Water safety plans for greywater in tribal schools, India

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Where water is in short supply, greywater treatment and reuse may be the answer. Such systems have been introduced in tribal residential schools in Madhya Pradesh, India. Both children and parent teacher associations were involved in drawing up and applying water safety plans for greywater reuse, and cartoons were used to publicize them.

Water is becoming a scarce resource in the world. In India alone the International Water Management Institute (IWMI) predicts that by 2025, one person in three will live in conditions of absolute water scarcity.[1] Dhar and Jhabua are two districts of Madhya Pradesh in central India that suffer recurrent water quantity and quality problems. In many tribal residential (Ashram) schools in Dhar and Jhabua Districts, a shortage of freshwater has prompted UNICEF, in collaboration with governmental and non-governmental partners, to explore the use of greywater for appropriate purposes such as cleaning of toilets and gardening. The World Health Organisation (WHO), in the revised *Guidelines for Drinking Water Quality (2004)* and *Guidelines for Safe Use of Wastewater, Excreta and Greywater* (2006) has moved towards a risk assessment and management approach to securing water safety. It is these plans that have been followed for managing greywater reuse systems in these ashram schools in Madhya Pradesh.

The greywater reuse system in operation

Greywater reuse system

Greywater is commonly defined as wastewater generated from the bathroom (excluding toilets), laundry and kitchen. Based on the study undertaken in ashram schools in Dhar and Jhabua districts, 50–60 per cent of water used (23–35 litres/person/day) results in greywater generation.[2] Various treatment options such as anaerobic sludge reactors, septic tanks, oxidation ponds and filters were evaluated, keeping in view the intended reuse of greywater in flushing the toilets and for gardening. A simple filtration technique consisting of screening, equalization, gravel filtration, sand filtration and chlorination was applied in nine ashram schools in Dhar and Jhabua districts. An analysis of the water balance in schools before and after setting up a greywater reuse system is given in Table 1.

The toilets in the ashram schools often became non-functional when water was not available. Setting-up a greywater reuse system has ensured that water is always available for toilet cleaning and ashram inmates have stopped resorting to open defecation.

The water safety plans

Risk management in ashram schools is undertaken to provide complete management of the greywater system 'from the tap to the toilet'. It identifies risk points in the greywater system and suggests appropriate critical limits for monitoring the system based on the establishment of health-based targets using a quantitative microbial risk assessment (QMRA). Once these limits are exceeded, the Water Safety Plan provides operation and maintenance solutions.

However, it was important to simplify the water safety plans for ashram schools. These were drawn up on the basis of WHO standards and other guides,[3] and they comprise four main steps:

- System description – detailed description of the greywater system developed by the Parent Teacher

Table 1. How the water reuse system reduces water requirements

	Water requirement (litres/person/day)	
	Before greywater reuse	*After grey water reuse*
Bathing	12–18	12–18
Washing clothes	8–12	8–12
Flushing W.C.	5–10	+
Washing the floor	2–5	+
Washing of utensils	3–5	3–5
Drinking and cooking	8	8
Gardening	10*	+
TOTAL	50–70	31–43

+ reduced to zero through greywater reuse, * water for gardening not available in water-scarce period

The schoolchildren present the water safety plan

Association (PTA) and children's groups;
- Hazard assessment – identification of main hazards in the greywater system;
- Matrix development – detailing who, what, how and where hazards will be monitored, as well as suggesting corrective actions and communicating them in a child-friendly manner through cartoons;
- Monitoring and maintenance – limits for physico-chemical monitoring and maintenance of the greywater system.

System description

An interdisciplinary team, comprising the head teacher, selected members of the PTA and student members of the school water safety club first describe the system. They draw the system on the wall of the school.

Hazard assessment

Based on the system description, specific sources of the microbiological hazards are identified using standardized sanitary inspection (SI) forms and 'learn by play' hygiene promotion techniques, such as those outlined in Boxes 1 and 2.

The PTA and children's groups undertake the sanitary inspection to prioritize hazards in the water reuse system. For the initial hazard assessment, the SI form is filled in by three groups, each comprising one member of the PTA with assistance from selected children. The results of the assessments are then shared to provide further improvements in the clarity of the questions and also to prioritize which hazards are of greatest significance.

To encourage the involvement of children in the hazard assessment, 'learn by play' techniques of hygiene promotion are used. Outlined in Box 2 are two examples of such games and the results from the second game are depicted in Figure 1.

Box 1. Sanitary inspection form
Sanitary inspection forms for the greywater systems

1. Village Name:
   Water Source Type:
   Year of Installation:
   Water Source No.:
2. Date of Visit:
3. Water sample taken? ....Sample No.. ..:

Specific Diagnostic Information for Assessment

	Remark
1. Do the children use the treated water for cleaning toilets?	Y/N
2. Are the inlet and outlet waste-water collection tanks properly covered with the lid ?	Y/N
3. Do the animals have access to the area around the greywater storage tank?	Y/N
4. Does the untreated water belong to the wastewater coming from bathing as well as laundries?	Y/N
5. Are the bathrooms being regularly cleaned and is the treated water being used for washing purposes?	Y/N
6. Are there any other sources of pollution?	Y/N
7. Is there any problem regarding the overflow in the greywater system?	Y/N
8. Are the pipes cracked from where the treated water is supplied to the tanks placed on the roofs?	Y/N
9. Does the spilt water collect in the area nearby the system?	Y/N
10. Is the treated water being properly chlorinated ?	Y/N
Total Score of Risks	

Risk score: 9-10 = Very high; 6-8 = High; 3-5 = Medium; 0-3 = Low

The water safety matrix at Kalidevi Ashram School.

The results of the exposure assessment are described in Table 2, then the size and the nature of the population exposed and the routes, concentrations and distribution of hazards are determined.[4]

Reused greywater may expose people directly via inhalation as well as through ingestion. The dose of a pathogen is calculated from the density of the organism in the water times the volume ingested.[5] Further to the exposure assessment, the response of the individual is used in ranking the risks associated with the system. Each of these risks is then prioritized and monitored accordingly in the water safety plan.

Matrix development

The Water Safety Plan matrix comprises four major activities:
- *Hazard event* – this is defined as the source of the microbiological contamination affecting the system. This is identified through the sanitary inspection form outlined above.
- *Risk* – this is defined as the severity of impact of the hazard event on the children (i.e. number of children falling ill due to exposure to the greywater) combined with the frequency of occurrence of the hazard event occurrence.
- *Monitoring* – this includes detail on the regular monitoring of physico-chemical surrogates as well as sanitary inspection undertaken by PTA and children's water safety clubs.
- *Maintenance* – if and when the hazard event occurs.

To explain this in schools, cartoon drawings are used and painted on the school wall. This has the advantage

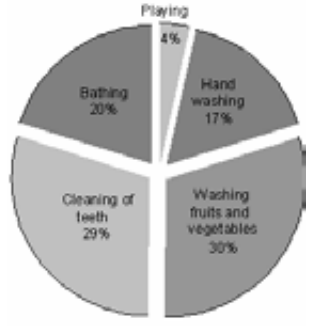

Figure 1. Assessing with the children the risks of greywater exposre

Children vote on which activity might be most detrimental to their health.

that it makes the matrix attractive to the children and also a permanent feature of the school. Outlined below are examples of the main components of a Water Safety Plan matrix in photographic and pictorial form.

Monitoring and maintenance

To ensure the involvement of the children, participation is encouraged in the monitoring of simple physico-chemical parameters such as turbidity, H_2S vials, temperature or pH. These parameters are then verified through the use of selected microbial parameters such as thermotolerant coliforms, enterococci or coliphage spores.[2] For example, the user can monitor the turbidity of the inlet and outlet water using turbidity tubes. Using the guideline values as indicated by WHO, inlet values of 500 NTU to 50 NTU are considered. If turbidity exceeds 50 NTU, the filter media in the system need to be changed and verification of microbial quality is required.

Further infrastructural precautions are also essential to ensure the separation of fresh and greywater in the water-supply system. These precautions include:

- no cross connection with the potable water supply
- greywater to be used to irrigate non-leafy vegetables and fruit plants where the fruit itself does not come into contact with the greywater
- prevention of mosquito breeding in the system
- different coloured pipe network for fresh and greywater
- signage to warn those entering the area that greywater is being used for irrigation. The sign should be on a white background with red lettering at least 40mm high.

Summary

Greywater reuse in ashram schools in Dhar and Jhabua districts has resulted in more water being available to meet the children's basic needs. The implementation of a child-friendly water safety plan has helped in operating and maintaining the greywater reuse system in addition to ensuring the safe delivery and use of greywater at minimal risk. Using cartoons to communicate water safety plans to children has proved an effective tool.

About the author

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Table 2. Exposure assessment for greywater reuse

Type of exposure	*Volume ingested (ml)*	*Frequency (times per year)*	*Number of persons affected*
Unintentional ingestion of greywater during handwashing	30	1	100
Child playing in greywater	1	2	30
Child drinking greywater	100	10	100
Unintentional ingestion of greywater during brushing teeth	30	1	2

Box 2. Learn as you play

This game helps children understand how the system works.

- The children are organized by the PTA into three lines.
- They join hands in three rows with the tallest children at the front (representing the gravel filters) followed by medium height children (medium gravels) and then the small children (representing the sand filter). The children are then asked to walk under the hands of the children.
- The biggest children are prevented from passing through the first row, followed by medium children in second row and small in the third, only the smallest children escape.

The PTA then explain that the three rows represent the filtration in the greywater, the protozoa are stopped in the gravels, the bacteria by the medium gravel and the viruses by the sand.

The second game helps children assess risks.

- Children draw all the identified hazards in the greywater system.
- Under the guidance of the PTA, the children are given one stone, with which they can vote on which hazard they think might be most detrimental to their health.
- The children vote by placing the stone in a pocket chart.
- The stones are counted and the results are discussed with the children to prioritize the hazards.