Gully assessment and prevention/control measures

Presentation Outline

- 1. Processes of soil erosion and gully formation
- 2. Occurrence and development of gullies
- 3. Assessment and mapping of gullies
- 4. Principles of gully prevention and control
- 5. Basic gully treatment measures (Physical and Biological measure)
- 6. Gully Related to Road Drainage
- 7. Gully as a RWH structure
- 8. Management/Maintenance and utilization of rehabilitated gullies
- 9. Observed changes and Impacts

1. PROCESSES OF SOIL EROSION AND GULLY FORMATION

Definition: a gully is a channel resulting from erosion and caused by concentrated but intermittent flow of water usually during and immediately following heavy rains

1. PROCESSES OF SOIL EROSION AND GULLY FORMATION Continued...

The principal effect of splash erosion is to detach soil

The principal effect of the other forms of erosion is to transport the detached soil

Based on the nature and extent/form of soil removal, wash erosion is classified as:

- sheet erosion
- rill erosion
- gully erosion
- stream bank erosion
- Land slumping / collapsing, piping, tunnelling

1. PROCESSES OF SOIL EROSION AND GULLY FORMATION Continued...

Rill Erosion:

Rill erosion is the removal of soil by running water forming shallow channels (<30cm depth) - "Maresha"

Rill erosion is regarded as a transition stage between sheet erosion and gulling

Gully Erosion:

- Is the removal of soil by running water
- Channels cannot be smoothened out completely by normal cultivation operation
- It is an advanced stage of rill erosion
- It is associated with accelerated and concentrated overland flow
- Cattle paths, earth tracks, dead furrows, tillage furrows, or other small depressions down a slope favour concentration of water

Gully advancing backwards b/c of waterway and traditional ditches – Gerchech, Zimac gully And the Contraction of the second second

Gullies in Tana Beles project areas – road drains

8/3/2015

Enkulal, Gelawdeos gully – " if we are on the moon"

Problem of under estimating, technology selection and dimensioning





Some of the gully control practices are like this in the field



Poor gully treatment exercise in Sekela, Lij Ambera - Mewale



Poorly designed and constructed road is a main cause of gully formation and its expansion!!!



Gully created as a result of the culvert – in Dhangego KA of Kersa



Gully from the culvert eating perennial crops (chat) in Dhangego KA of Kersa



Culvert not extended to the natural waterway – in Harla Belina KA





Alamata, Gira Kasso asphalt road and being a closed area and afforested is a good example of stable environment

2. Occurrence and development of gullies

- 2.1 Gully development process: A gully develops in three distinct phases ;
- a. Waterfall erosion /gully head advancement
- b. Channel erosion along gully beds side cutting typical of U-shaped gully
- c. Land-slide erosion on gully banks, sink holes, slumping, piping, tunneling



Drying and is attached to cracking i.e. Deep cracking



The soil collapsing as its get wet in the first rain



Classes of gully: gullies are classified under several xics a) Gully class based on size:

Gully classes	Gully depth (m)	Gully drainage area (ha)
(a) Small gully	< 1.5	< 10
(b) Medium Gully	1.5 to 3	10 to 30
(c) Large gully	> 3	> 30
Courses Themas 1007		

Source: Thomas, 1997

Gully stream ordering of finger/branch gullies



Cross-section of a gully





Classification of gullies continued...



U - Shoped gully

V - Shaped gully





Subsoil as resistent as topsail

Subsoil more resistant than topsoil



Effects of gully:

The effects of gully can be summarized as follows:

- Loss of productive land
- Dissection and fragmentation of land
- Reduced amenity and property values such as fences,...
- Silting up of storage dams, ponds, waterways and irrigation canals
- Silting up of fertile agricultural fields "Masachin Bemama Kumet Tekebere"
- Local lowering of the water table gullies suck water (NPC)
- Damage to infrastructures such as roads, bridges, culverts, buildings and irrigation or water supply schemes

Gully acting as moisture suction from the soil in deeper profiles





Gully threatening community well for water supply – Sekela, Lij Ambera



Gully tracking using GPS

Basic gully control measures continued...

Physical measures

Gully reshaping and re-vegetation Use of various types of checkdams Brushwood checkdam Loose stone checkdam Gabion checkdam Arc weir checkdam Organic gabion box checkdam Sand bag checkdam

Gully control measures continued ...



A. Gully reshaping and revegetation

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Basic gully treatment measures continued...

Most gullies expand by erosion caused from lateral runoff water entering through unprotected gully flanks



Basic gully treatment measures continued...



Gully planting & cultivation


Basic gully treatment measures continued...





- Trenches are excavated into the undisturbed soil profile and are therefore more stable than furrows
- Trenches do not collapse when walked on during watering period
- Trenches need not be constructed exactly in the contour line and therefore are more simple to construct – staggered
- Trenches harvest water and hold seedlings better than furrows
- Watering of seedlings in trenches is more efficient than watering of furrows

Basic gully treatment measures continued...



Looks very simple but amazing (Erosion control and water harvesting)



Plastic gabion filled with soils

Gabion checkdam filled with soil: These are gabion checkdams filled with soil which are good alternatives in areas where stone is not available – therefore, "*No complain!!!*" on









Loose stone checkdam with apron and parabolic spillway

Loose stone checkdams covered with bamboo mat

Gabion checkdam:

• Gabions are rectangular boxes varying in size and are mostly made of galvanized steel wire woven in to mesh.



• The boxes are tied together with wire and then field with stone and placed as building blocks.

- Gabion boxes are commonly used gully treatment, roadside protection, dam construction, river training, retaining wall, etc.
- Gabion checkdams are built by placing the galvanized wire boxes across gullies, "usually not higher than 1.5 m spillway height"

Gullies have got four distinctive parts:

Gully head



Gully bed

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Gully side wall



Live checkdams can replace physical structures after a while



Stabilizing physical structures with biological measures



Green gold behind the Gabion checkdam

Popular or willow sticks can be plugged in to the plastic for stabilization and additional biomass



Gully Related to Road Drainage

- Roads foot paths, cattle trafficking lines, cattle routs, small, medium, and big roads
- Watershed treatment and then road construction after???
- Do roads on the ridges only versus short cuts???
- By road construction we are creating intervention to the natural (stable) system
- Even here we can not harvest the whole water so control/ appurtenant structures are important
- In high R/F areas see off the runoff well to its mother water course
- There is evidence there is no problem on the approaching side, but on the leaving side
- Drain checks, catch drains, etc.
- Runoff diversion structures with all its auxiliary structures
- Gullies are major sources of sedimentation and infrastructural damages
- RWH from roads is a noble idea give priority to moisture stress areas "two flies in one slam"















\checkmark Cutoff drains should be properly connected to waterways



Waterways should be provided with scour checks and drop structures and covered with vegetation



a) Level



Chute for steep slopes



On the road from Kibuye to Kigali

15/11/2007

8/3/2015



What was the problem with these side drain checkdams?



Gully as a RWH Structure

Check-dams/gully plugging structures

- Mortar plastered gabion checkdams
- Arecwier checkdams
- Plastic gabion checkdams
- SS-Dams

Water harvesting check dam: is a check dam constructed in watercourses (i.e. rivers, streams, gullies) to harvest surface runoff.

Water harvesting check-dams are primarily built for two purposes :

- ✓ to provide direct irrigation when rains fail (diversions)
- to facilitate the recharging of surrounding wells and springs through percolation of water from check-dams (reservoirs).

Major requirements

To harvest water in a gully

- Treat the watershed properly and reduce the sediment load
- Put check-dams which can serve as sediment trapping structures on the upper parts of the gully
- Avoid water leakage through the foundation
- Select appropriate site: suitable reservoir and command areas

Emphasis for water harvesting: Creating catchment area



Existing experiences:



Bamboo mat (left) and soil filled (right) gabion check-dams

Cont'd



Small barriers having tremendous effect in harvesting water

Arcweir checkdams

- Arc-weir is a structure made up of stones connected with mortar of cement and sand
- When properly constructed, it is highly resistant to greater water pressure
- The structure is very susceptible to damage as a result of runoff coming with boulders
- From technical and economic point of view its importance for gully rehabilitation is very limited


Site / place for arcweir checkdam Alekt-Wenz

Proper foundation is important for archweir construction





Gravel filling in the foundation



The checkdam should be locked to each side of the gully



Watering is necessary until it finishes its curing period



Properly constructed archweir with apron A lot of sediment is trapped already and hence it is possible to plant on it

• Disadvantages of arch weirs:

- Need cement and special tools for masonry
- Need experienced masons/builders
- Need sand (sometimes difficult to get in the highlands)
- Regular shapes of stones are required (square or flat, not round)
- They are not cheap to build

Arc-weir structures have multiple functions

- They trap sediment and create new land in a gully
- · Harvest water/moisture in the soil/sand
- Recharge ground watertable and maintain base flow







Estimating the stored water volume :

- Length = 40m
- Av. Width = 5m
- Av. Depth = 2m

• Volume = 40*5*2 = 400m3 This is more than the volume of 3 HH ponds

Gabion check-dams for water harvesting

Gabion check dams are used to plug gullies In addition they can be used for water harvesting if plastered with cement



Gully as an opportunity rather than a threat























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Observed/measured changes and impacts

Look the changes: Awzet gully, Farta woreda



March 2012

August 2013









March 2012

August 2013



March 2012: Trainees presenting outputs

August 2013: Impact on water harvesting and biomass production





Even simple structures (brushwood) have pivotal role in rehabilitating the gully

Gully treatment in Farta, Alekt Wenz CW







Impact studies – hydrological monitoring


Achivements continued...

Number of observations and samples in MMP 2009 – 2012

	2009	2010	2011	2012	Total
Staff	3132	11812	12409	12125	39478
Turbidity	3131	12069	12469	12340	40009
Rain	3116	>12777	>15000	>15000	>47000
Flow					>500
Sed samples	1425	4176	3237	2873	11711

Achievement: Significant hydrological database (Excel and HYDATA) housed at BoWRD

Sediment concentration analyses and results





Indicator 1: Does Sediment Concentration decrease?

Mmaximum monthly average
sediment concentraion from
14 g/l in 2010 to 8 g/l in 2012)
≈ 43%

Achievement: Proof that watershed management and gully plugging works! n = 11711 Can watershed management....







Examples in Ethiopia-"Arego" from Kombolcha to Dessie on the left side





Model Watershed Development

10.00







Maccaferi Gabions





Prevention is better than cure

Vision for gully rehabilitation



PROTECT AND ENJOY THE LANDSCAPE !!!

Prevention is better than cure

THANK YOU

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