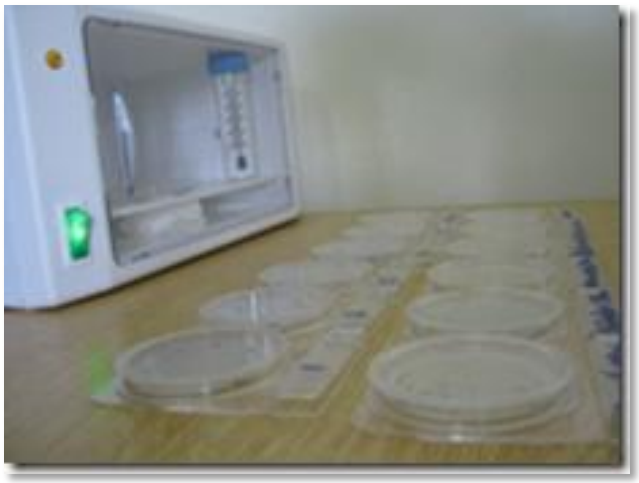
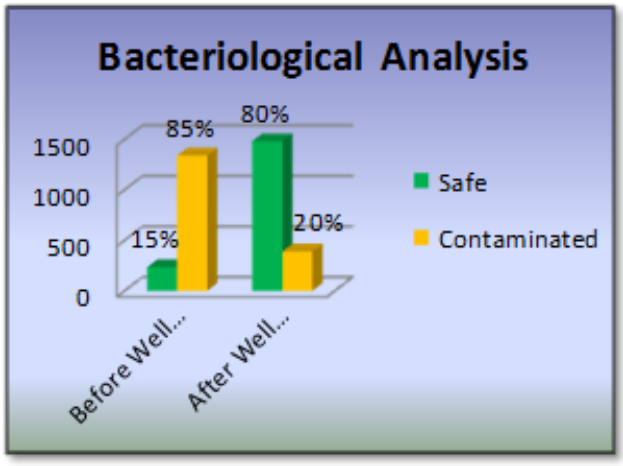
University of Applied Sciences and Arts of Southern Switzerland
Water Sanitation and Hygiene Competence Centre

SUPSI

Academic study on SDC water projects implemented in KPK Pakistan 2014
FINAL REPORT





Authors:

- Seema Anjum Khattak and Mohammad Riaz, National Center of Excellence in Geology, University of Peshawar, Pakistan
- Rashid Ali, Integrated Regional Support Program, Mardan, Pakistan
- Shahnaz Akhtar, JOBS International Private Limited (JIPL), Islamabad, Pakistan
- Luca Colombo, Sebastian Pera and Claudio Valsangiacomo, Swiss University of Applied Sciences of Southern Switzerland, Lugano, Switzerland

Peshawar, Charsadda, Lugano, xx November 2014

Introduction

Background and Context (Rashid please check)

After the emergency relief delivered during the devastating floods in 2010 and the measures taken to assist the affected populations in getting through the winter, the Humanitarian Aid Unit of the Swiss Agency for Development and Corporation (SDC-HA) has started various reconstruction projects in the domains of public infrastructure, drinking water and disaster risk reduction (DRR). The projects are implemented in the Province of Khyber Pakthunkwa (KPK) north-east of the country.

This study focuses on the Water, Sanitation and Hygiene programme in the districts of Charsadda and Nowshera in KPK. This programme includes well cleaning and contamination-prevention measures as well as water treatment and hygiene awareness activities. Water schemes for drinking water supply have been implemented at communal level and water committees for the management and the maintenance of the schemes have been established.

In 2010, the districts of Charsadda and Nowshera were badly hit by the floods that affected around 20 million people across the country. After having provided emergency aid, the SDC-HA started several reconstruction projects in the education and WASH sectors in July 2010. According to Relief International, an international non-governmental organisation, 98 percent of water and sanitation facilities were severely damaged or unusable due to heavy lilting or water flow in the two districts. After the floods, the availability of drinking water became a big concern as most water sources, including the groundwater, were contaminated and the wells were unusable.

The two components of the program are illustrated in the pictures below (Photos SDC)

"Hard component": Well cleaning and well rehabilitation activities	"Soft component": Hygiene promotion, training to female teachers on water and hygiene

Well rehabilitation has been done also in the frame of DRR for the prevention during future flood events.

Objectives of the study (Claudio)

Activity, as listed in the call	Approach proposed in the present offer
Analyse existing project documentation and relevant literature	To be done as required
Complement the existing GIS mapping of the project area with the inclusion of latest information	To be done by PAK local partner
Conduct an extensive water analysis campaign (bacteriological and chemical investigation) on a selection of water points representative of the hydrogeology of the project area	To be done as required, see parameter list. The analysis campaign should take place during the mission and involve a local PAK partner (IRSP?) below
Fill possible hydrogeological knowledge gaps with further investigations such as pumping tests, geophysics, constitution of a geological / hydrogeological library, hydrogeological modelling, etc	To be planned with local partners, and executed successively by local institutions. Partially incompatible with quality surveying but necessary to assess which processes drive water quality. In addition: piezometric maps dressing and geophysics.
Confirm or complement the overall information on beneficiaries in the project area with a special focus on social information pertaining to the acceptance of awareness campaigns, effective change of habits, or the proper use of HWTS	To be done as required: focus group discussion with stakeholders, together with local partner in Pakistan.
Whenever necessary, propose remedial actions to ensure the provision of clean drinking water	To be done as required. Remedial actions for wells will focus on reasonable/feasible remedial intervention, avoiding for examples "*individual rehabilitation of private wells*", that would require an enormous investment.

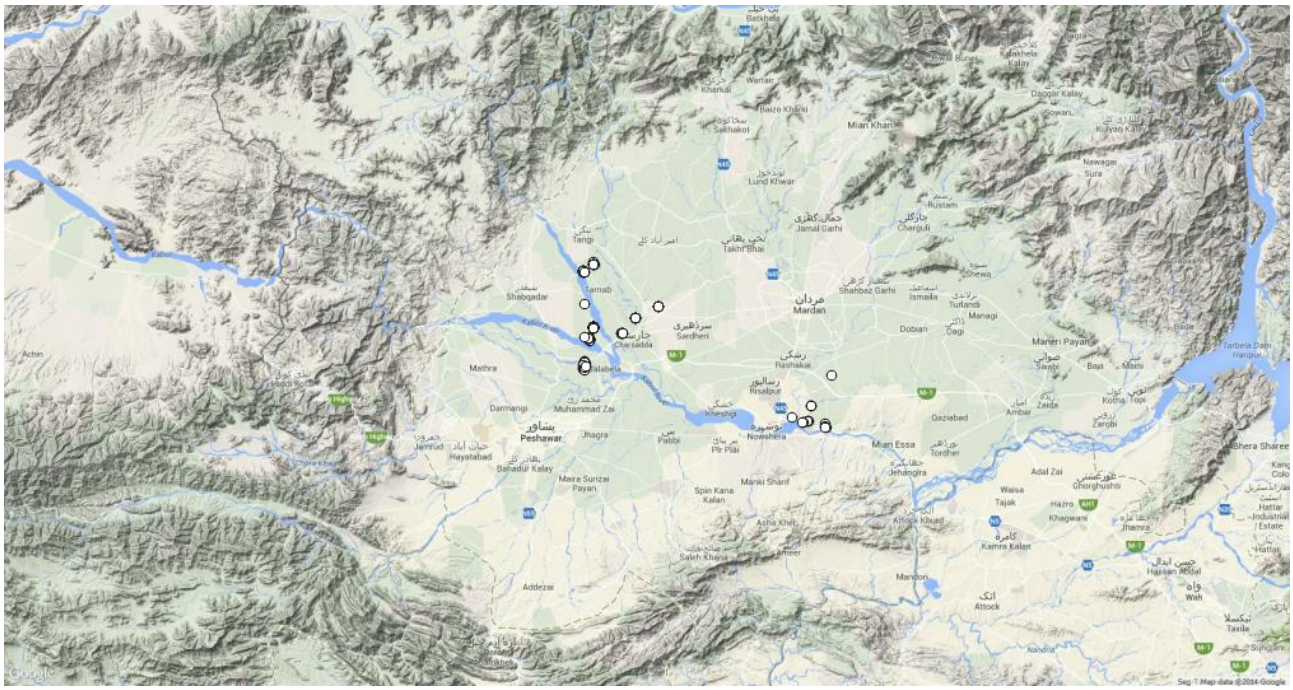
Team (Check names and institutions)

- Seema Anjum Khattak and Mohammad Riaz, National Center of Excellence in Geology, University of Peshawar, Pakistan
- Rashid Ali, Integrated Regional Support Program, Mardan, Pakistan
- Shahnaz Akhtar, JOBS International Private Limited (JIPL), Islamabad, Pakistan

- Luca Colombo, Sebastian Pera and Claudio Valsangiacomo, Swiss University of Applied Sciences of Southern Switzerland, Lugano, Switzerland

From left: Rashid Ali, Luca Colombo, Tahir Shah, Seema Anjum Khattak, Claudio Valsangiacomo, Sebastian Pera, Mohammad Riaz

Project area (geographic climatological) (Mohammed and Seema, please insert maps)



Hydrogeological settings (Mohammed)
Type of aquifer, geology, recharge, groundwater/surface water relations, hydraulic gradients, permeability,

Methodological approach

Present analytical work: ca. 100 wells, multiple parameters (Rashid)

- Number of wells 105, statistical relevance?
- Sampling strategy: distribution of sampling sites for statistical relevance (Seema? Rashid?)
- Choice of analytical parameters: before the field visit (standard parameters), during field visit (special parameters, e.g. agricultural contamination?) (Claudio)
- Kits, equipment, Standard operating procedures (Rashid)

Shahnaz
Before the team started activities within the targeted households, a baseline study was conducted in order to:

- Identify gaps in knowledge and practices regarding safe drinking water and hygiene practices
- To describe the socio demographic cultural information of respondents and villages.
- To find out the information on incidence of communicable diseases due to lack of utilization of hygienic practice.

- To determine the effectiveness and impact of the water, sanitation and hygiene promotion activities.

The data was collected through structured household questioners, focus group discussions and direct observations conducted by the survey teams. Based on the findings, the project approach and activities were designed and implemented successfully.

The project targeted 2 types of **groups**; users of HH dug wells and public institutions (health and education). The experience in Pakistan and KPK proved that awareness campaigns and training are key elements to ensure the sustainability of interventions; especially considering that water often gets contaminated not only at the source but also in the process of gathering and consumption. Therefore, the project adopted a comprehensive approach which combined hard and soft components, which combined the use of appropriate measures in hygiene education and awareness, and capacity building of service providers (school teachers, health workers and community members). More specifically, the private household (HH) dug wells were rehabilitated under the hard component, whereas the users and community members were educated on water source protection, treatment, storage, safe handling and hand hygiene, under the soft component.

Separate sessions were conducted for men and women. Primary school children were selected by their teachers to work as agents for change within their families and communities. Lady health workers (LHWs), shop keepers, parent-teacher council members, community support persons (CRPs), and religious leaders were mobilized, oriented and facilitated to communicate safe water and hand hygiene messages to the targeted communities. Special events were held as reminders to the schools and communities. World Water Days (WWD) and hand washing days were celebrated, using different interactive activities such as stage shows, hand washing competitions, quizzes, SODIS videos and display of information education and communication (IEC) materials. To further reinforce the messages, a SODIS video was displayed for the students in schools. Finally, the selected students were provided with SODIS bottles, stickers and monitoring sheets to start practicing immediately the message they have learnt through activities in the class. For these households, women participants were provided with IEC materials (calendars) to reinforce the messages and serve as reminders for the families. Women were also provided with SODIS bottles to immediately start practicing.

The hard component of the intervention targeted households with dug wells, where as the soft component also tartegeted the neighbors of the well owners (one participant per HH). Additionaly training of other community members, such as shop keepers, LHWs, BHU staff, religions people and community activists (CRPs), was conducted in order to ensure the sustainability of the project messages beyond the project life.

At the school level, teachers of classes 3 & 4 of the public and private primary schools were targeted. They conducted interactive sessions with their students in order to promote water safety and hygiene. This multi-prong approach ensured that various effective channels were utilized appropriately to reinforce that key messages were related to well protection, water treatment, water storage, handling and hand washing, for each targeted population.

The project has been conducting training and awareness on the following contents:

1. **Maintenance and proper use of WASH facilities** (washrooms, water points, Hand washing stations, cleanliness in and around school, and the proper disposal of garbage).
2. **Safe drinking water**

- Purification methods at the HH level (boiling, chlorination and SODIS)
- Safe storage (ensuring the water container was warshed regularly, keeping it in elevated locations out of the reach of children and animals).
- Safe handling (gathering the water using a lid or long handled scoop)
- Cover the well after water is gathered.
- Ensure that the rope and bucket remain clean (not placing the rope on the floor).
- Keep animals and children away from the well.

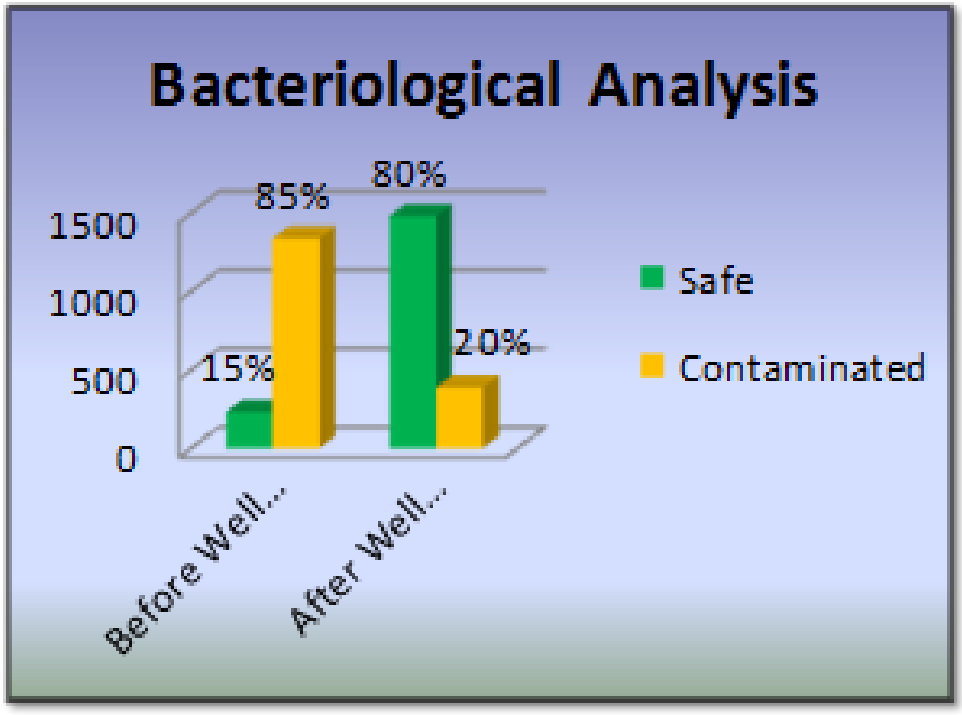
3. **Hygiene**

- Wash hands with soap for 20 seconds.
- Proiertize air-drying your hands over the use of a towel (which can contain germs)
- Always wash hands with soap after using the toilet, before eating, before feeding the children, and after working with animals.
- Help and guide your family members to wash hands with soap at/during these critical times.

Results and discussion

Previous analytical work (2010-2013) (Rashid)

- Number of wells cleaned, Numbers of analysis done, results
- Calculate the risk assessment values before and after well rehabilitation (compare sanitary inspections before and after cleaning), Rashid this has to be calculated.
- Evaluation of structural information of wells (performed on the 4’000 set of wells)
- Bacteriology, before and after rehabilitation



Present analytical work (summer 2014) (Rashid)

Please insert the information about wells with and without hand pumps, then calculate bacteriological contamination in wells with and without hand pumps.

Results: Physico-chemical analysis (Luca)

Physico-Chemical analysis of samples does not show any major public health concern regarding the considered parameters and respects in general the reference values indicated by the World Health Organizations[1] (see table below).

Specific comments:

- Regarding physical parameters, 2 samples present some slight increased turbidity (10 and 18 NTU resp.);10 samples present an increased electrical conductivity (salinity); 1 sample present increased Total dissolved solid. **However, all these parameters are not relevant for public health issues**.
- Regarding chemical parameters, 11 samples presented slight higher concentration of Sulfates, 1 samples presented slight high concentration in Chloride, 1 sample presented a slight higher concentration in Fluoride. **These limited overcomings of the reference values are not relevant for public health issues**. It is interesting to note that the values for Nitrates and Ammonia are relatively low, considering that latrines are often within the Safe minimal distance.

[1] WHO, 2011. "Guidelines for drinking-water quality - 4th ed."

Parameter	Unit	WHO Guidelines	Mean	Median	Minimum	Maximum
El. Cond.	µS/cm	1000	774.8	684.0	291.0	**2662.0**
TDS	mg/l	1000	395.3	353.0	145.0	**1331.0**
pH		6.5-8.5	7.4	7.4	6.8	8.3
Turbidity	NTU	5	2.0	1.4	0.2	**18.0**
Temperature	°C				29.9	33.0
Ca	mg/l	250	123.2	120.0	60.0	250.0
Mg	mg/l	250	32.7	24.0	24.0	133.0
Fe	mg/l	2	0.1	0.2	0.0	0.4
SO4	mg/l	250				**>400**
Cl	mg/l	250	64.3	41.0	29.0	**295.0**
NO3	mg/l	50	6.5	3.0	0.0	50.0
NO2	mg/l	3	0.006	0.000	0.000	0.300
NH3	mg/l		0.39	0.25	0.25	1.00
T.hardness	mg/l	500			125.0	375.0
Alkali	mg/l		164.4	150.0	60.0	360.0
As	mg/l	0.01	0.0	0.0	0.0	0.0
F	mg/l	1.5	0.46	0.37	0.18	**1.53**

Results: Bacteriological analysis (Claudio)

Bacteriological analysis show a significant presence of bacteria indicating fecal contamination, roughly 62% of the samples are contaminated with fecal material (see table below).

Grade	counts/100ml	Number of samples	%
A	0	40	38%
B	1-10	0	0%
C	11-100	**23**	**22%**
D	>100	**42**	**40%**

A significant difference between wells rehabilitated with the addition of manual pumps towards those without manual pump seems to be noticed (see table below). Wells with manual pumps present nearly no fecal contamination.

Village	nr of samples	% wells contaminated	% wells non-contaminated	% rehabilitation with hand pump	% rehabilitation with well covering
Jammat	17	64	36.0	0	100
Ghurambak	20	65	35.0	0	100
Totakai	2	80	20.0	0	100
Dildar	11	27	73.0	100	0
Shekan	6	50	50.0	0	100
Kamdari	19	58	42.0	0	100
Shamsudin	6	67	33.0	0	100
Nawi kali	5	80	20.0	0	100
Ghala	3	67	33.0	0	100
Hamza	3	33	67.0	0	100
Banaras	2	100	0.0	0	100
Zara	4	100	0.0	0	100
Tolandi	1	100	0.0	0	100
Mulgahki	1	0	100.0	0	100

Evaluation of results considering the hydrogeological framework and the impact of human activities (mainly settlement and agriculture) (Sebastian and Mohammad please complete)

In general:

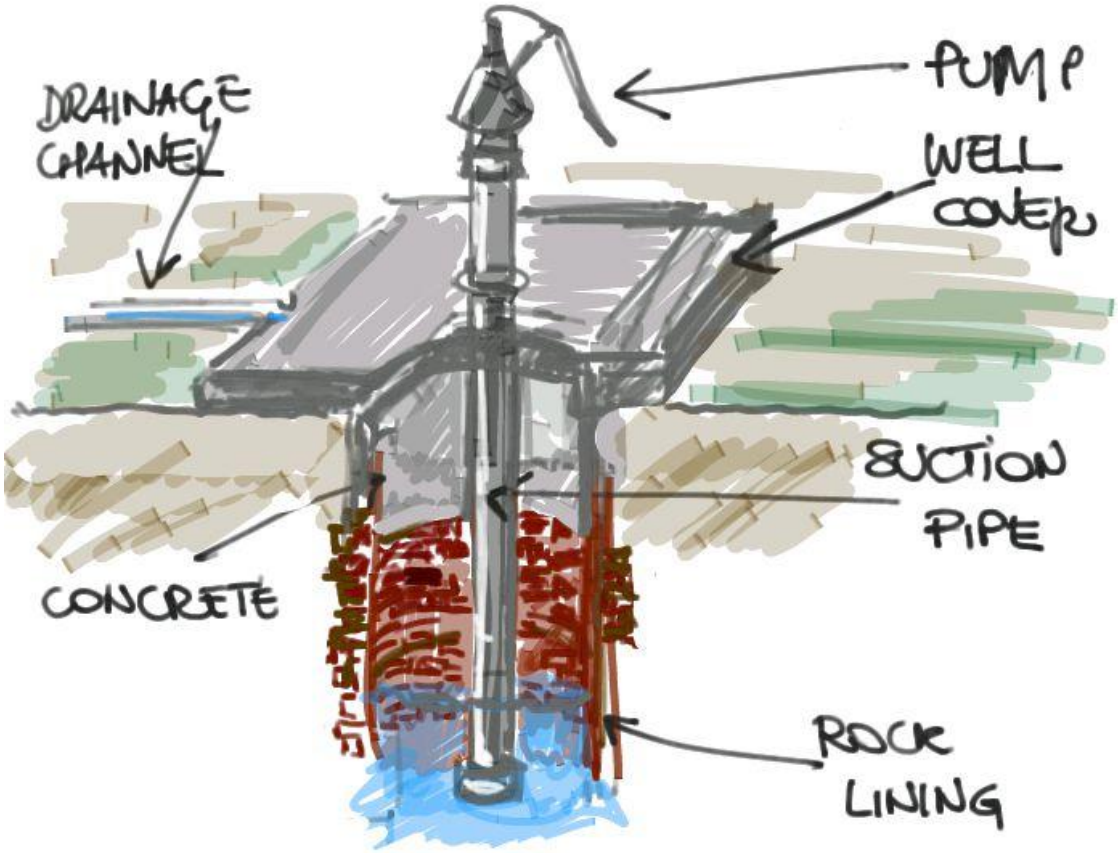
- Major rivers in the area are gaining streams. Some minor channels used for irrigation are parched in respect to the water table.
- The study area can be considered an homogeneous agricultural area.
- The exploited aquifer is constituted mainly by brownish loess close to major rivers, fluvial deposits are present (sand-gravel etc.).
- Electrical conductivity values seem to be lower in Charsadda than in Nowshera, see map below. Previously mentioned high values for EC seems to be related to local hydrogeological conditions and/or specific well characteristics (water column and water table depth).
- Nitrates and Ammonia. The low values of these parameters are probably related to the important thickness of the non-saturated zone.
- Low Nitrogen compounds and widespread fecal pollution suggest different paths for well pollution. Surface runoffs and/or unappropriated use of the wells (dirty bucket, animals in the surroundings, wells not covered) represent the main path of bacteriological (fecal) contamination, while for Nitrates infiltration through the unsaturated zone is the most relevant pathway.

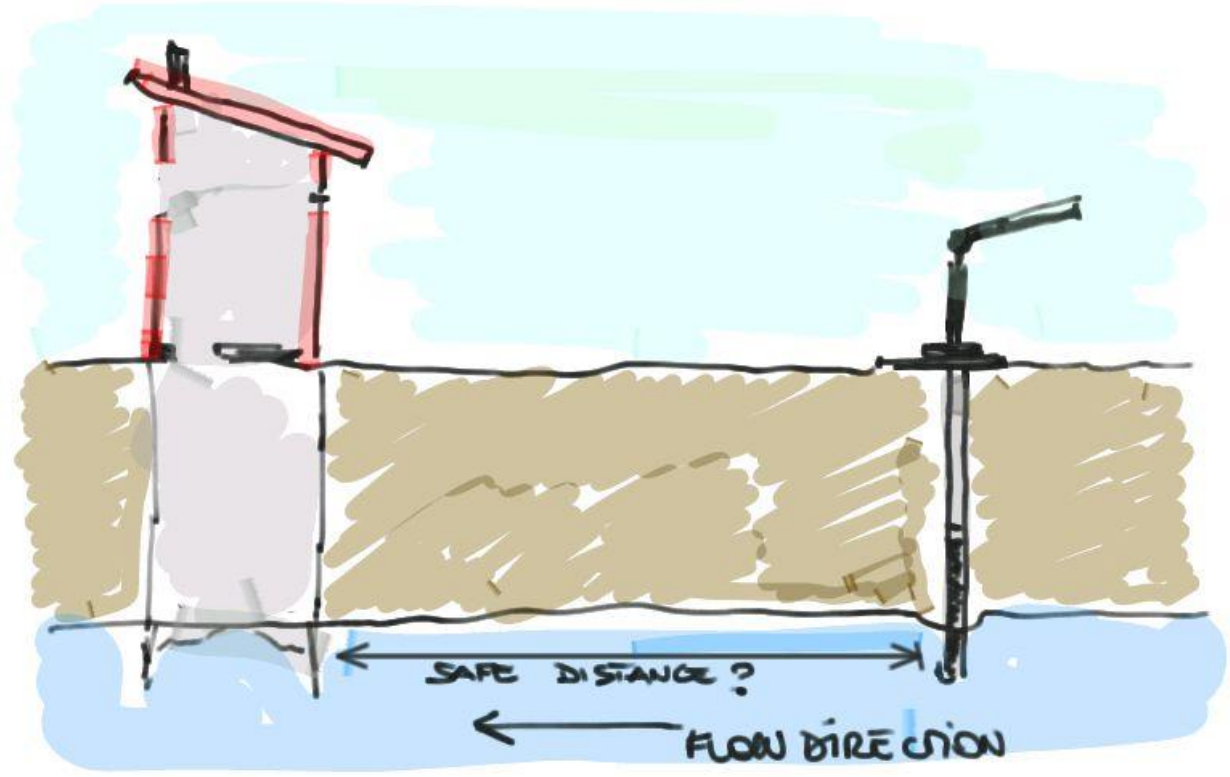
Conclusions and recommendations Claudio Luca Srbastian

- Situation at the beginning (emergency phase, SDC humanitarian intervention): 2010, flood, necessity to clean wells.
- Evaluation of efficacy of the well cleaning program considering evidence-based data
- Continuation of the well cleaning program in order to decrease risk grade of wells and to improve good hygiene practices. Rehabilitation of wells in order to prevent damages for future floods.
- Soft components implemented by JOBS (Shahnaz): hygiene promotion. The change of mindsets and habits linked to hygiene and sanitation practices is definitely a huge challenge and this requires long-term and constant efforts.
- Dissemination of results: scientific paper + institutional dissemination by University of Peshawar (e.g. PHED).
- Recommendations for future activities?
- Proposed remedial actions to ensure the provision of clean drinking water and potential future interventions for the communities and Pakistani Government .

Annexes

- TORs, working phases and Program of field mission
- Analytical parameters
- Full data set: analytical program on 105 wells
- Risk assessment of wells after WHO
- Maps
- Pictures


DRAINAGE CHANNEL
PUMP
WELL COVER
SUCTION PIPE
CONCRETE
ROCK LINING


SAFE DISTANCE ?
FLOW DIRECTION

Academic study on SDC water projects implemented in KPK Pakistan 2014, Program visit 17-27 September

Date	Activity	Responsibility, comments
Wednesday 17	Flight Milan-Islamabad	
Thursday 18	• Arrival at 01:25 at Islamabad Int. Airport, flight Emirates EK 0614 • Claudio-Luca-Sebastian Office work in Islamabad @ SDC Office (afternoon) • Security briefing + briefing with SDC Office	**Bilal**: pick-up from the airport and transfer to accommodation. Security + SDC briefing.
Friday 19 and Saturday 20	• Common work between Swiss team and Rashid (IRSP) and Seema (NCEG) in Islamabad. Definition of what has been done, what to do next	**Rashid and Seema** transfer to Islamabad and stay overnight.
Sunday 21	Claudio-Luca-Sebastian Office work in Islamabad @ SDC Office	
Monday 22-Wednesday 24	**Monday**: Visit to Peshawar University (NCEG) and meeting with Dr. Seema, Prof. Riaz and Rashid regarding the study along with sharing of data from NCEG. Meeting with Director of NCEG, visit of the institute, presentation workshop. **Tuesday**: Visit to Charsadda office and field and back to Peshawar for stay; • Villages**:** Jammat and Ghwarambaq of UC Agra • Villages**:** Dildar Garhi and Sanda Sarr of UC Mirzadher **Wednesday**: Meeting at PC Hotel in Peshawar (Swiss delegation + Seema and Riaz) and departure to Islamabad	**Bilal**: organizes transfer, NOC, stay over in Peshawar for 2 nights, security recommendations **Rashid**: organizes the plan of the field visit
Thursday 25	• Claudio-Luca-Sebastian Office work in Islamabad @ SDC Office. • Meeting with Swiss Ambassador	
Friday 26	• Debriefing with SDC Office (11 staff present)	
Saturday 27	• Departure Claudio- Luca-Sebastian departure at 9:00, flight Emirates EK 0613	**Bilal**: pick-up from the hotel to the airport.

Analytical parameters, according to "Guidelines for drinking-water quality", WHO, 4th Ed. 2011)

Parameter	No of samples	Purpose	Remark
Acceptability aspects: taste, odour and appearance	All samples	General evaluation	To be performed on all samples
Turbidity (in NTU), Free Residual Chlorine (in ppm), Temperature	All samples	General evaluation/ Health	FRC only for disinfected water
Conductivity, pH	All samples	Overall water quality	
Bacteriology: *E. coli* and faecal coliforms in 100 ml (EC- Compact, membrane filtration)	50-100	Health	Crucial parameter for Drinking water (a previous study has been carried out during well cleaning: bacteriology before and after cleaning). All rehabilitated schools and hospitals have to be analysed: top priority!
Simple chemical parameters, major constituents: • Potassium, Magnesium Calcium, Sodium • Sulfate, Chloride, Nitrate, Nitrite, Ammonia • Total Hardness, (Alcalinity)	50-100	Overall water quality	Some parameters will be performed on site with quick tests (semi-quantitative). Nitrite are not stable, to be done in the field
Simple chemical parameters geogenic: • Arsenic • Fluoride	20-30	Health/Geo genic	AS and F could be geogenic contaminants and will be interpreted by crossing data with hydrogeological charts
Special chemical parameters, industrial + agricultural pollution (Optional): • Volatile Organic Compounds GC* • Volatile Halogenated Compounds** • Pesticides*** • Volatile Chlorated Hydrocarbons **** • Chrome total and VI	5	Health/ industrial + agricultural pollution	Careful selection of parameters for identifying regions with significant industrial and/or agricultural activities + particular hydrogeological context. Very expensive parameters, to be done in Switzerland. Examples of costs per samples: VOC: 330.- CHF Pesticide: 275.- CHF VCH: 176.- CHF

Not included in the budget (to be decided during finalization of proposal):

* **VOC with Purge-and-Trap method**: Diclorometano, cis-1,2-dicloroetano, Metil-tert-butil etere (MTBE), Etil-tert-butil etere (ETBE), Cloroformio, 1,1,1-tricloroetano, Tetracloruro di carbonio, Benzolo, 1,2-dicloroetano, Tricloroetilene, Bromodiclorometano, Toluolo, Percloroetilene, Dibromoclorometano, Etilbenzolo, m + p-xilene, o-xilene, Bromoformio, 1,2,4-Trimetilbenzolo, Totale idrocarburi aromatici, solubili (BTEX), Totale idrocarburi alogenati volatili

** **VHC**: Diclorometano, cis-1,2-dicloroetano, Cloroformio, 1,1,1-tricloroetano Tetracloruro di carbonio, 1,2-dicloroetano,
Bromodiclorometano, Dibromoclorometano, Bromoformio, Tricloroetilene, Percloroetilene

*** **Pesticides**: Atrazina, Desetilatrazina, Simazina, Diuron, Bromacil, Totale erbicidi (somma)
**** **VCH**: Tricloroetano, Tricloroetilene, Percloroetilene