

Water Quantity Assessment of Silted Up Small Reservoirs

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Target group for the tool's application

Water resource managers, water engineers, Rural District Council Planners, policy makers, communities

Requirements for tool application

This tool requires technical personnel who can do basic calculations of water seepage and accumulation in observation wells. Community participation is also essential for digging up silt in wells and scooping water from dug wells. Equipment required is simple: auger, stopwatch, perforated PVC pipes, tape measure (50m), digital mass balance, level, pegs and stand.

Questions/challenges the tool addresses (scope)

There many small reservoirs in the Limpopo Basin but many of these are filled with silt. This creates difficulties for local communities as often there are no other nearby sources of water (especially in the dry season). Abstraction of water in silted up reservoir is a common practice worldwide. In some cases these are even termed “sand dams”, where water is said to be stored in the soil that has silted up the reservoir. This tool is used to quantify how much water is in a silted-up reservoir, and how much of it can be abstracted for community use.

Description and application of the tool

In order to quantify the water that is locked up in the silt of small reservoirs, estimates are needed of the volume of the silt and its moisture content. The volume of silt is calculated using the Trapezoidal rule (refer to basic surveying textbook);

$$\sum V = D_N (A_1 A_N) + A_2 + A_3 + A_4 + \dots + A_{N-1}.$$

where;

V= volume of silt, D_N = distance between area segments, b=formational width, h= the depth of silt, A_1 - A_N is area of segment 1 to segment N. Area measured is the surface area of the reservoir area.

Trapezoidal rule assumes that irregular boundary consists of parabolic arcs.

The area is calculated using the Simpson rule (refer to surveying textbooks):

$$A = X \left(\frac{Q_1 + Q_L}{2} \right) + Q_2 + Q_3 + Q_4 + Q_5 + \dots + Q_{(L-1)}$$

A=Area in (square meters)

Q=Offset length (m)

Q₁-Q_{L-1}= offset length of segment 1 to segment L-1

X =number of offset which is even.

Soil water content is estimated using the Oven Drying Method (refer to any basic Soil Physics text book). This is done as follows;

- The reservoir is divided into subsections which are approximately 30 meters apart.
- Silt samples are augured at approximately equal depth.
- Silt samples are placed in plastic bags and the initial mass of the silt is measured using digital mass balance. This is taken as the initial mass.
- Oven drying method is used to determine the final mass of the of the silt samples.

In quantifying the amount of water the following procedure is undertaken;

- Small observation wells of the same diameter and depth are dug across the reservoir at three or more subsections. The wells are dug to a depth where shallow underground water can be abstracted.
- PVC pipes of the same diameter are inserted into the observation wells. The initial height of water is noted.
- Each minute, a pipe is removed from the observation well and the change in water column height is noted.
- This is done until there is no noticeable change in water height i.e. no water rise.
- The water is removed from the observation wells and the pipes are inserted into the well and the initial height noted. The above procedure is repeated
- The same procedure is repeated for all different subsections throughout the dam.
- Three different readings are to be taken at each subsection, at the midpoint and the two ends and an average is extrapolated as the average water present at that section.

Lessons learnt and recommendations

Elsewhere it has been shown that silt in dams and rivers contains from 40% to 60% water in the pore spaces. This is especially the case for reservoirs that have been filled up by material of a coarse nature. When the material is fine silt or clay particles, it has a high water holding capacity but this water is not easy to harvest as it is tightly bound to soil particles.

The greatest threat to multi-purpose small dams is siltation because silt greatly reduces amount of water that can be stored. However, water silted up small dams can still help support rural livelihoods. When abstracting water, the abstraction rate should not exceed the recharge rate.

Moisture content of silt varies with the location of silt samples in the dam and the amount of water in the silt depends on time of year and the weather on any particular day. Further studies are needed to quantify water in the silt of silted-up reservoirs, as this study was done on one reservoir only. While the tool can help communities abstract water it is better to be proactive than reactive to the problem, which means strategies should be put in place to curb soil erosion or keep it at a minimum.



References

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