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PROVISION OF SAFE DRINKING WATER FOR FLOOD AFFECTED AREAS

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Abstract:

Floods can have disastrous impacts on people and property, including loss of life, destruction of houses and other buildings, and displacement of those whose homes are flooded.

Floods can also have dire effects on public health and the environment, particularly water quality. Containers with hazardous materials may be displaced and their contents spill into streams and spread over nearby area. Wastewater and septic systems may be overloaded and compromised. Contaminated flood waters may seep into ground water, which mostly supply drinking water for a community.

The recent floods of Pakistan which began in July 2010, following heavy monsoon rains, affected most of the Indus basin. At one point, approximately one-fifth of Pakistan's total land area was underwater. According to Pakistani government data the floods directly affected about 20 million people, mostly by destruction of property, livelihood and infrastructure, with a death toll of close to 2,000. Floods have submerged 17 million acres (69,000 km2) of Pakistan's most fertile crop land, have killed 200,000 herds of livestock and have washed away massive amounts of food grain. All this made both the surface and groundwater polluted and unfit for drinking, washing and other potable usage.

During rehabilitation of the flood affected community, an effort was made by the authors to provide enough quantity of potable water with as per national water quality standards. For this purpose a portable and economically viable water purifying system was designed and installed in the flood affected area of Nowshera KPK area where quite encouraging results were obtained. This paper will highlight the results obtained from this effort.

Key words: Water quality, floods, water purification, potable water, economically viable system

INTRODUCTION:

Safe drinking water is a human birthright – as much a birthright for clean air. However, much of the world's population does not have access to safe drinking water. Of the 6 billion people on earth, more than one billion (one in six) lack access to safe drinking water. Moreover, about 2.5 billion (more than one in three) do not have access to adequate sanitation services. Together, these shortcomings spawn waterborne diseases that kill on average more than 6 million children each year (about 20,000 children a day).

The long duration of the 2010 flood caused immense sufferings of the people in the affected areas. Disruptions of drinking water supply, sanitation, waste disposal, and disease transmission were among the major adverse impacts of this flood. This flood heavily affected the most parts of the country almost all the four provinces. About thirty million people in the affected areas got marooned.

The most serious problem encountered by the affected people was the quality of water, which deteriorated as a result of many factors. The floodwater, already fouled by the wash-aways from the upstream areas was further deteriorated by the complete submergence of the sewerage system, septic tanks and other sanitary facilities and by the direct disposal of human

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waste, kitchen waste and household refuse in the absence of sanitation and municipal facilities. The affected people were directly exposed to the polluted floodwater, which resulted in the outbreak of various skin diseases, in addition to serious diarrhoea and other waterborne diseases as a result of drinking contaminated water. This study was undertaken in order to assess the extent of deterioration of both the stagnant floodwater and the supplied drinking water quality.

Below is the table given for the important organisms and their recommended microbiological levels in the treated drinking water for Pakistan.

S.No	Organism	Recommended Maximum Value
01.	E coli	0/100 ml sample
02.	Shigella	0/100 ml sample
03.	Vibrio cholerae	0/100 ml sample
04.	Giardia lamblia	0/100 ml sample
05.	Cryptosporidium	0/100 ml sample
06.	Viruses*	Nil
07.	Psuedomonas aurginosa	0/100 ml sample

* Not for routine, only for surveillance purposes

Below is explained the methods for determination of most important microbial contaminants

E coli	Generally measured in 100 ml sample. A variety of procedures based on the production of acid and gas from lactose or the production of enzyme β-glucuronidase. The procedure includes membrane filtration followed by incubation of membranes on selective media at 44-45°C and counting of the colonies after 24 hrs.
Total coliform	Total coliform bacteria include a wide range of aerobic and facultatively anaerobic Gram-negative, non-spore forming bacilli capable of growing in the presence of relatively high concentrations of bile salts with the fermentation of lactose and production of acid and aldehyde within 24 hrs at 35-37°C. As part of lactose fermentation, the total coliforms produce β-glactosidase. The procedures include membrane filtration followed by incubation at 35-37°C.

Design of Water Treatment Plant for Small Community

For this study two populations of each 400 to 500 people were selected. A prefabricated water treatment plant of capacity 600 litres per hour to treat flood / river water for drinking purpose was designed to be installed in the center of the each community. The processes used in this plant are coagulation, sedimentation, pre-chlorination slow-sand filtration and adsorption.

A container of size 4ft x 8ft x 8ft was fabricated using steel pipe and fiber-glass sheets. Inside the container plastic tank of 800 litres for sedimentation, 600 litres plastic overhead tank with filter media tank of 600 liter, Galvanized steel filter media tank and electric motors were fixed as shown in Figure 1.150. Similarly, 150 packets per month of coagulant and disinfectant, (Alum + Calcium hypochlorite) were provided with each plant. Each packet is dosage for one run of 800 litres Flood / River water with 10 mg/ l dosage of Alum and 1 mg/l dosage of chlorine applied.

Filter media used was 8 inch layer of Lawrencepur Sand with effective size 0.65 over granular activated carbon layer of 6 inch of effective size 0.95. Another 6 in layer of aggregate crush is provided at the bottom. A perforated collection pipe was embedded in the aggregate crush layer. This perforated pipe was connected to the delivery pipe.

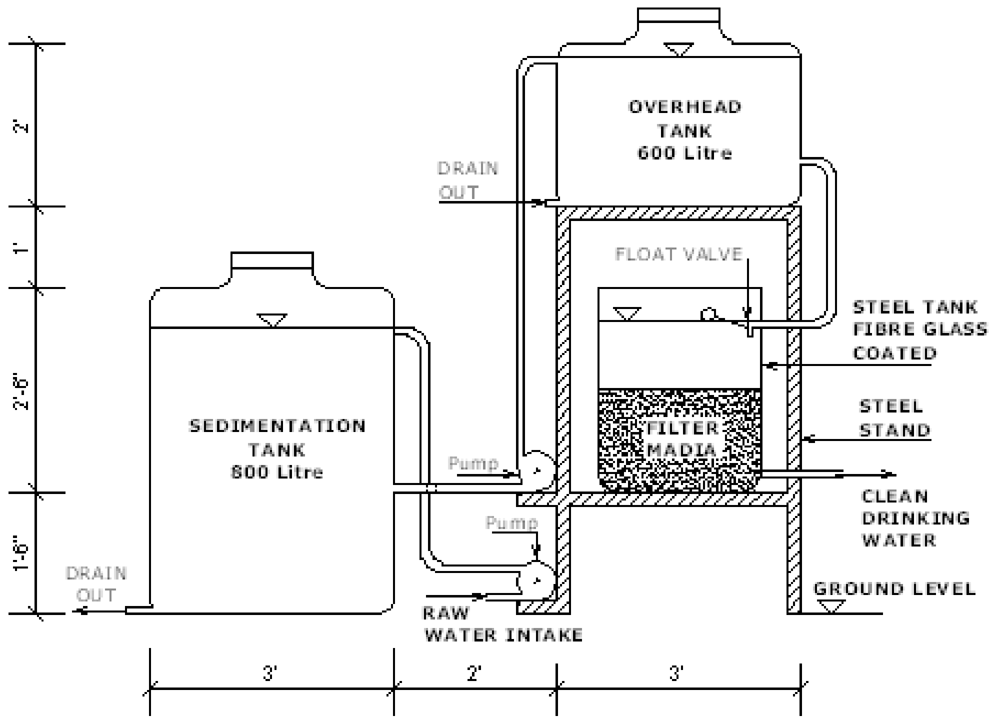

Figure1: Treatment Plant of 600 L/Hr Capacity

Plant runs manually with electricity. The electric motors will be operated with manual switch. One operator is required to operate it. Filling of 800 litres tank is done with electrical motor pump. It will take 15 minutes to fill this tank. Then filling of 600 litres overhead tank is also done with the electric motor. It will take 10 minutes to fill this tank. Once the 600 litres overhead tank is filled the supply of water is done through gravity flow and no electricity is required during this period. The electric water pump is 1 HP.

A float valve is provided at the top of filtration tank that controls the head of water in the filter media. Out flow is calibrated with a control valve provided at the exit of filter media before delivery valve.

A petrol generator is a good option that will be fixed with the stand. Continuous electricity to run the plant is not needed. Electricity is required for 25 minute in one hour run. The plant has to perform 2 to 3 hour run in the morning and same in the evening. So the generator is to run total 2 hours in the morning and 2 hours in the evening.

The plant is secure and the whole plant can be fitted in a cabin of 4 ft wide x 8 ft long x 8 ft high. The cabin walls are made of Fiber-glass sheet and frame will be of steel pipes. This cabin can be easily transported and will be useful to meet the security requirements at site.

Salient Features

- Compact and made of locally available material
- Treatment Plant is prefabricated

- Plant will serve the daily drinking water requirements of 500 to 600 people
- Space of 4 ft x 8ft is required for operation
- Very little / Less maintenance and operation cost
- Can be installed within one hour (pre-fabricated units)
- Easy to operate

Table 1. Cost of 600 Litres/Hour Water Treatment Plant

Items	**Cost (Pak Rs.)**
Cost of Steel Tank	10,000/-
PVC Tanks	15,000/-
Steel Frame Material	20,000/-
2 Motors 1 HP	10,000/-
Filter Media	20,000/-
Valves + Pipes+ Miscellaneous	10,000/-
1000 Packets of coagulant + Disinfectant (For Six month @ 5 to 6 Packets Daily)	10,000/-
Labor (Paint + Welding + Fixing + Fiber Glass Coating of steel tank)	25,000/-
Training of operation to field staff	5,000/-
Total Cost	**125,000/-**

Note:

1. Cost of 1 Kilowatt Generator not included.
2. Profit not included.
3. Transportation cost is also not included.

METHODOLOGY FOR PLANT OPERATION:

1. Fill the 800 litres tank with river / flood water with the help of Electric motor pump.
2. Add one packet of Coagulant and disinfectant into the tank and stir the water with stick for five minutes.
3. Leave the tank water stationary for 30 minutes. The mud will settle down.
4. Then with the help of second motor pump the clean water to overhead tank.
5. The water will flow from overhead tank to filter media tank under gravity and when filter media will be filled the water flow will be stopped automatically because of float valve.
6. Empty the sedimentation tank and again fill with Fresh River / flood water. Add Packet, stir and let the mud settle down for 30 minutes.
7. Pump the clean water from sedimentation tank to over head tank.
8. Open the valve of filter media tank and start supply to public. The water filter is designed to discharge 600 litres per hour.

9. The over head will empty one hour. During this one hour the sedimentation tank is again filled with fresh River/ Flood water and sedimentation of water is done after adding the packet. The clean water will be ready for pumping to over head tank.
10. Pump the water to overhead tank.
11. If plant is run for four hours in the morning and four hour in the evening it can easily meet the drinking requirement of 400 to 500 people.
12. After six months filter media to be replaced.

Figure 2. Filtration Plants Installed in the area (Nowshehra)

Table 2. Water quality monitored before and after filtration unit at Lab Scale

Turbidity (NTU)		**Microbial Contamination**	
Before Filtration	*After Filtration*	*Before Filtration*	*After Filtration*
120	2.5	Unlimited	No Contamination
105	2.3	Unlimited	No Contamination
55	2.2	High Contamination	No Contamination
53	1.2	High Contamination	No Contamination
57	2.2	High Contamination	No Contamination
50	1.4	High Contamination	No Contamination

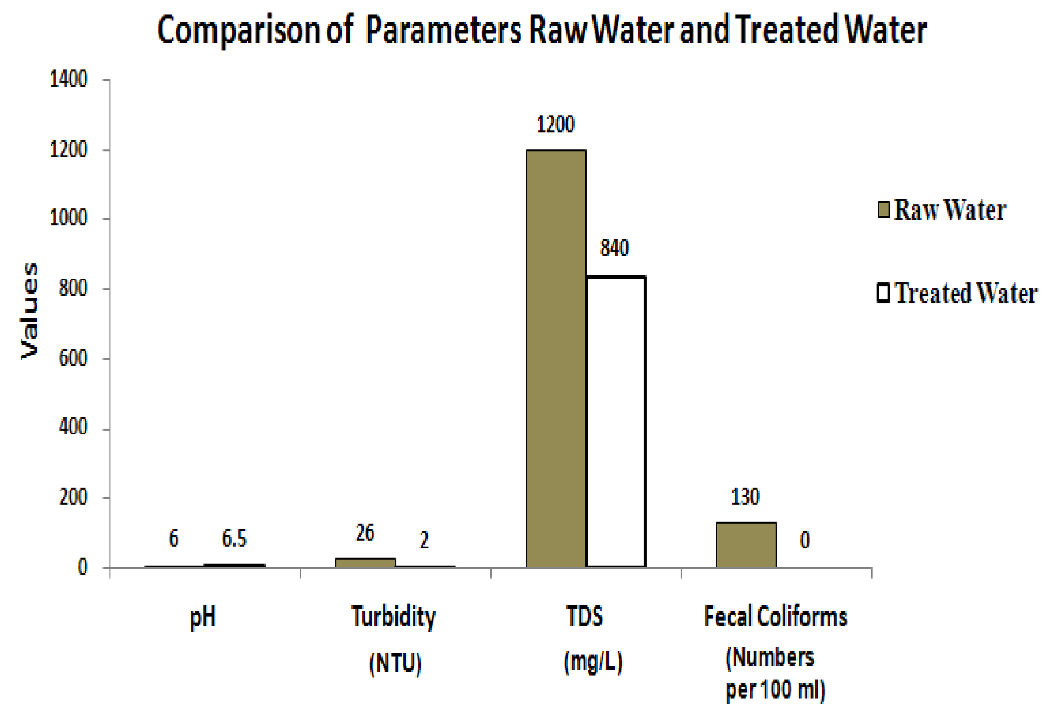

Figure 3. Comparison of Parameters Raw Water and Treated Water of Plant1

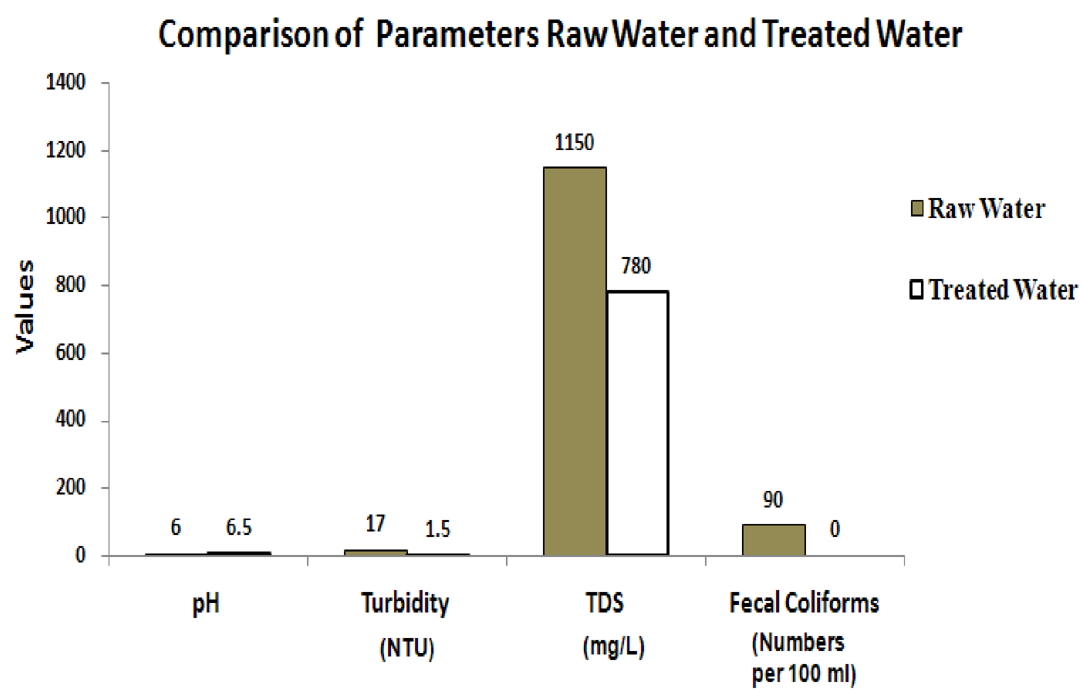

Figure 4. Comparison of Parameters Raw Water and Treated Water of Plant 2

Table 1: WHO limits for drinking water quality

S.No.	Water Parameter	Unit	WHO Limit
1	pH	-	6.5 – 8.5
2	Turbidity	NTU	5 NTU
3	Total Dissolved Solids	mg / L	1000 mg/L
4	Fecal Coliform Count	Numbers / 100ml	Nil

The results show that the treatment plant has efficiently treated the water. The basic parameters of the plant were tested i.e. pH, Turbidity, TDS and Fecal Coliform count. The turbidity of the raw water was 17 to 26 NTU and the treated water having a turbidity of 1.5 to 2 NTU which is in the permissible limits of safe drinking water as per WHO.

The TDS of the treated water range from 780 to 840 mg/l which is also within permissible limits. The treated water is free from Fecal coliform.

These plant are in operation for the last 7-8 months. One local person for each plant is trained. The plants are functioning efficiently by the workers and the community is happy and quite satisfied with the performance of the plants.

Conclusion:

The ground water gets polluted during floods. The well water remains turbid and contaminated with disease causing organisms after a long time after the flood. The treatment plant is an economical option for emergency situations particularly in floods. It is also sustainable because local material has been used for its fabrication and media for its filling.

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