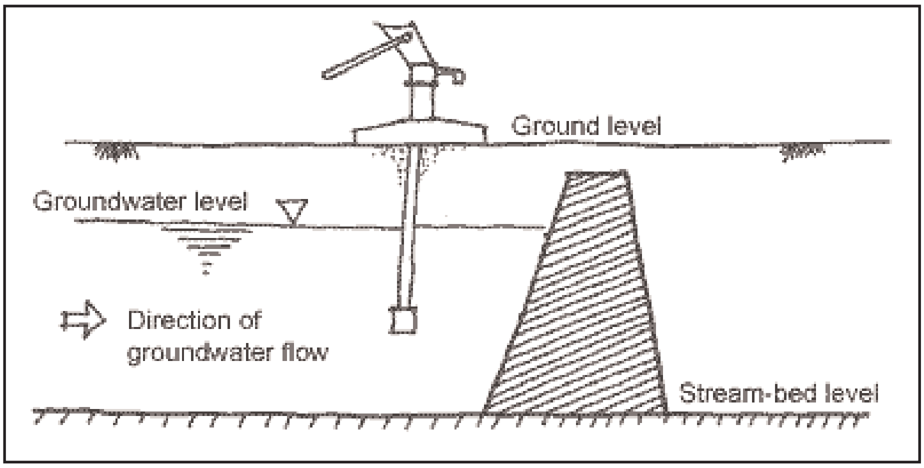
SUBSURFACE DAMS

What is this Action Sheet about?

In dry sandy areas, riverbeds are dry much of the time. When it rains, the river fills up, but the water flows away, often carrying precious soil with it. By building a small underground dam across a riverbed, you can slow the flow of water, saving it up in an underground reservoir for later use. Subsurface dams, sometimes known as sand dams, not only improve water supplies, but also help conserve soil. This Action Sheet explains how you can build a subsurface dam using only soil and labour



Sub-surface dam (Image: Rainwaterharvesting.org)

What are the benefits of building a small subsurface dam?

- By keeping water underground, subsurface dams add to local groundwater. You can draw on this water with a small well in front of the dam and use it to help grow crops around the dam. You will find the area around the dam easier to plant with crops, due to more water being held in the soil.
- The water gathered in subsurface dams is good quality for drinking, as it has been filtered by the sand and is stored underground away from contamination.
- When built in farmland, subsurface dams stop water rushing away with your soil, helping to keep your cropland fertile and stopping the river filling up with silt downstream.
- Small dams have less environmental impacts than large water control structures. During the seasonal flow, floodwater can still pass over the dam to reach people living downstream.
- Once built, subsurface dams do not require any maintenance.

How do you choose a good site for a subsurface dam?

A subsurface dam should, preferably, be constructed on an underground dyke. A dyke is a layer of hard rock that is sticking up underground and naturally stopping the underground water from flowing. Underground dykes are easiest to locate a couple of months after flooding by looking for places with:

- Natural waterholes because there is always one or several dykes downstream, holding the wate at that place
- Dry stunted vegetation on riverbanks with tall evergreen trees upstream. You can tell there is a dyke, because water for the green trees is trapped above the dry area

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Once you think you know where a dyke is, you can check in the following ways:

- Digging trial pits
- Probing with an iron rod hammered into the sand
- Dowsing with two rods made from a brazing rod cut in two halves

By starting the subsurface dam with a natural rock dyke, you have a solid impermeable base on which to build. Subsurface dams can be constructed in riverbeds with no dykes, but they might produce less water.

Other factors to consider when choosing the site:

- An ideal site is where rainwater from a large catchment area flows through a narrow passage
- Coarse sand can store more water than fine-grained sand. Riverbeds containing coarse sand are therefore preferable.
- Subsurface dams should not be located where waste from villages and other places can contaminate the riverbed
- The reservoir of subsurface dams should not contain salty soil or salty rocks, because that will make the water salty
- Boulders and fractured rocks should not be situated in the reservoirs, because they will cause leakage
- For soil conservation purposes, the dam should be built as close as possible to the head of the stream as this is where the water begins to erode the soil
- For water supply augmentation and soil conservation purposes, it might be better to build a series of small dams along the same stream, rather than building one large dam. A sequence of small dams increases deposition of silt in the water and improves infiltration more than a single large dam

What materials do you use to build the dam wall?

You can build the dam wall from soil, but first you need to choose the least porous soil from your dam site. To assess the porosity of soil (how easy it is for water to flow through)

1. Take a set of soil samples from different locations at the dam site.
2. Put the soil samples into transparent plastic bottles (at least 30cm tall) with the caps taken off and the bottom of the bottle removed.
3. Pour water onto the soil in the sample bottles until 10cm of water rests on the top of the soil.
4. Measure the time it takes for all the water resting on the top of the soil to seep through the soil in the bottle.
5. The sample in which the water took the longest time to disappear (soak in) is the least porous and thus the most suitable soil for building a dam wall.

How thick does the dam wall need to be?

The minimum width of the dam wall depends on how porous the soil is. If it takes more than 60 minutes for 10cm depth of water to seep through 20cm of soil, then the crest (top) of the dam wall should be 100cm wide. If 10cm of water seeps though 20cm of soil in less than 60 minutes, then the crest should be made 5cm wider for every minute less than 60 minutes.

E.g. If the water takes 59 minutes to soak through, the dam wall needs to be 105cm wide. After construction, the sides of a dam wall will slope 45 degrees outward from the crest and so the base will be much wider than the crest. You can then work out the width at the base if you know how deep it will be (see below).

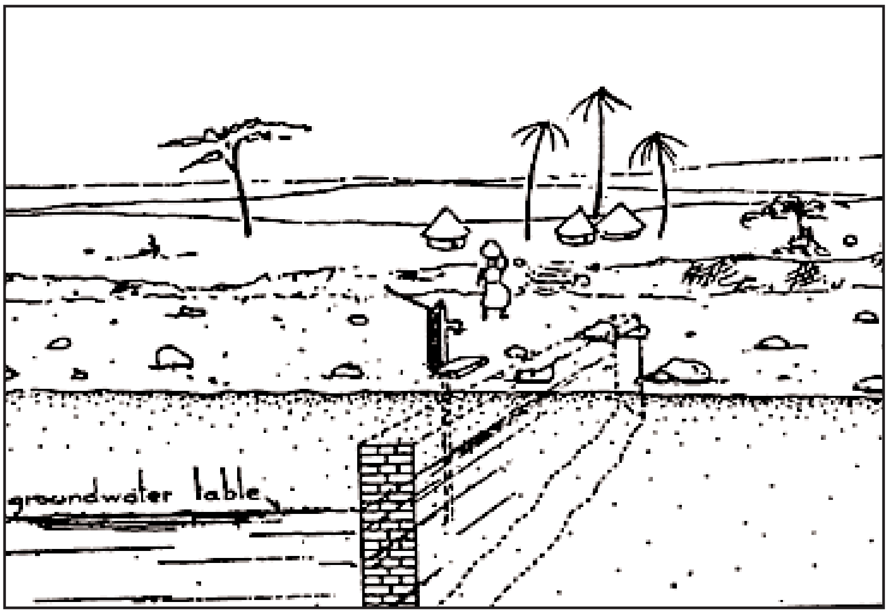
How wide does the dam wall need to be?

This depends on the natural size of the riverbed. To prevent seepage, the dam wall must extend past the edges of the river into the two banks of the river.

How deep does the dam wall need to go?

Again, this depends on the location. Dams vary from 2 to 10 metres high. Once the sandy surface of the riverbed has been removed, you will find the clay floor of the riverbed. The base of the entire dam wall should be at least 20cm beneath this clay surface. A central section of dam wall (the key) will extend 80cm below this surface.

How do you build the dam wall?



1. Build when no rain is expected!

2. Remove the sand overlaying the underground dyke in a stretch 2 metres wider than the base of the dam wall. You will reach the clay floor of the riverbed.

3. Dig out the width of the dam base to a depth of 20 cm into the clay or murram (the floor of the riverbed).

4. Dig out the key – a trench, at least 60 cm wide and 60 cm deep - into the firm soil along the middle of the dam wall, reaching to the top of both ends of the dam wall in the two banks.

5. Fill in the key trench and build up the dam wall with the least porous soil at the site. As you fill in and build, moisten the soil (wet it with water) and compact it (roll it with drums filled with water or with roller machinery) in layers of about 20 cm thickness until the top of the dam wall is reached.

6. Cut the sides of the dam wall to a 45 degree slope and smooth down.

7. Water-proof the upstream side of the dam wall by compacting a 5 cm layer of clay or cow-dung mixed with soil onto the dam wall.

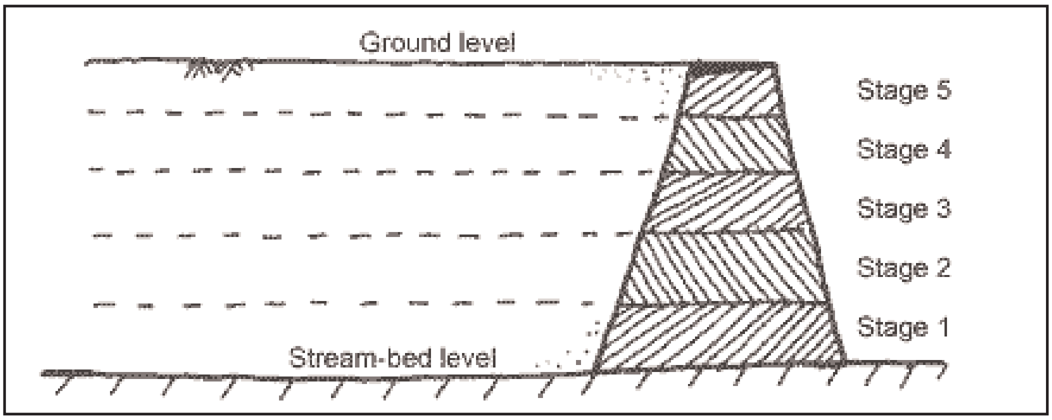
8. Back-fill sand against both sides of the dam wall, so that the top of the dam wall is equal with the level of sand in the riverbed.

How do you get the water held by the subsurface dam out?

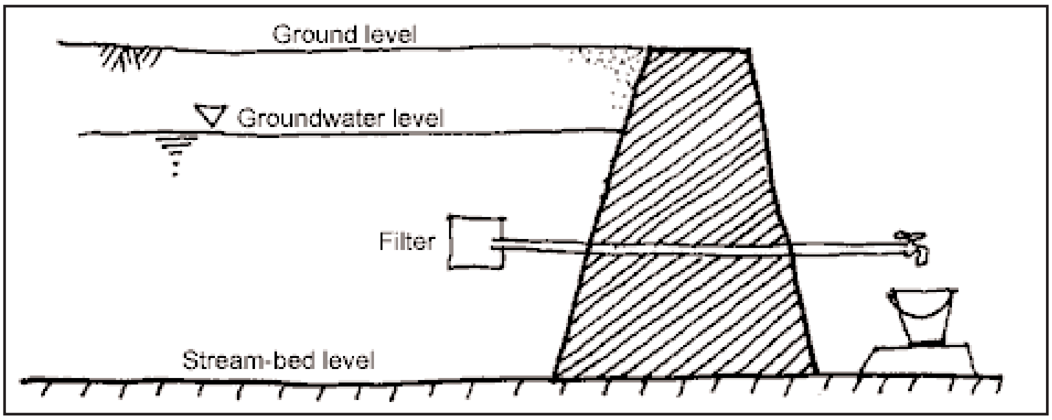
Water is drawn from sub-surface dams by either a hand-dug well sunk in the riverbed itself or by an intake pipe which allows water to flow by gravity to a well-shaft sunk in a riverbank..

Are there other similar small dam technologies that can also help conserve soils and water?

Yes. Sand dams are another way to create a groundwater store. Sand and soil particles transported during periods of high flow are allowed to deposit behind the dam, and water is stored in these sand deposits. The sand storage dam can be constructed in layers year by year. During the rainy season, sand is deposited behind the dam, whilst finer material is washed downstream.



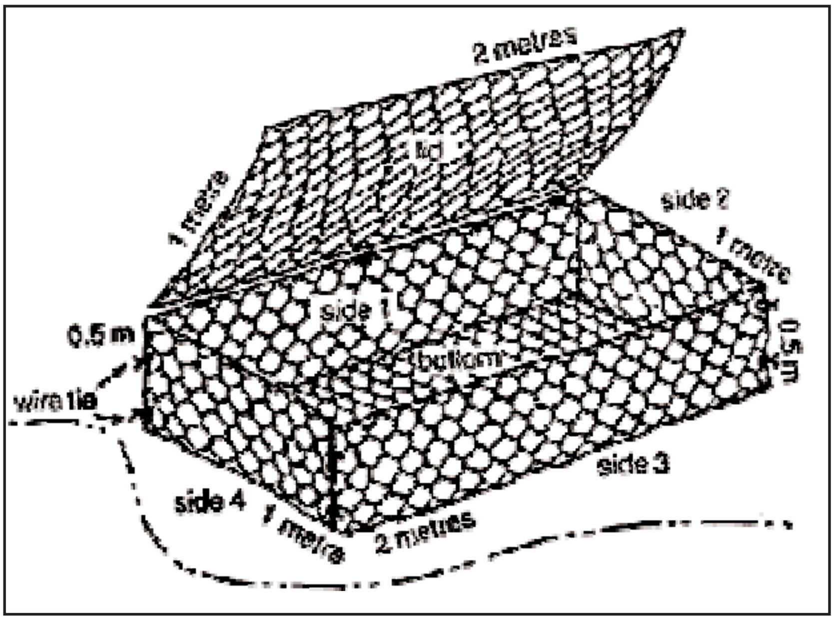
Sand dam built up layer by layer (Image: Rainwaterharvesting.org)



A sand dam with downstream collection point (Image: Rainwaterharvesting.org)

Sand dam materials include compacted clay, concrete, stones and clay, masonry wall or plastic sheets. It is wise to seek guidance from an engineer when designing such a dam, to ensure that it will be able to withstand the pressure of water building up behind it.

Rocks can be used to make gabions - permeable rock dams. These slow down water flow and increase infiltration of water into the ground, as well as reducing soil erosion and increasing silt deposition (Chleq and Dupriez, 1988). Again, it is wise to check your plans with an engineer.



A gabion is a container filled with stones - typical dimensions are given
(Image: UNEP Sourcebook of Alternative Technologies for Freshwater Augmentation in Africa - Chleq and Dupriez, 1988)

ACKNOWLEDGEMENTS: This Action Sheet is based on the SEARNET Rainwater Harvesting Technologies Database entry on Subsurface dams (www.searnet.org/rhtdatabase.asp?pn=3); the UNEP Sourcebook of Alternative Technologies for Freshwater Augmentation in Africa (www.unep.or.jp/ietc/publications/techpublications/techpub-8a/dams.asp); and the Information Sheet on Groundwater Dams by Dr. K.C.B. Raju on www.rainwaterharvesting.org www.rainwaterharvesting.org/methods/modern/gwdams.htm

FOR FURTHER INFORMATION

CONTACTS

Aquamor www.aquamor.tripod.com/index.html

GHARP - Greater Horn of Africa Rainwater Partnership www.gharainwater.org/index.html

International Rainwater Catchment Systems Association (IRCSA) www.ircsa.org

International Rainwater Harvesting Alliance www.irha-h2o.org

IRC - International Water and Sanitation Centre www.irc.nl

Practical Action (formerly known as ITDG) www.practicalaction.org/

SEARNET - Southern and Eastern Africa Rainwater Network www.searnet.org

Water Aid www.wateraid.org

WELL (WEDC) www.lboro.ac.uk/well/index.htm

BOOKS

Water Harvesting in Five African Countries, M.D. Lee and J.T. Visscher, IRC Occasional Paper No. 14, 1990

Vanishing Land and Water. Soil and Water Conservation in Drylands, J.L. Chleq and H. Dupriez, Macmillan, 1988

Groundwater Dams for Small-Scale Water Supply, Åke Nilsson, ITDG Publishing (available from www.developmentbookshop.com), 1988