Soil And Water Conservation Manual

Community Led Landscape Management Project

Meghalaya Basin Management Agency (MBMA)

THE WORLD BANK
SOIL AND WATER CONSERVATION MANUAL

I. SOIL AND WATER CONSERVATION ACTIVITIES:
Conservation of soil and water resources is important for sustainability of agriculture and environment. Soil and water resources are under immense pressure due to ever increasing population thereby ensuing growing demand for food, fiber and shelter. Soil and water resources are being deteriorated due to different anthropogenic and natural factors.

A. Land Development / Prevention of Soil Erosion

Soil Conservation is the name given to a handful of techniques aimed at preserving the soil. Soil loss and loss of soil fertility can be traced back to a number of causes including over-use, erosion, salinization and chemical contamination. Unsustainable subsistence farming and the slash and burn clearing methods used in some less developed regions, can often cause deforestation, loss of soil nutrients, erosion on a massive scale and sometimes even complete desertification.

Soil erosion removes the top soil that is necessary for organic matter, nutrients, micro-organisms that are requires for plants to grow and shine. Soil conservation is one such step that protects the soil from being washed away. The soil then ends up in aquatic resources bringing in pesticides and fertilizers used on agricultural land. Healthy soil is important for plants to grow and flourish. There are several ways to conserve soil that can be done through agricultural practices or measures you take at home.

Soil erosion is one of the several major deteriorative processes which results in deterioration of the soil. Soil erosion is removal of soil due to movement of water and/or air. Soil erosion may lead to the significant loss of soil productivity and thus may lead to the desertification under sever conditions. Water and wind are the major agencies which are responsible of soil erosion. Deforestation, over-grazing, mismanagement of cultivated soils, intensive cultivation and intensive urbanization are major factors triggering the soil erosion. For sustainable agriculture and environment, it is pertinent for the protection of soil resources against erosion. Different control measures should be adopted to protect the soil resources against erosion. The concept of soil conservation cannot be materialized without conserving and efficient use of water resources. It is therefore pre-requisite that soil conservation practices should be adopted. Soil conservation practice includes soil management, crop management, engineering structures, and forestry operation.

Benefits:

i. Increase in soil cover
ii. Provide permeable barriers
iii. Increase infiltration
iv. Maintain soil fertility
v. Stabilize mechanical structures
vi. Productive use of land occupied by conservation works
1. Bund
Techniques used in agriculture to collect surface run-off, increase water infiltration and prevent soil erosion.

**Purpose:** By building bunds along the contour lines, water runoff is slowed down, which leads to increased water infiltration and enhanced soil moisture.

**A. Peripheral Bund**
Bunds constructed along field boundaries without reference to contour. These bunds are formed at the margin of the field, road, river etc., to demarcate their boundary.

**Purpose:** They serve as fences, and give protection from water and wind erosion in low rainfall areas. They are not suitable in heavy rainfall areas but can be reinforced by vegetative coverage.

**Procedure:**
- i. This bund is constructed along the field boundaries.
- ii. Earth excavation around the field boundaries to prevent cattle grazing.
- iii. Plantation of live vegetation example, shrubs, trees beside the excavated bund.

**B. Contour Bund**
The bunds constructed exactly on contour or with permissible deviation from the contour, are called contour bunds. It is earthen embankments across the slope of the land, following the contour as closely as possible.

**Purpose:** acts as barriers to the flow of water, thus reducing the amount and velocity of the runoff.
B(i) *Earthen Contour Bund*

**Purpose:** To prevent soil erosion in a sloping terrain.

**Procedure:**
The soil is excavated and is filled at the lower portion to act as a contour bund.
B(ii) Loose Boulder Bund

**Purpose:** To prevent soil erosion in sloping terrain more than 15% by contour with boulder masonry.

**Procedure:**
The bund is constructed with boulder masonry with required depth and thickness as per site requirements.
2. Check Dam (Gully plug):
This is a small, temporary or permanent dam constructed across a drainage ditch, swale, or channel to lower the speed of concentrated flows for a certain design range of storms events.

**Purpose:** Are mainly built to prevent erosion and to settle sediments and pollutants.

**Procedure:**
The stone masonry wall is laid across the drainage with specific depth and thickness as per site requirements.

![Image of Check Dam (Gully plug)]

3. Erosion Control Gabion Check Dam

**Purpose:** Gabions are commonly used for Erosion Control, Gully Control and River Training works etc.

**Procedure:**

i. Earthwork is excavated as per site measurement.

ii. A rectangular wire mesh with required depth and thickness filled with boulder weighing not less than 25 kg is placed as per the required length.
4. Loose Boulder Check Dam

This is a small barrier constructed of rock, gravel bags, sandbags, fiber rolls, or reusable products, placed across a constructed swale or drainage ditch.

**Purpose:** These check dams reduce the effective slope of the channel, thereby reducing the velocity of flowing water, allowing sediment to settle and reducing erosion and can provide a ‘drought-proof’ water supply (from groundwater).

**Procedure:**

i. Earthwork is excavated as per site measurement.

ii. Boulder/ gravel bags/ or any other material suitable for constructing a check dam is placed as per the required measurement.
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ii. Boulder, gravel bags, or any other material suitable for constructing a check dam is placed as per the required measurement.

5. Erosion Control Gabion Wall

It is a retaining wall build of stacked stone-filled gabions tied together with wire. Gabion walls are usually battered (angled back towards the slope), or stepped back with the slope, rather than stacked vertically.

The life expectancy of gabions depends on the lifespan of the wire, not on the contents of the basket. The structure will fail when the wire fails. Galvanized steel wire is most common, but PVC-coated and stainless steel wire are also used.

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6. Halfmoon Terrace

Half moon terraces are used for planting of fruit and fodder trees in horticulture and agro forestry systems and made by cutting in half moon shape to create circular level bed having 1-1.5 m diameter.

**Purpose:** Also provides facilities for retaining moisture and easy application of fertilizers and manures for healthy growth of plants.

**Procedure:**

i. Cutting of soil is as per site requirement.

ii. Earth work is excavated in a half moon shape throughout its required length.

iii. The excavated earth is filled to the upper slope for cultivation.
7. Bench Terracing

Bench terracing is flat beds constructed by earthen embankments across the slope with cut and fills method and serve as barriers to break slope length and reduce the degree of slope. It can be adopted where soil depth more than 1m and can also be developed with vertical stone walling.

**Purpose:** To maintain top soils in terraces, construction should start from the foot hills.

**Procedure:**

i. For construction of bench terraces the cutting and filling should be started from the foot of the hill to the top.

ii. The vertical stone walling which acts as a river is constructed throughout the length of the terraces with a given height.

iii. Filling is made with the earth cut from the top position and it should be spread and level accordingly.

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![Bench Terracing](image)

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![Terracing](image)
8. **Slope Stabilization**

A system of permanent design measures used alone or in combination to minimize erosion from disturbed surfaces.

**Purpose:** To stabilize the soil, to reduce raindrop impact, to reduce the velocity of surface runoff, and to prevent erosion.

1. **Land Levelling**

This is a measure used in surface irrigation, such as basin and furrow irrigation. Levelling, smoothing and shaping the field surface is as important to the surface system as the design of laterals, manifolds, risers and outlets is for sprinkler or trickle irrigation systems. It is a process for ensuring that the depths and discharge variations over the field are relatively uniform and, as a result, that water distributions in the root zone are also uniform.

**B. Water Storage / Harvesting**

**Water conservation** is not a job that is just for the technician, soil scientist, hydrologist, forester, wildlife manager, plant scientist, city planner, park manager, farmer, rancher, or mine owner alone. It is a job for the everyday person who just likes to have access to the life sustaining resource of water. We must all recognize that water conservation really is our personal responsibility and not just leave it up to other people.

We must save water today so that it will be available to us tomorrow. We need to think of future generations, people who will not have a sufficient supply of water unless we become more concerned with how we use our water today. There are many things that we can do to help preserve water. These are not things that are hard. All it takes is a little bit of extra effort, and soon it will be second nature.

Conservation of water by building water harvesting structures such as check dams, wells, jalkund, micro-irrigation works etc to harvest or capture the rain water. Water collected could be stored for later use and recharged into the ground water again. Rain is primary water source for lakes, ground water and rivers are the secondary water source.

**Benefits:**

i. It can be used for drinking after filtered.
ii. It could be utilized for irrigation purposes.
iii. This water increases the underwater level
iv. It keeps from urban flood

1. **Contour Trench**

Construction of trenches on slope along contours to retain water and sediments transported by water or gravity down-slope generally constructed with light equipment.

**Purpose:** Contour trenches are used to break up the slope surface, to slow runoff and allow infiltration, and to trap sediments.

**Procedure**

i. The site should be clear from dirt, such as grass and vegetation.
ii. Soil excavation of 1.5m length, 0.6m width and 0.4m depth.
iii. Spacing of the trenches will depends on the slope of the site/topography of the area.
iv. The excavated soil should be placed downstream of the trenches.

v. The alignment of the trenches should be along the contour line as far as possible.

Contour Trenches

2. Reinforced Cement Concrete Check Dam

It is a permanent structure made to retain the water for future and difficult uses.

Procedure:

i. Earthwork is excavated as per measurement required in the site.

ii. Stone soling is laid on the excavated portion as per measurement.

iii. Reinforcement bars of required diameter are laid vertically and horizontally as per estimate.
iv. Shuttering for the structure is done before casting.

v. For casting reinforced cement concrete is used that is mixture of cement, sand and stone aggregate of desired proportion.

vi. The structure is left undisturbed 28 days for curing.

vii. After removal of framework that is, shuttering, plastering is applied with cement mortar.

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This manual was prepared by the Institute of Natural Resources; under the Meghalaya Basin Development Authority.
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4. Reinforced Cement Concrete Water Reservoir Tank

These are key water-related interventions with the potential to contribute to rapid improvements in the yields of rain fed crops. Water harvesting and small-storage technologies can also help provide water for domestic use, livestock, fodder and tree production, and – less commonly – fish and duck ponds.

**Purpose:** Water harvesting enables farmers to store water when it is plentiful and make it available when it is scarce.

Three categories of small-scale storage can be distinguished:

i. Soil moisture storage
ii. Groundwater storage
iii. Surface storage.

**Procedure:**

i. Earthwork is excavated as per measurement.
ii. Stone soling/stone masonry is laid on the excavated portion up to a required depth.
iii. Reinforcement bars of required diameter are laid vertical and horizontally as per estimate.
iv. Shuttering for the structure is done before casting.
v. For casting, reinforced cement concrete is used that is mixture of cement, sand and stone aggregate of desired proportion.
vi. The structure is left undisturbed 28 days for curing.
vii. After removal of formwork that is shuttering, plastering is applied with cement mortar in required proportion.
5. Dugout or Excavated Pond

*Dugout pond* is a rectangular shape subsurface pond with the excavated material forming an embankment downstream. It is constructed in the upper catchment of the watershed, along the rill/shallow gully. The site for the pond should be where there is a depression and high water table.

**Purpose:** Dugout ponds are usually taken up for water harvesting, storage of runoff.

**Procedure:**

1. Earthwork is excavated as per site measurement followed by proper levelling.
6. **Earthen Embankment with Cement Concrete Core Wall**

A raised structure (as of earth or gravel). It composed of suitable soils obtained from borrow areas or required excavation and compacted in layers.

The main advantages involved in the construction of Earthen Embankment are:

i. Local natural materials are used.
ii. Design procedures are straightforward.
iii. Comparatively small plant and equipment are required.
iv. Foundation requirements are less stringent than for other types of dam.
v. The broad base of an earth dam spreads the load on the foundation.
vi. Earth fill dams resist settlement and movement better than more rigid structures and can be more suitable for areas where earth movements are common.

**Purpose:** used especially to hold back water or to carry a roadway.

**Procedure:**

i. Earthwork is excavated as per site measurement
ii. Shuttering for the structure is done before casting.
iii. Plain cement concrete with coarse aggregate is provided in required thickness and depth of the wall
iv. Earth is filled on both faces of the wall.
Earthen Embankment with CC Core Wall

7. Earthen Embankment with Clay Core Wall
A raised structure (as of earth or gravel).

Procedure:-

i. Earthwork is excavated as per site measurement
ii. Shuttering for the structure is done before casting.
iii. Clay is filled up to a required thickness and depth of the wall.
iv. Earth is filled on both faces of the wall.
8. Earthen Embankment with Homogeneous Moderate Previous Earth Fill
A raised structure (as of earth or gravel).

Procedure:

i. Earthwork is excavated as per site measurement
ii. Earth filling with pervious earth to required depth and thickness.

9. Earthen Embankment with Cement Concrete Core Wall and Lining
A raised structure (as of earth or gravel).

Procedure:

i. Earthwork is excavated as per site measurement
ii. Shuttering for the structure is done before casting.
iii. Plain cement concrete with coarse aggregate is provided in required thickness and depth of the wall
iv. Earth is filled on both faces of the wall
v. Lining with random rubble stone masonry at both the faces of the wall with required thickness and depth.
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10. Filter Tank

Tank constructed for the purpose of treating the water are known as the filter tank. These structures are of different types with difference in the material used for construction, it can be constructed underground or above ground if constructed with cement concrete.

Procedure:-

i. Earthwork is excavated as per site measurement.

ii. Stone Soling is laid on the excavated portion up to a required depth.

iii. Cement Concrete work is laid on top of the stone soling up to proper depth.

iv. First class brick are laid as per estimated.

v. Plastering on the brickwork is followed as per required proportion.

vi. Gravel (20mm) is filled

vii. River sand is filled above gravel

viii. PVC pipe (3inch diameter) is fitted at the inlet and outlet of the filter tank.
11. Open Well
To tap the groundwater storage vertical hole of bigger diameter (2 to 10 metres generally) is some time dug or sunk in the rock or soil mass. The hole is sunk till it penetrates saturated underground material.

Procedure

i. Earthwork is excavated up to the level where water emerges.
ii. Stone masonry wall is constructed below the ground level and brick wall is constructed above the ground level.
iii. Applying cement mortar for plastering for brickwork only.
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Open Well
12. Micro Irrigation

Micro irrigation is defined as the frequent application of small quantities of water directly above and below the soil surface; usually as discrete drops, continuous drops or tiny streams through emitters placed along a water delivery line.
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Procedure:

Head work
i. Earthwork is excavated to a proper level.
ii. Stone soling of 100mm thick is laid in the foundation bed.
iii. Stone masonry are laid above stone soling at required height retain the water for irrigation.

Over Head Tank
i. Earthwork is excavated to a proper level.
ii. Stone soling of 100mm thick is laid in the foundation bed.
iii. Reinforcement bars of required diameter are laid vertically and horizontally as per estimate.
iv. Shuttering for the structure is done before casting.
v. For casting reinforced cement concrete is used that is mixture of cement, sand and stone aggregate of desired proportion.
vi. The structure is left undisturbed 28 days for curing.
vii. After removal of framework that is, shuttering, plastering is applied with cement mortar.
viii. PVC tank is placed at the overhead structure for water storage.
ix. GI pipe 50mm diameter is used to draw from the headwork to the supply tank to the field.

\[ a. \text{ Cement Concrete Weir} \]

![Diagram of the headwork and overhead tank](image-url)
b. Reinforced Cement Concrete Water Reservoir Tank

These are key water-related interventions with the potential to contribute to rapid improvements in the yields of rainfed crops. Water harvesting and small-storage technologies can also help provide water for domestic use, livestock, fodder and tree production, and – less commonly – fish and duck ponds.

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**Diagram:**

![Plan](image)

![Section AA'](image)
ACKNOWLEDGEMENT
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1. Training Manual Soil Conservation and Watershed Management Volume II And III
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3. Meghalaya Schedule Of Rate 2012-13 (Road and Bridges)
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