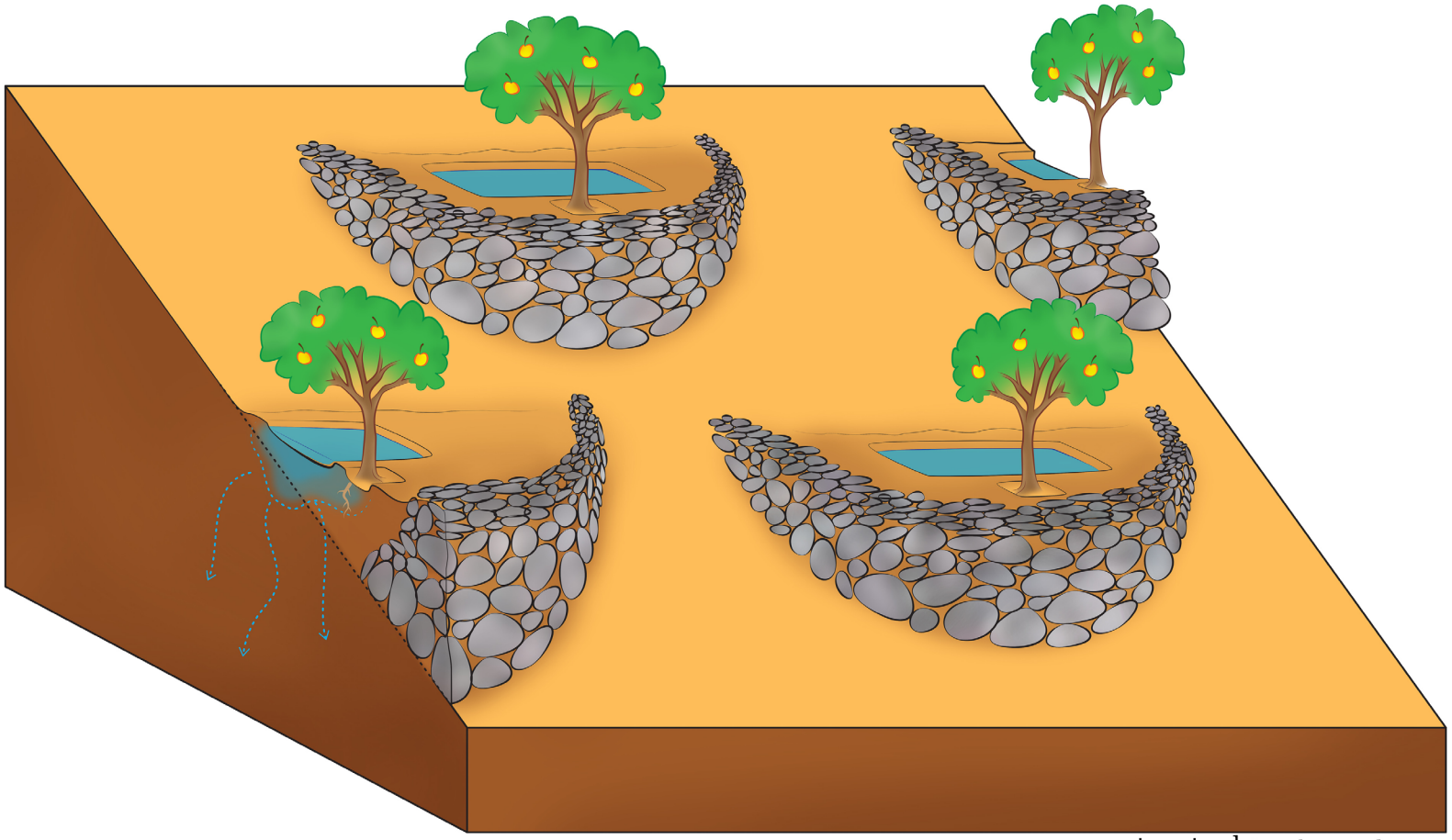
Half-moons



Half-moons

Introduction

Half-moons, also known as semi-circular bunds, eyebrows or demi moons, require the creation of small bunds in the shape of half-moons with their tips on the contour. The ponding area inside the half-moon retinas water flowing down the slope form above the bund. Their designs vary depending on the chosen plant requirements to be cropped on them (tree, crops or grasses), the topography and the climatic conditions. They are more efficient than trapezoidal bunds in the of the ratio between the bund volume and the ponded area.

Purpose

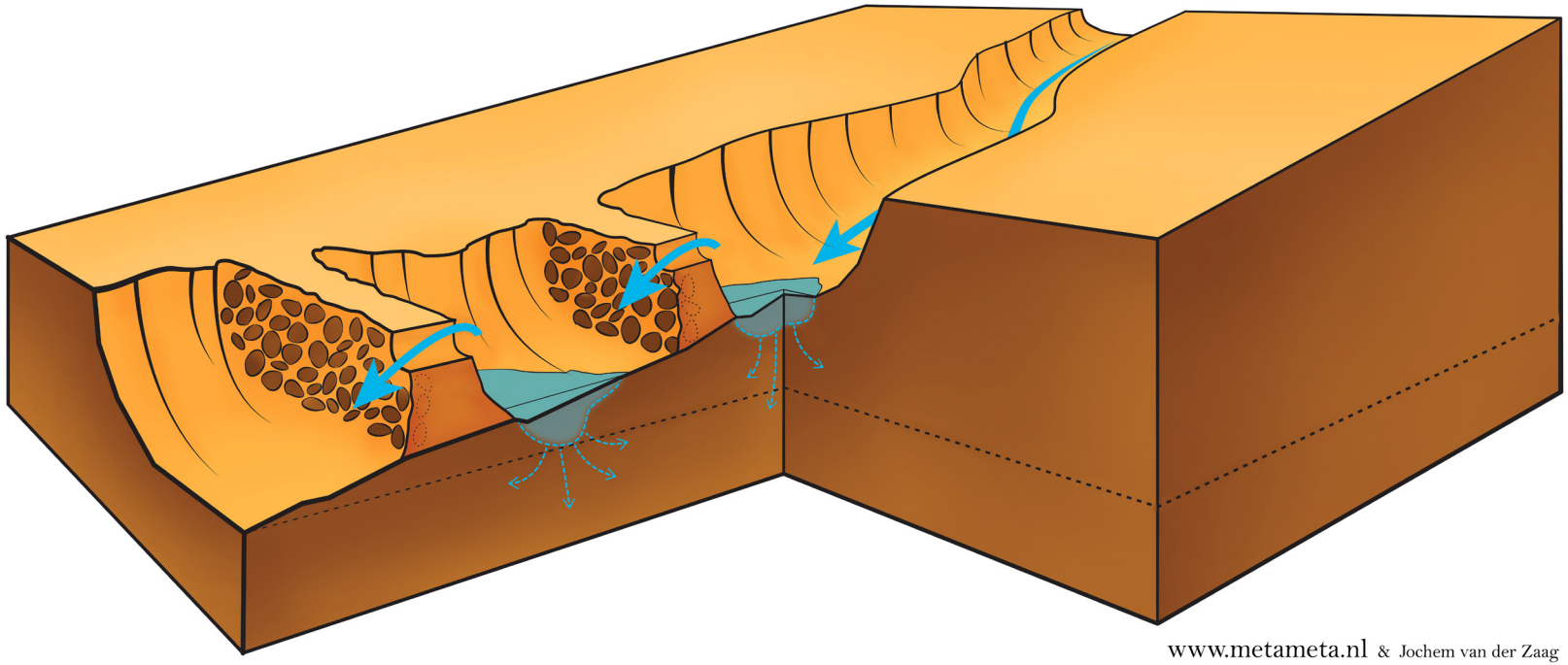
They capture runoff for and help increase the production of grass, trees, and crops. They are also used to regenerate rangelands. Function: water retention and re-use.

Geographical suitability

Soil moisture storage

Area/physical requirements	Construction requirements	Advantages	Limitations
• Slope: <1-<4% • Radius: 2-20m • Geographical suitability: soil moisture storage. • It can be used for rangeland restoration.	• In dry conditions, the bunds are bigger and equipped with spillways. It is necessary that they enclose a relatively large catchment area compared with the cultivable area. • In wetter conditions, more bunds of smaller radius are constructed per hectare. • To avoid the risk of breakage, diversion ditches can be carefully laid out on the half-moons to avoid excessive stress.	• On very steep slopes half-moons can be used to grow tree species. • Combined with controlled grazing further helps the vegetation regeneration.	• When the half-moons are constructed using soil, the first rain season may form breaches in them as the soil needs some time to get consolidated. • The structure can get breaches, due to animal grazing or other reasons. They should be repaired immediately.

Gully plugging



Gully plugging

Introduction

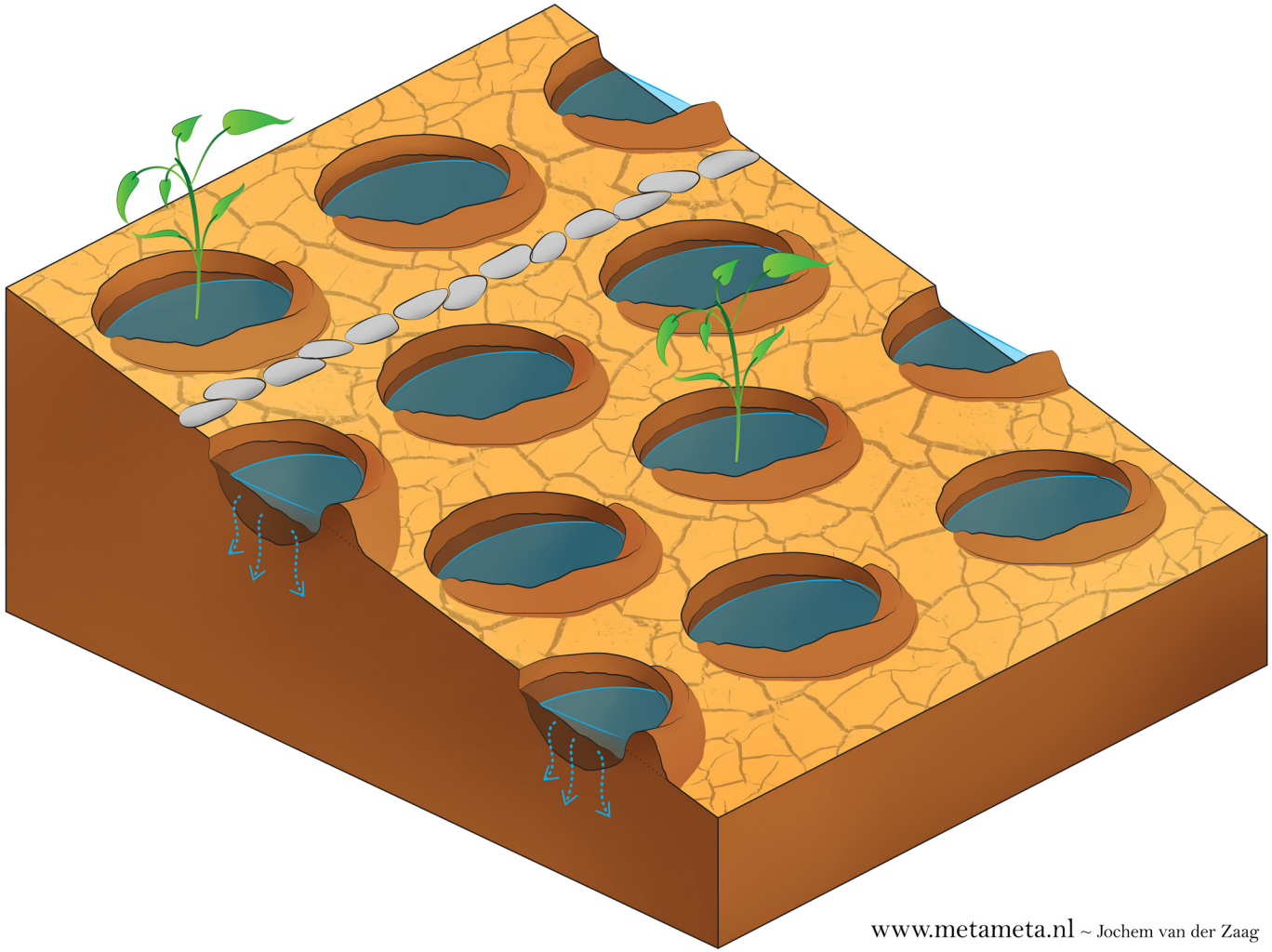
Gully plugs (permanent or temporally) are structural barriers that obstruct the concentrated runoff insider gullies and ravines. They are often temporary structures built to favour the establishment of a permanent soil cover to effectively conserve soil and water. They are often built-in series to progressively decrease the runoff speed and trap sediments through the whole length of the gully.

Purpose

Reduce erosion by capturing water and sediment. It contributed to flow regulation and water infiltration. Its application can imply the creation of new patches of land with potentially fertile soil. Function: soil conservation, recharge, and re-use.

Area/physical requirements	Construction requirements	Advantages	Limitations
• Arid and humid areas. • The gully should not be steeper than 10% or deeper than 1 m. • Geographical suitability: soil moisture storage.	• The distance between dams is a critical factor. The length and inclination of the slope between dams determine the runoff speed and its erosive power. • The distance between the dams also determines the extension of the catchment serving each structure. • Dams can be constructed using (flat) stones, brushwood, wooden posts and other locally available materials. • Gully plugging can be integrated with Dry Stone Measures, at the head of the gully or in between the DSM structures.	• The trapped sediments can be used as arable land which can provide additional income to the farmers.	• Availability of construction material (stones of wooden material). • Before treating gullies, it is mandatory that the catchment area feeding the gully is treated. • Take into account the erodibility of the soils. Only stable soils should be used in the dam to avoid further erosion.

Planting pits (zai pits)



Planting pits (zai pits)

Introduction

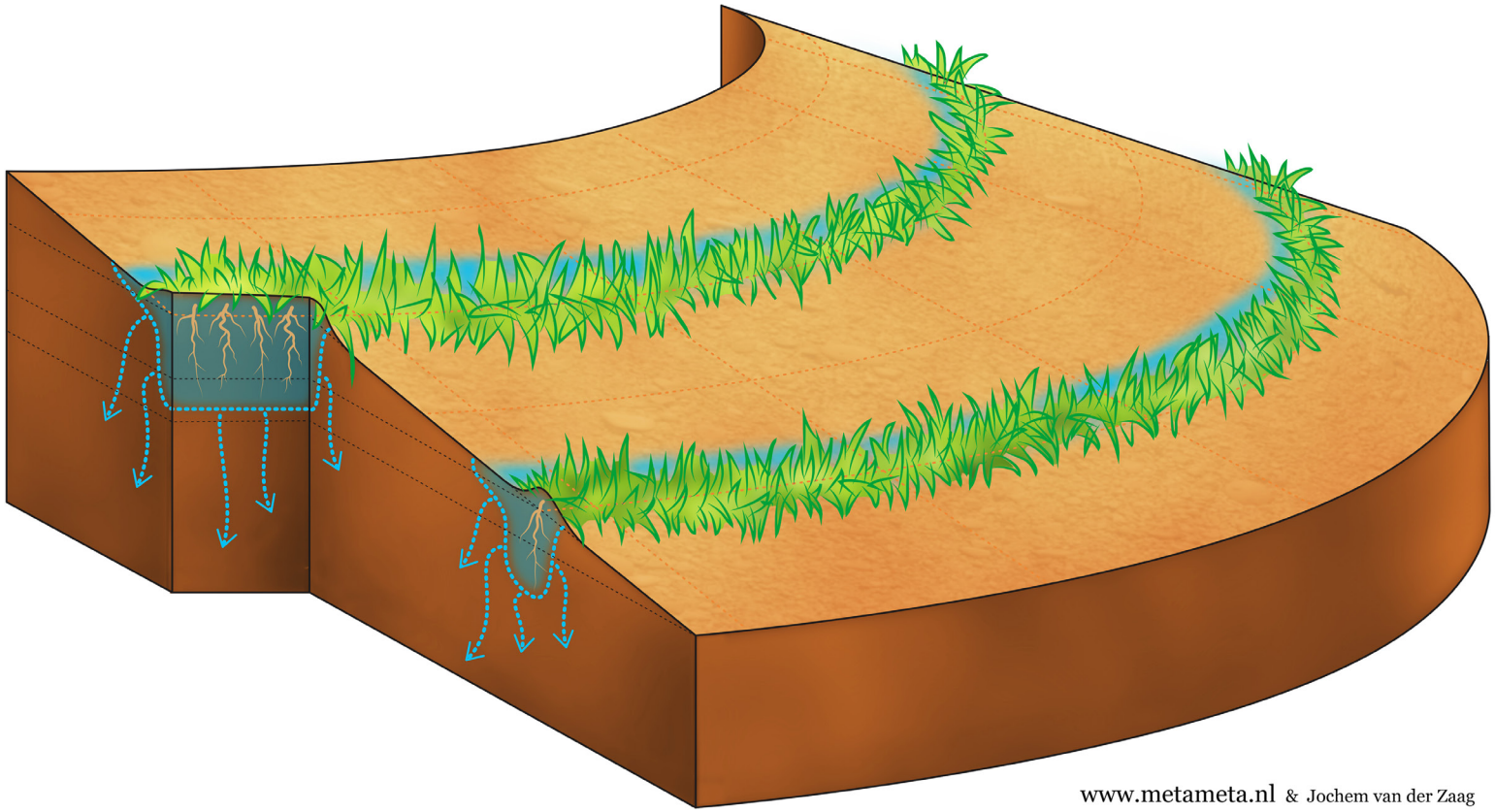
Planting pits consists of the creation of circular holes on the soil to catch and retain runoff water. Planting pits vary in dimensions, shape, and husbandry systems according to the tree or crop type planted on it. The best know is the western African 'zai'. It is a technique traditionally used to plant trees, although increasingly used for crops. It shares similarities with the technique of half-moons.

Purpose

Collect runoff, rainfall and concentrate soil moisture for increase production of trees and crops. Function: soil conservation, water recharge and water retention.

Area/physical requirements	Construction requirements	Advantages	Limitations
• Applicable in not sandy and loose soils. • Geographical suitability: soil moisture storage.	• High amount of manual labour. • It is suggested to do the excavation on the dry season (right after the rain period) when the soil is easier to work with. • To decrease the runoff speed, stone lines are laid on the contour every 20-30 lines.	• Restoration of degraded land and a significant increase in yield. • Groundwater levels raise. • Improve water retention and buffers the agroecosystems capacity. • Trees and crops are grown in the pits and benefit for higher moisture content. • If compost and/or manure is added, this adds nutrients and attracts termites that loosen up the soil around the planting pits which increases the soil capacity to absorb runoff water.	• Planting pits are not recommended for steep lands. • It is not suitable for sand and loose soils since there is risk of collapse. • If applied in pastoral lands, when land is rehabilitated with pits, the field must be protected from excessive grazing that could damage the structures.

Grass strips



Grass strips

Introduction

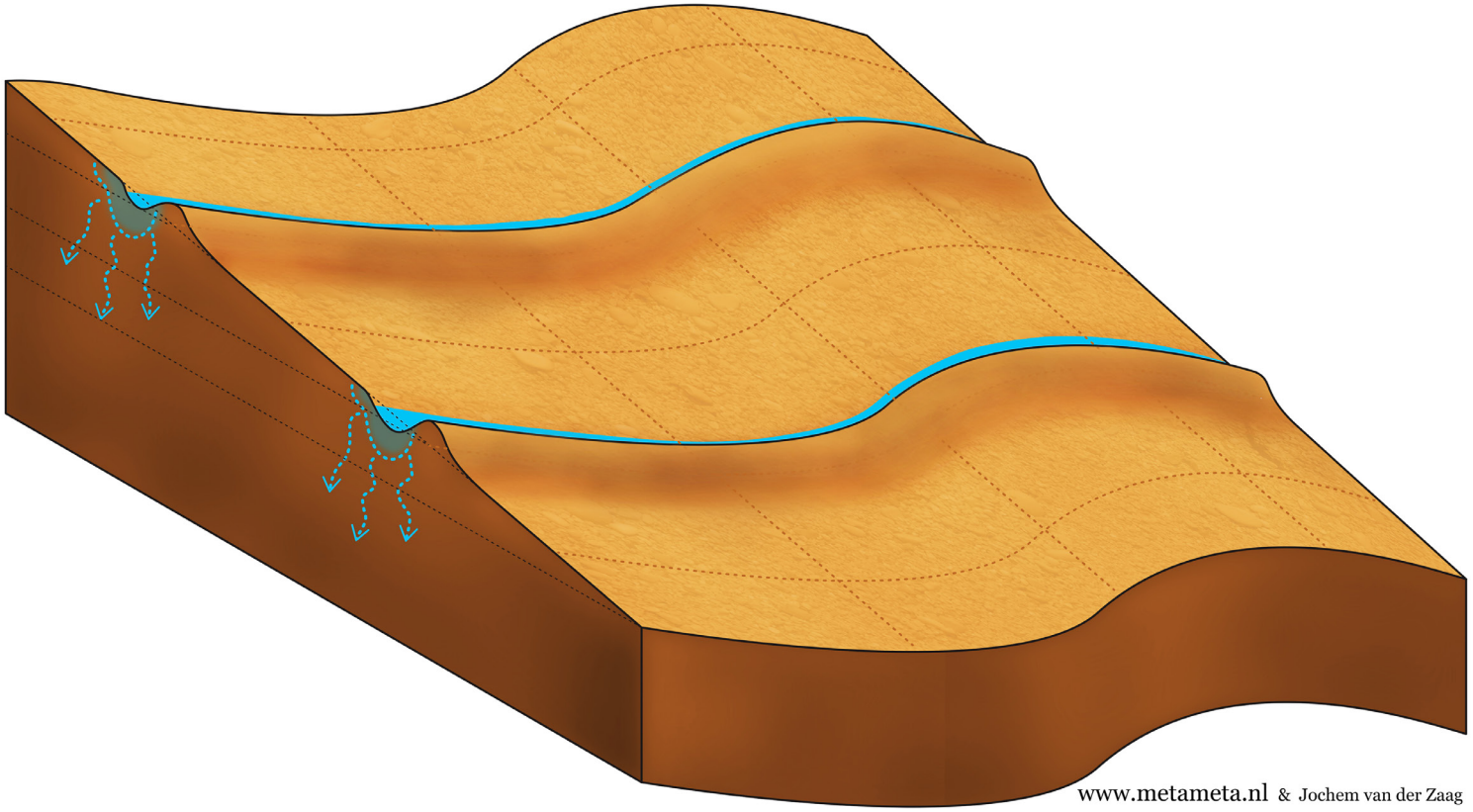
Grass strips imply the growing of grass in alternating strips following contour lines. Depending on the grass used, the strips may provide fodder for livestock as well. Grass strips can filter sediment, evacuate excess runoff and can also withstand inundation. They might ultimately form into bench terraces.

Purpose

Water storing by increased infiltration. Erosion prevention by reducing soil loss, slowing runoff water and trapping sediment. Function: soil conservation, retention, and water quality.

Area/physical requirements	Construction requirements	Advantages	Limitations
• Wet areas, high rainfall. • Gentle slopes and steep slopes. • Width 0.5-1.5 m. Permanent vegetations strips have a width of 2-4m. • Interrow distance depends on the slope. Stepper slopes higher intra-row distance. • Geographical suitability: soil moisture storage.	• Modest labour inputs. • Basic requirements (hoes, wires, and tree branches)	• Grass strips can be used as terrace embankments to provide fodder in zero-grazing areas. • They can be easily crossed by oxen and ploughs.	• The grass used should not be aggressive and expand into adjacent cropland. • Maintenance is important. The grass requires trimming and gap-filling to keep them dense. • Grass strips take up land • Grass strips should at least compensate for the loss of the land that would have been otherwise used for agriculture. • Grass strips are best used in small farms and are less suited to mechanized agriculture. • In dry areas, the capacity of grass strips to retain water is little.

Contour/Soil bunds



Contour/Soil bunds

Introduction

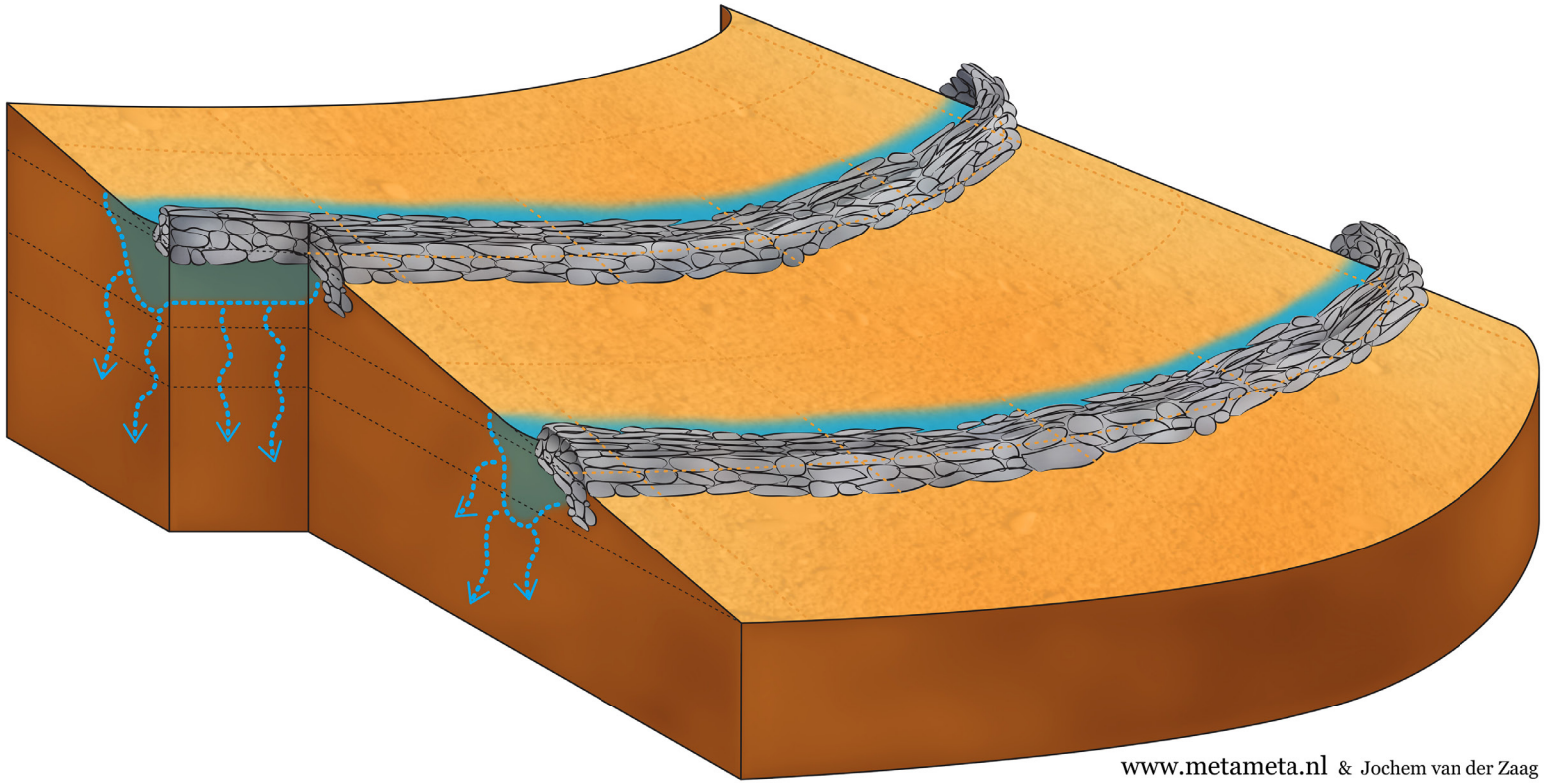
Contour bunds are a physical measure to control erosion, enhance infiltration and increase yields. Bunds are constructed on hillsides along contours – dividing the slope into several smaller micro-catchments. Bunds exist in many different designs and have been globally used as a mean of water buffering and soil conservation. Examples of this type of structure are soil bunds, stone bunds, tied ridges, and stone face bunds. The design of the bunds and their dimensions depend on climatic conditions and on the amount of water that will need to be intercepted by the bund.

Purpose

Store water and prevent erosion. Function: soil conservation, water recharge, and retention.

Area/physical requirements	Construction requirements	Advantages	Limitations
• Cultivated land • Slopes : <10% • Geographical suitability: soil moisture storage.	• Construction and maintenance are labour demanding. • The use of animal drawn scraper boards may provide relief.	• Increases soil moisture. • Increases fodder production.	• If not well-maintained or well-designed, bunds risk breaking. • Grazing animals can severely damage bunds • The relief of the slope should be as flat as possible to avoid excessive hydraulic load on portions of the structures. • If the outlying fields are not • A diversion channel should be constructed to protect the field. • If the retained water is concentrated in the planting area for too long, the crops could drown because of excessive moisture and lack of oxygen to the root system.

Stone bunds



Stone bunds

Introduction

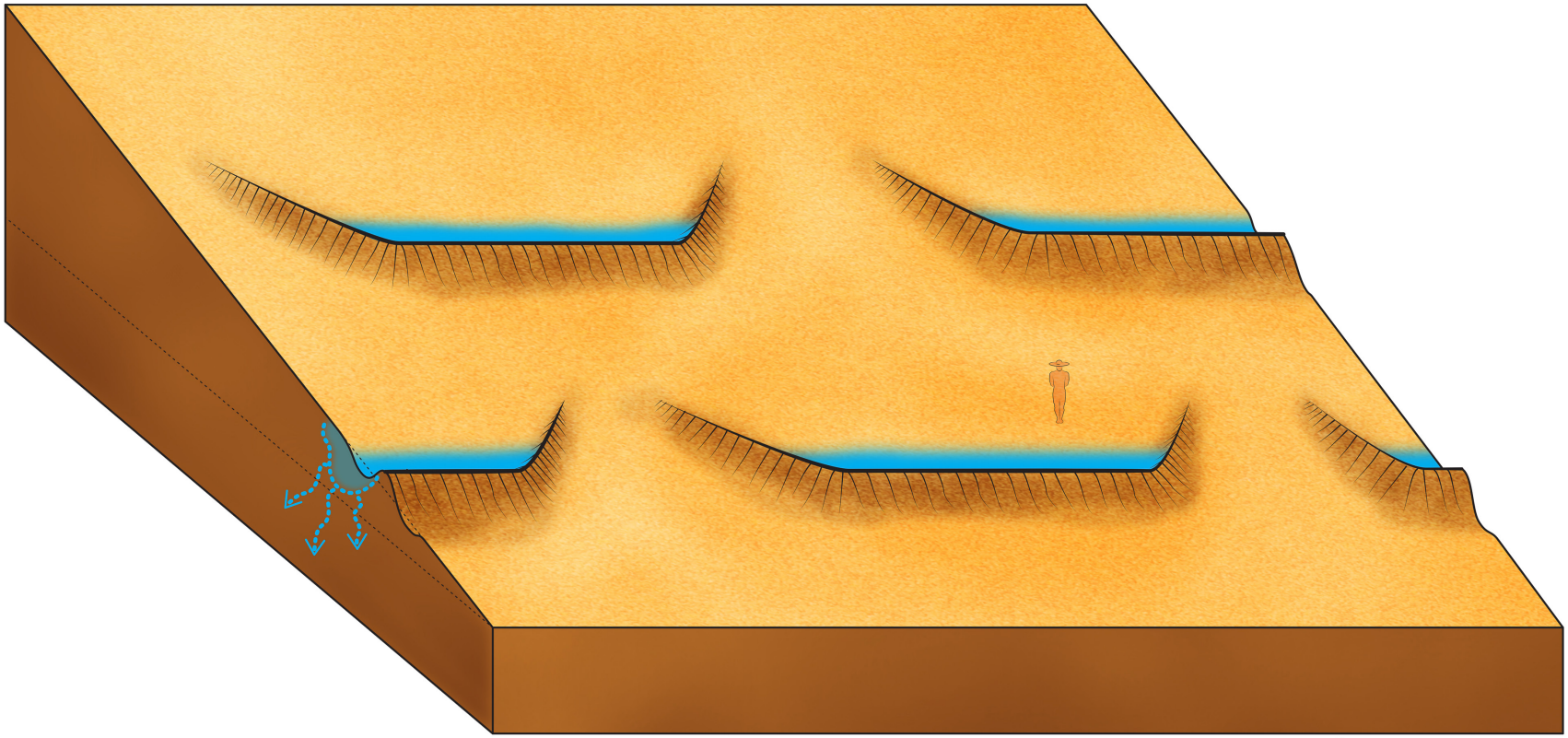
Stone bunds are stone lines structures built in series running along the slope. The bunds are semi-permeable, allowing the water to flow to the lower fields. The flow is distributed evenly, and it decreases the risk of gully formation. Additionally, the stone barrier blocks and settles down the sediments transported form the upper slopes. Stone bunds are a particular type of contour bunds and, over time, might develop in terraces. The width and height of the bund vary considerably with slope and availability of construction material. The stone bunds are comparable with Dry Stone Measures, with the difference that stone bunds can also be applied on slopes, and application is not limited to gullies but the stone bunds can also be created on (steep) slopes, along contour lines.

Purpose

Slow down runoff and favour infiltration in the soil. Therefore, they reduce erosion and store water. Function: soil conservation, recharge, and retention.

Area/physical requirements	Construction requirements	Advantages	Limitations
• Arid and semi-arid areas. If soils are well drained, they can also be applied in wetter zones. • In areas with a slope lower than 35%. • Geographical suitability: soil moisture storage.	• Construction is labour demanding and depends on the availability of suitable stones. • Bund should be heightened after the bund has retained soils, until the terrace has formed. • The height of the bund and distance between bunds is chosen according to the slope percentage.	• Increases soil moisture. • Increases fodder production.	• The profitability of the stone bunds depends directly on the availability of rock material. • In case of level soil bunds waterlogging can occur as the water does not flow through the stones. • If spacing in between lines is too small, the bunds might occupy a production are without a feasible reason. • Animal access needs to be limited and/ or the bund should be laid out in a way that allows the animals to pass trough.

Trapezoidal bunds



www.metameta.nl & Jochem van der Zaag

Trapezoidal bunds

Introduction

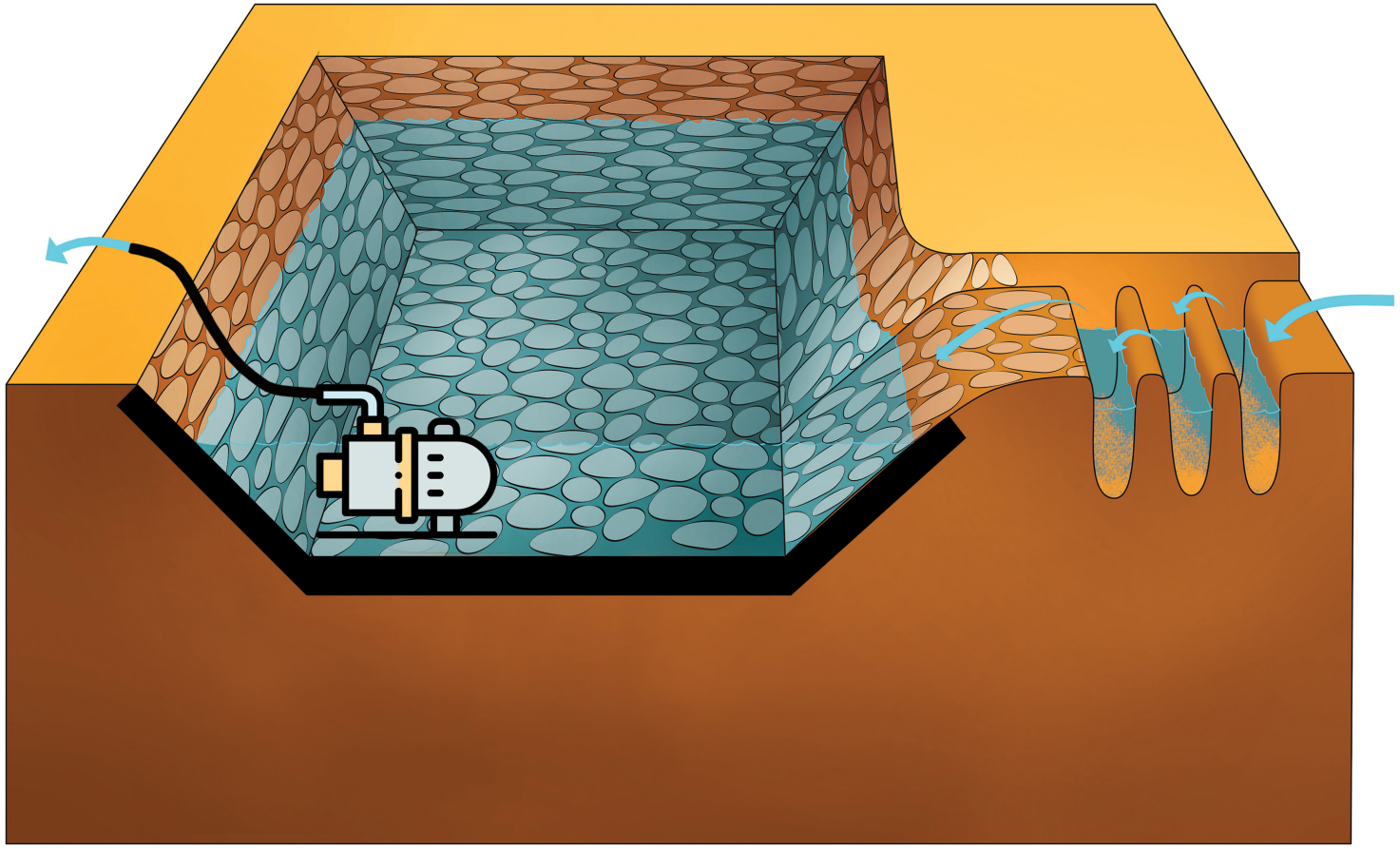
Trapezoidal bunds are structures that enclose large areas (up to 1 ha) and collect the runoff from the upstream catchment. The area is enclosed on three sides by a trapezoidal shaped bund with 45º angles. Trapezoidal bunds are usually made from the soil. The upstream side is left open to collect water from the outer slopes. The wings of the side bunds are preferably reinforced with stones. Trapezoidal bunds can be constructed as single units or in series.

Purpose

Regulate and spread surplus water. They can play a role in augmenting cattle watering and food production and in securing drought prone areas in general. Function: water recharge and re-use. conservation, retention, and water quality.

Area/physical requirements	Construction requirements	Advantages	Limitations
• Gentle slopes 0.5-1.5% • Geographical suitability: soil moisture storage.	• Labour intensive work (need of animal power or mechanized means)	• Trapezoidal bunds can be used for cultivation of cereals within the enclosed area or for livestock watering.	• Not suitable for clay soils.

Water harvesting ponds



Water harvesting ponds

Introduction

Water harvesting ponds, are ponds constructed to accumulate water from the surrounding naturally sloping surfaces, and conveyed form paves surfaces (roads, paths) and channels (cut-off drains). Water harvesting ponds can have different designs (circular, square or rectangular), materials and dimensions. The use of water harvesting ponds is suggested when other options are not possible.

Purpose

Make water available during dry spells in the rainy season and for a few months after the rains cease. The water harvested can be used to irrigate high value cash crops and fruit trees, to water the livestock and for domestic use. Function: water retention and re-use.

Area/physical requirements

- Small-household level.
- Low-lying areas.
- High-temperature.
- Geographical suitability: surface water storage and beneficial use of floods.

Construction requirements

- **Circular ponds**

The excavation has the shape of an overturned truncated cone. The bottom of the pond should be reinforced with cement mortar and wire mesh and paved with stones.

- **Square and rectangular ponds**

Digging a pit with a depth of 2.5-4 m and with a slope ratio of 1:1. The bottom of the pit can be lined with puddled clay or plastic sheets.

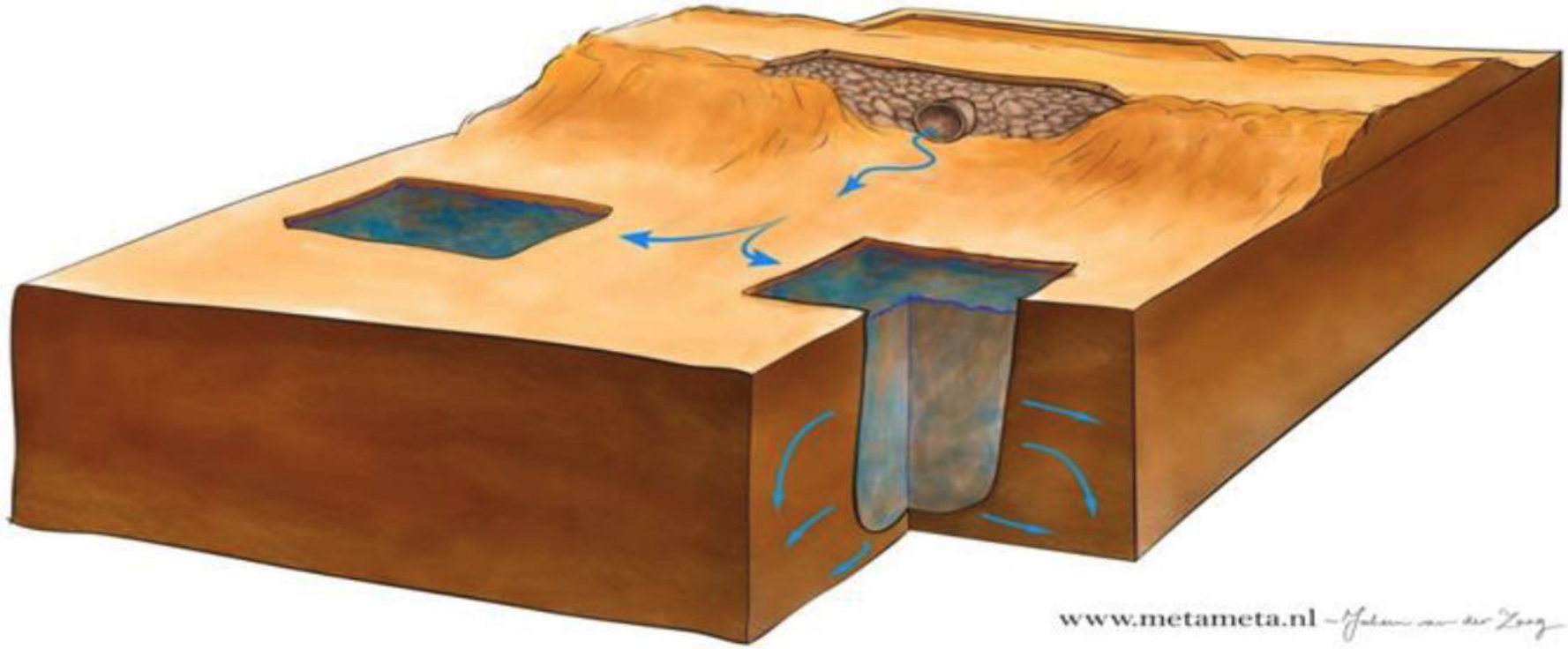
Advantages

- It is suitable in most agro-ecological zones that provide enough rains to fill the reservoir (>400mm/yr).
- If there is a constant supply of water the pond can be used for fish farming.
- Square and rectangular ponds are often the cheapest type of ponds, commonly dug and used at household level.

Limitations

- They can have negative impacts such as land loss, increased incidence of water borne diseases, and the risk of dam wall collapse.
- Water can be loosed to seepage.
- The micro-ponds need to be shaded in order to avoid malaria outbreaks.
- Not suitable on unstable soils.
- When the water is stored for several weeks or more, the quality may deteriorate and become insufficient for bathing and watering animals, let alone for drinking water.

Water harvesting with roads



Water harvesting with roads

Introduction

Water harvesting ponds, are ponds constructed to accumulate water from the surrounding naturally sloping surfaces, and conveyed form paves surfaces (roads, paths) and channels (cut-off drains). Water harvesting ponds can have different designs (circular, square or rectangular), materials and dimensions. The use of water harvesting ponds is suggested when other options are not possible. Water harvesting with roads includes a variety of practices for storing rainwater runoff form roads during rainy seasons.

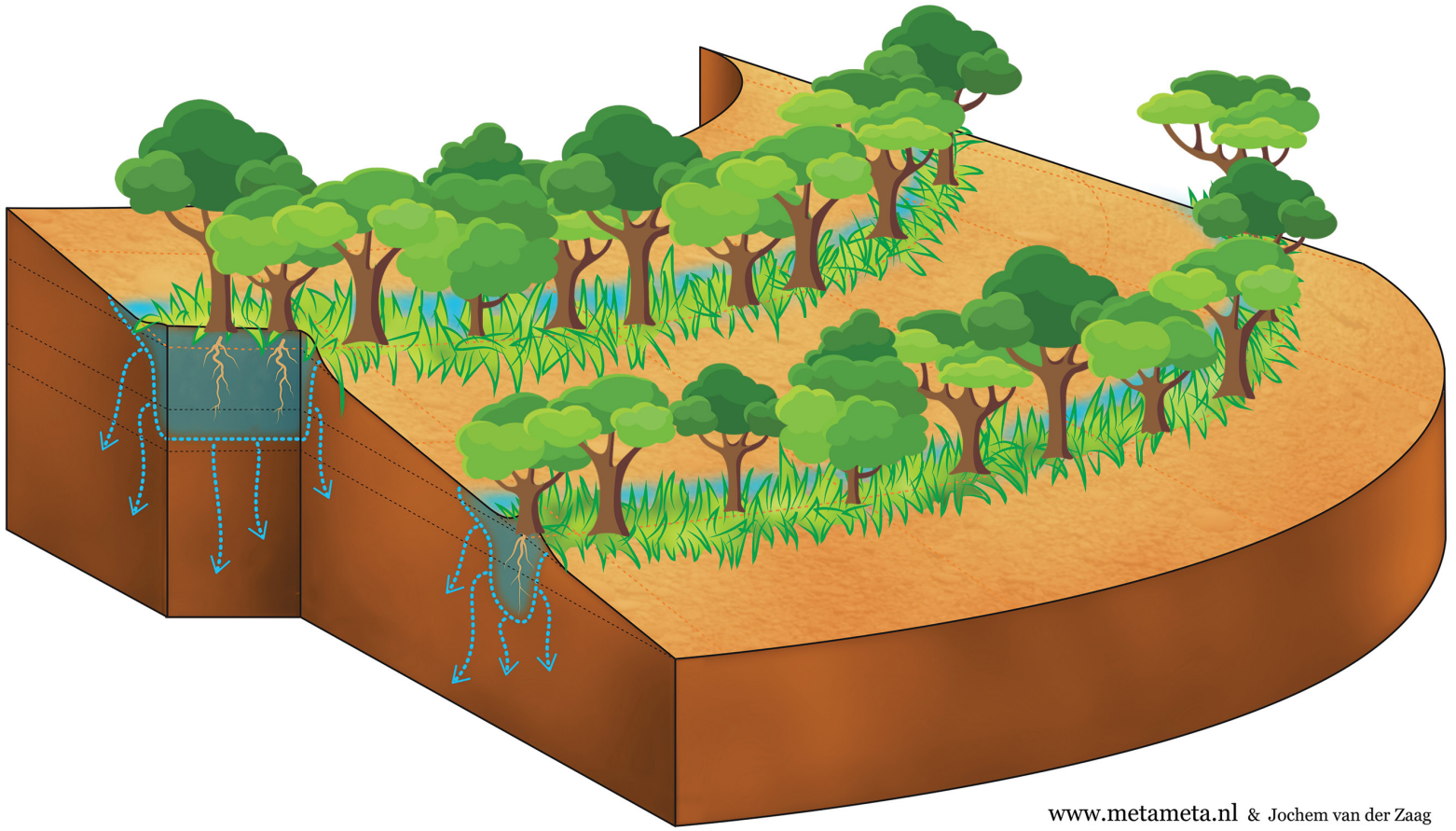
Water harvesting with roads can be implemented using a set of different techniques: earth dams (murram pits, pans and ponds, charco dams), water tanks (hemispherical tanks, cylindrical underground water tanks, berkads (excavated and lines tanks with cement, ferro-cement or concrete blocks), subsurface dams (floodwater passing roads, hand dug wells, weirs), runoff farming road (road engineering integrated with road water harvesting, bunds, check dams). Each of them has different material, labour and costs requirements.

Purpose

Water storage and water infiltration. Function: water retention and re-use.

Area/physical requirements	Construction requirements	Advantages	Limitations
• Especially suitable for arid and semi-arid regions. • Average seasonal rainfall needed to apply these practices is around 600 mm. • Geographical suitability: surface water storage and beneficial use of floods.	• The tools and materials depend on the chosen technique. • The most common requirements include sand, cement, stones, bricks, PVC pipes, water, lime, barbed wire, chicken mesh, transport, and labour.	• Increase in storage capacity of the local water buffer and a reduction of surface runoff.	• Water harvested from roads should be avoided to be used for drinking purposes since it could be polluted by motor oil, tar, rubber, etc. • Road-side structures such as culverts can turn into large gullies.

Agroforestry



Agroforestry

Introduction

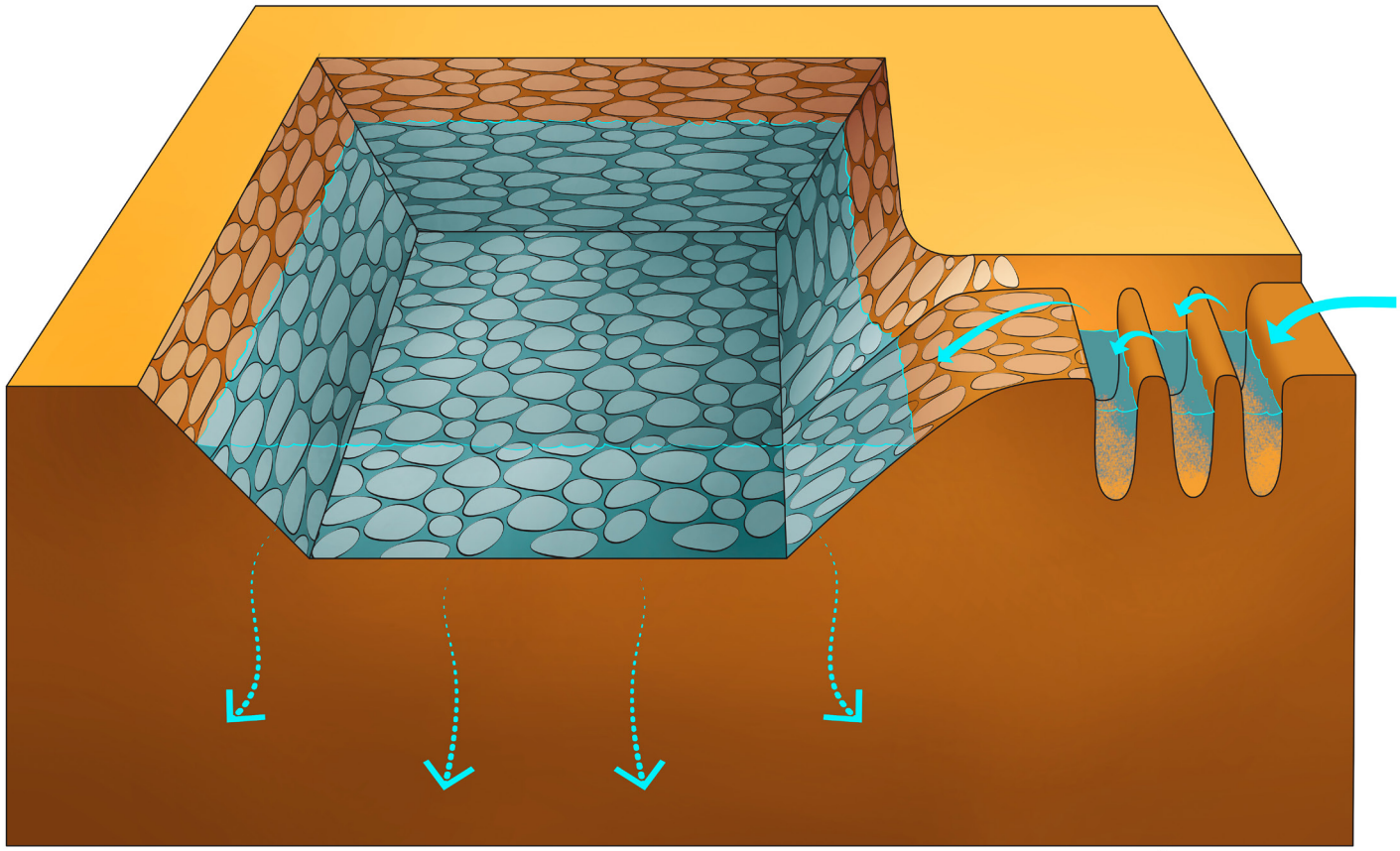
Farm forestry or agroforestry is a collective name for land-use systems and technologies where trees, shrubs, palms, bamboos etc are deliberately used on the same land-management units as agricultural crops and/or animals, in some forms of spatial arrangement or temporal sequence. It is a practice that acts as a buffer on periods of hardship, provided tree ownership is clear and market opportunities are at hand.

Purpose

It is a practice which can be used to stabilise slopes, influence the micro-climate, reduce erosion, provide with wind protection, and increase biodiversity. Function: soil conservation.

Area/physical requirements	Construction requirements	Advantages	Limitations
• Geographical suitability: agronomic measures and improved forestry practices.	• Labour: the timing of transplanting trees to make woodlots of windbreaks from the nursery to the field usually coincides with other agricultural activities. • Young plants must be protected from livestock • The type of trees must be chosen taking into account the local circumstances, including availability of moisture. • Fencing should be considered to avoid grazing of the vegetation.	• If indigenous tress is used, they do not need additional watering. • This system can provide with food, fodder, fuel, wood, etc. • Wind breaks.	• Precautions should be taken when considering planting Eucalyptus in water scarce environments. • Nurseries and young plants are susceptible to drought. • Some tree species withdraw water at a fast rate and might pose a threat to the water table. • Exposure to livestock, foraging for green areas, can damage the vegetation and prevent the trees from developing.

Infiltration Trench



Infiltration Trench

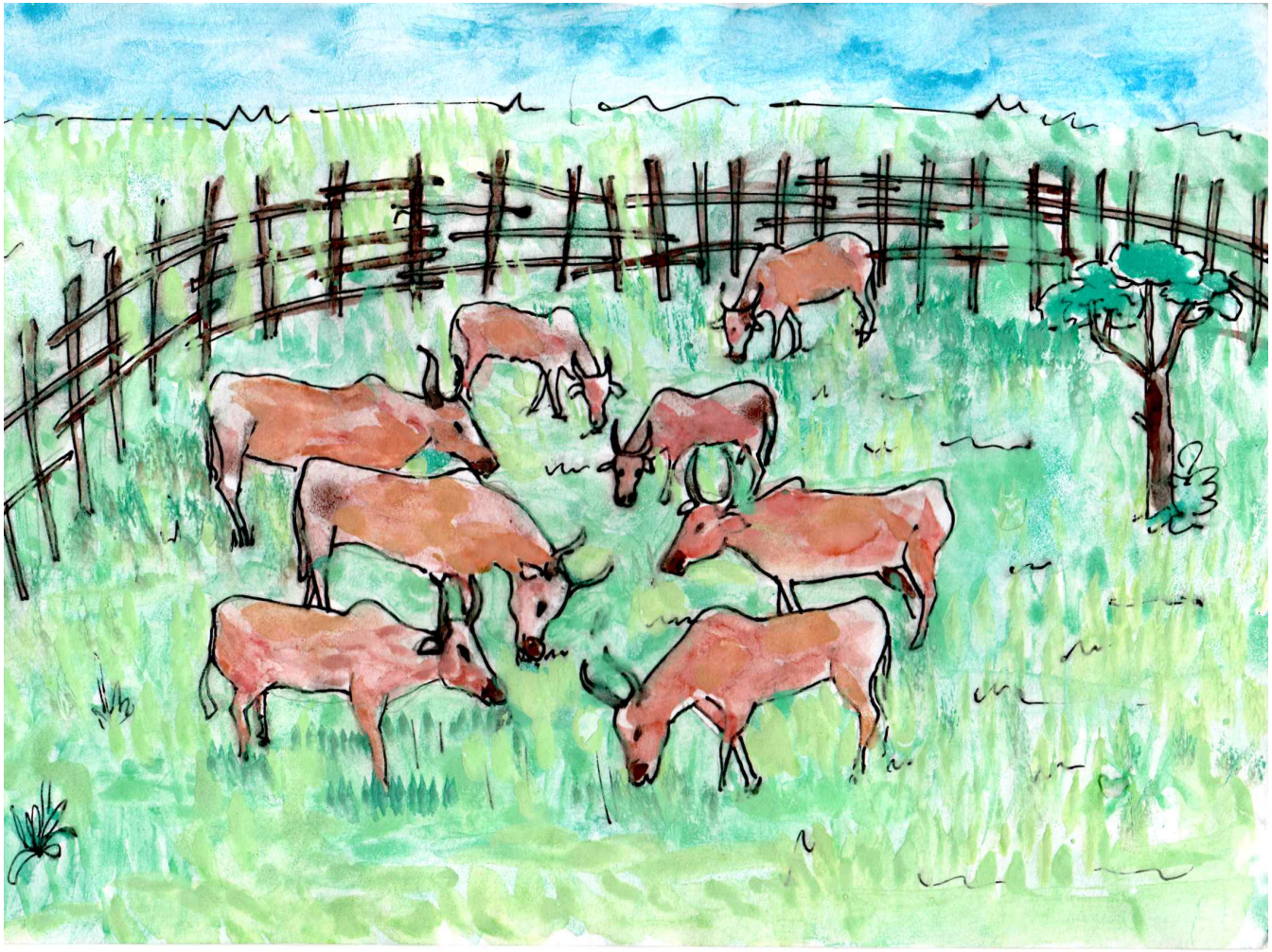
Introduction
Percolation ponds are used to capture runoff and augment the water buffering capacity of the region. They have similarities with contour trenches, but percolation ponds are specifically designed to capture runoff and recharge aquifers. They can be constructed alone or in series, in different shapes.

Purpose
Capture runoff and recharge aquifers.

Function
soil conservation and water recharge.

Area/physical requirements	Construction requirements	Advantages	Limitations
• Slopes between 10-25% • Do not excavate trenches across drainage ditches and streams. • Do not excavate trenches were there is already dense vegetation. • Ponds can be duged in every kind of landscape in which topography guarantees enough runoff. • They need to be built on pervious deep soils to guarantee the recharge of the underlying aquifer. • Geographical suitability: shallow groundwater recharge.	• Always start constructing trenches form the higher section of the field to be treated. • It is important to remove silt accumulated at the bottom 3-4 times per rainy season to guarantee proper infiltration. • Where the soil is erodible, it is suggested to reinforce the lateral walls to prevent erosion. • Suggested dimensions o Width – 50cm o Depth – 50cm o Length – 3 meter o Spacing between trenches – 1 meter	• The accumulated sediment when removed can be used to enhance the soil. • In between trenches you can prepare planting pits for multipurpose trees.	• Fine sediment accumulates at the bottom and has to removed frequently to prevent clogging. • Trenches can obstruct the movement of livestock and wildlife.

Intensive grazing



Intensive grazing

Introduction

Intensive controlled grazing, also called holistic planned grazing, is a practice that consist of allowing the cattle to graze on a small area for a short period of time. The idea is that this grazing pattern will improve the regeneration of all grasses and the capacity of the soil to absorb occasional rainfall.

Purpose

Increase the productivity and biodiversity of rangelands and dry savannahs and increase their capacity to increase carbon. Function: water recharge and micro-climate.

Area/physical requirements	Construction requirements	Advantages	Limitations
• Rangelands of dry savannahs. • Geographical suitability: agronomic measures and improved forestry practices.	• The creation of grazing schedules is key. It is needed to consider: (1) recovery periods rather than critical periods, (2) planning of grazing is done in critical periods, (3) the plan is carried out on a chart showing time, area and volume of herds. • Movable electric fencing might be required. Minimal capital input for movable fencing.	• Mature capping of soil decreases from 43% to 1% in some cases. • Over rested plants disappeared. • Unpalatable grass decreased from 86% to 46%.	• May interfere with traditional grazing practices. • It is a practice that requires flexibility, planning and shift in conventional thinking patterns. • Fencing, even with moveable electric barbed wire, carries a substantial cost.

Elephant grass

Elephant grass

Introduction

Elephant grass, also known as Napier grass, is a highly productive tropical grass and valuable forage. It can grow under a wide range of environmental conditions.

Purpose

The combination of erosion control and improved fodder quality and quantity, allowing improved livestock production. It can also be used as a windbreak for neighbouring crops.

Area/physical requirements	Construction requirements	Advantages	Limitations
• Rehabilitated land with floodwater access. • Minimum annual precipitation of 200mm. Optimum in rich and well drained soils.	• Land preparation before establishment is needed (furrows of planting holes). • Planting at the beginning until mid of the rainy season, with irrigation during the whole year. • Protection of elephant grass from grazing by roaming livestock during establishment (fencing) is needed. • Dense planting, with a staggered pattern between rows, is recommended for erosion control.	• Use for fodder grass. • Cut & carry system. • The root system prevents erosion and improve soil structure for increased water infiltration. • It can also add as a windbreak for crops or for indicating plot borders. • Contribution to a more reliable livestock fodder availability and to market income. • Improves the quantity and quality of fodder especially during the dry season.	• Need for sufficient soil moisture during establishment phase to develop the root system. • Sensitive to lack of water and waterlogging during establishment face. • Elephant grass does not withstand excessive flooding or waterlogging, especially in establishing phase. • Elephant grass doe does not withstand excessive grazing (needs fencing). • May outcompete native vegetation or encroach neighbouring cultivated areas without proper control.

Live check dam

Live check dam

Introduction

Live check dam is a practice which consists of the planting of drought tolerant Acacia plant species, elephant grass or other suitable species bound together across a gully bottom. It can be used combined with other measures such as, Water Spreading Weirs and Dry-Stone Measures. Usually, drought tolerant plants are used..

Purpose

Reinforce physical check dams.

Area/physical requirements	Construction requirements	Advantages	Limitations
• Highlands along gullies to reinforce physical check dams. • Specially used to reinforce Dry Stone measures.	• Can be applied by individuals and does not need the organization of a large group of people to undertake. • Use of drought tolerant woody perennial plants. • Establishment until mid-rainy season. • Replanting to achieve a continuous vegetation strip is needed.	• Contributed to increase the quantity and quality of fodder during the dry season. • Wood and non-timer products. • Reduces the velocity of water through the gully, thus reducing erosion.	• Narrow option of suitable species for live check dams. • Lack of experience form the beneficiaries on construction of live check dams. • Heavy floods might break live check dams. • Live check dams in shallow gullies might divert the flood and create new erosion at the sides. • Poor protection of the live check dams from animals' damage.

Enclosure/fencing

Enclosure/fencing

Introduction

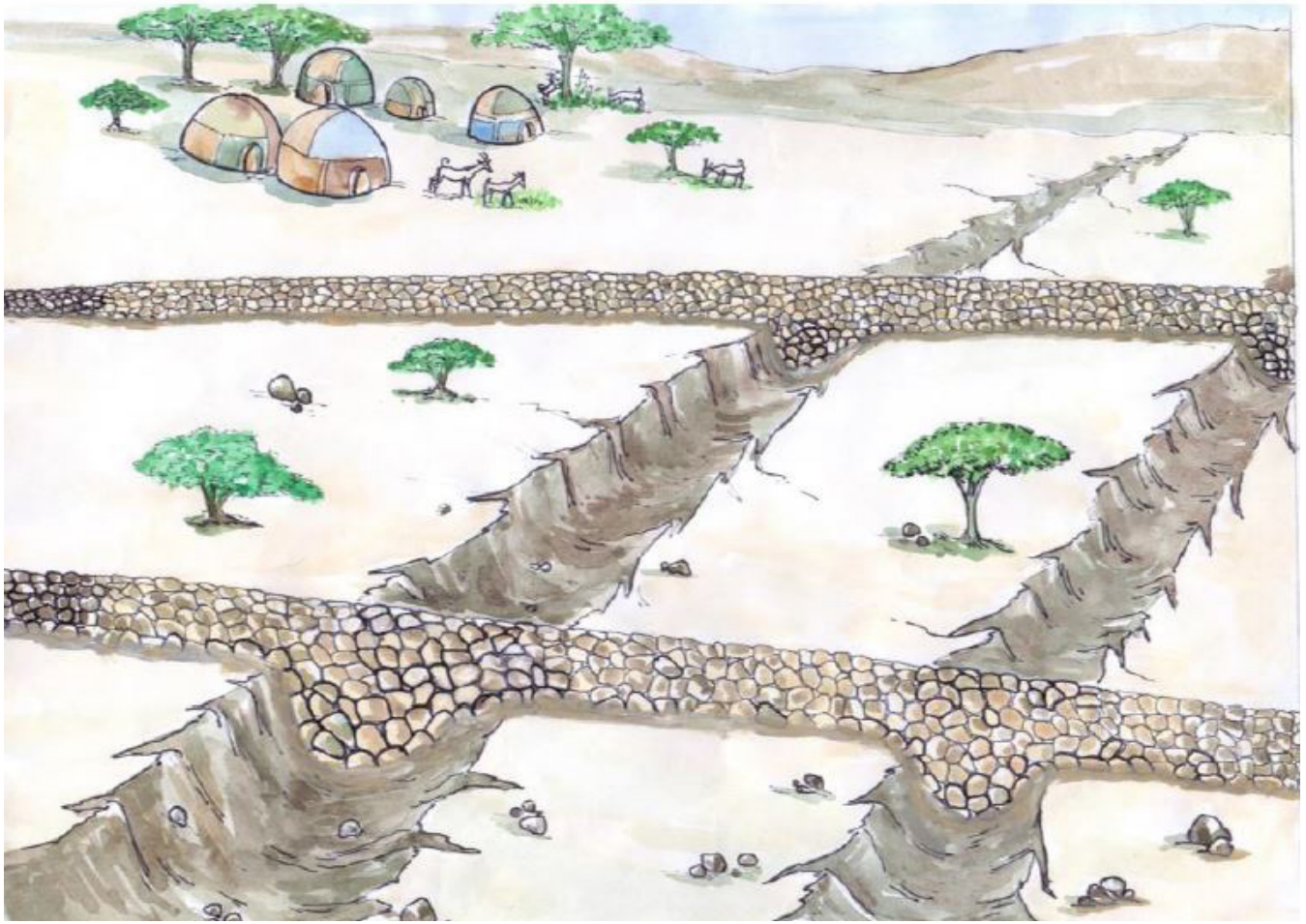
Enclosure or fencing is a practice that consists of the closure of a degraded area to exclude livestock and human interference to allow the establishment of planted crops or natural regeneration.

Purpose

Rehabilitation of indigenous vegetation or protection of food and fodder crops with the final purpose of productive use of rehabilitated land. It can also be used for protection for successful utilization of cooperative land.

Area/physical requirements	Construction requirements	Advantages	Limitations
• Around Water Spreading Weirs and Dry-Stone Measures. • Rangelands. • Applicable in areas where sufficient materials for sustainable closure implementation is available.	• To be implemented before the rainy season. • Monthly community meetings to survey regeneration progress, enforce use regulations and maintain the are enclosure is needed. • Management by the community must be strict.	• Increase of land productivity by execution of agricultural activities like cash crops, fodder, fruit trees and honey production. • The area can be used for cut & curry or controlled grazing.	• Period for re-establishment of vegetation, without additional soil and water conservation measures, might be considered too long by the community. • Conflicts may arise due to perception of all land being freely accessible as communal land. • Threat of deforestation without sustainable fencing concepts.

Dry stone measures



Dry stone measures

Introduction

Dry-Stone-Measures (DSMs are semipermeable rows of natural stones which does not contain cement. A dry-stone structure is built in a right angle to the water flow forming a horizontal line across a gully. They often used in cascades of multiple DSM rows and in combination with other measures.

Purpose

DSM spread and slow down the water flow and facilitate sedimentation behind the structure. Therefore, they prevent gully erosion over large areas of land. Plus, the sedimentation above the structure creates newly fertile soils which can increase food and fodder production.

Area/physical requirements	Construction requirements	Advantages	Limitations
• Dry areas with degradation on an early stage: • Terrains with slight lateral slopes • Horizontal lines • along riverbeds • Inside small gullies	• They are constructed with stones which can be easily found in the local environment. • They work best combined with biological protection.	• Biological protection is the cheapest and more sustainable way of firming the structure and making use of the infiltrated water and fertile sediment accumulated. • After the first rains happened and sedimentation takes place the risk of structure damage is minimized.	• DSM need more maintenance in the early stages, soon after construction. • Maintenance of the structure can only be done during the dry season.