# Technical Briefing for Emergency Response: *Water Supply and Treatment*

# Water Supply in Rural Flood Settings

**This Technical Brief looks at key water supply issues affecting populations in rural flood settings, including water tankering, storage and treatment; bottled water; rehabilitation of wells and boreholes; rainwater harvesting; and pond cleaning.**

It is important to plan the response with an understanding of the type of flood and its impact on the affected population. For example, floods may last from a few days up to many months. *Refer to Mwaniki (2009) for a comprehensive list of the different types of floods.*

The main challenges associated with water supply in floods are:

- To find water sources which are not contaminated and with low salinity.
- To deal with saline and polluted water that infiltrates all systems including into the water table.
- Disruption of main transport and communications services (access by roads, trains, telecommunications etc.).

**Figure 1:** *Rupture of transport and communication services (Bihar, 2009)*

- While the flood waters are still high, many of the water sources may be under water and it may be necessary to look further afield for safer water sources to transport in the initial stages of the flood.
- Access to populations living in remote/ isolated regions.
- Large affected areas.
- Complex logistical needs.

The type of intervention will not be the same for all flood situations, and it may be necessary to work in a phased approach. The phases are:

**Immediate action after the flood (1$^{st}$ Phase options),** typified by instability and rapidly changing situation (0 – 2 months).

*48 hours up to 2 weeks*

- Coordination with WASH Cluster / sector actors.
- An initial rapid assessment (see Figure 1).
- Identify public water supply installations, which can be rehabilitated quickly.
- Identify strategic places where mobile water supply and treatment plants can be delivered (health centres, shelters, IDP camps and any place with high concentration of people).
- A coordinated programme should be established for distribution of non-food item (NFI) kits containing water-purifying tablets, buckets for the transport of water etc.

1) What are the main sources of water supply? E.g. surface water, rivers, lakes, dams or groundwater, wells, boreholes, springs etc.

2) Which sources are contaminated, and which sources are available for rapid provision of safe water supply to the affected population?

3) What types of infrastructure (e.g. boreholes, wells, springs) require rehabilitation?

4) What services are run by the state, commune, villages, water boards?

5) Which areas need to receive rapid assistance (e.g. bottled water, non-food item (NFI) kits, water tankering and water treatment kits?)

6) The status of transport access by road, boat and air to the affected region?

**Figure 2:** *Essential questions for the initial rapid assessment*

- Make water distribution points available either through existing state or private water resources, or through new infrastructure in strategic places, and inform the population about those places.
- Distribute water to the most vulnerable groups through emergency supply activities such as water trucking, emergency water treatment plants, point of use treatment, and distribution of bottled water.

**Short to medium-term actions (2nd Phase),** typified by a stabilisation of the situation (from 2 – 6 months). Start rehabilitation of public and private water supply infrastructure. Continue delivery of water through emergency supply activities until the situation is stabilised so that emergency supplies are no longer necessary.

**Medium to long-term actions**, typified by the early recovery phase & resettlement of the affected communities (3 – 12 months or longer). Continue rehabilitation of state and private water infrastructure. Establish new water supplies rather than continue tankering.

### The importance of hygiene behaviour

Water supply, sanitation and health are directly affected by hygiene behaviour. ***It is essential to read this briefing in conjunction with the 'Hygiene Promotion in Flood Setting' briefing, Sow (2009).***

### Disaster Risk Reduction (DRR)

In areas at risk of recurrent flood emergencies, it is important to incorporate DRR activities into the response, for example:

- Advocacy for sustainable flood prevention, effective water resource and catchment management, additional protected water sources etc.
- Ensure that rehabilitated and newly constructed infrastructure is (more) disaster proof.
- Capacity building of local staff for protection of infrastructure, emergency preparedness and immediate flood response activities.
- Capacity building of the affected population for emergency preparedness.

## 1. Water quality and quantity

After floods it is important to ensure that people have adequate access (considering both distance and time) to sufficient quantities of water of acceptable quality for intended uses. From a health point of view, **a larger quantity of relatively good quality water is better than a small quantity of very high quality water** and this must be taken into account when choosing water sources and bearing in mind that a large quantity of raw water can always further be treated at communal and household level to bring it to a quality suitable for consumption.

For medium to long term actions, it is the responsibility of each agency to check water quality before delivery to beneficiaries, and to **make sure that the water is appropriate for consumption and is not contaminated by any chemicals or faecal contamination.**

Water quality requirements may differ for different uses. Water quality requirements for drinking water purposes are the most demanding. The main parameters to take into consideration for immediate supply are suspended solids, pH, the level of faecal contamination (microbiological), turbidity and conductivity (a measure of salinity).

Water quality for other purposes such as washing, cooking and cleaning is less demanding but it is often less confusing for the population to receive water of equally good quality for all their activities.

- **pH:** between 6.8-7.2 to allow effective chlorination.
- **Level of faecal contamination:** 0 thermotolerant coliforms per 100 ml.
- **Turbidity:** should not exceed 5 NTU prior to chlorination and 20 NTU before using sand filter.
- **Salinity:** should not exceed 1000 mg/L (TDS) or 1300 µS/cm (WHO).
- **Quantity:** 15L/capita/day for drinking, washing, cooking, livestock and other purposes (7.5L/capita/day is the minimum survival level).

**Figure 3:** *Minimum guidelines, inspired by Sphere, for water quality and quantity*

Water testing can often be performed by state services, which is recommended for large amounts of water or to check the quality of the groundwater. Analysis of water samples can be performed on-site for measurement of bacterial numbers (principally thermotolerant/faecal coliforms), physico chemical parameters, and concentrations of chemicals such as heavy metals with the use of portable water testing kits (e.g. those produced by Delagua and WagTech).

The use of these kits requires the use of a specific protocol for sampling and for analysis. For many quality parameters, water samples need to be analysed less than 6 hours after collection. For microbiological analysis, 6 hours is the maximum timescale and the sample must be held at under 5$^{o}$c for that time. If the sample is held above this temperature, even for short times during the 6 hour period, the results are not valid.

## 2. Water tankering and distribution

Water tankering has proven in many circumstances to be a life saving activity in the initial stages of an emergency such as rural flooding. Tankering of water requires adequate access and road infrastructure for tankers to bring water to the affected population. Sometimes other ways of access need be explored such as transport by boat or aircraft.

**Figure 4:** *Water transported by trucks*

Water distribution points can be either in places with concentrated population such as in camps, shelters, hospitals, or in strategic places where people can come from remote places and fetch the water.

Specific recommendations are:

- As it is an expensive activity, a clear exit plan must be in place before starting the tankering programme to ensure that tankering does not go on for months after the flood situation improves.
- A local water resource must be identified with sufficient quantity and quality to support the local and beneficiary populations.
- Adequate access and road infrastructure for tankers to bring water to the affected population. Sometimes other modes of transport are necessary, such as transport by boats or aircraft.
- Strategic locations are identified together with beneficiaries and local authorities for water delivery. Suitable locations can be close to health centres, shelters, at IDP camps or any place with high concentrations of people.
- Suitable tankers for the transportation of water must be available locally at a reasonable price. Tankers should be suitable for transporting water of potable quality. It is important to investigate whether suitable tankers are available from

drinks factories, breweries, dairies, etc. before hiring oil and fuel tankers, which would need to be cleaned thoroughly. Make sure that all tankers are cleaned and chlorinated before use.

- If trucking bladder tanks are selected, they should be supported on structures able to bear the weight when the tanks are filled with water.
- If the water is not turbid, (NTU < 5) the water can be chlorinated in situ. Otherwise, water will need to go through a water treatment process to improve its quality. The water should be regularly tested for faecal and chemical contamination.
- Suitable mass storage tanks should be used for the tanker water to be decanted and the population collect from the distribution tap stands rather than from the water tanker directly. This maximises the number of trips (and volume of water) the tankers can deliver in a day.
- A weekly distribution plan has to be set up based on the amount of water to be delivered and the estimated number of population that will collect water from the selected place. Clearly inform the population about the day and location of water delivery. Local radio and media can be used to communicate this information in combination with hygiene promotion messages. *Refer to Sow (2009)*.

# 3. Water Storage

Safe storage facilities are part of the chain for drinking water supply and should be provided both at communal and household levels.

**Communal storage facilities:** It is important to be aware of the needs of the target population and the peaks in water demand, when designing water storage systems. It may be appropriate to initially size the storage volume on the water required for food preparation and drinking only i.e. a minimum of 15 litres per person per day (Sphere). Storage tanks of different sizes and materials and uses (e.g. collection of water from springs, continuous flow water treatment systems), are available on the market. For example, Oxfam has developed a range of lightweight rapid response water tanks that can easily be ordered and quickly set up for use during emergencies (see **figures 5, 6 and 7**).

**Figure 5:** *Oxfam 30m$^3$ onion tank for water treatment.*

**Figure 6:** *Tank for water storage (50m3)*

**Figure 7:** *Inflatable water bladder (20m3)*

Simple structures made using locally available material can also be set up e.g. fibreglass tanks, wooden structures fitted with tarpaulin sheets, masonry, block or brickwork, reinforced concrete, ferro-cement.

**Household storage facilities:** Delivery of PVC (plastic) buckets with covers and storage containers should be included in the non-food item (NFI) kits delivered during the first stage of an emergency. However, after communication with the population, it may be that local water carriers are more appropriate than plastic buckets. Water containers must be culturally acceptable or the 14L/20L buckets distributed may not be used for water collection and / or storage. It is important to prioritise the use of local materials when assembling and distributing the kits. In some situations, it will not be practical and feasible to achieve this immediately. In this case, it will be necessary to distribute plastic buckets until traditional containers become available.

**Figure 8:** *Domestic storage facilities: plastic bucket (50 L) and traditional ceramic jar*

## 4. Source Water Treatment

Water must be totally free from pathogens in order to prevent the spread of disease during emergencies. In particular where there is overcrowding with poor water and sanitation conditions the risks of spread of disease are high. Removal of bacteria can be achieved either through a water treatment plant for larger groups of people living in shelters, IDP or refugee camps; a chlorinator or slow release tablets in floating pot chlorinators; or at household level, where families still live in their homes or (in some cases) in shelters or camps.

**Water treatment plants:** Provided that a suitable local water source exists, and depending on the quality of the water source, water treatment will be an important step before being able to provide "safe drinking water". The advantage of providing water treatment facilities is that it can enable a range of water source options to be made available. In theory, water can be pumped from a river, a pond or even from the sea (if a reverse osmosis unit is fitted to the water treatment system).

A water treatment plant usually consists of the following units and steps: Flocculation / sedimentation, sand filtration, charcoal (or activated carbon) filtration[1], chlorination. Variations of the different steps can be applied depending on the quality of the raw water. Turbidity is one of the most important parameters to check before considering chlorination or other disinfection options. *For further information refer to the 'Water Supply in Urban Flood Settings' briefing (Oess, 2009).*

**Mobile water treatment plants:** These are usually self contained, small, and portable units (often trailer mounted) that can be rapidly set up in an emergency to produce large amounts of treated water. They can be used to treat water from rivers or ponds. They usually contain simplified versions of the treatment stages in a full water treatment process. Units are even able to treat water contaminated by seawater, sewage, biological, or chemical substances. Packaged water treatment plants are technically advanced, and therefore require skilled and trained staff and specific chemicals for operation and maintenance of the system. Units that are supplied from abroad without a technician to install them and train local operators usually remain unused.

**Water treatment alone is not sufficient and can only be effective if adequate sanitation structures and accompanying measures of hygiene promotion are provided**. *Refer to Sow (2009).*

[1] It is important that a facility to regularly "clean" the charcoal is also included.

# 4. Point of Use (POU) Water Treatment

Point of Use (POU) or Household Water Treatment (HWT) is an important option to avoid waterborne or water source disease in the immediate stages of an emergency. Those whose houses have been destroyed may return during the day to their dwellings and/or help other families to start clean up, look for their belongings and save what they can. It is therefore important to give them the essential tools to minimise the risk of becoming sick while they are away from communal safe water supply sources.

There are different ways to obtain safe drinking water at household level (*see Table 1 overleaf*). It is important to avoid contamination by pathogens during collection, storage and consumption of water. The "best" option depends on existing water and sanitation conditions, water quality (including aesthetic conditions such as taste, odour and colour), availability of household water treatment technologies, cultural acceptability, implementation feasibility, environmental factors and other local conditions. What is most important is that households treat their water using a method or technology that is **readily available and acceptable to the community** in question.

**Regular water quality analysis** should be routinely carried out to ensure that the population are carrying out the treatment properly. **Household water treatment (HWT) should always be promoted with appropriate hygiene promotion** sensitisation, demonstrations and with visual leaflets and other relevant materials in the local language. Refer to '*Hygiene Promotion in Flood Settings' (Sow, 2009*). Households should continue treating water until they are advised by local authorities that their supply has been tested and found to be safe.

A number of examples are provided in Table 1 overleaf. Figures 10, 11 and 12 provide illustrations of popular techniques.


**Figure 10:** *PuR sachet instructions*

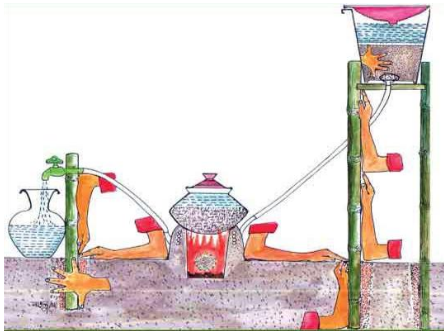

**Figure 11:** *Chulli filter*

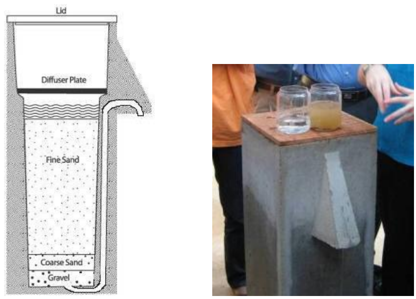


**Figure 12:** *Biosand filters*

| Method | Description |
|---|---|
| **Chemical disinfection** | An important method of water disinfection at household level in health centres, shelters, camps, or for those affected by the flood who are able to stay at home. A crucial parameter for the use of chemical tablets is the turbidity of the water: **Water < 5 NTU: use normal chlorination tablets** <br> **Water > 5 NTU: use a combined flocculation/ chlorination chemical** <br><br> Different types of chlorine compounds exist in the market. A few mg/litre of chlorine and contact times of at least 30 minutes generally inactivates >99.99% of enteric bacteria and viruses, provided the water has limited suspended solids. <br><br> **When the turbidity of water is above 5 NTU or cloudy and "dirty" it will be necessary to use a combined flocculation/ chlorination product such as PuR (Figure 10).** PuR allows removal of suspended organic and mineral matter. The water is normally stirred for a few minutes with the reactive chemicals and then allowed to stand for half an hour. Through this process, the suspended matter flocculates and sediments to the bottom of a container from which it can be removed by filtration. **For any type of chemical disinfection, it is important to follow the instructions on the packet.** |
| **Bleaching powder** | Bleaching powder should be stored in a dry, closed container, and kept in the dark and away from children. Add a quarter of a teaspoon to 1 kolsi (pot or jar) of water and stir. Let the water sit for at least half an hour before drinking. If there is no smell of chlorine the amount added was too little: Repeat adding bleaching powder until some chlorine can be smelled in the water. For more details of determining bleaching powder quantities, see the *Modified Horrocks' method described by Parr et al, (1999)*. |
| **Boiling** | Following a flood emergency, many families may lack the facilities and fuel to boil water. However, boiling can be appropriate in areas with enough fuel supply and a cultural tradition of boiling water e.g. to cook family meals, or when the taste of water treated with chlorine is not accepted. In the case that stoves are distributed, particular attention needs to be given to fuel supply and release of toxic gases. *Refer to Jetter (2009) for more information on recommendations on which type of stove to use.* |
| **Solar disinfection (SODIS)** | An appropriate method for use in emergency situations, especially when no chemical disinfectants are available. Solar radiation is used to inactivate pathogens present in water. This technique involves exposing water in clear plastic bottles or containers to sunlight for a day, for example on the roof of a house. In emergencies, empty bottles left over from an initial shipment of drinking water can be used (it is necessary to use small containers as solar rays will penetrate no more than about 10cm). Bottles need to be cleaned, filled to three quarters full and shaken thoroughly 20 times, before being filled completely. The bottles are then exposed to sunlight for 6 hours (or for 2 days if the sun is obscured by clouds). The water should be consumed directly from the bottle or transferred to a clean glass for drinking. |
| **Ceramic filters** | Ceramic filters, sometimes called candles, purify water by allowing it to pass through a ceramic filter element. Suspended particles are mechanically filtered from the water. To be effective, the impurities held back by the candle surface need to be brushed off under running water, at regular intervals and the inlet water should have a low turbidity. The filtered water is likely to be free from bacteria, but it is recommended that the water should also be boiled or otherwise disinfected, unless the filter is impregnated with silver which acts as a disinfectant and kills bacteria. Ceramic filters can be manufactured locally, but are also mass-produced. They can be costly but have a long storage life and so can be purchased and stored in preparation for future emergencies. |
| **Chulli filter** | A household water treatment technology based on the clay oven rural Bangladeshi women traditionally use to cook **(Figure 11)**. Water is poured into a bucket, where it is filtered by sand before flowing into a pipe, then a coil fixed into a clay oven. Water then flows into a tap, open only slightly, and collected into a pitcher or any other container. Water is warm and can be used directly or first cooled in the container (with a lid). |
| **Biosand filters** | Small, household slow sand filters, which operation in a similar way to Pond Sand Filters (Section 8) but on a smaller scale **(Figure 12)**. Water is filtered and (partially) disinfected when the 'Schuzdeke' layer forms (a layer of slime containing "good" bacteria). The sand can also remove some of the bacteria.[2] Water then flows into a pipe from which it can be collected. As biosand filters do not always kill all pathogens, it might be necessary to disinfect the outlet water (e.g. by boiling it or using bleach). <br><br> To be effective, regular maintenance of the sand, water and bio filters is essential. The layer of sand must always remain under water and must be regularly (at least once a month) washed or dealt with as if it is a "bio-hazard", as it contains millions of bacteria that can contaminate the environment. When the through put of water reduces, the top layer of sand has become saturated and must be removed and replaced. |

**Table 1:** *Household water treatment techniques*

[2] Setting up electromagnetic forces can further help with this by causing bacteria to attach to the sand particles.

## 5. Bottled water

Bottled water can be an immediate solution to drinking water for survival in the initial stage of an emergency. Sometimes bottled water is provided at low cost to governments and responding agencies, by the bottlers themselves. However, it is still usually expensive compared with other sources. In some countries, local water vendors sell water in bottles or in sealed plastic bags prior to a crisis, door-to-door (sometimes making use of boats during the floods) or positioned in strategic places at "kiosks".

**Figure 13:** *Jerrican water delivery*

**Figure 14:** *Delivery of water bottles*

Mapping the location and capacities of local water vendors should be part of the initial assessment. It is recommended to check with the vendors if they need chemicals or any support to be able continue their water delivery service, and to **monitor the quality of the water that is supplied and hygiene of their transport and storage containers**.

Care must be taken when bottled water is being distributed as many of the water bottles are discarded creating a solid waste issue. Make sure that the bottle sizes are as such that people will re-use them (e.g. for SODIS) rather than discard them.

## 6. Rehabilitation of Wells and Boreholes

The extent of pollution of the groundwater has to be assessed before cleaning wells and boreholes. Analysis of the groundwater can be carried out by local authorities or by WASH agencies. Be aware that in some places the bedrock may naturally contain high concentrations of arsenic, fluoride or toxic heavy metals such as cadmium and mercury. Places close to industrial activity, landfills or mining may contain organic and heavy metal pollutants. *Refer to WHO (2006) for guidance on threshold levels for each contaminant, analytical techniques for chemical analysis and appropriate techniques for removal of toxic components.* **If there is no simple and rapid technique available to remove a hazardous pollutant, avoid water treatment and look for another source of water supply.**

In many places it has been observed even after several cleanings that the quality of water from wells and boreholes is not safe enough for drinking purposes, but the water can be still be used for cooking or washing. Sometimes storm water will be stagnant and saturate the soil for many days or weeks before the actual infrastructure can be identified. **It is essential to ensure that any sources of contamination are removed before cleaning and rehabilitation.**

**Rehabilitation** may include:

- Repair or replacement of the pumping mechanism.
- Removal of polluted water and debris from wells using either buckets or pumps.
- Sealing the top of the well using a sanitary seal (can be concrete etc) built around top of well.

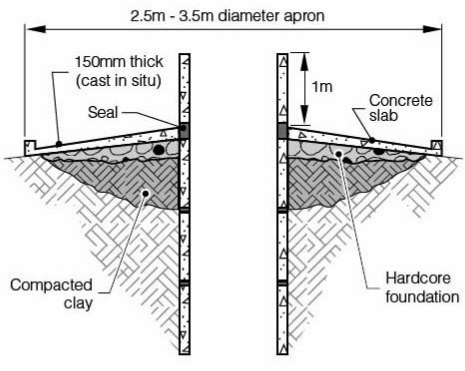


**Figure 15:** *Protection of the top of a well (Godfrey, 2005)*

- Construction of a drainage apron and head wall (minimum of 1m high) around the well to prevent surface water, insects and rodents entering the well.
- Relining the well to reduce the risk of subsurface contamination.
- Raise pumps in wells and boreholes as an emergency preparedness measure for future floods.

Check turbidity and pH, referring to Table 2 below. Following dewatering, cleaning and repair, allow the water level in the well to return to its normal position. Measure the turbidity and pH levels to check if chlorination will be effective.

| **Physico-chemical parameters** | | | |
|---|---|---|---|
| **Parameter** | **WHO GDWQ** | **Why?** | **Corrective action** |
| pH | 6-8 | pH of 6.8-7.2 is required to reduce level of chlorine required. | If pH is less than 6 add hydrated lime (calcium hydroxide) |
| Turbidity | <5NTU (20NTU emergency limit) | High turbidity (>5NTU) requires more chlorine to oxidise organic matter | Dewater well and rebleach well lining using chlorine solution |

**Table 2:** *Physico-chemical parameters (Godfrey, 2005)*

**Disinfection:** If the turbidity of the well water is greater than 5 NTU after the cleaning and rehabilitation stage, remove all the water and scrub the well lining with a strong concentration of bleach in water. Allow the well to refill with water and test turbidity levels again to ensure compliance.

**Well jetting:** Well jetting is a fast method of shallow well construction in suitable (sandy or alluvial) soils. The well is bored through the erosive action of a high velocity stream of water, or a mixture of water and air, to excavate the hole and carry the excavated material out of the hole. It requires a pump of reasonable capacity (motorised or hand-powered) as well as a supply of water. The water and excavated material can be separated in a settling pool or tank, allowing the water to be reused.

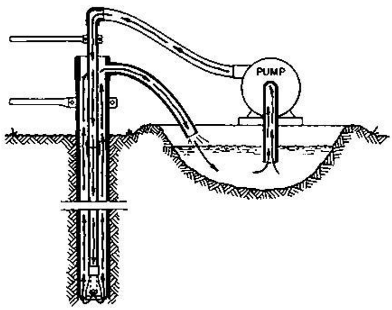


**Figure 16:** *Well jetting (FAO, undated)*

Compared with driven wells, jetting is much faster as mechanical force is not needed. **A team of experts can set up as many as six wells per day.** Since this method depends on the erosive action of water, extremely hard materials cannot be penetrated.

## 7. Rainwater Harvesting

Rainwater collected from the roofs of houses, local institutions or from specially prepared areas of ground, can make an important contribution to drinking water. In some cases, rainwater may be the only available, or economical, water source. Rainwater can also be used to "dilute" more salty bodies of water to make them more palatable to the consumers.

Components required for harvesting rainwater from roofs at individual, community or institutional level are: a roof, gutters, a first flush device and a storage tank with a sludge drain. Rain pattern, catchment area and storage capacity determine the quantity of water that can be collected[3].

Collected water is normally acceptable to users in terms of both taste and appearance. However, **it should not be assumed to be drinking water quality and will require testing and treatment if it is to be used for human consumption.**

**Figure 17:** *Rainwater harvesting device*

Specific recommendations:

- Simple tarpaulin sheets can be used as collection surfaces during the first phase of an emergency. They can either be placed on the roof or set up with basic supports (Figure 18). In places with ongoing rain, they could be **included in the initial hygiene or non-food item (NFI) kits.**

**Figure 18:** *Tarpaulin sheets in Ayeyarwady delta, Myanmar*

[3] Rainwater harvesting is particularly useful in areas with rainfall between 200 and 1000 mm and in areas with two separated rainy seasons.

- Roof gutters should have sufficient incline to avoid standing water but must be strong and large enough to carry peak flows.
- Ground catchments are more expensive than roof catchments and should be considered only in areas where rainwater is very scarce and other water sources are not available.
- The rate at which water is collected will depend on the plan area of the system, its efficiency (how much of the total rainfall flows over the surface), and intensity of rainfall.
- The first flush or run-off of rainwater after a dry period should be allowed to run to waste as it will be contaminated with dust, bird droppings, etc.
- Storage tanks should be covered to prevent mosquito breeding and to reduce evaporation losses, contamination and algal growth.
- Rainwater harvesting systems require regular maintenance and cleaning to keep the system hygienic and in good working order. **It is important to carry out a parallel programme of operation and maintenance training with users.**
- Users should avoid taking water from the bottom of the tank, or disturbing the sediment at the tank base.

# 8. Pond Cleaning / Rehabilitation

During floods ponds, which may form part of a very fragile ecosystem, become filled with contaminated surface water, debris, deposits, dead human and animal bodies. After floods, ponds need to be cleaned and refilled with water. Some ponds can even be used as sites for water treatment plants and, in some cases, new ponds can be constructed. Priority should be given to old pond rehabilitation, since many years are often needed to stabilise the bottom of a new pond due to the mixture of clay and sand layers. Construction/maintenance of the embankment and the fencing should be carried out at the same time. See *Table 3 below* for steps to clean a pond.

| | |
|---|---|
| **Initial Drainage** | Manually breaching the embankment walls at one or two points is the typical way to rapidly drain a pond. |
| **Pumps and pumping strategies** | After initial drainage, the rest of the water usually needs to be removed with a pump. Locally available pumps and engines should be favoured. |
| **Protection of pond bottom and embankment** | There are different options available for the protection of the pond bottom and embankment. For, example, lining the pond with brown clay, straw and borrow soil or bentonite. |
| **Use of lime** | Calcium oxide (CaO) (lime) can be used for pond cleaning. **It should be noted that lime use does not make pond water safe to drink without further treatment.** |
| **Chlorination** | Chlorination of ponds is not recommended at community level, since it has very little impact. In some cases, ponds are used as a reservoir for water treatment and distribution. In that case, chlorination will be the final step before distribution (see section 3). |
| **Chlorination of Sand filters** | In areas where groundwater is not available or of inappropriate quality (e.g. in areas with high concentrations of arsenic or salinity), but where surface freshwater is available (ponds, rivers etc.), Pond Sand Filters can improve the quality of these sources to provide drinking and cooking water. *Refer to GOB-DANIDA for more information.* |
| **Bio-treatment** | Local knowledge on maintaining pond water quality and the ecology needs to be respected and applied whenever possible. For example, the traditional use of lotus plants to clarify and detoxify pond water in South Asia (see **Figure 19**). Drumsticks seeds (moringa oleifera) and banana plant stems can also be used as a natural flocculent to purify water with high levels of turbidity. For more information, refer to "Biotreatment of Water" (Gapalan, s.d.). |

**Table 3:** *Steps to clean a pond*

It is recommended that cleaning is limited to water only; no digging should be done inside the pond. Care must be taken in areas with high water table to avoid excessive scraping, which could cause seepage and further saltwater intrusion. All debris and organic matter should be removed from the pond after drainage. A safe disposal site located away from watercourses should be identified. Due to saline saturated soils on the pond bottom and sides, drainage and cleaning sometimes needs to be repeated at least 3 times. As ponds are often very fragile ecosystems and take many years to achieve equilibrium and become efficient, it is recommended that they should not be filled with raw river or saline water, but to wait until the next rain comes. **It is important that chemical analysis is routinely carried out on pond water especially in agricultural areas for nitrate, nitrites and arsenic levels.**

**Figure 19:** *Traditional growing of lotus plant to clarify pond water in Myanmar*


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