Simple solutions to combat soil erosion

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Soil erosion is the cause of severe topsoil losses in South Africa. At the same time, it also dehydrates the affected landscape as less water will infiltrate the soil. It also reduces the capacity of strategic infrastructure such as reservoirs, as silt is discharged in the water and deposited in the reservoir water. It is also posing a growing problem at river mouths.

The purpose of any structure designed to control erosion is to reduce and even stop erosion in dongas. There are several ways to combat soil erosion. This can be done by erecting structures at the top of dongas to stabilise already existing erosion and thus prevent further damage. Structures can also be erected inside a donga to slow down water flow and to collect sufficient sediment in the donga for vegetation to establish.

By collecting and storing rainwater in the soil, as close as possible to where it falls, the flow can be slowed down before reaching the dongas. This slows down the eventual streamflow to the donga and subsequent erosion. The added advantage is that a bigger percentage of water can infiltrate the soil and replenish underground water sources.

This article focusses on several affordable and relatively easy-to-understand techniques and structures that make use of locally available materials to erect structures in dongas with small catchments, as well as to slow down the flow of water before it reaches dongas.

Swales with contour walls

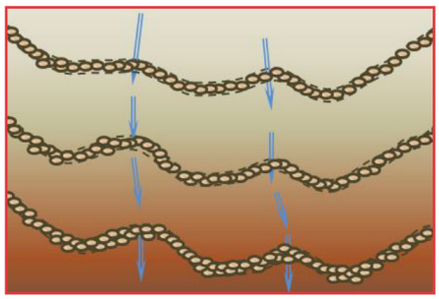
The general tendency is to get rid of rainwater as quickly as possible, ushering it into drainage systems. However, this can lead to several problems which include erosion.

By constructing a swale on the contour *(Figure 1*), perpendicular to the slope, and with a contour wall on the downstream side of the swale, the flow or rainwater can be slowed down. The swale has one or more overflows, allowing water to flow to the next swale lower down the slope, under controlled conditions.

It therefore breaks long slopes into smaller sections. This reduces the erosion potential of water runoff on the surface, as the velocity and volume of water are reduced.

Figure 1: Examples of furrows made on a contour.

Figure 2: Schematic representation of a packed stone contour bund.



Alternatively, the swale can be given a slight slope. This way, water is allowed to partially infiltrate the soil, while the remaining water flows to a reservoir or stream.

Packed stone contour bunds

Contoured stone bunds are lines of stone placed along the contour (*Figure 2*). The purpose of these lines is to reduce water runoff, deposit sediment on the upstream side of the wall, and increase water infiltration.

Since the entire structure is permeable, the water is spread out effectively along the length of the wall and distributed over the soil surface, thus no overflow is necessary. Over time, vegetation will also re-establish due to more moisture in the soil.

Water spreading banks

The purpose of earthen water spreading banks is to spread floodwater that has been diverted from a watercourse or that has reached the floodplain from a mountainside. Under certain conditions it can also be used for flood control. The idea is to spread the water and slow the runoff, thereby limiting soil erosion.

With this type of design, the spreading canal is built on the downslope side of the contour wall. This helps the water to spread evenly over the soil surface. An overflow of between 5 and 6m wide is made every 100 to 150m to facilitate the

flow of water through the wall, into the canal.

The overflow should be horizontal, constructed with concrete, or lined with rocks and planted with grass to prevent erosion. The flow through openings should not be directly opposite of each other.

Branch and brush filling

Branches from bushy vegetation are cut and used to cover bare areas, as well as shallow gullies that are smaller than 0,6 x 0,6m and with a slope of less than 10%. Branches should be removed in a way that does not destroy the plant from which they are cut, except in the case of invasive species.

The main purpose of brush fills is to slow down water runoff, retain sediment and grass seeds, and provide a favourable habitat for seedlings to germinate. By the time the branches have decayed, grass and other vegetation should be covering the area. This method is more suitable for arid and semi-arid areas, where dense trees or shrubs are present near the area that needs to be treated, or where invasive plants need to be removed.

Brush-fill work needs to start at the top of the gully or slope and branches must be placed with the stems facing down the slope.

Silt fences

Silt fences (*Figure 3*) are temporary structures with an effective lifespan of ten years. It must collect sufficient sediment and moisture over a short period of time, so that vegetation can re-establish within the structure's lifetime. Excellent results are obtained with this method. However, it is only suitable for low structures built in small catchment areas.

Materials that can be used to construct it are ultraviolet-treated shade-nets, Y-standards and 4mm diameter galvanised wire.

A sediment depth of 0,5m is suitable for the establishment of vegetation. Therefore, more than one structure is usually built in series in a donga. Silt fences can be spaced so that the overflow height of the lower lying structure is level with the bottom of the structure directly upstream (*Figure 4*). It also helps to delay the weathering of materials.

Figure 3: A finished silt fence.

As with any other erosion structures, silt fences require regular maintenance. During the first rainy season, it is especially important to ensure that there are no leaks around and underneath the structure. Wires that break or rust must be replaced. If the sealing material tears, a new piece can be inserted at the front.

Wire gabion check dams

Gabions are versatile structures that can be used at the top of a donga as an inlet structure, and as a weir further downstream. It is possible to design these structures to be able to handle any normal occurring flood.

Concrete structures

It can be cheaper to erect than a gabion structure, as it requires less labour. This is especially true where good foundation material is available and where an apron is unnecessary.

If the foundation material is not suitable, a floating concrete structure can be designed. Concrete structures, if designed correctly, require very little maintenance and are reasonably permanent. It is efficient at withstanding relatively big floods.

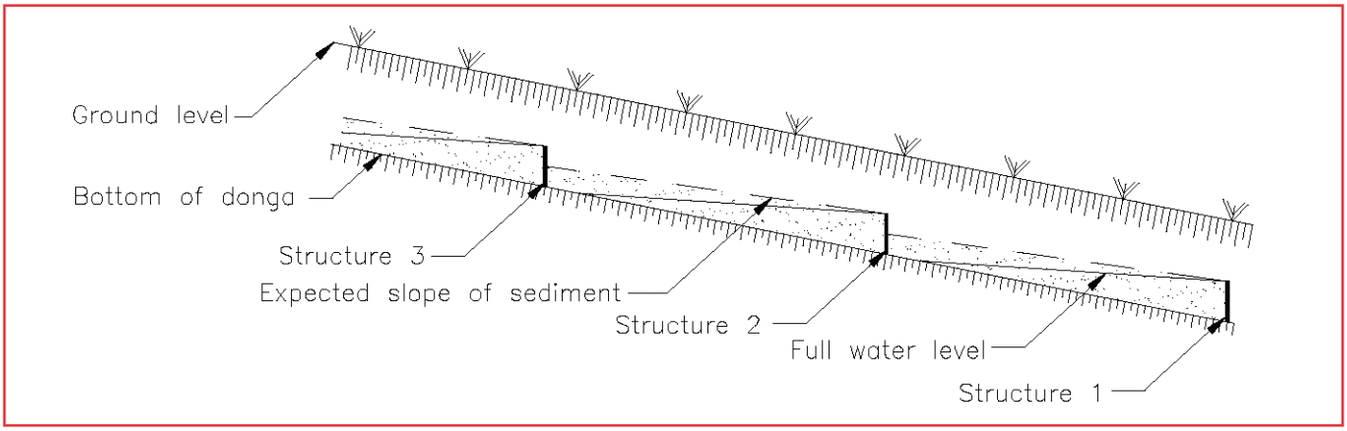
Key walls, shoulder walls and the apron are important parts of this type of structure and, therefore, the excavations must be done correctly and accurately. Where earthen walls form part of the structure, the soil must be compacted thoroughly. A professional must always design these structures.

Permeable wooden structures

These structures are made by placing wooden poles perpendicularly across the gully. Planks, concrete slabs or old railroad ties can also be used.

The purpose of this type of structure is to intercept and slow down water runoff, thereby causing sediment to settle behind

Figure 4: Schematic representation of the spacing of silt fences in a donga.



the structure and vegetation to establish so as to stabilise the gully. In areas where stones are scarce but wooden poles are plentiful, it is especially suitable. Wooden barriers are suitable for gullies that are shorter than 100m with catchments of less than 2ha.

If there is a risk of termites attacking the structure, poles should be treated with chromated copper arsenate.

Metal drum structures

Structures can also be constructed from old 200ℓ metal drums, if available. This type of structure can handle reasonably large floods if constructed correctly. The maximum allowable overflow depth is 0,3m. However, these structures require quite a considerable amount of excavation work.

Tyre structures

If old vehicle tyres are readily available, they can be useful in building soil conservation structures for slowing down runoff, and for erosion control in gullies with small catchment areas. These structures are prone to fires and vandalism, and are not environmentally friendly.

Figure 5: A representation of 'negarim'.

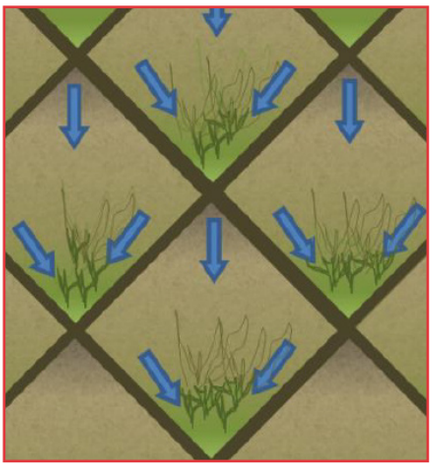
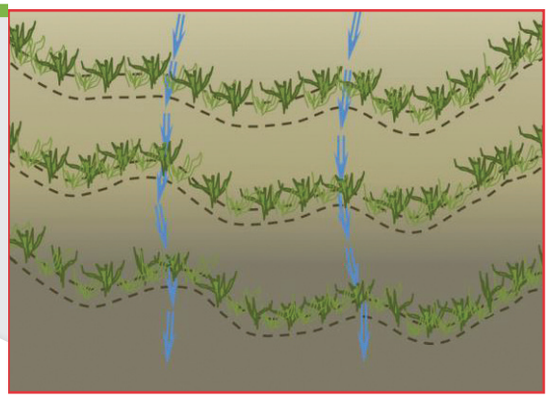


Figure 6: Representation of vetiver grass planting on the contour. (Source: *www.greener.land*)



Small basins and negarim

Negarim are small basins that are mostly diamond shaped (*Figure 5*). The name is derived from the Hebrew word 'neger' which means 'runoff'. The basins include a catchment area and the area where vegetation is planted. It is surrounded by low earthen bunds, which form the divisions between neighbouring basins.

It is mainly used for rainwater harvesting, and to grow crops and trees in arid and semi-arid areas. An additional benefit is that it also combats soil erosion by slowing water runoff.

The size of the basins can vary from 10 to 100m^2, depending on the water requirements of the plants, the average rainfall in the area, and the number of trees or shrubs to be established in the area.

If there are large bare patches with very hard soil surfaces, good results can be obtained by tilling the area with a pitter plough. This plough has a disc that is lifted and lowered by a cam on a wheel as the plough moves over the area, thereby forming small basins.

The establishment of vegetation can be accelerated by sowing grass seed and placing cut branches on the ground. However, it is not necessary for the re-establishment of vegetation in the treated area.

When sowing seed, ensure that it is seed from the surrounding grass species. If more palatable grasses are sown, animals will graze the area until it is barren again. The treated area should preferably be fenced off until the grasses are established again.

If fencing-off or branch piling is not possible, or if the area is situated against a slope, the contour should be pitter ploughed and vetiver grass should be established in the hedges. This will promote water infiltration and prevent erosion.

Ground cover

An often-overlooked fact is that sufficient soil cover and vegetation is far more important than physical structures in preventing erosion, whether the structures are contour hedgerows, concrete walls, gullies or any other structure.

Cover crops are generally not planted with soil conservation in mind, but rather soil fertility. However, these two aspects are closely related.

Contours planted with vegetation

With this method, vetiver grass or any other suitable vegetation can be planted in hedges on the contour to form a semi-permeable barrier. This way, soil erosion can be reduced as less water runoff occurs and water is slowed down, water infiltration is improved and sediment is retained. Soil moisture improves and plant roots also stabilise the soil.

Vetiver grass, sisal or agave, planted perpendicular across a donga, provide an effective barrier to slow water runoff, thereby limiting soil erosion and stabilising the donga. However, it would be necessary to excavate and level the sidewalls of the donga to a gradient of at least 1:1. This is necessary as the plants need to be planted along the sides right to the top.

Belts with grass, shrubs and trees

The purpose of these belts is to provide areas where the overland flow of runoff is interrupted, slowed down and spread out. This prolongs water-soil contact, allowing water to infiltrate the soil where it replenishes underground water sources.

These vegetation belts also provide shelter for beneficial insects that help control pests. Belts should be established especially on the banks of streams and rivers to protect it from erosion. In large, uninterrupted cultivated areas, such belts can be established on the contour, especially along riverbanks, in and around wetlands and in low-lying areas prone to waterlogging. SF

For references and technical enquiries, contact Fanie Vorster on 012 842 4052 or vorsters@arc.agric.za. Several publications on soil erosion prevention are available from the ARC: Agricultural Engineering. Contact Elmarie Stoltz on 012 842 4017 or stoltze@arc.agric.za in this regard.