

# Drinking Water Ponds in Spate Irrigation Areas



Practical Notes Spate Irrigation



## 1. Introduction

The provision of drinking water in spate irrigated areas can be problematic. Areas may be far from a perennial river or a spring. Preferably water is delivered from safe wells but in several spate irrigated areas there is no access to reliable or useable groundwater. In fact in large parts of the spate belt groundwater is saline. In such circumstances ponds (also called talaab), that collect rain and flood water, remain an important source of drinking water - for humans but also for livestock. This document aims to bring together the experience with improving water supply from such ponds.

## 2. Current status

It is not possible to state with any degree of accuracy how many people depend on drinking water ponds for their domestic needs, but the number is not insignificant. There are several areas where groundwater is saline or too deep to access for individual households: DI Khan, Tank, Laki Marwat, Kohat in NWFP, DG Khan and Rajanpur in Punjab, Cholistan desert in southern Punjab, areas of Dadu, Thatha, Badin, Sanghar and Tharparker districts in Sindh, Jhalmagsi, Kacchi, Dera Bugti, Kharan, Kalat, Mastung, Lasbela, Changhi, Killa Saifullah, Loralai districts in Balochistan. In the last three decades there has in several areas been much needed investment in rural drinking water systems, but coverage especially in dispersed settlements outside local rural centers is often still low. Another issue is the non-functionality of improved drinking water systems. Based on detailed work in three districts in Pakistan PCRWR established that at any point in time 37% of all rural systems are not operational. The pattern is that non-functionality is higher in remote areas that are more likely to be deprived of basic maintenance facilities. Taking all these into account a fair guesstimate is that at least 6 Million people use for part of the year the water collected in ponds. In addition large numbers of livestock in the same areas rely on the water from ponds.

The main challenges in the drinking water ponds are the duration of storage and water quality. Drinking water ponds loose water due to seepage and evaporation and unless well-maintained will silt up. It is not unusual for ponds over time to loose 90% of their storage capacity due to sedimentation. This reduces the capacity to buffer

the flood water but also accelerates losses as ponds become shallow and evaporation increases disproportionately. Water losses also occur due to seepage. Seepage is related to the soil condition of the pond. Particularly in lowland areas a layer of fine clay may seal the pond and limit effective seepage. In highland areas soils may be more porous and water loss from percolation may be higher.

Water quality from the open surface ponds is without exception far below official health standards. The main issues are bacteriological contamination and turbidity - the latter making it more difficult for sunlight to disintegrate pathogens<sup>1)</sup>. In the subsequent part of this note current practices in the management of drinking water ponds in spate irrigated are discussed (section 3) as well as possible improvements and support policies (section 4).

## 3. Development and management of drinking water ponds

Water ponds are low cost water providers. Using data from PLI in DI Khan (see table 1) excavation costs vary from PKR 36 to PKR 100 per m<sup>3</sup> (USD 0.40 to 1.20). Assuming the sunk cost of the pond is zero, this brings the costs of water provision per capita of water to USD 2.5 to 6.5. This compares very favorably with the cut-off cost of USD 35 per capita, which is often used in planning drinking water supply, but then of course the water is only temporary and the quality is low. Being open water bodies the ponds are prone to bacteriological contamination. As the water stands in the pond and is exposed to sunlight there is moreover a risk of algae growth, especially in the presence of nutrients. There is hence a maximum storage time for water in the pond – not more than six months, but very few ponds exceed this time.

Contamination of pond water is impossible to avoid but there are a number of practices that make the pressure lighter. In traditional ponds water quality is somehow safeguarded by avoiding that animals and human freely enter the pond area. This is done by making bush fences or mud walls around the pond. For livestock separate ponds may be in use. Another practice is to have a complete ban of fishing from the ponds. In some places off season floods are not allowed to fill the ponds, as the belief is that spring season

1) On some fronts water quality from ponds may be better - particularly in areas where fluoride or arsenic levels in groundwater are problematic pond water provides an alternative that is relatively free from this components.

Table 1. Rehabilitation of three drinking water ponds in DI Khan

	Thailan	Gatar	Gara Dasti
Population	600	700	350
House holds	75	60	40
Capacity before rehabilitation (m <sup>3</sup> )	679	407	401
Capacity after rehabilitation (m <sup>3</sup> )	4030	4241	4976
Cost per pond in PKR	337,000	140,000	269,000

Source: Arshad Haroon (2007)

water brings more contamination. Monsoon water - which is more abundant - on the other hand has a lower concentration of animal droppings and others. Though these practices are broadly known they are not necessarily always followed as such. Water users may use several means to improve water quality. The most common and most poignant methods is to use of handpump and sandfilter to take water from the pond. This remove the turbidity if not the bacteriological contamination. Introduced by NGO's for instance in the DG Khan and DI Khan this method has become popular. Further down the water chain a number of methods are used. Boiling is common but not always used. In some areas people use alum (aluminum potassium sulfate); in other areas people use almond nuts to remove turbidity<sup>2)</sup>. The most common treatment is to sieve water with fine cloth.

In traditional shallow ponds water storage in ponds typically last three months. When ponds dry out and when there is no other source of drinking water supply, people dig shallow wells near the pond and or dig shallow wells in spate river bed. Part of the family may also be forced to move - complete with livestock - to other areas. To make the ponds last longer in many spate areas natural depressions in river and channel beds are used first to draw water. This resting period allows silt and other impurities in the ponds to settle down. The pond is then used later in the dry season. Water storage can be increased by deepening the pond. In the Kacchi area it became popular to increased pond depth from the usual 1.5 meter to 4 meter. This not only helps to bring down the evaporation but also reduces the contact surface of water, which reduces seepage loss as well. Some newly made ponds last up to six months. The key to keep the storage capacity of drinking water ponds is maintenance. Spate

flows often carry 5-10% sediment by volume so a one-time filling of a pond of 3 meter depth will already deposit a layer of silt of 30 cm. The amount of sediment that ends in the ponds further depends on (1) the use of physical sediment traps (2) the use of vegetation to slow down sheet flow and catch sediment<sup>3)</sup> (3) the general route taken into the pond and (4) the water that is let into the pond. Sediment traps work well – but also require removal of sediment. By observing cloud movement, farmers will look at the origin of the floods. In some areas farmers may decide not to use flood water from a certain source.

Silt is removed either manually, by animal power or by tractor. The mud/soil from pond is not taken when it is completely dry. The preference is to desilt when the mud is drying out but still moist. In this condition it is easier to dig and handle. Particularly clayey deposits are hard to remove. The upper layer is usually taken either manually (using shovels, buckets, pick axes) or with the help of an animal-drawn (oxen or camel) scraper boards, whereas the deeper part is taken by a tractor or bulldozer. The wet soil is of course heavier to transport outside the pond but easy to handle. In some cases wet soil is dug and pulverized first then dried on the side of the pond and then transported further away. Mostly silt removal is done by the users of the pond on a collective basis, but recently government has also made tractors and bulldozers available. The mud from the pond is also a resource – that can be used in house construction, brick making and in soil improvement. The pond mud may be reused in the construction of houses or in fertilizing fields. In highland silt from pond is used as 'washed soil/new soil' in high value orchards due to its fertility and porosity.

2) The seeds of the *Moringa oleifera* is known to have to have a co-agulating effect. A similar practice is that of using *Stychnos potatorum* seeds to settle down turbidity in pond water in coastal Tamil Nadu. Other practices used in coastal Tamil Nadu (where a large number of people – estimated at 3 Million – depend on pond water) are adding burnt kankar (calcareous rock powder) or even saline water (one part on twelve). These also reduce turbidity yet obviously change the taste of water too. None of these practices removes pathogens, however.

3) The use of vegetation filters may also work to reduce the presence of bacteria in the flood water.

#### 4. Improvements to drinking water ponds

There are several ways to improve the water supply from ponds that are effective and relatively moderate in costs. Water supply from reticulation systems obviously is preferable but in many areas this is still out of reach or whereas in others non-functionality is a problem.

may be located in a deep depression that will give the same protection. In deepening wells and reducing losses from evaporation there is also the shape of the pond to consider.

Experimental work by PCRWR in Cholistan on a large number of ponds suggests that a depth of 4.5 to 6.5 meters is ideal to control evaporation, with side slopes of 1:2 or 1:3 - depending on

##### Box 1: Reusing the mud

In housing construction the mud that is accumulated at the bottom of the pond is not preferred but the mud and soil on slope is used readily. The explanation is according to local knowledge that mud/ soil at the bottom part lacks impurities and salts as does not stick together and is 'like new soil'. It can be used when mixed with other materials. Sometimes some of the first water in the ponds is used to whitewash houses. Brick masonry is preferably undertaken when there is still water in the pond. Upon receding water the soft material is used for construction of cooking stoves, bins for chicken, troughs for animals and other light purposes. The use of the mud differs with its hardness. Hard mud with a larger percentage of loam and sand is used to make bricks and burnt into kilns. Medium quality material is used for sun dried bricks. The bottom line is that both activities go together, i.e. cleaning of pond and its material used by villagers.



Improvement to drinking water ponds may concern the techniques in use: deepening ponds; using seepage wells: regulating access; reducing sedimentation; regulating access; improving point-of-use water treatment. A second category of improvements concerns the organization and maintenance. Below these improvements are briefly discussed.

##### Wells

Where local geohydrology allows shallow wells may be constructed around the pond<sup>4)</sup>. The advantage is that water from these wells will be to a large extent filtered of contaminants.

##### Deepened ponds

Deeper ponds will bring down evaporation losses. These losses can be very substantial at shallow depth particularly in high temperature seasons or under the influence of strong winds. In this regard the planting of trees is recommended to provide shade and shelter, provided water consumption by trees themselves is limited. In other areas the pond

the soil conditions (Maanics International 2002). This was based on a trapezoidal pond design<sup>5)</sup>. An alternative design, according to Nissen-Petersen (2006), is a bowl-shape, because it is a stable form that distributes internal and external pressure equally on the pond wall. In addition, the shape has the advantage of giving maximum volume of water for a minimum excavation of soil. In deepening ponds care is also required not to damage the existing impermeable layers of clay and fine sediment that prevent percolation.

##### Reduced sedimentation

Sedimentation can be reduced with silt traps and by vegetative measures, as well as by not allowing very heavy silt-laden water into the pond. The use of these measures is double edged: they reduce the volume of sediment, but the composition of the sediment that is still flowing into the ponds will be such that it is more difficult to remove - only fine clays will be left.

4) This is common in the hafir systems of Somalia.

5) The depth of excavation may also have practical limitations – some sources put the maximum at 4 meters.

Table 2. Improving drinking water from ponds

Intervention	Technique	Caution
Sediment removal	Tractor	Avoid not to penetrate silt clay layers
	Oxen with plough and scraper-boards	Not possible if sediment is too heavy (clayey)
	Manually	Ibid
Prevention of sediment	Vegetative sediment traps	Need regular cleaning out
	Sediment traps and depressions	
Prevent water contamination by livestock	Separate ponds for livestock	
	Use wall, fences or trenches to keep out livestock	
	Employ guards	
Improve water quality	Use seepage wells	If local geohydrology allows
	Point of use techniques	See Annex 1
Reduce seepage	Lining with polyethylene or geotextile	Take care not to rupture
	Clay puddling	
Reduce evaporation	Deepening ponds	Preferable depth 4-7 meter Take care not to disturb impermeable layers
	Trapezoidal ponds	Proposed (Maanics International 2002) but not tested
	Floating cushions of geomembrane	
Improve access	Stairs and platforms	

#### Reduced seepage

Several methods can be used to reduce seepage from ponds: in rising order of costs: the use of puddled clay; the use of poly-ethylene sheeting or geo-membrane lining. Lining is particularly useful if soils are sandy and highly permeable. WRRRI successfully lined a number of ponds with poly-ethylene sheeting. Care was taken to construct the trapezoidal sides of the ponds in steps, so as to avoid that the sheeting would slip during construction (see figure 1). Care was also taken in the placing of the sheets to avoid rupture or puncture of the poly-ethylene before it was covered again with soil. Work by PCRWR in Cholistan recommended the same: a 1 mm layer of poly-ethylene lying on the bed and side slopes - that may be covered with a clay layer. The sizes of these improved ponds were 10,000 - 18,000 cubic meters.

#### Regulated access

The main purpose of regulating access is to prevent livestock from using and polluting the water source - better to have separate facilities for livestock. Access is usually regulated by bush fencing or by mud walls. Another practice is to make a trench to avoid animals trespassing into

the pond area and having a guard in place in the season - this particularly makes sense for larger ponds serving several villages. A related improvement is to provide steps into the pond. Particular in deeper ponds this will make it easier to haul water from the pond and will avoid soil slippage.

#### Water purification

Water quality from ponds is low, yet there are several ways to improve this. In some areas sand filters are installed on ponds themselves. These will remove turbidity but will not significantly affect pathogens. For this to work the sand filter would need to be moist throughout the year to keep the bacteria active that will reduce other pathogenic bacteria. Point of use water treatment is more promising - either disinfection or filtering. Moreover, in recent years several new promising techniques have been added to the repertoire of point of use treatment methods. A summary overview is given in table 3.

Better approaches

Ponds are often neglected - and maintained on ad hoc manner. There is in many cases a need to revive the efforts and set in place a more effective local organization, linked to other self help improvement at local scale.

Figure 1. Top view of water pond (size in feet)

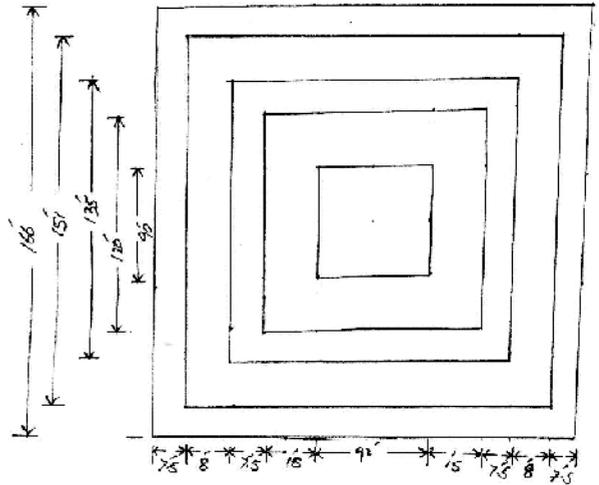


Table 3. Point of use water treatment methods compared

	Description	Advantages	Dis-advantages	Removes pathogens	Removes turbidity	Removes heavy metals
Disinfection	Boiling		Easy	Costly, requires much wood	•••	•
	Chlorine	Adding small dose of chlorine to drinking water	Production can be very low cost	Taste, requires routine	•••	•
	Sodis	UV using reused PET bottles	Low cost	Require much promotion	•••	•
	Silverdyne	Ionized silver compound solution	Broad range of functions, no smell	Costly		•
	PuR	Co-agulant available in sachets	Broad range of functions	High cost, not easy to use	•••	••
	Plation	Float	Very simple to use	Costly	•••	•
Filters	Biosand filters	Bacteria action in graded sand	Local production	Needs to be kept moist year-round	••	••
	Ceramic pot filters	Ceramic pots coated with silveroxide	Local production	Fragile in transport	••	••
	Candle filters	Ceramic candles with coal core	Easy to use	Cost, capacity, reliability	••	••
	Siphon filters	Siphon action draws water through candle filter	High capacity, easy to use quantities		••	••
	Lifestraw filters	High filling point filter	Effective	Expensive	••	••

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## Colofon

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